Caltrans District 6 & 10 Forecasting On-Call
Model Estimation, Calibration, and Validation
Wednesday, April 12, 2017
2:00 pm – 4:00 pm – On-line Meeting*

(reserved 2hrs to allow Q&A, with primary content targeted at 1hr)

1. **Introductions – 5 minutes**
   - Caltrans D6, D10, HQ
   - Amador, Calaveras, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, Tulare, Tuolumne
   - Consultants

2. **Questions on Homework Assignment – 10 Minutes**

3. **Overview – 10 Min**
   - Model Data
   - Estimation
   - Calibration
   - Validation

4. **Model Estimation – 20 Min**
   - Sample Size and Household Survey Weighting
   - Sub-Models
   - Implementation

5. **Model Calibration – 10 Min**
   - What to adjust, why, and by how much
   - Rules of thumb

6. **Model Validation – 20 Min**
   - Static and Dynamic Tests
   - Requirements vs Guidelines
   - Criteria
   - Competing objectives or conflicting data

7. **Other Items and Wrap Up**

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https://global.gotomeeting.com/join/534416733

Use your microphone and speakers (VoIP) - a headset is recommended. Or, call in using your telephone.

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Access Code: 534-416-733

Caltrans District 6 & 10 On-Call Training: Model Estimation, Calibration, and Validation

April 2017

WC15-3287 .013

FEHR PEERS

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INTRODUCTION AND OVERVIEW

This document serves as a reference for the calibration and validation of travel demand models. It contains descriptions of best practices for model calibration and validation, as well as documentation of the data and processes of estimation, calibration, and validation of the SJV MIP2 models specifically. The latter documentation serves as a case study, illustrating both best practices and practical contexts in which those best practices may or may not be followed.

Table 1 summarizes some of the most important issues and questions that come up in the context of model calibration and validation, and contains references to the relevant sections of the document where further information can be found.

TABLE 1 SUMMARY OF MODELING CAUTIONS

Caution	Reference
Household travel surveys can be useful for estimating a variety of travel model components. They gather data on travel made by a region's residents, usually based on travel diaries which detail all trips made – regardless of travel mode – by all household residents throughout an assigned travel day. For models which focus on person-trips made by all modes, household travel surveys are likely the best source of data for model estimation and calibration. However, for models based solely on vehicle trips, a household travel survey will contain a large amount of data which is not relevant to the model, and may therefore be more difficult to use for this purpose than other simpler data sources such as traffic counts. It should also be noted that household travel surveys measure only travel made by residents of the region being surveyed, and exclude travel made by visitors as well as commercial travel, both freight and smaller vehicles such as deliveries.	***Household Travel Surveys***
Only household-level weights were recalculated for use in estimation of the SJV MIP2 models. For some model development or calibration purposes it might be desirable to use individual-level variables such as gender, age, or ethnicity. In this case it would be advisable to further re-weight the CHTS data so that these variables also match control totals from the ACS or other appropriate sources.	***Weighting of Household Travel Survey data***
For purposes of model estimation, it may be desirable to include data from a wider region than the simply the model area. Reasons to expand the estimation dataset to pool data from other regions include: • The region being modeled might be changing in character, in which case it is advisable to include data from a region more similar to what the model region is becoming. • The model region may not contain a large enough sample of households or trips of certain types which may nevertheless be important to the model development process. Trips made by transit or bicycle are frequently sparse in household survey data, yet these trips may be important to include if the model is to adequately represent these modes. In this case, it is advisable to include data from a similar region to increase the number of households or trips with the desired characteristics.	***Pooling Data***

TABLE 1 SUMMARY OF MODELING CAUTIONS

Caution	Reference
An important trade-off to be aware of using Census data is that this data is generally available at relatively small geographic units, and it is also often available with multiple variables cross-classified simultaneously. However, it is generally not possible to get both: the more cross-classified variables are desired, the larger the geographic unit must be used, and the smaller the geographic unit desired, the fewer variables can be examined simultaneously.	***ACS and Census Data***
Auto availability models, sometimes specifically described as auto ownership models, are discrete choice models which predict each household's access to automobiles. For models based on person-trips which generate trips in all modes, this component can be an important part of the travel model process. For models based on vehicle-trips, auto availability models are generally not needed.	***Auto Availability models***
Models may generate trips in units of person-trips, modeling all trips made regardless of travel mode. If the model is intended to help answer questions about transit and active modes, or trade-offs made between these and auto modes, generating person-trips will be necessary. Alternately, some travel models may generate only vehicle trips, focusing the model specifically and solely on vehicular travel. A third option is to generate person-trips, but only for trips made by auto modes. This approach can be useful if the model will be used to answer questions about carpooling or HOV lanes, but is not needed for transit or active modes. When estimating, calibrating, or validating trip generation models, care must be taken to keep the units of the model (whether person-trips, vehicle-trips, or person-trips by auto modes) consistent with the units of the estimation or validation data.	***Trip Generation models***
Modeling trip rates for the non-residential end of a trip is generally a tricky process. In an ideal world, trip attractions (and non-home-based productions) would be estimated based on land use, since this is how the model will be used. In practice however, it is not common for household travel surveys to include land use data, and where such data is available the surveys are rarely weighted to reflect control totals for this data the way they are for residential data. For this reason, non-residential trip rates are frequently estimated in a much coarser and more aggregate fashion than residential trip rates.	***Attractions and non-home-based productions***
Estimation of gravity models for trip distribution is primarily a matter of first defining an impedance function which describes the time, distance, cost, or other impedances involved in travel between zones, and second calculating friction factors which govern the relationship between impedance and the resulting number of trips between zones. As with other model components, care must be taken to define impedance functions and estimate friction factors from data which uses the same units (person-trips, vehicle-trips, or person-trips by auto) as are used within the model's trip distribution component.	***Trip Distribution models***
Model validation results will help to determine how well the model performs at different geographic scales and for various metrics. When a model does not pass all of the static validation tests, it can be helpful to search for explanations -- eg not having a common base year for model inputs and travel behavior data, differences in TAZ structure, network data quality, or quality of land use input data. To help identify or target sub-regional areas that may require more refinements, users should review maps of daily validation locations. Any applications forecasts should also use an appropriate forecasting approach as described by National Cooperative Highway Research Program (NCHRP) Report 255 or 716 rather than using model forecast volumes directly.	***Model Validation***

DATA FOR TRAVEL MODELS

Fundamental to the development and use of any travel model is data related to travel patterns in the model region. This section describes sources of data used in the SJV MIP2 models as well as other sources of data to consider when calibrating and validating travel models.

HOUSEHOLD TRAVEL SURVEYS

Household travel surveys can be useful for estimating a variety of travel model components. They gather data on travel made by a region's residents, usually based on travel diaries which detail all trips made – regardless of travel mode – by all household residents throughout an assigned travel day. For models which focus on person-trips made by all modes, household travel surveys are likely the best source of data for model estimation and calibration. However, for models based solely on vehicle trips, a household travel survey will contain a large amount of data which is not relevant to the model, and may therefore be more difficult to use for this purpose than other simpler data sources such as traffic counts. It should also be noted that household travel surveys measure only travel made by residents of the region being surveyed, and exclude travel made by visitors as well as commercial travel, both freight and smaller vehicles such as deliveries.

The SJV MIP2 models were estimated using data from the 2012 California Household Travel Survey (CHTS), which surveyed travel from over 40,000 households throughout the state. In addition, this data was used to calibrate many components of the individual models. The publically available version of the 2012 CHTS required a substantial amount of preparation, including re-weighting, before being usable for model development. Details of the data preparation can be found in *Appendix A: Preparation of California Household Travel Survey Data*. Data dictionaries for the cleaned and prepared CHTS data, including households, trips, and persons files, can be found in *Appendix B: California Household Travel Survey Data Dictionary*.

PREPARATION AND CLEANING OF CHTS DATA

Portions of the CHTS data preparation most relevant to model development are described briefly below; for full details please see the appendices.

Weighting of Household Travel Survey data

Surveys are meant to capture the characteristics of an entire population by randomly sampling a small proportion of the population. Often, a perfectly random sample is hard to achieve–some groups are difficult to survey and are underrepresented, while other groups are over represented. To balance this bias, sample weights are estimated to 'reshape' the sample. For purposes of estimating the SJV MIP2 models, CHTS sample weights were estimated to balance the survey sample to match county-level percentages for several variables as reported in the 2012 American Community Survey 5-year estimates. Variables that appear in components of the SJV MIP2 models were selected to be used as controls for the re-weighting:

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

Note that only household-level weights were recalculated for use in estimation of the SJV MIP2 models. For some model development or calibration purposes it might be desirable to use individual-level variables such as gender, age, or ethnicity. In this case it would be advisable to further re-weight the CHTS data so that these variables also match control totals from the ACS or other appropriate sources.

Identification of Trip Purposes

The 2012 CHTS data does not describe trip purposes directly; instead it contains a "place" file whose attributes include a listing of up to three activities that the respondent participated in at that place. This activity information was first distilled into a small list of place purposes: HOME, WORK, COLLEGE, K12, SHOP, or OTHER. Each trip was then assigned a purpose such as home-based work, home-based K12, work-based other, and so on, based on the place purposes of each trip end.

Identification and Consolidation of Transit Trip Chains

In recording transit trips, the CHTS treats each portion of the transit trip chain as a separate trip. For example, a trip in which the traveler drives to a rail station, takes the train to a second rail station, and then walks to a workplace would be listed in the survey as three separate consecutive trips, with three separate modes. This method of record-keeping makes it possible to track the mode of access and egress for a transit trip, but for most travel behavior analyses it is preferable to consider these three trips as a single unit. Thus, a necessary step of data preparation is to identify and consolidate these chains which make up a single transit trip. Details of this process can be found in *Appendix A: Preparation of California Household Travel Survey Data*.

Census Place designation

Census Designated Places are a useful identification which includes cities as well as unincorporated but named places. The process of identifying a Census Designated Place for each location was made slightly more complex by the fact that the publically-available CHTS data is geo-coded only by census tract. Because the boundaries of Census Designated Places do not match neatly to census tracts, each census tract may have multiple Places associated with them. In cases where multiple Places make up a single census tract, the place with the largest population in the tract (as identified at the census block level) is used. If the largest population in the tract is outside all named Places, then the place is identified as an unincorporated portion of the relevant county.

Place Type

In addition to locating households and trip ends using census tracts, census designated places, and counties, each household location and trip end is also assigned a place type category. The place type is based on the number of jobs and the working-age population that are accessible from the household or trip end. These accessibility metrics are available as part of the EPA Smart Location Database (http://www2.epa.gov/smartgrowth/smart-location-mapping#SLD), and are weighted so that nearby jobs and population are more influential than further-away jobs and population. The resulting sum of accessible jobs and potential workers are categorized into place types as follows:

1. Under 40,000 jobs + workers
2. 40,000 – 100,000 jobs + workers
3. 100,000 – 200,000 jobs + workers
4. 200,000 – 450,000 jobs + workers
5. Over 450,000 jobs + workers

"Work" trips made by non-workers

The CHTS collects both employment data for each participant and trip purpose data for all trips undertaken. However, the survey does not ensure that these values are in agreement with one another. In particular, a small number of persons surveyed have an employment status which is either not reported, or is reported as "retired" or "unemployed", yet who make trips which are nevertheless categorized as work trips. Because this misalignment is not optimal for modeling purposes, any work trips made by a non-employed person were re-categorized for model development purposes; HBW trips are re-assigned to be HBO trips, and WBO trips are re-assigned to be OBO trips.

POOLING DATA

For purposes of model estimation, it may be desirable to include data from a wider region than the simply the model area. Reasons to expand the estimation dataset to pool data from other regions include:

- The region being modeled might be changing in character, in which case it is advisable to include data from a region more similar to what the model region is becoming.
- The model region may not contain a large enough sample of households or trips of certain types which may nevertheless be important to the model development process. Trips made by transit or bicycle are frequently sparse in household survey data, yet these trips may be important to include if the model is to adequately represent these modes. In this case, it is advisable to include data from a similar region to increase the number of households or trips with the desired characteristics.

For estimation of the SJV MIP2 models, these reasons prompted the decision to expand the set of CHTS data used for model estimation to include not only the eight SJV counties but also the six SACOG counties. Households whose travel diaries were completed on weekends were excluded from the estimation set. The distribution of households in the estimation dataset for the SJV MIP2 models is listed Table 2. Note that the table shows the (unweighted) number of households in the estimation set and the full CHTS, while the percentage in the final column represents the (weighted) proportion each county's households contribute to the final estimation set.

TABLE 2 CHTS DATA USED IN ESTIMATION OF SJV MIP2 MODELS

County	Households in Estimation Set	Total households in CHTS	Total households in County (2012 ACS)	Percentage of Estimation Set
Fresno	718	1,115	287,082	14%
Kern	961	1,544	253,178	12%
Kings	199	293	40,767	2%
Madera	205	311	42,063	2%
Merced	297	474	74,496	3%

TABLE 2 CHTS DATA USED IN ESTIMATION OF SJV MIP2 MODELS

County	Households in Estimation Set	Total households in CHTS	Total households in County (2012 ACS)	Percentage of Estimation Set
San Joaquin	468	629	213,632	12%
Stanislaus	383	552	165,999	8%
Tulare	537	799	129,996	6%
Sacramento	567	825	512,496	25%
El Dorado	151	208	67,846	2%
Placer	290	385	131,775	7%
Sutter	130	168	31,635	2%
Yuba	137	205	24,133	1%
Yolo	186	246	70,090	4%
Total	**5,229**	**7,754**	**512,496**	**100%**

CHTS SUMMARIES

Several broad summaries of CHTS data were produced and are suitable both for model development and for general information. Separate summaries were produced for the fourteen-county estimation region, the eight-county San Joaquin Valley region, the three-county Three County Model region, and each of the eight SJV counties individually. The "simple" and "flat" summaries contain one record per geography, and is suitable for joining to GIS. The "simple" summary contains a smaller number of metrics, while the "flat" summary contains many more details. The "filterable" summary contains many records per geography, and can be viewed in Excel. Details and data dictionaries for these summaries can be found in *Appendix C: Simple Summaries of CHTS Data*, *Appendix D: Flat Summaries of CHTS Data*, and *Appendix E: Filterable Summaries of CHTS Data*.

CHTS SIMPLIFIED DATA

In addition to being useful for model estimation, calibration, and validation, the California Household Travel Survey data is useful for a wide range of other purposes. To that end, we have provided simplified versions of CHTS data together with instructions for processing that data in Excel. The format is designed to be flexible, easy to use, and able to produce a variety of commonly-requested summaries such as mode shares, trip lengths and origin/destination tables. More information about the simplified data, and instructions for using it in Excel, can be found in *Appendix F: Simplified CHTS Data*.

ACS AND CENSUS DATA

The decennial census and the American Community Survey are a standard source of demographic data including numbers of households, household size, household income, and so on. This data can be used for a variety of model estimation and validation purposes, as well as to help create a set of inputs for running the travel model.

An important trade-off to be aware of using Census data is that this data is generally available at relatively small geographic units, and it is also often available with multiple variables cross-classified simultaneously. However, it is generally not possible to get both: the more cross-classified variables are desired, the larger the geographic unit must be used, and the smaller the geographic unit desired, the fewer variables can be examined simultaneously.

In the SJV MIP2 models, the 2010 Census were used for household totals and the 2013 American Community Survey 5-year estimates (ACS) data were used to update the land use cross classification tables, using the finest available geography. Most required data were available at the level of census block group or census tract, but a few multi-dimension tables were only available at the Public Use Microdata Sample (PUMA) level. It should be noted that these cross-classification tables are **ONLY** used in a percentage format. The control totals for demographic variables including total population, total numbers of households, and total number of residential units are provided at traffic analysis zone (TAZ) level by each MPO/County. The base year for the TCM is 2008. Some of the other SJV MPOs have opted to update model base years to 2014 under separate contracts, which as noted above is desirable to improve the model's ability to replicate observed conditions. Regardless of the model base year, 2013 ACS cross-classified tables are used to have more recent representation of demographic characteristic of each TAZ. Once each MPO/County provides recent demographic data at the TAZ level, the control total can be easily updated to a new base year.

ACCESSIBILITY METRICS

For some travel models, it may be desirable to incorporate built environment ("D variables"), particularly including accessibility. Sources for this data include the EPA Smart Location Database (SLD): https://www.epa.gov/smartgrowth/smart-location-mapping.

The SJV MIP2 models make use of several accessibility variables, described in Table 3.

TABLE 3 ACCESSIBILITY METRICS USED IN SJV MIP2 MODELS

Metric	Description	Where used
EMP_30AUT	Jobs within 30 minutes by auto	Place Type calculation
WRK_30AUT	Working-age population within 30 minutes by auto	Place Type Calculation
ATYPE	Place Type categorization of job+worker to five categories. (See Table 3).	Trip Generation
LOG_EMPD	Log of employment density (jobs per developed acre)	Auto Ownership, Mode Choice
INTDEN	Intersection density (intersections per square mile)	Auto Ownership, Mode Choice
EMP_30TRN	Jobs within 30 minutes by transit	Auto Ownership, Mode Choice
COMMUTECOST	Average annual commute cost	Auto Ownership

Place type is calculated from the sum of jobs within 30 minutes by auto and working-age population within 30 minutes by auto, and categorized into the five categories listed in Table 4.

TABLE 4 PLACE TYPES

Place Type Category	Alternate Name	Description
1	POP1	Under 40,000 jobs + working-age population within 30 minutes by auto
2	POP2	Between 40,000 and 100,000 jobs + working-age population within 30 minutes by auto
3	POP3	Between 100,000 and 200,000 jobs + working-age population within 30 minutes by auto

4	POP4	Between 200,000 and 450,000 jobs + working-age population within 30 minutes by auto
5	POP5	Over 450,000 jobs + working-age population within 30 minutes by auto

A full data dictionary of the accessibility metrics calculated in the model can be found in *Appendix H: Accessibility Variables*.

MODEL ESTIMATION

AUTO AVAILABILITY MODELS

Auto availability models, sometimes specifically described as auto ownership models, are discrete choice models which predict each household's access to automobiles. For models based on person-trips which generate trips in all modes, this component can be an important part of the travel model process. For models based on vehicle-trips, auto availability models are generally not needed.

The vehicle availability model is a disaggregate multinomial logit model which predicts the probability of a household owning 0, 1, 2, or 3, or 4+ vehicles based on the following variables:

TABLE 5 VARIABLES IN SJV MIP2 VEHICLE AVAILABILITY MODELS

Category	Variable	Description
Cost Variable	Commute Cost Ratio	Average annual commute cost divided by household income
Accessibility Variables	Intersection Density	Intersections per square mile
	Transit Accessibility	Jobs within 30 minutes via transit
	Employment Density	Log of (jobs per developed acre)
Household Demographic Variables	Household Size	See size categories in table 3.2-5
	Household Income	See income categories in table 3.2-6
	Household Residential Unit Type	See residential unit type groups in table 3.2-4

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

TRIP GENERATION MODELS

Fundamental to any travel model is trip generation, which models how many trips are being made within the model region. Models may generate trips on a scale of person-trips, modeling all trips made regardless of travel mode. If the model is intended to help answer questions about transit and active modes, or trade-offs made between these and auto modes, generating person-trips will be necessary. Alternately, some travel models may generate only vehicle trips, focusing the model specifically and solely on vehicular travel. A third option is to generate person-trips, but only for trips made by auto modes. This approach can be useful if the model will be used to answer questions about carpooling or HOV lanes, but is not needed for transit or active modes. When estimating, calibrating, or validating trip generation models, care must be taken to keep the units of the model (whether person-trips, vehicle-trips, or person-trips by auto modes) consistent with the units of the estimation or validation data.

The SJV MIP2 models generate person-trips from a consistent set of land uses, using cross-classified residential data, for a number of purposes including non-home-based purposes, K-12 and College trip purposes, and generate small, medium, and heavy truck trips. We have re-estimated trip generation rates, excluding truck rates, with the new CHTS data. The most significant changes in trip generation as compared to original VMIP are:

- Trip generation considers accessibility via the place type variable described in Accessibility / D variables.
- Non-home based trip generation is based on the new categorization of employment,
- Following trip generation, HBW trips are expanded into three new categories: HBW-High, HBW-Medium, and HBW-Low. These categories are based on household income on the production side and proportions of worker incomes for each employment category on the attraction side.
- Following trip generation and HBW expansion, trips are classified as ii, ix, or xi based on percentages calculated from CHTS data. These percentages are calculated by trip purpose and by Census Designated place.

HOME-BASED PRODUCTIONS: CROSS-CLASSIFICATION MODELS

Three of the home-based trip productions (HBW, HBS, HBO) were estimated using cross-classification models. These models are applied to SED data which has been cross-classified by four variables: household size, household income, residential unit type, and place type (as described in section Accessibility / D variables).

Estimation of trip rates using cross-classification models must ensure that all cross-classification groups have large enough sample size to produce sufficient variability to obtain a stable average trip rate. Because not all cross-classifications of the variables above do in fact have a large enough sample size, some cross-classifications were estimated in aggregate, resulting in identical trip rates being estimated for some cross-classification combinations.

Variables were added to the cross-classification model sequentially, and with each added variable existing groups were only subdivided if there was sufficient sample size (generally at least 40 households) to support a split. The order in which variables were added to the cross-classification models was as follows:

- Household size
- Household income
- Place Type
- Residential unit type

Although the model is coded to allow for five income categories and five place types, the data available did not allow for distinctions to be determined this finely -- either because of a lack of sufficient amount of data, or differences which weren't statistically significant, or both. In effect, this means that the estimated trip rates differ only among three income categories: low (under $50,000), medium ($50,000 - $100,000), and high (over $100,000); and only between two groups of place types: types 1 and 2 (with fewer than 100,000 workers+jobs within a 30 minute auto trip); and types 3, 4, and 5 (with more than 100,000 workers+jobs within a 30 minute auto trip). In addition, only a few combinations of household size, household income, and place type yielded different trip rates by residential unit type.

HOME-BASED PRODUCTIONS: SCHOOL PURPOSES

The remaining home-based trip productions, HBK and HBC, were estimated using regression models. The units of analysis for these models were households, and the explanatory variables were the numbers of household members in various age categories: Age 0-4, Age 5-14, Age 15-17, Age 18-24, and Age 25-54.

Two separate models were estimated for each trip purpose, one for households in place types 1 and 2 (with fewer than 100,000 workers+jobs within a 30 minute auto trip); and one for households in place types 3, 4, and 5 (with more than 100,000 workers+jobs within a 30 minute auto trip).

The resulting trip production rates, per person in the age ranges specified, are listed in the table below. Note that while one might reasonably expect each child to make two school trips per day (to and from), the actual trip rates are somewhat lower: the survey includes days when individual children don't go to school due to school holidays or illness. Furthermore, if children make intermediate stops between school and home, the resulting trips will not appear as HBK trips in the household survey but instead as multiple trips (eg OBO and HBO).

NON-RESIDENTIAL PRODUCTIONS AND ATTRACTIONS

Modeling trip rates for the non-residential end of a trip is generally a tricky process. In an ideal world, trip attractions (and non-home-based productions) would be estimated based on land use, since this is how the model will be used. In practice however, it is not common for household travel surveys to include land use data, and where such data is available the surveys are rarely weighted to reflect control totals for this data the way they are for residential data. For this reason, non-residential trip rates are frequently estimated in a much coarser and more aggregate fashion than residential trip rates.

For the SJV MIP2 models, trip attractions, along with trip productions for non-home-based trips, were estimated using either ordinary linear regression models or partial linear regression models. Unlike ordinary linear regression, partial linear regression can be used even when explanatory variables are strongly correlated with one another. Because the SJV MIP2 models include a large number of employment categories, which are highly correlated with one another, this model form resulted in more reasonable models than ordinary linear regression for some trip purposes.

Units of analysis for both kinds of regression models were groups of census tracts; the techniques used to group census tracts are described below. The explanatory variables for these models were the total number of jobs in each of the nine employment categories, school enrollment totals at the K-12 and university levels, and the total number of households. The nine employment categories used are listed below:

TABLE 6 EMPLOYMENT CATEGORIES FOR VMIP2 MODELS

Category	Description and NAICS code(s)
EMPEDU	Educational Services (61)
EMPFOO	Accommodation and Food Service (72), Art, Entertainment, and Recreation (71),
EMPAGR	Agriculture, Forestry, Fishing and Hunting (11)
EMPOTH	Mining (21), and Manufacturing (31-33)
EMPMED	Health Care and Social Assistance (62)
EMPIND	Utilities (22), Construction (23), Wholesale Trade (42), Transportation and Warehousing (48-49), Other Services (81)

TABLE 6 EMPLOYMENT CATEGORIES FOR VMIP2 MODELS

Category	Description and NAICS code(s)
EMPRET	Retail Trade (44-45)
EMPOFC	Information (51), Finance and Insurance (52), Real Estate Rental and Leasing (53), Professional, Scientific, and Technical Services (54), Management of Companies and Enterprises (55), and Administrative and Support and Waste Management and Remediation Services (56)
EMPGOV	Public Administration (92)

The units of analysis for these regression models were defined using a combination of geography (census tracts, census designated places, or counties) and place type (as measured by jobs+workers within a 30 minute auto trip). A "rolling up" process was used where the smallest possible analytic units with sufficient sample size were used. Where census tracts attracted at least 50 trips of a given purpose, they were used as analytic units; otherwise census places or full counties, grouped by place type, were used instead.

Data for school enrollments was only available at the full county level. For the home-based school and home-based college trip purposes, this data was used with analytic units equal to counties, despite the fact that this resulted in models with very few analytic units. However, for other trip purposes which used school enrollments as explanatory variables, school enrollments were distributed among those census tracts which had HBK or HBC trip attractions. The countywide total of school enrollments was kept constant, with each tract receiving a portion commensurate with its HBK or HBC trip attractions. The result, while not as accurate as using enrollment data at the tract level, allows trip purposes such as HBO and WBO to have a larger number of analytic units and nevertheless use the school enrollment data.

The table below summarizes the number of analytic units used for each regression model, by trip purpose and attraction (A) versus production (P). For example, the 61 analytic units used for the HBW attractions model includes 6 individual census tracts (with sufficiently many work trips attracted to each), 34 subsets of census places with the same Place Type (eg Fresno, type 4; Stockton, type 3; Hanford type 2; Unincorporated Tulare County type 2), and 21 subsets of counties grouped by Place Type (eg Sacramento County, types 2 and 3 or San Joaquin County, type 2).

TABLE 7 GEOGRAPHIC UNITS USED IN NON-RESIDENTIAL MODELS

Trip Purpose	Census Tracts	Census Places by Place Type	Counties by Place Type	Total
HBW (A)	6	34	21	61
HBK (A)	0	0	14	14
HBC (A)	0	0	0	14
HBS (A)	0	24	18	42
HBO (A)	32	78	14	124
WBO (P)	2	21	19	42
WBO (A)	1	20	18	39
OBO (P)	9	43	21	73
OBO (A)	10	47	18	75

Employment data used for model estimation was obtained from the EPA's Smart Location Database (SLD). The employment categories in the SLD do not fully match those in the model, so the model's Construction, Agricultural, and Industrial categories are combined; the resulting trip rate for the combined category is then applied to each of the three model categories. Additional explanatory variables tested include the number of households per tract, and the school enrollment per tract. School enrollment data was obtained from the California Department of Education (K12, public school enrollments only) and from the California Postsecondary Education Commission (College, public and private 2- and 4-year institutions).

All of the regression models estimated were either simple linear regressions with no intercept, or partial linear regressions with no intercept. In the case of non-home-based trips (WBO and OBO), the same variables were used for the production and the attraction models. The trip rates estimated for each model are listed below. As an example of interpreting these models, the home-based other attraction model states that each retail, service, and public sector job will attract roughly 2 HBO trips, each k-12 school enrollment will attract roughly 1.5 HBO trips, and each household will attract roughly 1.1 HBO trips.

HBW SEGMENTATION BY HOUSEHOLD INCOME

Following trip generation, HBW trips were further segmented by household income. On the production side, this segmentation was already achieved by virtue of the fact that household income was one of the variables present in cross-classification. On the attraction side, HBW trip attractions for each employment category were separated into high, medium, and low income based on percentages were obtained from LODES data.

PROPORTION OF II, IX, XI TRIPS

Once the base trip production and attraction rates were established, trip productions for each TAZ were further segmented into ii and ix trips, while trip attractions were further segmented into ii and xi trips. This segmentation was calculated separately for each trip purpose and each Census Designated Place (referred to below as simply places), as described below. Note that this segmentation simply describes the proportion of trips which enter or leave the county from each listed place; it does not govern the location of those trips, which is still governed by the trip distribution model.

First, all CHTS trip ends and households were associated with a place or were determined to fall in unincorporated areas. This process was made more complicated by the fact that the publically-available version of the CHTS has all locations geocoded by census tract; however, census tract boundaries may not align well with place boundaries, and each census tract may have multiple places associated with it. In cases where multiple places are associated with a single census tract, the place with the largest population in the tract (identified at the census block level) is used. If the largest population in the tract is outside all named places, then the tract is identified as an unincorporated portion of the relevant county. Note that some named places are not the largest population center in any census tract, and thus do not appear in the summaries of CHTS data, having been aggregated into either neighboring places or the unincorporated portion of the county.

Next, trip productions for each place and trip purpose were segmented into ii and ix trips; while trip attractions were segmented into ii and xi trips. In cases where the CHTS contains fewer than 30 trips for the place/purpose combination, the county-wide average ii versus ix or ii versus xi percentage was substituted.

TRIP DISTRIBUTION MODELS

Trip distribution models are typically one of two types: either a simpler gravity model, or a more complex destination choice model. The present document focuses solely on gravity models.

Estimation of gravity models for trip distribution is primarily a matter of first defining an impedance function which describes the time, distance, cost, or other impedances involved in travel between zones, and second calculating friction factors which govern the relationship between impedance and the resulting number of trips between zones. As with other model components, care must be taken to define impedance functions and estimate friction factors from data which uses the same units (person-trips, vehicle-trips, or person-trips by auto) as are used within the model's trip distribution component.

The SJV MIP2 models use an impedance function which incorporates travel time and cost, using the same coefficients for these variables as appear in the mode choice model and scaled by mode shares (see the following section on Mode Choice Models). For models without mode choice components, the impedances were estimated using walk time based on distance and an average of walk and drive time for origin-destination pairs where walk is competitive with auto. In addition, the sub-TAZ level of detail available in the GIS network was used in combination with TAZ size.

Friction factors in the SJV MIP2 models are exponential functions of the form

$$F_{i,j} = Ae^{C\,t_{i,j}}$$

where $F_{i,j}$ is the friction factor, $t_{i,j}$ is the impedance function, and A and C are constants set during estimation.

Additional features of the SJV MIP2 trip distribution models include:

- Added friction factors for additional trip purposes resulting in the jobs housing relationship – segmenting by income level as well as by internal-external.
- Friction factors for non-work trips do not screen out short trips which are likely candidates for non-motorized travel, particularly in models which have only used vehicle trip generation

MODE CHOICE MODELS

Mode choice models are discrete choice models in which the probability of a particular mode being selected is determined by variables including level of service variables describing each available mode of travel, variables describing the travelers, and variables describing the built environment at the trip origin and/or destination.

MODEL STRUCTURE AND AVAILABLE MODES

Mode choice models can be estimated in a wide variety of forms; the most typical include multinomial logit models, nested logit models, and cross-nested logit models. Typically, mode choice models are also segmented by certain variables which describe the trip or traveler, effectively creating separate discrete choice models for each segment.

The SJV MIP2 mode choice model is segmented by trip purpose and vehicle availability, using three vehicle availability categories as described in Table 8.

TABLE 8: VEHICLE AVAILABILITY SEGMENTS IN VMIP2 MODE CHOICE MODELS

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

The modes available in the VMIP 2 models are listed in Table 9.

TABLE 9: MODES AVAILABLE IN VMIP2 MODE CHOICE MODELS

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

All of the segments in the SJV MIP2 mode choice model use a multinomial logit structure. A nested logit structure would have been preferred for theoretical reasons, given the strong relationships among drive, transit, and active modes. However, no satisfactory nested logit models were estimated, likely because of severe constraints on the amount of transit data available. Multinomial logit models produced generally more sensible results and were used instead. Even so, the multinomial logit models produced some un-intuitive results. Rather than use un-intuitive coefficients, these un-intuitive were replaced by results from the earlier SJV MIP1 mode choice models, pooled models involving multiple segments or multiple trip purposes, or were omitted altogether.

VARIABLES INCLUDED

The variables used in each of the SJV MIP2 mode choice model segments are listed in the table below. Not all variables are used in all trip purposes models. For the accessibility and built environment variables, the table notes whether the variable is measured at the trip production (P) or trip attraction (A). Note that value of time is a direct consequence of the relationship between in-vehicle time and cost. As such, it is not estimated directly but is instead a consequence of the IVT and cost coefficients. For model implementation purposes, only VOT is used in the mode choice utility equation; for clarity both are reported in the tables below.

TABLE 10: VARIABLES IN SJV MIP2 MODE CHOICE MODELS

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

MODEL CALIBRATION

Travel model calibration is an iterative process where model settings are adjusted based on comparisons of model outputs and observed travel data. The general intent is to obtain a reasonable match between model estimates and observed conditions. Model calibration helps overcome issues of data quality, sample size, or aggregation bias and results in model outcomes tailored to the local travel characteristics. Caltrans, the California Transportation Commission, and the Federal Highway Administration (FHWA) produce guidelines for model calibration.

Traditional sources of observed data used in model validation include household travel surveys, ACS and census data, Census journey-to-work flows, and transit on-board surveys. Other data sources to consider for model calibration include GPS or cell phone traffic flow data.

CALIBRATION TARGETS

A cross-classification comparison is prepared of the model outcomes and validation behavior for each of the household dimensions. The model is calibrated in an iterative method by reducing or increasing the 2013 ACS values until the household cross-classification totals from the model match the validation data source totals. Each sub-model was calibrated and compared using the data and methods based on the guidelines below.

- Vehicle availability was calibrated using Census vehicle ownership cross-classified by household size and income.
- Trip generation was calibrated for trip productions, attractions, and trip balancing.
    - Trip production: A comparison of model total trips by purpose and observed totals from the expanded 2012 CHTS data. A secondary comparison, if needed, can be HBW trips from more aggregate sources such as the CTPP or NHTS. These sources are used with caution since they report 'usual' workplace locations and are not directly comparable to model generated workplace locations. Convert person trip rates to ITE rates using average vehicle occupancy by purpose.
    - Trip attraction: Compare HBW attractions to total jobs in zone, range of 1.2-1.5 HBW attractions per employee in zone (source TFResource.org)
    - Trip balancing: PA totals, within +-10% of totals and totals by purpose
- For trip distribution models: The gravity model and any associated friction factors (k-factors) were calibrated iteratively to match average trip lengths by purpose and trip length frequencies by purpose are compared with the household travel survey. As a secondary method, the model volumes are compared to observed traffic volumes or observed survey data of vehicle volumes.

- For mode choice models, observed transit ridership (when available) can be compared against trip tables and the model mode shares for validation. As a secondary method, the mode shares, developed by pooling all SJV households is compared to the local mode shares observed in the CHTS.

MODEL VALIDATION

MODEL STATIC VALIDATION

In static model validation tests, statistical tests are performed to measure how well the model output matches available traffic counts and roadway speeds. This process starts by measuring model performance at a screenline, which is composed of several parallel roadways to ensure that overall traffic flows are captured. The next step is to evaluate model performance for individual roadway segments. After each validation tests, model performance improvements were tested by further calibrating elements of the trip generation, trip distribution, mode choice, and traffic assignment modules.

Model validation results will help to determine how well the model performs at different geographic scales and for various metrics. When a model does not pass all of the static validation tests, it can be helpful to search for explanations -- eg not having a common base year for model inputs and travel behavior data, differences in TAZ structure, network data quality, or quality of land use input data. To help identify or target sub-regional areas that may require more refinements, users should review maps of daily validation locations. Any applications forecasts should also use an appropriate forecasting approach as described by National Cooperative Highway Research Program (NCHRP) Report 255 or 716 rather than using model forecast volumes directly.

MODEL DYNAMIC VALIDATION

After initial validation, dynamic validation tests were performed to help diagnose potential model refinements to improve the static validation performance. The mode choice and trip distribution sub-models were identified for testing due to overestimates of walk trips and VMT in the initial model runs.

MODE CHOICE

The mode choice sub model was developed as a function of the demographics, accessibility, and transportation network (distance, time, cost). In addition to specific variables described in Mode Choice Models, constants are used to account for other factors not specifically included as a variable. During dynamic testing, the input land use, highway and transit network, and other related built environment factors remained fixed and only the mode choice constants were adjusted. This was done to determine the sensitivity of the model to the variables that change by scenario compared to the fixed constants that were developed to match observed data. It is recommended that the mode choice constants be as small in magnitude as possible and the sign corresponding to the relative attractiveness of the mode and purpose relative to the most used mode (driving alone in the VMIP 2 models).

Test

Large positive constants for walk resulted in significant over estimation of walk mode for all trip purposes and significant under estimation of travel distance and VMT. The large positive constants for walk were updated to be small positive (mainly 0 vehicle households and school\shop purposes) or small negative numbers (multiple auto households and home to work\college purposes) to allow the D variables in the model to have more of an influence on mode choice rather than the constant. With the test factors, the attractiveness relative to drive alone by purpose and the relative trend within a purpose from 0 vehicle households to one vehicle and or more than one vehicle per household were also refined compared to the original constants.

The original and test constants are shown in the tables below.

TABLE 11: ORIGINAL MODE CHOICE WALK CONSTANTS

Variable	Purpose	0-Vehicle	1-Vehicle, 2+ person HH	All Others
Constant	Home-Work	2.452	1.493	0.875
	Home-Shop	5.779	3.439	0.98
	Home-School	5.287	6.151	5.838
	Home-College	-0.119	0.384	0.888
	Home-Other	4.922	2.992	2.499
	Work-Other	-0.0382	0.481	1.3
	Other-Other	4.833	1.821	1.008

TABLE 12: TEST MODE CHOICE WALK CONSTANTS

Variable	Purpose	0-Vehicle	1-Vehicle, 2+ person HH	All Others
Constant	Home-Work	-0.429	-2.829	-4.829
	Home-Shop	1.177	-3.463	-8.223
	Home-School	3.187	3.000	1.637
	Home-College	-1.495	-1.679	-1.864
	Home-Other	2.304	-0.935	-2.736
	Work-Other	-2.812	-3.165	-3.563
	Other-Other	2.655	-1.445	-3.347

Expectation

The addition of D variables within the accessibility calculation combined with less influence and in the correct direction (i.e. negative for less attractive compared to drive alone) from the mode choice constant are expected to produce mode shares closer to observed data.

Result

Below are the model results compared to observed mode shares both before and after modifying the walk mode share constants. As expected, reducing the influence of the mode choice constant to increase the sensitivity of the independent variables improved the model mode split estimates compared to observed data. With mode choice being a decision between multiple options, the changes to walk had the largest impact on walk and the resulting trips shifted to the other most attractive modes (drive alone, shared ride 2, and shared ride 3+). Transit, Bike, and Other (school bus) had minor changes that show as a few percentage points different due to the low number of trips.

TABLE 13: MODE SPLIT DIFFERENCE SPLIT BY PURPOSE - ORIGINAL

Purpose	Drove Alone	Shared Ride 2	Shared Ride 3+	Transit	Walk	Bike	Other
HBW	**-19%**	-6%	-1%	0%	**22%**	4%	0%
HBO	**-14%**	**-10%**	**-19%**	1%	**37%**	0%	0%
NHB	-5%	-6%	**-11%**	0%	**21%**	0%	0%
Total	**-11%**	-8%	**-13%**	1%	**31%**	1%	0%

Notes: Values shown are mode share for Model – CHTS. For values outside of recommended error, **negative red** numbers indicate the model is underestimating and **positive blue** numbers indicate the model is over estimating.
Source: 2012 California Household Travel Survey, Weekday Trips, re-weighted by F&P. Includes only internal-to-internal, weekday person trips for all modes. School bus trips are categorized as Other.

TABLE 14: MODE SPLIT DIFFERENCE SPLIT BY PURPOSE - TEST

Purpose	Drove Alone	Shared Ride 2	Shared Ride 3+	Transit	Walk	Bike	Other
HBW	3%	2%	0%	0%	-3%	-2%	0%
HBO	9%	2%	-4%	1%	-8%	0%	-1%
NHB	3%	1%	-2%	0%	-2%	0%	0%
Total	6%	2%	-3%	0%	-5%	-5%	0%

Notes: Values shown are mode share for Model – CHTS. For values outside of recommended error, **negative red** numbers indicate the model is underestimating and **positive blue** numbers indicate the model is over estimating.
Source: 2012 California Household Travel Survey, Weekday Trips, re-weighted by F&P. Includes only internal-to-internal, weekday person trips for all modes. School bus trips are categorized as Other.

DISTRIBUTION – TRAVEL TIME AND VMT

Although all trips are distributed prior to mode choice, the relative attractiveness and accessibility of the destination was included in VMIP 2 as described in Trip Distribution estimation and calibration section. After the calibration of the mode choice attractiveness and mode specific constants shifting trips from walk to drive, the model sensitivity to impedance (cost, distance, travel time) was evaluated.

Distribution Test 1 – Friction Factors

The friction factors are used to determine the relative willingness to travel for a given impedance and varies by purpose. For example, commute trips generally have more willingness to travel longer than shopping trips. For this test, the input land use, highway and transit network, mode choice and other related built environment factors remained fixed and only the friction factors were adjusted. The original and test friction factors are shown in the table below are used in the function $A * e^{(-B*time)}$. This function results in steeper curve (less willing to travel) for smaller values of A and the larger value of B.

TABLE 15: VARIABLES IN VMIP 2 VEHICLE AVAILABILITY MODEL

Variable	Original	Test
A	100	1
B – Home-Work High	-0.02	-0.2
B – Home-Work Medium	-0.02	-0.3
B – Home-Work Low	-0.02	-0.75
B – Home-Shop	-0.06	-1
B – Home-School	-0.09	-0.5
B – Home-College	-0.06	-0.4
B – Home-Other	-0.06	-0.6
B – Work-Other	-0.06	-0.6
B – Other-Other	-0.06	-0.1

Expectation

Dramatically reducing A and increasing B will have a significant reduction in travel time and VMT.

Result

Below are the model results comparing the original friction factors to the test friction factors. The trip distribution changes did not result in a substantial decrease in travel time or VMT. After further investigation it was discovered that the mode choice log sums (relative attractiveness of taking one mode over another for a given OD pair) produced results that were not all of the same sign (i.e. some were positive when all values should be negative).

TABLE 16: COMPARISON OF AVERAGE TRAVEL TIME (IN MINUTES) BY TRIP PURPOSE

Trip Purpose					
HBW		HBO		NHB	
Original	Test	Original	Test	Original	Test
29.4	28.4	49.3	49.3	36.0	34.6

TABLE 17: COMPARISON OF VMT

Metric	Original	Test
Daily VMT	37,341,600	37,039,700

Distribution Test 2 – Mode Choice Shift Constant and Friction Factors

Knowing that the logsum values need to be all the same sign, within the model catalog there is a Mode Constant Shift (Mod_Cost_Shift) to adjust the values so they are all negative. The Accessability and Log Sum process of the model outputs a file (03_Accessability\SCENARIO_ MAXLOGSUMVALUE.CSV) that should be checked and the maximum positive number should be less than the Mode Constant Shift. This is checked during model development or significant changes to the structure of the model and should not be changed between scenarios because the relative value of the logsums directly influence the mode choice values.

During the investigation of Distribution Test 1 results not being as expected it was discovered that the Mode Constant Shift was not sufficient to have all values the same sign. As a result, the impedance combination of cost, time, and distance was removed and resulted in no impedance for travel.

This test retained the same input files with the exception of friction factors, and also changed the Mode Constant Shift from -3 to -10. The original and test fiction factors are shown in the table below.

TABLE 18: VARIABLES IN VMIP 2 VEHICLE AVAILABILITY MODEL

Variable	Original	Test
A	100	100000
B – Home-Work High	-0.02	-0.045
B – Home-Work Medium	-0.02	-0.07
B – Home-Work Low	-0.02	-0.1
B – Home-Shop	-0.06	-0.112
B – Home-School	-0.09	-0.09
B – Home-College	-0.06	-0.06
B – Home-Other	-0.06	-0.115
B – Work-Other	-0.06	-0.11
B – Other-Other	-0.06	-0.1

Expectation

Dramatically reducing A and increasing B will have a significant reduction in travel time and VMT. The travel time and VMT will more closely match observed data.

Results

As shown in the tables below, the model performed as expected. By adjusting the Mode Constant Shift so the impedance values were calculated and adjusting the friction factors, the travel time and VMT were reduced by nearly half. When compared to observed data, the model travel times and VMT are slightly high but within the recommended guidelines.

TABLE 19: COMPARISON OF AVERAGE TRAVEL TIME (IN MINUTES) BY TRIP PURPOSE

Trip Purpose					
HBW		HBO		NHB	
Original	Test	Original	Test	Original	Test
29.4	18.8	49.3	16.4	36.0	12.1

TABLE 20: COMPARISON OF VMT

Metric	Original	Test
Daily VMT	37,341,600	18,065,800

TABLE 21: TRAVEL TIME AND VMT DIFFERENCE TO OBSERVED

Metric	Original	Test
Home-Work Travel Time	**67%**	7%
Home-Other Travel Time	**250%**	16%
Non-Home Travel Time	**205%**	3%
Daily VMT	**114%**	3%

Note: Values shown as Model – Observed. Observed travel times from CHTS 2012 and VMT from HPMS 2014. **Bold Red** indicate results outside of recommended guidelines.

TRAFFIC ASSIGNMENT – MAJOR CHANGE

The travel model will be used to evaluate major infrastructure changes such as freeway widening. In addition to physical capacity changes, technology in vehicles (driver assist warning, autonomous vehicles, etc) will have an influence on the capacity of the currently constructed facilities. Traffic assignment is used to estimate roadway volumes, and the congested speed is used in trip distribution, mode choice, and air quality analysis. The test was implemented for the base year to isolate the change in the results to the roadway changes.

Test

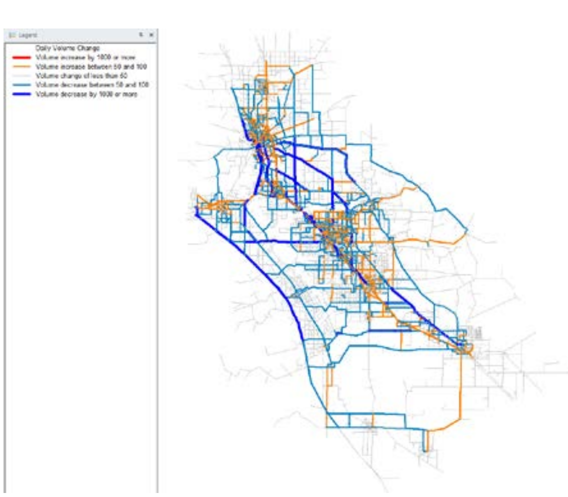
Keeping the trip distribution, mode choice, and all other factors constant, double the capacity of freeways and re-run assignment only.

Expectation

Freeways that were originally congested will have an increase in volume. Local streets, county roads, and freeways that were not congested will have a decrease in volume for trips that shifted to the previously congested freeway.

Result

As expected, the major increase in capacity influenced a large number of roadways. As shown in the image to the left, trips that previously used county roads decreased and non-congested freeways (blue shades), the alternative route connecting to the previously congested freeways increased (orange shades), and the congested routes (i.e. SR 99 and I-205) have an increase in volume. The bandwidth map on the right shows the magnitude of change being an aggregation of alternative routes focused on the previously congested freeways.

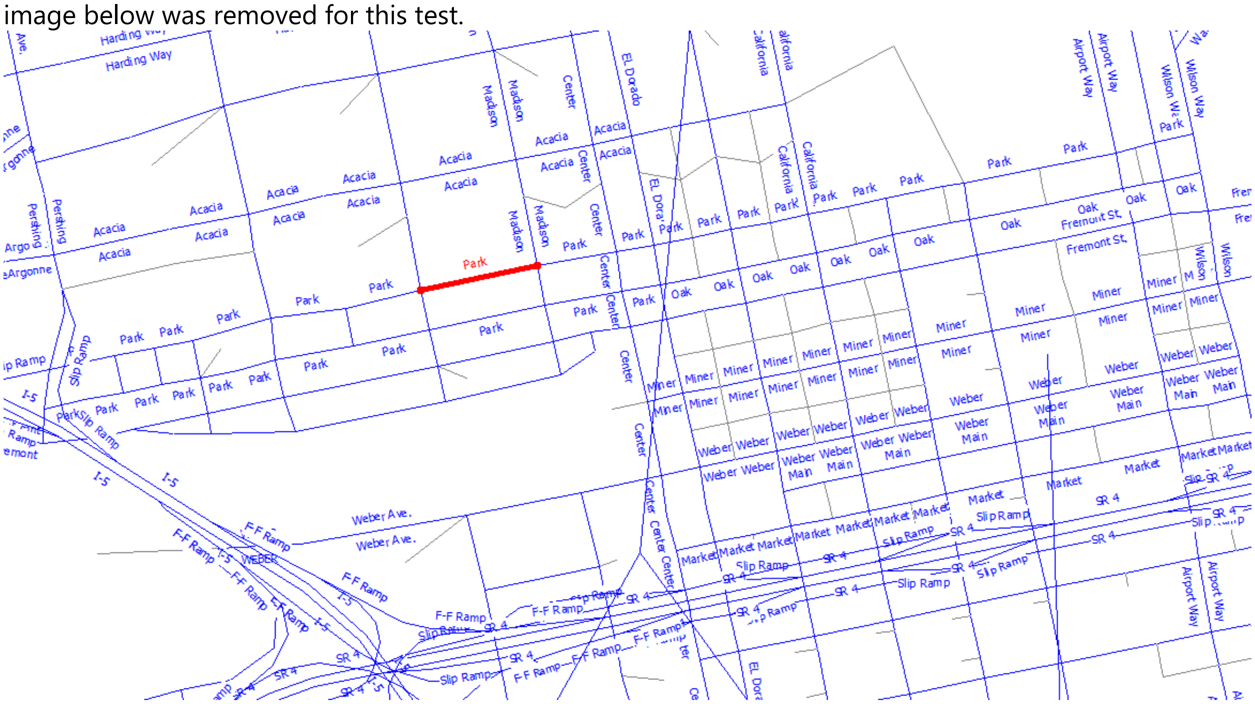


TRAFFIC ASSIGNMENT – MINOR CHANGE

The travel model will be used to evaluate minor\local infrastructure changes such as road diets or street conversions to pedestrian malls. Traffic assignment is used to estimate roadway volumes, and the congested speed is used in trip distribution, mode choice, and air quality analysis. The test was implemented for the base year to isolate the change in the results to the roadway changes.

Test

Keeping the trip distribution, mode choice, and all other factors constant, remove a minor street in downtown to represent a street closure and re-run assignment only. The red segment of Park Street in the image below was removed for this test.



Expectation

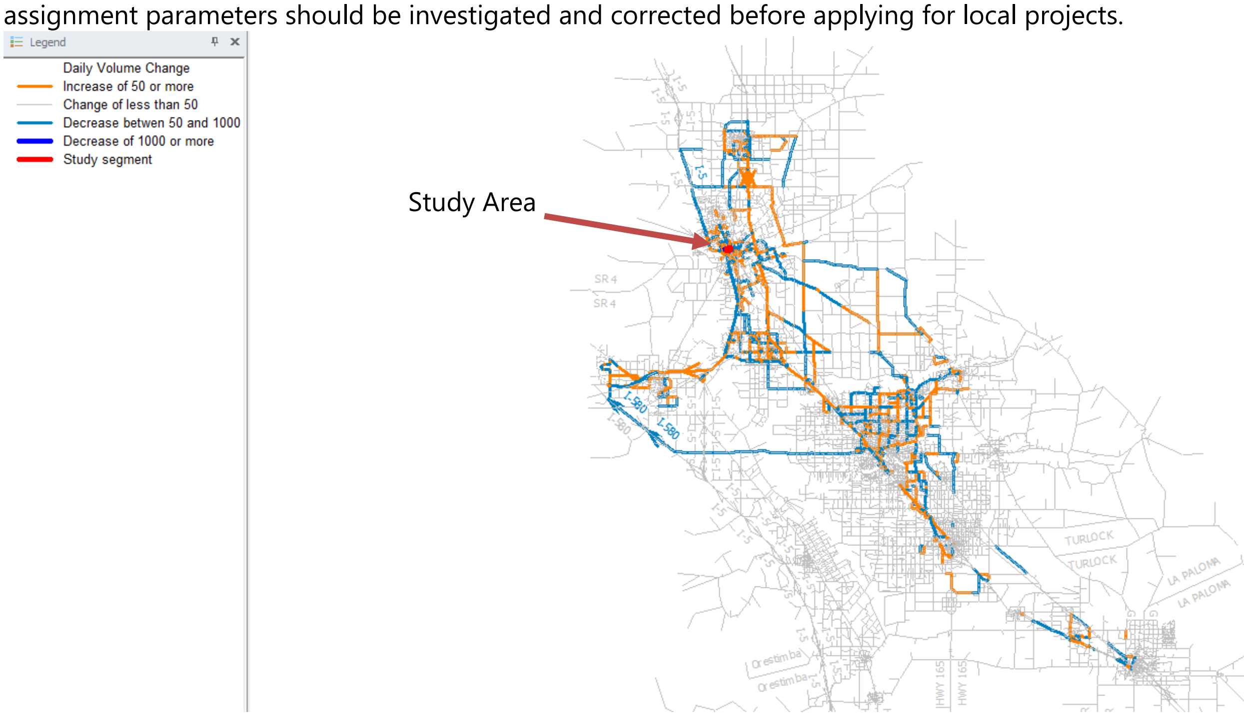
Streets nearby the removed link providing access in the same direction will increase by roughly the magnitude of volume on the original link, connecting streets will have minor change, and areas outside of downtown will have negligible if any change.

Result

The model behaved as expected within the study area, but the area beyond the study area showed unexpected results. Although the increase or decrease outside of the study area are less than 50 trips per day, the speeds and coding of the network and the relative gap and convergence criteria for traffic assignment should be investigated before applying the model for local roadway projects.

The segment of Park Street that was removed functions as a one-way couplet with access to downtown and the freeway, and through the connection of Waterloo also connects SR 99 to I-5. Within the downtown area the re-routing of trips from Park to SR 4 and other parallel routes is as expected. The figure below shows the one-way streets with arrows designating travel direction, and the change in volume relative to the base condition with blue shades being a reduction and orange shades being an increase.

What was not expected was the change outside of the local area. As shown in the figure below, the route choice for trips in Stanislaus County were also influenced by the local change. This shows the model is overly sensitive to minor changes. Roadway network coding (speed, capacity, lanes, functional type) and assignment parameters should be investigated and corrected before applying for local projects.



APPENDIX A:

PREPARATION OF CALIFORNIA HOUSEHOLD TRAVEL SURVEY DATA

MEMORANDUM

Date: June 23, 2015

To: Users of CHTS data prepared by Fehr & Peers

From: Jennifer Ziebarth

Subject: Cleaning and Weighting of California Household Travel Survey Data

WC14-3115

The purpose of this memo is to document the steps undertaken to prepare the 2012 California Household Travel Survey (CHTS) for use in the Valley Model Improvement Program (VMIP 2) project.

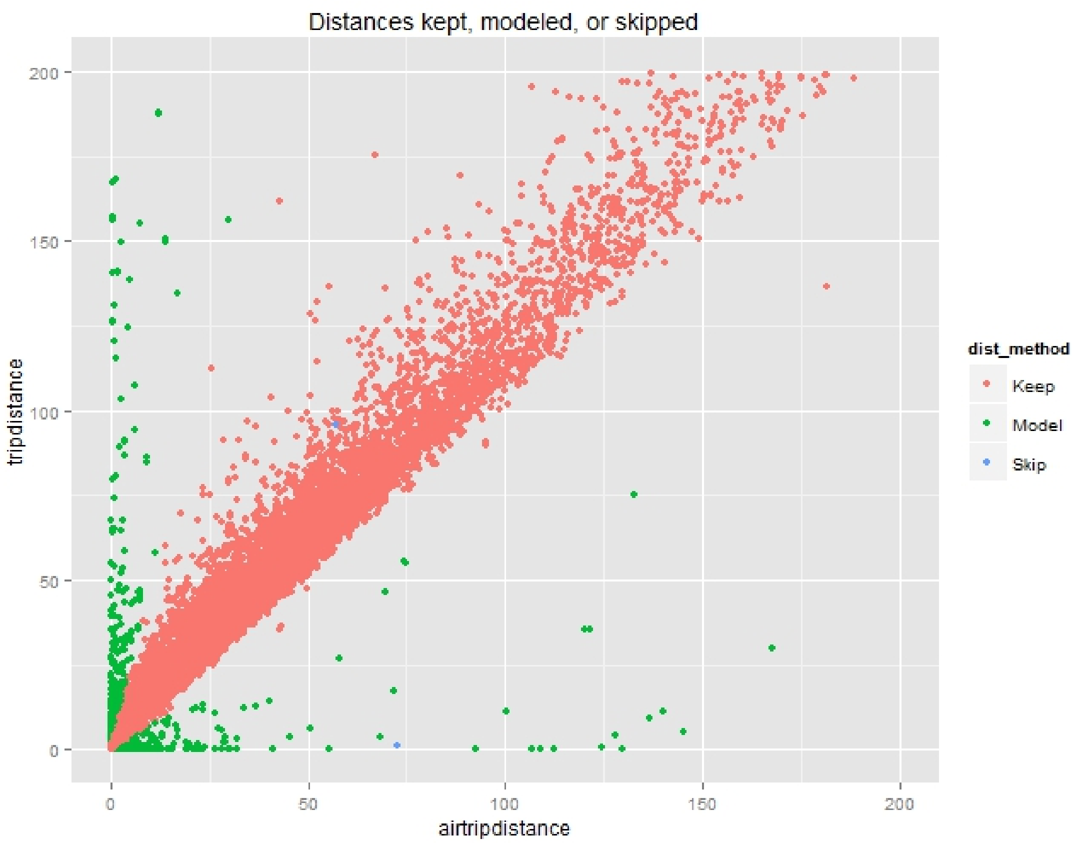
The 2012 CHTS is a statewide dataset of multi-modal travel behavior and household demographics. The survey includes data from a total of 42,431 households, collected using telephone surveys and GPS devices from all counties in California. The dataset includes travel patterns, including activity purpose, duration, travel distance, travel time, and mode choice. Demographics include household size, income, vehicle availability, and the additional characteristics of the individuals within the household.

Data preparation included the following steps:

1. Identify and repair unreasonable or missing trip distances.
2. Identify and consolidate transit trip chains.
3. Identify trip purposes.
4. Impute missing household income data.
5. Calculate a set of household-level weights to replace those provided with the CHTS.
6. Recode certain variables
7. Attach MPO and Census Designated Place information to trip and household records
8. Aggregate information about persons in the household to the household record
9. Attach person-level data to the trip records

TRIP DISTANCE CLEANING

The California Household Travel Survey provides trip distances in two formats: an "as-traveled" distance which is intended to be the actual distance traveled, and an "air distance" reflecting the straight-line distance between the trip's origin and destination. However, the as-traveled distance was missing from some trip records, and was unreasonable in others. The graph below shows the relationship between air distance and as-traveled distance for all non-airplane trips in the CHTS. Trips whose as-traveled distance deviate too much from their air distance are candidates for providing a "cleaned" distance.



To provide "cleaned" trip distances, a simple linear regression was performed for each travel mode separately based only on the data where the as-traveled distance is deemed reasonable.

IDENTIFY TRIP PURPOSES

To identify trip purposes, both the activity purpose from the CHTS activities file and the place name from the CHTS places file were used. The activity codes provided in the CHTS data are as follows:

1. PERSONAL ACTIVITIES (SLEEPING, PERSONAL CARE, LEISURE, CHORES)
2. PREPARING MEALS/EATING
3. HOSTING VISITORS/ENTERTAINING GUESTS
4. EXERCISE (WITH OR WITHOUT EQUIPMENT)/PLAYING SPORTS
5. STUDY / SCHOOLWORK
6. WORK FOR PAY AT HOME USING TELECOMMUNICATIONS EQUIPMENT
7. USING COMPUTER/TELEPHONE/CELL OR SMART PHONE OR OTHER COMMUNICATIONS DEVICE FOR PERSONAL ACTIVITIES
8. ALL OTHER ACTIVITIES AT MY HOME
9. WORK/JOB DUTIES
10. TRAINING
11. MEALS AT WORK
12. WORK-SPONSORED SOCIAL ACTIVITIES (HOLIDAY OR BIRTHDAY CELEBRATIONS, ETC)
13. NON-WORK RELATED ACTIVITIES (SOCIAL CLUBS, ETC)
14. EXERCISE/SPORTS
15. VOLUNTEER WORK/ACTIVITIES
16. ALL OTHER WORK-RELATED ACTIVITIES AT MY WORK
17. IN SCHOOL/CLASSROOM/LABORATORY
18. MEALS AT SCHOOL/COLLEGE
19. AFTER SCHOOL OR NON-CLASS-RELATED SPORTS/PHYSICAL ACTIVITY
20. ALL OTHER AFTER SCHOOL OR NON-CLASS RELATED ACTIVITIES (LIBRARY, BAND REHEARSAL, CLUBS, ETC)
21. CHANGE TYPE OF TRANSPORTATION/TRANSFER (WALK TO BUS, WALK TO/FROM PARKED CAR)
22. PICKUP/DROP OFF PASSENGER(S)

23. DRIVE THROUGH MEALS (SNACKS, COFFEE, ETC.) [SHOW IF PTYPE <> 1 (HOME)]
24. DRIVE THROUGH OTHER (ATM, BANK) [SHOW IF PTYPE <> 1]
25. WORK-RELATED (MEETING, SALES CALL, DELIVERY)
26. SERVICE PRIVATE VEHICLE (GAS, OIL, LUBE, REPAIRS)
27. ROUTINE SHOPPING (GROCERIES, CLOTHING, CONVENIENCE STORE, HH MAINTENANCE)
28. SHOPPING FOR MAJOR PURCHASES OR SPECIALTY ITEMS (APPLIANCE, ELECTRONICS, NEW VEHICLE, MAJOR HH REPAIRS)
29. HOUSEHOLD ERRANDS (BANK, DRY CLEANING, ETC.)
30. PERSONAL BUSINESS (VISIT GOVERNMENT OFFICE, ATTORNEY, ACCOUNTANT)
31. EAT MEAL AT RESTAURANT/DINER
32. HEALTH CARE (DOCTOR, DENTIST, EYE CARE, HIROPRACTOR, VETERINARIAN)
33. CIVIC/RELIGIOUS ACTIVITIES
34. OUTDOOR EXERCISE (PLAYING SPORTS/JOGGING, BICYCLING, WALKING, WALKING THE DOG, ETC.)
35. INDOOR EXERCISE (GYM, YOGA, ETC.)
36. ENTERTAINMENT (MOVIES, WATCH SPORTS, ETC)
37. SOCIAL/VISIT FRIENDS/RELATIVES
38. OTHER (SPECIFY) [NOTE: LISTED ON DIARY] (O_APURP)
39. LOOP TRIP (FOR INTERVIEWER ONLY-NOT LISTED ON DIARY)
99. DONT KNOW/REFUSED

Each place visited was assigned a place based on the following criteria:

- If the place name is "HOME", then the place is "HOME", regardless of the activity purposes.
- If the place includes an activity with purpose code between 9 and 16, then the place is "WORK".
- If the place includes an activity with purpose code between 17 and 20, then:
  - If the place name includes identifying strings such as "COLLEGE", "UNIV", "UCLA", or "USC", then the place is "COLLEGE".
  - If the place name includes "PRESCHOOL" or "DAYCARE", then the place is "OTHER".

- Otherwise the place is "K12"
- If the place includes an activity with purpose code 27 or 28, then the place is "SHOP".
- Otherwise, the place is "OTHER".

Once the purpose for each place has been determined, assigning a purpose to each trip is straightforward. For non-transit trips, the purpose at the trip origin is the purpose of the immediately preceding place record, and the purpose at the trip destination is the purpose of the place record itself. Then:

- If one end of the trip is "HOME" and the other is "WORK", then the trip is home-based work ("HBW").
- If one end of the trip is "HOME" and the other is "K12", then the trip is home-based K-12 ("HBK").
- If one end of the trip is "HOME" and the other is "COLLEGE", then the trip is home-based college ("HBC").
- If one end of the trip is "HOME" and the other is "SHOP", then the trip is home-based shop ("HBS").
- If one end of the trip is "HOME" and the other is either "OTHER" or "HOME", then the trip is home-based other ("HBO").
- If one end of the trip is "WORK" and the other end is anything but "HOME", then the trip is work-based other ("WBO").
- In all other cases, the trip is non-home-based ("NHB").

In some cases it is useful to consolidate these trips into a simpler scheme:

- Home-based work ("HBW") is the same as above.
- Home-based other ("HBO") includes "HBO", "HBK", "HBC", and "HBS" above.
- Non-home-based ("NHB") includes "WBO" and "NHB" above.

For transit trips, the purpose identification is slightly more complex and requires first that chains of transit trips be identified (see below).

JOINT TRAVEL AMONG HOUSEHOLD MEMBERS

When multiple household members travel together in a single vehicle, the trip is considered a joint trip. Such trips are identified using arrival and departure times as well as person codes for household members on the trip. If the only purpose of the trip is to drop off or pick up some household members, then the trip is flagged as an escort trip.

This coding allows flexibility in how escort trips are counted when CHTS records are summarized. To avoid losing potentially important information, no trip purposes are changed.

IDENTIFY AND CONSOLIDATE TRANSIT TRIP CHAINS

In recording transit trips, the California Household Travel Survey treats each portion of the transit trip chain as a separate trip. For example, a trip in which the traveler drives to a rail station, takes the train to a second rail station, and then walks to a workplace would be listed in the survey as three separate consecutive trips, with three separate modes. This method of record-keeping makes it possible to track the mode of access and egress for a transit trip, but for most travel behavior analyses it is preferable to consider these three trips as a single unit. Thus, a necessary step of data preparation is to identify and consolidate these chains which make up a single transit trip.

To identify chains of transit trips, trips are flagged as transit access, transit egress, or transit transfer using the following criteria. A transit access trip is one which:

- Immediately precedes a trip whose mode is a transit mode,
- Does not itself use a transit mode, and either
  - Has an activity of "change to type of transportation / transfer" coded, or
  - Has an activity duration less than 30 minutes and a location whose name contains a keyword suggesting a transit stop, such as "station", "bus", "subway", etc.
- Does not end at the traveler's home.

A transit egress trip is one which:

- Immediately follows a trip whose mode is a transit mode,
- Does not itself use a transit mode, and either
  - Has an activity of "change to type of transportation / transfer" coded, or
  - Has an activity duration less than 30 minutes and a location whose name contains a keyword suggesting a transit stop, such as "station", "bus", "subway", etc.
- Does not depart from the traveler's home.

A trip which fits both sets of criteria, appearing to be both transit access and transit egress, is considered to be a transit transfer.

Once potential access, transfer, and egress trips have been identified, the first and last legs of transit trip chains are identified according to the following criteria. The first leg of a transit trip chain is one which:

- Is flagged as a transit access trip, or
- Is a transit trip whose preceding trip is not transit and does not have an activity of "change to type of transportation" coded, and whose previous activity duration is greater than 30 minutes.

The last leg of a transit trip chain is one which:

- Is flagged as a transit egress trip, or
- Is a transit trip which does not have an activity of "change to type of transportation" coded, whose following trip is not transit and whose activity duration is greater than 30 minutes.

Note that the actual criteria are slightly more involved; for details see the R code. For validation of this process, it was confirmed that no person has a different number of trips flagged as the first in a transit chain than they have flagged as the last in a transit chain.

Once transit trip chains have been identified, then a trip purpose can be assigned to the chain as a whole. The chain origin is the origin for the first trip in the chain, that is, the purpose of the immediately preceding place. The chain destination is the destination for the final trip in the chain. The same categorization of trip purposes is used as described in the previous section.

COMPARISON OF TRIP MODES

The modes reported in the cleaned CHTS data are slightly simplified from those reported in the original CHTS data. In addition, mode categories in the cleaned CHTS data reflect vehicle occupancy of drive modes and mode of access for transit modes. The comparison between the original mode reported in the CHTS and the simplified mode in the cleaned data is as follows:

Simplified mode	Original modes
Walk	Walk; Wheelchair / Mobility Scooter Other Non-Motorized
Bike	Bike

Simplified mode	Original modes
Drive Alone	Auto / Van / Truck Driver Auto / Van / Truck Passenger Carpool / Vanpool Motorcycle / Scooter / Moped Rental Car / Vehicle
Drive Shared 2	Auto / Van / Truck Driver Auto / Van / Truck Passenger Carpool / Vanpool Motorcycle / Scooter / Moped Rental Car / Vehicle
Drive Shared 3	Auto / Van / Truck Driver Auto / Van / Truck Passenger Carpool / Vanpool Motorcycle / Scooter / Moped Rental Car / Vehicle
Drive Shared 4+	Auto / Van / Truck Driver Auto / Van / Truck Passenger Carpool / Vanpool Motorcycle / Scooter / Moped Rental Car / Vehicle
Taxi	Taxi / Hired Car / Limo
Shuttle	Private shuttle (SuperShuttle, employer, hotel, etc.) Other Private Transit
Walk to Bus	Greyhound Bus Local Bus, Rapid Bus Express Bus / Commuter Bus (AC Transbay, Golden Gate Transit, etc.) Premium Bus (Metro Orange / Silver Line) Public Transit Shuttle (DASH, Emery Go Round, etc.) AirBART / LAX FlyAway Amtrak Bus Other Bus
Drive to Bus	Greyhound Bus Local Bus, Rapid Bus Express Bus / Commuter Bus (AC Transbay, Golden Gate Transit, etc.) Premium Bus (Metro Orange / Silver Line) Public Transit Shuttle (DASH, Emery Go Round, etc.) AirBART / LAX FlyAway Amtrak Bus Other Bus

Simplified mode	Original modes
Walk to Rail	BART, Metro Red / Purple Line ACE, Amtrak, Caltrain, Coaster, Metrolink Metro Blue / Green / Gold Line, Muni Metro, Sacramento Light Rail, San Diego Sprinter / Trolley / Orange/Blue/Green, VTA Light Rail Street Car / Cable Car Other Rail
Drive to Rail	BART, Metro Red / Purple Line ACE, Amtrak, Caltrain, Coaster, Metrolink Metro Blue / Green / Gold Line, Muni Metro, Sacramento Light Rail, San Diego Sprinter / Trolley / Orange/Blue/Green, VTA Light Rail Street Car / Cable Car Other Rail
Walk to Ferry	Ferry / Boat
Drive to Ferry	Ferry / Boat
School Bus	School Bus
Paratransit	Dial-a-Ride / Paratransit (Access Services, etc.)
(removed from cleaned data)	Plane
NA	RF

IMPUTATION OF MISSING DATA

Although the household records are largely complete, certain key variables are missing for a small number of records. Variables which are used for estimating household weights (see next section) are imputed if they are missing. Additional variables were created to flag households whose data is imputed rather than reported in the original survey. The imputation process for these variables is described below.

HOUSEHOLD INCOME

Household income was not reported for 3642 (8.6%) of households. For these households, the most likely income was calculated by comparing households of the same size, number of vehicles owned, and tenure type (own versus rent). The imputed household income is the average income category of the comparable households. For cases where fewer than ten households were considered comparable, households were grouped to provide a larger sample.

HOUSEHOLD RESIDENTIAL TYPE

The residential unit type was not available for 69 households (0.2% of the full CHTS). Residential unit type was imputed for these households by examining the residential unit types of households with the same size, number of vehicles owned, and household income category. The imputed residential unit type (single family, multifamily, or other) is set to be most common residential unit type for matching households.

AGE OF HEAD OF HOUSEHOLD

Age of the head of household could not be determined for one household. This household was assumed to have a head in the age 25-64 category.

ESTIMATION OF SURVEY WEIGHTS

Surveys are meant to capture the characteristics of an entire population by randomly sampling a small proportion of the population. Often, a perfectly random sample is hard to achieve–some groups are difficult to survey and are underrepresented, other groups are over represented. To balance this bias, sample weights are estimated to 'reshape' the sample. Fehr & Peers estimated household sample weights for the CHTS to balance the survey sample to match county-level percentages for several variables as reported in the 2012 American Community Survey 5-year estimates. Variables used as controls for the re-weighting are:

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

Counties were weighted either individually or, in the case of counties with fewer CHTS households, in groups of at most four adjacent counties weighted as a single unit. The multi-county groups used for weighting where single-county sample sizes were insufficient were:

- Lake and Mendocino Counties
- Del Norte, Siskiyou, Lassen, Modoc, Plumas, Sierra, and Nevada Counties
- Shasta, Tehama, Trinity, Glenn, and Colusa Counties
- Yolo, Yuba, and Sutter Counties
- Alpine, Amador, Calaveras, Mariposa, Tuolomne, Inyo, and Mono Counties
- Monterey and San Benito Counties

Expansion weights, suitable for expanding CHTS data to represent the full population of a county, were calculated for each county individually. Separate expansion weights exist for all households, and for households whose travel day is a weekday.

Weighting reports for each of the eight San Joaquin Valley counties can be found in the appendix to this memo.

ATTACH MPO AND CENSUS DESIGNATED PLACE INFORMATION

Fields are added to the household record listing the MPO and the Census Designated Place (CDP) of the household location; fields are added to the trip record listing the MPO and CDP of the trip origin and destination. Many MPOs in California are a single county; in this case the MPO code is identical to the county FIP code. Multi-county MPOs are coded as follows:

1. AMBAG: Santa Cruz, Monterey, and San Benito Counties
2. MTC: Alameda, Contra Costa, Solano, Napa, Sonoma, Marin, San Francisco, San Mateo, and Santa Clara Counties
3. SACOG: Sacramento, Yolo, Yuba, Sutter, and portions of El Dorado and Placer counties
4. SCAG: Los Angeles, Ventura, Orange, Riverside, Imperial, and San Bernadino counties
5. TMPO: Portions of El Dorado and Placer counties

El Dorado and Placer counties are divided between two MPOs: the Tahoe Basin area lies in TMPO while the remainder of the counties are part of SACOG. Records are coded into the proper MPO using their census tract.

ATTACH PERSON DATA

A limited amount of data from the raw CHTS person file is attached to the final household and trip records. Demographic information such as the traveler's age, racial identity, worker and student status is attached to the trip record. Fields indicating the number of household members in various age categories are added to the household record, along with a field indicating the age category of the head of household. The age categories used are:

- Age 0-2
- Age 3-4
- Age 5-14
- Age 15-17
- Age 18-24
- Age 25-34
- Age 35-44
- Age 45-54
- Age 55-64
- Age 65-74
- Age 75 and up

APPENDIX B:

CALIFORNIA HOUSEHOLD TRAVEL SURVEY DATA DICTIONARY

MEMORANDUM

Date: April 21, 2015

To: File

From: Jennifer Ziebarth

Subject: Instructions for using CHTS cleaned data

WC14-3115

The purpose of this memo is to provide instructions for using the cleaned and re-weighted California Household Travel Survey data. It includes data dictionaries for both the household and trip files, and important instructions regarding the use of household and trip weights.

JOINING THE HOUSEHOLD AND TRIP FILES

The "sampno" variable is a household ID code which can be used to join the household and trip files.

USING THE WEIGHTS

Please note that the CHTS data comes with survey weights which must be correctly applied to yield accurate summaries.

There are three types of weights included with the cleaned CHTS data:

- Household-level weights (hhweight and hhexpweight)
- Trip-level weights (tripweight and tripexpweight)
- Trip correction factor (tcf)

In order to use CHTS data accurately, one or more of these weights must be applied. The instructions which follow will describe when to use each type of weight, and will explain and give examples of using the weights.

DETERMINING WHICH WEIGHTS TO USE

To determine which weights to use, consider the following criteria:

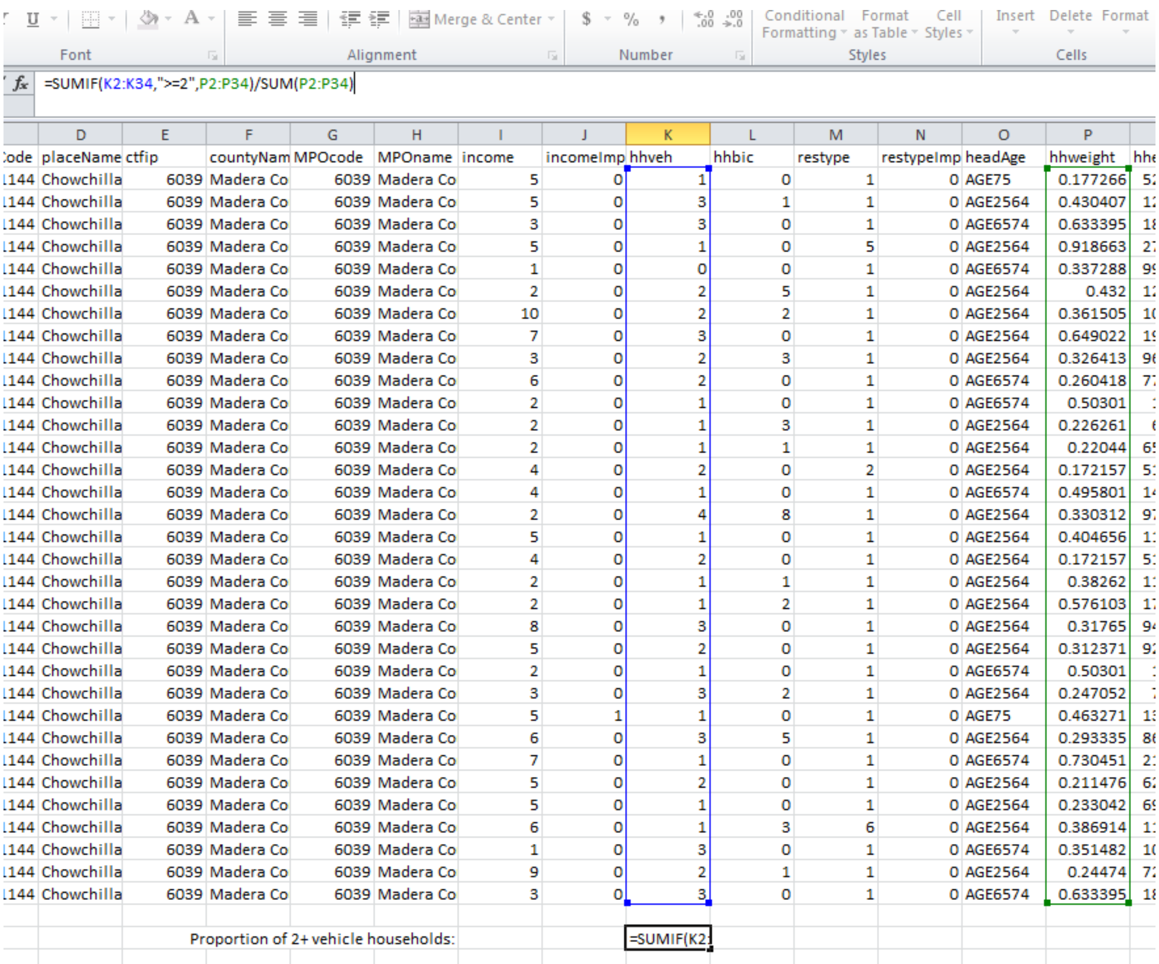
- When summing or averaging values that pertain to households, use the household weights *hhweight* or *hhexpweight*. Examples include calculating the percentage of 0-vehicle households in a region, calculating the average number licensed drivers per household, or calculating the number of households in a region with school-aged children. The *hhweight* weighting factor will weight households relative to one another and is useful for computing percentages, while the *hhexpweight* factor will also provide estimates of the total number of households.
- When summing or averaging values that pertain to trips from different households, use the trip weights *tripweight* or *tripexpweight*. Examples include calculating the average distance per vehicle trip, calculating mode shares, or calculating the distribution of travel times. As with the household weights, *tripweight* will weight trips relative to one another and is useful for computing percentages, while the *tripexpweight* factor will also provide estimates of the total number of trips.
- When summing or averaging values that pertain to trips, within a single household, use the trip correction factor *tcf*. Often this is not done on its own but as the first of a two-step process; examples include calculating average VMT per household: first sum the VMT per household using the *tcf* weight, then average each household's VMT using either the *hhweight* or the *hhexpweight* weight. Similar two-step processes should be used to calculate the number of person-trips per household and the number of vehicle-trips per household.
- **When in doubt about which weight to use, please contact Jennifer Ziebarth.** I'm more than happy to help or to double-check that you've chosen the right weighting factor for your situation.

EXAMPLE 1: PROPORTION OF 2-OR-MORE VEHICLE HOUSEHOLDS

To calculate the proportion of households with two or more vehicles, sum the weights of households with 2 or more vehicles, then divide by the sum of all household weights. In equation form:

$$Proportion\ of\ 2 - vehicle\ households = \frac{\sum_{2\ or\ more\ vehicle\ households}(household\ weight)}{\sum_{all\ households}(household\ weight)}$$

To do this in Excel, use the SUMIF and SUM functions:



ode	placeName	ctfip	countyNam	MPOcode	MPOname	income	incomeImp	hhveh	hhbic	restype	restypeImp	headAge	hhweight	hhe
1144	Chowchilla	6039	Madera Co	6039	Madera Co	5	0	1	0	1	0	AGE75	0.177266	52
1144	Chowchilla	6039	Madera Co	6039	Madera Co	5	0	3	1	1	0	AGE2564	0.430407	12
1144	Chowchilla	6039	Madera Co	6039	Madera Co	3	0	3	0	1	0	AGE6574	0.633395	18
1144	Chowchilla	6039	Madera Co	6039	Madera Co	5	0	1	0	5	0	AGE2564	0.918663	27
1144	Chowchilla	6039	Madera Co	6039	Madera Co	1	0	0	0	1	0	AGE6574	0.337288	99
1144	Chowchilla	6039	Madera Co	6039	Madera Co	2	0	2	5	1	0	AGE2564	0.432	12
1144	Chowchilla	6039	Madera Co	6039	Madera Co	10	0	2	2	1	0	AGE2564	0.361505	10
1144	Chowchilla	6039	Madera Co	6039	Madera Co	7	0	3	0	1	0	AGE2564	0.649022	19
1144	Chowchilla	6039	Madera Co	6039	Madera Co	3	0	2	3	1	0	AGE2564	0.326413	96
1144	Chowchilla	6039	Madera Co	6039	Madera Co	6	0	2	0	1	0	AGE6574	0.260418	77
1144	Chowchilla	6039	Madera Co	6039	Madera Co	2	0	1	0	1	0	AGE6574	0.50301	1
1144	Chowchilla	6039	Madera Co	6039	Madera Co	2	0	1	3	1	0	AGE2564	0.226261	6
1144	Chowchilla	6039	Madera Co	6039	Madera Co	2	0	1	1	1	0	AGE2564	0.22044	65
1144	Chowchilla	6039	Madera Co	6039	Madera Co	4	0	2	0	2	0	AGE2564	0.172157	51
1144	Chowchilla	6039	Madera Co	6039	Madera Co	4	0	1	0	1	0	AGE6574	0.495801	14
1144	Chowchilla	6039	Madera Co	6039	Madera Co	2	0	4	8	1	0	AGE2564	0.330312	97
1144	Chowchilla	6039	Madera Co	6039	Madera Co	5	0	1	0	1	0	AGE2564	0.404656	11
1144	Chowchilla	6039	Madera Co	6039	Madera Co	4	0	2	0	1	0	AGE2564	0.172157	51
1144	Chowchilla	6039	Madera Co	6039	Madera Co	2	0	1	1	1	0	AGE2564	0.38262	11
1144	Chowchilla	6039	Madera Co	6039	Madera Co	2	0	1	2	1	0	AGE2564	0.576103	17
1144	Chowchilla	6039	Madera Co	6039	Madera Co	8	0	3	0	1	0	AGE2564	0.31765	94
1144	Chowchilla	6039	Madera Co	6039	Madera Co	5	0	2	0	1	0	AGE2564	0.312371	92
1144	Chowchilla	6039	Madera Co	6039	Madera Co	2	0	1	0	1	0	AGE6574	0.50301	1
1144	Chowchilla	6039	Madera Co	6039	Madera Co	3	0	3	2	1	0	AGE2564	0.247052	7
1144	Chowchilla	6039	Madera Co	6039	Madera Co	5	1	1	0	1	0	AGE75	0.463271	13
1144	Chowchilla	6039	Madera Co	6039	Madera Co	6	0	3	5	1	0	AGE2564	0.293335	86
1144	Chowchilla	6039	Madera Co	6039	Madera Co	7	0	1	0	1	0	AGE6574	0.730451	21
1144	Chowchilla	6039	Madera Co	6039	Madera Co	5	0	2	0	1	0	AGE2564	0.211476	62
1144	Chowchilla	6039	Madera Co	6039	Madera Co	5	0	1	0	1	0	AGE2564	0.233042	69
1144	Chowchilla	6039	Madera Co	6039	Madera Co	6	0	1	3	6	0	AGE2564	0.386914	11
1144	Chowchilla	6039	Madera Co	6039	Madera Co	1	0	3	0	1	0	AGE6574	0.351482	10
1144	Chowchilla	6039	Madera Co	6039	Madera Co	9	0	2	1	1	0	AGE2564	0.24474	72
1144	Chowchilla	6039	Madera Co	6039	Madera Co	3	0	3	0	1	0	AGE6574	0.633395	18
			Proportion of 2+ vehicle households:					=SUMIF(K2						

To do this in R, use the sum function, identifying the subset of households with at least two vehicles in the numerator and all households in the denominator.

```
> prop_2plus <- sum(chowchilla$hhweight[chowchilla$hhveh>=2]) / sum(chowchilla$hhweight)
> prop_2plus
[1] 0.4930628
> |
```

EXAMPLE 2: AVERAGE TRIP DISTANCE

To calculate average trip distance for a collection of trips, sum the products of each trip distance multiplied by the trip weight, then divide by the sum of all trip weights. In equation form:

$$Average\ trip\ distance = \frac{\sum_{trips}(trip\ distance) * (trip\ weight)}{\sum_{trips}(trip\ weight)}$$

To do this in Excel, use the SUMPRODUCT and SUM functions:

Font | Alignment | Number | Styles | Cells

=sumproduct(R2:R94,BA2:BA94)/sum(BA2:BA94)

	D	E	F	G	H	Q	R	AB	AO	AZ	BA	BB	BC
	dTract	oPlace	oPlaceNam	dPlace	dPlaceNam	tripPurp	totalDist	modeString	age	tcf	tripweight	tripexpweight	
01	300	1144	Chowchilla	1144	Chowchilla	NHB	5.664943	Drive Alone	62	1.085538	0.186883	67.43078	
00	300	1144	Chowchilla	1144	Chowchilla	HBO	0.664659	Drive Alone	62	1.331198	0.229175	82.69053	
00	300	1144	Chowchilla	1144	Chowchilla	HBO	0.926246	Drive Shared 2	62	1.331198	0.229175	82.69053	
00	300	1144	Chowchilla	1144	Chowchilla	HBO	0.872687	Drive Alone	63	1.08895	0.187471	67.64272	
00	300	1144	Chowchilla	1144	Chowchilla	HBO	0.872687	Drive Alone	63	1.08895	0.187471	67.64272	
00	300	1144	Chowchilla	1144	Chowchilla	HBO	0.926246	Drive Shared 2	63	1.331198	0.229175	82.69053	
00	300	1144	Chowchilla	1144	Chowchilla	HBS	0.64899	Drive Shared 2	60	2.174432	0.83198	300.1934	
00	300	1144	Chowchilla	1144	Chowchilla	HBS	0.644164	Drive Shared 2	60	2.174432	0.83198	300.1934	
00	300	1144	Chowchilla	1144	Chowchilla	HBS	0.64899	Drive Shared 2	58	2.174432	0.83198	300.1934	
00	300	1144	Chowchilla	1144	Chowchilla	HBS	0.64899	Drive Shared 2	58	2.174432	0.83198	300.1934	
00	202	1144	Chowchilla	1144	Chowchilla	HBO	2.994741	Walk	18	0.696995	0.401541	144.8832	
02	300	1144	Chowchilla	1144	Chowchilla	HBO	2.994741	Drive Shared 2	18	0.988271	0.569346	205.4302	
02	300	1144	Chowchilla	1144	Chowchilla	HBO	5.840582	Drive Alone	77	1.188906	0.377656	136.265	
00	300	1144	Chowchilla	1144	Chowchilla	NHB	0.913314	Drive Shared 3	27	1.331198	0.328875	118.6639	
00	300	1144	Chowchilla	1144	Chowchilla	HBO	1.999179	Drive Alone	27	1.331198	0.328875	118.6639	
02	300	1144	Chowchilla	1144	Chowchilla	HBO	0.644646	Drive Alone	37	1.08895	0.319427	115.255	
00	202	1144	Chowchilla	1144	Chowchilla	HBO	0.642672	Drive Shared 3	37	1.08895	0.319427	115.255	
02	300	1144	Chowchilla	1144	Chowchilla	HBO	1.388131	Drive Shared 2	37	1.331198	0.390487	140.8946	
00	202	1144	Chowchilla	1144	Chowchilla	HBO	1.388131	Drive Alone	37	1.331198	0.390487	140.8946	
02	300	1144	Chowchilla	1144	Chowchilla	HBO	0.644646	Drive Shared 3	31	1.331198	0.390487	140.8946	
00	300	1144	Chowchilla	1144	Chowchilla	NHB	2.387291	Drive Alone	31	1.331198	0.390487	140.8946	
00	300	1144	Chowchilla	1144	Chowchilla	NHB	1.514051	Drive Alone	31	1.331198	0.390487	140.8946	
00	202	1144	Chowchilla	1144	Chowchilla	HBO	1.388131	Drive Shared 2	31	1.331198	0.390487	140.8946	
02	201	1144	Chowchilla	1144	Chowchilla	HBK	6.436982	School Bus	10	1.365993	0.400693	144.5773	
01	300	1144	Chowchilla	1144	Chowchilla	NHB	5.901662	School Bus	10	0.988271	0.289894	104.5991	
00	202	1144	Chowchilla	1144	Chowchilla	HBO	0.642672	Drive Shared 3	10	1.188906	0.348748	125.8344	
02	202	1144	Chowchilla	1144	Chowchilla	HBK	2.771092	School Bus	8	1.208368	0.354457	127.8942	
02	202	1144	Chowchilla	1144	Chowchilla	HBK	2.773391	School Bus	8	1.173979	0.344369	124.2544	
02	300	1144	Chowchilla	1144	Chowchilla	HBO	1.388131	Drive Shared 2	8	1.08895	0.319427	115.255	
00	202	1144	Chowchilla	1144	Chowchilla	HBO	1.388131	Drive Shared 2	8	1.08895	0.319427	115.255	
02	300	1144	Chowchilla	1144	Chowchilla	HBW	2.674768	Drive Alone	65	1.079488	0.228286	82.3697	
00	300	1144	Chowchilla	1144	Chowchilla	WBO	0.242534	Drive Alone	65	1.273109	0.269232	97.14383	
00	202	1144	Chowchilla	1144	Chowchilla	HBS	2.490271	Drive Alone	65	1.273109	0.269232	97.14383	
02	300	1144	Chowchilla	1144	Chowchilla	HBW	2.674768	Drive Alone	65	1.079488	0.228286	82.3697	
00	202	1144	Chowchilla	1144	Chowchilla	HBW	3.015911	Drive Alone	65	1.079488	0.228286	82.3697	
02	201	1144	Chowchilla	1144	Chowchilla	HBW	6.905395	Drive Alone	59	0.988271	0.208996	75.40944	
01	202	1144	Chowchilla	1144	Chowchilla	HBW	6.905395	Drive Alone	59	1.188906	0.251425	90.71877	
				Average trip distance			=sumproduct(R2:R94,BA2:BA94)/sum(BA2:BA94)						

To do this in R, use the weighted.mean function:

```
> weighted.mean(chowchilla_ii_trips$totalDist,chowchilla_ii_trips$tripweight)
[1] 2.282369
>
```

EXAMPLE 3: VMT PER HOUSEHOLD

To calculate the average VMT per household, we need to work with both the trips and the households data, and to use two different weights at different steps of the process. Note that the "sampno" variable is a household ID which can be used to join the household and trip data to each other.

The first step in calculating VMT per household is to find the sum of all vehicle trip distances for each household, using the trip correction factor as a weight. Note that to select vehicle trips, you can select trips for which autoDriver=1; this will select each vehicle trip exactly once. The total VMT per household is the sum $VMT = \sum_{vehicle\ trips}(trip\ distance) * (tcf)$.

The second step in calculating VMT per household is to find the weighted average of all of the household VMTs just calculated. Because we're working per household, we need to use the household weights:

$$Average\ VMT\ per\ household = \frac{\sum_{households}(household\ VMT) * (household\ weight)}{\sum_{households}(household\ weight)}$$

DATA DICTIONARY: HOUSEHOLDS

The following table documents the variables in the cleaned household data file.

HOUSEHOLDS FILE DATA DICTIONARY

Variable	Description
sampno	Household ID
hctract	Census tract of household residence. A 10-digit ID which includes the county FIP as well as the census tract.
placeCode, placeName	Census Designated Place of household residence
ctfip,countyName	County of household residence
MPOcode, MPOname	MPO of household residence. Same as county for 1-county MPOs.
servicepop	Service population: Jobs + workers within 45 minutes by auto (time-decay-weighted)
income, incomeImputed	Household income category, flag for imputed data 1 = Less than $10,000 2 = $10,000 - $24,999 3 = $25,000 - $34,999 4 = $35,000 - $49,999 5 = $50,000 - $74,999 6 = $75,000 - $99,999 7 = $100,000 - $149,999 8 = $150,000 - $199,999 9 = $200,000 or more
hhsize	Number of household residents
hhemp, hhstu, hhlic	Number of household workers, students, driver's license holders
hhveh, hhbic	Number of vehicles and number of bicycles owned by household

HOUSEHOLDS FILE DATA DICTIONARY

Variable	Description
restype, restypeImputed	Residential unit type, flag for imputed data
headAge, headAgeImputed	Age category of HH head, flag for imputed data
tripMonth	Month of travel day
tripDay	Day of week for travel day
householdTrips	Total number of person-trips taken by household members on the travel day
Age0002, Age0304, Age0514, Age1517, Age1824, Age2534, Age3544, Age4554, Age5564, Age6574, Age75	The number of household residents in each age category
hhweight	Household weight
hhexpweight, hhexpweight_weekday	Household expansion weight for all households and for weekday subset of households

Data sources: 2012 CHTS household and person files, as cleaned and prepared by F&P; for details see the CHTS data preparation memo.

DATA DICTIONARY: TRIPS

The following table documents the variables in the cleaned trips data file.

TRIPS FILE DATA DICTIONARY

Variable	Description
sampno, perno	Household ID, person ID
chainno, numLegs	Trip chain ID, number of legs in trip chain
dep_hr, dep_min, arr_hr, arr_min	Time of trip departure & arrival (hour, minute)
tripPurp	Trip purpose (7 categories)
modeString	Trip mode (16 categories)
totalDist, totalTime	Total trip distance (miles) and time (minutes)
oTract, dTract	Census tract of trip origin and destination. (10-digit number, includes county FIP code)

TRIPS FILE DATA DICTIONARY

Variable	Description
pTract, aTract	Census tract of trip production and attraction
oPlace, oPlaceName, dPlace, dPlaceName	Census Designated Place of trip origin and destination
pPlace, pPlaceName, aPlace, aPlaceName	Census Designated Place of trip production and attraction
oFIP, oCountyName, dFIP, dCountyName	County of trip origin and destination
pFIP, pCountyName, aFIP, aCountyName	County of trip production and attraction
oMPO, oMPOname, dMPO, dMPOname	MPO of trip origin & destination (same as county for one-county MPOs)
pMPO, pMPOname, aMPO, aMPOname	MPO of trip production and attraction
oServicePop, dServicePop	Service population (jobs + workers within 45 minutes by auto, time-decay-weighted) at trip origin and distination
opurp, dpurp	Purpose recorded at trip origin and destination
opurp1,opurp2,opurp3,dpurp1,dpurp2,dpurp3	Detailed activity purpose codes at trip origin and destination
totalDist	Total trip distance (including transit access/egress)
accessDist, xferDist, egressDist	Transit access, transfer , egress distances
IVT, accessTime, xferTime, egressTime, waitTime	In-vehicle time, transit access, transfer, egress, and wait times
dwellTime	Time spent at trip destination
autoDriver	Flag for driver of auto trips
nonHHDriver	Flag for trips where the respondent is a passenger on a trip where a non-HH member is the driver
hhmem, nonhhmem	Count of HH and non-HH passengers on trip (not including the driver)
escortFlag	Flag for trip whose only discernable purpose is to escort another person
accMode, egrMode	Transit access and egress modes
accOcc, egrOcc	Vehicle occupancy of access and egress modes
age	Age of trip-maker
gender,ntvty, hisp,race,disab	Gender,nativity, Hispanic & racial identity, disability status of trip-maker

TRIPS FILE DATA DICTIONARY

Variable	Description
worker,student, schoolType	Worker & student status, and school type of trip-maker
license, transPass	Driver's license, transit pass status of trip-maker
tcf, tripweight	Trip correction factor , trip weight

Data sources: Data sources: 2012 CHTS person, place, and activity files, as cleaned and prepared by F&P; for details see the CHTS data preparation memo.

APPENDIX C:

SIMPLE SUMMARIES OF CHTS DATA

MEMORANDUM

Date: December 29, 2015

To: File

From: Jennifer Ziebarth

Subject: **Data dictionary for CHTS simple summaries**

WC14-3115

The purpose of this memo is to provide a data dictionary for the "simple" summaries of CHTS data. These summaries come in both Excel (.xlsx) and csv (.csv) formats. The summaries have one record for each geographic unit, and are suitable for joining to a shapefile for visualization in GIS. The data summarized here includes the most commonly requested data from the CHTS, including mode shares, trip purposes, trip distance and trip time.

DATA DICTIONARY: CHTS SIMPLE SUMMARIES

Grouping	Variable	Description
Geography	geogCode, geogName, geogType, lookup	Code, name, and type of geography (eg state, county, MPO, or "place" (city or named place recognized by census). The lookup field is useful for creating VLOOKUPs in Excel, and helps to distinguish between cities and counties with the same name (eg Alameda_place is the city of Alameda; Alameda_county is the county.)
Households, Trips, and Sample Sizes	HHsampleSize, PTsampleSize,VTsampleSize	Number of household, person-trip, and vehicle-trip records in the CHTS for this geography. CAUTION: If there are fewer than 100 households or trips for a geography, then the corresponding summaries should be used with caution. If there are fewer than 30 households for a given geography, it is excluded from this summary. Consult Jennifer Ziebarth for advice on how to proceed.

DATA DICTIONARY: CHTS SIMPLE SUMMARIES

Grouping	Variable	Description
Households, Trips, and Sample Sizes	numHH, numPersonTrips, numVehTrips	The total number of households, person-trips, and vehicle trips represented by the CHTS for this geography.
Person-Trips per Household	PersonTrips_per_HH, PersonTrips_per_HH_HBW, PersonTrips_per_HH_HBO, PersonTrips_per_HH_NHB	The average number of person-trips per household, total and by trip purpose. Includes all travel modes, and all trips regardless of o/d.
Person-Trips per Household	PMT_per_HH, PMT_per_HH_HBW, PMT_per_HH_HBO, PMT_per_HH_NHB	The average number of person-miles traveled per household, total and by trip purpose. Includes all travel modes, and all trips regardless of o/d.
Person-Trips per Household	PHT_per_HH, PHT_per_HH_HBW, PHT_per_HH_HBO, PHT_per_HH_NHB	The average number of person-hours traveled per household, total and by trip purpose. Includes all travel modes, and all trips regardless of o/d.
Vehicle-Trips per Household	VehicleTrips_per_HH, VehicleTrips_per_HH_HBW, VehicleTrips_per_HH_HBO, VehicleTrips_per_HH_NHB	The average number of vehicle-trips per household, total and by trip purpose. Includes all trips regardless of o/d.
Vehicle-Trips per Household	VMT_per_HH, VMT_per_HH_HBW, VMT_per_HH_HBO, VMT_per_HH_NHB	The average number of vehcile-miles traveled per household, total and by trip purpose. Includes all trips regardless of o/d.
Vehicle-Trips per Household	VHT_per_HH, VHT_per_HH_HBW, VHT_per_HH_HBO, VHT_per_HH_NHB	The average number of vehicle-hours traveled per household, total and by trip purpose. Includes all trips regardless of o/d.
Person-Trips per Household (ii only)	PersonTrips_per_HH_ii, PersonTrips_per_HH_HBW_ii, PersonTrips_per_HH_HBO_ii, PersonTrips_per_HH_NHB_ii	The average number of person-trips per household, total and by trip purpose. Includes all travel modes, but only trips *within the named geography*.
Person-Trips per Household (ii only)	PMT_per_HH_ii, PMT_per_HH_HBW_ii, PMT_per_HH_HBO_ii, PMT_per_HH_NHB_ii	The average number of person-miles traveled per household, total and by trip purpose. Includes all travel modes, but only trips *within the named geography*.
Person-Trips per Household (ii only)	PHT_per_HH_ii, PHT_per_HH_HBW_ii, PHT_per_HH_HBO_ii, PHT_per_HH_NHB_ii	The average number of person-hours traveled per household, total and by trip purpose. Includes all travel modes, but only trips *within the named geography*.

DATA DICTIONARY: CHTS SIMPLE SUMMARIES

Grouping	Variable	Description
Vehicle-Trips per Household (ii only)	VehicleTrips_per_HH_ii, VehicleTrips_per_HH_HBW_ii, VehicleTrips_per_HH_HBO_ii, VehicleTrips_per_HH_NHB_ii	The average number of vehicle-trips per household, total and by trip purpose. Includes only trips *within the named geography*.
Vehicle-Trips per Household (ii only)	VMT_per_HH_ii, VMT_per_HH_HBW_ii, VMT_per_HH_HBO_ii, VMT_per_HH_NHB_ii	The average number of vehcile-miles traveled per household, total and by trip purpose. Includes only trips *within the named geography*.
Vehicle-Trips per Household (ii only)	VHT_per_HH_ii, VHT_per_HH_HBW_ii, VHT_per_HH_HBO_ii, VHT_per_HH_NHB_ii	The average number of vehicle-hours traveled per household, total and by trip purpose**.** Includes only trips *within the named geography*.
Person-Trip Distance by mode & purpose	PersonTrip_Avg_Distance_*mode-_purpose*	Average person-trip distance (miles) for each combination of mode and purpose. Includes ii trips (trips internal to the named geography) only.
Person-Trip Time by mode & purpose	PersonTrip_Avg_Time_*mode_purpose*	Average person-trip time (minutes) for each combination of mode and purpose. Includes ii trips (trips internal to the named geography) only.
Daily mode shares	modeShare_*mode_purpose*	Average daily mode share for the listed mode within all trips of the listed purpose. If no purpose is listed, mode share is for trips of all purposes. Includes ii trips (trips internal to the named geography) only.
Peak period mode shares	modeShare_*mode_purpose*_peak	Average peak period mode share for the listed mode within all trips of the listed purpose. For purposes of this summary, peak period is defined as 6-9 AM and 4-7 PM. If no purpose is listed, mode share is for trips of all purposes. Includes ii trips (trips internal to the named geography) only.
Daily purpose shares	purpShare_*mode_purpose*	Average daily purpose share for the listed purpose within all trips of the listed mode. Includes ii trips (trips internal to the named geography) only.
Peak period purpose shares	purpShare_*mode_purpose*_peak	Average peak period purpose share for the listed purpose within all trips of the listed mode. For purposes of this summary, peak period is defined as 6-9 AM and 4-7 PM. Includes ii trips (trips internal to the named geography) only.
Direction Share	dirShare_*direction_purpose*	Average daily share of trips by direction: internal (ii), outgoing (ix), and incoming (xi), within all trips of the given purpose. If no purpose is listed, then share of trips by direction for all purposes combined.

Data sources: 2012 CHTS household, person, place, and activity files, with F&P modifications
Summarized using script MasterCHTSSummaries.R

APPENDIX D:

FLAT SUMMARIES OF CHTS DATA

MEMORANDUM

Date: April 22, 2015

To: File

From: Jennifer Ziebarth

Subject: Data dictionary for CHTS flat summaries

WC14-3115

The purpose of this memo is to provide a data dictionary for the "flat" summaries of CHTS data. These summaries come in both Excel (.xlsx) and csv (.csv) formats. The summaries have one record for each geographic unit, and are suitable for joining to a shapefile for visualization in GIS.

DATA DICTIONARY: CHTS FLAT SUMMARIES

Grouping	Variable	Description
Geography	geogCode, geogName, geogType	Code, name, and type of geography (eg state, county, MPO, or "place" (city or named place recognized by census)
Number of Households and Trips	numHH, HHsampleSize, HH_Warning	Number of households represented by the CHTS for this geography, CHTS household sample size for this geography, and warning indicating whether data should be used with caution (*, 100 households or fewer) or used only when aggregated to include more households (**, 30 households or fewer).
Number of Households and Trips	numVehTrips, VTsampleSize, vehTripWarning	Number of vehicle trips represented by the CHTS for this geography, CHTS vehicle trip sample size for this geography, and warning indicating whether data should be used with caution (*, 100 vehicle trips or fewer) or used only when aggregated to include more vehicle trips (**, 30 vehicle trips or fewer).

DATA DICTIONARY: CHTS FLAT SUMMARIES

Grouping	Variable	Description
Number of Households and Trips	numPersonTrips, PTsampleSize, personTripWarning	Number of person trips represented by the CHTS for this geography, CHTS person trip sample size for this geography, and warning indicating whether data should be used with caution (*, 100 person trips or fewer) or used only when aggregated to include more person trips (**, 30 person trips or fewer).
Demographics	HH1, HH2, HH3, HH4, HH5, hhsize	Percentage of households with 1, 2, 3, 4, or 5+ members; average number of persons per household
Demographics	Veh0,Veh1,Veh2,Veh3,Veh4; hhveh	Percentage of households with 0,1,2,3, or 4+ autos; average number of vehicles per household
Demographics	Inc1, Inc2, Inc3, Inc4, Inc5, Inc6, Inc7, Inc8, Inc9	Percentage of households in each income category: 1. Less than $10,000 2. $10,000 to $24,999 3. $25,000 to $34,999 4. $35,000 to $49,999 5. $50,000 to $74,999 6. $75,000 to $99,999 7. $100,000 to $149,999 8. $150,000 to $199,999 9. $200,000 or more
Demographics	RUG1, RUG3, RUG6	Percentage of households by residential type. RUG1 = Single family; RUG3=Multifamily; RUG6 = Other (eg Mobile home, RV, boat)
Demographics	Age1824,Age2564,Age6574, Age75	Percentage of households by age category of household head
Demographics	Pop0005, Pop0514, Pop1517, Pop1824, Pop2554, Pop5564, Pop6574, Pop75	Average number of residents per HH in each category
Household Summaries	VMT_per_HH_*purpose_mode*	Average VMT per Household by purpose and mode.
Household Summaries	VehicleTrips_per_HH_*purpose_mode*	Average Vehicle Trips per Household by purpose and mode
Household Summaries	PersonTrips_per_HH_*purpose_mode*	Average Person Trips per Household by purpose and Mode
Vehicle Trip Summaries	numVehTrips_*purpose_mode_distribution*	Total number of vehicle trips represented for each combination of purpose, mode, distribution

DATA DICTIONARY: CHTS FLAT SUMMARIES

Grouping	Variable	Description
Vehicle Trip Summaries	vehDist_*purpose_mode_distribution*	Average vehicle trip distance for each combination of purpose, mode, distribution
Vehicle Trip Summaries	vehTime_*purpose_mode_distribution*	Average vehicle trip time for each combination of purpose, mode, distribution
Vehicle Trip Summaries	vehOcc_*purpose_mode_distribution*	Average vehicle occupancy for each combination of purpose, mode, distribution
Person Trip Summaries	numPersonTrips_*purpose_mode_distribution*	Total number of person trips represented for each combination of purpose, mode, distribution
Person Trip Summaries	PersDist_*purpose_mode_distribution*	Average person trip distance for each combination of purpose, mode, distribution
Person Trip Summaries	PersTime_*purpose_mode_distribution*	Average person trip time for each combination of purpose, mode, distribution

Data sources: 2012 CHTS household and person files, with F&P modifications
Summarized using script MasterCHTSSummaries.R

APPENDIX E:
FILTERABLE SUMMARIES OF CHTS DATA

MEMORANDUM

Date: December 29, 2015

To: File

From: Jennifer Ziebarth

Subject: Data dictionary for CHTS filterable summaries

WC14-3115

The purpose of this memo is to provide instructions for using the "filterable" summaries of CHTS data. Unlike the "flat" summaries, which are comparatively small in size, the "filterable" summaries allow for filtering based on multiple criteria, and as such they are quite large files. To simplify the summaries and allow for somewhat smaller file sizes, the filterable summaries are separated into two files, household summaries and trip summaries, which are described below.

INSTRUCTIONS AND HINTS

The filterable summaries allow CHTS data to be viewed by geography as well as selecting households or trips with certain demographic or travel profiles, such as households with 2 or more vehicles owned, or trips internal to the geography.

In most cases, it is possible to select any combination of filter variables and see a summary of the relevant CHTS data. However, note that for some combination the sample size of CHTS households, vehicle trips, or person trips may be quite small. Warning fields indicate whether the data can be used on its own or should be viewed with caution or only when aggregated with other data.

(green)	Large enough sample size for confident reporting.
* (yellow)	Use with caution: sample size may be not be large enough for statistical confidence.
** (red)	Do not use in isolation. Sample size is too small for this result to stand on its own.

OTHER TIPS

- Non-vehicle modes such as bike, walk, or transit always have 0 vehicle trips per household in the household summaries, and 0 vehicle trips in the trip summaries, because these modes do not generate vehicle trips.
- Mode shares (and other "share" variables) are measured relative to mode= "All", with all other filters identical.
- Note that in some cases cities and counties share a name, so you may need to filter on both geogName and geogType to get the result you're looking for.

EXAMPLES

The examples below shows some of the tips above:

	Geography			Filter variables						Summaries per Household								
	geogCode	geogName	geogType	HH size	HH vehicles	HH income	Trip purpose	Mode	Peak	HH total	HH sample size	HH Warning	Vehicle Trips per HH Mea	VMT per HH Mean	VHT per HH Mean	Person Trips per HH Mea	PMT per HH Mean	PHT per HH Mean
345	1797	Tulare	place	All	All	All	All	Bike	All	10,739	57	*	0.0	0.0	0.0	0.0	0.0	0.0
346	6107	Tulare	county	All	All	All	All	Bike	All	113,379	464		0.0	0.0	0.0	0.1	0.1	0.0
347	1797	Tulare	place	All	All	All	All	DriveAlon	All	10,739	57	*	4.4	25.5	1.1	4.4	25.5	1.1
40726	6107	Tulare	county	All	All	All	All	DriveAlon	All	113,379	464		4.9	35.4	1.2	4.9	35.5	1.2
40727	1797	Tulare	place	All	All	All	All	DriveShar	All	10,739	57	*	2.0	6.3	0.4	3.6	12.6	0.6
40728	6107	Tulare	county	All	All	All	All	DriveShar	All	113,379	464		1.8	11.2	0.4	3.3	20.9	0.8
86763	1797	Tulare	place	All	All	All	All	DriveShar	All	10,739	57	*	0.5	0.9	0.1	2.4	3.4	0.2
86764	6107	Tulare	county	All	All	All	All	DriveShar	All	113,379	464		0.9	5.1	0.2	3.0	14.5	0.7
86765	1797	Tulare	place	All	All	All	All	Other	All	10,739	57	*	0.0	0.0	0.0	0.3	0.7	0.1
86766	6107	Tulare	county	All	All	All	All	Other	All	113,379	464		0.0	0.0	0.0	0.3	1.7	0.1
127407	1797	Tulare	place	All	All	All	All	Transit	All	10,739	57	*	0.0	0.0	0.0	0.0	0.3	0.0
127408	6107	Tulare	county	All	All	All	All	Transit	All	113,379	464		0.0	0.0	0.0	0.1	1.8	0.1
127409	1797	Tulare	place	All	All	All	All	Walk	All	10,739	57	*	0.0	0.0	0.0	0.9	0.5	0.1
127410	6107	Tulare	county	All	All	All	All	Walk	All	113,379	464		0.0	0.0	0.0	1.5	0.8	0.3

- The summary shows both the city of Tulare and the county of Tulare; the CHTS has 464 households in the county, but only 57 households in the city. Thus, summaries for the city should be used with caution.
- Vehicle trips, VMT, and VHT per household are 0 for all modes except the drive modes.

Geography			Filter variables								Summaries per person-trip								
geogCode	geogName	geogType	HH size	HH vehicles	HH income	Trip purpose	Mode	Resident	Direction	Peak	Total Number of Person Trips	Person-trip Sample Size	Person Trip Warning	Person-trip Mode Share	Person-trip Purpose Share	Person-trip Resident Share	Person-trip Direction Share	Person-trip Distance Mean	Person-trip Time Mean
1797	Tulare	place	All	All	All	All	All	Res	ii	All	101,614	312		100%	100%	94%	83%	1.4	8.1
1797	Tulare	place	All	All	All	All	Bike	Res	ii	All	98	1	**	0%	100%	100%	100%	2.4	24.0
1797	Tulare	place	All	All	All	All	DriveAlon	Res	ii	All	34,581	132		34%	100%	90%	74%	1.7	9.0
1797	Tulare	place	All	All	All	All	DriveShar	Res	ii	All	31,815	80	*	31%	100%	100%	86%	1.4	8.0
1797	Tulare	place	All	All	All	All	DriveShar	Res	ii	All	21,865	56	*	22%	100%	93%	89%	1.2	5.4
1797	Tulare	place	All	All	All	All	Other	Res	ii	All	3,537	10	**	3%	100%	100%	100%	2.0	14.9
1797	Tulare	place	All	All	All	All	Walk	Res	ii	All	9,718	33	*	10%	100%	100%	99%	0.6	9.0
6107	Tulare	county	All	All	All	All	All	Res	ii	All	1,378,601	3,986		100%	100%	99%	96%	3.8	12.5
6107	Tulare	county	All	All	All	All	Bike	Res	ii	All	7,461	38	*	1%	100%	100%	100%	1.1	17.7
6107	Tulare	county	All	All	All	All	DriveAlon	Res	ii	All	513,362	1,729		37%	100%	99%	94%	4.8	12.8
6107	Tulare	county	All	All	All	All	DriveShar	Res	ii	All	337,192	1,042		24%	100%	99%	95%	4.2	11.5
6107	Tulare	county	All	All	All	All	DriveShar	Res	ii	All	325,740	734		24%	100%	100%	97%	3.3	11.3
6107	Tulare	county	All	All	All	All	Other	Res	ii	All	30,612	79	*	2%	100%	100%	95%	4.5	24.8
6107	Tulare	county	All	All	All	All	Transit	Res	ii	All	6,100	29	**	0%	100%	100%	86%	4.4	37.4
6107	Tulare	county	All	All	All	All	Walk	Res	ii	All	158,133	335		11%	100%	100%	100%	0.5	12.4

- All visible entries for "purpose share" are 100%, because trip purpose has been filtered to show all trip purposes combined ("All")
- Mode shares for rows where mode= "All" are 100%, while mode shares in other rows are smaller than 100%. The 34% mode share in the third row indicates that that row's mode ("Drive Alone") represents 34% of all person trips with the selected characteristics: In the city of Tulare, all household sizes, vehicles, and incomes, trips by residents only ("Res"), and only trips within Tulare ("ii").
- In many cases shown the number of households or trips is too small to draw any conclusions with just the visible data. For example, the second row indicates that the CHTS has only one weekday person trip, made by a resident of the city of Tulare, within that city, by bike. The red highlight serves as a warning that this single trip is not enough to draw wider conclusions.

DATA DICTIONARIES

DATA DICTIONARY: CHTS HOUSEHOLD FILTERABLE SUMMARIES

Type	Variable	Description
Geography	geogCode, geogName, geogType	Code, name, and type of geography (eg state, county, region/MPO, or "place" (city or named place recognized by census)
Filter	HH size	Household size : HH1=1, HH2=2, HH3=3, HH4=4, HH5=5 or more, HH4+ = 4 or more,
	HH vehicles	Number of vehicles owned by household: Veh0=0, Veh1=1, Veh2=2, Veh3=3, Veh4=4 or more, Veh2+ = 2 or more
	HH income	Household income by category: Low = $0 - $49,999; Med = $50,000 - $99,999; High = $100,000 or more

DATA DICTIONARY: CHTS HOUSEHOLD FILTERABLE SUMMARIES

Type	Variable	Description
Summaries Per Household	Trip purpose	Trip purpose, 3 categories (HBW, HBO, NHB). "HB" includes both HBW and NHB.
	Mode	Mode (Active, Drive Alone, Drive Shared 2, Drive Shared 3+, Transit, Other)
	Peak	All = All trips; Peak = 6-9am or 4-7pm; Offpeak = all other times
	HH total	Total number of households
	HH sample size	Number of CHTS household records
	HH Warning	Warning indicating whether data should be used with caution (*, 100 households or fewer) or used only when aggregated to include more households (**, 30 households or fewer).
	Person Trips per HH Mean	Average number of person trips per household
	PMT per HH Mean	Average Person Miles Traveled per household
	PHT per HH Mean	Average Person Hours Traveled per household
	Vehicle Trips per HH Mean	Average number of vehicle trips per household
	VMT per HH Mean	Average Vehicle Miles Traveled per household
	VHT per HH Mean	Average Vehicle Hours Traveled per household

Data sources: 2012 CHTS, as cleaned and summarized by Fehr and Peers

DATA DICTIONARY: CHTS TRIP FILTERABLE SUMMARIES

Type	Variable	Description
Geography	geogCode, geogName, geogType	Code, name, and type of geography (eg state, county, MPO, or "place" (city or named place recognized by census)
Filter	HH size	Household size : HH1=1, HH2=2, HH3=3, HH4=4, HH5=5 or more, HH4+ = 4 or more,
	HH vehicles	Number of vehicles owned by household: Veh0=0, Veh1=1, Veh2=2, Veh3=3, Veh4=4 or more, Veh2+ = 2 or more

DATA DICTIONARY: CHTS TRIP FILTERABLE SUMMARIES

Type	Variable	Description
Summaries per Vehicle Trip	HH income	Household income by category: Low = $0 - $49,999; Med = $50,000 - $99,999; High = $100,000 or more
	Trip purpose	Trip purpose, 3 categories (HBW, HBO, NHB). "HB" includes both HBW and NHB.
	Mode	Mode (Active, Drive Alone, Drive Shared 2, Drive Shared 3+, Transit, Other)
	Resident	Restrict to residents of the listed geography? Res= Only residents; Non= Only non-residents; All = Both residents and non-residents
	Direction	Direction of trip, relative to the listed geography. ii=internal trip within the geography. ix = outgoing trip which starts inside and ends outside the geography. xi= incoming trip which begins outside and ends inside the geography.
	Peak	All = All trips; Peak = 6-9am or 4-7pm; Offpeak = all other times
	Total Number of Vehicle Trips	Total number of vehicle trips
	Vehicle trip sample size	Number of CHTS vehicle trip records
	Vehicle Trip Warning	Warning indicating whether data should be used with caution (*, 100 vehicle trips or fewer) or used only when aggregated to include more vehicle trips (**, 30 vehicle trips or fewer).
	Vehicle Trip Mode Share, Vehicle Trip Purpose Share, Vehicle Trip Resident Share, Vehicle Trip Direction Share	Percent of vehicle trips with the current mode , purpose, residence status, or direction
	Vehicle Trip Distance Mean	Average vehicle trip distance
	Vehicle Trip Time Mean	Average vehicle trip time
	Vehicle Occupancy Mean	Average vehicle occupancy per vehicle trip
	Total Number of Person Trips	Total number of person trips
	Person Trip Sample Size	Number of CHTS person trip records

DATA DICTIONARY: CHTS TRIP FILTERABLE SUMMARIES

Type	Variable	Description
Summaries per Person Trip	Person Trip Warning	Warning indicating whether data should be used with caution (*, 100 person trips or fewer) or used only when aggregated to include more vehicle trips (**, 30 person trips or fewer).
	Person Trip Mode Share, Person Trip Purpose Share, Person Trip Resident Share, Person Trip Direction Share	Percent of person trips with the current mode , purpose, residence status, or direction
	Person Trip Distance Mean	Average person trip distance
	Person Trip Time Mean	Average person trip time

Data sources: 2012 CHTS, as cleaned and summarized by Fehr and Peers

APPENDIX F:

SIMPLIFIED CHTS DATA

MEMORANDUM

Date: October 7, 2015

To: File

From: Jennifer Ziebarth

Subject: How to use simplified CHTS data

WC14-3115

The purpose of this memo is to provide a data dictionary and instructions for using the simplified CHTS data (also known as "pivot summaries"). This data comes in csv format, and are meant to be further processed in Excel.

DATA DICTIONARY

The table below lists the variables present in the simplified CHTS data.

DATA DICTIONARY: SIMPLIFIED CHTS DATA

Grouping	Variables	Description
Location	oTract, dTract, homeTract, workTract	Census tract for trip origin, destination, home location, and (for respondents with a work trip on survey date) work location. Census tracts are listed as 10-digit state+county+tract FIPS code.
Location	oPlace, dPlace, homePlace, workPlace	Census Designated Place (eg city or other named place) for trip origin, destination, home location, and (for respondents with a work trip on survey date) work location.
Location	oFIP, dFIP, homeFIP, workFIP; oCounty, dCounty, homeCounty, workCounty	County (both FIPS code and name) for trip origin, destination, home location, and (for respondents with a work trip on survey date) work location.

DATA DICTIONARY: SIMPLIFIED CHTS DATA

Grouping	Variables	Description
Location	oRegion, dRegion, homeRegion, workRegion	Region for trip origin, destination, home location, and (for respondents with a work trip on survey date) work location. Regions are multi-county MPOs or other multi-county regions as listed below: • AMBAG: Monterey, San Benito, and Santa Cruz Counties • MTC: Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties • SACOG: El Dorado*, Placer*, Sacramento, Sutter, Yolo, and Yuba Counties, excluding Tahoe Basin area of El Dorado and Placer counties • SCAG: Imperial, Los Angeles, Orange, Riverside, San Bernadino, Ventura Counties • TMPO: Tahoe Basin area of El Dorado and Placer Counties • SJV: Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare Counties • North: Butte, Colusa, Del Norte, Glenn, Humboldt, Lake, Lassen, Mendocino, Modoc, Nevada, Plumas, Shasta, Sierra, Siskiyou, Tehama, and Trinity Counties • Central Mountains: Alpine, Amador, Calaveras, Inyo, Mariposa, Mono, and Tuolumne Counties • S Central Coast: San Luis Obispo and Santa Barbara Counties • SANDAG: San Diego County
Mode	Mode	One of the following travel modes: • DriveAlone, DriveShared • Bus, Rail, Ferry • Walk, Bike • Other (eg taxi, schoolbus, paratransit, …)
Purpose	Purpose	One of the following trip purposes: • HBW (home-based work) • HBO (home-based other) • NHB (non-home-based)
Distance	Distance	Total trip distance, rounded to the nearest mile. (Trips under half a mile are reported as distance 0). Note that trip distances in the survey are calculated from respondent's origin and destination, and the route used may not match the respondent's actual route.

DATA DICTIONARY: SIMPLIFIED CHTS DATA

Grouping	Variables	Description
Time	Time	Total trip time (including transit access/egress and waiting), rounded to the nearest 5 minutes. (Trips under 2.5 minutes are reported as time 0.) Note that trip times are self-reported by survey respondents.
Person-Trips	numPersTrips	Weighted and expanded number of person-trips for the given origin, destination, home, work, purpose, mode, distance, and time.
Person-Trips	rawPersTrips	Survey sample size for person-trips with the given origin, destination, home, work, purpose, mode, distance, and time.
Vehicle-Trips	numVehTrips	Weighted and expanded number of vehicle-trips for the given origin, destination, home, work, purpose, mode, distance, and time.
Vehicle-Trips	rawVehTrips	Survey sample size for vehicle-trips with the given origin, destination, home, work, purpose, mode, distance, and time.

Data sources: 2012 CHTS household and person files, with F&P modifications
Summarized using script ModeDistTime_PurposeDistrib.R

ON SURVEY WEIGHTING AND EXPANSION

The variables representing the number of person-trips and vehicle-trips are weighted and expanded to represent the total number of household-related trips of the listed type. While the survey is weighted to match household demographics (such as household size, household income, etc) on a per-county basis, some limitations of the survey should be kept in mind when using the expanded number of trips.

- Because the CHTS is a **household** travel survey, it only measures travel related to (California) households. It does not measure commercial trips, trips made by visitors, or trips made by California residents who are not classified by the census as belonging to households – eg residents of group living quarters such as college dormitories, military bases, medical facilities, or correctional facilities.
- The survey weights supplied with the CHTS were judged to be insufficient for Fehr and Peers purposes and we have therefore re-calculated weights in-house. For more information, see the CHTS data preparation memo or contact Jennifer Ziebarth.

USING THE SIMPLIFIED DATA

The simplified CHTS data is designed to be a flexible format which can produce the most commonly-requested summaries of CHTS data. Within Excel, this data can be filtered, summed, averaged, or brought into pivot tables and pivot charts to create a variety of summaries. Several common examples are detailed below. Two general comments may help you get started:

1. Because the CHTS is a weighted survey, you'll want to use the weighted variables numPersTrips and numVehTrips to count person-trips or vehicle-trips for almost any summary.
2. It's important to always confirm that your summary is based on a large enough sample to provide reasonable representation of the population. For this reason, the sample sizes rawPersTrips and rawVehTrips are also provided. In general, caution should be used when summaries are based on less than 100 total (person- or vehicle-) trips; summaries based on a sample of less than 30 total trips should not be used alone, but should rather be pooled with additional data.

EXAMPLES OF COMMONLY REQUESTED SUMMARIES

MODE SHARE BY TRIP PURPOSE

To create a table of mode shares by trip purpose, start by confirming that the CHTS has enough records to summarize the characteristics of interest. Create a pivot table with modes as rows, trip purposes as columns, and raw person-trips as values. In the Value Field Settings dialog, summarize values by Sum. Add filters to the pivot table to select other characteristics of interest such as residence or work location, origin, destination, etc. In the example below, we've selected records for respondents who live in Oakland and work in Walnut Creek.

homePlace	Oakland			
workPlace	Walnut Creek			
Sum of rawPersTrips	**Column Labels**			
Row Labels	**HBO**	**HBW**	**NHB**	**Grand Total**
DriveAlone	8	12	7	27
Rail		1	1	2
Walk	3		1	4
Grand Total	**11**	**13**	**9**	**33**

Unsurprisingly there aren't very many trips in the CHTS with these characteristics, so we should expand our criteria. A good guideline for mode share summaries is at least 100 trips total, and at least 30 trips for each trip purpose.

Once we've confirmed that the CHTS has enough responses with the characteristics of interest, create a second pivot table with the same rows, columns, and filters, and with number of person-trips as values. In the Value Field Settings dialog, summarize values by Sum, and show the values as percentage of column total.

homePlace	Oakland			
workCounty	Contra Costa			
Sum of numPersTrips	Column Labels			
Row Labels	HBO	HBW	NHB	Grand Total
DriveAlone	59%	84%	68%	70%
DriveShared	29%	0%	15%	14%
Rail	0%	16%	1%	5%
Walk	12%	0%	16%	11%
Grand Total	**100%**	**100%**	**100%**	**100%**

AVERAGE VEHICLE TRIP LENGTH

To estimate average vehicle-trip length, again start by confirming that the CHTS has enough trips with the desired characteristics. Create a pivot table with raw vehicle trips (summarized by sum) in the value field, and any other desired characteristics in filters, rows and columns. Here, we see that there are sufficient records for residents of all three AMBAG counties to allow summarizing vehicle trip length.

homeRegion	AMBAG			
Sum of rawVehTrips	Column Labels			
Row Labels	HBO	HBW	NHB	Grand Total
Monterey	1,597	827	997	3,421
San Benito	429	225	279	933
Santa Cruz	1,170	521	849	2,540
Grand Total	**3,196**	**1,573**	**2,125**	**6,894**

To determine average vehicle trip length by trip purpose, it's easier not to use a pivot table but to work with the relevant portion of the data directly. Set filters for the desired characteristics, and create a new column multiplying trip distance by the number of vehicle trips.

L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
homeRegic	workTr	workPl	workCc	workRe	mode	purpos	distanc	time	numPe	rawPer	numVe	rawVeh	numVT*distance	
AMBAG	NA	NA	NA	NA	DriveAlon	HBO	109	150	0.09	1	0.09	1	=W817*S817	
AMBAG	6E+09	San Leand	Alameda	MTC	DriveShar	HBW	92	170	1.07	1	1.07	1		
AMBAG	6E+09	Fremont	Alameda	MTC	DriveAlon	HBW	90	115	0.1	1	0.1	1		
AMBAG	NA	NA	NA	NA	DriveShar	NHB	111	270	0.19	2	0.09	1		
AMBAG	NA	NA	NA	NA	DriveAlon	HBO	333	340	0.06	1	0.06	1		
AMBAG	NA	NA	NA	NA	DriveShar	NHB	84	110	0.18	1	0.18	1		
AMBAG	NA	NA	NA	NA	DriveAlon	HBO	55	55	0.11	1	0.11	1		
AMBAG	6.05E+09	Los Banos	Merced	SJV	DriveShar	NHB	2	5	1.36	2	0.67	1		
AMBAG	6.05E+09	Los Banos	Merced	SJV	DriveShar	HBO	71	70	1.06	2	0.53	1		

Then, create sums for both the number of vehicle trips and vehicle trips * distance. Because we want to calculate average vehicle trip length for residents of the three AMBAG counties separately, SUMIF statements will help to sum only the values we're interested in.

=SUMIF($K1:$K195510,K$195618,$W1:$W195510)

J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
homeP	homeC	homeRegic	workTr	workPl	workCc	workRe	mode	purpos	distanc	time	numPe	rawPer	numVe	rawVeh	numVT*dist
Unincorpo	Santa Cru:	AMBAG	NA	NA	NA	NA	DriveShar	NHB	87	170	1.01	2	0.52	1	45.24
Santa Cru:	Santa Cru:	AMBAG	NA	NA	NA	NA	DriveAlon	NHB	90	120	0.05	1	0.05	1	4.5
Soquel	Santa Cru:	AMBAG	NA	NA	NA	NA	DriveShar	NHB	41	70	0.66	2	0.33	1	13.53
Santa Cru:	Santa Cru:	AMBAG	NA	NA	NA	NA	DriveShar	NHB	168	360	0.02	2	0.01	1	1.68
Felton	Santa Cru:	AMBAG	NA	NA	NA	NA	DriveShar	NHB	88	30	0.91	1	0.91	1	80.08
Felton	Santa Cru:	AMBAG	6.8E+09	Other US	Other US	Other US	DriveShar	NHB	1	15	0.86	1	0.86	1	0.86
Felton	Santa Cru:	AMBAG	6.8E+09	Other US	Other US	Other US	DriveShar	NHB	1	30	0.69	1	0.69	1	0.69
Rio del M:	Santa Cru:	AMBAG	NA	NA	NA	NA	DriveShar	NHB	163	240	0.91	4	0.25	1	40.75
Total	Monterey												=SUMIF($I		
Total	San Benito														
Total	Santa Cruz														
Total	AMBAG														

Finally, divide the sum of vehicle trips * distance by the sum of vehicle trips, and you have the average vehicle trip distance. Note that this process is creating a weighted average of the trip distance, using the number of vehicle trips as a weight.

	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
	homeP	homeC												numVe	rawVeh	numVT*distance	
7	Felton	Santa Cru:	A	N	N	N	N	D	N	#	#	1	1	0.91	1	80.08	
8	Felton	Santa Cru:	A	#	O	O	O	D	N	1	#	1	1	0.86	1	0.86	
9	Felton	Santa Cru:	A	#	O	O	O	D	N	1	#	1	1	0.69	1	0.69	
0	Rio del M:	Santa Cru:	A	N	N	N	N	D	N	#	#	1	4	0.25	1	40.75	
7																	Average Vehicle Trip Distance
8	Total	Monterey												1685.18		13083.81	7.76
9	Total	San Benito												250.92		2686.28	10.71
0	Total	Santa Cruz												1287.31		9913.47	7.70
1	Total	AMBAG												3223.41		25683.56	7.97
2																	

O/D TABLE

To create an O/D table for a set of geographies, again start by setting up a pivot table with the desired filters, with origins as rows, destinations as columns, and raw trips (either person- or vehicle-trips) as value; this will help you to confirm whether sample sizes are sufficient.

oRegion	SJV								
dRegion	SJV								
Sum of rawVehTrips	**Column Labels**								
Row Labels	**Fresno**	**Kern**	**Kings**	**Madera**	**Merced**	**San Joaquin**	**Stanislaus**	**Tulare**	**Grand Total**
Fresno	3,576	8	51	107	20	1	3	100	3,866
Kern	11	4,024	1		1	1	1	38	4,077
Kings	55	2	798	1				43	899
Madera	110	1	1	633	18	-	6		769
Merced	17	1		19	1,354	6	85	1	1,483
San Joaquin	2			2	7	2,076	104		2,191
Stanislaus	2	1		4	84	104	1,602	2	1,799
Tulare	99	33	46	4		1	1	2,519	2,703
Grand Total	**3,872**	**4,070**	**897**	**770**	**1,484**	**2,189**	**1,802**	**2,703**	**17,787**

In this example, overall we have plenty of vehicle trips to summarize, but for the pairs with a small number of survey records we shouldn't draw any conclusions beyond the obvious one that these pairs don't experience as much interaction as other pairs.

Create a second pivot table with the same rows, columns, and filters, and with number of trips as values. To help distinguish cells with enough sample size to draw conclusions, cells with sufficient sample size are highlighted in green in the example below.

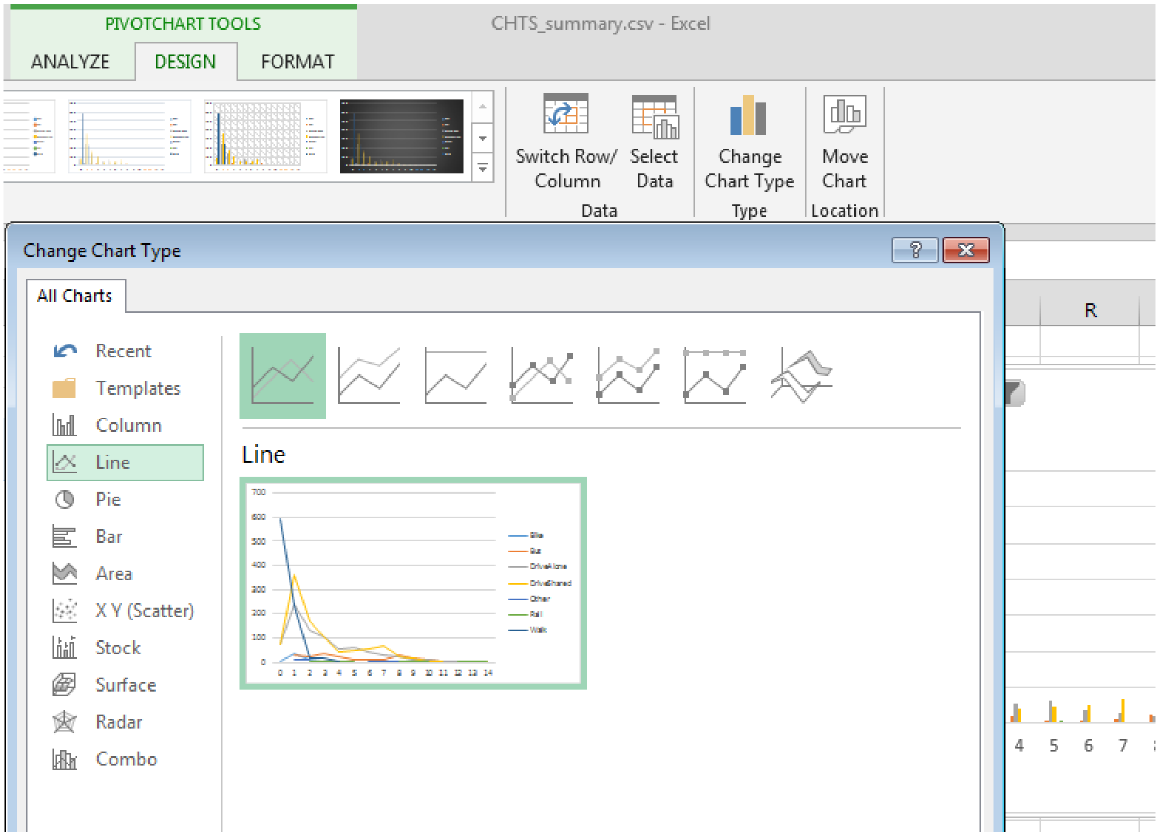
oRegion	SJV								
dRegion	SJV								
Sum of numVehTrips	**Column Labels**								
Row Labels	**Fresno**	**Kern**	**Kings**	**Madera**	**Merced**	**San Joaquin**	**Stanislaus**	**Tulare**	**Grand Total**
Fresno	1,716,778	1,962	13,634	18,028	8,853	266	1,077	22,169	1,782,766
Kern	2,265	1,439,497	162		448	162	211	9,538	1,452,284
Kings	14,181	470	215,434	269				8,006	238,360
Madera	20,314	330	269	165,030	3,725	-	1,463		191,130
Merced	9,487	583		3,981	372,138	716	25,554	121	412,581
San Joaquin	247			1,378	833	1,157,843	37,287		1,197,587
Stanislaus	556	621		1,120	25,876	36,474	793,667	500	858,813
Tulare	21,272	7,294	8,705	1,693		264	410	795,079	834,717
Grand Total	**1,785,099**	**1,450,758**	**238,204**	**191,498**	**411,873**	**1,195,725**	**859,669**	**835,413**	**6,968,238**

GRAPH OF TRIP DISTANCE BY MODE

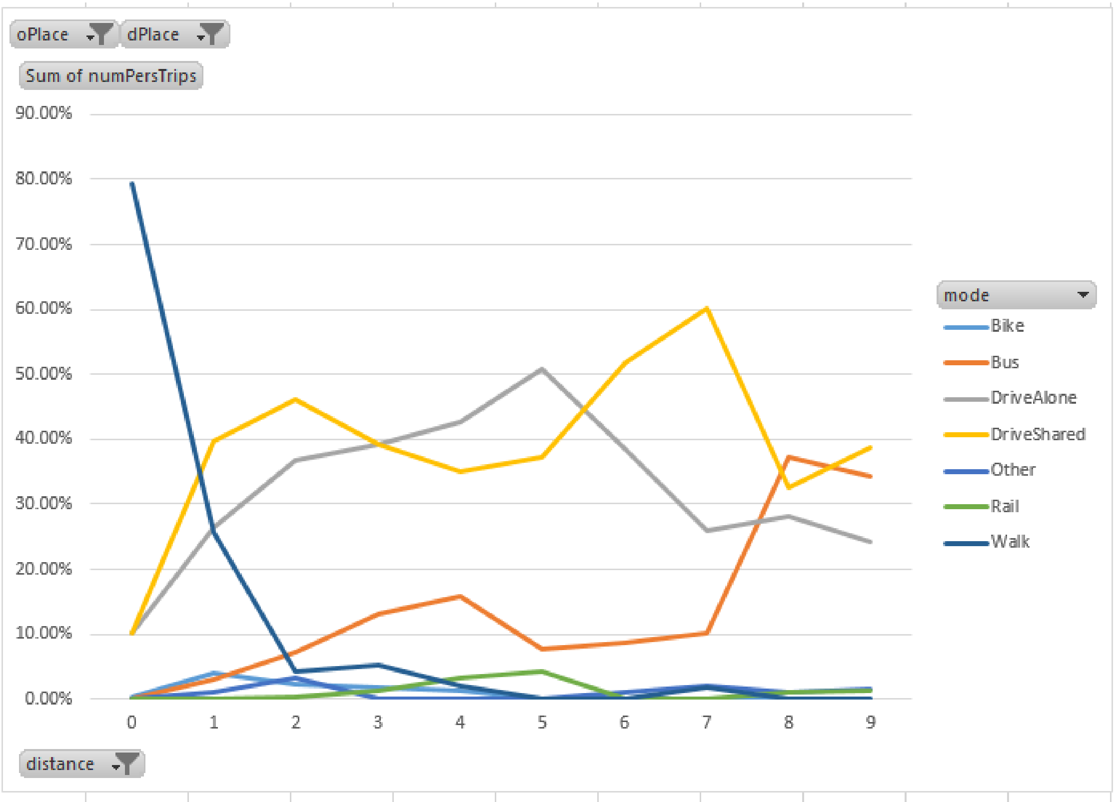
Excel can create pivot tables and pivot charts which appear side-by-side with the same data. As before, confirm that there are enough trips in the CHTS to summarize by creating a pivot table with mode as columns, distance as rows, raw person-trips as values (summarized by sum), and any desired filters. In this example, we certainly have enough trips for most modes, but should be cautious about drawing conclusions about Rail or Other modes. Also, trips of 10 miles or longer are few enough that they should be considered as an aggregate rather than mile-by-mile.

oPlace	Oakland							
dPlace	Oakland							
Sum of rawPersTrips	**Column Labels**							
Row Labels	**Bike**	**Bus**	**DriveAlone**	**DriveShared**	**Other**	**Rail**	**Walk**	**Grand Total**
0	4		58	60			384	506
1	31	16	162	245	10		149	613
2	9	14	110	122	11	1	10	277
3	4	22	85	84		3	4	202
4	1	13	42	38		2	4	100
5		5	53	43		6		107
6		6	36	33	1			76
7		3	20	24	2		1	50
8		7	18	17	1	1		44
9		7	13	12	1	1		34
10		4	6	3		4		17
11		2	5	3				10
12		1	2			1		4
13			1	7		1		9
14				2		1		3
Grand Total	**49**	**100**	**611**	**693**	**26**	**21**	**552**	**2052**

To create the graph, change the value field from raw person trips to number of person trips (still summarized by sum). While the default pivot-chart format of a bar chart does convey some information, it's probably clearer to see if we change the chart type to a line chart:



If we'd rather look at mode share for each distance, we can show the values as a percentage of the row total – remembering that trips of 10 miles are longer may show unreasonable variability because there are so few of them in the survey.


oPlace
dPlace
Sum of numPersTrips
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
0
1
2
3
4
5
6
7
8
9
distance
mode
Bike
Bus
DriveAlone
DriveShared
Other
Rail
Walk

APPENDIX G:

GUIDANCE ON STATIC VALIDATION

TABLE A-1:
DRAFT SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION

Model Component	Validation Statistic	Evaluation Criterion	Source	Notes, further guidance[1]	Documentation
Static Validation					
Transit Assignment	1. Difference between actual ridership to model results for entire system	+/- 20%	2010 RTP Guidelines Daily	Source of actual daily ridership: http://www.ntdprogram.gov/ntdprogram/archives.htm (National transit database for base year, typically 2008) 2010 RTP Guidelines specify difference between actual ridership to model results for a given year by route group (i.e., Local Bus, Express Bus, etc.). However, National transit database only specifies transit ridership for entire system. Valley Transit operators do not use consistent route groups.	Table
Traffic Assignment	2. % of Links within Caltrans Deviation Allowance	At Least 75%	2010 RTP Guidelines *Travel Forecasting Guidelines*, Caltrans, 1992	Source of traffic data: Vehicle count database for each County for comparison Daily, non directional	Table, Figure of location and deviation color (valid, +1, +2, -1, -2). Graph (model validation scatter plot).
	3. % of Screenlines within Caltrans Deviation Allowance	100%	2010 RTP Guidelines *Travel Forecasting Guidelines*, Caltrans, 1992	Daily, non directional	Table
	4. Correlation Coefficient	At Least 0.88	3.2010 RTP Guidelines *Travel Forecasting Guidelines*, Caltrans, 1992	Daily, non directional	Table

[1] Potential solutions to unexpected results will vary-: TMIP Guidelines are the standard reference for troubleshooting and solutions: http://tmip.fhwa.dot.gov/resources/clearinghouse/docs/FHWA-HEP-10-042/FHWA-HEP-10-042.pdf

TABLE A-1:
DRAFT SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION

Model Component	Validation Statistic	Evaluation Criterion	Source	Notes, further guidance[1]	Documentation
	5. Percent Root Mean Squared Error (RMSE) (model-wide)	Below 40%	2010 RTP Guidelines	Daily, non directional	Table
	6. Percent Root Mean Squared Error (RMSE) (functional classification)	Below 40%		No specific criteria available Daily, non directional Functional Class: Freeway Highway Expressway Arterial Collector	Table
	7. Percent Root Mean Squared Error (RMSE) (volume range)	0-4,999 – <116% 5,000 to 9,999 – <43% 10,000 to 19,999 – <28% 20,000 to 39,999 – < 25% 40,000 to 59,000 – < 30% 60,000 to 89,999 – <- 19%	Harvey, G., et al. A Manual of Regional Transportation Modeling Practice for Air Quality Analysis for the Natural Association of Regional Councils, Washington, D.C. July 1993	Is there a minimum number of counts in a volume range or functional class range that we want to consider?	Table
	8. Model Volume to Count Ratio (model-wide)	General relationship (i.e., high or low) between model volumes and counts	2010 RTP Guidelines	Daily, non directional *Minimum Travel Demand Model Calibration and Validation Guidelines for State of Tennessee*. FHWA - identifies that model volumes should be within 5-10% of observed traffic volumes on the highway network. This is the range reference in TMIP, *Model Validation and Reasonableness Checking Manual*, 1997 for screenlines	Table

TABLE A-1:
DRAFT SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION

Model Component	Validation Statistic	Evaluation Criterion	Source	Notes, further guidance[1]	Documentation
	9. Model Volume to Count Ratio (roadway functional classification)	Freeway – +/- 7% Major Arterial – 10% Minor Arterial – 15% Collector – 25%	TMIP, *Model Validation and Reasonableness Checking Manual*, 1997	Daily, non directional Percent difference targets for daily traffic volumes by facility type.	Table
	XX. Distribution of Class by Time of Day	Comparison to collected count data		Total vehicles trips stratified by class and time of day.	Table
	XX. .Distribution of Time of Day by Class	Comparison to collected count data		Total vehicles trips stratified by time of day and class.	Table
	10. Model Volume to Count Ratio (volume range)	<1,000 < 60% 1,000-2,500 < 47% 2,500-5,000 – <36% 5,000-10,000 – <29% 10,000-25,000 – <25% 25,000-50,000 – <22% >50,000 – <21%	TMIP, *Model Validation and Reasonableness Checking Manual*, 1997	Percent difference targets for daily traffic volumes for individual links.	Table
Reasonableness Checks					
Highway and Transit Networks	11. General roadway network and transit line coding	Reasonable ness Check	TDF Model	Centerline	

TABLE A-1:
DRAFT SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION

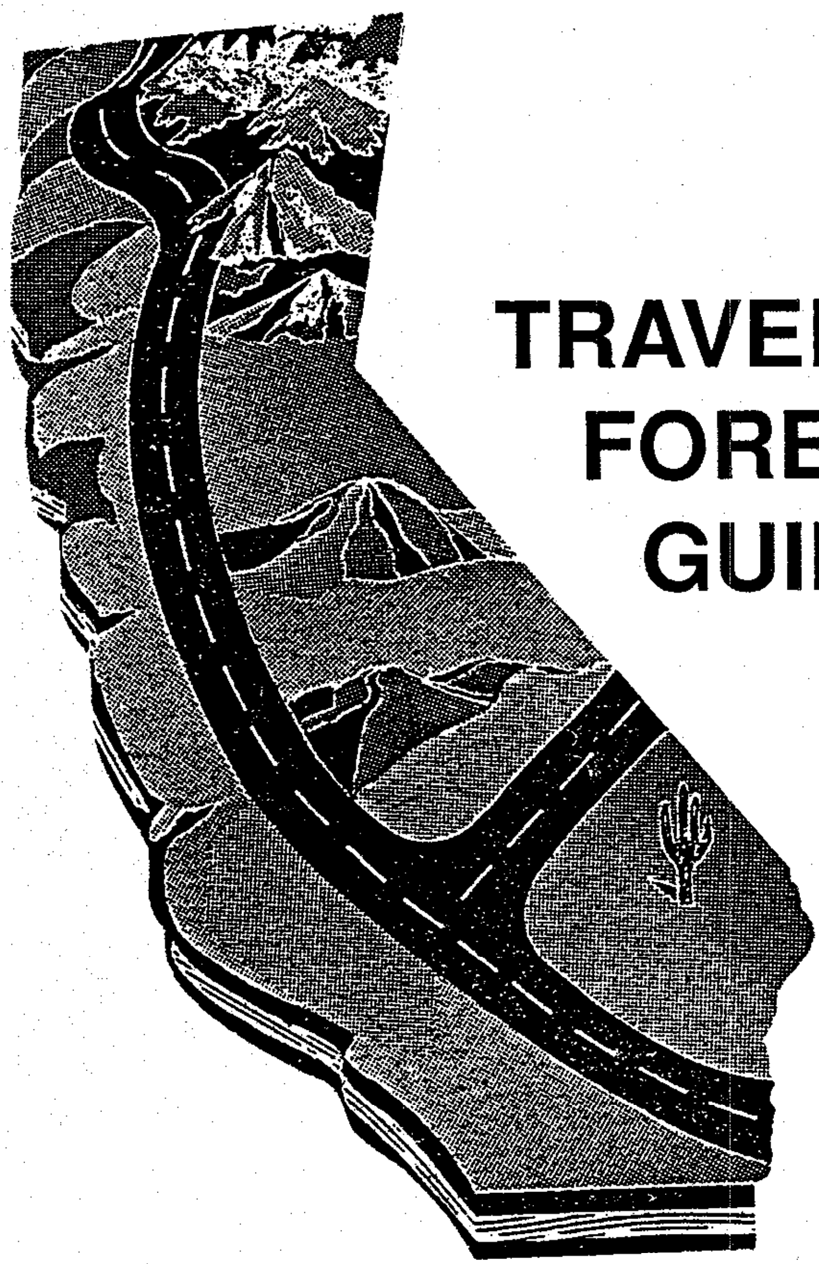
Model Component	Validation Statistic	Evaluation Criterion	Source	Notes, further guidance[1]	Documentation
Trip Generation	12. PA Balance	+/- 10% by purpose and overall	TDF Model	after including IX/XI trips	Table or bar chart comparing balance before and after adjustment
Trip Distribution	13. Zonal Trip Distribution		TDF Model	Select link assignment for gateways, TAZ near gateway, and TAZ central to model network.	Network bandwidth plots.
Vehicle Availability	14.		2010 ACS (Surveys from 2006-2010) and CHTS http://www.dot.ca.gov/hq/tsip/tab/documents/travelsurveys/Final2001_StwTravelSurveyWkdayRpt.pdf	County level comparison Compare percent of households (single and multiple) with 0, 1, 2, 3+ autos CHTS includes survey data for Fresno, Kern, Merced, San Joaquin, Stanislaus, and Tulare counties. (Table 4, Pages 26 – 30)	
Feedback Loop	15.			Convergence	
Comparisons					
Land Use	16. Total Population	Within 3% (based on RHNA criteria)	Census	by income group	Bar chart comparing model to census data.
	17. Total Households	Ideally within 3% (RHNA criteria)	Census or Department of Finance	RHNA allocations are not anticipated until mid 2013	Bar chart comparing model to census data.
	18. Total Employment	Note	Department of Finance	Check reasonableness of retail jobs per household and non-retail jobs per household. Job mix?	Bar chart comparing model to census data.
Trip Generation	19. Person trip rates		CAHHTS, ITE	Convert person trip rates to ITE rates using Ave Veh Occ by purpose	Table
Trip Distribution	20. Average Trip Length by Purpose		CAHHTS	3-County model also has OD survey	Table

TABLE A-1:
DRAFT SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION

Model Component	Validation Statistic	Evaluation Criterion	Source	Notes, further guidance[1]	Documentation
	21. Trip Length Frequency Distribution by Purpose		CAHHTS	3-County model also has OD survey	Graph for each purpose
	XX. Percentage of IX/XI/XX trips for long-distance trips		Cellphone Interregional Data	Compare percentage of II/IX/XI trips from model trip tables with percentage of II/IX/XI trips from cellphone interregional travel data.	Table and/or Map
Trip Assignment	22. Vehicle class		Count data	Percent by class for each period Percent by time period for each class	Table
	23. VMT	+/- 5%	HPMS http://www.dot.ca.gov/hq/tsip/hpms/hpmslibrary	Compare countywide daily VMT estimate from HPMS (Table 10, Page 80) Reasonableness of comparison should be based on how the model compares to HMPS estimates. In general, The model should be VMT forecasts should be lower than the HPMS estimate, since HPMS VMT is estimated for local streets that are not in the model networks.	Table
	24. Travel Speed by Functional Classification		Existing Data	Compare by functional classification based on observed data. For all classifications, summarize average speed, minimum, and maximum. If observed data is not available, compare relative congested speed by functional class.	Table
	25. Average Travel Time by Trip Purpose		CAHHTS	Daily CAHHTS provide travel time for HBW trips and total trips. http://www.dot.ca.gov/hq/tsip/tab/documents/travelsurveys/Final2001_StwTravelSurveyWkdayRpt.pdf	Table
Mode Split	26. Mode split by purpose		CAHHTS	Daily	Pie chart

Source: Fehr & Peers, 2016

Travel



TRAVEL FORECASTING GUIDELINES

CALIFORNIA DEPARTMENT OF TRANSPORTATION

Caltrans

November 1992

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STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TRAVEL FORECASTING GUIDELINES

Prepared in Cooperation
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U.S. Department of Transportation
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California Department of Transportation
California Air Resources Board
Southern California Association of Governments
Metropolitan Transportation Commission
San Diego Association of Governments
Orange County Environmental Management Agency
Kern Council of Governments

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CHAPTER 1

INTRODUCTION

CHAPTER 1. INTRODUCTION

1.1 PROJECT OVERVIEW AND OBJECTIVES

Travel demand forecasting models have been developed and applied over the last three decades to forecast travel demand for long term planning activities such as alternatives analyses, county general plans, and corridor analyses. In recent years, these travel demand forecasting models are being proposed for use in estimating emissions, traffic operational analyses and congestion management planning, brought about by the passage of the Federal Clean Air Act Amendments (1990) and the California Clean Air Act (1988) and the Congestion Management Program (1990). Each of these uses will have different requirements for the accuracy and usefulness of the model outputs, and the validity of the input assumptions and data. These new uses for existing travel demand forecasting models has prompted the California Department of Transportation to prepare this uniform set of travel demand forecasting guidelines.

The state and federal legislative requirements for modeling, particularly California's Congestion Management Program, have resulted in a proliferation of regional or countywide models. While regional modeling used to be practiced by only a few metropolitan planning organizations (MPOs) in the state, the CMP legislation has led to the development of a countywide model by virtually every county in the state that contains an urban area. Many of the regional or countywide models in the state are reasonably sophisticated and constitute good modeling practice, but some MPOs or CMP agencies are using procedures that have not been updated since the 1960s or 1970s or are using defaults provided with the software package being used by the agency. As a result, there is considerable variation in the level of sophistication and the level of accuracy of regional models within the state. This effort to develop statewide guidelines is designed to raise the overall level of the quality of modeling within the state and to provide some consistency in the way that modeling is practiced.

The primary purpose for regional modeling of travel when it was begun in the 1960s and 1970s was to determine the need for major highway investments. This determination was most often made on the basis of projected volumes on particular roadway links and from that estimation of the number of lanes of additional capacity needed or the need for new roadway facilities. When used for this purpose, rough approximations of forecast volumes was sufficient to determine when major new widenings or new facilities were needed. In the current regulatory and legislative environment, however, significantly greater accuracy and sensitivity is necessary. With the current emphasis on meeting air quality standards within the state, a primary focus in this project has been developing guidelines to improve the forecasting of travel activity data as an input to emissions estimation as part of an overall conformity analysis for regional transportation plans and transportation improvement programs. Because of a number of other regulatory and legislative requirements, there is also secondary concern about the accuracy of models for producing inputs to level of service calculations as required by the Congestion Management

Program, the evaluation of transportation control measures as required by the federal and state Clean Air Acts, and for evaluation of alternative modes such as transit or other high occupancy vehicle modes, including carpooling and vanpooling. Within each of these areas, there is concern about inconsistencies and inaccuracies in the model systems and how they represent travel behavior. Greater accuracy is desired as a means of more efficiently planning for transportation facilities or facility management programs. Greater consistency is desired to facilitate comparison of forecast between regions or between agencies within a same region in a process of prioritizing state project funds. For this purpose, there is a desire for the establishment of more consistent methodologies for travel forecasting and for more consistent use of assumptions within the models.

1.2 SUGGESTED USE OF THE GUIDELINES

The primary purpose for this project is to document reasonable and consistent methods that should be used in the preparation of regional travel forecasts developed to yield mobile source emissions inventories. This purpose has been addressed in this project in three major steps. They are as follows:

1. Providing an overview of the state-of-the-practice in transportation modeling.
2. Describing the linkage with mobile source emission inventories, including methods for addressing transportation control measures in the modeling process.
3. Discussing future research and model improvement needs.

The first two steps have resulted in the development of guidelines for minimal acceptable practice within the state. What constitutes minimal acceptable practice is often a function of the specific use for which a model is intended. However, this project has been oriented to models as they are used to provide input to a regional emission inventory or conformity analysis. Given this general purpose, what constitutes minimal acceptable practice would only vary as a function of the complexity of travel behavior in the region and the resources of the agency maintaining the model. This might result in different standards for small, medium, and large agencies. Some of the criteria that distinguish the level of complexity of travel behavior within a region would be --

- o Multimodal Travel: a significant percentage of the passenger travel in the region is by rail, bus, vanpool, or carpool and the model is used to estimate the distribution by the various modes;
- o Multi-County: the model produces forecasts for multiple counties and serves as a regional model that supports subarea models;
- o Population: the model is used for forecasting in a large metropolitan area with multiple employment centers;
- o Congestion: the level-of-service during peak commute periods is significantly different than level-of-service in the off-peak periods and congestion influences route or mode choice; and

o Air Quality: *the region is a serious, severe, or extreme non-attainment* area.

Using these criteria, two categories of regional modeling agencies have been identified. Those that would be considered complex with respect to most or all of these criteria constitute the first group; the second group would be all other agencies maintaining models for the purpose of emission inventories or trip conformity analysis. The first group is defined to include the MPOs for the four major metropolitan areas in the state: Los Angeles - Southern California Association of Governments; San Francisco/Oakland - Metropolitan Transportation Commission; Sacramento - Sacramento Area Council of Governments; and San Diego - San Diego Association of Governments. These four agencies are expected to maintain a more advanced modeling methodology than the other agencies in the state. The guidelines developed in this project specify a minimum acceptable standard that would apply to all agencies throughout the state and a more advanced level of acceptable practice that would be expected from the four larger agencies.

The material in this report is divided into two parts. <u>Specific guidelines are included in boxes</u> for easy identification, but additional text is provided to support the guidelines and to provide some additional assistance in defining the current state-of-the-practice and what constitutes good practice. Given the orientation of this document, it is expected that it would have a variety of audiences. These might include executive management level officials determining whether existing modeling practice is acceptable, or technical staff evaluating their own modeling capabilities. For these audiences, the guidelines can be used for a number of purposes, including the following:

1. To insure that modeling is performed correctly;
2. *To achieve a minimum acceptable level of accuracy;*
3. To provide some standardization and through it, better understanding of the modeling being performed;
4. *To adopt universally accepted definitions and terms;*
5. To meet the requirements of specific legislation in the state; and
6. To conform with what might be established as a legal basis for acceptable practice.

Forecasting of travel behavior involves representation of numerous complex decisions and forecasts can only be expected to roughly approximate reality. The state-of-the-art in travel forecasting continues to improve as individuals pursue new methods for analytically representing the complex decisions being made. Though these guidelines are intended to provide some degree of consistency through standardization of methodology, they are not intended to stifle the creativity that will ultimately lead to improvements in the practice. The guidelines are designed to represent a minimum level of acceptable practice and as such, designed to establish a minimum level of consistency and accuracy. To provide this desired consistency without restricting creativity, the document focuses on the principles of good forecasting practice rather than specifying which methods should be used. Specific methods are frequently used as examples to illustrate concepts or as useful guidance to a modeler without advanced training.

1.3 LEGISLATIVE AND PROCEDURAL REQUIREMENTS FOR USE OF THE MODEL

The Federal Clean Air Act Amendment of 1990 and the 1988 California Clean Air Act required the Environmental Protection Agency (EPA) and the California Air Resources Board (ARB), respectively, to provide guidance in meeting the Clean Air Act requirements. These acts specifically allow modeling to be a vehicle for determining compliance with the State Implementation Plan (SIP). The Federal Clean Air Act Amendment further requires that there be a consistency in methodology between the SIP, the Regional Transportation Plan (RTP), and the Regional Transportation Improvement Program (RTIP), prepared by each region in California. Both the Federal and State Clean Air Acts allow for use of models to verify the results of planning strategies to achieve the air quality standards specified in the acts. The results of the air quality modeling are then in turn verified through the monitoring of the transportation system.

Although final EPA guidelines have not been published, draft guidelines have been submitted and reviewed. The following statement is from the draft guidelines:

> In serious, severe, and extreme ozone areas, and serious CO areas, analyses to support conformity determinations made after January 1, 1994 must utilize a network-based transportation demand model that meets the requirements contained in EPA's VMT Forecasting and Tracking Guidance. The requirements address the year of most recent validation, use of constrained equilibrium for traffic assignments to alternate paths between areas, and recycling to achieve consistency between mode choice and trip distribution and zone-to-zone travel times. In addition, in these areas, analyses must utilize and document a logical correspondence between land development and use (thereby trip origins and destinations), and each transportation system scenario. The model must incorporate speed distributions which realistically reflect actual free-flow travel speeds, as well as average speed distributions over a 24-hour period; it must not limit free-flow speeds to an established speed limit without adequate justification.

During the interim period between adoption of Federal Clean Air Act and the issuance of the formal guidelines, EPA has been reviewing the modeling work performed by state and regional agencies in support of emission reduction programs and state implementation plans, regional transportation plans and regional transportation improvement programs to determine conformity between the plans and to ensure that adequate modeling is performed. EPA has prepared a checklist of questions that have been used in reviewing State Implementation Plans, Regional Transportation Plans, Transportation Improvement Plans, and the modeling that supports them. Both the draft guidelines and the EPA checklist suggests that county and regional agencies are being subjected to increasingly greater scrutiny in the Federal Conformity Analysis.

The California Clean Air Act requires that areas which cannot attain state air quality standards by the end of 1997 ("severe") to adopt transportation control measures as necessary to meet three transportation performance standards, (1) substantially reduce the rate of increase in trips and miles traveled per trip, (2) show no net increase in vehicle emissions after 1997, and (3) achieve a commute period vehicle occupancy of 1.5 by 1999. Areas which can achieve the state standard between 1995 and 1997 ("serious") need to meet the first of these performance standards.

EPA's draft guidelines have resulted in considerable ambiguity about what constitutes minimum acceptable standards, particularly for projects that are now being reviewed for conformity but for which modeling analysis has been done in previous years. The guidelines tend to suggest best practice or state-of-the-art rather than minimum acceptable practice or state-of-the-practice. This distinction was the focus of a conference in Washington D.C. sponsored by the National Association of Regional Councils. That project by NARC will ultimately lead to a manual describing best practices or state-of-the-art but leaving unresolved what constitutes minimum acceptable standards for EPA and ARB to use in evaluating modeling done in support of SIPs, RTPs, and RTIPs. We view a central focus of this project to be a definition of what constitutes minimum acceptable standards within the travel forecasting industry, while at the same time, identifying what constitutes preferred practice and where appropriate, best available practice.

It certainly will be the case that the requirements, or guidelines, will vary depending upon the purpose for which model output is to be used. Forecasts prepared for air quality analysis will have higher standards for accuracy and the estimation of trips because the number of trips is as an important determinant of emission estimates for certain pollutants as the number of vehicle miles traveled. Modeling use in support of Congestion Management Plans will have a higher standard for volume estimates on critical links and nodes because of the need to evaluate level-of-service in connection with the CMP program. Models used for analysis of transit, HOV, ridesharing, or TCM analysis will have a higher standard for mode choice and vehicle occupancy estimation procedures because of the sensitivity of the outcome to that analysis. However, while the standards may vary depending upon the use, a regional agency may choose to achieve a single set of higher level standards because the model system will ultimately be used for all of the purposes defined above. The conformity requirements of the Federal Clean Air Act will also increase the pressure for a consistent set of modeling procedures being used within a region.

The Congestion Management Program requires consistency among modeling procedures, but is ambiguous as to the guidelines for consistency. Section 65089. (c) of the Government Code states that "The agency, (CMA), in consultation with the regional agency, cities, and the county shall develop a uniform database on traffic impacts for use in a countywide transportation computer model and shall approve transportation computer models of specific areas within the county that will be used by local jurisdictions to determine the quantitative impacts of development on the circulation system that are based on the countywide model and standardized modeling assumptions and conventions. The computer models shall be consistent with the modeling methodology adopted by the regional planning agency. The databases used in the models shall be consistent with the databases used by the regional planning agency. Where the regional agency has jurisdiction over two or more counties, the databases used by the agency shall be consistent with the databases used by the regional agency." In order to improve the effectiveness of this consistency requirement, regional transportation agencies will need a set of guidelines for modeling procedures.

1.4 OUTLINE OF THE REPORT

The Caltrans Travel Forecasting Guidelines consists of two chapters that provide guidance on travel demand modeling, one chapter on the requirements that emission inventories places on travel demand modeling, and one chapter on further research that will promote improved travel demand modeling for air quality analysis. Following the introduction, the Travel Forecasting Guidelines is organized as follows:

Chapter 2: Input Data and Assumptions

Chapter 3: Travel Demand Modeling

Chapter 4: Emission Inventory Needs

Chapter 5: Research and Recommendations

CHAPTER 2

INPUT DATA AND ASSUMPTIONS

CHAPTER 2: INPUT DATA AND ASSUMPTIONS

This chapter describes the socio-economic, network, and validation data required for the different levels of regional models and methodologies for obtaining, estimating, coding, and error checking the data.

2.1 OVERVIEW

Input data requirements vary according to the goals and objectives of the model. Analyses designed for estimating transit patronage, or the effectiveness of transportation control measures (TCMs), will require more input data than models designed for assessing local traffic patterns and flows.

Transportation analysts must also balance the desire for more refined data against budget and time limitations. A careful balancing of modeling objectives and resources is required.

The input data requirements depend on whether the objective is base year model development (model calibration or validation) or future year forecasting, although there is overlap between the two. All modeling approaches require as a minimum the number of households and employment in each zone plus a highway network. The advanced approach augments these basic data requirements with additional information on income, population, auto ownership, travel costs, and a transit network.

Acceptable Approach

An acceptable modeling approach designed to forecast daily vehicle trips requires only basic residential (household) and non-residential (employment) data. The household data should be stratified by income or auto ownership and may also be stratified by other significant trip-making variables: number of persons, structure type (single family, multi-family, etc.), density (dwelling units/acre), or workers per household. Stratification of households can be estimated from mean values and existing distribution curves. The employment data need to be stratified into retail and non-retail categories, or basic and non-basic employment.[1] All of the data must then be distributed geographically into zones for the model. Major special generators should also be included, such as colleges, airports, military bases. These models may use "land use" based information, such as acres of residential uses, acres of industrial uses, building permits, and other readily accessible information that most city/county planning departments have, as opposed to "socio-economic" data derived from demographic and economic forecasts, with appropriate comparisons to reflect the compatibility of the data.

Advanced Approach

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[1]Area(e.g., acres) may be also used for the non-residential trip end estimation.

The advanced modeling approach would include (in addition to the data required for the acceptable approach) a stratification of the employment into four or more categories, generally following the Standard Industrial Classification Codes or ITE land use codes. Cost of travel data (tolls, parking costs, fares, auto operating costs, etc.) would be required for mode choice and other models. The management of an agency should determine which approach is acceptable, although this approach is generally applicable only to the state's four largest metropolitan areas: Los Angeles, San Francisco, San Diego, and Sacramento.

The recommended methods for obtaining and forecasting this data are discussed in the remaining sections of this chapter. The discussion is divided into six sections:

- o Socio-economic Data,
- o Special Trip Generators,
- o External Stations and Trips,
- o Network Data,
- o Travel Cost Data, and
- o Calibration and Validation Data.

The discussion generally follows the following format:

o	Objective:	Why are the data needed? What are they used for? How critical are they for the accuracy of the model?
o	Data Sources:	What are the best sources and methods for obtaining and/or estimating the data?
o	Forecasting Procedures:	What techniques should be used to forecast the data?
o	Error Checks:	What coding methods and error checking routines can be employed to ensure accuracy and reliability?

2.2 SOCIO-ECONOMIC DATA

Socio-economic data consist of housing and employment data. These data are supplemented with income and auto ownership data. Table 2-1 summarizes the recommended sources for the input data for models. There is often confusion about the difference between the terms *socioeconomic* and *land use* data. Table 2-2 may help clarify this relationship. Generally land use data involves areal units, such as acres or square footage. Socioeconomic data involves direct observations of social or economic characteristics, such as population, auto ownership, or employment. It is possible to go between the two types of measurements using conversion factors, as noted in Table 2-2.

2.2.1 Household, Income, and Auto Ownership Information

Information on the number of dwelling units, households, population, workers and household income are among the straightforward data to obtain for modeling purposes. The decennial U.S. Census provides most of this information at the census tract and block group levels. Transportation analysts must split (or aggregate) the data into analysis zones.

Objective

The number of households or dwelling units in a zone are used to estimate trip productions by each zone. This is a critical piece of information since trip attractions are normalized to trip production estimates. Household data are generally preferred to dwelling unit information, since dwelling units may be unoccupied. If dwelling units are used to estimate trips, it is important to identify the definition of dwelling unit to include or exclude vacant dwelling units.

Structure type (eg. single family detached versus multi-family), population, income, and auto availability provide supplementary information that improves the accuracy and sensitivity of the trip generation forecasts. Income and/or auto availability are critical pieces of information for the trip generation and mode split analysis.

The number of autos/vans/small trucks available for household use shows a considerable correlation with both person and vehicle trip generation of the household. It also influences mode choice, since zero-auto households are "transit or carpool passenger captive".

Table 2-1
Socio-Economic Input Data Sources

Data Type	Best Source(s)	Back-Up Source	Alternate Estimation Method
Households	Latest U.S. Census. Split Tracts as necessary.	Aerial Photos and Field Counts	Aerial Photos, building permits, utility company records
Employment	Latest Census Transportation Planning Package (CTPP). Split Census Tract data as necessary.	State Employment Office data by zip code. Split zip codes as necessary.	Derive from surveys of floor space and average employee densities. (Not recommended)
Median Income or Households stratified by Income	Latest U.S. Census	Derive stratification from median income	State Franchise Tax Board (Form 540 tax returns)
Average Population per Household or Households stratified by Persons/household	Latest U.S. Census	Derive stratification from ave. population/house (less satisfactory)	None

Note: The committee overseeing this report expressed several different views of what constituted the best sources of input data. Different circumstances may indicate different approaches. The analyst should therefore be cautioned that the above table does not represent definitive judgment in all cases. Each data source has some advantages and some disadvantages.

Table 2-2 Land Use and Socioeconomic Data Relationships			
	Basis	Residential Variables	Non-Residential Variables
Socioeconomic Data	people	households income auto ownership population dwelling unit type	employment
Conversion Factors	density	households per acre	employees per acre or employees per sq. ft.
Land Use Data	area	acres	acres or square feet

Household income or auto ownership must be included if models have a mode split/transit component, since low income and/or zero-car households are much more likely to use transit. Income or auto ownership is desirable even for highway models, since income is highly correlated with the number of trips made.

Non-Household Population is a variable infrequently included in models. This includes persons whose primary or permanent residence is outside of traditional housing units, in barracks, dormitories, nursing homes, congregate care facilities, or institutions (hospitals, prisons). The single characteristic that probably best defines this group is that eating/kitchen facilities are in common (shared). Three unrelated adults sharing a rented single-family home should be considered a "household" for purposes of trip generation analysis.

The importance of group quarters population will depend upon the number of such persons there are (they are classified in the census). In some cases, the non-household population may be treated as part of some larger special generator (like a military base or university).

Data Sources

The Census Bureau (US Department of Commerce) decennial census is the best source of information on current population and housing (including population, age, dwelling unit number/type data (see Table 2-2), by Census Tract or Block group.

The California Department of Finance also provides estimates of existing city and county population for January 1 and July 1 of every year. The California Department of Motor Vehicles can provide information on vehicle registrations by type of vehicle by county. This is useful in establishing historical vehicle ownership trends. Aerial photos may be helpful, but since the use of the structure is difficult to discern (except for single family homes), they are useful mainly for dwelling unit counts. Aggregation of the large number of photos needed to cover any reasonable size study area is also very time consuming. Local utilities are a source of new water or electric connections, by type of unit (single family, multi-family, commercial) and can be helpful in identifying growth since the last census.

Forecasting Procedures

Planners typically forecast population and household growth using one of two procedures: a "market based" approach based upon demographic and economic trends, and a "build-out" approach based upon local agency General Plans. These procedures are sometimes distinguished as "top down" and "bottom up" approaches.

The "top down" approach is preferred because it is based on national, state, and regional economic and demographic trends which are known to control regional growth. Land use plans by contrast can only allocate the growth to specific geographic locations. The ideal forecasting approach combines both approaches, identifying and resolving differences between local General Plans and economic reality.

The most important criteria in picking any approach is that it be consistent with the decennial census, in terms of the variables produced. Various survey methods that can be used to update the census are discussed later in this chapter.

- o <u>Population Forecasts:</u> The California Department of Finance (DOF) forecasts the population of the state for five year intervals to the year 2020. Recent DOF experience indicates that the greatest source of error in predicting California's population has been in predicting net migration and births, both of which were greater than projected during the 1980's. Migration depends on state, national, and international conditions that are very difficult to forecast. Births depend on age-specific fertility rates, which also can be difficult to predict. Population growth is allocated to the counties based on current and estimated future shares of state growth. Advanced practice should include in-house cohort survival and migration models.

- o <u>Household Forecasts:</u> The current trends in persons per household are extrapolated and modified based upon current expectations regarding household formation and family size. Local planning departments typically make forecasts of household size in their General Plans. The forecasted number of households is calculated by dividing the population forecast by the estimated number of persons per household.

- o <u>Allocation to Jurisdictions and Zones:</u> An acceptable method of doing population forecasts, particularly for shorter term periods, is a "shift/share" type of model. A shift share model begins with the assumption that an area has typically "captured" a certain share of growth in the state/region/county. More advanced practice should allocate land uses to the TAZ's (Traffic Analysis Zones) based on factors such as availability of land suitable for particular uses, topography/slopes, zoning and growth control ordinances/restrictions, and so forth. The details of this methodology is beyond the scope of this document, however.

Usually there is relatively little dispute regarding the total regional forecasts. Some local agencies may dispute allocations at the jurisdiction level. Most of the problems occur at the zonal level where a great deal of judgement is used to decide which zones get which kind of growth. At this microscopic level, a detailed review by local agency planners is extremely valuable.

Error Checks

The recommended procedures to follow in validating socio-economic input data are as follows:
o Check data against city/county regional control totals *o Compare existing to forecasted data by district* *o Check densities by zone* *o Check jobs/employed residents balance (difference is net importation of workers)*

- o Check Data Against City/County/Regional Control Totals: Sum up existing and future zonal population, household, employment, and other socio-economic data by city and county and for the whole region. Check these totals against control totals for these jurisdictions obtained from Census data and independent forecasts for jurisdictions.

- o Compare Existing to Forecasted Data by District: Subtract the existing data from the forecast data at the zone or district level. This will show which zones grow (and which ones decline) in activity level, and may indicate inconsistencies in the forecasting techniques or "busts" in the keypunching. Negative growth in particular should stand out. A GIS or graphic software color display of this data by zone is especially useful for spotting errors.

- o Check Densities: Calculate population, employed resident, and employment densities (persons per acre) for each zone and display in a GIS format using colors or bar charts keyed to density. Aberrations will stick out like "sore thumbs". Look for zones that violate general trends in density.

- o Check Balance: Check ratio of employed residents to jobs at regional level (be sure to add in external residents working in the region and subtract residents working outside the region into the calculation). The ratio should be within a few percent of 1.0.

More advanced practice should consider the allocation of socio-economic data to individual traffic zones. Forecasting this information is best performed within a computer software package that can automatically track the totals and the allocations.

2.2.2 Employment Information

Employment data are one of the more difficult pieces of input data to obtain for a model. It is prone to a greater level of uncertainty than household information. The best sources are at the state level. Some analysts have attempted to use commercial floor space in-lieu of employment data but their models have been subject to a greater level of uncertainty (and consequently more difficult to calibrate) since not all floor space is occupied and occupancy densities can vary widely.

Data Sources

There no single "best" source of employment data. The modeler must trade off accuracy and reliability against the difficulty of obtaining data from the respective source. Some recommended sources for both acceptable and advanced practice are noted below.

The California Employment Development Department (EDD) have data on the existing number of jobs and employed residents, by industry sector and county. EDD also makes short-term projections of future employment (2-5 years out). More detailed data by zip code can be obtained on magnetic tape but these data are subject to "non-disclosure" requirements that may prevent presentation of data to the public at levels of detail that would allow the identification of a single employer in the data set. The 1990 Census Transportation Planning Package (CTPP) provides information on where resident workers work.

City/county building and finance departments may have information on building permits and local business employment, especially if the business license tax is based on number of employees. Data vary widely, but usually includes the work place address and type of business, and sometimes the number of employees on the premises. County Assessors can provide information based on their parcel records: unfortunately, use of these data will require much aggregation. Past experience has shown the records can contain some inaccuracies, and the land use codes used for assessment purposes have marginal value for transportation purposes.

Dun and Bradstreet (D&B), among others, can provide information on existing employment in an area. Information is typically provided at the zip code level, by firm size. It is also possible to obtain individual firm names and addresses, which could be aggregated into traffic analysis zones (TAZ's) using an address matching program. This information is proprietary and somewhat expensive, although it may be less costly than having to do field surveys or using other primary data collection techniques.

County Business Patterns (published every five years) provides estimates of employment by zip code and firm size (for private for-profit firms only). The Department of Commerce/Bureau of Economic Analysis (BEA) makes projections of future employment, by sector, for all metropolitan statistical areas (MSA's) in the United States. The current forecasts go out to the year 2040.

Forecasting Procedures

The forecasting procedures for employment are quite similar to those used for households. See the discussion for households for more information.

Error Checks

The coding and error checking procedures for employment data are identical to those discussed above for household information. Please see that discussion for more information.

2.2.3 Conformity For Sub-Area Models

These models are created to provide more detail within a specific jurisdiction and are designed to be used within that jurisdiction to address local concerns. However, these models could also be used to generate air quality and travel behavior information for use in decision-making at the regional level.

The regional transportation planning agency should discuss and determine with the local agencies the degree of conformity or consistency desired or required in terms of: input socio-economic forecasts, forecasting assumptions, and forecasting results. Agencies that are using area-based land use data should also develop socioeconomic data/forecasts using conversion factors that will allow for comparison to regional socioeconomic forecasts.

2.3 SPECIAL TRIP GENERATORS

Special trip generation input data are used to estimate the trip making characteristics of specialized land uses (special generators) internal to the region. Special trip generation input data sources are summarized in Table 2-3. Special generators are major land uses for which the standard trip generation and distribution equations are not expected to produce reliable estimates of their travel patterns. They augment information from the trip generation portion of the forecasting process.

Special generators should be used wherever trip generation cannot be adequately represented by the standard equations in the trip generation model. At a minimum, special generators should represent airports, colleges and military bases.

The best source of existing condition's data for a special generator is a cordon count of the generator (to establish trip generation) plus socioeconomic data on the generator provided by the institution itself. Where actual trip generation counts of the site (either using manual techniques or automatic counters) are not feasible, then published trip generation studies may be used, such as; Institute of Transportation Engineer's Trip Generation, Caltrans District 4 (the periodic "Progress Reports on Trip End Generation"), and the San Diego Association of Government's "Traffic Generators." Special generators may generate trip productions, trip attractions, or both.

The travel characteristics of special generators should be best forecasted based upon projections provided by the institutions themselves. In the absence of this information, the analyst may use trend line projections.

2.4 EXTERNAL STATIONS AND TRIPS

External stations are points on the boundary (or cordon line) of the region where significant amounts of travelers (usually highway traffic) enter and exit the region. Travel at an external station represents both through travel (sometimes called "X-X" trips), and other external trips (sometimes called "I-X" or "X-I" trips).

> *Acceptable practice would estimate external trips by collecting traffic counts at the external stations, while more advanced practice would include conducting origin-destination surveys conducted at the external stations.*

Table 2-3
Special Generator and External Station Input Data Sources

Data Type	Best Source(s)	Back-Up Source	Alternate Estimation Method
External Station Counts	Field Survey for model (actual counts)	Agency records	NCHRP 187
Special Generators	Actual Counts	Caltrans Progress Reports, Traffic Generators, ITE Trip Generation Manual	None

Data Sources

There are a variety of techniques for assessing base year external station travel volumes: manual and machine counts; larger (regional or Caltrans' statewide) travel models; roadside interview surveys; license plate surveys (license plate matching or postcard survey of registered owners). These input data sources are identified in Table 2-3.

Forecasting Procedures

> *Future travel to external stations should be determined by applying either growth factor techniques, or using the Statewide Travel Demand Model.*

The growth factor technique typically applies a growth factor to the existing count based on the population growth of the counties outside the model area served by that external station. Caltrans Office of Travel Forecasting can supply base and future year 2010 AADT's on State highways that cross county lines.

Error Checks

External stations are best coded as separate trip purposes. This allows the modeler to give these trips special treatment at the trip distribution stage. These data can be entered into a spreadsheet and imported into the transportation planning software package. Sources of the count data and assumptions used in the forecasts should be well documented to ensure capability of reproducing the results in future model updates.

2.5 NETWORK CODING

This section presents recommended procedures for selecting zones, coding the highway network, and coding the transit network.

2.5.1 Overview

Data Sources

The best sources of highway network and transit network data are shown in Table 2-4. Field surveys and local public works departments are the generally the best source of network information.

Forecasting Procedures

Forecasting network improvements generally consists of compiling lists of proposed, approved, and funded projects from local agencies, Caltrans, the Transportation Improvement Program (TIP), and the Regional Transportation Plan (RTP) or Transportation/Circulation Elements of Local General Plans.

2.5.2 Transportation Analysis Zones

Analysts are significantly constrained by resource availability in deciding how many zones to create in the region and what the boundaries should be for these zones. Generally, more zones means increased accuracy of the model; however, land use data is difficult to obtain for levels of detail smaller than the census tract or block group level. Zone boundaries should ideally be set to include only homogeneous land uses and to facilitate loading of traffic on the network, however; census tract boundaries pretty much dictate the feasible zone boundaries for the model.

Number of Zones

Typically 200 to 800 zones are used in urban area and single county models. Large regions may exceed 1000 zones. Rural area models might use as few as 100 zones. These are some approximate guidelines:

- o Regional models typically have zones that are aggregations of one or more census tracts. Some regions may have one zone per census tract.
- o Single county models may split the census tracts and have one to three zones within each census tract, or may use block group level data.

Whatever number of zones are used, the number of zones should be balanced to the level of detail in the coded highway network.

Table 2-4 Network and Travel Cost Data Sources			
Data Type	Best Source	Back-Up Source	Alternate Estimation Method
Highway capacities, distances, free-flow speeds, HOV facilities, Park and ride lots, Ramp metering	Field survey geometric and speed data. Use HCM to calculate capacities. Contact local office of state transportation department for HOV facility, park and ride lots, and ramp metering data.		
Transit service frequencies, distances, fares, and speeds.	Transit agency route maps and route schedules		
Cost of parking.	Survey of actual costs paid by parkers	Estimate from average parking fees charged in area discounted for employer/store subsidies	None
Perceived auto operating costs per mile.	Home Interview Survey	State or other MPO estimates	US.DOT or AAA annual estimates
Speed-flow curves by functional class	Field survey speed-flow relationships	Use 1985 HCM speed-flow relationships	BPR curve with modifications
Intersection peak period turn counts	Field surveys		
Intersection geometry and signal timing.	Field surveys and aerial photos		

If the transportation model is used for facility planning, then the network should include at least one lower level facility type than the lowest level being analyzed. Most models will have about 8 to 12 highway network links for each zone. To estimate intersection turning movements, the model needs about 3 zones for every intersection. Thus to model turning movements at 100 intersections, about 300 zones are needed. Even more zones are often needed because a less than ideal zone system must be used to conform to the Census Tract boundaries.

Too many zones can also cause rounding problems for most software packages. For models with more than 600 zones, modelers should consider using a trip generation multiplication factor of between 10 and 100 to minimize rounding problems during trip distribution and mode split.

Zone Boundaries

To the extent possible, zones should contain a single homogeneous land use (thus minimizing intra-zonal trips that are not assigned to the network). Zones should not be split by major topographical barriers to travel such as rivers, mountain ranges, canyons, freeways, etc. (since the model assumes that 100% of the zone is accessible to each of the centroid connectors by which the zone is connected to the network). Walk access to transit service should also be considered.

Practical considerations (ie. aggregation and disaggregation requirements) however dictate that traffic analysis zones nest within census tract boundaries. Census tracts may be aggregated or disaggregated as necessary, but the census tract boundaries must be preserved to facilitate working with the census data. Rules for developing zone boundaries can be found in other publications, such as the FHWA's "Calibration and Adjustment of Travel Forecasting Models" (1990).

2.5.3 Highway Networks

Basic Data (mapping)

Accurately scaled base mapping is a must for all models. The best mapping will depend upon the area covered and level of detail. US Geologic Survey (USGS) maps are often used, and are now available in digitized form for many CAD and GIS packages. Proprietary maps are often used, but the modeler should be aware that such maps contain a surprising number of errors and may not always be up to date. It may be desirable to standardize node coordinates on the California Coordinate System to make it easier to splice networks from different regions.

Centroid Connectors

Centroids are the "center of activity" of a zone. They do not represent the geographic center of the zone, unless development is uniform within the zone. Strip commercial zones are a problem with centroid location; usually drawing the zone around the strip commercial area and locating the centroid in the center of activity solves this problem, although it may still result in the modelled trips being less than the actual counts along the street, due to intrazonal trips. In large rural zones, code the centroid connector in a location representing the logical center of possible future development.

As a minimum, one can code the same speed on all connectors (typically, 15 mph). More desirable practice is to vary the speed according to the area type (e.g., CBD might be 5-10 mph, while rural areas would be 20-25 mph).The speeds on centroid connectors should represent local street system.

In a CBD, auto trips may be attracted to a zone with a *parking facility* in it rather than the zone with the attraction-end land use in it. This is particularly true if the zones are small, as suggested above, to reflect walk access to transit system. In that case, it may be desirable to consider the vehicle trip end attractions in the zone where parking is available, by re-assigning these trips after the mode choice phase.

Link Data

Link data include the inventory of the existing and future highway and transit services supplied to the area. Minimum practice is to code these types of facilities as independent functional classes:

- o centroid connectors
- o freeways
- o expressways or divided arterials
- o arterials
- o collectors

Some modelers include more detailed divisions, such as rural roads, local streets, freeway ramps (sometimes metered vs. unmetered), streets with two-way left turn lanes, and so forth. The number of classes depends upon the limitation of the software, as well as what the modeler intends to do with the information (are separate capacities or speeds to be assigned to each, for example). The degree of access control should also be taken into account when assigning link capacities.

Specific link data specifications are discussed below:

- o Time/speed on link ("free" vs. congested): Most transportation software require the "free flow" speed, which represents the uncongested travel time *with traffic control devices in place* (some people think of this as the travel speed at 3 AM). In certain instances, the level of service "C" speed should be used (for example, as an input to the gravity model).

- o Directionality (one or two way): Various error checking techniques are available to assure that a two-way link has not been coded as one-way, and visa versa.

- o Number of travel lanes: The availability of special lanes (left turn pockets, two-way left turn lanes, auxiliary lanes on freeways) increase capacity, but should generally be accounted for with either a different functional class/assignment group code, or a special user field code.

- o Link capacities: Link capacities are typically coded at level of service "C" (the point at which noticeable reduction in speeds begins), but in some cases LOS "E" is used. Capacities may also be adjusted, either on individual-links or network-wide, as part of the calibration process. For peak hour, use ideal Highway Capacity Manual saturation flows adjusted for percent green time at signals. For average daily traffic take the peak hour capacity and convert it to daily capacity assuming a set percent of daily traffic occurring during the peak hour. Daily capacities are typically 10 times peak hour but can be as high as 20 times peak hour capacity on heavily congested facilities.

- o Node coordinate (XY) data: Some analysts have used a generic system of coordinates, such as the state planar coordinate systems, or the universal transverse mercator (UTM) systems. USGS topographical quads usually have the former in black, and the latter in blue. Typically each coordinate (X or Y) requires five or six digits; the modeler should assure himself that his software can accommodate coordinates of this size before embarking upon coding.

- o User Fields: Most software also allows coding of "user" fields for a link, which can be used creatively for a number of purposes. These include specification of the city or county where the link is located; the air quality grid cell the link belongs to; whether the link is part of the (urban) county's Congestion Management Program network; the federal-aid status of the link, and so forth.

Intersection Turn Penalties and Prohibitors

Intersection turn penalties are not really necessary to get good assignments except in a fine grid network. Turn prohibitors (infinite penalties) however may be needed to prevent impossible movements (coding one way links at an intersection is an alternative to using turn prohibitors). Many software packages do not fully implement turn prohibitors. Some minimum path algorithms get confused by turn prohibitors. As a minimum, turn prohibitors should be used in any model where particular movements are not possible due to physical characteristics of the road network, or regulations. Time (delay) penalties are sometimes coded in more advanced models, and models where the size of the area and importance of the turn movements output make these delays relatively important. Most software permit at least two approaches to coding turn penalties.

Special Links and Issues (e.g., HOV, ramp metering)

- o Freeways and Freeway/Freeway Interchanges: As a minimum, these facilities should be coded as one way links with ramps as nodes. This practice tends to reduce the mistakes made in coding prohibited turns at interchanges and other locations, and makes the freeways stand out better on plots. Expressways are sometimes coded as a pair of one-way links, as well.

- o Freeway Interchanges with Surface Streets: Practice varies in this area, with the minimum being to code a freeway interchange as a set of two nodes. If this is done, the movements to/from the freeway from the surface street should probably be penalized (see above). Desirable practice is to code all important features of the interchange: entrance and exit ramps, collector/distributor roads, and so forth. If ramps are explicitly coded, the modeler should be careful that the distance and time on the ramps is correctly specified. Use of automatic features within the model to calculate distance based on coordinates should not be used for these facilities; interchanges are often "exploded" (made larger) to make them more legible on plots and computer displays, and so these features will not be truly to scale. This is particularly true where loop ramps are used, although the loop configuration need not be explicitly coded.

- o High Occupancy Vehicle facilities: Most transportation planning software available today allows coding of HOV facilities as a special type of link usable only by HOV trips (of course, a trip OD matrix of such trips is also required). The modeler should refer to the specific coding requirements in his software documentation.

- o Ramp Metering Penalties: This is an area where practice is still evolving. As a minimum, some agencies have coded a fixed penalty associated with entrance ramps of one to three minutes, to represent the average delay during the peak hour (ramp meter delays probably should not be included in ADT models). However, it has been noted that this approach may create oscillations and instabilities[1] since the delay penalty is flow dependent. A desirable approach might be to code the metered ramp as a special facility with separate volume/delay curve. The "capacity" of the ramp would have to be adjusted to reflect the average ramp metering rate over the peak period. This assumes that the ramp metering rate is fixed, which is probably not an unreasonable assumption.

[1] Increasing the ramp penalty will divert trips to other routes, thereby reducing demand and thus the ramp delay itself. This feedback effect may be difficult to equilibrate in practice.

Error Checks

All networks contain errors; given that literally thousands of pieces of information are included even in small networks, this is not surprising. What is surprising is that even well-checked networks can contain a surprising number of errors, and that modelers often do not make use of simple error-checking features available to them.

> *The modeler should spend as much time as possible in checking the networks and other input data prior to the calibration phase.*[1]

The modeler should use these techniques to check his network:

- o Range checking: Check for valid ranges of input values
- o Visually inspect the network
- o Use colors to plot network attributes
- o Multiple review: have more than one person review the input data
- o Build trees/shortest paths from selected (key) zones
- o Produce and check a table of shortest travel times between zones.

2.5.4 Advanced Practice: Transit Networks[2]

Some guidelines for important transit network inputs include:

- o Transfer Links: Walking links between transit stops with a distance and walking speed (no capacity) should be coded. These are typically a maximum of one-quarter mile long with average walk speed of 2 to 3 miles per hour. Transfer time is usually weighted with a factor between 1.5 and 3, compared to in-vehicle travel time.

- o Walk Access Links: Walking links between a zone centroid and a transit stop of a given distance and walking speed (no capacity). These should be no more than half a mile long with a typical maximum speed of 2 to 3 miles per hour). Transit passengers are normally not allowed to use walk access links to walk through a zone centroid from one transit stop to another stop. Walk access links represent the primary way transit trips get to or from the transit network. They are very important because they define area that is transit accessible (unlike the highway network, many areas within the region are not within a reasonable walk of a transit line). Most networks use a rule of connecting any centroids to the network when the walk distance to a stop or station is less than .25-0.5 miles. Desirable practice is to define what percent of zone (i.e., trips) is transit accessible (e.g., 75% of the trip ends are transit accessible). This requires additional effort, but it may be possible to

[1] If the results are not checked until after calibration, it is possible that multiple errors may tend to cancel each other. This could result in satisfactory calibration, but unsatisfactory forecasts.

[2] An excellent reference on this topic has been produced by UMTA: "Procedures and Technical Methods for Transit Project Planning," Review Draft, September 1986, Part II, Chapters 5 and 6.

automate this process in the future (e.g., SANDAG is working a process using a GIS package to determine the percentage of households that are walk accessible to transit in a zone). The key is to provide small zones around areas that are transit (walk) accessible. Walk time is usually coded with a weight between 2 and 3. The weights are usually determined as part of the calibration of the mode choice model to survey data.

Walking speed is typically coded at 3 mph, but the modeler should consider barriers (topography, drainage) and steep grades as inhibitors of pedestrian access.

- Auto Access Links: Auto links between a zone centroid and a transit stop of a given distance and speed (no capacity). Transit passengers are allowed to use this link in one direction (from zone to transit stop), but not in the reverse direction. For this reason, these auto access links cannot typically be used to represent the use of taxis at the destination end of a transit trip. Drive access to transit plays an important role primarily to express transit services (bus or rail) going to downtown. Auto access links should be coded only at the production end of the trip, since few people keep a car at the attraction-end of their trip (they cannot drive from attraction-end station). Some software allows this to be done in path building. In software without this feature, the directionality of the drive access link can be made one-way (*toward* the transit route in the AM peak, or *away* from transit in the PM peak).

  Auto connectors are typically coded at 15-25 mph. Since tripmakers may perceive this as out-of-vehicle (excess) time, it may be appropriate to weight this time by a factor of between 1.5 to 3 compared to in-vehicle (line haul) travel time. Usually a stiff transfer penalty is added to avoid over-estimation of trips. The penalty represents the physical time needed to transfer, as well as schedule "padding" that the trip maker adds to make sure he is at the stop on time. Some models have had to use as much as 100 minutes of in-vehicle travel time to calibrate the model, but more reasonable values are probably in the range of 10-15 minutes.

  The true catchment area for park-and-ride difficult to determine; user surveys should be used if possible to determine this. Typical practice is to link only those areas outside the walk area, and no more than 3-5 miles away; end of line stations may have larger catchment areas. It is probably desirable to restrict drive access to express bus and rail services, unless local surveys indicate otherwise. This can be done with mode-to-mode transfer prohibitors available in most software.

Basic Data

Good scaled base mapping is critical as with highway network, and even more important in downtown areas, because the density of transit routes is very high. The modeler should also obtain transit schedules and route maps for all services to be included. Minor services (paratransit, dial-a-ride, small city transit operations, club/subscription buses, airport services) are generally excluded.

Both daily and peak transit networks are used by different agencies. However, the preferred approach is to develop a peak network, since transit services often vary considerably by time of day, and it is difficult to represent "average daily" transit supply conditions. The volumes obtained from the peak hour network can be factored to daily using relationships specific to the transit operator and type of service being provided (express or local). Future transit service plans are typically developed from the region's RTP, from Short Range Transit Plans, and long range studies transit operators have done.

Headways

> *Typically, only transit services that have at least two trips during peak period are included in the transit network. If headways are irregular, the most common practice is to use the mean headway. When headways exceed 10-15 minutes, passengers usually consult schedules, so the true waiting time may be less than headway suggests.*

The "cap" should be determined by the calibration process; it is usually in the range of 15 to 20 minutes. The modeler should be forewarned, however, that any changes in headway outside the cap (say, a reduction in headway from 60 to 30 minutes) will not show an increase in mode share. SCAG overcomes this problem by discounting the wait time for headways in excess of 20 minutes:

$$\text{Average Wait} = 10 \text{ minutes} + 0.2 * (\text{headway} - 20 \text{ minutes})$$

The theory is that for long headways travellers will schedule their arrival at the station so that all of the waiting time will not be spent at the station.

Transfer Coding

> *Transfers should be prohibited for certain modal combinations (e.g., drive-to-local bus). A matrix of penalties can also be added for certain types of transfers (such as drive access).*

Special walk access links may be coded between transit stops/stations that are not proximate to each other, but where transfers are known to occur. Transfer wait time is usually considered to be one-half the headway of the transit route transferred to, but if timed-transfers are present, the transfer wait time can probably be capped at between five and ten minutes. No less amount of time should be used, since in most cases, the physical change of vehicle, as well as scheduling requirements, require that timed-transfers be this long.

Error Checks

Most software can now plot and/or display transit networks. The same error checking procedures used in highway network checking (noted above) should be used to check the transit network, such as zone to zone skims (both in-vehicle, as well as with waiting times added).

Some cautions:

- o Mode split is very sensitive to how the auto access links are coded. Use the same coding convention (eg. no auto access links for a zone that has walk links, no auto access links in excess of 6 miles, etc.). Once the coding convention has been established and the model calibrated, do not change the convention or the results will biased.
- o Be careful coding an auto access link in parallel to a walk link. The model will always chose the auto link, since it is faster. Then since the auto link has been selected, the model will not allow transit trips to travel in the reverse direction to access the zone!
- o Be careful about coding too many auto access links. In theory a person can drive to any transit station in the region, but since the auto is often faster than transit, the model will always choose the longest auto access link in the direction of travel to the destination.
- o Some (and perhaps many) software packages have a great deal of trouble accurately estimating average headways for "skip stop" services. Check carefully the model's estimated average headways for all the stations where some transit lines skip stops. You may need to over-ride the calculation.

2.6 TRAVEL COST INFORMATION

All costs should be expressed in a common (base) year value. The easiest way of dealing with inflation is to assume it applies equally to income and to costs. Then one need consider only those factors that might cause certain costs to increase faster than inflation.

2.6.1 Auto Operating Costs

There are few objective standards for determining auto operating costs. As a minimum, fuel costs alone (about six cents per mile in 1992) should be used. Most models use larger values (8 to 15 cents per mile); whatever value is chosen should be obtained from calibrating the mode choice model to a local travel demand (usually household travel survey) database.

> *The California Energy Commission (CEC) and federal Argonne National Laboratory can provide information on projected future energy prices.*

2.6.2. Parking Costs

The appropriate zonal value for parking cost should also be a result of the mode choice model calibration process. Some travel demand models consider the parking cost only for those who pay for parking (e.g. the "posted parking rates on lates) A valid option is to consider average parking cost including those who park free; that way reduction or elimination of free parking (by the free market, or public policy) can be tested directly. Parking duration (typically eight hours for work trips, and one to two hours for non-work trips) should be used to convert per-hour costs into per person trip costs.

Forecasting future parking charges should be done in one of two basic ways. The minimum technique would assume that the "real" (i.e., inflation adjusted) cost remains the same in the future, or else a modest increase over inflation occurs. A better technique involves projecting parking cost as a function of employment density in CBD, or else would consider ratio of parking supply vs. demand in a specific area.

This technique would be most applicable in areas that expect to grow or densify significantly in the future.

2.6.3 Transit Fares

Future transit fares are probably best developed in discussion with transit operators, who often operate under legislative constraints in California of maintaining minimum fare box recovery percentages.

In the absence of compelling evidence to the contrary, it is probably best to assume that the existing (real) fares will remain constant in the future (equivalent to assuming that fares increase at the same rate as other prices in the economy).

Most models use the adult cash fare. It may be desirable to make exceptions where evidence suggests otherwise. For example, if a large number of commuters use monthly passes that are heavily discounted, it may be better to use that fare for home based work trips. Appropriate transfer fares (from one operator to another, or between modes) should also be included. Transit agency staff should be consulted regarding their fare increase policies.

2.6.4 Tolls

Only the three largest metro areas in state have toll facilities, although others are considering them. As a minimum practice, the analyst should convert the toll cost (e.g., $1) into time cost (say, at $6/hour), and add to the delay on link; then include in trip distribution, mode choice, and trip assignment models. Discounted tolls (using toll ticket books) might be considered if the discount is significant, and a significant number of drivers use them. The discounted value might be applied only to home-based-work trips, and could be based on the weighted average of auto toll paid. Certain software packages allow the addition of a "cost" variable to a link, which can be used to create a "user cost" network.

2.7 CALIBRATION AND VALIDATION DATA

Calibration data is used to determine the parameters and constants of the model travel demand equations. Validation data is used to determine the accuracy of the model traffic and transit patronage estimates, i.e., how well does the model perform on a known data set? Calibration and validation must utilize different data sources. Calibration data is vital to ensure the accuracy of individual equations and parameters used in the model. Validation data is vital to test the overall validity of the model's forecasts.

The best source of model estimation and calibration data is a local household travel survey that is less than ten years old. The 1990 Census Transportation Planning Package (CTPP) is the next best source of travel behavior data (however it gives information only on commuter travel[1]). The greatest strength of the CTPP is the small-scale geography to which information is coded: if a public agency provides the Census Bureau with a correspondence table between its TAZ system and census block groups or tracts, the Census Bureau will tabulate all of the transportation related questions by TAZ. Furthermore, the Bureau can produce an origin-destination matrix of "commuters" (i.e., home and work locations). This O-D matrix must, of course, be factored to produce actual trips, since not every person makes a trip to his work place each day.[2] Table 2-5 shows the data needed to develop and calibrate travel models and the best sources for this data.

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[1]Multi-purpose trips (such as home-daycare center-work) are not explicitly dealt with in the census.

[2]Further information can be found in a forthcoming report to be published by ITE, "1990 Census and Transportation Planning," Report of Committee 6Y-48. Also see Transportation Research Record #981: "Uses of Census Data for Transportation Analysis," pp. 59-70.

Table 2-5 Calibration and Validation Data Sources			
Data Type	**Best Source**	**Back-Up Source**	**Alternate Estimation Method**
Travel Demand Data			
Vehicle trip generation rates and peaking	Household travel survey	NCHRP 187 or other area surveys	ITE rates
Time and cost elasticities for mode choice.	Household survey and logit model calibration	Elasticities from other areas	NCHRP 187
Walk and auto access links.	Local coding conventions	UMTA/FTA Draft Guidelines	None
Trip length distribution	Household travel survey	U.S. Census CTPP and/or other areas	NCHRP 187 friction factor curves
Validation Data			
Daily and peak period traffic counts	7-day counts conducted specifically for model	24 hour counts obtained from agency records	None
Home interview survey	Home interview survey every 10 years	surveys elsewhere	None
Seasonal, and day of week adjustment factors	Historic data from permanent count stations	Data from other areas	HCM Manual
Vehicle occupancy	Field surveys	NCHRP 187 or other areas (not recommended)	None
Daily/peak transit boardings	Field counts for model	Transit operator records/on-board survey	None
Peak period turning movement counts	2-hr AM and PM counts for model	historic data from agency records	None

2.7.1 Traffic Counts

> *Counts should be for the same year as the year for which land use data have been compiled. Count locations should also be tied to the cordon line or screenlines used when calibrating the model.*

Caltrans Traffic Volumes (annual publication) should be used with caution, since these counts actually represent AADT's, and are based on "profiles" of a route updated with control station counts. The local Caltrans district office may have updated other traffic counts that are not included in the Traffic Volumes report.

Screenlines should preferably bisect the study area along major physical barriers so that all real world streets that cross screenline are also in your model network. Avoid splitting zones with screenline.

Multi-day counts are best and should be geared to the season in which model is calibrated for. When calibrating a peak model, counts should all be from a consistent peak period (e.g., 4:30-5:30PM P.M.). It is desirable to have *directional* volumes for peak calibration. The count locations should be distributed throughout the study area, and used to create screenlines/cordon lines.

2.7.2 Highway Travel Speeds/ Travel Times

Travel speeds are used in coding the model. Motorists typically will travel faster than the posted speed (on average) under free-flow speeds (LOS "A"). Pneumatic traffic counters can also provide speeds. Some Caltrans districts operate tachograph-equipped trucks to perform this function regularly on freeways, and sometimes other state facilities. Floating car runs can provide a useful source of information on not only free-flow, but also congested, speeds; the model output speeds can be used as a comparison with the "loaded" (post-assignment) speeds in the calibrated model.[1]

> *Use of posted speeds is acceptable, but they do not always represent a good reflection of the free-flow speeds along a road; advanced practice should include "floating car" runs to check both free and congested (loaded) speeds.*

2.7.3 Origin-Destination and Trip Length Information

Primary sources of information include the decennial census (for Journey-to-Work information) and the statewide travel survey (conducted in spring 1991).

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[1] More information on floating car and other traffic data collection techniques can be found in ITE's publication, Manual of Traffic Engineering Studies, 5th edition.

Available sources of data should be supplemented with the agency's own household travel surveys at ten year intervals and possibly with roadside interview or license plate surveys at selected locations.

The biggest problem is that it is costly to collect, so it cannot be updated frequently. Small scale surveys (involving several hundred, up to a few thousand households) can be useful in calibrating the model coefficients in gravity and mode choice models. Larger surveys are needed to establish valid origin-destination patterns, particularly if the analyst wants to disaggregate this information by time of day, mode, income, or other travel-related characteristics.

2.7.4 Vehicle Occupancy

This data is usually collected for peak periods only at screen- or cut-lines, although it can be included in household travel surveys for all trip purposes and time periods. If direct observation of this information is made by surveyors, the key points in the highway network should be selected, such as external stations, cut line locations; cordons around business districts; and on freeways.

2.7.5 Local Trip Generation Surveys

Local trip generation studies can provide area-specific data on trip-making characteristics. These are usually done only for special generators, and in central business districts. ITE rates may vary in downtown areas from local data as they are based on suburban land uses, and most downtowns have a large number of trips made by parking and then walking from one activity to the next. If demographic characteristics in an area are much different than the average (e.g., family size/composition), it may be worthwhile to do local trip generation studies. Trip generation rates are sometimes adjusted as part of the calibration process. In most cases, it has been found that the "site" trip generation rate (e.g., the ITE rate for single family homes is 10.1 vehicle trip-ends/day) tends to overestimate the travel in a regional model. Typically ITE rates are from East Coast middle-income suburban areas with relatively low levels of transit service or walk mode share.

CHAPTER 3

TRAVEL DEMAND MODELING

CHAPTER 3: TRAVEL DEMAND MODELING

This chapter describes the four-step modeling process and methodologies for specifying, calibrating and validating travel demand models. The chapter also discusses time-of-day distributions, forecasts, feedback mechanisms, special model applications, regional and subregional modeling relationships and model documentation.

3.1 FOUR-STEP DEMAND MODELING OVERVIEW

Travel demand modeling, as it is most commonly practiced in California, is often referred to as the "four-step process." The four steps, as illustrated in Figure 3-1, are trip generation, trip distribution, mode choice, and trip assignment. This chapter provides guidelines for acceptable and advanced modeling practice for each of the steps within the four-step process.

As indicated in Chapter 1, guidelines have been developed for two different levels of modeling: a minimum acceptable level of practice for small and medium sized regions and a more advanced level of practice that is recommended for large regions. As indicated in Chapter 1, the differentiation between large regions and other regions is based on a combination of population and density of the region, complexity of the transportation system, number and location of activity centers, degree of congestion, and degree of air pollution. Whenever possible, it is also desirable for the models for small and medium sized regions to also meet the guidelines for advanced models. However, time, staff, and budget resources often constrain the capabilities of small and medium size regions and achieving the advanced level of practice is not always feasible.

There is substantial experience with the four-step modeling process in California. It has been in use for roughly 25 years. Most of the significant development in the four-step process occurred during the first ten years of that period. Most existing models in the state are based on a model structure and specifications that are 15 to 20 years old. The most significant advancements in the past ten years have been in transferring regional models from mainframe computer software to software that can be run on micro and minicomputer systems. With this transition has come some simplification of the model systems and some enhancement to improve the sensitivity, flexibility, or accuracy of the models.

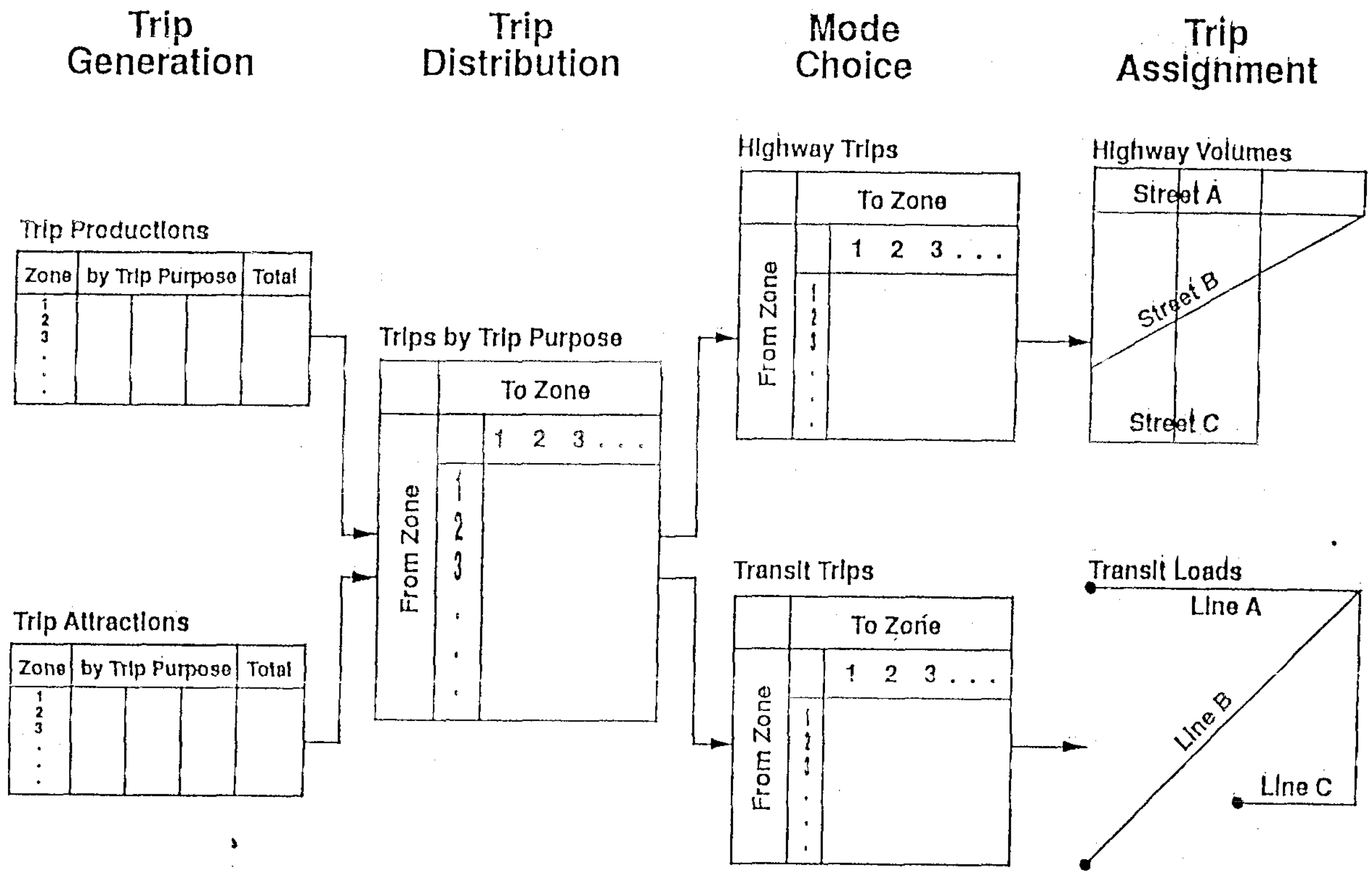


Figure 3-1
Four Step Travel Demand Forecasting Process

This chapter defines the criteria that transportation models should meet if they are to provide a sound basis for travel demand forecasting. Each model should rely on sound behavioral theory of how individuals or households make travel choices. The structure of choice sequences and the variables used in each model of choices should reflect a logical process of decision-making and the behavioral theory analyzing that process should provide a basis for judging the reasonableness of model estimation results. The models, through their input variables, should be sensitive to relevant influences. The importance of this sensitivity is necessary to capture travel behavior and to evaluate alternatives based on changes in policy or exogenous variables. If the models are not sensitive to relevant influences, then they are not useful for analyzing alternatives based on these influences, regardless of the precision with which they match base year ground counts. Finally, the models should be unbiased. Models are often calibrated to reproduce observed traffic counts or travel behavior, but without regard to behavioral theory or econometric principles. Bias in the model, due to improper or incomplete model specification, inaccurately measured input data, or multi-colinearity in input variables can result in highly inaccurate forecasts for future years. These criteria for developing and applying travel demand forecasting models are specifically designed to address the predictive capabilities of the models. If they do not capture travel behavior and remain biased, then they are not useful predictors of future travel demand.

In this Chapter, each of the four steps in the demand modeling process is described with a set of guidelines designed to meet the criteria established. Specific state-of-the-practice methods for developing models in accordance with the guidelines are also provided. The coverage of each of the four steps is provided in four parts: a description of the objective of the step, methods for specifications of the modeling procedures, methods for calibrating the procedures and methods for validating the procedures.

Specification of the models is the process of defining the model structure and the econometric methods for estimating the model and selecting the variables for inclusion in the model. Model specification also involves defining the terms relevant to each step.

Calibration is defined as the process of estimation of the parameters of the model from baseline travel data. For trip generation, the calibration process results in trip rates or equations for trip productions and attractions. For trip distribution, calibration is the estimation of the factors affecting the propensity to travel. For mode choice, calibration produces the coefficients and constants in the utility equation of each completing mode. In trip assignment, calibration results in the estimation of the parameters in the volume-delay equations.

Validation of the four-step model is the process of determining the relative accuracy and sensitivity of the model as a forecasting tool. This usually involves the application of the modeling processing using aggregate data sources, representing a current or previous year, and the comparison of the results to actual data collected in the field. Validation data sources should be different than those used in calibration but validation can also include application of the model with the calibration data but stratified by socioeconomic characteristics or geographic subdivision. This provides a test of the sensitivity of the model to variation in input data. Validation may also include checks on the reasonableness of model parameters. This can be done by comparison of model results with results from other models in the state or to reported state or national trends. Validation using actual data sources is often limited to verify the entire four-step process, after trip assignment, but each of the other three steps in the process should be validated for consistency and/or reasonableness. Each step in the four-step process incorporates the results from the previous steps and should be validated separately to reduce the compounding of errors.

3.2 TRIP GENERATION

3.2.1 Objective

Trip generation models provide the estimates of the number of trips (by purpose) produced by or attracted to a traffic analysis zone as a function of the demographic, socioeconomic, locational, and land use characteristics of the zone. Trip generation models have three parts: trip production models, trip attraction models and the normalizing or scaling process that converts the total trips generated into trip productions and attractions. Trip productions are defined as the number of trips produced in a traffic analysis zone; trip attractions are the number of trips attracted to a traffic analysis zone. Trip production models estimate trips produced in a zone, trip attraction models estimate the trips attracted to a zone and the scaling process ensures that, for each trip purpose, the number of trips attracted within the total modeling domain equals the number of trips produced.

The distinction between trip productions and attractions and trip origins and destinations can be described with an example: If a traveler makes a round trip from home to work, the trip generation model will estimate two home-based-work trip productions from the home zone attracted to the work zone, and the trip balancing process (to convert trip productions/attractions to origins/destinations) converts these two trips into one home-based-work trip from the origin (home zone) to the destination (work zone), and one home-based-work trip from the origin (work zone) to the destination (home zone).

In California, trip generation models are divided into five areas: home-based trip productions, home-based trip attractions, non-home-based trip productions and attractions, internal/external and external-internal trips productions and attractions and external (through) trips. The areas are distinguished by the measures, or variables, used to estimate trips. Non-home-based trips are generated from residential variables and converted to trip productions through a re-allocation process that shifts the production zone from the residential areas to the non-residential areas, in keeping with the nature of non-home-based trips. External trips are often estimated outside of the trip generation model, based on trip-making characteristics outside the study area or region.

Trip generation models can be designed to produce estimates of either person trips or vehicle trips, depending on the derivation of the trip rates or equations. A model that produces estimates of vehicle trips, in the trip generation step of the process, precludes the application of a separate mode choice model in the third step of the process because the mode has been pre-determined to be auto (or vehicle) for all of the trips generated. Such models have no sensitivity to policies or programs that would influence mode choice or auto occupancy severely limiting their usefulness for transportation planning in the current environment.

Trip generation models should estimate person-trip productions and attractions for each traffic analysis zone.

3.2.2 Modeling Specifications

Trip generation models determine the total number of trips or the demand for travel of each traffic analysis zone in the region. The results of the trip generation models are used in conjunction with the other three modeling steps to estimate travel demand for each highway and transit route segment. The results of the trip generation model are also used to estimate trip-related emissions (starts and parks) for air quality analysis.

Trip generation models should be based on an econometric relationship that estimates person trip productions and attractions on the basis of trip-making behavior of the individual, land uses, and socioeconomic characteristics.

The econometric relationship of a trip generation model defines the frequency and distribution of travel as a function of the activities and land uses in a traffic analysis zone. This model assumes that trip making and activity can be related by trip purpose. Trip purposes are classified as home-based or non-home-based trips. The model also assumes that the intensity of travel can be estimated independent of the transportation system characteristics. This assumption has been questioned and will be addressed further in Chapter 5. Finally, the model assumes that the relationships between trip making and activity will remain stable over time. The remainder of the discussion on trip generation model specifications focusses on definition of trip purpose, residential and nonresidential trip generation models, and special generator trips.

Trip Purposes

Trip generation models include individual specifications for trip productions and attractions by trip purpose. The decision to include more trip purposes should be weighed against the increased complexity and effort involved in estimating travel behavior for each purpose. Trips are defined as internal, if both ends of the trip are within the study area, and external, if both ends of the trip are outside of the study area. Trips with one end of the trip in the study area and one end outside the study area are internal-external or external-internal trips. Most models stratify trips by purpose only for internal trips.

> ***Travel demand forecasting models should provide estimates of trips for at least three internal trip purposes (home-based work, home-based non-work and non-home-based), and should differentiate internal-external, external-internal, and external-external (through) trips. Advanced models should estimate trips for at least five internal trip purposes, in addition to the other externally-related trip types.***

The trip purposes stratify travel behavior into activities such as work, school or shopping. The model generates or attracts trips by purpose to a particular zone and provides sensitivity in the model to evaluate trip-making behavior. If a regional agency proposes to estimate trips for three internal trip purposes, these purposes are most often defined as:

- home-based work;
- home-based non-work, and
- non-home-based.

If a regional agency proposes to estimate trips for five or more internal trip proposed, then the trip purposes to consider include:

- home-based work (or home-to-work)
- home-based shop (or home-to-shop)
- home-based social/recreational
- home-based school
- home-based other (home-to-other)
- non-home-based (or other-to-other and/or other-to-work)
- visitor (total-based trips)

There are two types of trips that introduce additional complexity into specifications of trip purpose: linked trips and chained trips. Linked trips are those trips that serve a passenger, such as taking a student to school, or that require multiple modes, such as driving to a transit station and completing the trip on transit.

Linked trips should be included in the travel demand model as a single trip.

Chained trips are trips with more than one purpose, such as stopping at the dry cleaners on the way to work. Chained trips are represented in the model as two un-related trips, each with a single destination and single purpose. Accounting for multiple-purpose trips, or trip-chaining, is addressed in Chapter 5.

It is important to recognize the definition of chained trips in the survey data available for use in developing the model. The Census Journey-to-Work data defines the single or multi-purpose trip to the work place as one trip from home to work. This definition is not compatible with most surveys taken in California, including the Caltrans Statewide O-D Survey, which defines any multi-purpose trip as two (or more) individual trips.

Home-Based Trip Production Models

Trip generation models are defined by the travel behavior associated with home-based trips and estimate trips based on a measure of resident population. The most commonly used variable in these models is the number of households or occupied dwelling units in a traffic analysis zone, although residential population can be used in combination with the number of households or dwelling units. Home-based trip production models should also include socioeconomic characteristics of the resident population to refine trip rates. The most common socioeconomic characteristics used in home-based trip production models are income and auto ownership. Additional socioeconomic characteristics that may be used include household size, dwelling unit type (single family or multi-family), density (dwelling units per acre) or workers per household.

Home-based trip productions should be based on a measure of residential population and should be stratified by income or auto ownership and may also include other socioeconomic characteristics of the residential population.

Home-Based Trip Attraction Models

The trip generation models produce estimates of home-based trip attractions based on the land use or socioeconomic data of a traffic analysis zone. The home-based trip attractions should be based on an estimate of the intensity of the non-residential uses (number of employees or floor area) and the nature of the use (the type of industry) and possibly a measure of the population. The stratification of non-residential uses should include at a minimum, retail and non-retail land uses. Further stratification of non-residential land uses could easily be justified by the range of trip attraction rates developed for these land uses in ITE's Trip Generation (ITE, 5th Edition, 1991), but needs to be weighed against the difficulty of estimating and projecting these data for application of the model.[1] Four or more categories of non-residential data are recommended for advanced models to capture the variations in travel behavior affected by different types of land uses. Some typical categories for non-residential land uses include agriculture, industry, commerce, office, public buildings, transportation and utilities, and/or education and health. It is important to recognize the difference between land use (or socioeconomic) categories and Standard Industrial Classifications (SIC). Land use data describe the type of activity and SIC codes describe the type of industry. An example is the headquarters of a mining corporation, which has a SIC code for mining and an office land use.

Home-based trip attraction models should be based on non-residential land uses stratified by at least two categories of land use or socioeconomic data. Advanced models should stratify non-residential data by at least four categories of land use or socioeconomic data.

Non-Home-Based Models

Non-home-based trip productions and attractions are related to an estimate of the residential and non-residential land uses in an analysis zone. These trips will include visitor trips, trips by workers from work to shop, non-work trips by residents for which neither end of the trip is home, and truck trips. The non-home-based trip purpose often provides less accurate estimates of trips than the home-based purposes because of higher uncertainty in the estimates of non-residential land uses and the lack of data collected in most travel surveys for this purpose. Commercial (including truck or freight) travel is particularly difficult to explain in the absence of a survey directed at commercial travel. Non-home-based travel should incorporate a measure of residential population as well as non-residential land uses stratified by industry type.

Non-home-based trip productions and attractions should be based on a measure of residential and non-residential land use or socioeconomic data, stratified by the nature of use or the socioeconomic characteristics.

State-of-the-Practice Methods

Two commonly used techniques for estimating internal trip productions and attractions are the cross-classification method and the linear regression method. The cross-classification method is simple to calibrate and apply and requires fewer assumptions about underlying distributions among the zones than the regression method. The cross-classification method requires a reasonable number of observations in each of the cross-classification cells, and these data are generally more readily available for home-based trip production models than for the other trip

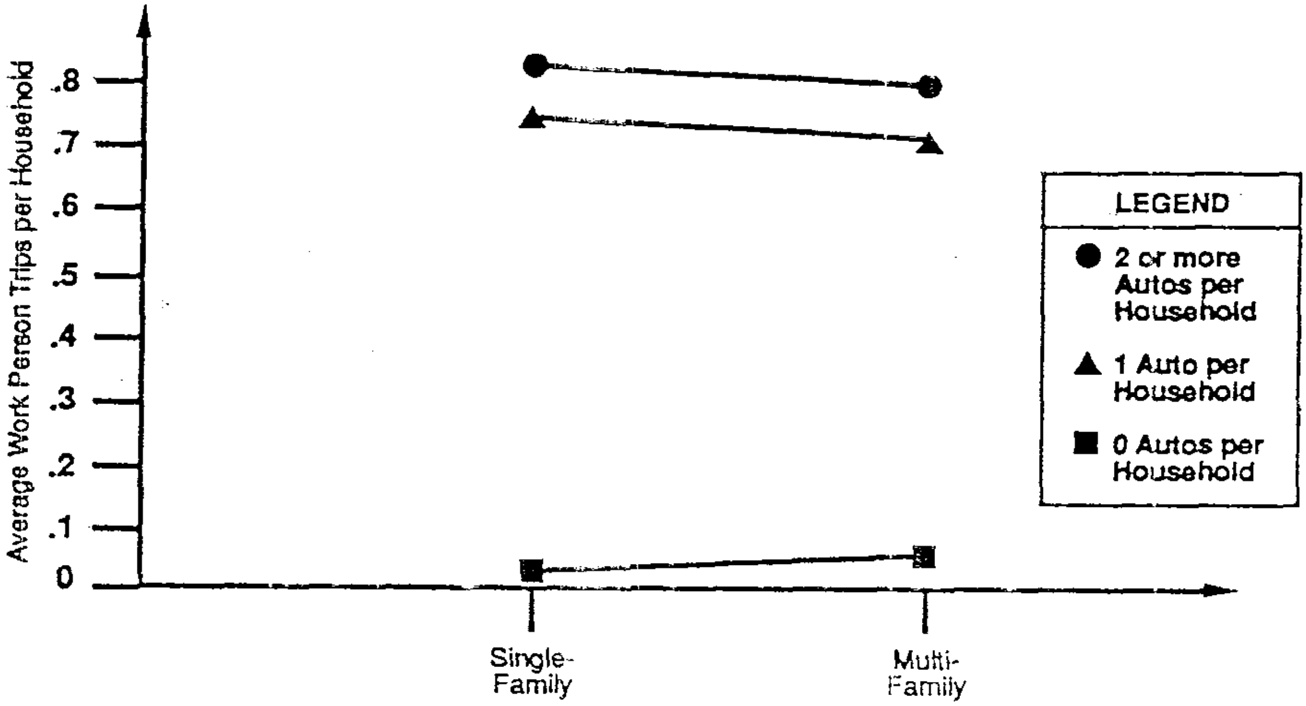
[1] The ITE Trip Generation report should not be used to estimate trip rates for home-based trip attraction models. It is presented here as a tool for identifying appropriate stratifications of non-residential land uses. It can also be used to estimate special generators.

generation models. Regression analysis can have problems resulting from highly correlated trip-making characteristics. These correlated variables can produce illogical coefficients and bias constants that are inappropriate at the traffic analysis zone level. This has further repercussions for applying the regression analysis to a focussed model with large variations in zone size or for transferring the model to an area with different zone sizes.

The two methods are demonstrated in Figure 3-2a and 3-2b: the cross-classification example estimates home-based-work trip productions from trip rates by auto ownership and type of dwelling unit and the linear regression example estimates home-based work attractions from total employment.

> Linear regression or distribution curves can also be used to stratify the households or dwelling units into auto ownership or income categories. An example of a linear regression equation to stratify households into auto ownership categories is:

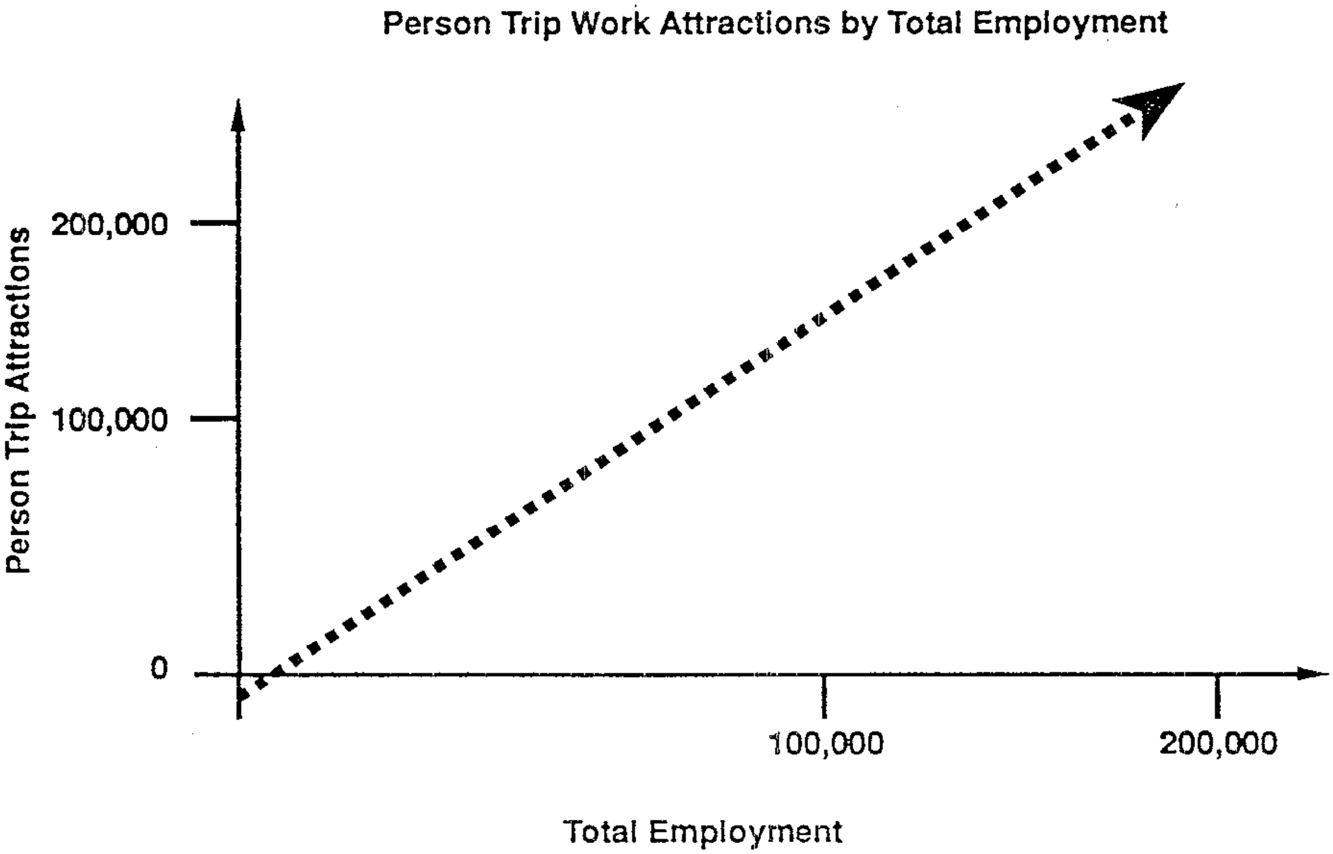
Relationship of Dwelling Unit Type and Auto Ownership to Average Work Person Trips per Household



Person Work Trip Rates by Auto Ownership and Dwelling Unit Type

Dwelling Unit Type	Auto Ownership		
	0	1	2+
Single Family	.002	.757	.809
Multi Family	.006	.727	.778

Figure 3-2a
Trip Generation Techniques
Cross-Classification Method



Trip Attraction Regression Equation

Trip Attractions = 1.478 * Total Employment –17.419

Figure 3-2b
Trip Generation Techniques
Linear Regression Method

Households with no Vehicles = Total Households * [0.24
- 0.22* (Single Family Households/Total Households)
-0.13* Ln(Population/Total Households)
+1.68* (1000/income)]

An example of a distribution curve is for zones in the low income group:

35% of households have low income
26% of households have low-medium income
22% of households have medium-high income
17% of households have high income

Internal-External and External-Internal Trips

Internal-external and external-internal trips are estimated using the same techniques as the internal trip purposes, but only for the internal portion of the trip. The external portion of the trip is set equal to the traffic count at the external station, less any external (through) traffic. The trip generation model uses this estimate of traffic at the external station as a "control" for the number of trips entering and exiting the study area at this location.

External Trips

External, or through, trips begin and end outside the study area, but travel through the study area at some point. Through trips are frequently estimated outside the trip generation model, using available data sources such as the Caltrans Statewide Travel Model or origin-destination survey data.

Special Generator Trips

Special generators are land uses that have significantly different trip rates than the general land use category trip rate associated with it. The ITE Trip Generation Manual (ITE, 5th Edition, 1991) provides trip rates for most specialized land uses. Traffic analysis zones may have land uses other than the special generator, which should estimate trips based on the trip production and attraction trip rates. One should be careful not to double-count special generator trips.

Special generator trips should, at a minimum, be estimated for military bases, airports and colleges.

3.2.3 Calibration

The calibration of the trip generation model generally occurs in three steps for each trip purpose: estimating trip productions, estimating trip attractions, and balancing the trip ends from each model. The calibration process will result in an identification of the significant variables and the trip rates or regression equations. The process may also include estimation of equations to strategy or distribute the variables by their socioeconomic characteristics.

The calibration process may result in the identification of significant variables that are difficult to forecast. As an example, if crime rate becomes a significant factor it may be useful in predicting the number of trips generated, but it may be difficult to forecast and could reduce the predictive abilities of the model if the forecast of the variable is inaccurate. Other variables may be considered that would capture the travel behavior and provide more confidence in the forecasts. Another example is provided in models that have developed sub-models to distribute the residential population into socio-economic groups, such as income stratifications, when the forecasts were only developed for average income. In this case, the forecast distribution of the population into income groups may be assumed to be the same as the distribution that is estimated in the base year. Variables that are difficult to forecast accurately should be avoided.

A number of commonly available statistical software packages can be used to estimate trip rates or regression equations from survey data and produce the necessary statistics to evaluate the model. Linear regression models have statistical measures to evaluate the goodness-of-fit. Unfortunately, there are no readily available statistical measures to assess the goodness-of-fit or reliability of the cross-classification method. One should consider the variability of the data within each cell of the classification scheme, because the cross-classification method is sensitive to the classification of each variable. The highest and lowest classifications are often less reliable, because of the relatively low number of observations typically found there. (Stopher & Meyburg,-1975).

Trip generation models should be calibrated from survey data and re-calibrated every ten years.

A reasonableness check of the model should identify if the trip rates or regression coefficients are consistent with behavioral theory. One example is whether trip rates increase with increasing income. Another example is the size of the constant in the regression equation. A final check might be whether the overall number of trips per household (or person) correlate to regional or statewide estimates.

The final step in the trip generation calibration process is to "match" the production and attraction trip ends. The trip distribution model requires that total productions equal total attractions. Typically, the attraction trip ends are scaled, or normalized, to equal the total number of production trip ends, based on the assumption that the trip production model is more reliable than the trip attraction model for the home-based trip purposes. The non-home-based trip purpose should be scaled using a different approach, that accounts for the fact that the non-home-based trip is often produced in a different zone than it is generated. If the non-home-based trip production model is estimated from household-based survey data then the model estimates nonhome-based trips from households when the trip is, by definition, "not home-based." One approach to normalizing the non-home-based trips is a "re-allocation" of the trip productions from the zone of generation to the zone of attraction. The re-allocation process would then reflect the production of trips from the source of the activity.

The results of trip generation models are the number of trips produced or attracted in each analysis zone, by trip purpose. Figure 3-3 illustrates the trip production and attraction model results, by trip purpose, estimated for each socioeconomic data variable. Figure 3-3 presents the results of the trip productions and attractions before and after the scaling process to demonstrate the impacts of the scaling process on the total number of trip productions and attractions.

3.2.4 Validation

The validation process is designed to ensure that the trip generation model adequately replicates travel behavior under the range of conditions for which the model is likely to be applied. The time and cost involved in obtaining actual field data sources for the validation of the trip generation model may limit this type of validation. Validation includes comparing the results to other models and state or federal averages for consistency and reasonableness. Application of the trip generation model in a previous year, for which survey data are available, may provide a test of the temporal stability of the model.

Trip generation model results should be validated for total trips in each trip purpose and total person trips per household or per person should be compared to national or statewide sources or other regional models in California.

Land Use	Home-Based-Work		Home-Based-Other		Non-Home-Based	
	Prod.	Attr.	Prod.	Attr.	Prod.	Attr.
HOUSEHOLDS						
Family Size						
0 - 0 Autos						
1 Auto						
2+ Autos						
1 - 0 Autos	100,000					
1 Auto			150,000			
⋮					20,000	
↓						20,000
5 - 0 Autos						
1 Auto						
2+ Autos						
EMPLOYMENT						
Total		110,000				
Retail						
Industrial				140,000		
Agricultural					40,000	
Office						40,000
Total (before balancing)	100,000	110,000	150,000	140,000	60,000	60,000
Total (after balancing)	100,000	100,000	150,000	150,000	60,000	60,000

(FIG3-3)

Figure 3-3
Trip Generation Model Application

3.3 TRIP DISTRIBUTION

3.3.1 Objective

The trip distribution step in the four-step process distributes all trips produced in a zone to all possible attraction zones. The model uses the number of trip productions and attractions estimated in the trip generation model and the transportation system characteristics to distribute the trips. The product of trip distribution is a set of zone-to-zone person trip tables stratified by trip purpose.

The trip distribution model should estimate person trip tables for each trip purpose.

3.3.2 Model Specifications

A central assumption of the trip distribution model is that each traveler making a trip chooses a destination from all of the available destinations on the basis of the characteristics of each competing destination and the relative impedance associated with traveling to each destination. For each trip purpose, the destination choices will be determined by the relevant variables chosen in the model. The two most significant factors for destination choice are the relative attractiveness of a zone, measured by the number of attraction trip ends, and the relative impedance between the production zone and the attraction zone, measured as a function of time and cost. Other socio-economic factors, such as income or auto ownership, may influence destination choice and possible methods for including socioeconomic factors are presented in Chapter 5 as an area for further research. Figure 3-4 provides a graphic description of the process for development of impedance tables and a typical application of the trip distribution model.

Trip distribution models should distribute trips in a manner related to the attractiveness of alternate destination zones and inversely related to the impedance associated with traveling to each competing zone.

State-of-Practice Methods

There are two types of trip distribution models in widespread use: gravity models and growth factor models (Fratar). One distinction between these methods is the data requirements. The gravity model requires data on the attractiveness of a zone (from the trip generation model), and the growth factor models require both a base estimate of origin and destination trips and a growth factor. Recently, there has been research into the applications of more behavioral choice-based distribution models (and this research is described in Chapter 5). The gravity model remains the most common trip distribution model in practice today. The growth factor (Fratar) model is frequently used for distributing external trips (through travel) or for producing incremental updates of trip tables when full application of the trip distribution model is not warranted.

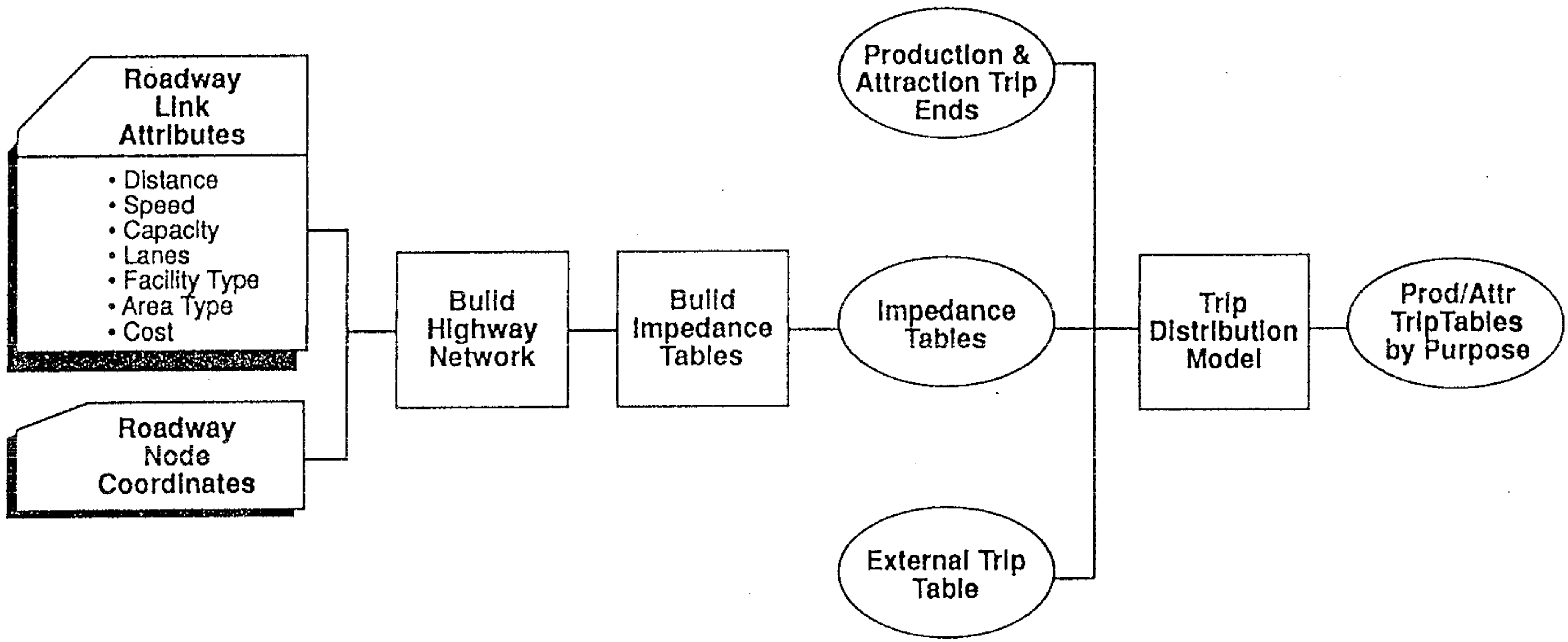


Figure 3-4
Trip Distribution Model and Impedance Tables

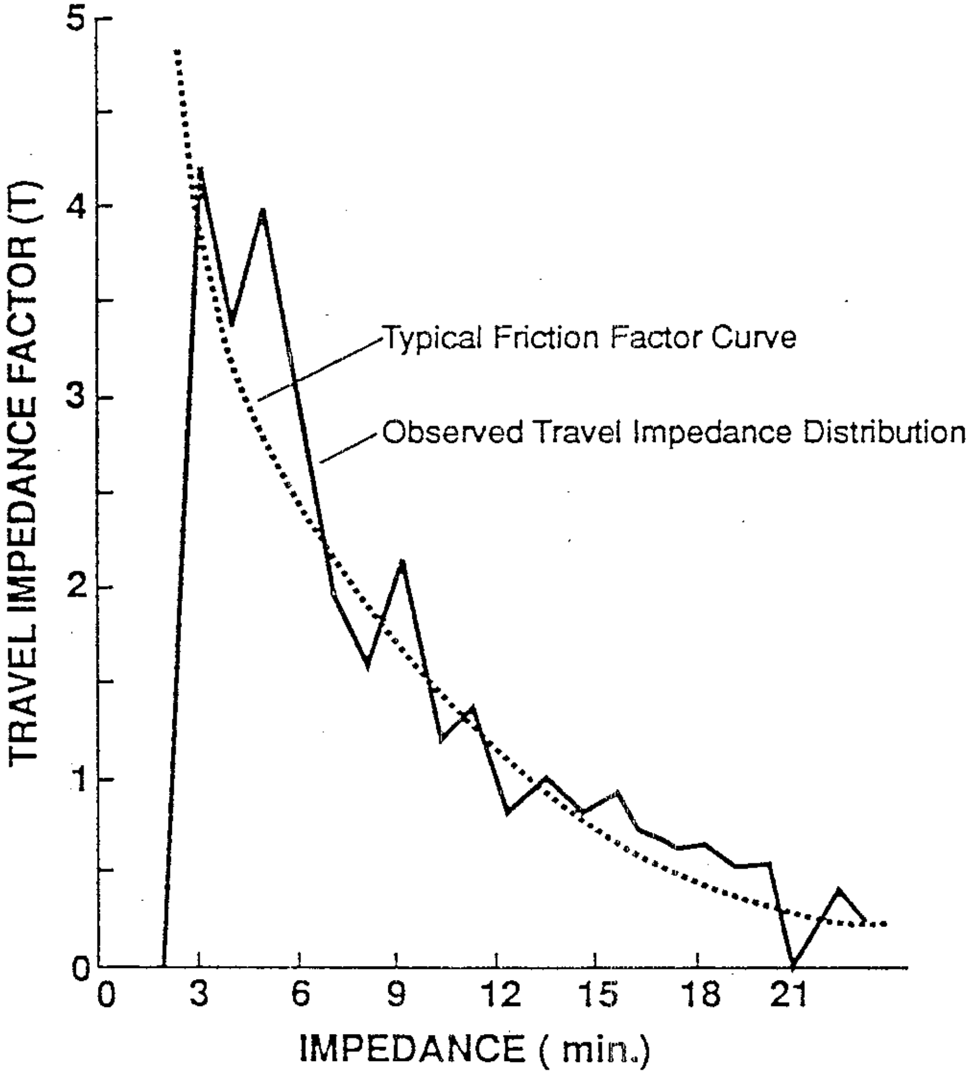
The gravity model is based on Newton's law of gravity, which describes the gravitational force between two bodies. The gravitational force, in transportation models, is a function of the attractiveness of a zone (measured in the number of trip attractions) and the impedance (measured as a travel time or friction factor) to the zone:

$$T_{ij} = P_i \frac{A_j F_{ij} K_{ij}}{\sum_n A_j F_{ij} K_{ij}}$$

where: T_{ij} = number of trips produced in zone i and attracted to zone j
P_i = number of trips produced in zone i
A_j = number of trips attracted to zone j
F_{ij} = travel time or "friction" factor
K_{ij} = zone-to-zone adjustment factor (takes into account the effect on travel patterns of defined social or economic linkages not otherwise incorporated in the gravity model)

The gravity model, in its traditional form, assumes that the trip productions are fixed and iterates to estimate the trip attractions in each zone. This procedure assumes people choose where to work or shop, based upon where they live.

The friction factor is developed from the travel impedance distribution as shown in Figure 3-5. Typically, application of the friction factor involves use of higher friction factors for shorter trips to demonstrate a realistic assessment of the propensity to travel. The use of travel demand models for air quality analysis has increased the need for accuracy of the friction factor curve for short trips because the friction curve has often been assumed to be a steadily decreasing function, instead of the actual travel impedance distribution, which is zero for trips of walking distance and then follows a similar function. (Further research on the separation of walk trips from other person trips is identified in Chapter 5.) The best-fit friction factor curve should reflect the full travel impedance distribution. Friction factors are calculated from a comparison of the estimated and observed trip length frequency distributions, and research has shown that these distributions (or the average trip length) remain relatively stable over time (Voorhees, 1968).



Source: Stopher & Meyburg, *Urban Transportation Modeling and Planning,* 1975.

Figure 3-5
Typical Travel Impedance Distribution

Growth factor models represent a simple form of the trip distribution model, based upon an expansion of existing interzonal trips by using growth factors. Growth factor models are generally used because of the limited data requirements. External (or through) trips that are not generated in or attracted to the study area are often distributed using this method.

The Fratar (growth factor) model should be used to forecast external, or through, travel.

Impedance

The gravity model requires a measure of impedance from each origin zone to each destination zone. Impedance generally represents the travel time, based on speed and distance, and cost, expressed in minutes (as a value of time). Many distribution models in the past defined impedance as the "free-flow" or uncongested travel impedance for all trip purposes volume-to-capacity ratio on a route segment but more accurate representation of impedance may be warranted for many applications. Impedance values have been constructed to reflect --

- congested or uncongested time periods
- a composite of highway and transit travel impedances
- a composite of travel time and cost

Most regional models in California use congested travel time for the home-based work trip purpose and all other trip purposes use the uncongested travel time. Methods are available to use a volume-weighted combination of congested and uncongested travel impedance appropriate for each individual trip purpose, but this process is not widely used in California.

Trip distribution models should use a value for impedance that is based on realistic estimates of travel time and speed. Impedance values should reflect those used in the calibration process.

Advanced models should incorporate a feedback loop from trip assignment to trip distribution when there is evidence that congestion significantly affects impedance. Uncongested travel impedances input to trip distribution are acceptable if the impact of congestion is not significant.

Most trip distribution models in California have been developed with the assumption that the highway travel impedance is a sufficient representation of travel impedance for estimating destination choice and that the development of a composite highway and transit travel impedance is not sufficiently cost-effective to justify the extra effort required. The definition of travel impedance as a composite of travel time and cost has been used commonly in California to include cost for toll facilities, but exclude operating cost.

The trip distribution model should use a value of impedance that is derived from the highway travel time and should include cost if toll facilities exist in the network or are being evaluated.

K-Factors

K-Factors are the zone-to-zone adjustment factors that account for social or economic linkages that impact travel patterns but are not reflected accurately by the gravity model. One example of an economic situation affecting travel patterns is the proximity of blue collar neighborhoods near a central business district to the white collar jobs in the same area. The gravity model may overestimate trips in this case, based on the short travel impedances, when the actual travel patterns may be quite different.

Unfortunately, the use of K-Factors reduces the credibility of the forecasts because they limit the response of the model to the variables such as travel time and cost that are likely to vary over time. As a result, they should be used sparingly and cautiously. A few K-Factors may be justified for specific social or economic linkages that impact travel patterns.

> ***Trip distribution models should minimize or eliminate the use of K-Factors in gravity model applications.***

Intrazonal trips

Intrazonal trips represent trips made totally within a zone. They are assumed to travel only on local streets and are not assigned to the roadway network during trip assignment. The estimation of the vehicle-miles-traveled due to intrazonal trips is easily calculated if desired or essential to the analysis. One example is the use of travel models for emission inventories for which intrazonal travel can have a significant impact on total regional emissions but little impact on major transportation facilities.

Intrazonal impedances are typically estimated using the nearest neighbor method, which uses half of the travel impedance to the nearest zone as the intrazonal impedance. These may be adjusted to reflect terminal impedances or the time spent outside the vehicle at the beginning or end of the trip. The number of intrazonal trips are generally determined by applying the gravity model, but other methods include assuming that a fixed percentage of the trips by purpose will be intrazonal regardless of zone size.

> ***Trip distribution models should estimate intrazonal impedances using the nearest neighborhood method, or other reasonable estimation of intrazonal trips, by purpose.***

3.3.3 Calibration

The calibration of the gravity model involves the estimation of friction factors (F_{ij}) and zone-to-zone adjustment factors (K_{ij}). In the first iteration of the gravity model calibration, the F_{ij} and K_{ij} are set equal to one. The friction factor is then calculated from the comparison of observed to model-estimated trip length frequency distributions, using a manual adjustment of the curves or variety of mathematical functions. Most calibration processes require an iterative procedure to estimate the friction factors. Two of the functions used to estimate friction factors are the gamma function:

$$F = a * I^{b} * e^{cI}$$

and the negative exponential function:

$$F = a * e^{-bI}$$

where: F is the friction factor
a,b,c are calibrated model coefficients
I is the impedance

K-factors can be calculated from a comparison of observed trips to estimated trips for a zone-to-zone (or district-to-district) interchange, but should represent only explanatory differences in socio-economic data from one area to another, rather than zone-to-zone adjustment factors used to improve the model results.

Trip distribution models should be calibrated at least once every ten years, based upon available survey data.

3.3.4 Validation

The validation procedure for the trip distribution model is similar to the validation of the trip generation model. Due to time and cost limitations in collecting data other than that used in calibration, the validation process often relies on the verification of consistency and reasonableness to available data sources. Back-casts to a previous year, for which survey data are available, often does provide a test of the temporal stability of the model.

Trip distribution models should be validated by comparing the average trip length for each trip purpose to national or statewide averages and other regional models in California and, where possible, by applying the model for another year for which survey data are available.

3.4 MODE CHOICE

3.4.1 Objective

The mode-choice model separates the person trip table into the various alternative modes, by trip purpose. The available modes have expanded in recent years to include stratifications of the auto mode by vehicle occupancy (drive alone, two occupants, three occupants, etc.); and the stratification of transit modes into transit technologies and types of operation, (local bus, express bus, light rail, heavy rail, etc.); and types of access (walk or drive).

The mode choice model should estimate person trip tables by mode and purpose.

3.4.2 Model Specifications

The mode choice model estimates a traveler's choice between modes, based on characteristics of the traveler, the journey, and the transportation systems. The traveler characteristics affecting mode choice include auto ownership, income, workers per household, and trips for more than one purpose (chained trips); the journey characteristics are the origin and destination, the trip purpose and the time of day the trip is taken; and the transportation characteristics include travel time (in and out of the vehicle), costs (fares and auto operating costs), and availability and cost of parking, as well as comfort, convenience, reliability and security.

Traveler characteristics should include the significant variables affecting mode choice. These most often include income and/or auto ownership.

The characteristics of the journey are a function of the trip purpose and the time of day when the trip is taken. For simplicity, many mode-choice models assume that trip purpose defines when the trip is taken, i.e., that all home-based-work trips occur in the peak period and all other trip purposes occur in the off-peak time period. This assumption allows peak impedance tables to be used for the home-based-work mode-choice model and off-peak impedance tables to be used for other purposes.

The characteristics of the transportation system include travel times (in-vehicle and out-of-vehicle travel times) and costs (out-of-pocket, maintenance and operating costs) as well as performance-related variables that are difficult to quantify, such as comfort, reliability, and security. Transit travel times should include time spent driving to transit, as well as time spent in transit vehicles. Out-of-vehicle travel time should be classified by function for transit: waiting time, walking time, time to transfer, etc.; and classified by terminal end for highway: origin terminal time and destination terminal time. Transit mode of access (walk or drive) can be included in mode-choice models in addition to access travel times.

In small and medium-sized regions in California, the transit modal share is small enough that the effort involved in developing a behavioral choice model for mode choice is often is not justified by the benefits the model provides. A simplified approach is to estimate district-to-district factors representing the transit, carpool, and drive-alone modal shares (based on observed values for a baseline year or an external estimate for a future year) and apply them to each trip table, by purpose. The method is acceptable if the regional agency is not involved in testing the sensitivity of carpool or transit policies.

The mode-choice model should be consistent with good econometric practice and should remain an unbiased estimator of trips by mode and purpose. The method should include significant variables, and provide sensitivity to policy variables. Application of district-to-district factors for vehicle occupancy or transit mode shares is acceptable if the regional agency is not testing the sensitivity of carpool or transit policies.

Discrete choice models, where the choice between modes is limited to the number of available modes, have been well researched (Ben-Akiva and Lerman, 1985, and Hensher and Johnson, 1981, and Stopher and Meyburg, 1976) and may be the most common modeling methodology used in mode-choice models. Discrete choice modeling allows the incorporation of all significant variables, which reduces the bias from influences not included in the model. The remainder of this section covers the specifications for discrete choice and incremental mode-choice models.

Discrete Choice Models

The predominant mode-choice model in use today is a logit model, a form of discrete choice model based on the behavior of travelers within a particular market. Logit models predict the "choice" that a traveler will make based upon travel times and costs, socio-economic information on the traveler, and other unique characteristics of the trip. The process for application of the mode-choice model is graphically illustrated in Figure 3-6. Work mode choice models vary from non-work mode choice models based on the peak and off-peak transportation services available for these trip purposes.

The logit model is based on the assumption that an individual associates a utility with each alternative in a choice set. The individual then will select the alternative which provides him or her the highest utility. The utility, U_{in}, which individual n associates with alternative i has two components; a systematic component, V_{in}, which can be represented analytically as a function of observable characteristics of the individual and the alternative, and a random component, e_{in}. This random component results from unobserved attributes of the alternative, such as taste variations among individuals and inaccuracies in the specification of the systematic component of the utility.

An assumption of the logit model is that the random components of the utilities are independent and identically distributed. An additional assumption that distinguishes logit from other probabilistic discrete choice models is that the random components also have a Gumbel *distribution. (Ben-Akiva and Lerman, 1985)*

The characteristics of the logistic curve for mode-choice models are derived by relating the systematic utilities that individual n associates with each mode to probabilities of choosing a particular mode. For a binary choice:

$$P_n(i) = \frac{\exp(V_{in})}{\exp(V_{in}) + \exp(V_{jn})}$$

where: $P_n(i)$ = the probability that individual n will chose mode i
V_{in} = the systematic utility that individual n associates with mode i

V_{jn} = the systematic utility that individual n associates with mode j

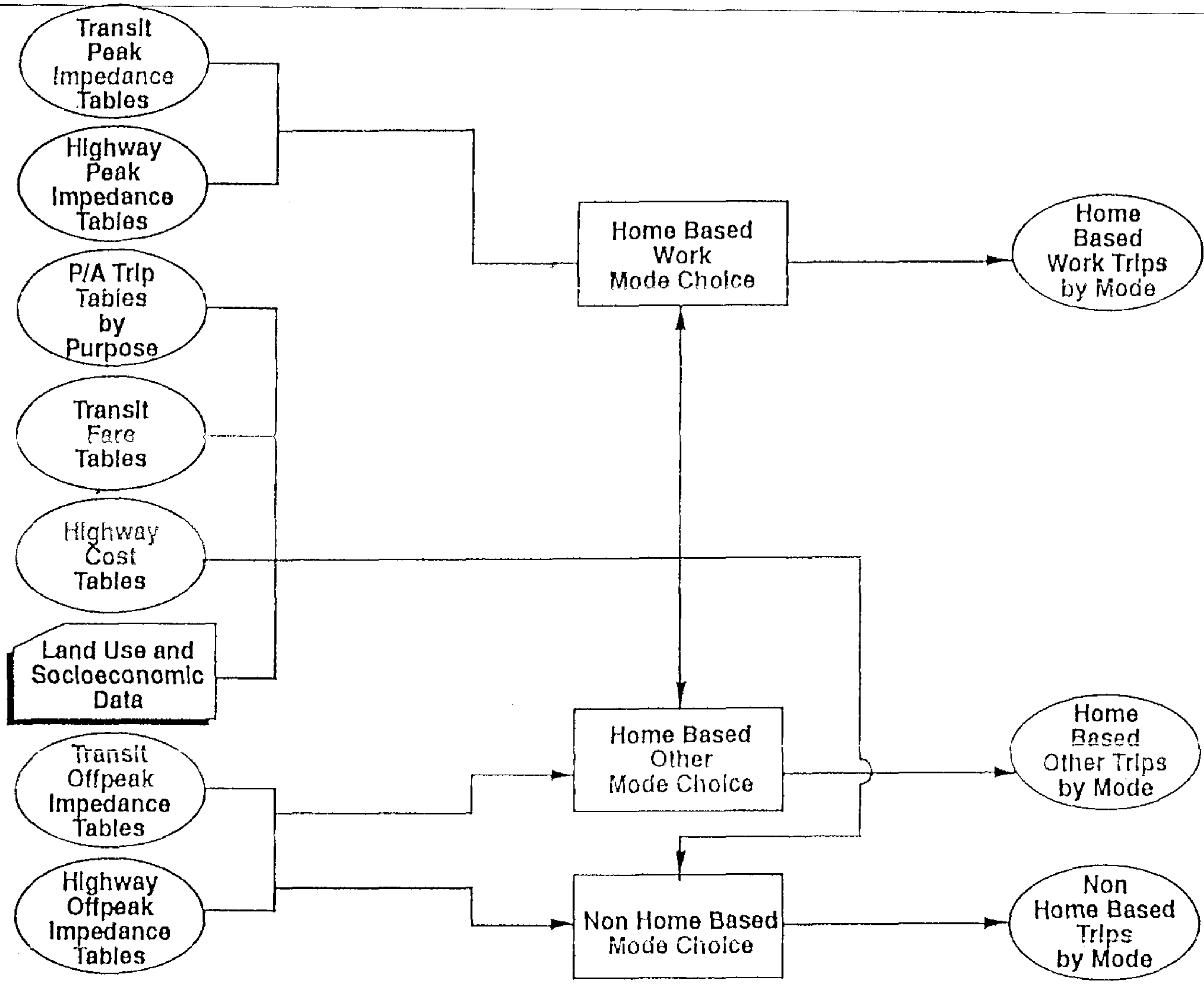


Figure 3-6
Mode Choice Model

In the case of a multinomial choice model, the formulation is:

$$P_n(i) = \frac{\exp(V_{in})}{\sum_{j \epsilon J_n} \exp(V_{jn})}$$

where: $P_n(i)$, V_{in} = as defined above
V_{jn} = the systematic utility that individual n associates with mode j_J_n
Σ = the summation over all modes available to individual n and denoted by J_n

The utility function allows any number and specification of the explanatory variables, as opposed to the case of the generalized cost function in conventional models which are generally limited and have several fixed parameters. This allows a more flexible representation of the policy variables considered relevant. The coefficients of the variable reflect the relative importance of each attribute (Ortuzar and Willumsen, 1990).

An assumption implied by the use of the logit form is the independence from irrelevant alternatives (IIA) property. The independence assumption can be violated if two or more alternatives are correlated in their unmeasured attributes. This may result from incorrect or incomplete specification of the utility function. This can easily happen when two alternatives are perceived by the decision-maker as being very similar in some unobserved attribute.

If there exists a high correlation in the unobserved attributes of two or more alternatives in a choice set, a bias in the parameter estimates will result. There are two approaches which can reduce or eliminate bias. The first, which retains the logit model structure, is to "nest" the choice model; first modeling the choice among the alternatives with high correlation in unobserved attributes and then modeling the choice of primary alternatives (grouped alternatives). The second approach is to drop the logit formulation entirely and use instead a probit formulation which explicitly incorporates the correlation between alternatives in the model. The use of the probit structure is analytically more complex and can be prohibitively expensive to estimate if the number of alternatives is large.

The logit model assumes that the error terms are independent across alternatives. If there are unobserved attributes shared by two or more alternatives in a choice set which results in correlation in one of the components of the error term, the conditions necessary for the logit model may be violated. The direction of the nesting structure then depends on which choice has correlated unobserved attributes. One example of a nested mode choice model structure is presented in Figure 3-7.

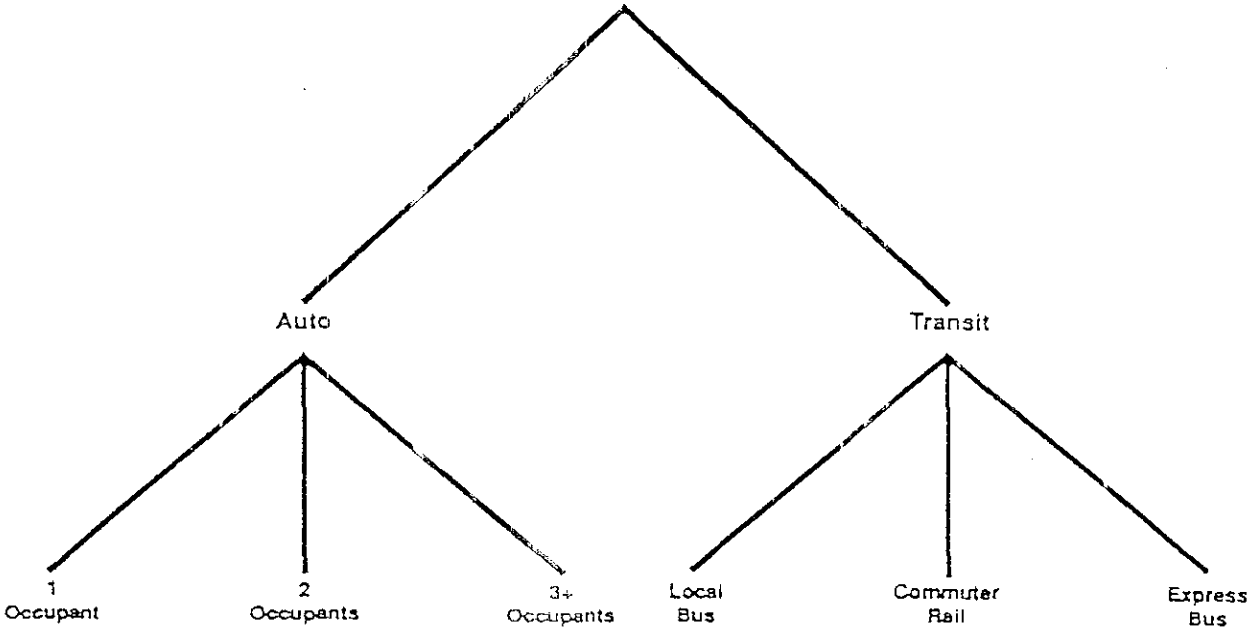


Figure 3-7
Nested Mode Choice Model Structure

Ben-Akiva and Lerman (1977) and McFadden (1973) have demonstrated that when a nested logit structure is appropriate, the models can be estimated sequentially. They showed that a logit model of the choice for which there are shared unobserved attributes for alternatives with common choices of x (which suggests the first nesting structure) can be estimated as a marginal probability model for the choice of X:

$$p_x(x) = \frac{\exp[(V_{xn} + w(\Gamma_{xn})]}{\sum_{x' \in X_x} \exp[(V_{x'/x} + w(\Gamma_{x'/x})]}$$

where: $p_n(x)$ = the probability that individual n will chose x from the choice set X_n
V_{xn} = as before
w = a scale parameter that measures the relative variance of e_{xy} and $(e_x + e_{xy})$
and:

$$\Gamma_{xn} = \log \sum_{y' \in Y_{xn}} \exp[(V_{xy'/x} + V_{y'/x})]$$

which is designated LOGSUM (x) and is equal to the natural logarithm of the denominator of the conditional probability

If the independence from irrelevant alternatives (IIA) assumption is correct, then the multinomial logit structure can be used in lieu of the nested logit structure.

Incremental Mode-Choice Models

The incremental mode choice model provides a method to analyze the impact of changes in fares, levels of service, or other attributes of a mode on mode split when baseline mode share and baseline values of the attributes are known. There are two types of incremental mode choice models: incremental elasticity and pivot-point. Incremental elasticity analysis uses a sensitivity factor (percentage change in mode share that will result from a one percentage change in an attribute) that can be based on a logit model or can be based on observed response to changes in an attribute. Pivot-point mode-choice models use the multinomial logit model and the changes in the level-of-service variables (only for those variables that are expected to change). Further information on incremental models can be found in Ortuzar and Willumsen (1990).

The incremental approach has the advantage of forecasting mode shares directly from the actual (existing) mode shares, as opposed to full discrete-choice models that forecast mode shares based on relative travel times and costs for each mode. In contrast, the discrete-choice models can provide more insight for new modes that are not adequately represented in existing mode shares, such as HOV trips where there are currently no HOV facilities.

3.4.3 Calibration

The calibration of the mode choice model should produce estimates of the coefficients and the bias constant in the modal utilities in the logit equation. One example of a typical utility equation for the transit impedance can be found in the Procedures and Technical Methods for Transit Project Planning (UMTA, 1990):

Transit utility = - 0.5 (bias constant)
- 0.02 * transit in-vehicle travel time
- 0.04 * transit out-of-vehicle travel time
- 0.008 * transit fare/household income
- 1.5 * autos owned
- 1.0 (0 if walk access, 1 if drive access)

After specifying the available set of alternatives and the variables to consider the calibration of the mode choice model should produce the utility function for each mode alternative. There are available software packages to estimate multinomial and nested logit models.

Goodness-of-fit measures test the performance of the model in predicting mode choice by comparing predicted volumes to observed data. The t-test will determine the significance of any variable in the modal utility equation. The coefficient of the variable is significantly different than zero at the 95% confidence level if the absolute value of the t-score is greater than 1.96. The sign of the coefficient is also a test of the expected impact of the variable on the utility equation (or the utility equations is improperly specified). If it is an incorrect sign, the variable should not be used in the utility equation. If the sign is correct and if the coefficient on the variable is significant, the variable can be included in the utility equation. Policy variables can be included in the utility equation if the sign is correct, even if the coefficient was not significant, because the lack of significance could be caused by lack of variability in the data. One additional test is the log-likelihood ratio test. In this test, a variable improves the overall performance of the model if the log likelihood ratio decreases.

If a nested logit model structure is being evaluated, various combinations of nested structures should be tested and compared to the original multinomial structure. These tests will ensure that the model structure chosen is appropriate for the area being modeled. Also it is important to discern whether the nested structure significantly improves the model performance compared to the multinomial structure, otherwise it may not warrant the additional effort involved.

Mode choice models should be calibrated at least once every ten years. Nested model structures should be evaluated in advanced models used to evaluate carpool alternatives or multi-modal transit systems.

3.4.4 Validation

The validation process for the mode-choice model involves identifying a validation data source, that is different than the calibration data source, and comparing observed modal splits with model-estimated modal shares by districts. Again, the cost-effectiveness of collecting data for validation limits the ability to validate using actual data, but application to a prior year or to a segment of the calibration dataset can provide a text of the sensitivity of the model. Similar to the validation procedure for trip generation and distribution, validation for mode-choice models should rely on the consistency and reasonableness of the results compared to available data sources.

Mode-choice models should be validated using available estimates from national, statewide, or regional sources of transit or carpool mode shares, by purpose. Assignments of the transit or carpool mode shares may be used to compare the results to on-board surveys or actual traffic counts.

3.5 TRIP ASSIGNMENT

3.5.1 Objective

The objective of the trip assignment model is to assign the various modal trip tables to the alternative paths or route available. Typically, transit trips are assigned to the transit network where path choice includes all transit modes, and vehicle trips are assigned to the highway network, where path choice is affected by various use restrictions for HOV or truck trips.

The trip assignment model should produce estimates of vehicular traffic assignments on the roadway network and person trip assignments on the transit network.

3.5.2 Model Specifications

Trip assignment models use impedance to determine path choice for each mode. The methods for trip assignment vary by mode: highway and carpool (HOV) assignments, and transit assignments. The assignment methodologies for each are determined by the structure of the network, available path-building algorithms, and capacity restraint capabilities.

Impedance

The highway network characteristics contain data to determine the travel impedance for each path, or route, where travel impedance is defined by some combination of travel time and cost. The travel impedance is defined in Section 3.3.2 for the trip distribution model.

The value of speed used in calculating travel impedance should represent average observed uncongested speeds identified as "free-flow" speeds. The application of the trip assignment results in an estimate of congested speeds.

In the past, models would input free-flow link speeds and adjust this value during validation of the model. The performance of the trip assignment model has historically been based on accurate link volumes, and the adjustment of speeds was used to assist in this goal. The objective of travel demand forecasting models has shifted to include producing data for emissions inventories, which are dependent upon accurate estimates of speeds. This additional purpose of estimating accurate speeds in the trip assignment model may change the requirements for the input travel impedance.

Travel impedance values in the trip assignment model should represent the travel time (and cost for areas with toll facilities), along a link, calculated from the average observed uncongested speed along a facility, including intersections and other average delays. The average observed uncongested speed should not include any delays due to congestion.

Capacity

The capacity of a roadway link is affected by the level-of-service on the link. The capacity of a freeway link at level-of-service E may be 2,000 vehicles per lane per hour, when the capacity of the same freeway link at level-of-service C might be 1,750 vehicles per lane per hour. Typically, travel demand forecasting models use link capacity defined by level-of-service C or D. The capacity will impact the congestion on a link, defined by the volume-to-capacity ratio, and also the delay on the link, caused by congestion.

Highway Assignment

Highway assignment models load the vehicle trips onto the highway network using a range of path-building algorithms, and typically iterate each assignment to account for congestion on the system. There are two path-building algorithms in wide use: all-or-nothing and stochastic (or multi-path). The all-or-nothing algorithm assigns all of the trips to the minimum path and should only be used in combination with iterative, incremental, averaging or equilibrium methods to further adjust the assignments. The stochastic algorithm estimates a probability that a trip will take the minimum path or some other "efficient" path, and assigns proportions of the total trips to various paths based upon the estimated probabilities. This technique was popular for some time based on its ability to capture travel behavior more effectively than the all-or-nothing algorithm, but the stochastic assignment cannot produce turning movements for intersection capacity analysis or selected-link assignments. These limitations significantly restrict use of the model.

The iterative process used in highway assignment models provides a variety of methods to combine the results of each iteration: equilibrium, incremental and averaging. The equilibrium method first developed by UMTA in the UTPS programs, is an optimization procedure, that searches for the best combination of the current and previous iterations. Equilibrium is said to be achieved when no trip can reduce travel impedance by changing paths. The incremental approach combines the previous iteration with a fixed percentage of the current iteration. Certain applications of the incremental method will update speeds for capacity restraint based upon a full assignment of the trips, but keeps only the fixed percentage identified in the increment. The averaging method combines the results from one iteration with the results of other iterations, to produce a volume-weighted average assignment across all iterations.

The most common highway assignment models include adjustments to the travel time or speed estimated for each path based on congestion, defined by the volume-to-capacity ratio. This is generally termed a capacity restrained assignment. These adjustments are made through volume-delay equations, that estimate the delay associated with traffic volumes for each segment in the system. These volume-delay equations most frequently have one of two forms: the Bureau of Public Roads (BPR) equation and the exponential equation as follows:

BPR Equation:

$$Delay = Impedance * A \frac{(V/C)^c}{B}$$

defaults:
A = .15
B = 1.0
C = 4

Exponential Equation:

$$Delay = Length * minimum\ (A * exp\ (B*VC), C)$$

defaults:
A = .02
B = 4.0
C = 60 minutes/mile limit

where: Impedance = average observed uncongested travel time and cost
VC = volume-to-capacity ratio
Delay = average vehicle delay
Length = link length

Figure 3-8 presents the volume-delay curves plotted for the two equations using the standard default values.

Various assignment highway path building algorithms, iterative techniques, and volume-delay equations should be tested to determine the trip assignment model that produces the closest match to actual traffic counts while remaining behaviorally consistent and producing useful output reports.

HOV Assignments

High-occupancy-vehicle (HOV) trips, estimated with the mode-choice model, can be assigned to the highway network simultaneously with low-occupancy-vehicle (LOV) trips, or sequentially before or after the LOV trips. HOV trips are defined as any vehicle trip for which the occupancy level is sufficiently high to satisfy restrictions on HOV links in the system. In some regions this may vary by facility. Low-occupancy vehicle trips may be drive-alone only or drive-alone and two-person carpool depending on the facility-specific definition of HOV. Another frequently used term, single-occupant-vehicle (SOV), refers only to the drive-alone mode. The preferred method loads the HOV trips simultaneous with the LOV trips. This method provides equal opportunity for HOV trips to use LOV facilities and causes LOV trips to consider HOV volumes in selecting the best paths, which can be critical on arterial approaches to HOV facilities. The sequential approach gives preference to the trip table assigned first, but may be useful if software packages do not support the simultaneous method.

Transit Assignment

The transit assignment procedures predict the route choices for the transit trips. The choice of a transit route is influenced by different attributes of the transit network, all of which affect the overall travel impedance. The perception that time spent outside a vehicle or time spent transferring from one vehicle to another is more onerous than time spent riding in a vehicle affects the weight of these variables in the impedance function but both types of travel time should be included.

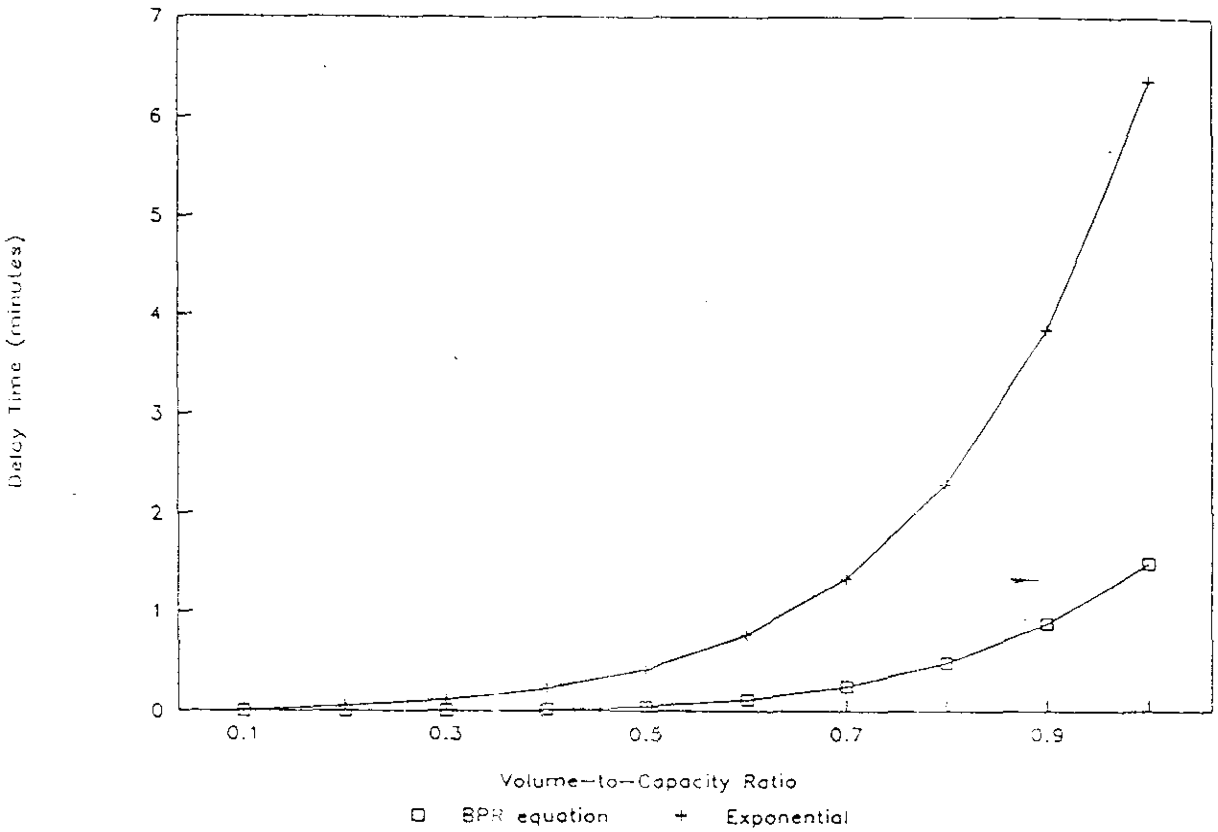


Figure 3-8
Volume-Delay Curves for Capacity Restraint

There are three issues that warrant discussion concerning transit assignment: supply of transit services, estimated cost of transit service to the passenger, and the definition of generalized impedance. The supply of transit services is defined by the capacity of a transit vehicle and its corresponding frequency. The transit network consists of route segments (links) and transit stops (nodes) that form transit routes (lines). The estimated cost of using a transit service is the average fare paid to take the trip, including transfer fares. If discounted fares are significant, the average fare should reflect these discounts.

The generalized impedance is a function of the in-vehicle travel time (IVTT), the time spent waiting for a vehicle (WAIT), the time spent walking to the transit stop (WALK), the time spent transferring from one route to another (XFER), including a penalty to represent resistance to transferring (XPEN), and the fare (FARE):

IMPEDANCE = a*IVTT + b*WAIT + c*WALK + d*XFER + a*XPEN + e*FARE

Where: a,b,c,d,e are coefficients associated with the impedance.

The coefficients on the out-of-vehicle travel times (WAIT, WALK, XFER) can be two to three times the value of the coefficient on in-vehicle travel time.

Transit assignment techniques may vary from one software package to another, but the most common path-building algorithm is the all-or-nothing method. This method chooses the minimum impedance path based on the generalized impedance function. The all-or-nothing method can overestimate routes with a high frequency of service or underestimate routes that are highly competitive, but are not on the minimum path. Modeling the path choice or using a multi-path transit path-building algorithm are possible solutions to the weakness of the all-or-nothing algorithm. Another issue in transit assignment is the assumption that capacity does not limit transit route choice or assignment. Prashker (1990) investigated the possibility of restraining transit assignments to available capacities, as well as incorporating a multi-path path-building algorithm.

Further guidance on transit assignment techniques may be found in the "Procedures for Transit Project Planning," (UMTA, 1990) and Modeling Transport (Ortizar and Willumsen, 1990). The objective of the transit trip assignment model is to reflect the impact of transit vehicles on congestion and air quality, but the transit assignments process assigns transit person trips, not transit vehicles. The assignment of transit vehicles is determined by a combination of operational policies and travel demand. For the purposes of air quality analysis, the transit travel demand model is relatively insensitive to the assignment of transit vehicles and the resulting air quality.

3.5.3 Calibration and Validation

Technically, the separation of calibration and validation of the trip assignment model is difficult because there is generally only one data source available for both exercises. In practice, the calibration of the highway assignment model includes identifying the model specifications and adjusting the volume-delay equations to adequately represent the region. The validation of the model includes checking the accuracy of any link data assumptions and evaluating the reasonableness of the input data (network or zone based) by comparing the model estimated assignments to traffic counts. It is important to recognize that traffic counts are themselves only estimates of traffic volume and should be tested for reasonableness during validation along with the other input data. Counts could have errors caused by variation in the mix of vehicles or may not have been adjusted for season or day-of-the-week variations. Errors could also be due to mechanical counter failure, field personnel mistakes, or improper count location.

Traditionally, highway assignment models have been calibrated and validated based primarily on the comparison of estimated model volumes to traffic counts. The calibration results can be summarized from the model estimated volumes on link segments and compared to traffic counts for various facility types and for facilities experiencing congestion. Adjustments to the volume-delay equation or the trip assignment method can impact general over- or under-estimations of link volumes. The validation effort involves more link-specific summaries of model-estimated volumes compared to traffic counts, either by screenline or by district or by individual link. Errors found at this step in the modeling process can lead to adjustments in the modeling process which may compensate for assignment/ground count differences. Inaccurate screenline estimates may imply incorrect trip distributions, inaccurate district estimates can imply incorrect trip generation rates or equations and inaccurate link estimates can imply incorrect network characteristics. Incorrect mode-choice estimates may also affect any or all of the above.

The regional agency should strive to obtain traffic counts on ten percent or more of the regionwide highway segments being analyzed, if resources allow. This ten percent goal applies also to the distribution of counts in each functional classification (freeways and principal arterials, at a minimum). Validation for groups of links in a screenline should include all highway segments crossing the screenline.

Calibration and validation of the transit assignment model follows the same procedures as the highway assignment model, except that transit ridership counts would replace traffic counts. Again, inaccurate estimates can imply incorrect assumptions used in path-building or mode-choice.

There are many statistics that can be helpful in calibrating or validating trip assignment models: absolute difference, percent difference, average error, average percent error, standard deviation, R squared, root mean square error and the correlation coefficient. The statistics are helpful in determining the overall performance of the trip assignment model, and the four-step travel demand forecasting process.

A test of the percent error by functional classification will provide insight into whether the assignment model is loading trips onto the functionally classified systems in a reasonable manner. The percent error by functional classification is the total assigned traffic volumes divided by the total counted traffic volumes (ground counts) for all links that have counted volumes, disaggregated by functional classification. Suggested error limits are:

Suggested Regionwide Validation Criteria

Functional Classification	Percent Error
Freeways	Less than 7 percent
Principal Arterials	Less than 10 percent
Minor Arterials	Less than 15 percent
Collectors	Less than 25 percent
Frontage Roads	Less than 25 percent

Source: FHWA *Calibration & Adjustment of System Planning Models*; December 1990

The correlation coefficient estimates the correlation between the actual ground counts and the estimated traffic volumes and is produced by most software packages.

Suggested Regionwide Correlation Coefficient > 0.88.

The vehicle-miles-traveled is a significant factor for emission inventories and should be compared to available data sources, such as the Highway Performance Management System (HPMS). HPMS and other estimates of regional estimates of VMT are also subject to estimation error and are reasonable only as verification of consistency and do not provide a useful measure of the accuracy of the model system.

The validation process should also include the comparison of ground counts to estimated volumes on individual freeway and principal arterial links, as well as screenlines defined to capture the travel demand from one area to another. Figure 3-9 presents the maximum desirable deviation for individual link volumes and total screenline volume. Figure 3-9 also shows the approximate error in a single traffic count for individual links.

The suggested link-specific validation criteria is that 75% of freeway and principal arterials and all screenlines meet the maximum desirable deviation in Figure 3-9.

3.6 TIME-OF-DAY DISTRIBUTION

The allocation of travel to specific time periods can occur at various stages within the four-step modeling process, but the most common application is to develop time period specific trip tables after mode-choice.

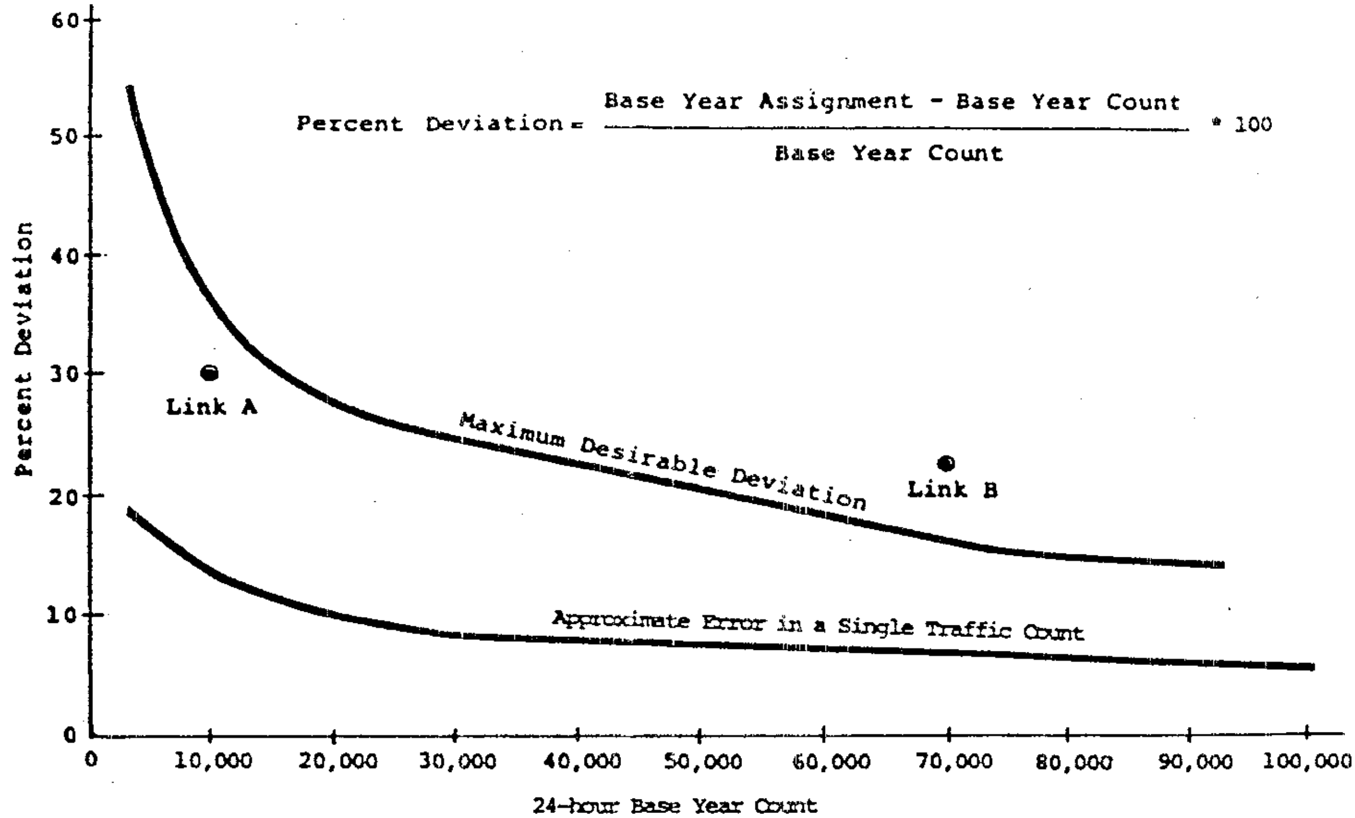
> *Time-period specific trip tables should be developed for severely congested time periods in the day and should be identified by the nature of the difference between impedances from one time period to another as peak-period or peak-hour tables.*

Peak-period trip tables represent all trips within a one- to four-hour period of peak travel. Peak-hour trip tables represent the highest hour of travel within the morning or afternoon time periods. Peak spreading is a phenomenon that occurs when the capacity of the transportation system is severely constrained in the highest demand portion of the peak period. To avoid severe congestion, travelers choose to make trips earlier or later and a spreading of the peak occurs. The result is usually a longer peak (congested) period and a more even distribution within the peak period. If peak spreading has occurred, then a separation of the peak-periods into individual peak-hours is often not warranted. If the level of congestion in the peak-hour is significantly different than the average conditions in the peak-period, then the peak hour should be estimated separately.

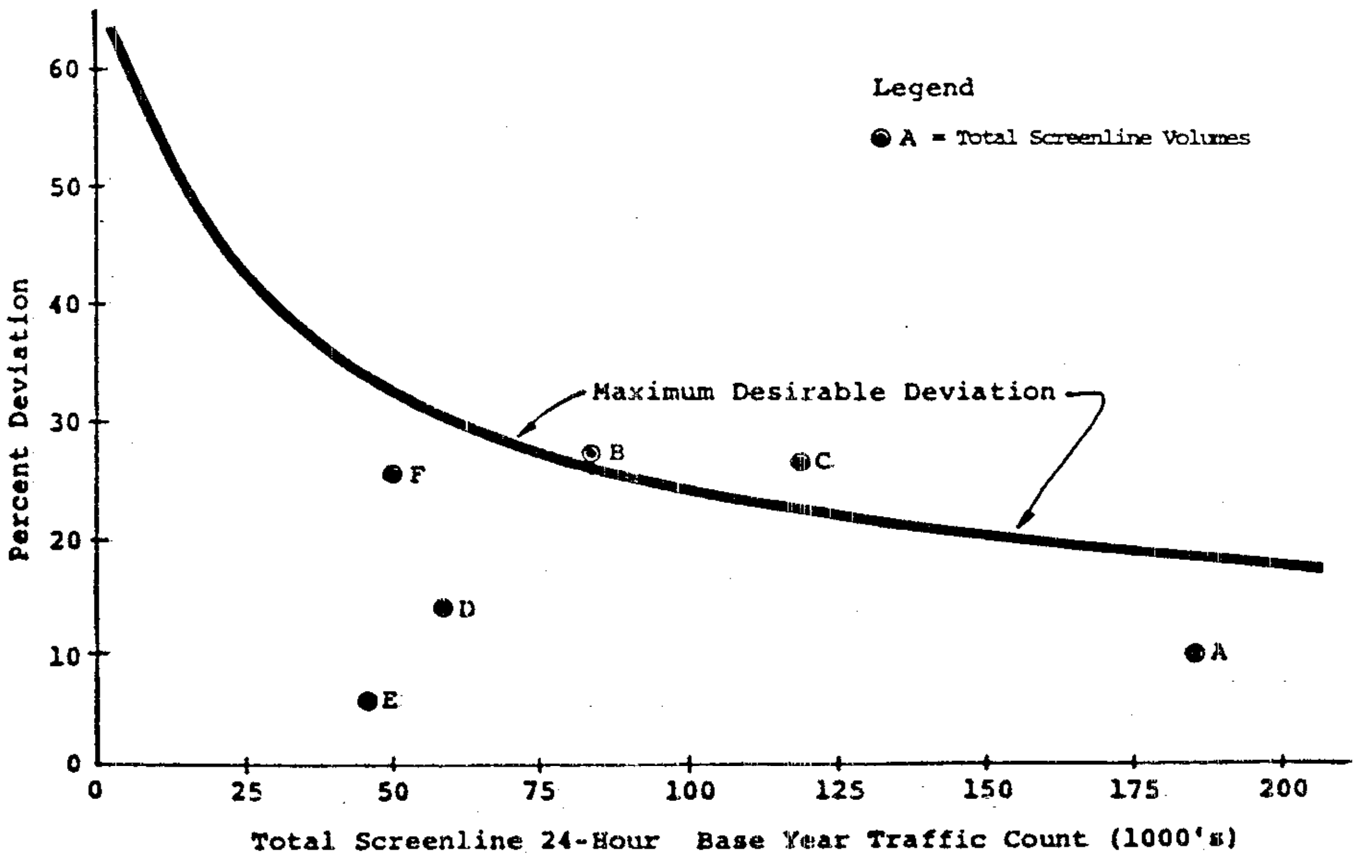
Time-of-day distributions by trip purpose are presented in Figure 3-10. The stratification of link volumes by hour of the day as a post-process to trip assignment is commonly used to estimate emissions.

Time-of-day distributions can be estimated at various stages in the four-step travel demand process (see Figure 3-11 in Section 3.8): prior to trip generation, trip rates are stratefied by time period and purpose; following mode choice, peaking factors are applied by purpose and mode for each time period, and following trip assignment, link volumes are stratified by hour of the day. The most common method to estimate the time-of-day distribution in regional travel models is to apply a set of peaking factors to the trips by purpose and mode estimated from actual data. The peaking factors indicate the proportion of trips in a particular time period that are destined to (or away from) the trip attractors. Peaking factors are often developed for the A.M. and P.M. peak-periods (or peak-hours) and the remainder of the daily trip table is allocated to the off-peak period.

Some models assume that the home-based-work purpose represents the peak-period trips and all other trip purposes represent the off-peak period. This assumption may be reasonable for the mode choice model, but may not be reasonable for trip assignment. Regional travel demand models have in the past emphasized the peak-period for planning purposes, but further accuracy in time-of-day forecasts are required for emissions inventories.



Maximum Desirable Error for Link Volumes



Maximum Desirable Deviation in Total Screenline Volumes

Figure 3-9

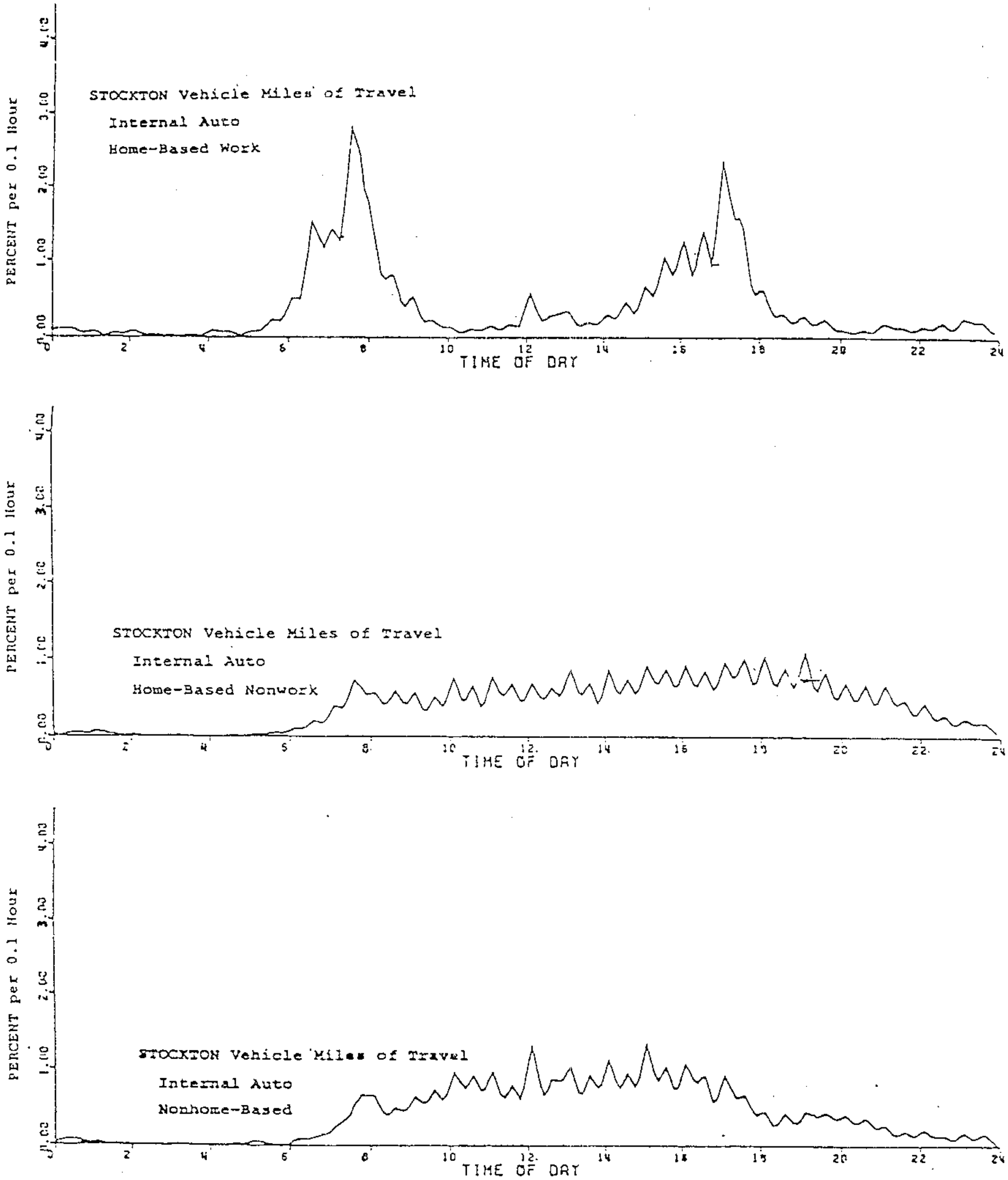
3.7 FORECASTS

The complexity of travel demand models is often limited by the ability to accurately forecast the data and assumptions defined in the models. Although the basic structure of the four-step modeling process has changed little in the past twenty years, there have been some developments over time to incorporate more complex traveler behavior and system performance characteristics to capture the causal relationships behind shifts in travel. Both the calibration and validation efforts involved in each of the four models can verify the ability to estimate travel demand from travel behavior and system characteristics. Typically, each of the four models in the travel demand forecasting process assumes that the parameters and coefficients estimated through model calibration do not change over time. The input socio-economic and network characteristics tested during model validation will change over time and are developed for each model application year.

Forecasts for the trip generation model require estimates of future year socio-economic data (households and employment, stratified by those categories identified in the trip generation model). If special generators were used in the base model, estimates of future special generator trips should be incorporated into the forecast year model. If internal-external and external-internal trips were based on estimates of traffic at the external station, these need to be estimated for the future year. Typically, special generator and external travel are estimated by growth factors for the forecast year.

The gravity model application of the trip distribution model assumes that the friction factors and K-factors do not change over time. This assumption is based on the use of these factors to capture the travel behavior not otherwise accounted for in the model. Because the behavior producing these factors is not well defined, the assumption that the factors will not change over time is suspect. The production and attraction trip ends are forecasted from the trip generation model and the zone-to-zone impedances are estimated from the system characteristics for the forecast year.

The mode-choice model contains coefficients that explain the relationships between travel behavior and mode choice. The model-calibrated coefficients remain constant over time. The travel time, or impedance, values are derived from forecasted changes to the highway and transit systems. Costs are input in base year dollars and only change over time if the forecasts differ from the increase due to inflation.



Source: *An Analysis of Urban Area Travel by Time of Day,* U.S. Department of Transportation, Federal Highway Administration, 1972.

Figure 3-10
Time-of-Day Distribution by Trip Purpose

Assessments of the forecasting performance of travel demand forecasting models have indicated that the errors occurring are dominated by poor forecasting of the input variables (Bates, Dasgupta, 1990). Additional difficulties with forecasting performance are the assumptions in trip distribution and trip assignment, that are not directly related to travel behavior (such as K-factors and path-building algorithms) and are difficult to forecast.

3.8 FEEDBACK MECHANISMS

There are many assumptions in the four-step travel demand forecasting process that concern the impedance of a trip. The impedance of a trip is a function of the travel time and cost from the origin to the destination. The impedance is derived from the transportation system characteristics. Feedback mechanisms represent the equilibration of impedance at one or more steps in the modeling process, as shown in Figure 3-11. Much of the discussion on feedback mechanisms of impedance leads to a need for further research for the benefits of incorporating feedback mechanisms versus the costs associated with the equilibration required in the modeling process. A significant portion of the costs involved will result from the need to re-calibrate each model, after incorporation of feedback loops. Several discussions on feedback and equilibration in travel demand forecasting can be found in the "Review of Transportation Planning Textbooks & Other Material on Feedback & Equilibration" (Purvis, November 19, 1991). The first assumption occurs in the development of land use data. Land use forecasts are frequently developed with the assumption that transportation system characteristics will not impact the land use. Land use will be developed for a forecast year and assumed to be constant across various transportation system alternatives. Sometimes, low, medium and high growth scenarios are developed, but again, are often not impacted by the transportation system alternatives. This assumption is based upon the need to produce objective forecasts of land use data and the few practical applications into the behavioral theory of how land use is impacted by transportation system characteristics.

Most trip generation models assume that the decision to make a trip is made independent of transportation system characteristics. This assumption has been identified as further research for the trip generation model, but has not been incorporated into state-of-the-practice models.

The trip distribution model is the first of the four-step process to incorporate impedance values as a variable. The current state-of-practice models use uncongested impedances to determine the destination choice of a trip. Some models estimate congested impedances as a function of facility type and area type as a shortcut to using modeled congested impedances. Current state-of-the-art models complete the four-step process and feedback the congested impedances to trip distribution. Some models equilibrate this feedback loop until the congested impedances used in trip distribution match the congested impedances output from trip assignment.

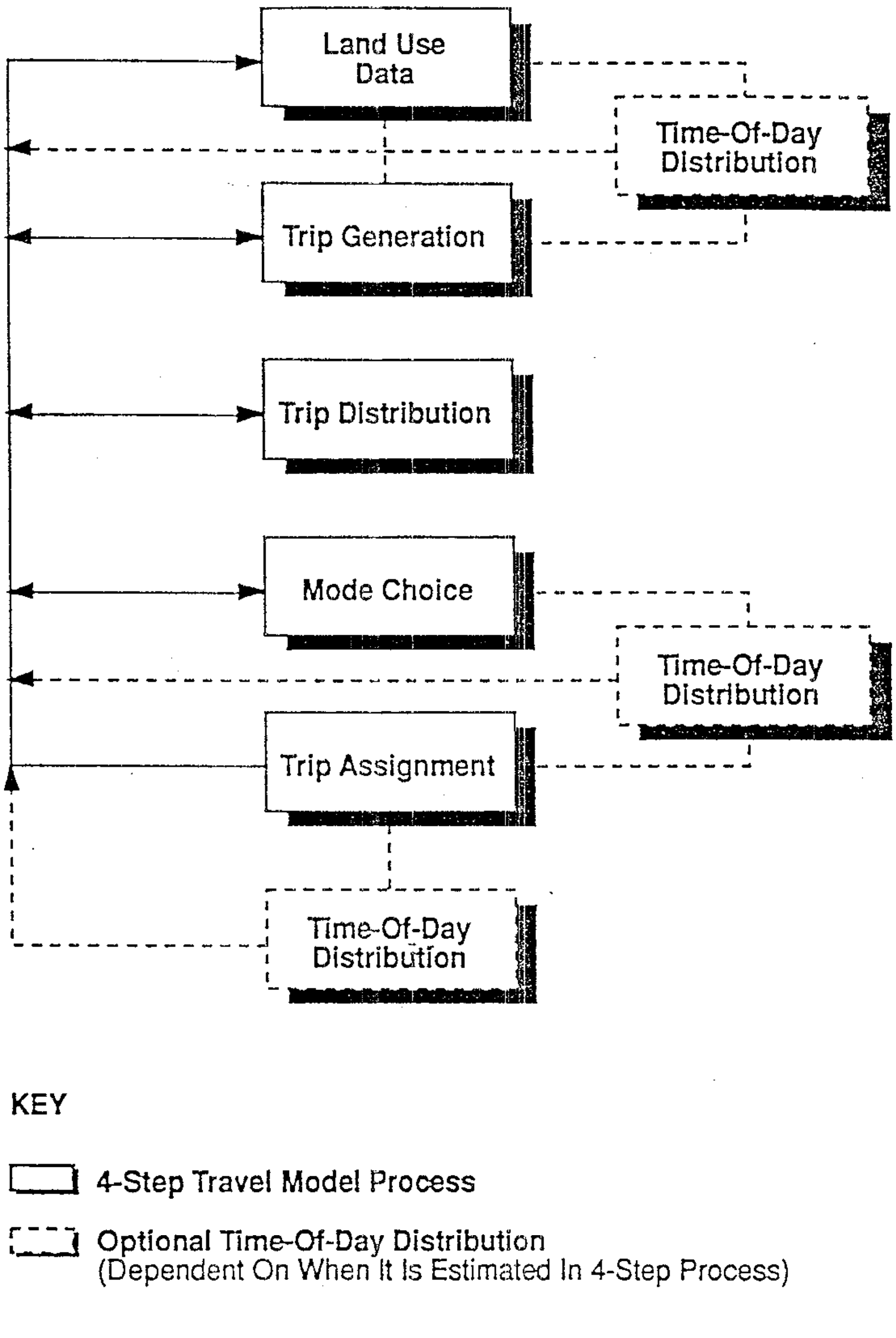


Figure 3-11
Feedback Mechanisms to Equilibrate Impedance

Congestion has been identified as having a significant impact on mode choice, thus state-of-the-practice mode choice models have incorporated feedback loops of the congested impedances to not only the mode choice models, but also the estimate of transit impedance where it is effected by highway congestion. State-of-the-art models have equilibrated this feedback loop. (Purvis, Nov. 19, 1991)

Trip assignment is the only step in the modeling process in which feedback loops and the equilibration of congested impedances is incorporated into state-of-the-practice models. The capacity restraint function, depicted by the BPR equation or the exponential equation, is the technique used to estimate delay from congestion and iterate to affect path choice on the basis of this delay.

3.9 MODEL APPLICATIONS

3.9.1 Analysis of Transportation Control Measures

The increasing concern about air quality has resulted in increasing use of travel demand forecasting models in the evaluation of the potential impact of transportation control measures (TCM). TCMs include a wide variety of measures designed to reduce vehicular travel, including rideshare promotion, parking pricing, increased transit service, alternative work schedules, and bicycle and pedestrian facilities. The impacts of TCMs are normally assessed on the basis of changes in vehicle miles of travel, trips, or changes in pollutant emissions. Travel demand models would readily produce the impacts in the desired form, but most travel demand models are relatively insensitive to the variables that are affected by the TCM's, such as trip cost by alternative mode, travel comfort, or awareness of alternatives. An analysis of TCM's can often use the data contained in the travel demand model, even when the travel demand model itself is not capable of forecasting TCM impacts. In such applications, the travel demand model supplies baseline travel characteristics, but the actual TCM impact is predicted in a post-process model that is sensitive to the relevant influences.

TCM analysis should predict TCM impact on the basis of either relevant econometric relationships based on travel behavior theory or on empirical evidence of effectiveness where methods have been tried before. It should be clear whether empirical evidence represents average effectiveness or maximum feasible effectiveness. The TCM analysis should take explicit account of the cumulative impact of multiple TCM measures and how that may differ from the sum of the individual impacts. When TCM's are analyzed as a post-process, care should be taken to ensure that TCM measures already incorporated in the travel demand model are not double counted.

3.9.2 Congestion Management

The Congestion Management Program has become a driving force for many regional transportation agencies to develop or update their transportation model. While the CMP legislation does not specifically require a travel demand model, there are certain requirements that imply the need for a model. The land use analysis program, for instance, requires a "program to analyze the impacts of land use decisions made by local jurisdictions on regional transportation systems...". The legislation continues to state "the agency... shall develop a uniform database on traffic impacts for use in a countywide transportation computer model and shall approve transportation computer models of specific areas within the county that will be used by local jurisdictions to determine the quantitative impacts of development on the circulation system that are based on the countywide model and standardized modeling assumptions and conventions". (Section 65089, Government Code)

It is this legislation, in combination with the Federal Clean Air Act Amendments (1990) and the California Clean Air Act (1988) that has prompted a critical look at travel demand forecasting models. Many people apply travel demand forecasting models without a clear understanding of the strengths and weaknesses. This often results in a lack of understanding of the appropriate applications of the model. For instance, transportation modelers do not believe that regional transportation models are accurate enough for intersection capacity analysis, but can be used in an incremental analysis to forecast level-of-service for intersections. Subregional models are often used for intersection capacity analysis; these models are required, by legislation, to be consistent with the regional model. This requirement will serve to determine an equivalence between one forecast and another, and should improve the decision-making process by providing results based upon similar assumptions. In theory, this is a strength of the legislation, but in practice, it will take some time to provide consistency between travel demand forecasting models.

The intent of the CMP is to reduce congestion on the highway network by coordinating land use, air quality and transportation planning. The travel demand model is the link between these areas, and will provide the necessary connection from one arena to another. The models are currently being applied to analyze congestion on highway and transit networks and as input data to emissions inventories.

3.10 REGIONAL AND SUBREGIONAL MODELING RELATIONSHIP

The CMP legislation requires consistency between regional and subregional (or local) models. Consistency should be determined by comparisons of the input data, model assumptions and results. The most effective way to achieve consistency between these models is to directly connect the input data sources and the parameters and assumptions. Some regional models are developed to incorporate existing local area models. Subregional models can be developed directly from regional model databases and follow similar modeling assumptions or apply regional modeling results where appropriate, such as to capture major mode split impacts of large transportation projects. Subregional models have the advantage of closer attention to detail and more accurate input data, while regional models have the advantage of capturing regional travel behaviors that might be difficult to model in a smaller area. Both models stand to gain from incorporating parts of other models, or using the other models as a reasonableness check where validation data is scarce.

3.11 MODEL DOCUMENTATION

Model documentation is a step towards improving the understanding and usefulness of travel demand forecasting models. If the model documentation is too brief to be useful, or it is not updated with changes to the model, then it will not be as useful to modelers. Model documentation may contain many variations of information, and are difficult to compare or contrast without guidelines. The following is a list of suggested topics for model documentation:

- Description of modeled area and network coverage
- Tabulation of land use or socioeconomic data for all years modeled
- Description and summaries of all variables in the networks
- Source and coverage of traffic counts used in modeling
- Description of the trip generation model by trip purpose
- Identification of special generator and external trips input to trip generation
- Summary of trip generation results (productions and attractions by purpose by year)
- Description of the trip distribution model by trip purpose
- Description of the source and form of friction factors used by trip purpose
- Description of the impedance measures used in trip distribution, including intrazonal and terminal times
- Identification of K-Factors and their derivation
- Summary of trip distribution results (total and intrazonal trips and average trip length by trip purpose)
- Description of the mode choice model by trip purpose
- Description of the variables (and units) used in the mode choice model
- Summary of the mode choice results (district to district trips by purpose by mode)
- Identification of the source and value of inter-regional trips
- Description, if applicable, of the peak hour models
- Description of the trip assignment model
- Description of the impedance measures used in trip assignment
- Identification of the volume-delay and path-building algorithms applied in trip assignment
- Summary of the trip assignment results (VMT, VHT, delay and average speed)
- Identification of model validation tests and results for each model stage.

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CHAPTER 4

EMISSION INVENTORY NEEDS

CHAPTER 4: EMISSION INVENTORY NEEDS

4.1. OVERVIEW

This chapter describes the travel activity data required for air pollutant emission inventory needs. The chapter identifies which elements of the travel activity data are derived from regional travel models and provides guidelines for how those elements should be produced. The chapter also describes sources of supplemental data that aid in emission inventory analysis and methods for validating the travel activity data used in the analysis.

4.1.1 - Historical Development of Emission Estimation Practice

The Federal Clean Air Act of 1970 produced a legislative mandate to improve air quality in certain metropolitan areas by controlling on-road motor vehicle emissions. The 1970 Clean Air Act initiated a linkage between travel forecasting and planning and air quality analysis that has continued for almost twenty years. Developments in the last few years, however, have suggested that the integration of travel forecasting and air quality analysis can be performed much more accurately than has been the practice.

The 1970 Clean Air Act established strict emission standards for all auto makers for cars sold in the United States. As a framework for determining compliance with the standard, the U.S. Environmental Protection Agency (EPA) developed the Federal Test Procedure (FTP), which contained a specific driving cycle -pattern of start, accelerations, cruising, decelerations, and idles over a specified terrain. Vehicles could then be tested to determine whether they were within the threshold limit of emissions over this FTP driving cycle, the average speed for which was 19.6 miles per hour (Horowitz, 1982). The use of the FTP, however, went far beyond its original intended application. A table of vehicle emission rates by speed was developed by interpolating between the emissions from the FTP cycle and several other cycles with different average speeds. The tables developed by EPA were then based on the emissions produced for each specific average speed measured over the test cycle (Guensler, et.al. 1991). As a result, the emissions did not reflect the rate produced at a continuous cruise at the specified speed but were instead a combination of starts, accelerations, decelerations, cruising and idling over a cycle that averaged the speed indicated.

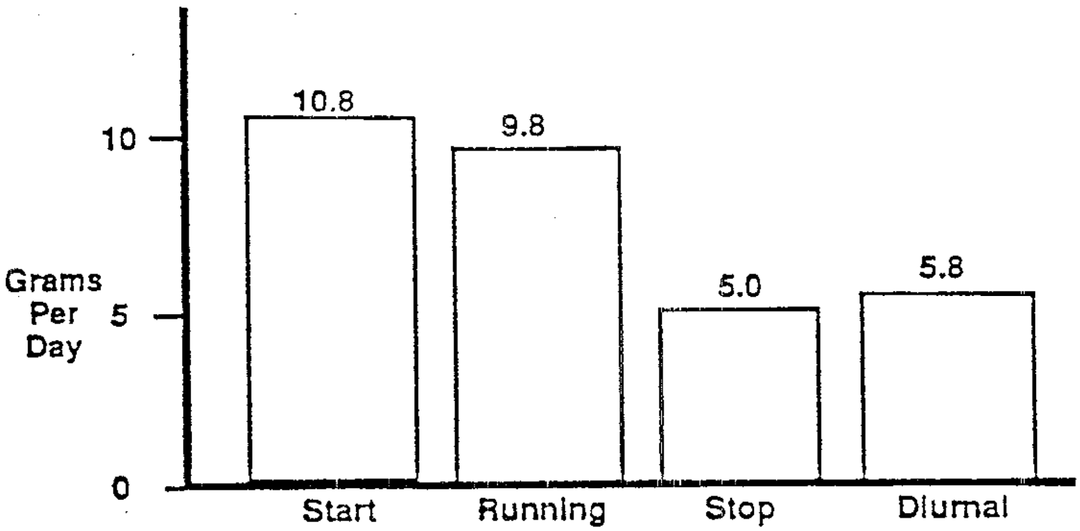
With the development of speed- and vehicle-type-specific emission rates, the next step was the application of these emission rates to the link-specific volumes and speeds produced by regional travel forecasting models common throughout metropolitan areas in the United States. Although the approach provided a previously unavailable method for estimating emissions from travel forecasts, it focused exclusively on VMT and average link speed as determinants of emission rates.

4.1.2 - Sensitivity of Emissions to Travel Characteristics

Despite the extensive use of the FTP driving cycle and speed-based emission rates produced from it, research continued at EPA and state organizations such as the California Air Resource Board (CARB) to identify the more specific determinants of variation in emission rates. The result of this research has been a fairly clear determination that vehicle emissions can be identified in at least four specific categories: trip start emissions, (cold start or hot start depending upon the period for which the vehicle has been turned off), hot stabilized running emissions (exhaust and evaporative), hot soak evaporative trip end emissions and diurnal emissions (hydrocarbon emissions from evaporation that are essentially unrelated to the amount the vehicle is driven).

Although the research is continuing as to the degree to which each of the types of emissions contribute to the overall motor vehicle emissions, an indication of the magnitude of each is provided in Figure 4-1. This graph provides an estimate of the pollutant emissions of hydrocarbon (reactive organic gases or non-methane hydrocarbons) that would occur in 1990 from a 20 mile round trip by a light duty automobile[1] at roughly 75 degrees at an average operating speed of 40 mph. The estimate of these emission components was based on factors derived from CARB's EMFAC7E model. The trip would produce a total of approximately 31.4 grams of hydrocarbon, however, only about one third of the emissions are associated with VMT from the trip. Fifty percent of the emissions result from the trip being made -- this is a combination of the trip start emissions and the evaporative hot soak emissions that occur at the trip end. A final one sixth of the emissions, referred to as the diurnal emissions, occur as a result of evaporation of fuel from the gasoline tank and occur whether the vehicle is driven or not. This calculation certainly demonstrates the importance of including trip starts and ends in emission estimation as well as VMT and operating speed.

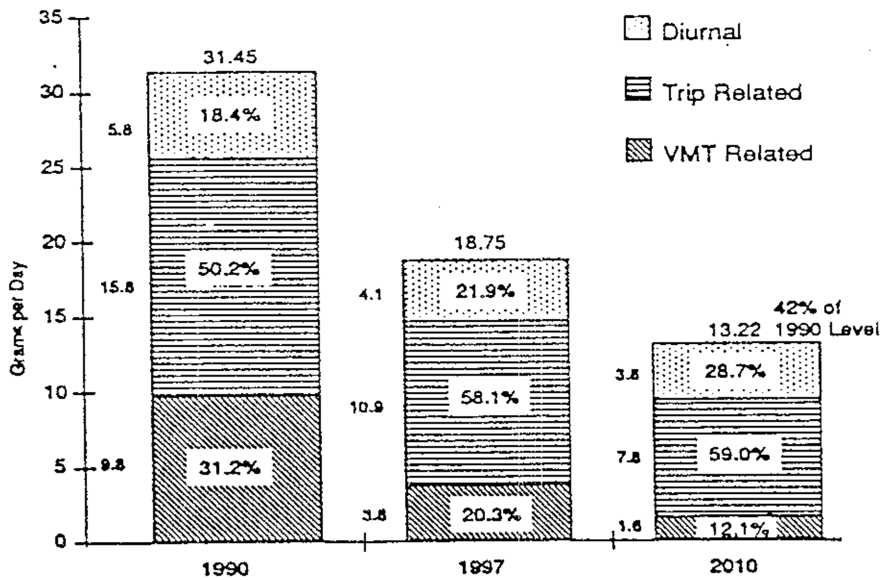
[1]A composite of the light duty automobiles on the road in 1990.



Based on a 20-Mile Round Trip for a Light Duty Automobile in 1990 at an Average Speed of 40 MPH

Figure 4-1

Hydrocarbon Emissions by Type for Prototypical Trip.



Based on a 20-Mile Round Trip for a Light Duty Automobile at an Average Speed of 40 MPH

Figure 4-2

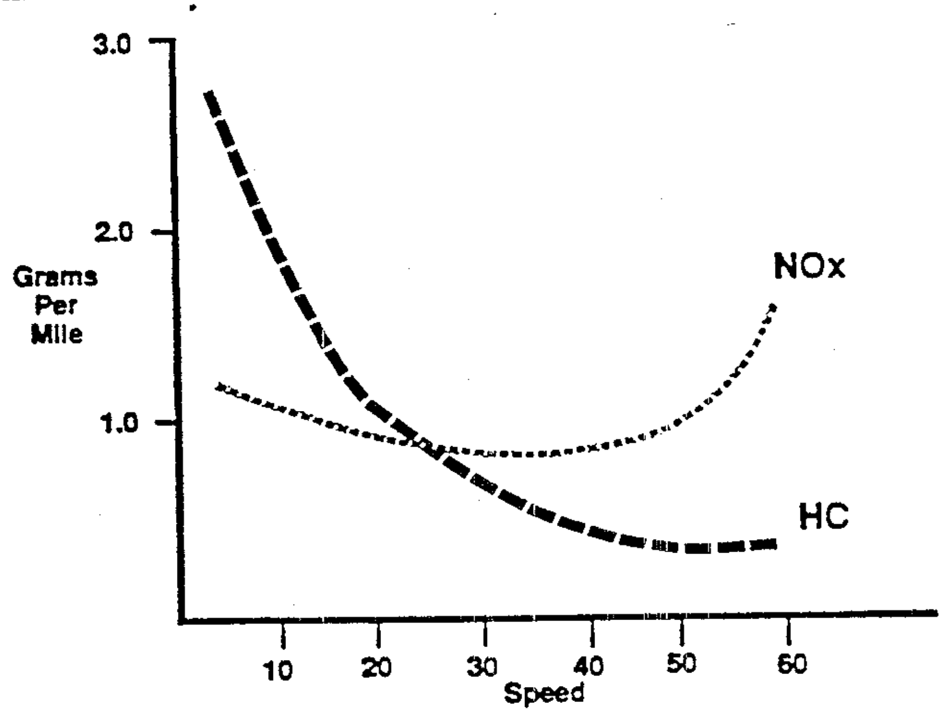
Expected Change in Hydrocarbon Emissions Over Time for Prototypical Trip

Figure 4-2 provides a similar breakdown between VMT-related, trip-related and diurnal emissions for the example trip in Figure 4-1 for 1990 and for the predicted emission rates in 1997 and 2010. The importance of VMT as a determinant of hydrocarbon emissions decreases over time. By 2010, the VMT portion of the emissions for this prototypical trip would be only about one eighth of the total.

Research by EPA and CARB has established that a significant relationship does exist between travel speed and emission rates after controlling for trip-start, trip-end and diurnal emissions. Although the speed-specific rates do still include effects of acceleration, deceleration, cruise and idling, Figure 4-3 provides an approximate mapping of the relationship between emissions for hydrocarbon and NOx and speed. Carbon monoxide emissions are significantly higher on a grams-per-mile basis than hydrocarbons but follow a similar pattern with respect to speed. Figure 4-3 indicates that at least within certain ranges of speeds, emission rates for all three primary pollutants are sensitive to speeds. It is also significant that the relationship for all three pollutants is nonlinear and concave in shape. Research now underway will determine the extent to which the speed sensitivity is a function of the number of acceleration episodes implicit in a particular speed and the extent to which the emission rate is sensitive to the cruise speed itself. Some initial research suggest that most of the variation in rates across speeds are explained by the presence of acceleration periods and that very little variability exists across most normal driving ranges of cruise speed.

The California emissions rate model, EMFAC7E, produces rates in grams-per-hour by dividing by the speed (in miles-per-hour). The rates can be converted to a grams-per-mile basis as illustrated in Figure4-3 but the relationship is undefined at a spread of zero. Emission rates on a grams-per-hour basis are relatively a fairly constant across speeds which has led many analyst in the industry to focus on the use of grams-per-hour based rates.

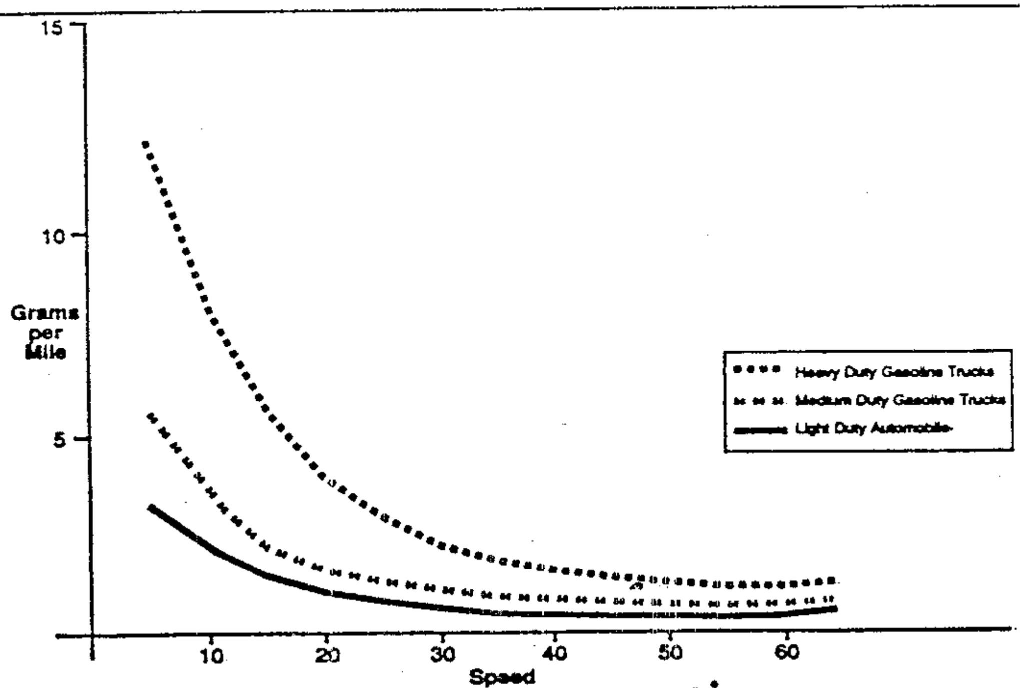
Research on emission rates long ago clearly established that rates vary significantly by vehicle type. The relationship between emission rates and vehicle type is clearly demonstrated by the graphic in Figure 4-4. This graph compares emission rates across three vehicle types: light duty automobiles, medium duty gasoline trucks and heavy duty gasoline trucks. The figure demonstrates that heavier vehicles have higher emission rates at all speeds but that heavier vehicles are also more sensitive to speed. A final area of sensitivity necessary in air quality modeling is the time that emissions occur. This is important in two respects: the ambient temperature (at a specific hour of the day) under which a vehicle has been started will affect the start emission and the time at which emissions are produced will affect the maximum concentrations and location of pollutants.



Based on 1990 Rate for Light Duty Automobile in the Bay Area of California

Figure 4-3

Relationship of Emission Rate to Speed



Based on 1990 rate for gasoline vehicles in California at 75°

Figure 4-4

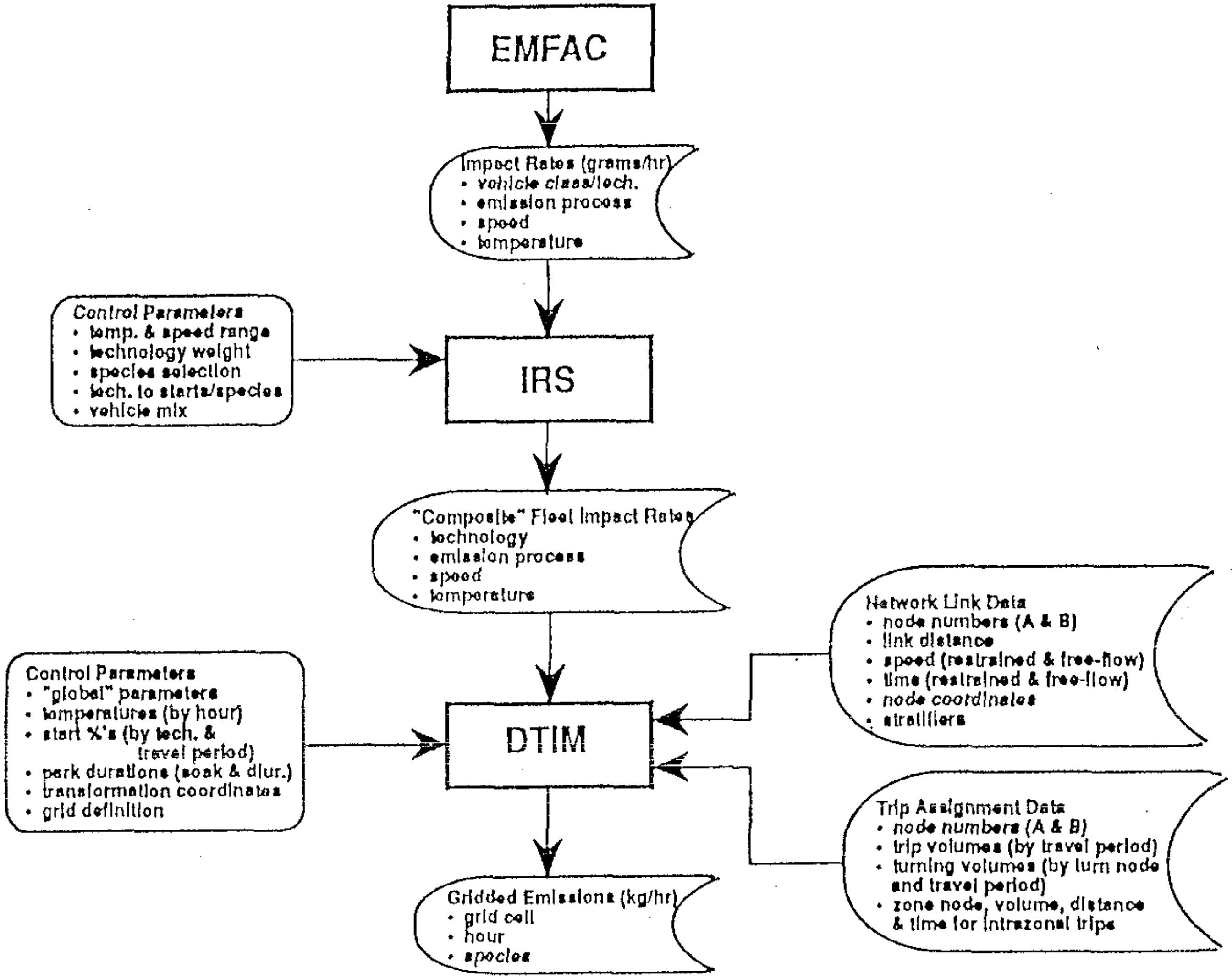
Relationship of Hydrocarbon Emission Rate to Speed by Vehicle Type

4.1.3 - California's Direct Travel Impact Model

These concerns about the sensitivity of pollutant emissions to trip starts, total vehicles (diurnal emissions), operating speeds, vehicle type and time of emissions all suggested that the previously common practice of basing emission forecast on only daily VMT and average operating speeds could produce highly inaccurate results. Fortunately new data and computing capabilities have made significantly more accurate forecasting of motor vehicle emissions possible. Certainly the disaggregation of emission rates into more explanatory component parts (cold start, hot start, running hot stabilize, hot soak evaporative, and diurnal) has significantly increased the ability to predict the quantity, timing and location of pollutant emissions using regional travel models. The Direct Travel Impact Model (DTIM) developed by the California Department of Transportation (Seitz, 1989a and 1989b) has provided the capability to use the output of a regional travel model in an emissions inventory with sensitivity to variations in VMT, number of trips, park duration, temperature, vehicle type mix and speeds. An overview of the DTIM model and its function in emissions estimation is provided graphically in Figure 4-5.

DTIM couples a set of emission impact rates produced by ARB's EMFAC/IRS model with transportation model data and ambient temperature data to compute emissions by square grid cell and hour. Running exhaust emissions are computed for each individual roadway link in the input network file as a function of the average travel time[1] (or speed) on the link. From each link's coordinates (X,Y) the emissions are spatially allocated into grid cells. Starting exhaust emissions are estimated by applying starting impact rates to trip starts compiled by time of day and traffic analysis zone. Evaporative (soak and diurnal) emissions are computed similar to starting emissions except average parking durations are required in addition to the number of "parks" by time of day.

[1]DTIM applies emission rates on a grams-per-hour basis for a specific speed to the estimated travel time (vehicle hours of travel) on the link.



Source: Sierra Research for "Overview of the Travel and Emissions Estimation Procedures for the San Joaquin Valley Emission Inventory," JHK & Associates and Sierra Research, 1991.

Figure 4-5
Detailed Flow Chart for Emission Estimation Procedures

The model is typically run by taking travel estimates for three daily periods: AM peak, PM peak and off-peak to the emission impact rates. Individual hourly variation in emissions within either of these periods is then based on input hourly temperature variations and trip starts or "parks" data (see INPUTS/Control Parameters).

Key Assumptions:

- Vehicle starting emissions are assumed to occur as cold or hot starts based on the duration the vehicle is parked before starting as follows:

	Hot	Cold
Catalyst vehicles	1 hour or less	over 1 hour
Non-catalyst vehicles	4 hours or less	over 4 hours

- Emissions within the grid domain are based on a single diurnal temperature profile.

- Hot soak evaporative emission rates are a function of soak (park) times (normalized for one hour) as follows:

Minutes (of park)	0	30	60	120	>120
Cumulative rate (%)	0	70	100	130	130

Inputs:

- Control Parameters

  - o "global" parameters (calendar year, altitude, pollutants, speed and temperature range, etc.)
  - o transformation coordinates (to translate network coordinates to grid coordinates)
  - o grid definition (origin, size and number of cells)
  - o ambient temperatures (by hour, single site)
  - o starts (% of trips which are hot and cold starts by technology and travel period)
  - o parks (% of trips which are parks (not starts) and average park duration by travel period)

- "Composite" Impacts Rates - Emission impacts rates by technology, emissions process, speed and temperature produced by IRS program.

- Network Link Data - Network link data from a transportation planning model. Each record describes a link in the network. The link description incudes:
  - o node numbers (identifying numbers for the link endpoints)
  - o link distance
  - o link speed (peak and off-peak)
  - o link travel time (peak and off-peak)
  - o link type (freeway or other)
  - o link node (endpoint) coordinates

  Running exhaust emissions are computed by applying impact rates specified by the link speed individually to each link in the network. (Link volumes are given in the Trip Assignment file described below.) This process can be run by hour and the emissions are then allocated into grid cells.

- Trip Assignment Data - Trip assignment data is input to DTIM from a single file containing three types of records: Profile (Link) Volume records, Intrazonal volume records and Terminal (Trip End) Records. Each is described in detail below.

- o Profile record - Contains vehicle volumes by travel period (e.g., peak and off-peak) for each of the network links (identified by node numbers). Each record represents an individual link.

- o Intrazonal record - Transportation Planning models estimates of vehicle volumes throughout an urban area consist of an additional component of travel called "intrazonal". A roadway system is modeled as a number of irregularly shaped zones (traffic analysis zones), each of which contains a number of individual links, representing the roadways in the zone. From socio-economic data, trips between each of the zones are developed and volumes are assigned to links between each zone pair based on the "resistance" assumptions in the network. Short trips which occur within each individual zone are estimated separately and intrazonal volumes from these trips are assigned to each zone. The intrazonal record contains intrazonal volume for each travel period and the estimated average time, distance and speed of these trips. Each record represents a single zone.

- o Terminal record - Contains trips (productions and attractions) by travel period for each zone pair in the roadway system.

  The formats of Network Link file records and each of the Trip Assignment file records are similar to those produced by transportation planning models. However, there are a number of transportation models in use and the output record structure varies for many of them.

The basic guidelines for emission inventory analysis in California have been established by the statewide use of DTIM. The methodology contained in DTIM represents the most sophisticated approach to using regional travel model output to produce emission inventory data for on-road motor vehicle activity. New software is now being developed to apply the same concepts contained in DTIM, but the DTIM model remains the standard for emission inventory development. Because of its sophistication and its widespread use, the input requirements of DTIM define the acceptable level of practice for California. The guidelines in this chapter generally suggest the acceptable level of practice for development of the DTIM inputs.

4.2 TRIP VOLUMES BY PURPOSE AND TIME PERIOD

4.2.1 - Trip Purpose Categories

Accurate prediction of the air quality impacts of on-road motor vehicle activity is critically dependent on accurate prediction of trip volume by purpose and by time period. As indicated in the overview section to this chapter, the quantity of pollutant emissions is highly dependent on the number of trips as well as the number of miles traveled. But also important determinants are the speed at which travel occurs, the temperature at which the travel occurs, and characteristics of the vehicle being operated. Although these detail characteristics of the travel are generally not direct outputs of the regional model (speed is estimated on an aggregate basis for certain time periods or on a daily basis), they can be approximated in post-processing steps on the basis of trip purpose. For that reason, the prediction of trip volume by trip purpose in the regional modeling process is important to the determination of pollutant emissions.

If trip purpose is used to estimate time-of-day and vehicle type distribution, at least three trip purposes should be used: home-based work (HBW), home-based non-work (HBNW), and non home-based (NHB).

This minimum trip purpose differentiation separates those trips for which the total number is based on number of households in the region (HBW and HBNW) from those trips which are not directly related to number of households (NHB). The second category is often used to include commercial travel, tourist travel, and other travel not reflected in resident-based home interview surveys. As a result, the trip volume in this category is often adjusted in calibrating a regional model to produce an appropriate number of total trips. The separation of work from non-work trips out of the total home-based trips provides significant information about the timing of trips and about the length of stay at the trip destination (the attraction end of the trip). Further differentiation of home-based non-work trips and non-home-based into subcategories can significantly improve on representation of travel behavior and is recommended for advanced practice. This improvement, however, is generally more significant in the estimation of other travel characteristics such as trip length, trip destination, and mode choice than in the estimation of time-of-day or vehicle-type distribution.

4.2.2 - Time Period Definitions

Most regional travel models that provide average annual daily forecasts normally also produce either one or two peak-period forecasts designed to represent the travel that occurs under the heaviest flow conditions during the day. In some cases, a period may represent a single peak hour or it may represent a two- or three-hour period.

Time period definition should be designed to capture homogeneous characteristics of travel such as congestion, mix of trip purpose, and travel speeds. Whenever congestion has a significant impact on peak period speeds, peak periods should be modeled separately.

Time period definition should be chosen to distinguish the travel occurring under congested conditions from the travel occurring under free flow or uncongested conditions. Because emission rates are so critically dependent on speed (using existing emission rates), the most important criteria for definition of time periods for emission estimation is probably homogeneity with respect to speeds. The DTIM program allows for two different speeds to be specified for each link in the system -- a peak-period speed and an off-peak period speed. While this certainly does not capture all of the variation in speed and will result in some biasing of emission estimates, it is a significant improvement over an assumption of constant speed throughout the day.

4.2.3 - Travel with External Trip Ends

The treatment of trips into, out of, or through a region introduces additional complexity into the estimation of emissions. The normal practice in regional modeling is to create external zones at the periphery of the region to represent the origin or destination of these trips. The total volume into or out of these zones can be estimated for a baseline year using observed traffic counts. The volume for a future forecast year is estimated using a variety of projection techniques, the most common being to project past growth rates on the roadway observed. Allocation of travel to and from these zones to time periods becomes complex for any trips with the production end in the external zone. For these trips, the trip purpose is not known and so a supplemental, empirically-based method for allocating the trips to a time period must be used. This can be based on the time-of-day distribution for the traffic count used to set the total volume of trips out of the zone.

4.2.4 - Special Forecasts

By far the most common practice in California is to calibrate regional forecasting models for average annual weekday travel. Special accommodation must therefore be made if a model is to be used to represent a particular season of the year (the most serious ozone violations tend to occur during the hottest part of the summer) or for weekend days.

> *Whenever the model is used to forecast for a specific season, corrections based on observed seasonal variation should be made to account for the difference between average annual conditions and the particular season being evaluated.*

If the forecast is for a typical weekday, the correction may be quite minor because the same trip purposes might apply. Forecasts for weekend days, however, should, whenever possible, be based on a model of weekend travel. Much of the travel that occurs on an average weekday, such as work and school trips, do not occur in as great a number on weekend days. In addition, there is a significant amount of weekend recreational travel that is not included in weekday models.

> *In general, when weekend forecasts are made, forecasts should rely on observed weekend data, and the use of trip purpose from weekday forecasts should be minimized.*

Vehicle emissions can also be affected significantly by the occurrence of special events that would affect either the total volume of travel or the nature of the travel that occurs (timing, speed, vehicle mix, etc.). Special events might be planned events such as fairs, sporting events, etc., or unplanned events such as traffic accidents. Incorporation of the effects of special events is generally beyond the scope and capability of a regional model.

> *Wherever special events are known to have a significant impact on an emission inventory, external adjustments should be made to the travel activity data to reflect the impacts of the event. This may include adjustment of the number of trips, adjustment of VMT on particular links, adjustment of average operating speeds, adjustment of the time-of-day distribution of travel, or adjustment of vehicle type distribution on a particular link.*

4.2.5 - Comprehensive Coverage of Trips

As the use of regional models in emission inventory development increases, the concern about comprehensive coverage of all travel also increases. Most regional models were constructed primarily for the evaluation of transportation infrastructure needs. The main purpose in evaluating the regional models was the accuracy of estimating peak-hour or peak-period volume of major facilities, whether they be roadway or transit facilities. The volumes predicted for future years were then used to determine the appropriate size for the facility in that future year. Under these conditions, exclusion of some trips from the modeling system was not important if those trips did not contribute significantly to the VMT on major facilities during peak periods. For emission estimation, however, comprehensive coverage of all trips is much more important. Because of the significant contribution of emissions from starts, particularly cold starts, a trip can have a significant impact on emissions regardless of the length of the trip.

Because of the significance that they may have in an emission inventory, all trips regardless of time of day, location, or trip length, should be included in a transportation model.

Because of the regional nature of certain pollution problems such as ozone, the exact location where the emissions occurs is of less significance than the quantity of the emissions and in DTIM, emissions are aggregated by grid cell. Emissions occurring on minor or residential roads can contribute equally to ozone formation as emissions occurring on a major freeway. But because of the significant relationship between speed and emission rate, the impact of short trips on minor roads on emissions is generally greater than their impact on VMT or total trips. Most minor streets in urban areas operate with average operating speeds of less than 20 mph because of frequent stops. As a result, this travel is probably the most polluting on a grams-per-mile basis.

The major source of data used in the development of a regional travel model (those developed from regional data not transferred from another region) is a home interview survey. As a result, the regional models are most fully developed for trips made by residents of the region and particularly those trips made to or from the home. Non-home-based trips by residents and trips by non-residents are frequently underrepresented or excluded entirely. This most frequently includes commercial travel, tourist or visitor travel and recreational travel. Although classified as home-based trips, school trips are also frequently underreported or excluded. A special effort should be made to ensure that all of these trip types are included in the travel activity data.

If the regional model output underrepresents or excludes any trip types, supplemental activity data should be provided.

The DTIM model operates on vehicle trip assignments for a regional travel model. As a result, a DTIM-based emission inventory potentially excludes emissions from transit vehicles. This is likely to be a significant factor in major metropolitan areas with a substantial bus fleet.

Where emissions from transit vehicles is likely to be significant, DTIM analysis should be supplemented with travel activity data for transit vehicles.

In areas with park-and-ride facilities, the regional modeling also often ignores the automobile access to the park-and-ride lot. Because a significant percentage of emissions from a trip are associated with the starting of the car, the trips to and from the lot can be significant and should be recognized in an emissions inventory.

Where a significant number of transit or carpool trips use park-and-ride lots, DTIM analysis should be supplemented with activity data on the trips to and from the park-and-ride lots.

4.3 VEHICULAR SPEEDS

4.3.1 - Relationship between Speed and Emission Rate

As indicated in the overview section for this chapter, current emission rates from California Air Resources Board reflect a significant relationship between emissions on a gram-per-mile basis and average operating speed. The U.S. Environmental Protection Agency's model, MOBILE4.1, reflects a similar relationship, although California's EMFAC model goes farther in separating out trip end related emissions from hot stabilized running emissions. Within these speed-dependent emission rates, however, there is considerable uncertainty that arises from the method by which the relationship is developed.

The speed-based emission rates from EMFAC and MOBILE represent an average rate on a grams-per-hour basis over a range of operating modes (accelerating, decelerations, cruise speeds and idles) for which the total time and travel distance reflect the average operating speed that the emission rate represents. The actual emissions that occur for a particular operating speed depend on the specific pattern of operations that occur. The emission that occurs at a constant cruise speed of 30 miles per hour are much lower than the emission that would occur over a series of accelerations and decelerations that produce the same 30-mile per hour average operating speed.

Despite the imprecise nature of current emission rates, specifically the relationship between speed and emission rates, close attention to the speeds is still warranted, while the existing methodology for relating emission rates to speed captures more than just the relationship of speed itself, average operating speed remains a reasonable proxy for the characteristics that influence the emission rates. It is important to recognize, however, that this relationship with speed may be one of only correlation and not direct impact.

4.3.2 - Consistent Use of Speed

To be consistent with the emission rate models, speeds should represent average operating speed over a section of a facility, not the mid-block cruise speed or the speed limit on the facility.

The speed supplied to DTIM should represent the average over the cycle of acceleration, deceleration, cruise, and idles that occur over a reasonably long section of the facility. To the maximum extent practical, the speeds used in the travel modeling steps should be consistent with the speeds used in the emission estimation. However, the travel forecasting steps are generally less sensitive to speed variation than emission estimation and the same level of detail may not be warranted in the travel forecasting model. For this reason, the speeds used in emission estimation may be developed through a post-processing speed/volume/capacity analysis step using data that have greater time-of-day detail than was available from the model system. As a result, the speeds used in emission estimation may not be identical to those used in the modeling steps. There may be sufficient variation for speeds within a peak period to justify hour-by-hour estimate of speeds by link using post-processing steps for emission estimation. Hour-by-hour assignment within the transportation model may not be justified, however, and so separate speeds for emission estimation and for modeling travel behavior might be warranted.

It is also common practice to use free flow speeds for off-peak periods in regions where there is little or no congestion during the off-peak periods. For emission estimation, however, there can be a significant difference between a free flow speed and the slightly lower loaded speed that results even under uncongested conditions. This may be particularly important at the high end range of speeds, at which higher speeds can result in greater emissions.

Given that speed is used as a proxy to represent a variety of travel characteristics that affect emission rate, speed should be estimated for emission estimation purposes in as detailed a manner as is practical and consistent with the definition of speea used in emission rate models.

4.3.3 - Averaging of Speeds

The nonlinearity of the relationship between speed and emission rate introduces a significant concern about the effects of averaging of speeds. Because the relationship is nonlinear and concave in shape, the emission estimate using an average of two speeds will almost always produce a lower value than the sum of the estimates using the two different speeds. While it has been clear for some time that emission rate increases sharply with a decrease in speed at low speeds, there has recently been an increasing amount of evidence that the emission rates for all three of the primary pollutants also increases with speed in higher speeds over 50mph. This research reflects in greater non-linearity in the relationship and argues more strongly against averaging of speeds.

Because of the nonlinearity, averaging of speeds over time periods or across vehicles within the same time period should be minimized.

The evidence of increasing emission rates at high speeds has also focused new attention on the maximum speeds allowed within a model system. While the transportation modeling has not been particularly sensitive to these maximum speeds, emission estimates may be.

The free flow speed on a link should be based on observed free flow speeds under uncongested conditions on the facility and not be constrained to speed limits as the maximum speed.

The nonlinearity of the relationship between speeds and emissions also raises a concern about the treatment of the distribution of speeds within a time period. Current practice is to estimate an average speed for the period using speed/volume/capacity relationships. While these relationships might produce accurate estimates of the average speed on a link, use of the average may cause significant bias in the emission estimates. As the relationship between speed and emissions becomes more clearly defined with current, ongoing research at ARB and EPA, more consideration should be given to use of speed distribution in emission estimation rather than just average speeds. This could be incorporated directly into the emission rates if the emission rates can be more specific to roadway characteristics or level of service. At present, the emission rate for 30 mph is the same for a freeway as it is for an arterial, although the cycle of operating modes would be quite different and therefore the emissions quite different. An average operating speed of 30 mph on a freeway is likely to have far more acceleration and deceleration than 30 mph on an arterial. There is also likely to be significantly greater variation in the individual speeds of vehicles at an average operating speed of 30 mph on a freeway than on an arterial, both of which would directly affect the applicable emission rate.

Figure 4-4 in the overview to this chapter provided an example of how the relationship between speed and emission rates varies by vehicle type. Not only does the emission rate increase with vehicle size at all speed levels, but the emission rate for heavy-duty gasoline trucks is more sensitive to speed than medium-duty gasoline trucks or light-duty automobiles. There is also evidence in traffic engineering literature to indicate that there is variation in the relationship between speed and roadway level of service for different types of vehicles. A methodology that differentiates volume by vehicle type and estimates separate speeds for each vehicle type will therefore produce more accurate estimates of emission rates than a methodology that assumes the same average operating speed for all vehicle types on a link.

4.3.4 - Methods for Validating Speed Estimation

Because of the sensitivity of emission estimates to speed estimates, the validation of an emission inventory methodology should include a validation of the speed estimates provided with the travel activity data. Such a validation, however, is much more difficult than the validation of volumes on links because the speeds represented in the model are average operating speeds over a section of the facility rather than instantaneous speeds at a particular point on the network. True validation of the speed estimates would have to be based on travel time runs over a segment which provide only one estimate of speed per run. Collection of sufficient data for validation of speeds is therefore quite costly and potentially beyond the resources of many regional agencies.

A less accurate but approximate validation of speeds can be provided by the spot checks of speeds at single locations. If measured at a mid-block location, this would generally represent an upper bound on the speed estimated by the model because it does not include the effects of intersection delays on average operating speed. The difference between these mid-block speeds and average operating speeds is most significant on arterials or minor streets where there are frequent stop signs or signals, while on freeways the two may be quite similar if not the same.

> *Whenever possible, validation of the speeds used in emission estimation should be validated using floating car speed estimates over a variety of facility types and operating levels of service; but where resources do not permit this method of validation, spot checks of mid-link speeds should be used.*

4.4 PRE-START AND POST-PARK PARAMETERS

With the awareness of the importance of trip start emissions, trip end emissions, and diurnal emissions, increasing attention has been given to the nature of trip starts and trip ends or parks. Because of the limited treatment of trip starts and parks within regional models, DTIM provides significant supplemental data on start and park characteristics. Regional travel models are generally limited to only the prediction of trip ends by zone by trip purpose. In more sophisticated models, trip ends by purpose are predicted for each time period while simpler models predict trip ends only on a daily basis.

More detailed information than is provided by the regional model is required to determine the timing of each trip start and each trip end (the specific hour of the day) and the duration of the park. As indicated in the overview, the hour in which a start or park occurs is necessary to determine the timing of the pollutant emissions, but also the amount of pollutant emissions. The amount of emissions that occur with a start or a park vary with the ambient temperature, and in many areas of California the temperature can vary significantly over the day. In addition, diurnal emissions (those that occur from evaporation of fuel from the gasoline tank and fuel line) occur predominantly with a rise in temperature; therefore, the location of the diurnal emissions of hydrocarbons will be located where the vehicle was located during the period of rising temperature during the day.

The data necessary for specification of pre-start and post-park characteristics within DTIM consist of survey data on:

- o Distribution of start times and end times by trip purpose
- o Distribution of park duration by trip purpose

The most common source for this data is the home interview survey. With this survey data, traditional regional model output can be supplemented to provide the necessary start and park information to provide a reasonable prediction of the timing, location, and quantity of pollutant emissions that are not VMT related.

Although relating trip start and park characteristics to trip purpose as determined by the regional model is the method used in the current DTIM software, other travel characteristics or characteristics of the model zones, could potentially serve the same function as trip purpose. Start and park characteristics from survey data could be related to zonal land use, development density, area type, or other characteristics of the zone. Developing such relationships from survey data might be useful in situations where a regional model does not predict travel behavior by trip purpose or it may be used as a further refinement of start and park characteristics when trip purpose is used as the main determinant. If zonal characteristics are to be used to relate start and park characteristics to model output, the zonal characteristics for each respondent in the survey that is used to develop the relationship will have to be known. An advantage to using only trip purpose is that all of the information necessary to estimate the relationships are normally contained within a single survey of individual travel behavior, such as a home interview survey.

Regardless of the explanatory variables used to predict start and park characteristics, the methodology used to predict these characteristics as a function of regional travel forecast data should be based on a survey of individual travel behavior.

CHAPTER 5

RESEARCH AND RECOMMENDATIONS

CHAPTER 5: RESEARCH AND RECOMMENDATIONS

5.1 INSTITUTIONAL AND RESOURCE REQUIREMENTS

There are three considerations for institutional and resource requirements that would benefit from additional information, further research and a better understanding of the requirements. The legislative requirements are complex and extensive, requiring effort to learn and understand the benefits and costs of each legislative requirement. The modeling coordination between agencies is required by the legislation, but the interpretation of what constitutes coordination is flexible. Modeling coordination between agencies can maximize the resources available for transportation modeling. The consistency requirement of the legislation will improve the comparison of transportation impacts from one area to another and may improve the reasonableness of individual modeling assumptions.

5.1.1 Legislative Requirements

Each regional agency should understand the implications of the legislative requirements, the areas of the legislation that may change over time, and the overall objective of the legislation. Implementation of the legislative requirements will produce additional understanding of the strengths and weaknesses of the legislation. The weaknesses will provide insight to the areas of the legislation that may change over time. Additional research will be required to implement the changes needed in the legislation and carry through the full intent of the legislation. When complying with the first application of any of the legislative requirements, the regional agencies should consider the overall objective of the legislation, and apply judgement to determine appropriate responses to the specifics of the legislation, recognizing that the legislation may change over time.

Recommendation: Seek clarification of legislative requirements and areas were legislation may change to provide understanding of the legislation.

Congestion Management Programs

The intent of the legislation for congestion management programs was to facilitate joint planning efforts among coordinating agencies involved with land use, transportation, or air quality planning. While the intent of the legislation is a significant step in the right direction for congestion management planning, the short time schedule to complete the legislation caused problems in the implementation and understanding of the legislative requirements. The "Congestion Management Program: Resource Handbook", written in November, 1990, offers guidance to understanding the California Government Codes referencing Congestion Management Programs and lists technical resources available to implement the legislative requirements.

There are a few discrepancies in the CMP legislation that warrant further research. Under the current requirements, local agencies may be responsible for mitigating circulation impacts caused by another agency. The legislation states that the agency responsible for the transportation impacts causing the CMP system to drop below the level-of-service standard will be responsible for mitigating these impacts. If other jurisdictions have projects that contributed to these impacts in that area, but did not cause the CMP system to drop below the level-of-service standard, they are not legislatively responsible for mitigating the impacts. This discrepancy causes an unequal distribution of the costs of mitigating transportation impacts. Many congestion management agencies (CMA's) are investigating a traffic impact fee to distribute the costs of mitigating impacts among all developments that caused the impacts.

The CMP legislation states that a deficiency plan must include "....A list of improvements, programs, or actions, and estimates of costs, that will (i) measurably improve the level-of-service in the system....". This term "measurably improve" is not defined in the legislation and could be interpreted differently by different agencies.

The first application of the level-of-service standard allows for "grandfathering" segments or intersections that are below the established level-of-service standards, and established site-specific level-of-service standards for these facilities. This practice could force resources to be redirected to less congested facilities, by identifying less congested facilities as below the level-of-service standard, when existing facilities have a lower level-of-service, but meet the standards applied by the "grandfathering" clause in the first application of the CMP.

The CMP legislation is unclear regarding the responsibility for monitoring and maintenance of the level-of-service on state facilities. This leaves the decision up to the individual congestion management agency, without any clear guidance as to the coordination between Caltrans and the CMA, or the specific responsibilities for each agency.

There are possible conflicting goals of the CMP and air quality programs, such as policies that promote the management of congestion but increase air pollution. One example is the policy to encourage workers to travel to work during non-peak hours (flex-time), when this policy could discourage the use of public transportation or carpooling for these trips. Flex-time policies can reduce congestion on the system, but will not reduce air pollution because it does not encourage transit or carpooling modes of travel.

Federal Clean Air Act Amendments and California Clean Air Act

The intent of the clean air acts was to achieve clean air in the state of California and in the U.S by requiring air quality agencies to meet the air quality standards specified in the acts. The acts require the Environmental Protection Agency (EPA) and the California Air Resources Board (ARB) to provide guidance in meeting the clean air act requirements. EPA has recently completed the updated "Transportation Air Quality Planning Guidelines," and is still working with DOT to complete conformity guidelines. ARB has completed guidance on the transportation provisions of the California Clean Air Act, and subsequent guidance on the CCAA transportation performance standards. Specific legislative references to transportation and indirect source control can be found in the "Congestion Management Program: Resource Handbook".

The EPA RTP Modeling Checklist asks for a variety of feedback mechanisms and equilibration techniques in travel demand models to reflect impacts from one part of the modeling process to another. Some of these methods are being used in state-of-the-practice models and some of these methods have been tested in state-of-the-art models, but have not been widely tested in model applications. The checklist asks for feedback loops in the transportation model to reflect congestion/travel times in land use distributions. Some land use planners accomplish this feedback by a qualitative evaluation of the impacts of congestion on land use distributions, but it is most often not addressed in a quantitative evaluation. This area requires further research before travel demand models can adequately address feedback loops to land use distributions in practice.

Feedback mechanisms to incorporate the impacts of congestion or travel times on the trip generation model will require modification to most trip generation models in use in California. Some guidance from further research could propose acceptable and advanced methods for incorporating these impacts into trip generation.

Intermodal Surface Transportation Efficiency Act

The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 creates many challenges for the transportation professional. One area of the act that may require additional guidance from the U.S. Department of Transportation is the integration of travel demand forecasting models with the management information systems required by the act.

5.1.2 Modeling Coordination Between Agencies

The purpose for coordination of modeling between agencies is to maximize the resources available to develop and apply travel demand models and to recognize the differences between model applications. The area of this coordination that has received attention directly from the legislative requirements is information sharing among travel model user groups and workshops for specific applications of the travel demand models (such as for the congestion management programs). This type of coordination should provide regularly scheduled interactions between the state agencies and the regional agencies, between the regional agencies and the county agencies and between the county agencies and the city, or local, agencies.

Recommendation: Support the interaction between agencies with travel model users group meetings and one-on-one meetings between agencies.

5.1.3 Consistency Of Modeling Approach

The determination of consistency for models of different government agencies (regional, county, or city) should reflect consistency of the input data, assumptions, and results of the four-step travel demand modeling process. Each regional and county agency should determine the requirements to obtain consistency in these three areas. The guidelines for modeling by regional agencies contained in this document should ensure consistency for regional models, without establishing specific requirements for consistency. The state travel model cannot represent reasonable "urban" model results for regional travel demand models and should not be used as a control for the results, but can be used to compare certain model assumptions with regional models.

Recommendation: Evaluate consistency of the modeling approach by comparing input data, assumptions, and results of the four step travel demand model.

5.2 DATA RESEARCH NEEDS

These research needs are based upon the consultant's experience of where the greatest potential weaknesses are in current travel forecasting techniques, and where the greatest payoffs would occur (in terms of improved travel forecasts) with new research.

5.2.1 Land Use and Socioeconomic Data

What is the best method for stratifying employment (attraction trip end) by income categories?

Present modeling techniques either ignore this issue (due to lack of data), or else use crude proxies (e.g., estimating work-end income based on the income of surrounding *residential* areas). Better information may be available from social security tape files, state income tax, or other sources. The stratification of employment by income categories is desirable.

What kinds of biases are create by using the median income in a zone to "created" a stratification of household income categories?

The median is often used to stratify the percentage of households into low/medium/high income categories for trip generation analysis. Is the improved accuracy offset by the errors or biases in the process to stratify households?

Is auto ownership or household income a better predictor of trip generation? Should household size (number of persons) be included as an additional variable?

Both approaches are widely used in the state, with little consensus on which is better.

How can the land use allocation process be improved?

More sophisticated models use mathematical programming techniques to minimize costs of total firm inputs, although most analysts feel that the results to date are still disappointing. A better understanding of the linkage between transportation supply (new projects) and the spatial distribution of land uses is also needed.

How can the role of accessibility in firm and household location in a region be better understood (possible before/after studies).

Recent court decisions have made it imperative that MPO's include this in their evaluation of RTIP projects, and yet there has been relatively little research in the US on this topic.

What are better approaches to analyzing jobs/housing balance issues?

The congestion management programs mandate consideration of this issue, and yet the gravity model may be too aggregate a tool to effectively deal with this issue (the gravity model is an analog, not a behavioral model, and may not be capable of addressing this issue effectively). Since much new affordable housing is being built at the periphery of metropolitan areas in California, the gravity model may be underpredicting trip lengths and long commutes.

5.2.2 Network/Supply Information

Are computerized GIS systems a cost-effective way to maintain and manage the highway and transit network databases?

Is it desirable to use the network as a database tool to store all traffic data? (counts, pavement conditions, accidents, cost, proposed improvements, etc.)

Are intersection penalties a cost-effective method for improving traffic forecasts? How good are software packages that make turn penalties flow-dependent?

Are there data to develop reliable volume/delay curves for ramp metering?

These could be used to create user-defined delay curves in the assignment step.

5.2.3 Cost Information

Is there a single "best" auto operating cost for use in model?

Most areas use the value (cost/mile) that provides best mode split model calibration, but there is no agreement on whether this should include a share of maintenance or other ownership costs of the vehicle.

How can improved methods of forecasting direct parking costs be developed?

These models need to be sensitive to development density, land values, parking availability/excess time (demand/supply imbalances), and the availability of free/subsidized parking.

5.3 MODEL IMPROVEMENTS

The following identifies areas of travel demand forecasting models that need further research. The differentiation between short term and long term model improvements is a determination of the resources available and the resources required for the improvement, and the overall benefits to the model and may also be dependent upon local agency goals, policies, or purpose for model development.

5.3.1 Modeling Assumptions

The validity of assumptions can be tested or verified by collecting data that would support the assumption or by comparing the assumption to other regional models. The latter is recommended as acceptable practice for all regions. For instance, the auto operating cost per mile should be comparable from one region to another, and even though the gasoline, insurance and maintenance of an automobile can vary, the differences can be reasonably qualified for comparison. These types of comparisons can be facilitated by the modeling coordination groups described in Section 5.1.3.

Recommendation: Compare modeling assumptions to other regional models.

5.3.2 Data Needs for Models

There are two areas where data needs can improve the usefulness and accuracy of the travel demand models. Regional travel models should be developed and updated using survey data sources. Many existing travel models rely on transferred demand models due to limited resources. These models may have biases or assumptions that are not applicable to the region, and are not as useful for capturing travel demand behavior for a specific region. If resources for updating the model are not available, the analysis of the Caltrans Statewide Survey can be used.

The use of database management systems to maintain and update input data for the travel demand models will reduce the errors inherent in managing large datasets of this type and will increase the usefulness of the data for other purposes. Developing interfaces with Geographic Information Systems (GIS) data would increase the flexibility of the level of detail in the model and reduce the duplication of effort in various planning departments.

Recommendation: Use database management and geographic information systems tools to maintain and verify input data.

5.3.3 Four-Step Demand Model Improvements

What variable(s) should be used in trip attraction models?

Most trip attraction models use estimates of employment stratified by industry type or floor area stratified by land use to estimate the trip attraction model. The determination of which variable to use in the model is dependent on the data available to develop the database, the data available to calibrate the model and the data available to validate the model. Often the data available at the local level for the development of the database is floor area stratified by land use, because of inaccuracies by zone of employment-based data. The data available in surveys to calibrate or validate the trip attraction model is typically employment. Floor area is difficult to obtain for this purpose. The amount of stratification for either employment or floor area should reflect the variations in trip attraction rates for the industry types or land use types for each region. A category such as non-retail employment may have large fluctuations in trip rates.

Should transportation system characteristics be incorporated into trip generation models?

Most trip generation models assume that transportation system characteristics, such as speed or capacity, do not significantly affect trip-making behavior. This assumption limits the trip generation model in its ability to capture travel behavior, as well as, in its ability to test changes in the transportation system. The identification of which system characteristics should be incorporated is left for further research.

Should trip generation models incorporate feedback loops for transportation system characteristics?

This will become feasible after trip generation models are modified to include system characteristics. Once they are included in the trip generation model, the argument to include feedback loops is consistent with the argument to include feedback loops to trip distribution and mode choice.

Should the trip distribution model be a choice-based model?

There are many advantages and disadvantages to applying a choice-based trip distribution model. The choice-based model can incorporate many variables into the trip distribution model; the gravity model is restricted to the number of variables it can incorporate. The choice-based model is more cumbersome to calibrate, but may provide more insight to the trip distribution characteristics.

Should socioeconomic variable(s) be incorporated to trip distribution models?

There are a number of applications of the gravity model and choice-based models for trip distribution that incorporate socioeconomic variables and indicate that incorporating socioeconomic variables does improve the trip distribution model. The tradeoff with the gravity model is the increased number of trip purposes generated from stratifying each purpose by the socioeconomic variable (such as income).

Should the trip distribution model incorporate composite costs?

Composite costs represent a weighted average of the travel times and costs for the available modes in the system. This requires a feedback of these composite costs from the mode choice model.

Should the mode choice model estimate walking and bicycle trips?

The mode choice model should estimate walking and bicycle trips separate from the other trips, as the number of vehicle trips, including intrazonals, is an important input to emissions models. There are some applications of mode choice models in the U.S. which estimate walking and bicycle trips as a post-process, but this practice is not wide-spread in California. Further research could incorporate procedures to estimate bicycle and walk trips into the mode-choice model.

Should mode choice models account for multi-modal trips, such as park-and-ride?

Typically, park-and-ride trips are estimated by the mode choice model as drive access transit trips. The driving portion of these trips should be translated to the highway trip assignment model to account for the congestion and air pollution these trips contribute. Existing software packages do not provide automated procedures for assigning park-and-ride trips to the highway network.

Should trip assignment models use composite costs?

Consistent estimates of composite costs should be used in each of the four-step models. The highway assignment model should reflect highway related travel times and costs, and the transit assignment model should reflect transit travel times and costs, in a similar manner to those costs used in the mode choice model.

5.3.4 Other Research Needs

Can cross-sectional data obtained at a single point in time be used to estimate travel behavior over time?

Typically, models are calibrated with cross-sectional data taken at a particular point in time, and may not be useful in developing models that estimate trip-making behavior over time. (Bates, Dasgupta, 1990) The solution to this issue is costly data collection or further analysis of historical data collection efforts and the historical performance of travel demand models.

How does the size of the transportation system limit the complexity of the model?

The size of urban transportation systems will limit the complexity of the models that can be developed. Considerations to increase the complexity of the models, add variables or feedback loops, or modify existing model structures must be weighed against the resources available to forecast the data and calibrate the existing models.

How does model improvements, and more accurate forecasts, compare to the cost of the improvement and the errors in input data?

Improvements to the four-step travel demand modeling process may increase the ability of the model to estimate travel demand and produce more accurate forecasts, at some cost to implement the improvement. These costs and benefits need to be weighed against the error introduced by using externally dependent forecasts. Some resources could be allocated to more sophisticated techniques to forecast the input data to the travel demand models.

Should travel demand models account for multiple-purpose trips?

Travel demand models may be improved by recognizing the phenomena of trip-chaining and accounting for these multiple-purpose trips. Trip-making behavior is often determined by the multiple-purpose trips, where existing travel demand models estimate single-purpose trips. There is available research on the impacts of trip-chaining (Kitamura, 1983).

Can travel demand models evaluate IVHS and other new technologies?

New technologies such as Intelligent Vehicle Highway Systems (IVHS) will impact the behavior of travelers. The current travel demand models will need to respond to these new technologies by providing models that can adequately test the impacts on the transportation system.

5.4 EMISSION INVENTORY AND OTHER AIR QUALITY RESEARCH NEEDS

Adoption of the Federal Clean Air Act Amendments of 1990 has renewed interest in use of regional travel models in developing emission inventories and in predicting the impact of growth and transportation projects on air quality. While it is generally recognized that regional models are essential in developing the data for air quality analysis, it is also recognized that there are certain limitations in the models that affect the accuracy of the emission estimates produced from their output. If the emission inventories and the air quality analyses are to continue to rely on regional models for travel activity data, new research is warranted to adapt the regional models more specifically to emissions estimation. Such research is warranted in four major areas: 1.) comprehensive coverage of trips, 2.) prediction of starts and parks, 3.) modeling of weekend and summertime travel, 4.) enhancement of emission rates. A brief discussion of each of these areas is provided below.

5.4.1 Comprehensive Coverage of Trips

Because of the importance of trips/starts as a determinant of pollutant emissions, additional research to improve the comprehensive coverage of trips is warranted. With the current round of home interview surveys being conducted around the state, the opportunity exists for an analysis of bias in trip reporting. With the new data there should be an effort to identify each time a vehicle is started, regardless of the length of the trip or the trip purpose. Research with the new data should also explore a better understanding of non-home-based trips, particularly lunch trips, personal errands, business travel, and commercial trips. These are all areas in which there is a significant potential for under-reporting in a home interview survey. More comprehensive coverage of these non-home-based trips in the modeling system will lead not only to better emission inventory estimations, but also to greater sensitivity to demand management policies.

5.4.2 Prediction of Starts and Parks

The representation of starts and parks is an important element of the DTIM model methodology for emission estimation, yet the methodology is based on limited survey data. Additional research on the nature of trips starts and parking duration is warranted and is possible with the new home interview survey data. As the coverage of trip types becomes more comprehensive and shorter trips are included in the activity data, differentiation of hot and cold starts will become more important. In addition, as the tightening of standards reduces the running emissions the trips starts, trip ends, and diurnal emissions will constitute an increasingly larger portion of total emissions.

5.4.3 Modeling of Weekend and Summertime Travel

Recent air quality monitoring in California has indicated that in numerous locations ambient air quality standards have been violated during the summer months and frequently on weekend days. Virtually all regional travel models are designed to represent an average annual weekday, and their usefulness in representing these summertime or weekend conditions is limited. New survey and research leading to the development of models for weekends and summertime travel would significantly enhance the emission inventories for these periods.

5.4.4 Enhancement of Emission Rates

Research now underway at the California Air Resources Board is providing preliminary evidence that there is wide variation in emission rates on a grams-per-mile or a grams-per-hour basis, depending on the operating mode characteristics additional research is needed to relate these emission rates more specifically to the roadway and travel characteristics supplied by the regional travel models. At present emission rates, vary by vehicle type and age, and by average operating speed, but do not vary by facility type or facility characteristics that could produce significant variation in actual emissions for the same average operating speed. As an example, an average operating speed of 30 mph on an arterial might represent free flow without stops, while 30 mph on a freeway would represent congested conditions with frequent accelerations and a significantly higher emission rate. The research on emission rates should lead towards more precise specification of rates using more data from the modeling system.

5.5 TRAFFIC MANAGEMENT AND DEMAND MANAGEMENT ANALYSIS NEEDS

As the opportunities to build new highway facilities or widen existing facilities in congested urban corridors have decreased, focus has shifted to transportation management options to accommodate travel demand. Throughout the state there is increasing interest in high occupancy vehicle facilities such as HOV lanes and ramp meter bypass for high occupancy vehicles. (Traffic management options such as surveillance, incident response, ramp metering, changeable message signs, and signal optimization and numerous demand management options including congestion pricing, parking restrictions, rideshare incentives, and alternative work schedules are being explored.) Many regional models that were sufficiently sensitive for analysis of new facilities or for significant widening of existing facilities are now insufficient for traffic management and demand management analyses. A significant amount of new research and development is needed to improve the sensitivity of regional models to these increasingly popular options.

5.5.1 Traffic Management

Many of the traffic management options achieve their effectiveness by changing the nature and location of delays. And in doing so increase the through-put in a corridor and also reduce the total person hours of delay. Most regional planning models are deficient in their representation of delay and so are insensitive to the measures being considered. The sensitivity to the measures and their impact on delay can often be provided by a variety of simulation models such as NETSIM for arterial systems and FREQ for freeway systems. But these models have serious limitations for regional analysis. To gain the intensive to the traffic management options, the simulation models become highly data sensitive and consume significant computer resources in producing simulations. As a result, only limited areas can be represented in a simulation model. Research is needed to more closely link planning and simulation models to provide more sensitivity to traffic management options while maintaining reasonable resource requirements.

As computing capabilities evolve and simulation algorithms are made more efficient, the opportunities for fully integrating simulation models into the assignment step of the four step modeling process becomes a possibility. This full integration of the simulation and planning models would provide the most complete response to the needs but is unlikely with the existing state of computer technology. Alternatives to this full integration would be automated transfer of data in both directions between planning models and simulation models to reduce the time required for iterations of the two models in analysis of traffic management options. A second alternative would be to develop generalized prototype simulation modules to represent approximate delay as a function of supply and demand characteristics generated by the planning models. If these generalized modules could be embedded within the regional planning model, the planning model output would provide more accurate assignments and a better starting input for simulation models.

5.5.2 Demand Management

Regional travel models could enhance their sensitivity to demand management options such as parking pricing, ridesharing incentives, or alternative work schedules. Existing trip generation distribution and mode split models operate on a basis of aggregate representations of travel time/cost tradeoffs that may not capture the relative influences of the demand management measures. Most current analysis of demand management measures is performed external to regional travel models using sensitivity factors based on reported experience. Quite often this reported experience represents only best efforts rather than a cross section of efforts to implement the demand management option. New data are now available from Regulation 15 in the South Coast Air Quality Management District and from other similar trip reduction ordinances around the state and a new opportunity has emerged for development of policy sensitive travel models. Because of the importance of demand management in maintaining mobility and in reducing pollution levels throughout the state, additional research on the behavioral response to demand management actions is warranted.

5.6 INTERFACE BETWEEN LAND USE AND TRANSPORTATION

With the growing recognition that increasing travel demand from growth cannot be accommodated with new facilities, interest has turned to reducing the amount of new travel from growth by changing the nature of development. There is also concern that the development of new transportation facilities can influence the amount and location of new development and thereby induce growth in travel by the supply of transportation facilities. Both of these are areas in which new research is required if regional forecasting models are to be sensitive to the land use/transportation interaction. The legislation for Congestion Management Programs described in Section 5.1.1 addresses the need for an interface between land use and transportation.

5.6.1 Urban Design Impacts

Efforts to control the amount of new vehicular travel generated by development have generated new designs more oriented towards use of transit or use of non-vehicular modes for short trips. These transit oriented designs (TODs) and pedestrian oriented designs (PODs) are being given increasing consideration in suburban activity centers and in residential developments as well. There is little empirical evidence, however, of the trip reduction impacts of these designs. As TODs and PODs are developed, opportunities for understanding their impacts on travel characteristics become possible. As data become available new model estimation should reflect the impact of design on trip generation, trip distribution, and mode choice to the extent possible.

5.6.2 Transportation's Impact on Land Use

The second significant area of research need is the impact of transportation facilities on land use. There is at least a theoretical basis for the assumption that an improvement in transportation level of service will stimulate new development. There is little empirical evidence, however, that this is true on more than a location-specific basis. There is little evidence to indicate that the supply of transportation facilities or that highway level of service affects the total growth that occurs within a region. And yet the amount and location of development is the most significant determinant of travel demand, and this interaction is worthy of further exploration.

Sample Model Calibration and Validation Iterative Thought Process

1. Updated the file path in Validation summary sheet and ran the macro.

2. Report -

Table 12.3-8:
Trip Assignment – Average Travel Time (in minutes) by Trip Purpose

Trip Purpose					
HBW		HBO		NHB	
CHTS	Model	CHTS	Model	CHTS	Model
20.8	20.5	14.0	19.6	13.0	13.5

Notes: 2012 California Household Travel Survey, Weekday Trips, re-weighted by F&P. Includes only internal-to-internal, weekday person trips for all modes.

Off by:	-1.6%		40.3%		3.8%

   a. Model over predicts HBO other trips but sometimes people are not sure of trip duration when giving the survey which might lead them to underestimate their actual trip time.

Table 12.3-6:
Trip Assignment – VMT

Evaluation Criterion	HPMS	Model	% Deviation
+-3%	22,972,000	35,552,460	55%

Notes: Daily Vehicle Miles Traveled. Highway Performance Management System – 2008 California Public Road Data, Table 11.

   b. Model predicts higher VMT than actual. The model allows longer trips than what people actually make.
   c. So, I guess I will increase penalty by some amount in all HBO, HWH and NHB categories

TABLE 12-2.2														
MODE SPLIT BY PURPOSE														
	Total (All Modes)		Drove Alone		Shared Ride 2		Shared Ride 3+		Transit		Walk		Bike	
Purpose	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model
HBW	13%	15%	81%	82%	8%	10%	4%	5%	2%	2%	4%	2%	1%	1%
HBO	59%	63%	27%	29%	28%	22%	24%	17%	2%	2%	13%	25%	3%	3%
NHB	28%	22%	46%	45%	26%	24%	21%	19%	1%	0%	5%	10%	2%	2%
Total (All Purposes)	100%	100%	40%	41%	25%	21%	20%	16%	2%	2%	10%	18%	2%	2%

Notes: 2012 California Household Travel Survey, Weekday Trips, re-weighted by F&P. Includes only internal-to-internal, weekday person trips for all modes. School bus trips are categorized as Other.

d. Model over predicts hbo trips and under predicts nhb trips
e. But don't think if this could be fixed by changing FF.

TABLE 12-2.3										
TRIP PURPOSES BY MODE										
	Total (All Modes)		Drove Alone		Shared Ride 2		Shared Ride 3+		Transit	
Purpose	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model
HBW	13%	15%	27%	31%	4%	7%	2%	5%	14%	15%
HBO	59%	63%	41%	45%	67%	68%	69%	69%	78%	81%
NHB	28%	22%	32%	24%	29%	25%	29%	27%	8%	3%
Total (All Purposes)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Notes: 2012 California Household Travel Survey, Weekday Trips, re-weighted by F&P. Includes only internal-to-internal, weekday person trips for all modes. School bus trips are categorized as Other.

f. Again, I don't think if this table could guide me in calibrating FF

3. Old FF - **FFParam**

;INDEX	A	B	C	KEY
1	100000	-0.045	0	;HWH
2	100000	-0.045	0	;HWM
3	100000	-0.045	0	;HWL
4	100000	-0.08	0	;HS
5	100000	-0.07	0	;HK
6	100000	-0.045	0	;HC
7	100000	-0.07	0	;HO
8	100000	-0.07	0	;WO
9	100000	-0.075	0	;OO
10	100000	-0.05	0	;HY
11	100000	-0.07	-0.5	;TS
12	100000	-0.07	-0.5	;TM

13	100000	-0.07	-0.5	;TH

4. New FF – **FFParam2**

;INDEX	A	B	C	KEY
1	100000	-0.06	0	;HWH
2	100000	-0.06	0	;HWM
3	100000	-0.06	0	;HWL
4	100000	-0.095	0	;HS
5	100000	-0.09	0	;HK
6	100000	-0.06	0	;HC
7	100000	-0.085	0	;HO
8	100000	-0.085	0	;WO
9	100000	-0.09	0	;OO
10	100000	-0.065	0	;HY
11	100000	-0.07	-0.5	;TS
12	100000	-0.07	-0.5	;TM
13	100000	-0.07	-0.5	;TH

8/18/16

Table 12.3-8:					
Trip Assignment – Average Travel Time (in minutes) by Trip Purpose					
Trip Purpose					
HBW		**HBO**		**NHB**	
CHTS	**Model**	**CHTS**	**Model**	**CHTS**	**Model**
20.8	19.8	14.0	18.9	13.0	13.3
Notes: 2012 California Household Travel Survey, Weekday Trips, re-weighted by F&P. Includes only internal-to-internal, weekday person trips for all modes.					
Off by:	-4.8%		34.8%		2.1%

Travel times in the model have decreased; this was expected since we are increasing the penalty for making longer trips

Table 12.3-6:			
Trip Assignment – VMT			
Evaluation Criterion	**HPMS**	**Model**	**% Deviation**
+-3%	22,972,000	37,821,154	65%
Notes: Daily Vehicle Miles Traveled. Highway Performance Management System – 2008 California Public Road Data, Table 11.			

VMT has increased surprisingly. I expected it to decrease since I am increasing the penalty.

TABLE 12-2.2

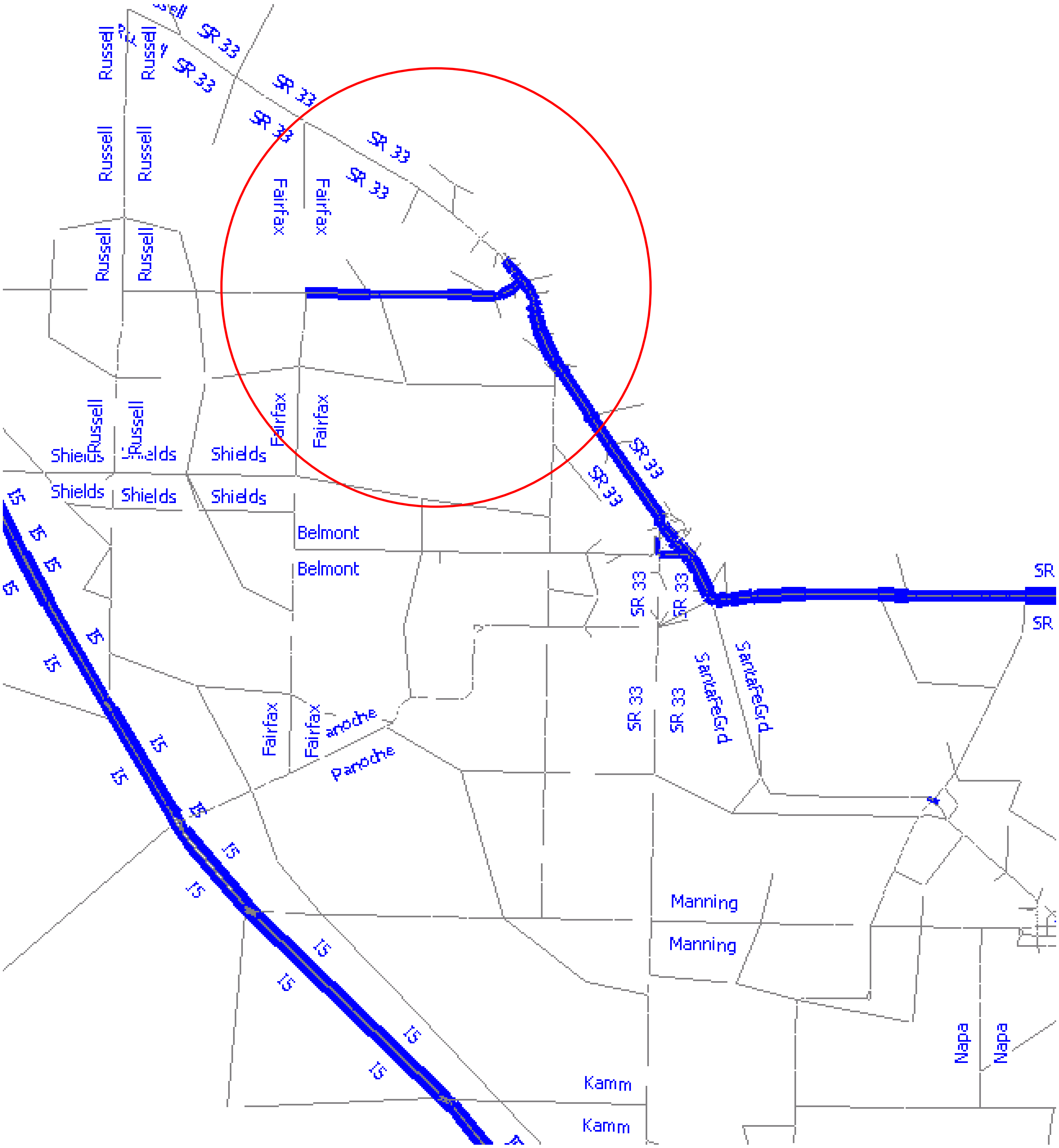
MODE SPLIT BY PURPOSE

Purpose	Total (All Modes)		Drove Alone		Shared Ride 2		Shared Ride 3+		Transit		Walk		Bike		Other	
	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model
HBW	13%	15%	81%	79%	8%	11%	4%	5%	2%	2%	4%	2%	1%	1%	0%	0%
HBO	59%	63%	27%	27%	28%	24%	24%	19%	2%	3%	13%	24%	3%	3%	3%	2%
NHB	28%	22%	46%	46%	26%	25%	21%	18%	1%	0%	5%	8%	2%	2%	0%	0%
Total (All Purposes)	100%	100%	40%	39%	25%	22%	20%	16%	2%	2%	10%	17%	2%	2%	1%	1%

Notes: 2012 California Household Travel Survey, Weekday Trips, re-weighted by F&P. Includes only internal-to-internal, weekday person trips for all modes. School bus trips are categorized as Other.

Mike suggested using bandwidth analysis for the loaded network and see where trips are ending and then check with aerial maps to validate if the trips are as expected

My first suspect –

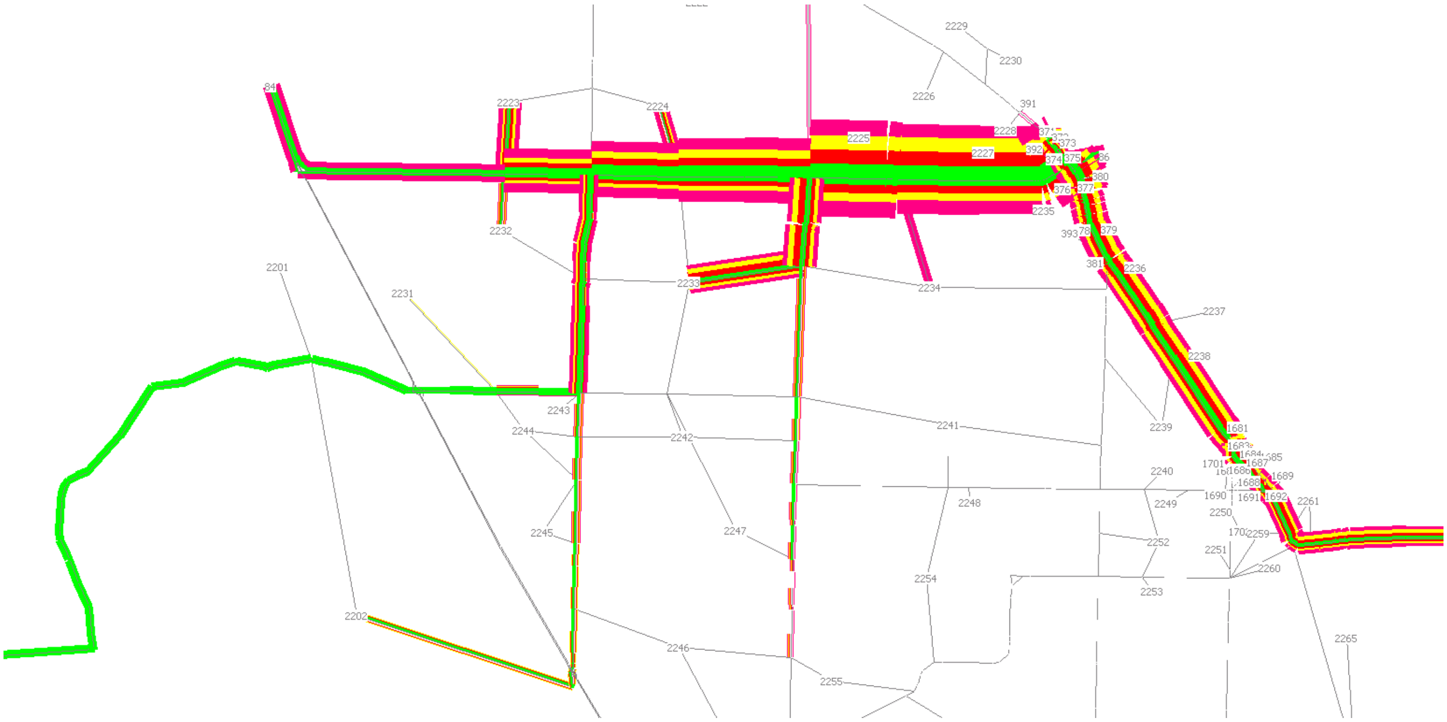


This is what we get from aerial map –

North bound trips probably end at school and therefore seems reasonable. The node number is 371. From land use files, I got to know that the total households are 133 and the population is 410. Therefore it is reasonable to get trips over there.

But it looks like west bound trips end in the farms. I am suspicious about that. Node #2225, TOTHH = 5 and TOTPOP = 15.62. It is completely unreasonable to have trips in this area because the population is too low. Do select link on A=28298 and B=51734 – SL=1

Did multi-bandwidth analysis -



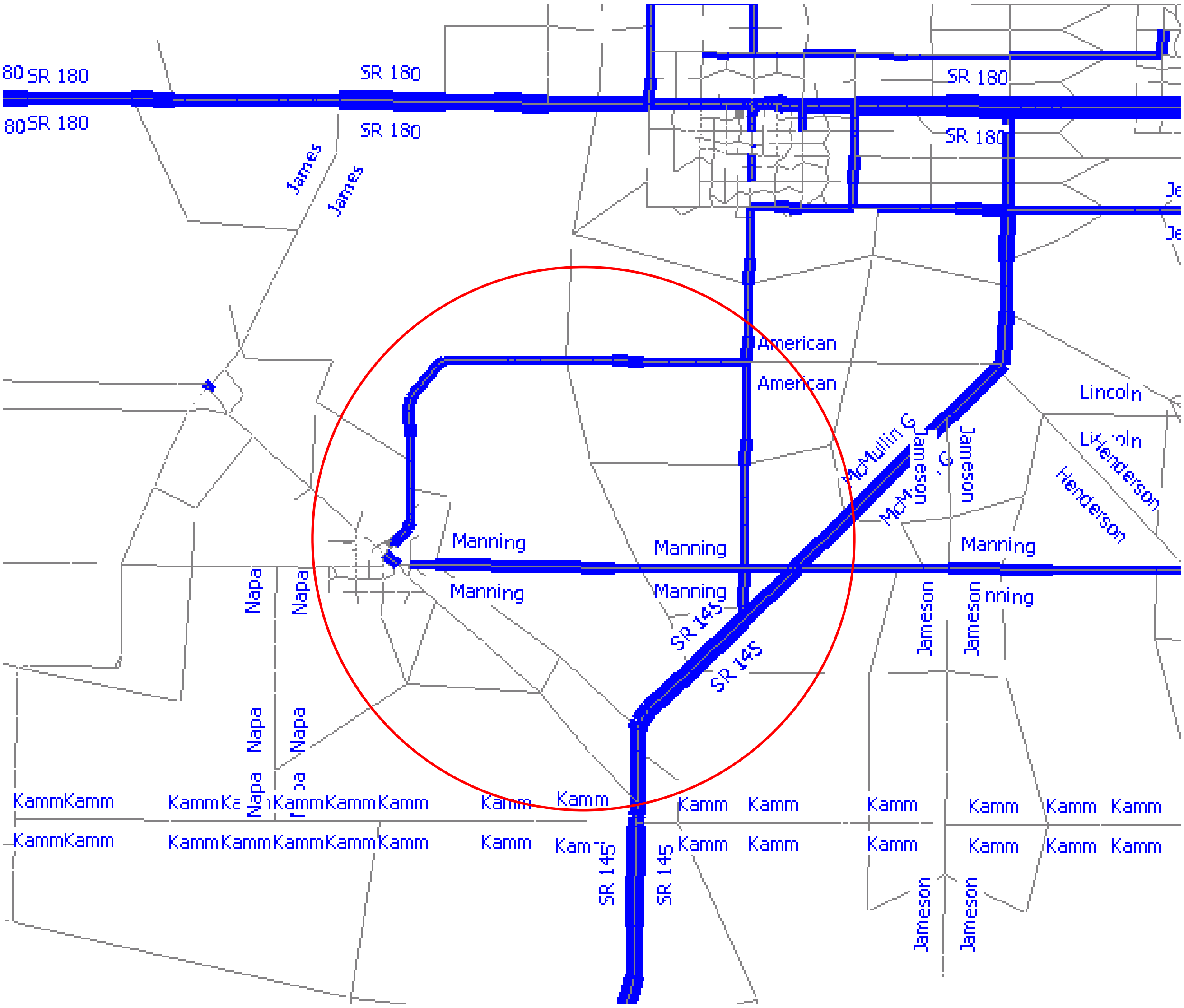
Checked zone #2223 – HH = 96 EMPAGR = 625

Upon aerial inspection found a chemical plant, some industry in the region. But 625 looks like a large number to be employed in agriculture for an area of this size.

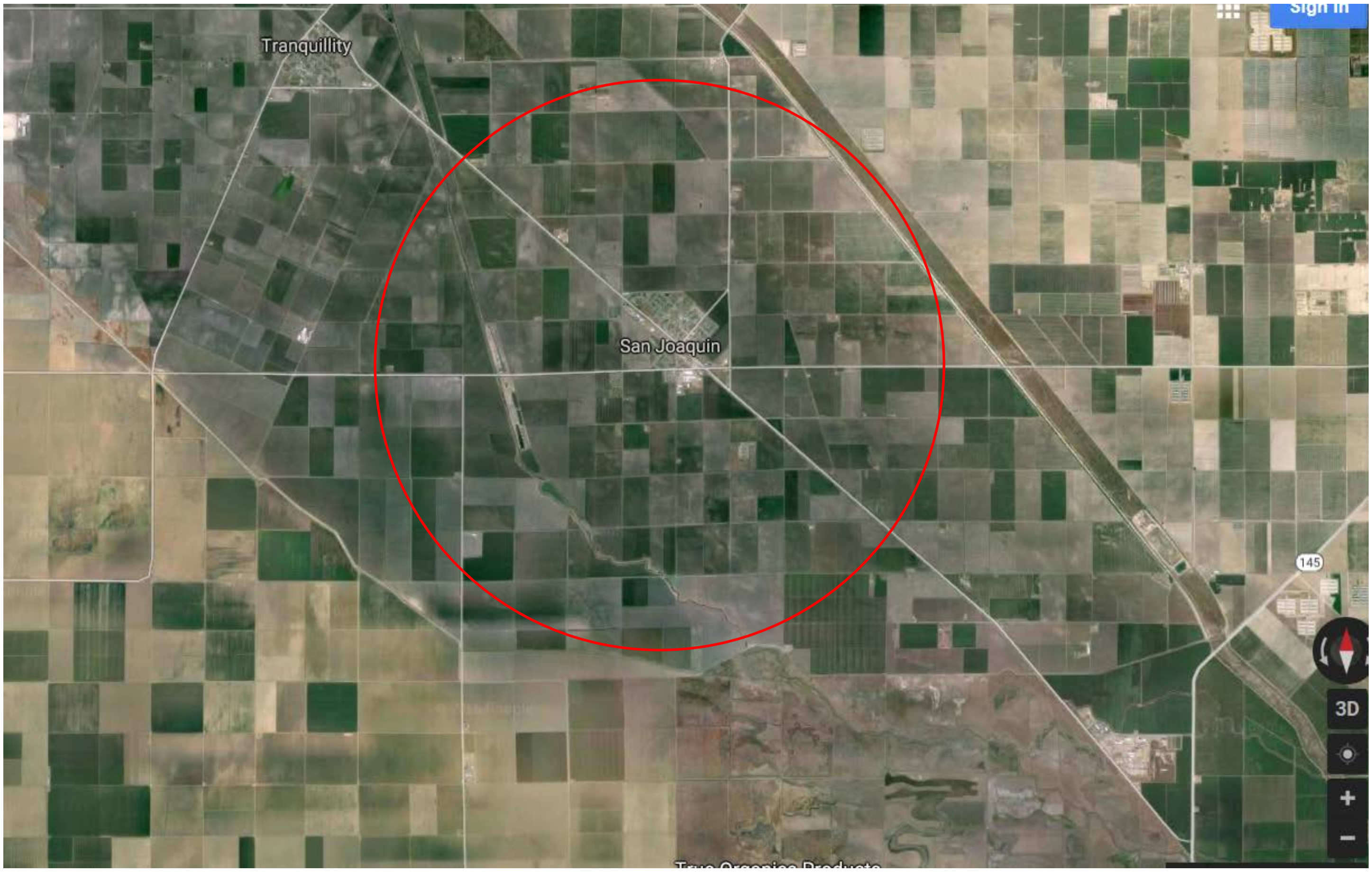
Checked zone #2224 – HH = 5, EMPAGR = 300. But again 300 looks like a large number to be employed in agriculture for an area of this size.

Checked zone #2233 – HH = 29, EMPAGR = 524 and EMPRET = 27. But again 524 looks like a large number to be employed in agriculture for an area of this size.

This is my second point –

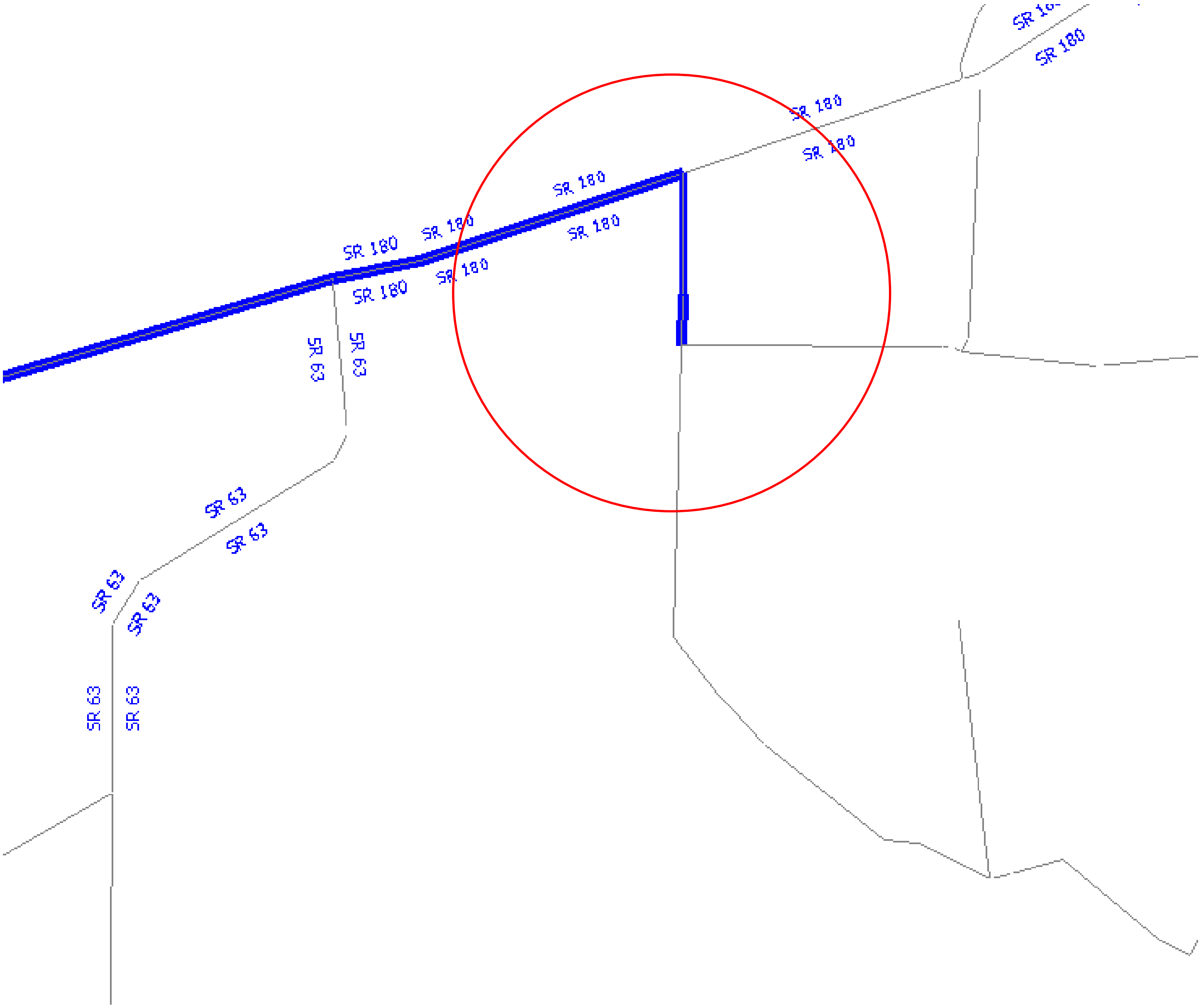


This is what aerial shows –

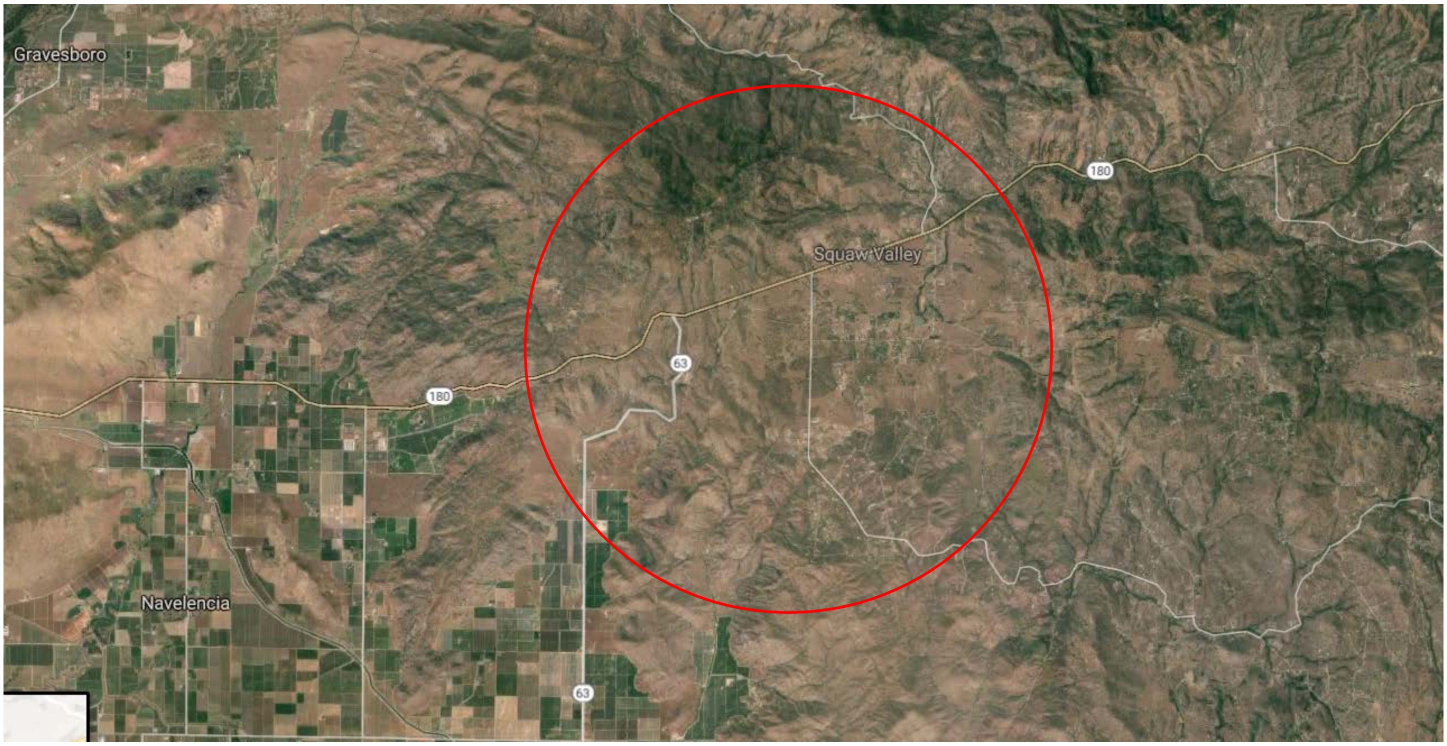


Googled up this location and upon zooming in found out that there is a school, residential place and decent amount of development in this area. The school enrollment itself is 820. It is reasonable to get a high number of trips in this area.

Third suspect –



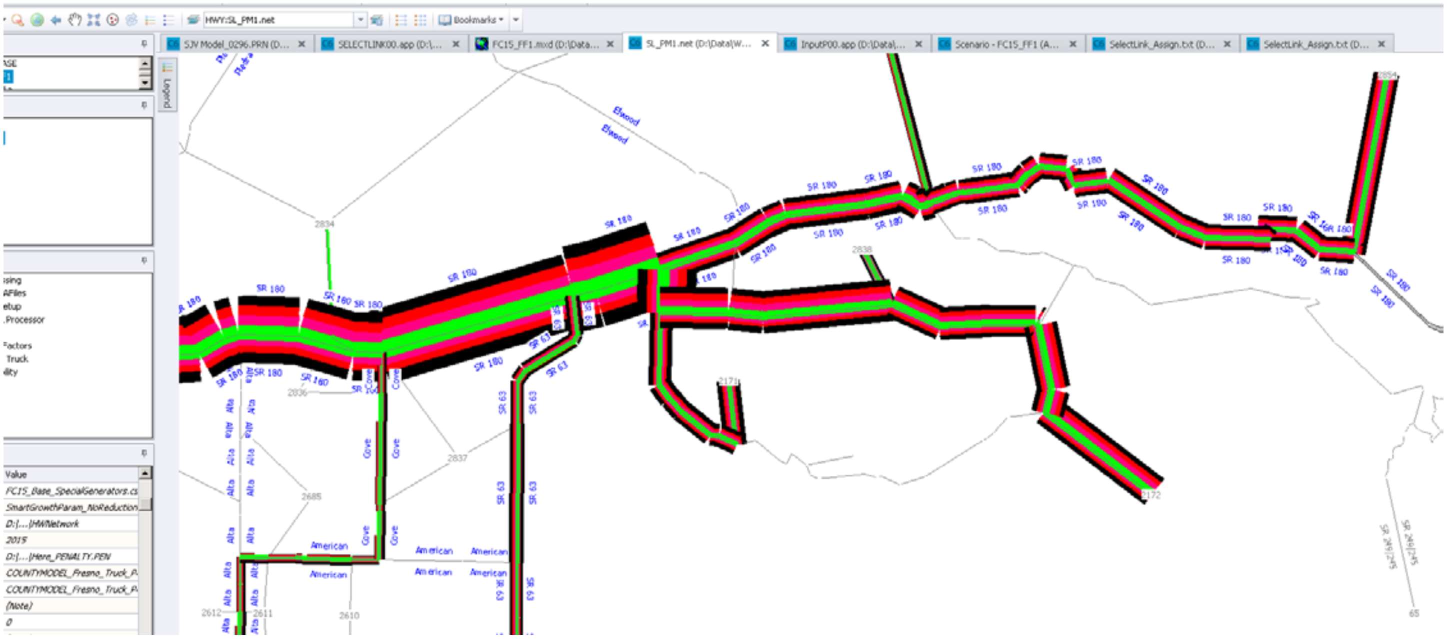
What aerial looks like –



This one looks suspicious since there is no development in this area to attract all those trips. It might be a sight seeing spot, but not sure.

Nodes in the vicinity have 42 households and total population of 92. But the D24_TOT is around 9,000. Such a high daily traffic is totally unreasonable for 42 households. Do select link; A = 29103 and B=29104 = SL=2

Did multi-bandwidth analysis –



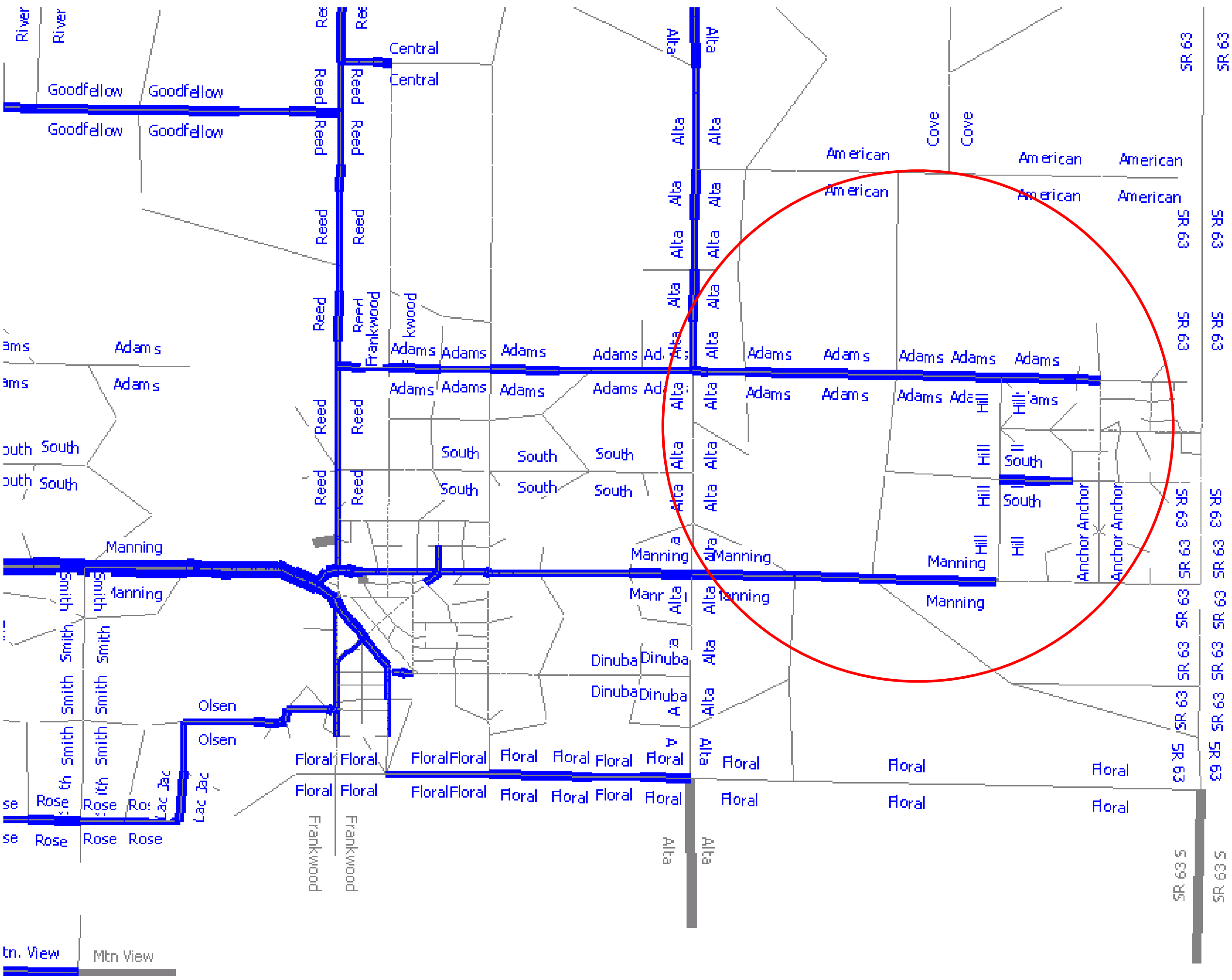
Zone number – 2171 has 470 HH, its' ok to expect these trips

Zone #2172 has 1146 HH

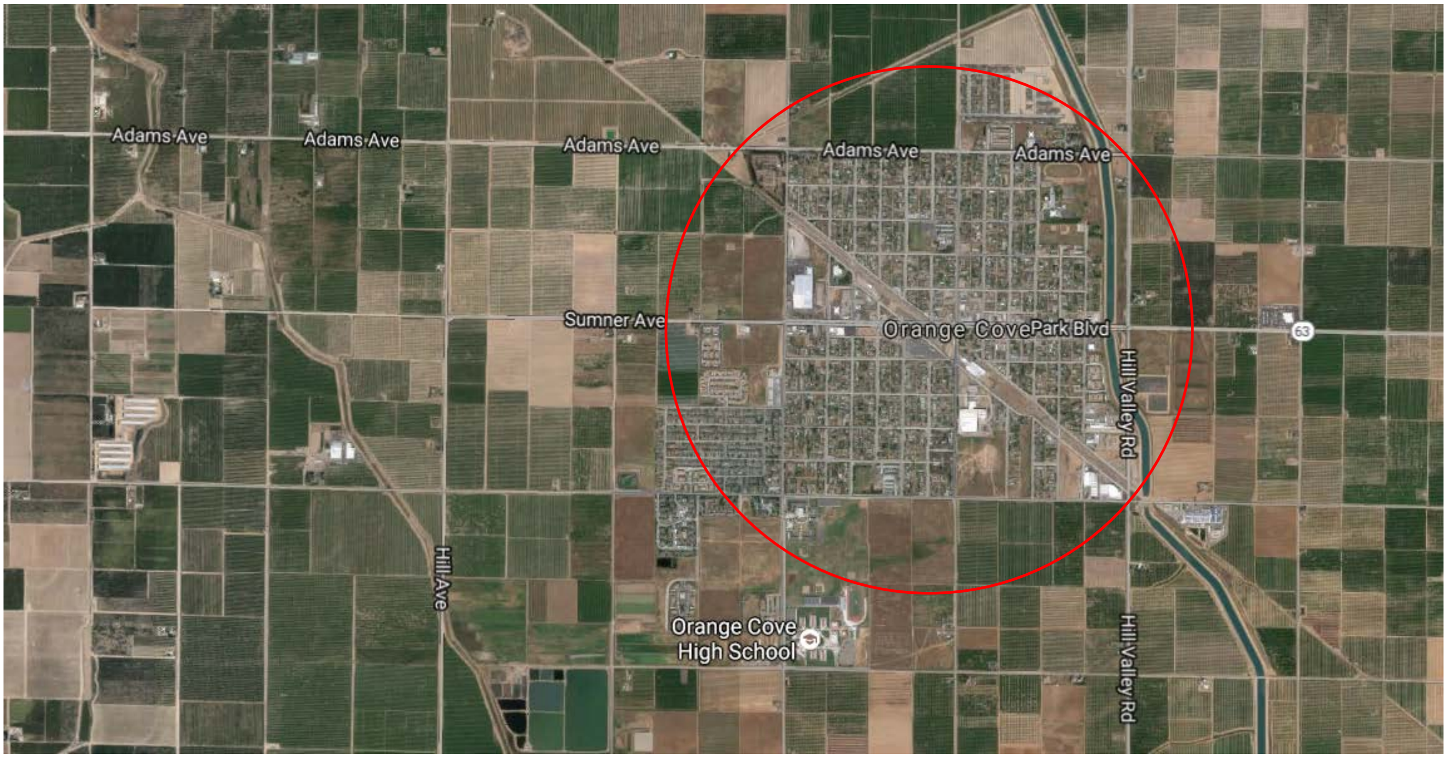
Zone #2854 has 612 HH

Upon aerial inspection, found houses in the locality. So I would give it a green signal.

Next one –

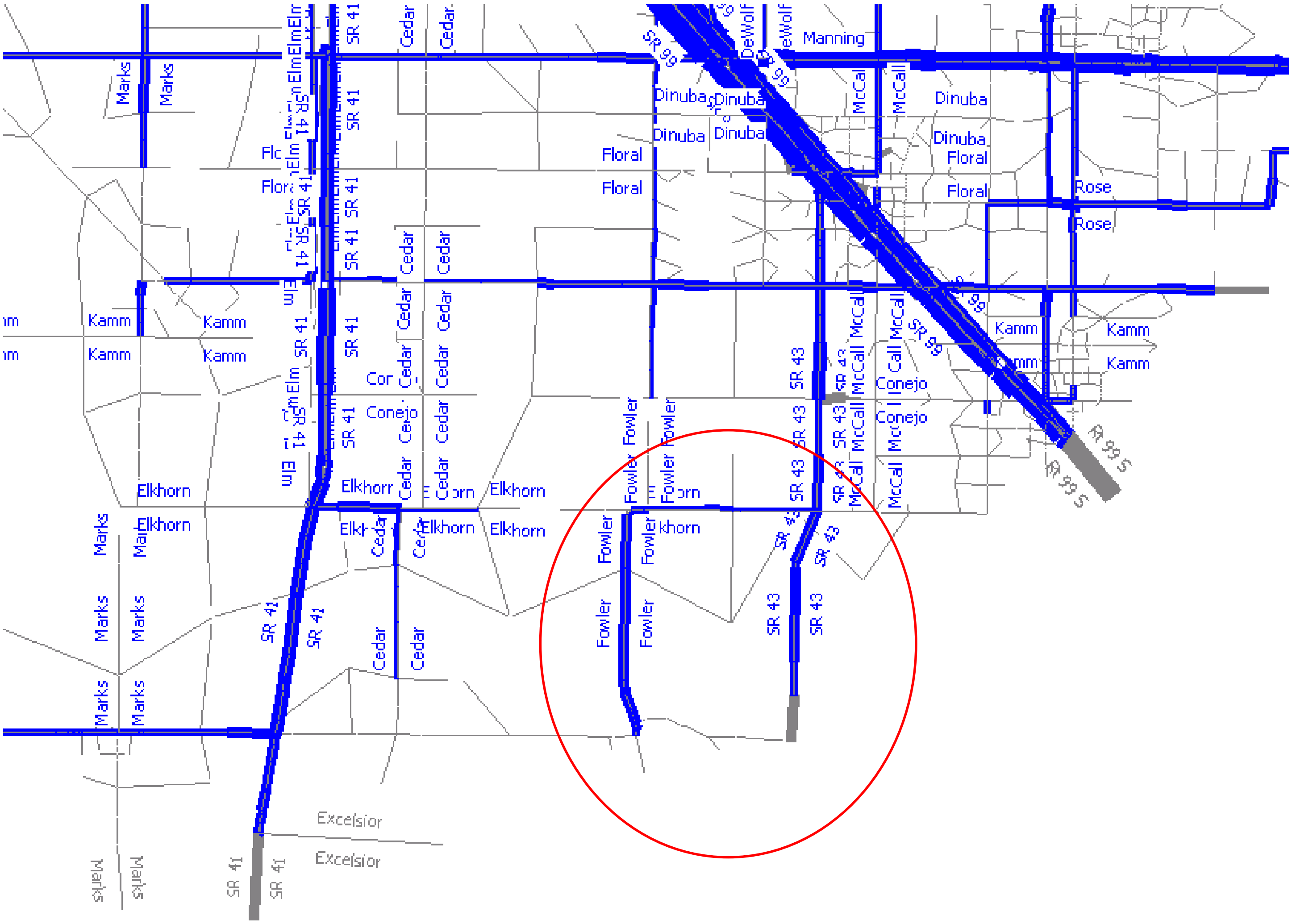


Aerial image –

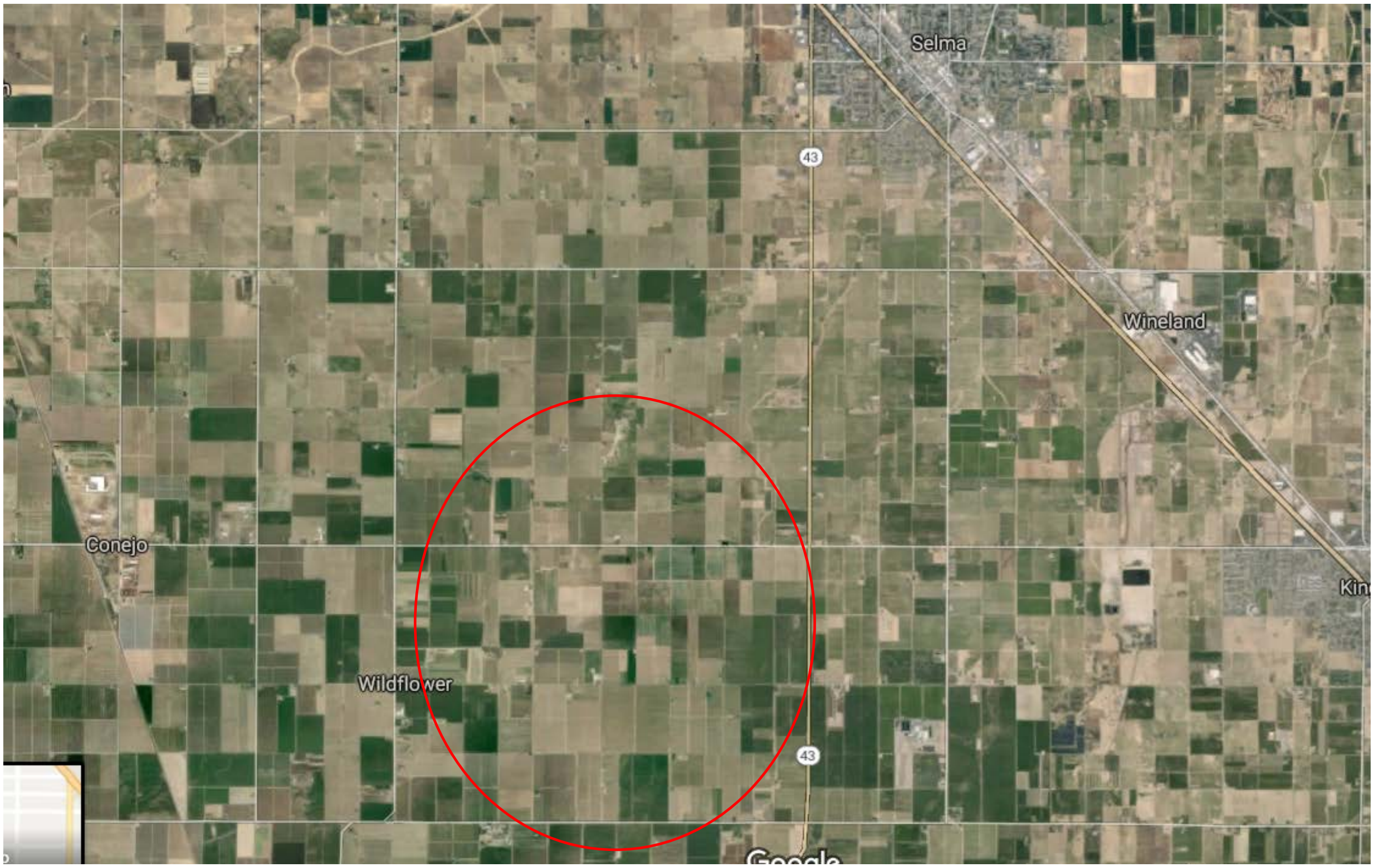


This looks fine since there is a development in the area. There are around 500 households in the area and it is perfectly reasonable to have trips here.

Next suspect –

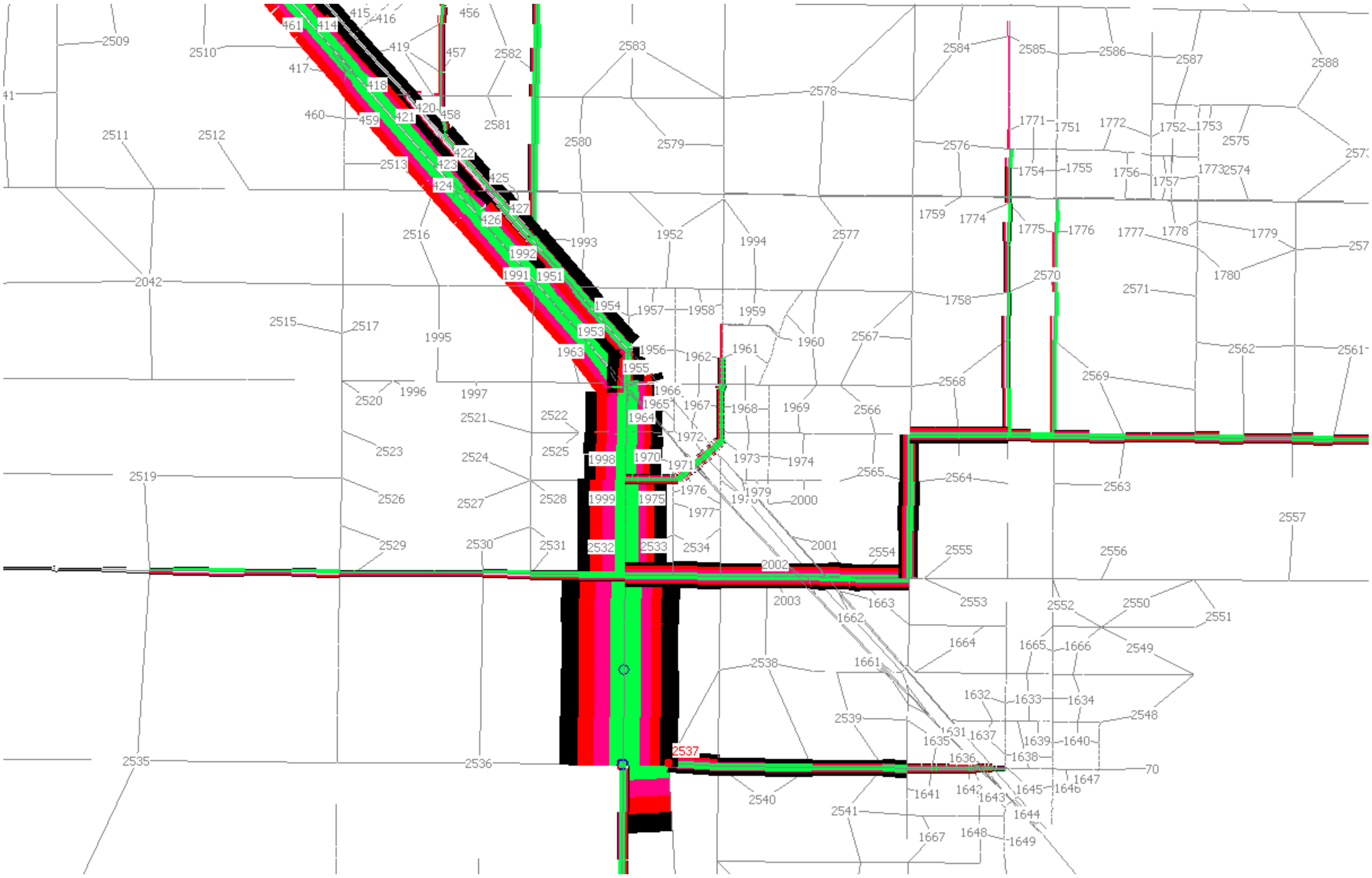


Aerial image –



This is suspicious since there is no development in the area. Node #2131 is in the vicinity and it has 489 households according to the land use file. In that case, it is reasonable to get such traffic. Node #2537 – check agricultural trip generation – SL=3. Too many retail trips – 868 but it should be 0 as per aerials.

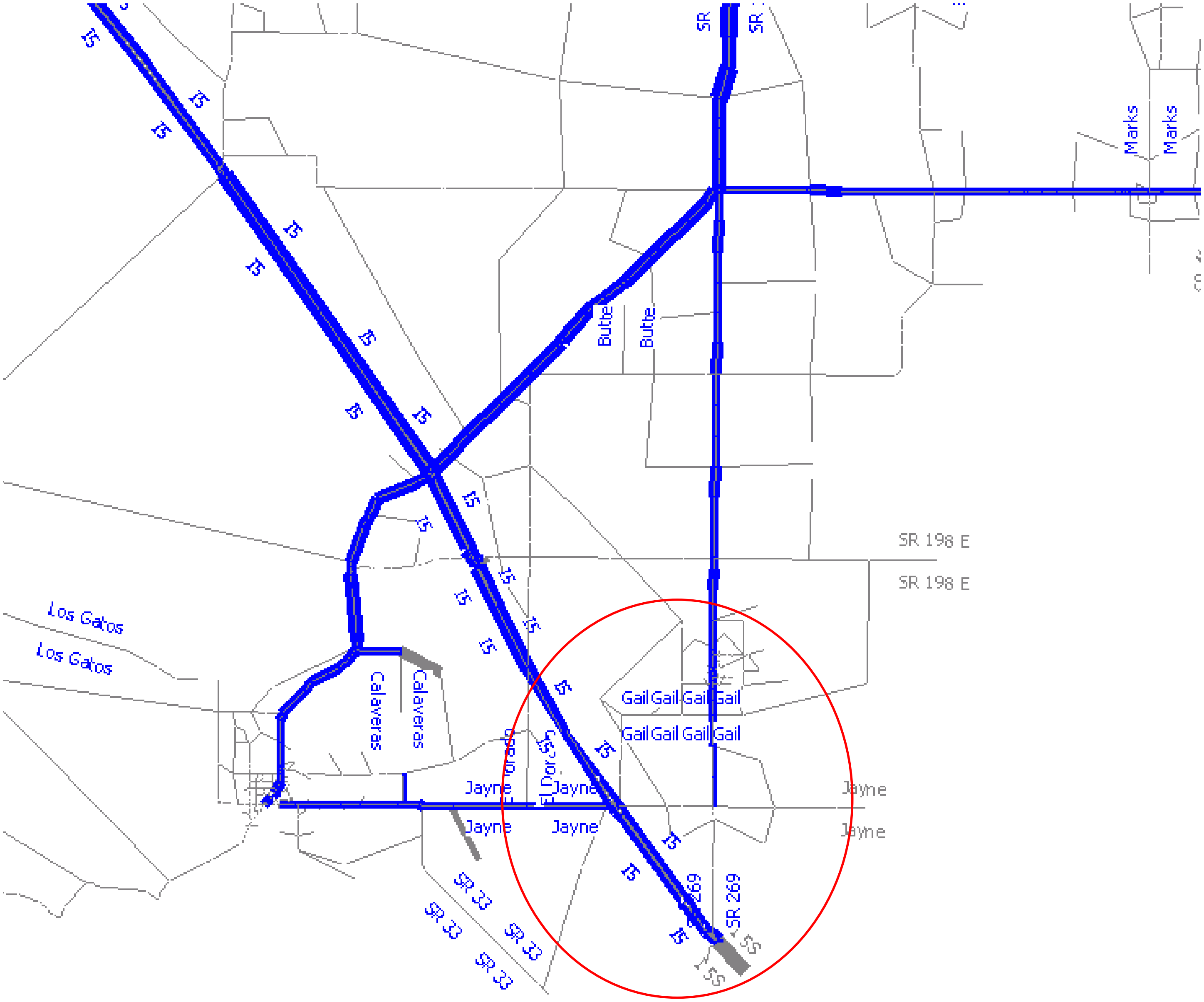
Did multi-bandwidth analysis –



Checked zone #2537

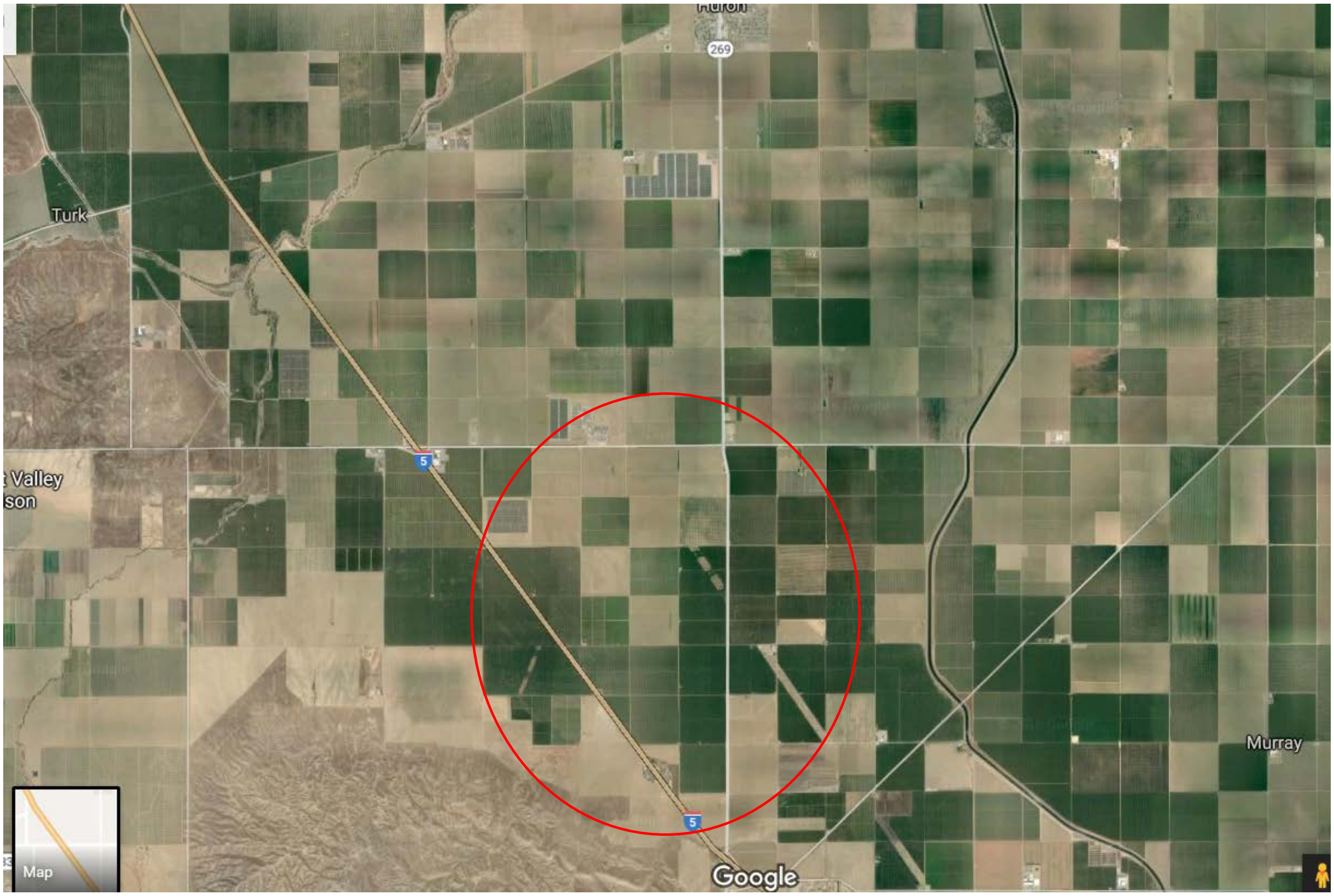
Found 868 retail employment. But upon aerial inspection found no retail development in the area. This is generating too many trips in the model which doesn't happen in reality.

Next one –



I5
SR
Marks
Butte
SR 198 E
Los Gatos
Calaveras
Gail
El Dorado
Jayne
SR 269
SR 33
I 55

Aerial view –



Again suspicious since there is no development. There is no population in this area as per the land use file. There should not be any traffic in this area. Do link check at #2315

2017 Regional Transportation Plan Guidelines for Metropolitan Planning Organizations

California Transportation Commission

2017
Regional Transportation Plan Guidelines for Metropolitan Planning Organizations

Adopted by the California Transportation Commission
On January 18, 2017

Pursuant to California Government Code Section 14522

Commissioners
Bob Alvarado – Chair
Fran Inman – Vice Chair
Yvonne B. Burke
Lucetta Dunn
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Regional GHG Emissions Requirements & Considerations in the RTP

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Chapter 1

Introduction

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INTRODUCTION

1.0 Applicability of the Regional Transportation Plan Guidelines

Every Metropolitan Planning Organization (MPO) is required by law to conduct long range planning to ensure that the region's vision and goals are clearly identified and to ensure effective decision making in furtherance of the vision and goals. The long range plan, known as the Regional Transportation Plan (RTP), is an important policy document that is based on the unique needs and characteristics of a region, helps shape the region's economy, environment and social future, and communicates regional and vision to the state and federal government. As fundamental building blocks of the State's transportation system, the RTP should also support state goals for transportation, environmental quality, economic growth, and social equity (California Government Code Section 65041.1).

The California Transportation Commission (Commission or CTC) is authorized to develop guidelines by Government Code Section 14522, which reads:

> *In cooperation with the regional transportation planning agencies, the commission may prescribe study areas for analysis and evaluation by such agencies and guidelines for the preparation of the regional transportation plans.*

These eighteen MPOs, in alphabetical order, are:

Association of Monterey Bay Governments, Butte County Association of Governments, Fresno Council of Governments, Kings County Association of Governments, Kern Council of Governments, Merced County Association of Governments, Madera County Transportation Commission, Metropolitan Transportation Commission, Sacramento Area Council of Governments, San Diego Association of Governments, San Joaquin Council of Governments, San Luis Obispo Council of Governments, Santa Barbara County Association of Governments, Shasta Regional Transportation Agency, Southern California Association of Governments, Stanislaus Council of Governments, Tulare County Association of Governments, and Tahoe Metropolitan Planning Organization.

While the guidelines include both state and federal requirements, MPOs have the flexibility to be creative in selecting transportation planning options that best fit their regional needs. The guidelines recognize that "one size does not fit all." Solutions and techniques used by a larger MPO will be different than those used by a smaller MPO.

The 2017 RTP Guidelines continue to use the words "Shall" and "Should", a convention established by the previous RTP Guidelines. Where the RTP Guidelines reflect a state or federal statutory or regulatory requirement, the word "Shall" is used with a statutory or regulatory citation. The word "Should" is used where the Guidelines reflect a permissive or optional statutory reference such as "May" or "Should." Each section ends with federal and state requirements (Shalls), federal and state recommendations (Shoulds), and refers to Appendix L for Planning Practices Examples where appropriate. Planning practice examples are intended to highlight exemplary, state of the art planning practices that MPOs can seek to emulate as financial and technical resources allow.

Changes to federal statute are implemented by the Code of Federal Regulations (CFRs) that are also known as the "final rules". On May 27, 2016, the Statewide and Nonmetropolitan

Transportation Planning *and* Metropolitan Transportation Planning Final Rule was issued, with an effective date of June 27, 2016, for Title 23 CFR Parts 450 and 771 and Title 49 CFR Part 613. The Federal Highway Administration (FHWA)/Federal Transit Administration (FTA) are still in the process of finalizing the remaining rules for implementation of the Moving Ahead for Progress in the 21st Century (MAP-21) and the Fixing America's Surface Transportation (FAST) Acts. Unless otherwise noted, the RTP Guidelines will show the CFRs for MAP-21/FAST Act. The majority of citations in these guidelines refer to the implementing regulations, i.e., the CFR section.

MPO RTPs are updated every four years (or five years in attainment regions); however, many MPOs begin the next RTP update immediately upon adoption of the current RTP. As RTP development is a continuous process, consideration is given to MPOs that will be too far along in the planning process to conform their RTPs to the 2017 RTP Guidelines. All RTP updates started after the 2017 RTP Guidelines are adopted by the CTC must use the new RTP Guidelines. Furthermore, federal regulations outline the timeline for complying with MAP-21/FAST Act transportation planning requirements. Prior to May 27, 2018, an MPO may adopt an RTP that has been developed using the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) requirements or the provisions of the Statewide and Nonmetropolitan Transportation Planning *and* Metropolitan Transportation Planning Final Rule (23 CFR Part 450 and 771 and 49 CFR Part 613). On or after May 27, 2018, an MPO may not adopt an RTP that has not been developed according to the provisions of MAP-21/FAST Act as specified in the Planning Final Rule. MPOs are encouraged to communicate with Caltrans and FHWA/FTA to discuss schedules for RTP adoption.

1.1 Why Conduct Long-Range Transportation Planning?

The long range transportation planning process in metropolitan areas is uniquely suited to address a number of federal, state, regional, and local goals, from supporting economic growth to achieving environmental goals and promoting public health and quality of life. Not only does the transportation system provide for the mobility of people and goods, it also influences patterns of growth and economic activity through accessibility to land. Furthermore, the performance of this system affects such public policy concerns as air quality, greenhouse gas (GHG) emissions, natural resources, environmental protection and conservation, social equity, smart growth, housing affordability, jobs/housing balance, economic development, safety, and security. Transportation planning recognizes the critical links between transportation and other societal goals. The planning process is more than merely a listing of multimodal capital investments; it requires developing strategies for operating, managing, maintaining, funding, and financing the area's transportation system in such a way as to advance the area's long-term goals.

Over the past ten years, combating climate change has emerged as a key goal for the state of California. Starting with the passage of Assembly Bill 32 – The California Global Warming Solutions Act of 2006 (AB 32, Chapter 488, Statutes of 2006), the state has set aggressive goals to reduce GHG emissions responsible for climate change. AB 32 requires a reduction in state GHG emission by limiting state GHG emissions in 2020 to no more than the 1990 state emission levels. On September 8, 2016, the California Global Warming Act of 2006 was amended by Senate Bill 32 (SB 32, Chapter 249, Statutes of 2016) to require a further reduction of GHG emissions to achieve at least a 40 percent reduction below 1990 levels by 2030. Governor Schwarzenegger's Executive Order S-3-05 and Governor Brown's Executive Order B-

30-15 target a reduction of GHG emission to achieve a reduction of 80 percent below 1990 levels by 2050. Enacted legislation, SB 391 (Chapter 585, Statutes of 2009) directs Caltrans to model how to achieve the 80 percent reduction in GHG emissions by 2050, and that modeling was included in the California Transportation Plan 2040, which was released in June 2016. According to the California Air Resources Board (ARB) 2016 Mobile Source Strategy, the transportation sector accounts for nearly 50 percent of GHG emissions in California[1]. As such, the long-range transportation planning process in metropolitan areas has evolved to address climate change amongst many other goals in the balance.

In 2008, transportation planning and land use planning became further linked following the passage of SB 375 (Chapter 728, Statutes of 2008). SB 375 requires the MPOs to develop a Sustainable Communities Strategy (SCS) or Alternative Planning Strategy (APS) to demonstrate meeting regional GHG emissions reduction targets established by ARB through the planned transportation network, forecasted development patterns, and transportation measures and policies within the RTP. In 2013, the connection between higher-density development and GHG reduction was strengthened further yet with the passage of SB 743 (Chapter 386, Statutes of 2013), which requires an update in the California Environmental Quality Act (CEQA) transportation metrics to align with climate and planning goals.

In addition, Executive Order B-30-15 directs State agencies to take climate change into account in planning and investment decisions, and employ full life-cycle cost accounting to evaluate and compare infrastructure investments and alternatives. Planning and investment shall be guided by the following principles:

- Priority should be given to actions that both build climate preparedness and reduce GHG emissions;
- Where possible, flexible and adaptive approaches should be taken to prepare for uncertain climate impacts;
- Actions should protect the state's most vulnerable populations; and,
- Natural infrastructure solutions, as defined in Public resources code 71154(c)(3) (e.g., flood plain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planning to reduce high heat days), should be prioritized.

The RTP, also called a Metropolitan Transportation Plan (MTP) or Long-Range Transportation Plan is the mechanism used in California for MPOs to conduct long-range (minimum of 20 years) transportation planning, integrated with local jurisdiction's land use planning, in their regions to achieve local and regional goals, in consideration of state and federal goals. Because transportation infrastructure investments have effects on travel patterns, smart investments play a key role in meeting climate targets. As a result of state legislation, as well as executive orders, GHG emission reduction, transportation electrification, climate resilience, improving transportation mobility, addressing federal air quality criteria pollutants, and ensuring that the statewide regional transportation system addresses tribal, local, regional, and statewide

[1] This number reflects a wheel-to-well GHG estimate from aviation, construction and mining equipment, buses, heavy duty trucks, passenger vehicles, light duty trucks, rail, ships and commercial harbor craft, and the petroleum refining for transportation fuel. Federal and State law provide limited authority to MPOs. Collaborative planning between the state and MPOs is needed to meet the state's GHG reduction goals.

mobility and economic needs are key priorities in the statewide and regional transportation planning process.

Equally important to consider in long-range transportation planning is how transportation can affect human health in many ways, for example: safety – reduction of collisions; air quality – reduction of vehicle emissions; physical activity – increasing biking and walking; access to goods, services, and opportunities – increasing livability in communities; and noise – designing road improvements to decrease sound exposure. A timely opportunity to address public health outcomes is early during the RTP development process. MPOs can consider health priorities in selection of projects for the RTP and FTIP. MPOs also can play a significant role in engaging residents and stakeholders in the regional transportation planning process to ensure the improvement of health outcomes for all segments of the population.

As interest in the link between transportation and health has grown, much cross-sector coordination and collaboration between transportation professionals and health practitioners has occurred at all levels of government, with input from public health and equity advocates, as well as active transportation stakeholders. The optimal result of this process is to improve transportation decisions and thereby improve access to healthy and active lifestyles. Recent legislation geared at achieving this, AB 441 Monning (Chapter 365, Statutes of 2012), was passed to capture the work that MPOs are doing in their RTPs to promote health and health equity. Pursuant to AB 441, the 2017 RTP Guidelines includes a new attachment, Appendix K, that highlights the various health and health equity-promoting projects, programs, and policies currently employed in MPO RTPs in California. Public health is further discussed in Section 2.3.

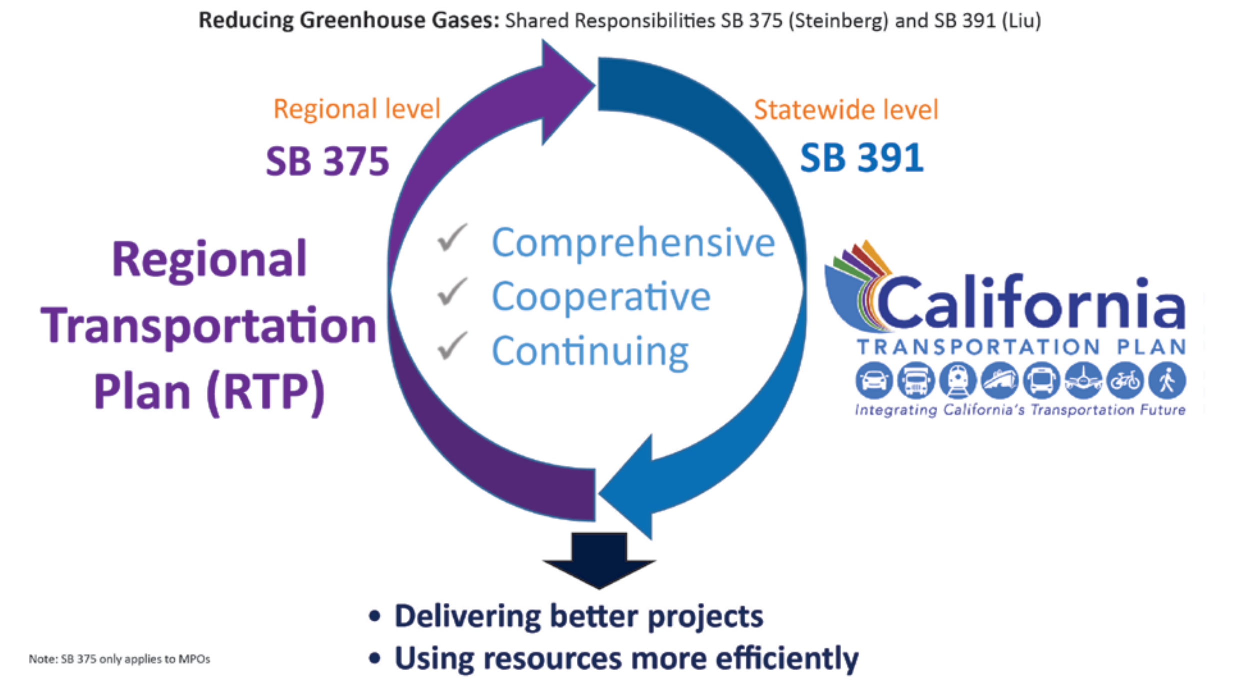
Lastly, long-range transportation planning provides the opportunity to compare alternative improvement strategies, track performance over time, and identify funding priorities. The CTP defines this as performance management that helps ensure efficient and effective investment of transportation funds by refocusing on established goals, increasing accountability and transparency, and improving project decision-making. To further reach this end, MAP-21/FAST Act require States and MPOs to implement a performance-based approach in the scope of the statewide and nonmetropolitan *and* metropolitan transportation planning process. In addition to federal performance based planning, the State of California has articulated through statute, regulation, executive order, and legislative intent language, numerous state goals for the transportation system, the environment, the economy, and social equity. RTPs are developed to reflect regional and local priorities and goals, but they are also instruments that can be used by federal and state agencies to demonstrate how regional agency efforts contribute to those federal and state agencies meeting their own transportation system goals. Inclusion of goal setting in RTPs allows the federal and state governments to both understand regional goals, and track progress toward federal and state goals.

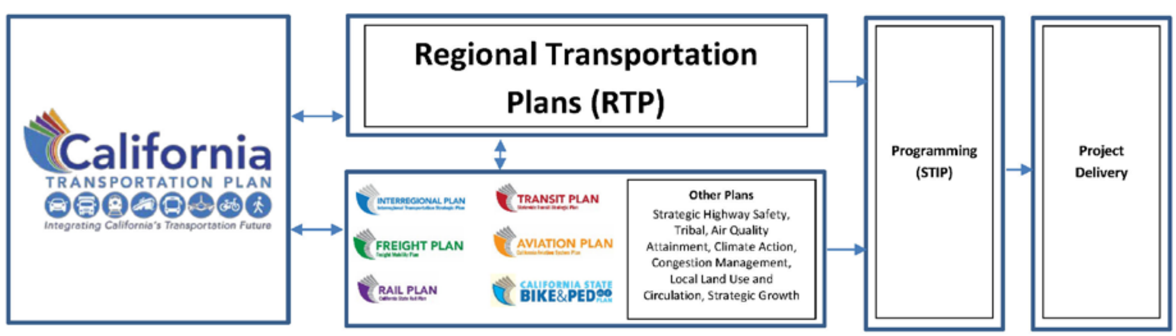
Performance-based planning is the application of performance management within the planning process to help the federal government, states and regional agencies achieve desired outcomes for the multimodal transportation system. The benefits of well-designed and appropriately used performance measures are transparency about the benefits of the RTP, not only for transportation system performance, but also for other regionally important priorities such as improved public health, housing affordability, farmland conservation, habitat preservation, and cost-effective infrastructure investment. As the performance-based approach is implemented at the federal and State levels, performance measures will continue to develop over the years to come. Transportation performance management and the performance-based approach are further discussed in Chapter 7.

1.2 RTPs & the California Transportation Plan

Similar to the SB 375 requirements for Regional Transportation Plans (RTPs), SB 391 adds new requirements to the State's long-range transportation plan to meet California's climate change goals under AB 32. The bill requires the California Transportation Plan (CTP) to address how the state will achieve maximum feasible emissions reductions in order to attain a statewide reduction of GHG emissions to 1990 levels by 2020 and 80% below 1990 levels by 2050. The bill also requires the CTP to identify the statewide integrated multimodal transportation system needed to achieve these results and specifies that the plan take into consideration the use of alternative fuels, new vehicle technology, tail pipe emission reductions, and the expansion of public transit, commuter rail, intercity rail, bicycling, and walking. In addition, SB 391 required Caltrans to update the CTP by December 31, 2015, and every 5 years thereafter.

The CTP is a core document that addresses the applicable federal statewide and non-metropolitan transportation planning regulations and helps tie together several internal and external plans and programs to help define and plan transportation in California. Unlike the RTP, it is not project specific or subject to both federal air quality conformity regulations and CEQA, but it does look at how SCS implementation will influence the statewide multimodal transportation system, as well as how the state will achieve sufficient emission reductions in order to meet AB 32 and SB 391. While the CTP is prepared by Caltrans, it is developed in collaboration with various stakeholders and public involvement. Furthermore, the CTP is a fiscally unconstrained aspirational policy document that integrates and builds upon six Caltrans modal plans (Interregional Plan, Freight Plan, Rail Plan, Aviation Plan, Transit Plan, and Bicycle and Pedestrian Plan) as well as the fiscally constrained RTPs prepared by the MPOs and the Regional Transportation Planning Agencies (RTPAs). RTPAs and MPOs address transportation from a regional perspective, while the CTP, building on regional plans, addresses the connectivity and/or travel between regions and applies a statewide perspective for transportation system. Therefore, integration of CTP and RTP goals (where applicable and consistent with federal and state fiscal restraint requirements) may provide greater mobility choices for travelers not only within their regions but across the state. The CTP and the RTP can be developed in a cyclical pattern aligning one with another using comprehensive, cooperative and continuing planning. This should result in delivering better projects and using resources more efficiently. The following diagrams illustrate the relationship between the CTP and RTP.





1.3 Background & Purpose of the RTP Guidelines

The purposes of these RTP Guidelines are to:

1. Promote an integrated, statewide, multimodal, regional transportation planning process and effective transportation investments;
2. Set forth a uniform transportation planning framework throughout California by identifying federal and state requirements and statutes impacting the development of RTPs;
3. Promote a continuous, comprehensive, and cooperative transportation planning process that facilitates the rapid and efficient development and implementation of projects that maintain California's commitment to public health and environmental quality; and,
4. Promote a planning process that considers the views of all stakeholders.

The purpose of RTPs is to encourage and promote the safe and efficient management, operation and development of a regional intermodal transportation system that, when linked with appropriate land use planning, will serve the mobility needs of goods and people. The RTP Guidelines are intended to provide guidance so that MPOs will develop their RTPs to be consistent with federal and state transportation planning requirements. This is important because state statutes require that RTPs serve as the foundation of the Federal Transportation Improvement Program (FTIP). The FTIPs are prepared by MPOs and identify the next four years of transportation projects to be funded for construction. The California Transportation Commission (CTC) cannot program projects that are not identified in the RTP.

Since the mid-1970s, with the passage of AB 69, (Chapter 1253, Statutes of 1972) California state law has required the preparation of RTPs to address transportation issues and assist local and state decision-makers in shaping California's transportation infrastructure. SB 375 requires that the RTP Guidelines are to be developed pursuant to California Government Code Sections 14522 and 65080 which state:

"14522. In cooperation with the regional transportation planning agencies, the commission may prescribe study areas for analysis and evaluation by such agencies and guidelines for the preparation of the regional transportation plans."

"14522.1. (a) (1) The commission, in consultation with the department and the State Air Resources Board, shall maintain guidelines for travel demand models used in the development of regional transportation plans by federally designated metropolitan planning organizations.
(2) Any revision of the guidelines shall include the formation of an advisory committee that shall include representatives of the metropolitan planning organizations, the department, organizations knowledgeable in the creation and use of travel demand models, local governments, and organizations concerned with the impacts of transportation investments on communities and the environment. Before amending the guidelines, the commission shall hold two workshops on the guidelines, one in northern California and one in southern California. The workshops shall be incorporated into regular commission meetings.
(b) The guidelines shall, at a minimum and to the extent practicable, taking into account such factors as the size and available resources of the metropolitan planning organization, account for all of the following:
(1) The relationship between land use density and household vehicle ownership and vehicle miles traveled in a way that is consistent with statistical research.
(2) The impact of enhanced transit service levels on household vehicle ownership and vehicle miles traveled.
(3) Changes in travel and land development likely to result from highway or passenger rail expansion.
(4) Mode splitting that allocates trips among automobile, transit, carpool, and bicycle and pedestrian trips. If a travel demand model is unable to forecast bicycle and pedestrian trips, another means may be used to estimate those trips.
(5) Speed and frequency, days, and hours of operation of transit service."

"65080 (d) Except as otherwise provided in this subdivision, each transportation planning agency shall adopt and submit, every four years, an updated regional transportation plan to the California Transportation Commission and the Department of Transportation. A transportation planning agency located in a federally designated air quality attainment area or that does not contain an urbanized area may at its option adopt and submit a regional transportation plan every five years. When applicable, the plan shall be consistent with federal planning and

programming requirements and shall conform to the regional transportation plan guidelines adopted by the California Transportation Commission. Prior to adoption of the regional transportation plan, a public hearing shall be held after the giving of notice of the hearing by publication in the affected county or counties pursuant to Section 6061."

The California RTP Guidelines were first adopted by the CTC in 1978 and subsequently revised in 1982, 1987, 1991, 1992, 1994, 1999, 2007, and 2010.

The 1999 revision of the Guidelines was prepared to achieve conformance with state and federal transportation planning legislation and was based on the Federal Transportation Equity Act for the 21st Century (TEA-21) and California SB 45 (Chapter 622 Statutes 1997). A 2003 Supplement was also prepared that was based on a 2003 RTP Evaluation Report completed for the CTC. The federal surface transportation reauthorization bill called the SAFETEA-LU was signed into law in 2005. The 2007 revision of the RTP Guidelines was prepared in order to address changes in the planning process resulting from SAFETEA-LU.

Subsequent to the passage of AB 32 (California Global Warming Solutions Act of 2006), an addendum to the 2007 RTP Guidelines was adopted by the CTC in May 2008 to address a request from the California Legislature to ensure climate change issues were incorporated in the RTP process. That addendum was adopted by the CTC prior to the September 2008 passage of SB 375.

The 2010 update was prepared to incorporate new planning requirements as a result of SB 375 and to incorporate the addendum to the 2007 RTP Guidelines. SB 375 requires the 18 MPOs in the state to identify a forecasted development pattern and transportation network that, if implemented, will meet GHG emission reduction targets specified by the California Air Resources Board (ARB) through their RTP planning processes.

Since the 2010 update, two federal surface transportation reauthorization bills have been signed into law. First, the two-year bill with numerous extensions, MAP-21, was signed on July 6, 2012. Most recently, a longer term five-year funding bill, FAST, was signed on December 4, 2015.

2015 MPO RTP Review Report

The 2017 RTP Guidelines update was prepared to incorporate Recommendations that were included in the December 2015 MPO RTP Review Report. This Report can be found at: http://www.dot.ca.gov/hq/tpp/offices/orip/rtp/index.html. One of these Recommendations called for an MPO focused RTP Guidelines document addressing just the requirements for MPOs when developing, completing, adopting and implementing an RTP. In addition, the 2017 update reflects the data and analysis needs of the ARB to evaluate the Sustainable Communities Strategy (SCS) component of an MPO's RTP.

1.4 <u>MPOs in California</u>

In cooperation with the Governor, there are 18 federally designated MPOs that prepare RTPs in California. MPOs must adhere to federal planning regulations during the preparation of their RTPs. California statutes and the RTP Guidelines identify the RTP requirements for MPOs.

Federal legislation passed in the early 1970's required the formation of an MPO for any urbanized area with a population greater than 50,000. MPOs were created in order to ensure that existing and future expenditures for transportation projects and programs were based on a continuing, cooperative and comprehensive (3-C) planning process. One of the core functions of an MPO is to develop an RTP through the planning process.

An MPO has five core functions:

1. Maintain a setting for regional decision-making;
2. Prepare an Overall Work Program (OWP);
3. Involve the public in this decision-making;
4. Prepare an RTP; and,
5. Develop a Transportation Improvement Program (TIP).

MPOs federally required responsibilities are identified in Title 23 U.S.C. Section 134 and Title 23 Code of Federal Regulations (CFR) Part 450.300. To carry out various transportation planning functions, MPOs receive annual federal metropolitan planning funds from the FHWA and FTA.

The California Government Code sets forth the requirements for an RTP to be an internally consistent document that contains a SCS in addition to the policy, action and financial elements. With the added requirement for an SCS in 2008, state law placed new emphasis on the RTP as an integrated planning document that promotes sustainable land use and increases mobility options. This heightens the importance of the MPOs as regional leaders to bring together local governments in a collaborative discussion about alternate scenarios for the region's future.

The map below identifies the 18 MPOs (in darker shade) and the 26 RTPAs that prepare RTPs (in lighter shade or dot pattern).


CALIFORNIA
Metropolitan Planning Organizations(MPOs)
and
Regional Transportation Planning Agencies (RTPAs)
AMBAG[1] Association of Monterey Bay Area Governments
BCAG Butte County Association of Governments
FCOG Fresno Council of Governments
KCAG Kings County Association of Governments
KCOG Kern Council of Governments
MCAG Merced County Association of Governments
MCTC Madera County Transportation Commission
MTC[2] Metropolitan Transportation Commission
SACOG[3] Sacramento Area Council of Governments
SANDAG San Diego Association of Governments
SJCOG San Joaquin Council of Governments
SLOCOG San Luis Obispo Council of Governments
SBCAG Santa Barbara County Association of Governments
SRTA Shasta Regional Transportation Agency
SCAG[4] Southern California Association of Governments
StanCOG Stanislaus Council of Governments
TCAG Tulare County Association of Governments
TMPO[5] Tahoe Metropolitan Planning Organization
[1]AMBAG includes SCCRTC, TAMC, and SBtCOG. All retain RTPA status.
[2]MTC covers a nine county region.
[3]SACOG is the RTPA for Sacramento, Sutter, Yolo, and Yuba Counties. It is the MPO for the federally designated ozone non-attainment area in Sacramento, Yolo, Yuba, Sutter, Placer, and El Dorado Counties. Placer and El Dorado Counties retain RTPA status up to the crest of the Sierras.
[4]SCAG covers a six county region that serve as County Transportation Commissions: ICTC, LAMTA, OCTA, RCTC, SANBAG, and VCTC.
[5]TMPO is a multi-state MPO created by federal law. It covers portions of El Dorado and Placer counties as well as Washoe and Douglas counties in Nevada, and shares board members with the TRPA.
Del Norte LTC
Siskiyou CLTC
Modoc CTC
Humboldt CAG
Trinity CTC
SRTA
Lassen CTC
Tehama CTC
Plumas CTC
Mendocino COG
Glenn CTC
BCAG
Sierra LTC
Nevada CTC
Colusa CTC
Lake CCAPC
Yuba
Placer CTPA
TMPO
TRPA
Sutter
Yolo
El Dorado CTC
Sonoma
Napa
SACOG
Sacramento
Alpine LTC
Amador CTC
MTC
Solano
Marin
Calaveras COG
Tuolumne TCTC
Mono LTC
Contra Costa
SJCOG
San Francisco
Alameda
StanCOG
Mariposa LTC
San Mateo
Santa Clara
MCAG
MCTC
Santa Cruz County Regional Transportation Commission (SCCRTC)
AMBAG
San Benito COG
FCOG
Inyo LTC
Transportation Agency for Monterey County
TCAG
KCAG
SLOCOG
KCOG
San Bernardino Associated Governments
SBCAG
Ventura CTC
Los Angeles County MTA
SCAG
Riverside CTC
Orange County Transportation Authority
SANDAG
Imperial County Transportation Commission
RTPAs within MPOs
MPO Areas
Non-MPO Rural RTPA Areas
California Department of Transportation
Division of Transportation Planning
March 2016

1.5 Purpose of the RTP

RTPs are planning documents developed by MPOs in cooperation with FHWA, FTA, Caltrans and other stakeholders, including system users. Following the passage of SB 375, MPOs also need to work closely with the California Air Resources Board (ARB) and the California Department of Housing and Community Development (HCD) (Government Code Section 65080 et seq.). MPOs are required to prepare these long-range plans per federal statute (Title 23 U.S.C. Section 134). The purpose of the RTP is to establish regional goals, identify present and future needs, deficiencies and constraints, analyze potential solutions, estimate available funding, and propose investments.

California statute refers to these documents as “Regional Transportation Plans” or RTPs. In California planning circles, these long range planning documents normally use the term “RTP”. However several California MPOs refer to RTPs using the term “Metropolitan Transportation Plan or MTP” which is used in federal planning regulations. “RTP” or “MTP” are terms used to describe the same document.

Pursuant to Title 23 CFR Part 450.324 et seq. FHWA describes the development and contents of RTPs as follows:

> *“The transportation plan is the Statement of the ways the region plans to invest in the transportation system. The plan shall “include both long-range and short-range program strategies/actions that lead to the development of an integrated intermodal transportation system that facilitates the efficient movement of people and goods.” The plan has several elements, for example: Identify policies, strategies, and projects for the future; Determine project demand for transportation services over 20 years; Focus at the systems level, including roadways, transit, non-motorized transportation, and intermodal connections; Articulate regional land use, development, housing, and employment goals and plans; Estimate costs and identify reasonably available financial sources for operation, maintenance, and capital investments); Determine ways to preserve existing roads and facilities and make efficient use of the existing system; be consistent with the Statewide transportation plan; and Be updated every five years or four years in air quality nonattainment and maintenance areas. MPOs should make special efforts to engage interested parties in the development of the plan. In cases where a metropolitan area is designated as a nonattainment or maintenance area, the plan must conform to the State Implementation Plan (SIP) for air quality.”*

The regional transportation planning led by the MPOs is a collaborative process that is widely participated by the federal, state, local and tribal governments/agencies, as well as other key stakeholders and the general public. The process is designed to foster involvement by all interested parties, such as the business community, California Tribal Governments, community groups, environmental organizations, the general public, and local jurisdictions through a proactive public participation process conducted by the MPO in coordination with the state and transit operators. It is essential to extend public participation to include people who have been traditionally underserved by the transportation system and services in the region. Neglecting public involvement early in the planning stage can result in delays during the project stage.

While new federal MAP-21/FAST Act requirements are addressed in Section 1.7 of these guidelines, the traditional steps undertaken during the regional planning process include:

1. Providing a long-term (20 year) visioning framework;
2. Monitoring existing conditions;
3. Forecasting future population and employment growth;
4. Assessing projected land uses in the region and identifying major growth corridors;
5. Identifying alternatives and needs and analyzing, through detailed planning studies, various transportation improvements;
6. Developing alternative capital and operating strategies for people and goods;
7. Estimating the impact of the transportation system on air quality within the region; and,
8. Developing a financial plan that covers operating costs, maintenance of the system, system preservation costs, and new capital investments.

The overall scope of the RTP prepared by MPOs has expanded as a result of SB 375 to require the inclusion of a Sustainable Communities Strategy (SCS):

1. Transportation projects, non-auto mobility strategies, and the forecasted development pattern in the RTP must be modeled to determine their impacts on regional GHG emissions. Current travel models are not always sensitive to the land use and transportation strategies in an SCS; therefore, MPOs have had to find alternative methods to quantify the GHG emissions reduction benefits of these strategies. Off-model methods are discussed further in Chapter 3.
2. The RTP must contain an SCS that includes a forecasted development pattern for the region, which, when integrated with the transportation network, and other transportation measures and policies, will reduce the GHG emissions from automobiles and light trucks to achieve, if feasible, the GHG emission reduction target approved for the region by the ARB. The MPO will need to coordinate with cities and counties within the region to work towards strategies that will reduce regional GHG emissions.
3. The MPO must prepare an Alternative Planning Strategy (APS) if the SCS is unable to reduce GHG emissions to achieve the GHG emissions reduction targets established by the ARB. The APS shall be a separate document from the RTP, but it may be adopted concurrently with the RTP.

The RTPs are developed to provide a clear vision of the regional transportation goals, objectives and strategies. This vision must be realistic and within fiscal constraints. In addition to providing a vision, the RTPs have many specific functions, including:

1. Providing an assessment of the current modes of transportation and the potential of new travel options within the region;
2. Projecting/estimating the future needs for travel and goods movement;
3. Identification and documentation of specific actions necessary to address regional mobility and accessibility needs;
4. Identification of guidance and documentation of public policy decisions by local, regional, state and federal officials regarding transportation expenditures and financing and future growth patterns;

5. Identification of needed transportation improvements, in sufficient detail, to serve as a foundation for the: (a) Development of the Federal Transportation Improvement Program (FTIP), and the State Transportation Improvement Program (STIP), (b) Facilitation of the National Environmental Policy Act (NEPA)/404 integration process and (c) Identification of project purpose and need;
6. Employing performance measures that demonstrate the effectiveness of the system of transportation improvement projects in meeting the intended goals;
7. Promotion of consistency between the CTP, the regional transportation plan and other plans developed by cities, counties, districts, California Tribal Governments, and state and federal agencies in responding to statewide and interregional transportation issues and needs;
8. Providing a forum for: (1) participation and cooperation and (2) facilitation of partnerships that reconcile transportation issues which transcend regional boundaries; and,
9. Involving community-based organizations as part of the public, Federal, State and local agencies, California Tribal Governments, as well as local elected officials, early in the transportation planning process so as to include them in discussions and decisions on the social, economic, air quality and environmental issues related to transportation.

1.6 California Transportation Planning & Programming Process

The State of California and federal transportation agencies allocate millions of dollars of planning funds annually to help support California's transportation planning process. The RTP establishes the basis for programming local, state, and federal funds for transportation projects within a region. State and federal planning and programming legislation has been in place and is periodically revised to provide guidance in the use of these funds to plan, maintain and improve the transportation system.

The RTP Guidelines include recommendations and suggestions for providing documentation that is needed to meet the requirements of the Federal Transportation Improvement Program (FTIP) and the State Transportation Improvement Program (STIP). Because there are a variety of names used for the programming document that is prepared by an MPO, the RTP Guidelines refer to the programming document that accompanies an RTP as the FTIP. The FTIP is defined as a constrained four-year prioritized list of regionally significant and non-regionally significant transportation projects that are proposed for federal, state and local funding. The FTIP is developed and adopted by the MPO and is updated every two years. It is consistent with the RTP and it is required as a prerequisite for federal funding. In this document the words FTIP and Regional Transportation Improvement Program (RTIP) are used interchangeably.

The planning and programming process is the result of state and federal legislation to ensure that:

1. The process is as open and transparent as possible;
2. Environmental considerations are addressed; and,
3. Funds are allocated in an equitable manner to address transportation needs.

The chart in Appendix A attempts to provide a simple diagram of a complex process. Each entity in the chart reflects extensive staff support and legislative direction. The result is the planning and programming process that reflects the legislative and funding support of the

California transportation system. Additional information regarding the programming process is available in Sections 2.5 and 6.15.

1.7 MAP-21/FAST Act Items Impacting the Development of RTPs

This section is intended to outline the new federal requirements resulting from MAP-21/FAST Act and the Final Rule issued May 27, 2016 with an effective date of June 27, 2016 for Statewide and Nonmetropolitan Transportation Planning *and* Metropolitan Transportation Planning. Only the items that have a direct impact on RTP development are listed. Other sections may contain optional requirements that could have impacts to the overall regional transportation planning *process*.

As specified in 23 CFR 450.340(a), prior to May 27, 2018, an MPO may adopt an RTP that has been developed using the SAFETEA-LU requirements or the provisions and requirements of 23 CFR 450. On or after May 27, 2018, an MPO may not adopt an RTP that has not been developed according to the provisions of 23 CFR 450. MPOs are encouraged to communicate with Caltrans and FHWA/FTA to discuss schedules for RTP adoption.

Two New Planning Factors (Section 2.4) – MPOs shall consider and implement two new planning factors added to the scope of the transportation planning process: Improve resiliency and reliability of the transportation system and reduce or mitigate stormwater impacts of surface transportation; and enhance travel and tourism. 23 CFR 450.306 (b)(9) and (10)

Performance-Based Planning Approach (Section 7.2) – MPOs are required to integrate the goals, objectives, performance measures, and targets described in other performance-based plans into their RTPs. The implementation timeline for MPOs to satisfy the new requirements is two years from the effective date of each rule establishing performance measures under 23 U.S.C. 150(c), 49 U.S.C. 5326, and 49 U.S.C. 5329 FHWA/FTA. A future update of the RTP Guidelines will capture any “shoulds” or “shalls” resulting from the rulemaking process. 23 CFR 450.306; 23 CFR 450.324 (f)(3) and (4)

Assessment of Capital Investment and Other Strategies (Section 6.22) – RTPs are required to include an assessment of capital investment and other strategies to: (1) preserve the existing and projected future transportation infrastructure, (2) provide for multimodal capacity increases based on regional needs and priorities, and (3) reduce vulnerability of the existing infrastructure to natural disasters. 23 CFR 450.324 (f)(7)

Consideration of Public Transportation Facilities and Intercity Bus Facilities (Section 6.10) – RTPs must also consider the role of intercity bus systems, including systems that are privately owned and operated, in reducing congestion, and including transportation alternatives. 23 CFR 450.324 (f)(8)

Interested Parties, Public Participation, and Consultation (Sections 4.4, 4.6, and 6.21) – In addition to the interested parties listed, MPOs must also provide public ports with a reasonable opportunity to comment on the RTP. MPOs should also consult with officials responsible for tourism and natural disaster risk reduction when developing RTPs and FTIPs. 23 CFR 450.316(a) and (b); 23 CFR 450.324(j)

Optional Scenario Planning – MPOs may use scenario planning during the development of RTPs. Many California MPOs already employ scenario planning as an analytical framework to inform decision-makers about the implications of various investments and policies on transportation system condition and performance during the development of their plan. 23 CFR 450.324(i)

1.8 Key Additions to the 2017 RTP Guidelines

Key Additions to the 2017 RTP Guidelines include the following items:

1. Separating RTP Guidelines, one for the MPOs and one for the RTPAs to better address the specific requirements for their RTPs.
2. Appendix C – Adds questions to the RTP Checklist for Title VI compliance.
3. Appendix K, AB 441 Monning – For the first time in the RTP Guidelines, this Appendix highlights the various public health and health equity-promoting policies incorporated within the MPO RTPs.
4. Appendix L, Planning Practice Examples – aggregates the former Appendix I, Land Use and Transportation Strategies to address Regional GHG Emissions, and the "Best Practices" component of RTP Guidelines as a new appendix, accessible by topic.
5. Updates for the MAP-21/FAST Act throughout the RTP Guidelines.
6. Section 1.0 – Provides guidance on applicability of the RTP Guidelines and defines "shalls" and "shoulds."
7. Section 1.2 – Defines the relationship between the RTP and the CTP.
8. Section 1.7 – Outlines MAP-21/FAST Act items with a direct impact on RTP development.
9. Section 2.2 – Includes updates to State Climate Change Legislation and Executive Orders.
10. Section 2.3 – Provides an introduction to Appendix K, the public health and health equity-promoting policies that are found throughout the MPO RTPs.
11. Section 2.6 – Adds local, regional, and State prepared plans that MPOs should consult with during RTP preparation.
12. Section 2.7 – Includes Planning and Environmental Linkages, updates Context Sensitive Solutions, and additional System Planning documents that are used in partnership with MPOs in the transportation planning process.
13. Chapter 3 – Updates the Modeling Chapter from the 2010 version.
14. Chapter 4 – Includes new legislation highlighting the required Native American Tribal Government Consultation and Coordination process.
15. Section 4.2 – Describes Title VI considerations in the RTP, Principles of Environmental Justice (EJ), and Title VI Analysis & EJ Analysis.
16. Section 4.4 – Includes Periodic Evaluation of the Public Participation Plan to evaluate the effectiveness of the procedures and strategies for developing the RTP.
17. Section 4.6 – Adds public ports to the list of interested parties.
18. Chapter 5 – Describes SB 743 (Chapter 386, Statutes of 2013) and the anticipated future change to transportation analysis for transit priority areas.
19. Section 5.4 – Adds Cultural Resources, Habitat Connectivity, and Air Quality Impacts to the list of environmental resources that typically require avoidance alternative and mitigation.
20. Chapter 6 – Introduces the California Freight Mobility Plan and the California Sustainable Freight Action Plan.

21. Chapter 6 – Provides preliminary information on MAP-21/FAST Act impacts on Asset Management.
22. Section 6.8 – Adds items to consider in the highways discussion of the RTP, including zero-emission vehicles, widespread transportation electrification, community impacts their participation in project development.
23. Section 6.10 – Adds first/last mile transit connectivity to the transit discussion of the RTP as well as the MAP-21/FAST Act requirement to discuss the role of intercity buses in reducing congestion, pollution, and energy consumption.
24. Section 6.12 – Adds supporting the State's freight system efficiency target and identification of opportunities/innovations that reduce freight emissions to the goods movement discussion of the RTP.
25. Section 6.19 – New Section 6.19 provides a summary of federal and State legislation to prepare for new technologies and innovations for the future of transportation.
26. Section 6.20 – Updates Transportation Safety for MAP-21/FAST Act.
27. Section 6.21 – Updates Transportation Security for the MAP-21/FAST Act requirement to consult with agencies and officials responsible for natural disaster risk reduction.
28. Section 6.22 – Adds new RTP requirement for an Assessment of Capital Investment & Other Strategies.
29. Section 6.23 – Updates Congestion Management Process for the MAP-21/FAST Act framework for developing a Congestion Management Plan.
30. Section 6.26 – Updates addressing housing needs and adds a new subsection, Considering Rural Communities in the SCS.
31. Section 6.28 – Adds many transportation strategies to address regional GHG emissions, including employer-sponsored shuttle services, active transportation plans, and coordinating with school district plans and investments.
32. Section 6.30 – Updates for Climate Adaptation background, State legislation, executive orders, and planning resources for MPOs.
33. Chapter 7 – A new chapter, Transportation Performance Management, provides the appropriate emphasis on the RTP as a performance-driven plan for which performance measures must be developed and used by the MPO for plan development, implementation, and monitoring. This chapter includes updates for MAP-21/FAST Act requirements for MPOs to implement the performance based approach into the scope of the metropolitan planning process, including the RTP.

Chapter 2

RTP Process

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RTP PROCESS

2.1 State Requirements

California statute relating to the development of the RTP is primarily contained in Government Code Section 65080.

Just like federal legislation, Government Code Section 65080 also requires that MPOs located in nonattainment regions update their RTPs at least every four years. State statute provides MPOs located in air quality attainment regions the option to update their RTPs every five years.

When applicable, RTPs shall be consistent with federal planning and programming requirements and shall conform to the RTP Guidelines adopted by the California Transportation Commission (CTC) pursuant to Government Code Section 65080(d). In addition, the CTC cannot program projects in the State Transportation Improvement Program (STIP) that are not identified in an RTP. Section 65080 states RTPs shall include the following:

1. Policy Element
2. Sustainable Communities Strategy
3. Action Element
4. Financial Element

The following California Government Code Sections apply to the development of RTPs:

Government Code Section 65080.1 – Each MPO whose jurisdiction includes a portion of the California Coastal Trail, or property designated for the trail shall coordinate with the State Coastal Conservancy, the California Coastal Commission and Caltrans regarding the development of the trail. The trail must be identified in the RTP.

Government Code Section 65080.3 - An MPO with a population exceeding 200,000 persons may prepare at least one "alternative planning scenario" during the development of the RTP. The purpose of the alternative planning scenario is to address attempts to reduce growth in traffic congestion, make more efficient use of existing transportation infrastructure, and reduce the need for costly future public infrastructure.

Government Code Section 65080.5 - Prior to adoption of the RTP, a public hearing shall be held after publishing notice of the hearing. After the RTP is adopted by the MPO, the plan shall be submitted to the CTC and Caltrans. One copy should be sent to the CTC. Two copies should be submitted to the appropriate Caltrans district office. The Caltrans district office will send one copy to the headquarters Division of Transportation Planning.

Government Code Section 65081.1 - Regions that contain a primary air carrier airport (defined by the Federal Aviation Administration as an airport having at least 10,000 annual scheduled passenger boardings) shall work collaboratively to include an airport ground access improvement program within the RTP. This program shall address airport access improvement projects, including major arterial and highway widening and extension projects, with special consideration given to mass transit.

Requirements (Shalls)
State: Government Code Sections 65080, 65080.1, 65081.1

2.2 Background on State Climate Change Legislation & Executive Orders

This section provides background for State climate change legislation and related executive orders. First, a description is provided for AB 32, SB 32, and SB 375 which have direct implications for MPOs in the development of RTPs. Next, other state legislation that impacts State agencies is outlined to provide important context for MPOs to consider in development of RTPs. Lastly, executive orders on climate change are discussed to provide a critical framework for MPOs. While the executive orders are directed at State agencies, MPOs are encouraged to integrate policies and strategies that support these state policies in the development of RTPs.

AB 32 – The California Global Warming Solutions Act of 2006

California established itself as a national leader in addressing climate change issues with the passage of AB 32, the Global Warming Solutions Act of 2006. As a result of AB 32, California statute specifies that by the year 2020, GHG emissions within the state must be at 1990 levels. The ARB is the primary state agency responsible for implementing the necessary regulatory and market mechanisms to achieve reductions in GHG emissions to comply with the requirements of AB 32.

AB 32 identifies GHGs as specific air pollutants that are responsible for global warming and climate change. This is particularly relevant to the RTP Guidelines because, according to the ARB Mobile Source Strategy, the transportation sector represents nearly 50 percent of GHG emissions in California[2]. California has focused on six GHGs (CO2, Methane, Nitrous Oxide, Hydro fluorocarbons, perfluorocarbons, and Sulfur Hexafluoride). CO2 is the most prevalent GHG. All other GHGs are referenced in terms of a CO2 equivalent.

AB 32 directed the ARB to develop actions to reduce GHGs, including the preparation of a scoping plan to identify how best to reach the 2020 goal. According to the scoping plan, the framework for achieving GHG emissions reductions from land use and transportation planning includes implementation of SB 375.

SB 32 – California Global Warming Solutions Act of 2006: Emissions Limit

In recognition that GHG reduction is critical for the protection of all areas of the state, but especially for the state's most disadvantaged communities, as those communities are most affected by the adverse impacts of climate change, SB 32 (Chapter 249, Statutes of 2016) was signed into law on September 8, 2016. SB 32 extends the AB 32 required reductions of GHG emissions by requiring a GHG reduction of at least 40 percent of 1990 levels no later than December 31, 2030. Furthermore, SB 32 authorizes ARB to adopt rules and regulations to achieve the maximum technologically feasible and cost-effective GHG emissions reductions. ARB shall carry out the process to achieve GHG emissions reductions in a manner that benefits the state's most disadvantaged communities and is transparent and accountable to the public and Legislature.

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[2] This number reflects a wheel-to-well GHG estimate from aviation, construction and mining equipment, buses, heavy duty trucks, passenger vehicles, light duty trucks, rail, ships and commercial harbor craft, and the petroleum refining for transportation fuel. Federal and State law provide limited authority to MPOs. Collaborative planning between the state and MPOs is needed to meet the state's GHG reduction goals.

SB 375 – The Sustainable Communities and Climate Protection Act of 2008

SB 375 was signed into law in September 2008. The bill addressed five primary areas:

1. Requires the ARB to develop regional GHG emission reduction targets for cars and light trucks for each of the 18 MPOs in California.
2. Through their respective planning processes, each of the MPOs is required to prepare a sustainable communities strategy (SCS) that will specify how the GHG emissions reduction target set by ARB for 2020 and 2035 can be achieved for the region. If the target cannot be met through the SCS, then an Alternative Planning Strategy (APS) shall be prepared.
3. Provides streamlining of California Environmental Quality Act (CEQA) requirements for specific residential and mixed-use developments that are consistent with an SCS or APS that has been determined by ARB to achieve the regional GHG emissions reduction target.
4. Synchronizes the Regional Housing Needs Assessment (RHNA) process with the RTP process; requires local governments to update the housing element of their general plans and to rezone consistent with the updated housing element generally within three years of adoption; and provides that RHNA allocations must be consistent with the development pattern in the SCS. Housing element updates are moved from five year cycles to eight year cycles for member jurisdictions of all MPOs, classified as nonattainment or maintenance (required to adopt an updated RTP every four years) and for jurisdictions within other MPOs and RTPAs that elect to change the RTP adoption schedule from five years to every four years pursuant to Government Code Section 65080 (b)(2)(M). MPOs should carefully estimate a realistic RTP adoption date in providing the 12 month notice to HCD and not adopt a RTP at a later date. RTP adoption past the estimated adoption date relied on by HCD in determining new housing unit allocation for a specific planning period creates a conflict and shifts the housing element planning period to an ending period that lacks a requisite housing unit allocation.
5. Requires the California Transportation Commission (CTC) to maintain guidelines for the use of travel demand models used in the development of regional transportation plans that, taking into consideration MPO resources, account for: 1.) the relationship between land use density, household vehicle ownership, and vehicle miles traveled (VMT), consistent with statistical research, 2.) the impact of enhanced transit service on household vehicle ownership and VMT, 3.) likely changes in travel and land development from highway or passenger rail expansion, 4.) mode splitting that allocates trips between automobile, transit, carpool, bicycle and pedestrian trips, and 5.) speed and frequency, days, and hours of operation of transit service. (Government Code Section 14522.1)

Requirements (Shalls)
State: Government Code Section 65080

The following State legislation is directed at State agencies. MPOs are encouraged to consider and incorporate, where applicable and appropriate, the policies and strategies that support requirements placed on the State.

AB 1482 – Climate Adaptation

AB 1482 (Chapter 603, Statutes of 2015) addresses two areas:

1. Requires the Natural Resources Agency to update the state's Climate Adaptation Strategy (Safeguarding California) by July 1, 2017, and every three years thereafter.
2. Requires the Strategic Growth Council to identify and review activities and funding programs of State agencies that may be coordinated, including those that:
    a. Increase the availability of affordable housing, improve transportation, encourage sustainable land use planning, and revitalize urban and community centers in a sustainable manner.
    b. Meet the goals of the California Global Warming Solutions Act of 2006 and the strategies and priorities developed in the Safeguarding California Plan, the state's climate adaptation strategy.
    c. At a minimum, review and comment on the five-year infrastructure plan.

SB 246 – Climate Change Adaptation

SB 246 (Chapter 606, Statutes of 2015) establishes the Integrated Climate Adaptation and Resiliency Program through the Office of Planning and Research (OPR) to coordinate regional and local adaptation efforts with state climate adaptation strategies.

SB 350 - Clean Energy and Pollution Reduction Act of 2015

SB 350 (Chapter 547, Statutes of 2015) describes the importance of widespread transportation electrification for meeting climate goals and federal air quality standards. SB 350 focuses on "widespread" transportation electrification. The term "widespread" is important because adhering to existing patterns of investment in wealthier communities relative to low- or moderate-income communities would result in underinvestment in low-income communities and overinvestment in wealthier communities. SB 350 notes that "widespread transportation electrification requires increased access for disadvantaged communities, low- and moderate-income communities, and other consumers of zero-emission and near-zero-emission vehicles."

Pursuant to PUC 740.12(a)(2), it is the policy of the state and the intent of the legislature to encourage transportation electrification as a means to achieve ambient air quality standards and the state's climate goals. Agencies designing and implementing regulation, guidelines, plans, and funding programs to reduce GHG emissions shall take the findings described in paragraph (1) of PUC Section 740.12 into account. MPOs are encouraged to support widespread transportation electrification and partner with state agencies to advance California toward the standards and goals outlined in Public Utilities Code Section 740.12(a)(1). These include:

- Reducing emissions of GHGs to 40 percent below 1990 levels by 2030 and to 80 percent below 1990 levels by 2050.
- Achieving the goals of the Charge Ahead California Initiative (Chapter 8.5 (commencing with Section 44258) of Part 5 of Division 26 of the Health and Safety Code).
- Meeting air quality standards, reducing petroleum use, improving public health, and achieving GHG emission reduction goals.
- Attracting investments and high quality jobs.

Executive Orders on Climate Change Issues

The executive orders on climate change below are discussed to provide a critical framework for MPOs. While these Executive Orders are directed at State agencies, integration of climate change policies in the RTP supports the State's effort to reduce per capita GHG emissions and combat the effects of climate change.

Three Governor Executive Orders were issued from 2005-2008 to address climate change: S-3-05 (June 1, 2005) that calls for a coordinated approach to address the detrimental air quality effects of GHGs; S-20-06 (October 17, 2006) that requires State agencies to continue their cooperation to reduce GHG emissions and to have the Climate Action Team develop a plan to outline a number of actions to reduce GHG; and S-13-08 (November 14, 2008) that directs the Natural Resources Agency to develop the State's first Climate Adaptation Strategy (CAS) guide. Information on climate change and California climate change activities can be found at the following links:
http://www.climatechange.ca.gov/
http://www.arb.ca.gov/cc/facts/facts.htm

More recently, Governor Executive Orders were issued in 2012 and 2015. Executive Order B-16-12 sets a 2050 GHG emissions reduction goal for the transportation sector to achieve 80 percent less than 1990 levels. Executive Order B-32-15 works toward achieving GHG reduction targets with the California Sustainable Freight Action Plan, an integrated plan that establishes clear targets to improve freight efficiency, transition to zero-emission technologies, and increase competitiveness of California's freight system.

In addition, Executive Order B-30-15 established a new interim statewide GHG emission reduction target to reduce GHG emissions to 40 percent below 1990 levels by 2030 to ensure California meets its target of reducing GHG emissions to 80 percent below 1990 levels by 2050. All State agencies with jurisdiction over sources of GHG emissions shall implement measures, pursuant to statutory authority, to achieve reductions of GHG emissions to meet the 2030 and 2050 GHG emissions reductions targets. Furthermore, State agencies shall take climate change into account in their planning and investment decisions, and employ full life-cycle cost accounting to evaluate and compare infrastructure investments and alternatives. State agencies' planning and investment shall be guided by the following principles:

- Priority should be given to actions that both build climate preparedness and reduce GHG emissions;
- Where possible, flexible and adaptive approaches should be taken to prepare for uncertain climate impacts;
- Actions should protect the states most vulnerable populations;
- Natural infrastructure solutions, as defined in Public resources code 71154(c)(3) (e.g., flood plain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planning to reduce high heat days), should be prioritized; and,
- Lastly, the State Five-Year Infrastructure Plan will take current and future climate change impacts into account in all infrastructure projects.

These Executive Orders are available at:

B-16-12: https://www.gov.ca.gov/news.php?id=17472
B-30-15: https://www.gov.ca.gov/news.php?id=18938
B-32-15: https://www.gov.ca.gov/news.php?id=19046

2.3 Promoting Public Health & Health Equity

Health-promoting policies are found throughout Regional Transportation Plans (RTPs). RTPs often incorporate many or all of the following: safe routes to school programs; complete streets strategies; equity considerations; transportation safety; and policies to promote transit, bicycling and walking. These kinds of transportation-related policies and programs, and others as well, foster more accessible, more livable, and healthier communities. Explicitly identifying their public health benefits can reinforce the role of RTPs in building stronger communities and regions. In addition, local health departments and other public health stakeholders can be valuable partners in RTP development, to increase understanding of the relationship between transportation and health. Their participation can help to maximize the RTP's public health and equity benefits and ensure that the RTP is responsive to community needs.

Appendix K provides a summary of policies, practices, and projects that have been employed by MPOs in their RTPs to promote health and health equity. This is in fulfillment of requirements set forth by AB 441, Gov. Code 14522.3. Appendix K focuses on examples from existing RTPs, in keeping with the legislative intent of AB 441 as expressed in Section 1(a)(d) of the bill: "The Legislature intends that projects, programs, and practices that promote health and health equity in regional transportation plans that are employed by metropolitan planning organizations be shared in the voluntary state guidance on regional transportation planning." It is important to note that Appendix K is not intended to provide a "one size fits all" approach. In light of the diversity of California MPOs, and the varying level of financial resources and technical capabilities to undertake the long range regional transportation planning process, Appendix K outlines direct and indirect effects of transportation projects and policies, provides key terms and definitions, offers examples from both rural and urban regions, and recognizes the importance of a regionally-appropriate approach to addressing health and health equity in the RTP. It is also important to acknowledge that improving the built environment is one of many factors in improving public health. Appendix K is meant to provide examples of how the RTP can contribute to improved public health and is not meant to imply that by implementing these recommendations, all public health needs will be addressed.

The role of transportation in public health is increasingly recognized by health advocates and transportation providers alike. Federal, state, regional, and local transportation agencies have long focused on improving both air quality and safety, which are very important to public health. More recently, the understanding of the relationship of transportation and health has been expanding to include a much broader range of community needs. One fundamental example is the way in which transportation can encourage physical activity, such as walking and biking, often referred to as active transportation. There is a demonstrated relationship between increased physical activity and a wide range of health benefits. If a higher level of investment is made on active transportation, the walk and bike mode shares could be increased, which could help a community to lower its rates of obesity, hypertension, and other chronic diseases. MPOs can play an important role in setting regional priorities and providing access to funding to local jurisdictions for active transportation projects. In addition, they can provide resources and technical assistance to access statewide funding such as the Active Transportation Program. Finally, they can encourage local cities to develop land use patterns that are supportive of walkable and bikeable communities by providing planning funding and including supportive policies or guidance in their SCS.

Another role of the RTP, in addressing public health, is to demonstrate transportation air quality conformity (further described in Sections 2.4 and 5.7), and to set goals and strategies that encourage implementing agencies to make investments that benefit public health in federally designated air quality nonattainment and maintenance areas. Of particular note are strategies that address criteria pollutants, which are scientifically shown to be detrimental to health. Key strategies controlled by local implementing agencies include carpooling, transit, signal synchronization, and other Transportation Demand Management/Transportation System Management (TDM/TSM) improvements. At the federal and state levels, key strategies include vehicle emission and fuel standards, as well as incentive programs to expedite the adoption of clean technologies. These have been shown to be by far the most effective strategies for reducing the public's exposure to harmful pollutants, as well as for reducing GHG emissions.

Transportation is also being seen not as an end in itself, but as a means of providing access to important destinations: access to jobs, education, healthy food, recreation, worship, community activities, healthcare, and more. Improved access to key destinations is especially critical for disadvantaged and underserved communities. The design of the transportation system, in combination with land use and housing decisions, also plays a role in public health. Coordinated planning of transportation and land use can promote public health through the development of livable, walkable, accessible communities. And as nations, states and regions shift away from fossil fuel dependent transportation modes, the benefits of reducing the effects of climate change will also help to reduce the public health risks from climate change effects such as extreme heat, storms, and drought. Transportation and public health providers can help one another to address all of these factors, learning from each other and joining their skills to improve transportation for better health outcomes for everyone.

Improving transportation infrastructure in ways that encourages walking and cycling is one of several effective ways to improve physical activity, decrease traffic collisions, and improve one's health status. But, transportation planning also has a tremendous impact on community health, safety, and neighborhood cohesion. For instance, health-focused transportation plans can help reduce the rate of injuries and fatalities from collisions. Some research suggests that there is a multiplier effect: when streets are designed to safely accommodate walking and biking, more people do so, and as more people walk and bike the rate of collisions actually goes down as pedestrians and bicyclists become more visible to motorists.[3] In addition, more people out walking and biking in a neighborhood has an important public safety benefit, as it means there are more "eyes on the street" to deter criminal activity. Taking this a step further, studies have shown that people who live in neighborhoods with less traffic and higher rates of walking, bicycling, and transit use know more of their neighbors, visit their neighbor's homes more often, and are less fearful of their neighbors.[4] When streets are inhospitable to pedestrians and bicyclists, residents don't feel safe walking or biking to nearby transit and their ability to access regional educational and employment opportunities is hampered. In short, improving traffic safety results in better public health beyond simply reduced injuries and fatalities.

Additional examples of how transportation planning can promote health include:

- Transportation planning can help residents reach jobs, education, social services, and medical care by walking, biking or public transportation in a timely manner.

[3] At the Intersection of Active Transportation and Equity." Safe Routes to School National Partnership. 2015. <http://saferoutespartnership.org/sites/default/files/resource_files/at-the-intersection-of-activetransportation-and-equity.pdf>.

[4] At the Intersection of Active Transportation and Equity." Safe Routes to School National Partnership. 2015. <http://saferoutespartnership.org/sites/default/files/resource_files/at-the-intersection-of-activetransportation-and-equity.pdf>.

- Reducing commute times and increasing public transportation reliability can reduce stress and improve mental health.
- Affordable transportation options enables low income households to invest in savings, education, and healthier food options—all factors that contribute to greater individual and community health.

Planning Practice Examples: Available in Appendix K

2.4 Federal Requirements

Federal requirements for the development of RTPs are directed at the federally designated MPOs. The primary federal requirements regarding RTPs are addressed in the metropolitan transportation planning rules – Title 23 CFR Part 450 and 771 and Title 49 CFR Part 613. These federal regulations incorporating both MAP-21/FAST Act changes were updated by FHWA and FTA and published in the May 27, 2016 Federal Register.

The final guidance is commonly referred to as the Final Rule. In the Final Rule, the metropolitan transportation planning process provides for consideration of the following federal planning factors:

1. Support the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity, and efficiency;
2. Increase the safety of the transportation system for motorized and non-motorized users;
3. Increase the security of the transportation system for motorized and non-motorized users;
4. Increase accessibility and mobility of people and freight;
5. Protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between (regional) transportation improvements and State and local planned growth and economic development patterns;
6. Enhance the integration and connectivity of the transportation system, across and between modes, for people and freight;
7. Promote efficient system management and operation;
8. Emphasize the preservation of the existing transportation system;
9. Improve the resiliency and reliability of the transportation system and reduce or mitigate stormwater impacts of surface transportation; and
10. Enhance travel and tourism.

It is important to note that failure to consider any factor specified in Title 23 CFR 450.306 (b) or (d), shall not be reviewable by any court under Title 23 U.S.C., Title 49 U.S.C. Chapter 53, Subchapter II of Title 5 U.S.C. Chapter 5, or Title 5 U.S.C. Chapter 7 in any matter affecting an RTP, TIP, a project or strategy, or the certification of a metropolitan transportation planning process.

Federal Clean Air Act conformity requirements pursuant to the Amendments of 1990, apply in all MPO nonattainment and maintenance areas. Section 176(c) of the Clean Air Act (CAA), as amended (Title 42 U.S.C. 7506(c), and the related requirements of Title 23 U.S.C. 109(j), “transportation conformity” requirement ensures that federal funding and approval are given to transportation plans, programs and projects that are consistent with the air quality goals established by a State Implementation Plan (SIP). For MPO nonattainment regions, the MPO, FHWA, and FTA are responsible for making the RTP conformity determination. Under the U.S. Department of Transportation (U.S. DOT) Metropolitan Planning Regulations (Title 23 CFR Part 450 and 771 and Title 49 CFR Part 613) and EPA's Transportation Conformity Rule (Title 40 CFR Part 93) requirements, the RTP needs to meet four requirements: 1.) Regional emissions analysis, 2.) Timely implementation of Transportation Control Measures, 3.) Financial constraints analysis, and 4.) Interagency consultation and public involvement. The transportation conformity rule (Title 40 CFR Part 93 Subpart A) sets forth the policy, criteria, and procedures for demonstrating and assuring conformity of transportation activities.

Title VI of the Civil Rights Act of 1964 ensures that all people have equal access to the transportation planning process. It is important that MPOs comply with this federal civil rights requirement during the RTP development process. Title VI states that: all people regardless of their race, sexual orientation or income level, will be included in the decision-making process. Additional information regarding equal access to the transportation planning process is available in Sections 4.2, 4.3, and 4.4.

Requirements (Shalls)
Federal: Title 23 CFR Part 450 and 771; 49 CFR Part 613; Title 40 CFR Part 93; and Title VI of the Civil Rights Act of 1964

2.5 Relationship between the RTP, OWP, FTIP, STIP (RTIP & ITIP), & FSTIP

The key planning documents produced by the MPOs, RTPAs, County Transportation Commissions (CTCs), and Caltrans are:

1. Regional Transportation Plan – Looks out over a 20 plus-year period providing a vision for future demand and transportation investment within the region.

2. Overall Work Program – The OWP lists the transportation planning studies and tasks to be performed by the MPO, RTPA or member agency during that fiscal year. The OWP is also referred to as a Unified Planning Work Program (UPWP) in federal regulations.

Federal Program - MPOs Only:

3. Federal Transportation Improvement Program – The FTIP is a financially constrained four-year program listing all federally funded and regionally significant and non-regionally significant projects in the region.

State Program – RTPAs, County Transportation Commissions (CTCs) and Caltrans:

4. State Transportation Improvement Program – The STIP is a biennial program adopted by the California Transportation Commission. Each STIP covers a five year period and includes projects proposed by regional agencies in their regional transportation improvement programs (RTIPs) and by Caltrans in its interregional transportation improvement program (ITIP).
    a. Regional Transportation Improvement Program – The RTIP is a five year program of projects prepared by the RTPAs and County Transportation Commissions. Each RTIP should be based on the regional transportation plan and a region wide assessment of transportation needs and deficiencies.

b. Interregional Transportation Improvement Program – The ITIP is a five year list of projects that is prepared by Caltrans, in consultation with MPOs and RTPAs. Projects included in the interregional program shall be consistent with the Interregional Transportation Strategic Plan and relevant adopted regional transportation plan(s).

State & Federal Program – MPOs, RTPAs, and Caltrans:

5. State Federal Transportation Improvement Program (FSTIP) - The FSTIP is a constrained four-year prioritized list of regionally significant transportation projects that are proposed for *federal, state and local* funding. The FSTIP is updated every four-years and is developed by Caltrans in coordination with MPOs/RTPAs and approved by the FHWA/FTA. It is consistent with the RTP and it is required as a prerequisite for federal programming of funding.

Key Planning & Programming Documents Produced by MPOs/RTPAs & County Transportation Commissions (CTCs)/Caltrans

	Time/Horizon	*Contents*	*Update Requirements*
RTP	*20+ Years*	*Future Goals, Strategies & Projects*	*Nonattainment MPOs – Every 4 Years Attainment MPOs – Optional Every 5 Years RTPAs – Optional Every 5 Years (State law allows option to change from 5 to 4 years)*
OWP	*1 Year*	*Planning Studies and Tasks*	*Annually*
FTIP (MPOs Only)	*4 Years*	*Transportation Projects*	*At least every 4 Years*
RTIP (RTPAs/CTCs)	*5 Years*	*Transportation Projects*	*Every 2 Years*
ITIP (Caltrans)	*5 Years*	*Transportation Projects*	*Every 2 Years*
FSTIP	*4 years*	*Transportation Projects*	*At least every 4 years*

Requirements (Shalls)
Federal: Title 23 CFR Part 450.326(a) requires MPOs to prepare a transportation improvement program (TIP)
State: California Government Code Sections 65082, 14526, 14527 and 14529 require the preparation of the STIP, RTIPs and ITIP.

2.6 Consistency with Other Planning Documents

It is very important that the RTP be consistent with other plans prepared by local, state, federal agencies and Native American Tribal Governments. Consistency can be described as a balance and reconciliation between different policies, programs, and plans. This consistency will ensure that no conflicts would impact future transportation projects. MPOs depend upon the collaborative process described in Chapter 4 for the numerous plans below to be incorporated or consulted with. MPOs also rely on the aforementioned stakeholders to contribute to RTP development, according to their plans and areas of expertise. While preparing an updated RTP, MPOs should, as appropriate, incorporate or consult such local/regionally prepared documents as:

1. General Plans (especially the Circulation and Housing Elements);
2. Airport Land Use Compatibility Plans;
3. Air quality State Implementation Plans (SIPs);
4. Short- and Long-Range Transit Plans;
5. Habitat Conservation Plans/Natural Community Conservation Plan including an integrated regional mitigation strategy (if applicable);
6. Urban Water Management Plans;
7. Local Coastal Programs (if applicable);
8. Public Agency Trail Plans (if applicable);
9. Local Public Health Plans;
10. Regional Bicycle and Pedestrian Plans
11. Americans with Disabilities Act Transition Plans;
12. Master Plans, Specific Plans;
13. Impact Fee Nexus Plans;
14. Local Capital Improvement Programs;
15. Mitigation Monitoring Programs;
16. Countywide Long-Range Transportation Plans (if applicable); and,
17. Tribal Transportation Plans.

MPOs also should consult State/Federal prepared transportation planning documents such as:

1. California Transportation Plan;
2. California Rail Plan;
3. Interregional Transportation Strategic Plan;
4. Transportation Concept Reports;
5. District System Management Plans;
6. California Aviation System Plan;
7. Goods Movement Action Plan;
8. Sustainable Freight Action Plan;
9. California Freight Mobility Plan;
10. Strategic Highway Safety Plan;
11. California Strategic Highway Safety Plan, and Corridor System Management Plans; and,
12. Federal Lands Management Plans.

MPOs should also consult State prepared environmental planning documents such as:

1. Draft Environmental Goals and Policy Report;
2. State Wildlife Action Plan;
3. Vulnerability Assessments;
4. California Climate Adaptation Planning Guide;
5. Safeguarding California Plan; and,
6. Safeguarding California: Implementation Action Plans.

Federal regulations require MPOs to consult with resource agencies during the development of the RTP. This consultation should include the development of regional mitigation and identification of key documents prepared by those resource agencies that may impact future transportation plans or projects (See Chapter 5 RTP Environmental Considerations). MPO staff should make a concerted effort to ensure any actions in the RTP do not conflict with conservation strategies and goals of the resource agencies. Chapter 4 provides the federal requirements for resource agency consultation.

2.7 Coordination with Other Planning Processes

RTPs are prepared within the context of many other planning processes conducted by federal, tribal, state, regional and local agencies. This section provides background information, along with planning practice examples in Appendix L, for how MPOs can integrate the planning processes associated with the Smart Mobility Framework, Complete Streets, Context Sensitive Solutions, Planning and Environmental Linkages, and system planning documents specifically Transportation Concept Reports (TCRs), Corridor System Management Plans (CSMPs), District System Management Plans (DSMPs), the Interregional Transportation Strategic Plan (ITSP), and other transportation plans into development of the RTP. These initiatives and implementation tools work toward achieving the California Transportation Plan goals. They also align with the principles of the federal Partnership for Sustainable Communities. As the RTP is bound to fiscal constraints, the strategies, actions, and improvements described in this section are intended to provide guidance and should be considered to the maximum extent feasible in the development of the RTP.

Smart Mobility Framework

The Caltrans Smart Mobility Framework[5] (SMF) is a key strategic tool for integrating transportation with land-use, to develop healthy and livable communities through multi-modal travel options, reliable travel times, and safety for all users of the transportation system. The SMF supports the goals of climate change intervention and energy security while supporting the goals of the CTP, and the federal Livability Principles for Sustainable Communities[6].

The SMF integrates transportation and land use by applying principles of location efficiency, complete streets, connected and integrated multimodal networks, housing near destinations for all income levels, and protection of parks and open space. This framework is designed to help keep California communities livable and supportive of healthy life styles while allowing each to maintain its unique community identify.

The CTP reflects the understanding that a full set of transportation strategies includes initiatives to address land use and development. The SMF provides a framework to plan for the challenges of increased demands on an aging transportation system, climate change, and current and future generations' demands for multi-modal transportation choices.

In addressing the need for access to destinations for people and goods, the SMF provides guidance to incorporate new concepts and tools alongside well-established ones. It calls for participation and partnership by agencies at all levels of government, as well as private sector and community involvement.

[5] Smart Mobility Framework: http://www.dot.ca.gov/hq/tpp/offices/ocp/smf.html
[6] Livability Principles for Sustainable Communities:
https://www.sustainablecommunities.gov/mission/livability-principles

One method for supporting the implementation of SMF is the SMF Learning Network, a series of educational forums and webinars designed to extend the reach of SMF to internal and external partners. The networks serves as an opportunity to share examples of Smart Mobility applications and strengthen strategic partnerships between Caltrans and other agencies. The information sharing and feedback that results from these forums will shape the future integration of Smart Mobility principles into Caltrans processes.

Complete Streets

The term "Complete Streets" refers to a transportation network that is planned, designed, constructed, operated and maintained to provide safe mobility for all users, including bicyclists, pedestrians, transit and rail riders, commercial vehicles and motorists appropriate to the function and context of the facility.

The California Complete Streets Act of 2008 (AB 1358) ensures that the general plans of California cities and counties meet the needs of all users, including pedestrians, transit, bicyclists, the elderly, motorists, movers of commercial goods, and the disabled. AB 1358 requires cities and counties to identify how the jurisdiction will provide accommodation of all users of roadways during the revision of the circulation element of their general plan. The Governor's Office of Planning and Research amended guidelines for the development of the circulation element to accommodate all users. A comprehensive update of the General Plan Guidelines in 2016 includes guidance on how cities and counties can modify the circulation element to plan for a balanced, integrated, multimodal transportation network that meets the needs of all users of the streets, roads, and highways for safe and convenient travel in a manner that is suitable to the rural, suburban, or urban context of the general plan.

The benefits of Complete Streets can include: Safety; Health; GHG Emission Reduction; and Economic Development and Cost Savings.

Multimodal transportation networks, using complete streets planning practice examples, can lead to safer travel for all roadway users. Designing streets and travel routes that consider safe travel for all modes can reduce the occurrence and severity of vehicular collisions with pedestrians and bicyclists. Streets and other transportation facility design considerations that accommodate a variety of modes and users abilities can contribute to a safer environment that makes all modes of travel more appealing.

Planning for Complete Streets will enable local governments to provide healthier lives by encouraging physical activity. Public health studies have demonstrated that people are more likely to walk in their neighborhood if it has sidewalks. Also, studies have found that people with safe walking environments within a 10 minute walking radius are more likely to meet recommended physical activity levels. The integration of sidewalks, bike lanes, transit and rail amenities, and safe crossings into initial design of projects is more cost-effective than making costly retrofits later. Complete Streets is also a key strategy in the reduction of GHG emissions. Providing community residents with an option that gets them out of their cars is a proven strategy for improving communities, reducing air pollution, and generating local business. Similarly, Complete Streets consider Safe Routes to School, a public health strategy connecting communities to schools, includes but is not limited to child safety, reducing traffic congestion, sidewalks, crosswalks and bicycle lanes.

Creating integrated, multimodal transportation networks can improve economic conditions for both business owners and residents. A network of Complete Streets can be safer and more appealing to residents and visitors, which can benefit retail and commercial development. Multimodal transportation networks can improve conditions for existing businesses by helping revitalize an area attracting new economic activity. Equally important to sustain economic vitality are commercial vehicles and their operational needs. Vibrant urban environments cannot function without commercial vehicles delivering goods that sustain the economic activities that take place.

Integrating the needs of all users can also be cost-effective by reducing public and private costs. Accommodating all modes reduces the need for larger infrastructure projects, such as additional vehicle parking and road widening, which can be more costly than Complete Streets retrofits.

While AB 1358 provides no statutory requirement for MPOs, integration of Complete Streets policies support local agencies' requirements to address Complete Streets in circulation elements of their general plans.

MPOs should also integrate Complete Streets policies into their RTPs, not only as a means to develop a SCS, but also to identify the financial resources necessary to accommodate such policies, and should consider accelerating programming for projects that retrofit existing roads to provide safe and convenient travel by all users.

MPOs should encourage all jurisdictions and agencies within the region to ensure that their circulation elements and street and road standards, including planning, design, construction, operations, and maintenance procedures address the needs of all users. Streets, roads and highways should also be safe for convenient travel in a manner that is suitable within the context of Complete Streets. To the maximum extent feasible, MPO funded transportation system projects, corresponding Complete Street facilities, and improvements should meet the needs in project areas to maximize connectivity, convenience and safety for all users.

Along the shoreline of coastal counties, one element of the Complete Streets program should be the California Coastal Trail (CCT). For additional information regarding the CCT see Section 6.11.

Recommendations (Shoulds)
Federal: FAST Act Section 1442. Safety for users, encourages each State and Metropolitan Planning Organization to adopt standards for the design of Federal surface transportation projects that provide for the safe and adequate accommodation (as determined by the State) of all users of the surface transportation network, including motorized and non-motorized users, in all phases of project planning development and operation.

Investing in development of Complete Streets Policy Guides that assist member agencies in the adoption of Complete Streets policy for their jurisdictions. A policy guide can function as a template. It can provide flexibility and be revised to accommodate individual agency's needs.

Recommendations (Shoulds)
State: According to Government Code 65040.2 Section (2)(h)(h), it is the intent of the Legislature to require in the development of the circulation element of a local government's general plan that the circulation of users of streets, roads, and highways be accommodated in a manner suitable for the respective setting in rural, suburban, and urban contexts, and that users

of streets, roads, and highways include bicyclists, children, persons with disabilities, motorists, movers of commercial goods, pedestrians, public transportation, and seniors.

Planning Practice Examples: Available in Appendix L

Context Sensitive Solutions

Context Sensitive Solutions is the process of engaging stakeholders in addressing transportation goals with the community, economic, social and environmental context. It is an inclusive approach used during planning, designing, constructing, maintaining, and operating the transportation system. It integrates and balances community and stakeholder values with transportation safety, maintenance, and performance goals. Context sensitive solutions are reached through a collaborative, interdisciplinary process involving all stakeholders and requires careful, imaginative, and early planning, and continuous stakeholder involvement.

Goals, issues, and values of California Tribal Governments and tribal communities, if applicable, should also be defined identified and addressed through outreach, collaboration and consultation. This would assist with identification and protection of cultural resources, historic sites, and environmental justice issues as well as, transportation needs and strategies. The evolution of economic development for some California Tribes has created increased demand for improved transportation infrastructure (i.e. roads, traffic control, access, etc.) and increased need for collaboration and consensus building with these stakeholders to address these new demands.

In towns and cities across California, the State highway may also function as a community street. These communities may desire that their main street be an economic, social, and cultural asset as well as provide for the safe and efficient movement of people and goods. Addressing all these needs throughout the planning and development process will help ensure that transportation solutions meet more than transportation objectives.

More information is available at the following links:
http://www.dot.ca.gov/hq/LandArch/16_livability/css/index.htm

http://www.contextsensitivesolutions.org/

Planning and Environmental Linkages

Federal statute and regulations outline an optional process for incorporating transportation planning documents or other source material directly or by reference into subsequent environmental documents that are prepared in compliance with the National Environmental Policy Act (NEPA). Appendix A to 23 CFR §450 provides additional information to explain the linkage between the transportation planning and project development/NEPA processes; it supports congressional intent that statewide and metropolitan transportation planning should be the foundation for highway and transit project decisions. The results or decisions of transportation planning studies may be used as part of the overall project development process consistent with NEPA and associated implementing regulations. Federal law specifically states that this does not subject transportation plans and programs to NEPA.

Publicly available documents or other source material produced by, or in support of the transportation planning process, may be incorporated directly or by reference into subsequent

NEPA documents in accordance with federal regulations. If an MPO and its project delivery partner(s) decide to take advantage of this opportunity to streamline and simplify the overall project delivery process, they should coordinate regarding the conditions that must be met during regional transportation planning. Most of the conditions, though perhaps not all, are routinely met during preparation of the RTP.

Additional information to further explain the linkages between the transportation and project development/NEPA processes is provided in Section 5.3 and Appendix D.

NCHRP Report 541, Consideration of Environmental Factors in Transportation Systems Planning, is an additional resource, at:
http://environment.transportation.org/pdf/RT_1_RM_7.pdf.

The FHWA's Environmental Review Toolkit, Program Overview for Planning and Environmental Linkages, also provides information, available at:
https://www.environment.fhwa.dot.gov/integ/index.asp

Recommendations (Shoulds)
Federal: Title 23 U.S.C. 168 Integration of planning and environmental review; Title 23 CFR 450.318 Transportation planning studies and project development; Appendix A of 23 CFR Part 450 – Linking the Transportation Planning and NEPA Processes (Appendix D of this document).

System Planning Documents

District System Management Plans (DSMPs)

The DSMP is a long-range, 20-25 year, policy planning document that describes how the District envisions the transportation system will be maintained, preserved, managed, operated, and developed within the planning horizon. It provides a vehicle for the development of multimodal, intermodal, and multijurisdictional system strategies. These strategies are developed in partnership with related Caltrans functional units, Divisions, and Districts, as well as external partners, such as MPOs, cities, counties, tribal governments, other partner agencies, and the public. The DSMP plays a major role in guiding the development of both the Transportation Concept Reports (TCRs) and the Corridor System Management Plans (CSMPs).

Interregional Transportation Strategic Plan (ITSP)

The ITSP is a Caltrans planning document that provides guidance for the identification and prioritization of interregional transportation projects identified on the State's Interregional Transportation System. The ITSP provides an overview of the interregional transportation system, including identification of the major Strategic Interregional Corridors and Priority Interregional Facilities, which are the corridors and transportation facilities that have the greatest impact on interregional travel. Concepts have been created for each Strategic Interregional Corridor that will be used by public agencies to plan and program transportation improvements.

Transportation Concept Reports (TCRs)

Caltrans prepares TCRs, long-range transportation planning documents, that guide the development of California's State Highway System (SHS) as required by Government Code

65086, Title 23 CFR Part 450 Subpart B, and the transportation needs of the public, stakeholders, and SHS users. The comprehensive planning document for each highway route and the corresponding transportation corridor provides a focused look at the existing conditions and performance of the route, future transportation needs and demands, integrates and aligns with the State Wildlife Action Plan (SWAP), habitat conservation plans and regional green-prints (where applicable), and articulates improvements necessary to address those needs within the context of the communities and rural areas the highways traverse. Caltrans meets this need through the development of the TCRs. Each Caltrans District is delegated the responsibility to create a TCR for the SHS routes within their respective district boundaries.

Corridor System Management Planning (CSMP)

A CSMP is a comprehensive, integrated management plan for optimizing efficient, effective multimodal system performance within a transportation corridor. A CSMP includes all travel modes in a defined corridor - highways and freeways, parallel and connecting roadways, public transit (bus, bus rapid transit, light rail, intercity rail) and bikeways and pedestrian facilities. A CSMP results in a listing and phasing plan of recommended operational improvements, Intelligent Transportation System (ITS) strategies, and system expansion projects to preserve or improve performance measures within the corridor. CSMPs are developed and implemented by Caltrans in partnership with regional and local transportation agencies and other partners.

A CSMP incorporates both capital and operational improvements and is developed through the following steps:

1) Corridor limits defined.
2) Corridor team established.
3) Performance objectives defined; preliminary assessment performed.
4) Comprehensive performance assessment performed; causation of performance issues identified.
5) Simulate and test improvement scenarios and alternatives for most effective mix of projects, strategies and actions.
6) Alternatives selected and CSMP prepared. The Plan should be accepted or adopted by Caltrans, the MPO/RTPA, cities and counties as a guide for corridor management.

Completed CSMPs and other Caltrans system planning documents can be viewed at: http://www.dot.ca.gov/hq/tpp/corridor-mobility/

With regard to corridor system planning, the RTP should:

- Include by corridor all strategies, actions and improvements identified in system planning documents taking into consideration statewide and regional objectives which can include but are not limited to: multi-modal mobility, accessibility, environmental protection, and GHG reduction.
- Describe how the corridor will be managed across jurisdictions and modes to preserve corridor productivity based upon performance measurement.
- Include a reasonable time-line for each corridor to determine the need for each region to consider multiple objectives regarding corridor mobility.
- Describe roles and relationships among units of local government, modal agencies, Caltrans and related agencies for managing the corridor for highest mobility benefits and for measuring and evaluating performance.

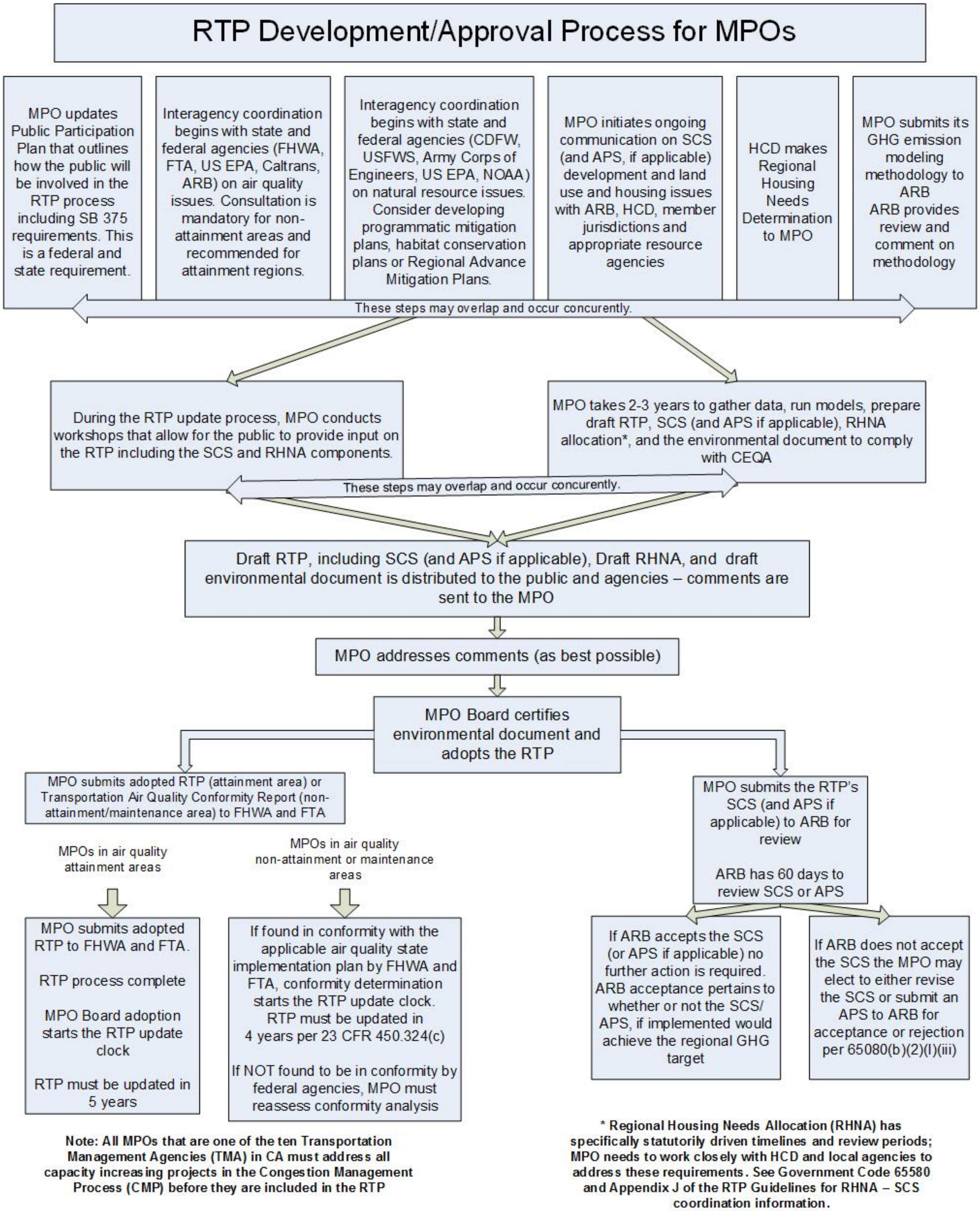
2.8 RTP Development Sequencing Process

Following the passage of SB 375 in 2008, MPOs will need to continue to coordinate with the ARB and HCD. MPOs are encouraged to continue to communicate with ARB as early in the RTP development as possible to obtain input. ARB must review the SCS and possibly an APS after the documents are prepared. Communication between the MPO and HCD should also take place as early in the RTP process as possible to ensure the RHNA is coordinated with the development of the SCS. SB 375 amended the law to require regional planning agencies to estimate the RTP adoption date and provide HCD a notice at least 12 months before the estimated adoption date.

In summary, early communication and coordination with all appropriate levels of government, elected officials and the public is very important to avoid delays that may impede the final federal air quality conformity determination, the determination by ARB whether the SCS or APS, if implemented, would achieve the regional GHG emission reduction target, or successful coordination of the RHNA with the SCS.

The following flowchart entitled: “RTP Development/Approval Process for MPOs” was prepared to help summarize the overall steps that MPOs must undertake to ultimately adopt an RTP with a transportation air quality conformity report that has been found in conformity with the applicable air quality state implementation plan (for nonattainment and maintenance regions) and that has received acceptance by ARB that the SCS/APS, if implemented, would achieve the region’s GHG emissions reduction target. The process outlined in this flowchart is very complex and may take several years from RTP inception to RTP adoption, SCS/APS acceptance/rejection, and federal conformity determination.

Requirements (Shalls)
Federal: Title 23 CFR Part 450
State: Government Code Section 65080 and 65588(e)(5)



RTP Development/Approval Process for MPOs
MPO updates Public Participation Plan that outlines how the public will be involved in the RTP process including SB 375 requirements. This is a federal and state requirement.
Interagency coordination begins with state and federal agencies (FHWA, FTA, US EPA, Caltrans, ARB) on air quality issues. Consultation is mandatory for non-attainment areas and recommended for attainment regions.
Interagency coordination begins with state and federal agencies (CDFW, USFWS, Army Corps of Engineers, US EPA, NOAA) on natural resource issues. Consider developing programmatic mitigation plans, habitat conservation plans or Regional Advance Mitigation Plans.
MPO initiates ongoing communication on SCS (and APS, if applicable) development and land use and housing issues with ARB, HCD, member jurisdictions and appropriate resource agencies
HCD makes Regional Housing Needs Determination to MPO
MPO submits its GHG emission modeling methodology to ARB
ARB provides review and comment on methodology
These steps may overlap and occur concurently.
During the RTP update process, MPO conducts workshops that allow for the public to provide input on the RTP including the SCS and RHNA components.
MPO takes 2-3 years to gather data, run models, prepare draft RTP, SCS (and APS if applicable), RHNA allocation*, and the environmental document to comply with CEQA
These steps may overlap and occur concurently.
Draft RTP, including SCS (and APS if applicable), Draft RHNA, and draft environmental document is distributed to the public and agencies – comments are sent to the MPO
MPO addresses comments (as best possible)
MPO Board certifies environmental document and adopts the RTP
MPO submits adopted RTP (attainment area) or Transportation Air Quality Conformity Report (non-attainment/maintenance area) to FHWA and FTA
MPOs in air quality attainment areas
MPOs in air quality non-attainment or maintenance areas
MPO submits adopted RTP to FHWA and FTA.
RTP process complete
MPO Board adoption starts the RTP update clock
RTP must be updated in 5 years
If found in conformity with the applicable air quality state implementation plan by FHWA and FTA, conformity determination starts the RTP update clock.
RTP must be updated in 4 years per 23 CFR 450.324(c)
If NOT found to be in conformity by federal agencies, MPO must reassess conformity analysis
MPO submits the RTP's SCS (and APS if applicable) to ARB for review
ARB has 60 days to review SCS or APS
If ARB accepts the SCS (or APS if applicable) no further action is required. ARB acceptance pertains to whether or not the SCS/APS, if implemented would achieve the regional GHG target
If ARB does not accept the SCS the MPO may elect to either revise the SCS or submit an APS to ARB for acceptance or rejection per 65080(b)(2)(I)(iii)
Note: All MPOs that are one of the ten Transportation Management Agencies (TMA) in CA must address all capacity increasing projects in the Congestion Management Process (CMP) before they are included in the RTP
* Regional Housing Needs Allocation (RHNA) has specifically statutorily driven timelines and review periods; MPO needs to work closely with HCD and local agencies to address these requirements. See Government Code 65580 and Appendix J of the RTP Guidelines for RHNA – SCS coordination information.

2.9 Adoption - Update Cycles & Amendments

Regional transportation planning is a dynamic process requiring continuous monitoring and periodic updating. Updating an RTP ensures the MPOs planning process is valid and consistent with current and forecasted transportation and land use conditions and trends for at least a 20-year planning horizon.

MPOs may revise the transportation plan at any time using the procedures in this section without a requirement to extend the horizon year. Regional planning agencies should consult with local governments well in advance of adopting an RTP to ensure an RTP adoption date facilitates alignment of the RTP schedule, RHNA schedule and planning period, and local government housing element update schedule and planning period, pursuant to SB 375 amendments. The transportation plan (and any revisions or amendments) shall be approved by the MPO's Board and submitted for informational purposes to the CTC and Caltrans. Copies of any revised or amended transportation plans must be provided to the FHWA and the FTA.

California state law, (Government Code Section 65080(d)) mirrors the federal update requirement and states that nonattainment MPOs must update their RTPs at least every four years and attainment MPOs at least every five years. Title 23 CFR Part 450.322(a) states that in nonattainment and maintenance areas, the effective date of the RTP shall be the date of a conformity determination issued by FHWA and FTA. In attainment areas, the effective date of the RTP shall be its date of adoption by the MPO. An MPO that is required to adopt a RTP not less than every five years, may elect to adopt the plan not less than every four years in order that their member cities and counties can revise their housing elements every 8 years pursuant to Government Code Sections 65080 (b)(2)(M) and 65588(b).

Failure of an MPO to adhere to the State and Federal required update period could result in the FHWA not approving the region's FTIP. Failure of an MPO to adhere to the required update period could result in a lack of state and federal funding as projects that are programmed for state or federal funding in the STIP and FTIP must be included in the approved RTP.

RTPs can be amended or modified. The U.S. DOT identified two types of revision methods for an RTP (1) A major revision that is an "amendment" and, (2) A minor revision that is an "administrative modification." The definitions in Title 23 CFR Part 450.104 clarify major and minor amendments to RTPs. It is recommended that MPOs coordinate with Caltrans district regional planners on reviewing, commenting and at times facilitating the determination of what constitutes an RTP Amendment or Administrative modification.

RTP Amendment (major)

RTPs must be amended whenever a plan revision takes place such as the addition or deletion of a project or a major change in project scope, cost and schedule. Other potential triggers for an RTP Amendment could include changing programmed project phases or any major change in design concept or design scope (e.g. changing project termini or the number of through traffic lanes). Amendments require public review for possible comments, demonstration of fiscal constraint and conformity determination (for MPOs located in nonattainment and maintenance areas).

RTP Administrative Modification (minor)

Federal regulations define Administrative Modification as a minor revision to an RTP that includes minor changes to project/project phase costs, minor changes to funding sources of previously included projects, and other minor changes to projects/project phase initiation dates.

An RTP administrative modification is much more flexible and open to wide interpretation. An administrative modification is a revision that does not require public review and comment, re-demonstration of fiscal constraint, or a conformity determination (in nonattainment and maintenance areas).

Re-Adopting Existing RTPs

Re-adopting the existing RTP is an option if no significant factors have occurred within the region that would impact the existing RTP. However, this option would require close evaluation of the current status of the RTPs fiscal constraint, conformity determination and any changes to the project scope, cost and schedule of the RTPs. Re-adopting an RTP could mean that no new projects are presented in the document, nor will there be new projects in the current update cycle of the RTP.

Conformity Considerations

When an MPO Board prepares an RTP amendment or update, they also need to be aware that a conformity determination may need to be conducted, depending on the type of changes, modifications or amendments. An amendment that makes any of the following changes to the RTP would require a new conformity determination for the RTP:

1) The amendment adds or deletes a non-exempt project;
2) The amendment significantly changes the design concept or scope of a regionally significant project; or
3) The amendment changes the implementation year such that it affects a transportation conformity analysis year.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.324(a) and (c), mandatory RTP update cycles for MPOs.

2.10 RTP Checklist

The RTP Checklist is contained in Appendix C of this document. The purpose of the RTP Checklist is to establish a minimum standard for developing the RTP. The checklist of transportation planning requirements has been updated in order to conform to federal and state RTP requirements.

MPOs should include the page numbers indicating where the Checklist items are addressed in the region's RTP. This requirement of identifying page numbers will assist the general public, federal, state and local agencies to locate the information contained in the RTP.

The checklist should be completed by the MPO/RTPA and submitted to the CTC and Caltrans along with the draft and final RTP. This checklist is available electronically from Caltrans planning staff. Each MPO is encouraged to complete the checklist electronically. Following its completion, the MPO Executive Director (or designated representative) must sign the checklist to indicate that the information is complete and correct.

Requirements (Shalls)
Federal: None
State: Pursuant to California Government Code Section 14032(a), which authorizes the CTC to request an evaluation of all RTPs statewide to be conducted by Caltrans. All MPOs are required to submit an RTP Checklist with their **Draft** and **Final** RTP when the document is submitted to Caltrans and the CTC.

Chapter 3

RTP Analysis and Modeling

(MPOs Only)

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RTP ANALYSIS & MODELING

3.0 Introduction

The purpose of this guidance is to provide MPOs clear and relevant travel development model development (TDM) direction for supporting RTP analysis, determine federal air quality conformity, and for SB 375 SCS development.

The 2017 RTP guidelines builds upon the 2010 guidelines, 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. The guidelines also links to the most recent and relevant "living documents" such as the Recommendations of the Regional Targets Advisory Committee (RTAC) Pursuant to SB 375, the Description of Methodology for CARB Staff Review of GHG Reductions from SCS Pursuant to SB 375, and to input received from various agencies.

Organization of this Chapter

- Sections 3.0 to 3.4 - Provides the background and context of regional transportation planning analysis as well as general descriptions of terminology, technical and policies tool, and planning practice examples.
- Section 3.5 – Lists federal and state statutory or regulatory requirements and recommendations that MPO Modeling practitioners need to implement.

Federal/State Requirements, Recommendations, and Planning Practice Example Terminology

This chapter follows the convention for "Shalls," "Shoulds," and "Planning Practice Examples" as defined in Section 1.0 of this document.

"Shalls": reflect a federal or state statutory or regulatory requirement and are used with a statutory or regulatory citation.

"Shoulds" reflect a federal or state permissive, optional, or recommended statutory reference such as "may" or "should" and are used with a statutory or regulatory citation.

"Planning Practice Examples": reflect federal/state guidelines, the state of the practices, and good modeling practices. They are not federal or state statutory or regulatory requirements or recommendations. Where Chapter 3 reflects "planning practice examples," the words "encouraged to," "consider," and "can" are used.

3.1 Modeling in the RTP Development Process Transportation & Land Use Models

Transportation planners and engineers utilize analytical tools to assist in the policy formation and decision-making process during the regional transportation planning process.

Policy Tools:

- Improve the decision-making process by assisting the public and decision-makers in evaluating and identifying strategies that best address the transportation needs of their jurisdiction.

- Used to present market strategies to the public/stakeholders. Some models such as Geographic Information Systems (GIS) have excellent graphical and animation displays that can show “what if” scenarios.

Technical Tools:

- Provide a clear explanation of the modeling and analytical techniques applied in assessing the implications of the land use scenarios or other alternates studied.
- Demonstrate how various policy assumptions impact the forecast results. For example, they provide estimates of the elasticities and cross-elasticities of demand for various modes of travel with respect to critical variables such as access time, travel time, reliability, safety, and cost.
- Assist with the evaluation and prioritization of planning and operational alternatives.
- Assist in the operation and management of existing roadway capacity. Some models provide optimization capabilities, recommending the best design or control strategies to maximize the performance of a transportation facility.

3.2 Requirements for RTP Analysis

Federal legislation requires each MPO to develop an RTP as part of its transportation planning process [23 U.S.C. 134(g) and 49 U.S.C.. 5303(f)]. The plan is required to cover a minimum 20-year horizon, include long and short-range strategies and actions, and describe the ways the region intends to invest in the transportation system (23 CFR §450.322)*.*

State law aligns with federal law and requires each MPOs to prepare a SCS subject to the requirements of 23 CFR §450 and 40 CFR §93, including the requirements to utilize the most recent planning assumptions considering local general plans and other factors (Gov. Code, § 65080(b)(2)(B)).

Travel Demand Models (TDM)

Transportation planners and engineers utilize TDMs to comply with federal and state requirements identified (see Section 3.5), for evaluating alternative strategies as part of an RTP, and to quantify GHG emission reductions associated with SCSs *(See Chapter 6, Regional GHG Emissions Requirements and Considerations in the RTP).*

A TDM utilizes a series of mathematical equations that forecast travel behavior and transportation service demand in a given region. The inputs include but are not limited to population, employment, land use, and the transportation network. The outputs of a TDM are used to assist decision-makers in developing policies and strategies, to inform the public, and for the National Environmental Protection Act (NEPA) and the California Environmental Quality Act (CEQA) analysis. For additional guidance see the latest CARB, Methodologies for Review of GHG Reduction for SCSs Pursuant to SB 375 Document.

California Statewide Travel Demand Model (CSTDM)

Interregional travel is the sum of the following:

1. Trips beginning outside a given MPO’s boundary and ending within it (X-I trip)
2. Trips beginning inside a given MPO’s boundary and ending outside it (I-X trip)
3. Trips beginning outside a given MPO’s boundary, traveling across some portion of the region and ending outside the boundary (X-X trip)

For MPOs to account for the emissions from interregional travel and share responsibly for reducing those emissions with bordering regions, it is critical that they have the ability to accurately capture VMT associated with interregional travel trips. The CSTDM is used to forecast interregional trips and other travel types. MPOs can use this model to assist in capturing interregional VMT and as a point of reference in instances where adjacent MPO models produce dissimilar interregional volumes. Regional transportation planning agencies can use this data if they do not have access to a TDM.

Close collaboration is urged between bordering MPOs and Caltrans in developing interregional trip estimates. In those instances where MPO models produce dissimilar interregional volumes, the CSTDM may act as a point of reference that the MPO regional models should reasonably consider. Caltrans can act as the facilitator in these situations to help reach consensus. *(For more information see, http://www.dot.ca.gov/hq/tpp/offices/omsp/statewide_modeling/cstdm.html)*

Visualization Techniques & Sketch Modeling of Scenarios

Pursuant to 23 CFR 450.316(a)(1)(iii) MPOs are required to employing visualization techniques to describe regional transportation plans and TIPs. Examples include GIS-based information, maps, charts, and other visual aids that are useable and understandable by the public. Furthermore, MPOs are required under California Government Code 65080(b)(2)(F)(iii) to the extent practical use urban simulation computer modeling to create visual representations of the SCS or APS during their public workshops. *See Chapter 6, Regional GHG Emissions Requirements and Consideration in the RTP, and Visualization and Mapping for additional information related to SCS development.*

EMFAC Model

California Air Resources Board (ARB) developed the EMFAC emissions model to assess emissions from on-road vehicles including cars, trucks, and buses, to support CARB's regulatory and air quality planning, and by MPOs to meet the federal Clean Air Act (CAA) requirements. The most recent approved current version located in the Federal Register. The mobile source emissions inventory is CARB's tool for assessing vehicle population, activity, and emissions from mobile sources. These inventories are constantly being, updated to support the latest air quality plans and regulations.
(http://www.arb.ca.gov/msei/categories.htm#onroad_motor_vehicles)

3.3 TDM Quality Control & Consistency

Regional travel demand modeling consistency and quality control are essential for creating confidence in modeling results.

Model Inputs & Assumptions

Model inputs and assumptions are a necessary part of running a TDM. Although it is not required under the transportation conformity rule, the United States Environmental Protection Agency (EPA) and the United States Department of Transportation (U.S. DOT) encourage MPOs in nonattainment and maintenance areas to review and update their planning assumptions (especially population, employment, and vehicle registration) at least every five years or to justify in the conformity determination why the planning assumptions have not been updated.

Data

Modeling results are only as good as the data that goes into them. If travel survey samples are limited to a given region, other available sources of data including the National Household Travel Survey, the American Community Survey, and trip rates associated with a region that is similar in size (such as demographic and socioeconomic characteristics) can be used. For statewide consistency, and if feasible, MPOs are encouraged to use common data definitions and sources. As new technology and new data sources become available (e.g. "big data"), MPOs are encouraged to consider ways to incorporate them into their analysis and modeling practices.

For additional guidance, see the latest ARB, Methodologies for Review of GHG Reduction for SCSs Pursuant to SB 375.

Model Calibration & Validation

Calibration is used to adjust the model parameters until the model matches observed regional travel patterns and demand. Validation involves testing the model's predictive capabilities (ability to replicate observed conditions (within reason)) before it is used to produce forecasts. The outputs and observed or empirical travel data are compared, and the model's parameters are adjusted until the outputs fall within an acceptable range of error. Static validation tests compare the model's base year traffic volume estimates to traffic counts using statistical measures and threshold criteria.

Because emission estimates are sensitive to vehicle speed changes, the U.S. EPA and U.S. DOT suggest that areas using network-based travel models compare the speeds estimated in the validation year with speeds empirically observed during the peak and off-peak periods. The significant sensitivity of emissions to highway speeds emphasizes the need to monitor and maintain the ability of the transportation model to provide accurate speed estimates.[7]

The U.S. EPA and U.S. DOT also suggest that every component of a model, as well as the entire model system, validated.[8] Nonattainment and maintenance areas using network-based travel models are encouraged by the U.S. EPA and U.S. DOT to establish criteria for validating the congestion speeds predicted by the transportation model with the observed speed data.

Static Validation Criteria

- Volume-to-count ratio – is computed by dividing the volume assigned by the model and the actual traffic count for individual roadways model-wide. It provides a general context for the relationship (i.e., high or low) between model volumes and counts.
- Percent of links with volume-to-count within Caltrans deviation allowance – the deviation is the difference between the model volume and the actual count divided by the actual count. The Caltrans deviation thresholds recognize that allowances shrink as the count increases (i.e., lower tolerance for differences between the model volume estimates and counts).
- Correlation coefficient – estimates the correlation (strength and direction of the linear relationship) between the actual traffic counts and the estimated traffic volumes from the model.
- Percent root mean square error (RMSE) – is the square root of the model volume minus the actual count squared divided by the number of counts. It is a measure similar to standard deviation in that it assesses the accuracy of the entire model.

[7] Guidance for the Use of Latest Planning Assumptions in Transportation Conformity Determinations, Revision to January 18, 2001 Guidance Memorandum, EAP, December 2008, page 9

[8] Travel Model Validation and Reasonableness Checking Manual second edition, page 1-6, September 24, 2010

MPOs are encouraged to meet the recommended static validation and transit assignment validation thresholds listed below. Where a model does not meet the thresholds, the MPO is encouraged to clearly document impediments.

Recommended Static Validation Thresholds

Validation Metric	Thresholds
Percent of links with volume-to-count ratios within Caltrans deviation allowance	At Least 75%
Correlation Coefficient	At Least 0.88
Percent Root Mean Squared Error (RMSE)	Below 40%

The table below specifies possible transit assignment validation criteria.

Recommended Transit Assignment Validation Thresholds

Validation Metric	Thresholds
Difference between actual counts and model results for a given year by route group (e.g. local bus, express bus, etc.)	+/- 20%
Difference between actual counts and model results for a given year by Transit Mode (e.g., light rail, bus, etc.)	+/- 10%

For additional guidance, see the FHWA's, The Travel Model Validation and Reasonableness Checking Manual, ‖ Second Edition, September 2010, and the latest ARB, Methodologies for Review of GHG Reduction for SCSs Pursuant to SB 375 Document.

Model Sensitivity Analysis

Sensitivity testing is the application of the model and the model set using alternative input data or assumptions. Sensitivity analysis of individual model components can include the estimation of the elasticities and cross-elasticities of model coefficients. Sensitivity analysis can also be applied to the entire set of models using alternative assumptions regarding the demographic and socioeconomic input data, or changes in transportation system to determine if the model results are plausible and reasonable[9].

Sensitivity testing includes both disaggregate and aggregate checks. Disaggregate checks, such as the determination of model elasticities, are performed during model estimation. Aggregate sensitivity testing results from temporal validation. During sensitivity testing, reasonableness and logic checks can be performed. These checks also include the comparison of estimated (or calibrated) model parameters against those estimated in other regions with similar models. "Reasonableness and logic checks can also include "components of change" analyses and an evaluation of whether or not the models "tell a coherent story" as recommended by the FTA for New Starts analysis." *(Travel Model Validation and Reasonableness Checking Manual Second Edition, September 2010, 1-7)*

The output of sensitivity tests can include total VMT, mode share, the number of the person and vehicle trips by purpose, average trip length by mode, and transit boardings. Each MPO is encouraged to improve model sensitivity and accuracy related to measuring GHG emissions associated with both land use or transportation network decisions. However, the application of these quality control criteria will vary based on the size of the MPO, severity of non-attainment status, the sophistication of transit system, the degree of model sophistication, and the presence of pricing variables, among other characteristics.

[9] *Travel Model Validation and Reasonableness Checking Manual Second Edition, September 2010,* 1-5

The following inputs can be changed as part of sensitivity tests:

Highway Network: Add or delete lanes to a link, change link speeds, and change link capacities

Land use: Residential and employment density (households and number of jobs), proximity to transit, regional accessibility, and land use mix

Pricing: Increase/decrease auto operating costs, parking price, and toll rates

Demand Management (if included in the model): Increase/decrease telecommute and vanpooling, and change HOV lanes/policy

Transit: Increase/decrease transit fares, transit capacity - (BRT, express bus, regular bus, and a combination of all bus types), and transit frequency

Socioeconomic: Changes in demographic and in economic growth, and household income distribution

For additional guidance see the Federal Highway Administration's, The Travel Model Validation and Reasonableness Checking Manual,‖ Second Edition, 10.2 Sensitivity Testing September 2010, the latest CARB, Methodologies for Review of GHG Reduction for SCSs Pursuant to SB 375 Document, and the Recommendations RTAC Pursuant to SB 375, September 2009.

Calculating Vehicle Miles Traveled (VMT)

Vehicle miles traveled (VMT) is key data for highway planning and management and a common measure of roadway use and travel demand. MPOs use VMT, along with other data, in estimating congestion, air quality, and potential gas-tax revenues. They also use VMT or VMT stratified by speed, as inputs in the development of SCSs, NEPA and CEQA (SB 743) documents, and for purposes other than RTP development.

Performance Indicators

Performance indicators are critical for tracking the progress of SCSs. They are sets of real world data that are tracked over time and used for system performance evaluation. The RTAC Committee recommended performance indicators in funding, land use, transportation, pricing and TDM/TSM to keep track of the progress of land use and transportation changes after the implementation of the SCSs *(See the Recommendations of the RTAC Pursuant to SB 375 pp. 44-46 and the latest CARB, Methodologies for Review of GHG Reduction for SCSs Pursuant to SB 375 Document).*

Co-benefits of SCS

MPOs are encouraged to quantify, to the extent possible, the co-benefits associated with the achievement of their GHG reduction targets, as a means of increasing public understanding and support *(See the Recommendations of the RTAC Pursuant to SB 375 pp. 42-44 for addition guidance).*

Documentation

Quality documentation is key to providing planners, engineers, and decision-makers with a better understanding of the reliability of the tools used to produce the forecast. In addition to documentation, the key modeling processes (model estimation, calibration, and validation), it is also important to identify model limitations and document how they are addressed within the post-processing model (if an off-model strategy is used). For more guidance see, the California Air Resource Board's Off-Model Strategies Adopted by California is in Sustainable Communities Strategies as of April 29, 2016. *http://www.arb.ca.gov/cc/sb375/mpo_off-model_strategies.pdf*

Model Peer Review / Peer Advisory Committee

MPOs are encouraged to formally seek out peer reviews from Californian transportation modelers from other agencies of similar size during model development or after a major modeling enhancement. In addition to the review by peers, agencies can utilize FHWA's Travel Model Improvement Program peer review process or use the FHWA/FTA certification review to verify that the travel forecasting methods the agencies are using support the applications.

In addition to the committee, transportation modeling agencies are also encouraged to participate statewide, regional, and local modeling forums and user groups as a way to share ideas, review model inputs and methodologies, and coordinate modeling activities.

<u>California Interagency (CIA) Modeling Forum</u>

Analytical and forecasting tools, as well as transportation technologies, are dynamic and evolving; therefore, it is important that state, regional, local, and air quality agencies have on-going dialogue that supports model improvement activities by focusing on increasing model accuracy, policy sensitivity, data development and acquisition, and transparency. As a result, Caltrans will enhance the CIA Modeling Forum to facilitate an on-going dialogue between state and regional agencies, and other modeling practitioners. The CIA Modeling Forum will be organized and facilitated by Caltrans, with an additional objective of developing recommendations for the RTP Guidelines. Caltrans will share any existing information/research reports with the group and the public.

Transportation modelers from state, regional, and local agencies including Caltrans, ARB, California Energy Commission, MPOs, and RTPAs will meet to discuss modeling topics of general interest and to learn about new developments in the field. This forum will also be used for education, collaboration, consensus building, for encouraging MPO model improvement activities (consistent with current professional practice), and for recommending areas for future research.

This group will provide a memo to the California Transportation Commission (CTC) on an annual basis with recommended changes to the RTP Analysis and Modeling Chapter of the RTP Guidelines, status of work, on-going efforts. In areas where consensus is not reached, the group will provide the CTC a summary of the perspectives. During the applicable RTP Guidelines update, the RTP guidelines may be updated, as appropriate and applicable. MPO Model improvement programs must be developed to meet MPO needs and fit within their available modeling resources. All recommendations from the CIA forum shall take into account factors such as the size and available resources of the MPO, consistent with California Government Code Section 14522.1.

To ensure recommendations from the CIA forum are consistent with regional, state, and federal policy direction, Caltrans will coordinate with MPO planning directors and other state agencies in the development of study areas for consideration by the CIA modeling forum.

Initial areas recommended for discussion include, but are not limited to (not in priority order):

- The calculation and forecasting of auto operating cost
- Should vehicle ownership models be developed for all MPOs?
- Induced travel demand modeling
- The role of backcasting and sensitivity testing in model development
- The impact of changing vehicle and transportation technologies on model development
- Guidance for activity-based modeling
- Model validation and calibration criteria

- Guidance for peer review process of MPO models
- External travel/visitor model
- Freight forecasting
- Integration with other models
- Guidance on transferable parameters
- Statewide data collection to support MPO modeling efforts
- Additional items as deemed appropriate and applicable by the group

3.4 RTP Modeling Improvement Program (MIP) / Planning Practice Examples

Analysis and forecasting tools, as well as transportation technologies, are not static; therefore it is important that state, regional, local, and air quality agencies have on-going model improvement programs that support model calibration and validation activities by focusing on increasing model accuracy, policy sensitivity, and data development and acquisitions.

The RTP MIP includes planning practice examples that take into account factors such as the MPO's size and available resources and considers all modeling related to RTP development (e.g. federal air quality conformity and SCS analysis).

❋For all federal and state statutory and regulatory requirements and recommendations please refer to Section 3.5 - RTP Travel Analysis Groupings.

Category 1 –*MPOs with attainment Air Quality (AQ), slow growth in population and jobs, little or no congestion, and no significant capacity-enhancing projects or limited transit expansion plans or areas of non-attainment due to transport*

MPOs with attainment AQ, slow to moderate growth, population under 200,000, and no urbanized area or transit having more than a minimal potential impact on VMT, plus rural isolated non-attainment areas due to transport

- These counties are not federally recognized MPOs subject to federal air quality conformity analysis as part of RTP development. They do not need to run a network travel model.

Category 2 - *MPOs with moderate to rapid growth, nonattainment, and maintenance -AQ, or the potential for transit to reduce VMT.*

Consider the planning practice examples listed below.

Travel Demand Models:

- The number of residents per travel analysis zone (TAZ) is encouraged to be greater than 1,200, but less than 3,000; each TAZ is encouraged to yield less than 15,000 person trips per day; and the size of each TAZ is encouraged to range from one-quarter to one square mile in area (NCHRP 716, page 14)
- If an MPO uses a gravity model in their trip distribution step, a different friction factor can be used for each trip purpose. For example, home-based school trips can consider the school district areas in developing the friction factors and can be calibrated based on the local household travel survey
- MPOs are encouraged to have a minimum of three trip purposes in their model (home-based work (HBW), home-based other (HBO), and nonhome-based (HHB) trips). MPOs are

encouraged to include more trip purposes such as home-based school (HBS), home-based university (HBU), home-based shopping (HBSh) and other trip purposes as appropriate.

- Each MPO model is encouraged to account for auto operating costs in forecasting the travel. Auto operating cost is a key parameter in various steps of the TDM and can consist of fuel (primarily gasoline) costs and non-fuel-related (repair, maintenance, tires, and accessories) costs. This can also include the effective fuel efficiency of the vehicle fleet.
- The models can have sufficient temporal resolution (at least three time periods) to adequately model peak and off-peak periods.
- MPOs can consider developing a logit based destination choice model as part of their trip distribution step.
- Consider including a percentage share of all trips (work and non-work) made by all single occupant vehicles, multiple occupant vehicles, or carpool, transit, walking, and bicycling in the measures of means of travel.
- MPOs can model the entire regional transit network when modeling the transit mode.
- Mode choice models can be segmented by vehicle availability or household income.
- Because such variables as walking time and parking costs are important elements in mode choice, walking and auto access to transit modes can be modeled separately, unless there is little demand for transit where people drive or are driven to the transit stop (*NCHRP 716, page 54).*
- Consider using several employment types along with several trip purposes.

Visualization Techniques and Sketch Modeling of Scenarios:

- Consider developing GIS capabilities such as creating a parcel and land use data layers.
- Consider using an urban scenario model to calculate environmental impacts on terrestrial and aquatic ecosystems and/or to inform the land-use model of areas to be avoided in order to help locate alternative development.

Freight Models:

- Consider developing a simple freight model.

Policy Analysis Capabilities:

- Can define and evaluate trend forecasts, combined general plans, and preferred RTP scenarios.
- Models can be used to evaluate increased density and mix, urban growth limits, improved neighborhood walkability and bikeability, and one or more transit improvement proposals, as well as demand management, pricing strategies, and housing affordability.
- Can evaluate policies for their effects on lower-income households. This can be done by evaluating traveler welfare measures based on the mode choice log sums for each household income class, or based on travel costs for them.

Category 3 - *MPOs that are nonattainment for ozone or CO, with a metropolitan planning area containing an urbanized population over 200,000.*

Can consider all the planning practice examples identified in Category 2 and those listed below.

Travel Demand Models:

- Four-step models can be developed with full feedback across travel model steps and some sort of land use modeling.

- Vehicle ownership model can be developed and used. A vehicle ownership model is used to determine the number of motor vehicles available for use by household members. MPOs can consider variables such as household size, income, the number of workers, types of housing units, residential and employment density, and access to transit and non-motorized transport as part of vehicle ownership model.
- Walk, drive, wait, and in-vehicle travel time can be included when calculating the duration of a transit trip.
- A time of day model can be developed and used to allocate daily trips.
- Vehicle occupancy rate can be varied based on the trip purpose and time of day.

Regional Economic & Land-Use Models:

- Consider using travel costs or mode choice log sums for simple environmental justice analysis. Examples of such analyses include the effects of transportation and development scenarios on low-income or transit-dependent households, the combined housing/transportation cost burden on these households, and the jobs/housing fit.
- Consider developing models that test joint (or simultaneous)-choice of mode and destination.

Freight Models:

- Consider implementing freight or commodity flow models.

Policy Analysis Capabilities:

- Travel welfare can be measured using various economic measures (wages, jobs, production, and exports) can be created.

Category 4 - *The largest MPOs with rapid growth, large population centers and established transit systems.*

Consider all the planning practice examples identified in Categories 2 and 3 and those listed below.

Travel Demand Models:

- MPOs are encouraged to transition to activity-based TDM
- Technology influences the travel behavior by substituting for travel (telework) and leading to more travel by allowing for people to live farther away from their jobs. Consider reflecting the interactions between technology and travel behavior within the TDM.

Regional Economic & Land Use Models:

- If resources permit, consider building formal microeconomic land use models to analyze and evaluate the effects of growth scenarios on economic welfare (utility), including land prices, home affordability, jobs-housing fit, the combined housing-transportation cost burden, and economic development (wages, jobs, exports).
- Consider integrating land use and activity-based models into a single modeling system – integrated land use/transportation model that would allow planners to analyze the interactions between land use and the transportation system. ("Jobs-housing fit" is the extent to which the rents and mortgages in the community are affordable to the people who currently work there or will fill anticipated jobs).

Freight Models:

- Consider incorporating freight movement into the travel demand process. Consider documenting assumptions about freight growth and mode choice that impact truck VMT.
- Consider using information from the statewide freight model, local trip-based truck demand models, or commodity flows models when available. MPOs are encouraged to coordinated freight data collection programs with statewide efforts.

<u>Data:</u>

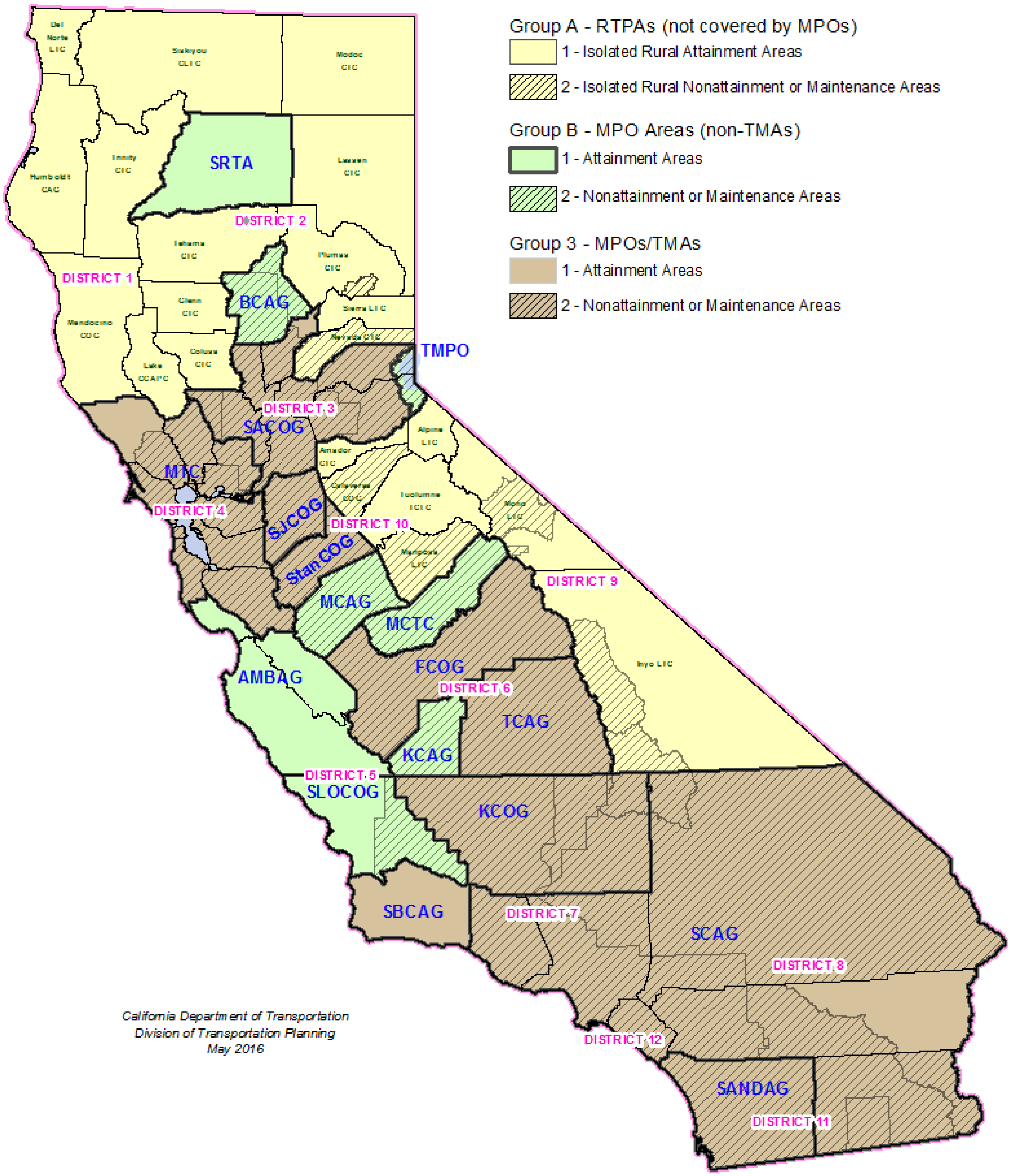
- Household travel surveys can be activity-based and include a tour table. Global Positioning System (GPS) sampling is encouraged and extra emphasis can be placed on accurate geocoding of households, workplace locations, and stops. Regions are encouraged to carefully design and follow the survey's data collection procedures so that the results are appropriate for the type of model being utilized. Coordination with Caltrans' travel survey efforts is encouraged

<u>Policy Analysis Capabilities:</u>

- Integrating land use modeling with transportation demand modeling can simulate the complex interactions of proposed changes in land use, economic, and transportation systems. Equity analysis can include changes in welfare by household income class. Economic development impacts may be comprehensively evaluated with this model set. Time-of-day road tolls can be evaluated.
- Agencies can take transit capacity constraints into consideration to derive operating scenarios that avoid overcrowded buses and trains. The amount of transit service thus derived can advise policy makers on needed transit capital and operating funding levels.

3.5 RTP Travel Analysis Groupings – Federal/State Laws

MPOs, regional transportation planning agencies (RTPAs), and congestion management agencies (CMAs) are organized into travel analysis groups based on federal and state laws (see map below). Group A includes Isolated Rural Attainment Areas (A1) and Isolated Rural Nonattainment or Maintenance Areas (A2) RTPAs that fall within the A grouping are not



required to conduct federal air quality conformity analysis as part of their RTP development. Caltrans is required to perform project-level air quality conformity analysis for regionally significant federal funded projects.

Group B includes federally recognized MPOs not located within a metropolitan transportation area with a population over 200,000 and therefore, not designated transportation management areas (TMAs). This group includes two categories based on federal air quality conformity laws, (B1) Attainment Areas and (B2) Nonattainment or Maintenance Areas. Group C includes MPOs located within TMAs. This grouping includes (C1) Attainment Areas and (C2) Nonattainment or Maintenance Areas.

Group A1: Isolated Rural Attainment Areas -- Federal Requirements *(Shalls)*

None

Group A1: Isolated Rural Attainment Areas -- State Requirements *(Shalls)*

California Government Code

§65080(a) Each transportation planning agency designated under Section 29532 or 29532.1 shall prepare and adopt a regional transportation plan directed at achieving a coordinated and balanced regional transportation system, including, but not limited to, mass transportation, highway, railroad, maritime, bicycle, pedestrian, goods movement, and aviation facilities and services. The plan shall be action-oriented and pragmatic, considering both the short-term and long-term future, and shall present clear, concise policy guidance to local and state officials. The regional transportation plan shall consider factors specified in Section 134 of Title 23 of the United States Code. Each transportation planning agency shall consider and incorporate, as appropriate, the transportation plans of cities, counties, districts, private organizations, and state and federal agencies.

Group A1: Isolated Rural Attainment Areas -- Federal Recommendations *(Shoulds)*

None

Group A1: Isolated Rural Attainment Areas -- State Recommendations *(Shoulds)*

California Government Code

§14522.2(b) Transportation planning agencies other than those identified in paragraph (1) of subdivision (a) of Section 14522.1, cities, and counties are encouraged, but not required, to utilize travel demand models that are consistent with the guidelines in the development of their regional transportation plans.

§65080(c) Each transportation planning agency may also include other factors of local significance as an element of the regional transportation plan, including, but not limited to, issues of mobility for specific sectors of the community, including, but not limited to, senior citizens.

Group A2: Isolated Rural Nonattainment or Maintenance Areas -- Federal Requirements *(Shalls)*

Regional Transportation Planning Agencies are not required to perform federal air quality conformity analysis as part of their RTP development. Caltrans is the responsible agency for performing the project level air quality analysis requirements and recommendations listed in this grouping.

40 CFR §93

§93.109 Criteria and procedures for determining conformity of transportation plans, programs, and projects: General.

(g) Isolated rural nonattainment and maintenance areas. This paragraph applies to any nonattainment or maintenance area (or portion thereof) which does not have a metropolitan transportation plan or TIP and whose projects are not part of the emissions analysis of any MPO's metropolitan transportation plan or TIP. This paragraph does not apply to “donut” areas which are outside the metropolitan planning boundary and inside the nonattainment/maintenance area boundary.

(1) FHWA/FTA projects in all isolated rural nonattainment and maintenance areas must satisfy the requirements of §§93.110, 93.111, 93.112, 93.113(d), 93.116, and 93.117. Until EPA approves the control strategy implementation plan or maintenance plan for a rural CO nonattainment or maintenance area, FHWA/FTA projects must also satisfy the requirements of §93.116(b) (“Localized CO, PM10, and PM2.5 violations (hot spots)”).

(2) Isolated rural nonattainment and maintenance areas are subject to the budget and/or interim emissions tests as described in paragraph (c) of this section, with the following modifications:

(i) When the requirements of §§93.106(d), 93.116, 93.118, and 93.119 apply to isolated rural nonattainment and maintenance areas, references to “transportation plan” or “TIP” should be taken to mean those projects in the statewide transportation plan or statewide TIP which are in the rural nonattainment or maintenance area. When the requirements of §93.106(d) apply to isolated rural nonattainment and maintenance areas, references to “MPO” should be taken to mean the state department of transportation.

(ii) In isolated rural nonattainment and maintenance areas that are subject to §93.118, FHWA/FTA projects must be consistent with motor vehicle emissions budget(s) for the years in the timeframe of the attainment demonstration or maintenance plan. For years after the attainment year (if a maintenance plan has not been submitted) or after the last year of the maintenance plan, FHWA/FTA projects must satisfy one of the following requirements:

(A) §93.118;

(B) §93.119 (including regional emissions analysis for NOX in all ozone nonattainment and maintenance areas, notwithstanding §93.119(f)(2)); or

(C) As demonstrated by the air quality dispersion model or other air quality modeling technique used in the attainment demonstration or maintenance plan, the FHWA/FTA project, in combination with all other regionally significant projects expected in the area in the timeframe of the statewide transportation plan, must not cause or contribute to any new violation of any standard in any areas; increase the frequency or severity of any existing violation of any standard in any area; or delay timely attainment of any standard or any required interim emission reductions or other milestones in any area. Control measures assumed in the analysis must be enforceable.

(iii) The choice of requirements in paragraph (g)(2)(ii) of this section and the methodology used to meet the requirements of paragraph (g)(2)(ii)(C) of this section must be determined through the interagency consultation process required in §93.105(c)(1)(vi) through which the relevant recipients of title 23 U.S.C. or Federal Transit Laws funds, the local air quality agency, the State air quality agency, and the State department of transportation should reach consensus about the option and methodology selected. EPA and DOT must be consulted through this process as well. In the event of unresolved disputes, conflicts may be escalated to the Governor consistent with the procedure in §93.105(d), which applies for any State air agency comments on a conformity determination.

Group A2: Isolated Rural Nonattainment or Maintenance Areas -- State Requirements *(Shalls)*

California Government Code

§65080(d) Except as otherwise provided in this subdivision, each transportation planning agency shall adopt and submit, every four years, an updated regional transportation plan to the California Transportation Commission and the Department of Transportation. A transportation planning agency located in a federally designated air quality attainment area or that does not contain an urbanized area may at its option adopt and submit a regional transportation plan every five years. When applicable, the plan shall be consistent with federal planning and programming requirements and shall conform to the regional transportation plan guidelines adopted by the California Transportation Commission. Prior to the adoption of the regional transportation plan, a public hearing shall be held after the giving of notice of the hearing by publication in the affected county or counties pursuant to Section 6061.

Group A2: Isolated Rural Nonattainment or Maintenance Areas -- Federal Recommendations *(Shoulds)*

None

Group A2: Isolated Rural Nonattainment or Maintenance Areas -- State Recommendations *(Shoulds)*

None

Group B1: Non-TMA MPOs - Attainment Areas -- Federal Requirements *(Shalls)*

Title 23 CFR §450

§450.306 Scope of the metropolitan transportation planning process.
(c) Consideration of the planning factors in paragraph (b) of this section shall be reflected, as appropriate, in the metropolitan transportation planning process. The degree of consideration and analysis of the factors should be based on the scale and complexity of many issues, including transportation system development, land use, employment, economic development, human and natural environment (including Section 4(f) properties as defined in 23 CFR 774.17), and housing and community development.

§450.316 Interested parties, participation, and consultation.
(a) The MPO shall develop and use a documented participation plan that defines a process for providing individuals, affected public agencies, representatives of public transportation employees, public ports, freight shippers, providers of freight transportation services, private providers of transportation (including intercity bus operators, employer-based commuting programs, such as carpool program, vanpool program, transit benefit program, parking cash-out program, shuttle program, or telework program), representatives of users of public transportation, representatives of users of pedestrian walkways and bicycle transportation facilities, representatives of the disabled, and other interested parties with reasonable opportunities to be involved in the metropolitan transportation planning process.

(1) The MPO shall develop the participation plan in consultation with all interested parties and shall, at a minimum, describe explicit procedures, strategies, and desired outcomes for:

(iii) MPOs are required to use visualization techniques as part the public participation plan, RTP, and TIP development that are usable and understandable to the public.

(iv) Making public information (technical information and meeting notices) available in electronically accessible formats and means, such as the World Wide Web;

§450.324 Development and content of the metropolitan transportation plan.

(a) The metropolitan transportation planning process shall include the development of a transportation plan addressing no less than a 20-year planning horizon as of the effective date. In formulating the transportation plan, the MPO shall consider factors described in § 450.306 as the factors relate to a minimum 20-year forecast period. In attainment areas, the effective date of the transportation plan shall be its date of adoption by the MPO.

(b) MPOs are required to develop RTPs that address a minimum of 20-year horizon and include both long and short-range strategies/actions that lead to the development of an integrated multimodal transportation system that facilitates the safe and efficient movement of people and goods in addressing current and future transportation demand.

(c) The MPO shall review and update the transportation plan at least every 5 years in attainment areas to confirm the transportation plan's validity and consistency with current and forecasted transportation and land use conditions and trends and to extend the forecast period to at least a 20-year planning horizon. The MPO shall approve the transportation plan (and any revisions) and submit it for information purposes to the Governor. Copies of any updated or revised transportation plans must be provided to the FHWA and the FTA.

(e) The MPO, the State(s), and the public transportation operator(s) shall validate data used in preparing other existing modal plans for providing input to the transportation plan. In updating the transportation plan, the MPO shall base the update on the latest available estimates and assumptions for population, land use, travel, employment, congestion, and economic activity. The MPO shall approve transportation plan contents and supporting analyses produced by a transportation plan update.

(f) The metropolitan transportation plan shall, at a minimum, include:

(1) The current and projected transportation demand of persons and goods in the metropolitan planning area over the period of the transportation plan

(2) Existing and proposed transportation facilities (including major roadways, public transportation facilities, intercity bus facilities, multimodal and intermodal facilities, nonmotorized transportation facilities (e.g., pedestrian walkways and bicycle facilities), and intermodal connectors) that should function as an integrated metropolitan transportation system, giving emphasis to those facilities that serve important national and regional transportation functions over the period of the transportation plan

Group B1: Non-TMA MPOs – Attainment Areas -- <u>State requirements</u> *(Shalls)*

<u>California Government Code</u>

§14522.2 (a) MPOs are required to disseminate the methodology, results, and key assumptions of whichever travel demand models it uses in a way that would be usable and understandable to the public

§65080 (b) The regional transportation plan shall be an internally consistent document and shall include all of the following:

(1) A policy element that describes the transportation issues in the region, identifies and quantifies regional needs, and describes the desired short-range and long-range transportation goals, and pragmatic objective and policy statements. The objective and policy statements shall be consistent with the funding estimates of the financial element. The policy element of transportation planning agencies with populations that exceed 200,000 persons may quantify a set of indicators including, but not limited to, all of the following:

(A) Measures of mobility and traffic congestion, including, but not limited to, daily vehicle hours of delay per capita and vehicle miles traveled per capita.

(B) Measures of road and bridge maintenance and rehabilitation needs, including, but not limited to, roadway pavement and bridge conditions.

(C) Measures of means of travel, including, but not limited to, percentage share of all trips (work and non-work) made by all of the following:

(i) Single occupant vehicle;

(ii) Multiple occupant vehicle or carpool;

(iii) Public transit including commuter rail and intercity rail;

(iv). Walking;

(v) Bicycling.

(D) Measures of safety and security, including, but not limited to, total injuries and fatalities assigned to each of the modes set forth in subparagraph (C).

(E) Measures of equity and accessibility, including, but not limited to, percentage of the population served by frequent and reliable public transit, with a breakdown by income bracket, and percentage of all jobs accessible by frequent and reliable public transit service, with a breakdown by income bracket.

(F) The requirements of this section may be met utilizing existing sources of information. No additional traffic counts, household surveys, or other sources of data shall be required.

Group B1: NonTMAs MPOs - *Attainment Areas* -- Federal Recommendations *(Shoulds):*

Title 23 CFR §450

§450.306 Scope of the metropolitan transportation planning process.

(c) The degree of the consideration and analysis of the planning factors (23 CFR §450.306(b)) should be based on the scale and complexity of the many issues, including transportation system development, land use, employment, economic development, human and natural environment (including Section 4(f) properties as defined in (23 CFR §774.17), and housing and community development).

§450.324 Development and content of the metropolitan transportation plan.

(c) In addition, the MPO may revise the transportation plan at any time using the procedures in this section without a requirement to extend the horizon year.

Group B1: NonTMAs MPOs - *Attainment Areas* -- State Recommendations *(Shoulds)*

This section includes all of the Isolated Rural Attainment (see Map) state recommendations. No new recommendations are identified in this section.

Group B2: Non-TMA MPOs – Nonattainment or Maintenance Areas -- Federal Requirements *(Shalls)*

This section includes all of Group B1 federal requirements and the following requirements.

Federal Clean Air Act of 1990

Section 176(c)(1)(B)(iii) of the Clean Air Act states that "[t]he determination of conformity shall be based on the most recent estimates of emissions, and such estimates shall be determined from the most recent population, employment, travel, and congestion estimates as determined by the MPO or other agency authorized to make such estimates." The Clean Air Act requires that transportation investments be based on the most recent information that is available, in order to protect public health over the long-term.

Title 40 CFR §93

§93.102 Applicability. (a) Action applicability.

(1) Except as provided for in paragraph (c) of this section or §93.126, conformity determinations are required for:

(i) The adoption, acceptance, approval or support of transportation plans and transportation plan amendments developed pursuant to 23 CFR part 450 or 49 CFR part 613 by an MPO or DOT;

(ii) The adoption, acceptance, approval or support of TIPs and TIP amendments developed pursuant to 23 CFR part 450 or 49 CFR part 613 by an MPO or DOT; and

(iii) The approval, funding, or implementation of FHWA/FTA projects.

(b) Geographic applicability. The provisions of this subpart shall apply in all nonattainment and maintenance areas for transportation-related criteria pollutants for which the area is designated nonattainment or has a maintenance plan.

§93.104 Frequency of conformity determinations.

(a) Conformity determinations and conformity redetermination for transportation plans, TIPS, and FHWA/FTA projects must be make according to the requirements of this section and applicable implementation plan.

(b) Frequency of conformity determinations for transportation plans.

(1) Each new transportation plan must be demonstrated to conform before the transportation plan is approved by the MPO or accepted by DOT

(2) All transportation plan amendments must be found to conform before the transportation plan amendments are approved by the MPO or accepted by DOT, unless the amendment merely adds or deletes exempt projects listed in §93.126 or §93.127. The conformity determination must be based on the transportation plan and the amendment taken as a whole.

(3) The MPO and DOT must determine the conformity of the transportation plan (including a new regional emissions analysis) no less frequently than every four years. If more than four years elapse after DOT's conformity determination without the MPO and DOT determining conformity of the transportation plan, a 12-month grace period will be implemented as described in paragraph (f) of this section. At the end of this 12-month grace period, the existing conformity determination will lapse.

(e) Triggers for transportation plan and TIP conformity determinations. Conformity of existing transportation plans and TIPs must be redetermined within two years of the following, or after a 12-month grace period (as described in paragraph (f) of this section) the existing conformity determination will lapse, and no new project-level conformity determinations may be made until conformity of the transportation plan and TIP has been determined by the MPO and DOT:

(1) The effective date of EPA's finding that motor vehicle emissions budgets from an initially submitted control strategy implementation plan or maintenance plan are adequate pursuant to §93.118(e) and can be used for transportation conformity purposes;

(2) The effective date of EPA approval of a control strategy implementation plan revision or maintenance plan which establishes or revises a motor vehicle emissions budget if that budget has not yet been used in a conformity determination prior to approval; and

(3) The effective date of EPA promulgation of an implementation plan which establishes or revises a motor vehicle emissions budget.

§93.105 Consultation. Sections (a) and (c)

(a) General. The implementation plan revision required under §51.390 of this chapter shall include procedures for interagency consultation (Federal, State, and local), resolution of conflicts, and public consultation as described in paragraphs (a) through (e) of this section. Public consultation procedures will be developed in accordance with the requirements for public involvement in 23 CFR part 450.

(c) Interagency consultation procedures: Specific processes. Interagency consultation procedures shall also include the following specific processes:

(1) A process involving the MPO, State and local air quality planning agencies, State and local transportation agencies, EPA, and DOT for the following:

(i) Evaluating and choosing a model (or models) and associated methods and assumptions to be used in hot-spot analyses and regional emissions analyses;

(ii) Determining which minor arterials and other transportation projects should be considered "regionally significant" for the purposes of regional emissions analysis (in addition to those functionally classified as principal arterial or higher or fixed guideway systems or extensions that offer an alternative to regional highway travel), and which projects should be considered to have a significant change in design concept and scope from the transportation plan or TIP;

(iii) Evaluating whether projects otherwise exempted from meeting the requirements of this subpart (see §§93.126 and 93.127) should be treated as non-exempt in cases where potential adverse emissions impacts may exist for any reason;

(iv) Making a determination, as required by §93.113(c)(1), whether past obstacles to implementation of TCMs which are behind the schedule established in the applicable implementation plan have been identified and are being overcome, and whether State and local agencies with influence over approvals or funding for TCMs are giving maximum priority to approval or funding for TCMs. This process shall also consider whether delays in all the applicable implementation plan to remove TCMs or substitute TCMs or other emission reduction measures;

(v) Notification of transportation plan or TIP amendments which merely add or delete exempt projects listed in §93.126 or §93.127; and

(vi) Choosing conformity tests and methodologies for isolated rural nonattainment and maintenance areas, as required by §93.109(g)(2)(iii).

(2) A process involving the MPO and State and local air quality planning agencies and transportation agencies for the following:

(i) Evaluating events which will trigger new conformity determinations in addition to those triggering events established in §93.104; and

(ii) Consulting on emissions analysis for transportation activities which cross the borders of MPOs or nonattainment areas or air basins.

(3) Where the metropolitan planning area does not include the entire nonattainment or maintenance area, a process involving the MPO and the State department of transportation for cooperative planning and analysis for purposes of determining conformity of all projects outside the metropolitan area and within the nonattainment or maintenance area.

(4) A process to ensure that plans for construction of regionally significant projects which are not FHWA/FTA projects (including projects for which alternative locations, design concept and scope, or the no-build option are still being considered), including those by recipients of funds designated under title 23 U.S.C. or the Federal Transit Laws, are disclosed to the MPO on a regular basis, and to ensure that any changes to those plans are immediately disclosed.

(5) A process involving the MPO and other recipients of funds designated under title 23 U.S.C. or the Federal Transit Laws for assuming the location and design concept and scope of projects which are disclosed to the MPO as required by paragraph (c)(4) of this section but whose sponsors have not yet decided these features, in sufficient detail to perform the regional emissions analysis according to the requirements of §93.122.

(6) A process for consulting on the design, schedule, and funding of research and data collection efforts and regional transportation model development by the MPO (e.g., household/ travel transportation surveys).

(7) Interagency consultation procedures shall include a process for providing final documents (including applicable implementation plans and implementation plan revisions) and supporting information to each agency after approval or adoption. This process is applicable to all agencies described in paragraph (a)(1) of this section, including Federal agencies (40 CFR 93.105).

§93.106 Content of transportation plans and timeframe of conformity determinations.

(c) Transportation plans for other areas. Transportation plans for other areas must meet the requirements of paragraph (a) of this section at least to the extent it has been the previous practice of the MPO to prepare plans which meet those requirements. Otherwise, the transportation system envisioned for the future must be sufficiently described within the transportation plans so that a conformity determination can be made according to the criteria and procedures of §§93.109 through 93.11

§93.110 Criteria and procedures: Latest planning assumptions.

(a) If new data that become available (after the analysis begins) they are required to use it for the conformity determination only if a significant delay in the analysis has occurred (as determined through interagency consultation).

(b) The assumptions are required to be derived from the estimates of current and future population, employment, travel, and congestion most recently developed by the MPO or other agency authorized to make such estimates and approved by the MPO. The conformity determination must also be based on the latest assumptions about current and future background concentrations.

(c) The conformity determination for each transportation plan and TIP must discuss how transit operating policies (including fares and service levels) and assumed transit ridership have changed since the previous conformity determination.

(d) The conformity determination must include reasonable assumptions about transit service and increases in transit fares and road and bridge tolls over time.

(e) The conformity determination must use the latest existing information regarding the effectiveness of the TCMs and other implementation plan measures which have already been implemented.

(f) Key assumptions shall be specified and included in the draft documents and supporting materials used for the interagency and public consultation required by §93.105 (40 CFR 93.110(f)).

§93.111 Criteria and procedures: Latest emissions model.

(a) The conformity determination must be based on the latest emission estimation model available. This criterion is satisfied if the most current version of the motor vehicle emissions model specified by EPA for use in the preparation or revision of implementation plans in that State or area is used for the conformity analysis. Where EMFAC is the motor vehicle emissions model used in preparing or revising the applicable implementation plan, new versions must be approved by EPA before they are used in the conformity analysis.

§93.122 Procedures for determining regional transportation-related emissions.

(a) General requirements**.**

(1) The regional emissions analysis required by §§93.118 and 93.119 for the transportation plan, TIP, or project not from a conforming plan and TIP must include all regionally significant projects expected in the nonattainment or maintenance area. The analysis shall include FHWA/FTA projects proposed in the transportation plan and TIP and all other regionally significant projects which are disclosed to the MPO as required by §93.105. Projects which are not regionally significant are not required to be explicitly modeled, but vehicle miles traveled (VMT) from such projects must be estimated in accordance with reasonable professional practice. The effects of TCMs and similar projects that are not regionally significant may also be estimated in accordance with reasonable professional practice.

(7) Reasonable methods shall be used to estimate nonattainment or maintenance area VMT on off-network roadways within the urban transportation planning area, and on roadways outside the urban transportation planning area.

§93.122 Procedures for determining regional transportation-related emissions.

(d) In all areas not otherwise subject to paragraph (b) of this section, regional emissions analyses must use those procedures described in paragraph (b) of this section if the use of those procedures has been the previous practice of the MPO. Otherwise, areas not subject to paragraph (b) of this section may estimate regional emissions using any appropriate methods that account for VMT growth by, for example, extrapolating historical VMT or projecting future VMT by considering growth in population and historical growth trends for VMT per person. These methods must also consider future economic activity, transit alternatives, and transportation system policies.

Title 23 CFR §450

§450.324 Development and content of the metropolitan transportation plan.

(a) In nonattainment and maintenance areas, the effective date of the transportation plan shall be the date of a conformity determination issued by the FHWA and the FTA.

(c) The MPO shall review and update the transportation plan at least every 4 years in air quality nonattainment and maintenance areas to confirm the transportation plan's validity and consistency with current and forecasted transportation and land use conditions and trends and to extend the forecast period to at least a 20-year planning horizon.

(d) In metropolitan areas that are in nonattainment for ozone or carbon monoxide, the MPO shall coordinate the development of the metropolitan transportation plan with the process for developing transportation control measures (TCMs) in a State Implementation Plan (SIP).

Group B2: Non-TMA MPOs – Nonattainment or Maintenance Areas -- State Requirements *(Shalls)*

This section includes all of Group A and B1 state requirements. No new requirements are identified in this section.

Group B2: Non-TMA MPOs - Nonattainment or Maintenance Areas -- Federal Recommendations *(Shoulds)*

This section includes all of Group A and B1 federal recommendations. No new requirements are identified in this section.

Group B2: Non-TMA MPOs - Nonattainment or Maintenance Areas -- State Recommendations *(Shoulds)*

This section includes all of Group A and B1 state recommendations. No new requirements are identified in this section.

Group C1: TMA MPOs - Attainment Areas -- Federal Requirements *(Shalls)*

This section includes all Group B1 and B2 federal requirements and the following requirements

Title 23 CFR §450

§450.322 Congestion management process in transportation management areas.
a) The transportation planning process in a TMA shall address congestion management through a process that provides for safe and effective integrated management and operation of the multimodal transportation system, based on a cooperatively developed and implemented the metropolitan-wide strategy, of new and existing transportation facilities eligible for funding under title 23 U.S.C. and title 49 U.S.C. Chapter 53 through the use of travel demand reduction (including intercity bus operators, employer-based commuting programs such as a carpool program, vanpool program, transit benefit program, parking cash-out program, shuttle program, or telework program), job access projects, and operational management strategies.
(d) The congestion management process shall be developed, established, and implemented as part of the metropolitan transportation planning process that includes coordination with transportation system management and operations activities. The congestion management process shall include.

(1) Methods to monitor and evaluate the performance of the multimodal transportation system, identify the underlying causes of recurring and nonrecurring congestion, identify and evaluate alternative strategies, provide information supporting the implementation of actions, and evaluate the effectiveness of implemented actions;
(2) Definition of congestion management objectives and appropriate performance measures to assess the extent of congestion and support the evaluation of the effectiveness of congestion reduction and mobility enhancement strategies for the movement of people and goods;
(3) Establishment of a coordinated program for data collection and system performance monitoring to define the extent and duration of congestion, to contribute in determining the causes of congestion, and evaluate the efficiency and effectiveness of implemented actions;
(4) Identification and evaluation of the anticipated performance and expected benefits of appropriate congestion management strategies that will contribute to the more effective use and improved safety of existing and future transportation systems based on the established performance measures.

Group C1: TMAs MPOs - Attainment Areas -- State Requirements *(Shalls)*

Includes all state requirements in Group B. No new requirements are identified in this section.

Group C1: TMA MPOs - Attainment Areas -- Federal Recommendations *(Shoulds)*

Includes all federal recommendations in Group B and the following requirements.

Title 23 CFR §450

§450.322 Congestion management process in transportation management areas
(d)(3) To the extent possible, TMA's data collection programs should be coordinated with existing data sources, archived operational/ITS data, and coordinated with operations managers in metropolitan areas.

Group C1: TMA MPOs - Attainment Areas -- State Recommendations *(Shoulds)*

Includes all state recommendations in Group B. No new requirements are identified in this section.

Group C2: TMA MPOs - Nonattainment or Maintenance Areas -- Federal Requirements *(Shalls)*

Includes all federal requirements in Group B and C (1) and the following requirement.

Title 40 CFR §93

§93.106 Content of transportation plans and timeframe of conformity determinations.

(a) Transportation plans adopted after January 1, 1997 in serious, severe, or extreme ozone nonattainment areas and in serious CO nonattainment areas. If the metropolitan planning area contains an urbanized area population greater than 200,000, the transportation plan must specifically describe the transportation system envisioned for certain future years which shall be called horizon years

(1) The agency or organization developing the transportation plan may choose any years to be horizon years, subject to the following restriction:

(i) Horizon years may be no more than 10 years apart;

(ii) The first horizon year may be no more than 10 years from the base year used to validate the transportation demand planning model;

(iii) The attainment year must be a horizon year if it is in the timeframe of the transportation plan and conformity determination;

(iv) The last year of the transportation plan's forecast period must be a horizon year; and

(v) If the timeframe of the conformity determination has been shortened under paragraph (d) of this section, the last year of the timeframe of the conformity determination must be a horizon year.

(2) For these horizon years described in:

(i) The transportation plan shall quantify and document the demographic and employment factors influencing expected transportation demand, including land use forecasts, in accordance with implementation plan provisions and the consultation requirements specified by §93.105;

(ii) The highway and transit system shall be described in terms of the regionally significant additions or modifications to the existing transportation network which the transportation plan envisions to be operational in the horizon years. Additions and modifications to the highway network shall be sufficiently identified to indicate intersections with existing regionally significant facilities, and to determine their effect on route options between transportation analysis zones. Each added or modified highway segment shall also be sufficiently identified in terms of its design concept and design scope to allow modeling of travel times under various traffic volumes, consistent with the modeling methods for area-wide transportation analysis in use by the MPO. Transit facilities, equipment, and services envisioned for the future shall be identified in terms of design concept, design scope, and operating policies that are sufficient for modeling of their transit ridership. Additions and modifications to the transportation network shall be described sufficiently to show that there is a reasonable relationship between expected land use and the envisioned transportation system; and iii) Other future transportation policies, requirements, services, and activities, including intermodal activities, shall be describe;

(iii) Other future transportation policies, requirements, services, and activities, including intermodal activities, shall be described.

§93.122 Procedures for determining regional transportation-related emissions.

(b) Regional emissions analysis in serious, severe, and extreme ozone nonattainment areas and serious CO nonattainment areas must meet the requirements of paragraphs (b) (1) through (3) of this section if their metropolitan planning area contains an urbanized area population over 200,000.

(1) By January 1, 1997, estimates of regional transportation-related emissions used to support conformity determinations must be made at a minimum using network-based travel models according to procedures and methods that are available and in practice and supported by current and available documentation. These procedures, methods, and practices are available from DOT and will be updated periodically. Agencies must discuss these modeling procedures and practices through the interagency consultation process, as required by §93.105(c)(1)(i). Network-based travel models must at a minimum satisfy the following requirements:

(i) Network-based travel models must be validated against observed counts (peak and off-peak, if possible) for a base year that is not more than 10 years prior to the date of the conformity determination. Model forecasts must be analyzed for reasonableness and compared to historical trends and other factors, and the results must be documented;

(ii) Land use, population, employment, and other network-based travel model assumptions must be documented and based on the best available information;

(iii) Scenarios of land development and use must be consistent with the future transportation system alternatives for which emissions are being estimated. The distribution of employment and residences for different transportation options must be reasonable;

(iv) A capacity-sensitive assignment methodology must be used, and emissions estimates must be based on a methodology which differentiates between peak and off-peak link volumes and speeds and uses speeds based on final assigned volumes;

(v) Zone-to-zone travel impedances used to distribute trips between origin and destination pairs must be in reasonable agreement with the travel times that are estimated from final assigned traffic volumes. Where use of transit currently is anticipated to be a significant factor in satisfying transportation demand, these times should also be used for modeling mode splits; and;

(vi) Network-based travel models must be reasonably sensitive to changes in the time(s), cost(s), and other factors affecting travel choices;

(2) Reasonable methods in accordance with good practice must be used to estimate traffic speeds and delays in a manner that is sensitive to the estimated volume of travel on each roadway segment represented in the network-based travel model;

(3) Highway Performance Monitoring System (HPMS) estimates of vehicle miles traveled (VMT) shall be considered the primary measure of VMT within the portion of the nonattainment or maintenance area and for the functional classes of roadways included in HPMS, for urban areas which are sampled on a separate urban area basis. For areas with network-based travel models, a factor (or factors) may be developed to reconcile and calibrate the network-based travel model estimates of VMT in the base year of its validation to the HPMS estimates for the same period. These factors may then be applied to model estimates of future VMT. In this factoring process, consideration will be given to differences between HPMS and network-based travel models, such as differences in the facility coverage of the HPMS and the modeled network description. Locally developed count- based programs and other departures from these procedures are permitted subject to the interagency consultation procedures of §93.105(c)(1)(i).

Title 23 CFR §450

§450.322 Congestion management process in transportation management areas.

(f) In TMAs designated as nonattainment for ozone or carbon monoxide, the congestion management process shall provide an appropriate analysis of reasonable (including multimodal) travel demand reduction and operational management strategies for the corridor in which a project that will result in a significant increase in capacity for SOVs (as described in paragraph (d) of this section) is proposed to be advanced with Federal funds. If the analysis demonstrates that travel demand reduction and operational management strategies cannot fully satisfy the need for additional capacity in the corridor and additional SOV capacity is warranted, then the congestion management process shall identify all reasonable strategies to manage the SOV facility safely and effectively (or to facilitate its management in the future). Other travel demand reduction and operational management strategies appropriate for the corridor, but not appropriate for incorporation into the SOV facility itself, shall also be identified through the congestion management process. All identified reasonable travel demand reduction and operational management strategies shall be incorporated into the SOV project or committed to by the State and MPO for implementation.

Group C2: TMA MPOs – Nonattainment or Maintenance Areas -- State Requirements *(Shalls)*

Includes all state requirements in Group A and B. No new requirements are identified in this section.

Group C2: TMA MPOs – Nonattainment or Maintenance Areas -- Federal Recommendations *(Shoulds)*

Includes all federal recommendations in Group B and C1. No new recommendations are identified in this section.

Group C2: TMA MPOs – Nonattainment or Maintenance Areas -- State Recommendations *(Shoulds)*

Includes all state recommendations in Group B. No new recommendations are identified in this section.

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Chapter 4

RTP Consultation and Coordination

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RTP CONSULTATION & COORDINATION

4.1 Consultation & Coordination

Transportation planning is a collaborative process, led by the MPO and other key stakeholders in the regional transportation system. Transportation planning activities include visioning, forecasting population/employment, identifying major growth corridors, projecting future land use in conjunction with local jurisdictions, assessing needs, developing capital and operating strategies to move people and goods, and developing a financial plan. Consistent with SB 375 and Title 23 CFR Part 450.316, the required planning processes are designed to foster involvement by all interested parties, such as walking and bicycling representatives, public health departments and public health non-governmental organizations, affordable housing advocates, transportation advocates, neighborhood and community groups, environmental advocates, home builder representatives, broad-based business organizations, landowners, commercial property interests and homeowner associations, the Native American community, neighboring MPOs and the general public through a proactive public participation process. Review all sections of this chapter for detailed public participation requirements.

Coordination is the cooperative development of plans, programs and schedules among agencies and entities with legal standing in order to achieve general consistency. Consultation means that one or more parties confer with other identified parties in accordance with the established process and, prior to taking action(s), considers the views of the other parties and periodically informs them about action(s) taken. It is very important for the development of the RTP to be conducted both in coordination and consultation with interested parties.

In addition to having an extensive public participation process, each MPO should coordinate its regional transportation planning activities with all transportation providers, facility operators such as airports, appropriate federal, state, local agencies, Native American Tribal Governments, environmental resource agencies, air districts, pedestrian and bicycle representatives and adjoining MPOs. The RTP shall (Title 23 CFR Part 450.324(g)(1) and (2)) reflect consultation with resource and permit agencies to ensure early coordination with environmental resource protection and management plans, for additional information regarding consultation with resource agencies see Section 4.10.

RTPs are required to be developed in coordination with local and regional air quality planning authorities and shall reflect specific consultation activities with air quality agencies on the development of the RTP (Title 40 CFR Part 93.105 (b)). MPOs participate in air quality planning by providing travel activity data for emissions inventories. They also implement Transportation Control Measures to reduce transportation related emissions. This participation helps lay the groundwork for future SIP conformity determinations. All MPOs in nonattainment and maintenance areas shall coordinate the development of their RTPs with their respective Air Quality Management District(s), the California Air Resources Board, Caltrans, local transportation agencies, EPA, and U.S. DOT in order to ensure conformity with the SIP. The federal Clean Air Act Amendments of 1990 requires SIP development to be coordinated with the transportation planning process (Title 42 Section 7504(b)). Detailed requirements may also be found in Title 40 CFR Parts 51 and 93 (Transportation Conformity rules).

Development of the Public Participation Plan and the RTP shall include consultation and coordination with all interested parties and shall, at a minimum, describe explicit procedures, strategies and desired outcomes (Title 23 CFR Part 450.316).

In summary, the consultation process shall:

1. Provide adequate public notice and the opportunity to comment on proposed RTPs and public participation plans;
2. Employ visualization techniques to describe the RTP;
3. Make the RTP electronically accessible, such as placing it on the Internet;
4. Hold public hearings at convenient and accessible locations and times;
5. Demonstrate explicit consideration and response to public input on the RTP (documentation);
6. Seek out and consider the needs of those traditionally underserved by existing transportation systems, such as low income and minority households;
7. Provide additional opportunities to comment on the RTP and the FTIP, if the final version differs due to additional comments;
8. Coordinate with the state transportation planning and public involvement processes; and,
9. Periodically review intended RTP outcomes, products and/or services.

Requirements (Shalls)
Federal: Transportation Conformity Regulations of Title 40 CFR Part 93.105; Title 23 CFR Part 450.316 requires MPOs to develop a process and mechanism in which all parties may provide comments/input on the MPOs public participation plan and in the development of the RTP.

State: Government Code Section 65080(b)(2)(E)

Planning Practice Examples: Available in Appendix L

4.2 Title VI & Environmental Justice Considerations in the RTP

Evaluation of the entire range of a region's needs is a key element in the process of developing an RTP, and like consideration of public comment is required by both federal and state law. Providing more transportation and mobility choices such as increased transit, bicycle, and pedestrian facilities, as well as appropriate housing choices near job centers increases opportunities for all segments of the population at all income levels. Each region is required by federal regulation and state laws to plan for and implement transportation system improvements that will provide a fair share of benefits to all residents, regardless of race, ethnicity or income level. As discussed in Section 4.4, the public participation plan must provide for "Seeking out and considering the needs of those traditionally underserved by existing transportation systems, such as low-income and minority households as well as people with limited English proficiency, who may face challenges accessing employment and other services." This section discusses separate legal requirements that protect low-income and minority individuals: Title VI of the federal Civil Rights Act of 1964, Section 11135 of the California Government Code, Presidential Executive Order 12898 on Environmental Justice (EJ), and the U.S. DOT EJ Order 5610.2(A). As discussed below, these laws and orders require MPOs to conduct analyses to determine (under Title VI) whether transportation and land use changes identified in the RTP result in disparate impacts to minority communities and populations and (with respect to EJ) to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of programs, policies, and activities on low-income populations and minority populations resulting from the transportation and land use changes in the RTP.

Title VI of the Civil Rights Act of 1964

Title VI of the Civil Rights Act of 1964 prohibits discrimination by recipients of federal funds on the basis of race, color or national origin. A similar prohibition applies to recipients of state funds under California Gov. Code section 11135, which prohibits discrimination on the basis of race, color or national origin, as well as ethnic group identification, religion, age, sex, sexual orientation, genetic information, or disability. When an MPO receives federal funding for only a limited purpose, such as a specific service or project, it is still subject to Title VI in all of its "policies, programs or activities," whether or not they are directly supported with the federal funds.

The general prohibition of Title VI is far-reaching. While U.S. DOT's Title VI regulations (49 CFR § 21.5) enumerates specific prohibitions, they also state that "the enumeration of specific forms of prohibited discrimination in [the regulations] does not limit the generality of the prohibition." Among the numerous specific forms of discrimination the regulations call out are prohibitions on subjecting a person to segregation in any matter related to receipt of any benefit under the program; denying a person the opportunity to participate as a member of a planning, advisory, or similar body which is an integral part of the program; or utilizing any criteria or methods of administration that have the effect of subjecting persons to discrimination. Other discriminatory actions are specifically prohibited. Title VI and its implementing regulations (49 CFR § 21.5) state that the recipient of federal funds may not directly or through contractual or other arrangements, on the grounds of race, color, or national origin:

1. Deny a person any service, financial aid, or other benefit provided under the program;
2. Provide any service, financial aid, or other benefit to a person which is different, or is provided in a different manner, from that provided to others under the program;
3. Subject a person to segregation or separate treatment in any matter related to his receipt of any service, financial aid, or other benefit under the program;
4. Restrict a person in any way in the enjoyment of any advantage or privilege enjoyed by others receiving any service, financial aid, or other benefit under the program;
5. Treat a person differently from others in determining whether he satisfies any admission, enrollment, quota, eligibility, membership, or other requirement or condition which persons must meet in order to be provided any service, financial aid, or other benefit provided under the program;
6. Deny a person an opportunity to participate in the program through the provision of services or otherwise or afford him an opportunity to do so which is different from that afforded others under the program; or
7. Deny a person the opportunity to participate as a member of a planning, advisory, or similar body which is an integral part of the program.

Title VI Analysis

In addition to prohibiting discrimination, the Title VI regulation imposes affirmative obligations on recipients. Among other things, recipients are prohibited from denying a person an opportunity to participate in the program through the provision of services or otherwise afford him an opportunity to do so which is different from that afforded others under the program. The Title VI regulation also requires them to "take affirmative action to assure that no person is excluded from participation in or denied the benefits of the program or activity on the grounds of race, color, or national origin," and both as part of the Title VI report described below and more generally, to "have available for the Secretary racial and ethnic data showing the extent to which members of minority groups are beneficiaries of programs receiving Federal financial assistance."

As described in FTA Circular 4702.1B, *"Title VI Requirements and Guidelines for FTA Recipients,"* part of the Title VI Program for MPOs includes an analysis of impacts that identifies any disparate impacts on basis of race, color, or national origin. Specifically, FTA Circular 4702.1B requires MPOs to submit a Title VI Program report certifying compliance every three years. (MPOs that have the responsibility typically held by transit operators, such as development of new transit services or setting of transit fares must also conduct equity studies if proposing significant service or fare changes.) The Circular requires that MPOs include the following information in their Title VI Program reports:

1. All general requirements set out in section 4 of Chapter III of the Circular;
2. A demographic profile of the metropolitan area that includes identification of the locations of minority populations in the aggregate;
3. A description of the procedures by which the mobility needs of minority populations are identified and considered within the planning process;
4. Demographic maps that overlay the percent minority and non-minority populations as identified by Census or ACS data, at Census tract or block group level, and charts that analyze the impacts of the distribution of State and Federal funds in the aggregate for public transportation purposes, including Federal funds managed by the MPO as a designated recipient;
5. An analysis of impacts identified in paragraph (4) that identifies any disparate impacts on the basis of race, color, or national origin, and, if so, determines whether there is a substantial legitimate justification for the policy that resulted in the disparate impacts, and if there are alternatives that could be employed that would have a less discriminatory impact.

This information is submitted to the State as the primary recipient of funding and also to FTA separately from the RTP. This Title VI analysis is applicable to the MPO activities and planning process as a whole. Federal law requires each MPO periodically to "certify . . . that the metropolitan transportation planning process is being carried out in accordance with . . . Title VI of the Civil Rights Act of 1964." 23 C.F.R. § 450.334 (a) (3). A valid Title VI Analysis is an essential part of a valid Title VI certification.

The Circular includes the following related definitions:

1. Discrimination refers to any action or inaction, whether intentional or unintentional, in any program or activity of a Federal aid recipient, sub-recipient, or contractor that results in disparate treatment, disparate impact, or perpetuating the effects of prior discrimination based on race, color, or national origin.
2. Disparate impact refers to a facially neutral policy or practice that disproportionately affects members of a group identified by race, color, or national origin, where the recipient's policy or practice lacks a substantial legitimate justification and where there exists one or more alternatives that would serve the same legitimate objectives but with less disproportionate effect on the basis of race, color, or national origin.
3. Disproportionate burden refers to a neutral policy or practice that disproportionately affects low-income populations more than non-low-income populations. A finding of

disproportionate burden requires the recipient to evaluate alternatives and mitigate burdens where practicable.

4. Disparate treatment refers to actions that result in circumstances where similarly situated persons are intentionally treated differently (i.e., less favorably) than others because of their race, color, or national origin….
5. Minority population means any readily identifiable group of minority persons who live in geographic proximity and, if circumstances warrant, geographically dispersed/transient populations (such as migrant workers or Native Americans) who will be similarly affected by a proposed DOT program, policy, or activity.

Environmental Justice

Presidential Executive Order 12898 requires that "each federal agency shall conduct its programs, policies, and activities that substantially affect human health or the environment, in a manner that ensures such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under, such programs, policies, and activities, because of their race, color, or national origin." It also requires federal executive agencies and the entities to which they extend financial support or project approval to "identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations."

The U.S. DOT Order 5610.2(a) on EJ defines "adverse effects" as "the totality of significant individual or cumulative human *health or environmental effects*." That phrase is defined broadly as extending to "interrelated social and economic effects, which may include, but are not limited to: bodily impairment, infirmity, illness or death; air, noise, and water pollution and soil contamination; destruction or disruption of man-made or natural resources; destruction or diminution of aesthetic values; destruction or disruption of community cohesion or a community's economic vitality; destruction or disruption of the availability of public and private facilities and services; vibration; adverse employment effects; displacement of persons, businesses, farms, or nonprofit organizations; increased traffic congestion, isolation, exclusion or separation of minority or low-income individuals within a given community or from the broader community." That phrase also includes "the denial of, reduction in, or *significant delay in the receipt of, benefits* of DOT programs, policies, or activities."

Environmental Justice at FHWA means "*identifying and addressing disproportionately high and adverse effects of the agency's programs, policies, and activities on minority and low-income populations to achieve an equitable distribution of benefits and burdens. This includes the full and fair participation by all potentially affected communities in the transportation decision-making process".*

The FTA EJ Circular 4703.1 describes an EJ analysis to determine whether the activity will result in a "[d]isproportionately high and adverse effect on human health and environment." The DOT order prohibits, if further mitigation measures or alternatives that would reduce the disproportionately high and adverse effects are feasible, any "[d]isproportionately high and adverse effect on minority and low-income populations," defined as "an adverse effect that: (l) is *predominately borne by* a minority population and/or a low-income population, or (2) will be suffered by the minority population and/or low-income population and is *appreciably more severe or greater in magnitude* than the adverse effect that will be suffered by the non-minority population and/or non-low-income population."

DOT EJ Order 5610.2(a) and FTA EJ Circular 4703.1 provide direction related to the responsibilities of MPOs on environmental justice as recipients of federal funds. There are three federally established guiding EJ principles, summarized in FTA Circular 4703.1, to consider throughout transportation planning, public outreach and participation efforts conducted in development of the RTP:

- "To avoid, minimize, or mitigate disproportionately *high and adverse human health and environmental effects, including social and economic effects*, on minority populations and low-income populations.
- To ensure the *full and fair participation* by all potentially affected communities in the transportation decision-making process.
- To prevent the *denial of, reduction in, or significant delay in the receipt of benefits* by minority and low-income populations."

While Title VI and EJ are closely related, FTA Circular 4703.1, "*Environmental Justice Policy Guidance for FTA Recipients,"* provides an understanding of the overlap and distinction between the two. Title VI prohibits discrimination by recipients of federal assistance on the basis of race, color, and national origin. By contrast, the Executive Order on EJ extends its protections not only to "minority populations" but also to "low-income populations."

DOT EJ Order 5610.2(a) defines "Minority Population" to mean "any readily identifiable groups of minority persons who live in geographic proximity, and if circumstances warrant, geographically dispersed/transient persons (such as migrant workers or Native Americans) who will be similarly affected by a proposed DOT program, policy or activity." The U.S. DOT EJ Order similarly defines "Low-Income Population" as "any readily identifiable groups of low-income persons who live in geographic proximity, and if circumstances warrant, geographically dispersed/transient person (such as migrant workers or Native Americans) who will be similarly affected by a proposed DOT program, policy or activity." FTA's EJ Circular 4703.1 and FTA's 2012 Title VI Circular 4702.1B include similar definitions.

Incorporating Environmental Justice Principles into Decision Making Processes

Specific to low-income and minority populations, MPOs are required to conduct an EJ analysis. The requirement of an EJ analysis grows out of the requirement in the federal EJ Executive Order to "*identify and address*, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations." As described in FTA Circular 4703.1, an EJ analysis starts with knowing basic socioeconomic information about the people who live and/or work in the region. This information will provide a basis for developing a public engagement plan that will encourage the full and fair participation by all members of the affected communities. The public engagement plan will then guide the rest of the analysis as consideration of whether the proposed programs, policies and activities will result in disproportionately high and adverse human health or environmental effects on EJ populations.

Chapter 2 of FTA Circular 4703.1 on EJ describes a four-step process for conducting an EJ analysis: "Step 1: Know your community by analyzing demographic data. Step 2: Develop Public Engagement Plan that responds to the community. Step 3: Consider proposed project and likely adverse effects and benefits. Step 4: Select alternative, incorporate mitigation as needed." MPOs may adjust the above four step framework to fit the particular activity they are analyzing. Each step is discussed in more detail in the Circular: Step 1 is discussed in chapter II; Step 2 in chapter III; and Steps 3 and 4 in Chapters IV and V. MPOs are advised to consult this Circular for details and specific requirements and recommendations. The Circular also contains recommendations for State DOTs, MPOs, and transit providers on "(1) how to fully engage EJ populations in the transportation decision-making process; (2) how to determine whether EJ populations would be subjected to disproportionately high and adverse human health or environmental effects of a public transportation project, policy or activity; and (3) how to avoid, minimize or mitigate these effects."

Title VI Analysis & EJ Analysis

There may be some overlap between EJ and Title VI analyses; however, engaging in EJ analysis during the federal transportation planning process will not necessarily satisfy Title VI requirements. Conversely, a Title VI analysis would not necessarily satisfy EJ requirements, since Title VI does not include low-income populations. Moreover, Title VI applies to all federally-funded projects and activities, including those that will provide new benefits or services, not solely those activities that may have adverse human health or environmental effects on communities, which the U.S. DOT Order on EJ defines very broadly.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.316(a); Title 42 U.S.C. Chapter 21 Section 2000(d) (Title VI of the federal Civil Rights Act of 1964); Title 49 CFR Part 21 (Title VI Regulations); portions of FTA Circular 4702.1B – Title VI Requirements and Guidelines for FTA Recipients; Presidential Executive Order 12898 on Environmental Justice (1994): portions of U.S. DOT Order 5610.2(a) (2012) and FHWA Order 6640.23A (2012).
State: Government Code Section 11135

Recommendations (Shoulds)
Federal: FTA Circular 4703.1 – EJ Policy Guidance for FTA Recipients; portions of FTA Circular 4702.1B-Title VI Requirements and Guidance for FTA Recipients; portions of U.S. DOT EJ Order 5610.2(a), and FHWA Order 6640.23A (2012).

Planning Practice Examples: Available in Appendix L

4.3 <u>Social Equity Factors</u>

Social equity factors relevant to RTP development include, but are not limited to, housing and transportation affordability, access to transportation, displacement and gentrification, and the jobs/housing fit.

Title 23 CFR Part 450.316(a)(1)(vii) requires that an MPO's public participation plan describe explicit procedures, strategies and desired outcomes for seeking out and considering the needs of those traditionally underserved by existing transportation systems, such as low-income communities and communities of color, who may face challenges accessing employment and other services.

MPOs can encourage the involvement of low-income communities and communities of color by proactively seeking the input of these households and by making public meetings as accessible as possible. Public engagement strategies may include:

- Provide all materials related to the update with adequate time for public review and input.
- Hold meetings at convenient and accessible locations and outside of traditional working hours (e.g. evenings and weekends);
- Locate meetings in low-income communities and communities of color;
- Locate meetings at sites accessible via affordable transit;
- Translate meeting materials for non-English speakers;
- Consider the needs to low-income and individuals with limited English proficiency when translating outreach materials and ensuring that documents are easy to understand (i.e. evaluate the reading level of the materials and quality of translations);
- Technology and the Internet can reach many people, but efforts should be made to reach individuals with limited/no internet access;
- Provide interpretation at meetings for non-English speakers; and,
- Ensure meetings are attended by MPO decision makers in addition to MPO staff.

In addition to the practices listed above, MPOs are also encouraged, to the extent practicable, to develop partnerships with local, regional and state-wide organizations that can assist in achieving RTP participation goals.

Planning Practice Examples: Available in Appendix L

4.4 <u>Participation Plan</u>

Involving the public in planning and project development poses a major challenge as well as an opportunity. Many people are skeptical about whether they can truly influence the outcome of a transportation project. Others feel that transportation plans are too abstract and long-term to warrant attention. At the same time, especially for MPOs as a result of SB 375, there has been and continues to be, increased interest in regional transportation planning by individuals and groups not previously involved.

The RTP is one of the key processes an MPO undertakes. It is a primary avenue for public participation in the long-range transportation planning process. Title 23 CFR Part 450.316(a) states the following concerning participation and consultation:

"The MPO shall develop and use a documented participation plan that defines a process for providing individuals, affected public agencies, representatives of public transportation employees, public ports, freight shippers, providers of freight transportation services, private providers of transportation, representatives of users of public transportation, representatives of users of pedestrian walkways and bicycle transportation facilities, representatives of the disabled, and other interested parties with reasonable opportunities to be involved in the metropolitan transportation planning process."

Title 23 CFR Part 450.316(a)(1) also requires that public participation plans be developed by MPOs in consultation with all interested parties and describe explicit procedures, strategies, and desired outcomes for:

(i) Providing adequate public notice of public participation activities and time for public review and comment at key decision points, including but not limited to a reasonable opportunity to comment on the proposed metropolitan transportation plan and the TIP;
(ii) Providing timely notice and reasonable access to information about transportation issues and processes;
(v) Holding any public meetings at convenient and accessible locations and times;
(vii) Seeking out and considering the needs of those traditionally underserved by existing transportation systems, such as low-income and minority households, who may face challenges accessing employment and other services.

The purpose of the MPO's participation plan is to establish the process by which the public can participate in the development of regional transportation plans and programs. The public participation plan should be designed to assist MPO staff in implementing an effective public participation process through a variety of strategies. It provides MPO staff with a menu of techniques or activities from which they can tailor their specific program's input process. MPOs should also refer to the CTP Public Participation Plan document, or the CTP/FSTIP Public Participation Plan, which can provide the most effective methods for engaging with the public. This document can be accessed through the following link: http://www.dot.ca.gov/hq/tpp/offices/osp/ppp_files/CTPE_PPP_Final_052913_dg_29.pdf#zoom=75. Which public participation methods the MPO uses will require a careful analysis of what is desired to be accomplished as well as the scope of the particular transportation project(s). Plenty of flexibility is available to MPOs in developing specific public involvement programs. Every given situation or region in California is different, and each approach to a specific public involvement challenge will be unique.

When significant written and oral comments are received on the draft RTP and as a result of the participation process or the interagency consultation process required under the EPA transportation conformity regulations (Title 40 CFR Part 93), a summary, analysis, and report of the proposed comments shall be made as part of the final RTP.

It is important to note that the public participation plan should be prepared prior to the development of the RTP. The public participation plan should have public input during its preparation and have a 45-day comment period before the MPOs board adopts it. This enhanced public participation plan is a federal requirement. MPOs that currently have a public participation plan per federal requirements do not need to adopt another plan to meet new SB 375 requirements for additional public participation. The public participation requirements for development of the Sustainable Communities Strategy, pursuant to the requirements of SB 375, can be incorporated into the existing plan.

Title 23 CFR Part 450.316(a)(1)(iii) requires the participation plan to use visualization techniques to describe the RTP and FTIP. Visualization techniques range from a simple line drawing or hand written chart to technologically complex web cast public meetings, GIS modeling and computer generated maps. The specific type of visualization technique is determined by the MPO.

The public participation plan, the draft and adopted RTP shall be posted on the MPO website to the maximum extent practicable and for the life of the RTP. It is also recommended that MPOs place hard copies of the draft and adopted copies of RTPs in local libraries and other locations where the public would have access to these documents.

Public involvement programs for regional transportation plans in California are required to follow state and federal requirements. If the minimum state and federal requirements are inadequate for the region, the MPO may develop a more specialized public involvement program if that promises to be more effective.

In developing RTPs, the MPO should consult with agencies and officials responsible for other planning activities within their region that are affected by transportation or at least coordinate the planning process to incorporate input. These areas include, but are not limited to, the listed examples:

1. State and local growth;
2. Public health;
3. Housing;
4. Economic development;
5. Tourism;
6. Natural disaster risk reduction;
7. Environmental protection;
8. Airport operations; and,
9. Goods Movement.

When the MPO region includes California Indian Tribal Lands (reservations, Rancherias, and allotments) the MPO shall appropriately involve the federally recognized Native American Tribal Government(s) in the development of the RTP. The MPO should also seek input even from tribes that are not federally recognized or from other "interested parties" that may have a background and/or history of Native American culture within the region. In addition, AB 52 (Chapter 532, Statutes of 2014) established "Tribal Cultural Resources as a new, separate, and distinct resource to be analyzed in the CEQA process. A project that causes an adverse change to a TCR is one that may have a significant effect on the environment, so the MPO should avoid or mitigate impacts to Tribal Cultural Resources when feasible. The MPO must also begin consultation with a California Native American Tribe that is traditionally and culturally affiliated with the MPO region prior to the release of a Negative Declaration, a Mitigated Negative Declaration, or an Environmental Impact Report if the tribe requested, in writing, to be informed by the lead agency of proposed projects in that geographic area and if other procedural requirements are met. See Section 4.9 Native American Tribal Government Consultation and Coordination for further discussion.

Similarly, when the MPO region includes federal public lands, the MPO shall appropriately involve the federal land management agencies in the development of RTP.

The MPO shall also, to the extent practicable, develop a documented process that outlines roles, responsibilities, and key decision points for consulting with other governments and agencies.

MPOs are also encouraged to involve the media, including ethnic media as appropriate, as a tool to promote public participation in the RTP development, review and commenting process.

For MPOs, SB 375 increased the minimum level of public participation required in the regional transportation planning process including collaboration between partners in the region during the development of a SCS (see Sections 4.7 and 4.8).

Public participation and consultation for the development of the RTP remains an essential element of the overall RTP process. Mapping and visualization tools should be used, to the extent practicable, to create visual representations of proposed scenarios, the SCS and the APS, if applicable. Use of these tools will help facilitate more effective and meaningful public involvement in development and refinement of the SCS and APS, if applicable. A Public Participation Plan includes public outreach, public awareness, and public input beginning with the planning stage.

Periodic Evaluation of the Public Participation Plan

A periodic review of the public participation plan is important to evaluate the effectiveness of the procedures and strategies employed during the full and open participation process. This periodic review can help to ensure that the public participation plan, once adopted, is being implemented effectively and is achieving its goals of engaging low-income and minority residents in expressing and prioritizing their needs and their views on how the RTP can best meet those needs.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.316 requires that the MPO shall develop and use a documented participation plan that defines a process for providing reasonable opportunities for all parties to comment and be involved in the metropolitan transportation planning process.
State: Government Code Section 65080; Public Resources Code Section 5097.94, and Sections 21073 through 21084.3.

Planning Practice Examples: Available in Appendix L

4.5 <u>Private Sector Involvement</u>

Private sector involvement relates to how the goods movement industry and other business or commercial interests are represented in the development of the RTP. Trucks, freight trains, taxis, limousines all use the transportation network and are an integral part of the regional transportation system. Other examples of private sector involvement in the development of the RTP include Transportation Management Associations, private transit operators, developers, and Chambers of Commerce. Their absence in the regional transportation planning process adversely impacts the efficiency of the transportation network.

In urbanized areas of California, the number of trucks on the highway system has substantially increased. This has had a direct impact on traffic congestion within these areas. An increased level of truck activity has also had an impact in rural areas of the state, although primarily on the principal routes in rural counties. For these reasons, an RTP that does not include the “Private Sector” in the planning process is not a viable plan. The impact of the private sector on the transportation system is significant and must be included and documented in the RTP process.

Unfortunately, in many plans, the private sector is not identified as a planning partner. Where addressed, goods movement is discussed in the abstract with minimal long-range assumptions identified or assessed.

MPOs should take necessary actions to ensure major trucking firms, large employers and business organizations are formally invited to participate in the preparation of the RTP. The

MPO should strive to include any major long-range plans of these organizations that may have an impact on the regional transportation system. The purpose is to provide private sector transportation providers a process of communication and involvement into the region's transportation planning process. The specific outreach techniques developed and ultimately used is dependent on the size and composition of the region. These efforts to solicit input into the long-range regional transportation planning process should be documented in the RTP.

Requirements (Shalls)
Federal: Federal regulations require private sector involvement as a component of the regional transportation planning process. Title 23 U.S.C. Part 134 (g)(4), Title 23 U.S.C. Section 135(e) and Title 23 CFR Part 450.316 (a) require the transportation planning process include input from the goods movement industry and other transportation organizations.

Recommendations (Shoulds)
State: California Government Code Section 14000(d) recommends that a comprehensive multimodal transportation planning process should be established which involves all levels of government and the private sector in a cooperative process to develop coordinated transportation plans.

Planning Practice Examples: Available in Appendix L

4.6 Consultation with Interested Parties

The U.S. DOT defines consultation as when: "*one or more parties confer with other identified parties in accordance with an established process and, prior to taking action(s), considers the views of the other parties and periodically informs them about action(s) taken*." Some areas of consultation could include transportation, land use, employment, economic development, housing, community development and environmental issues.

The U.S. DOT definition of "interested parties" to be engaged in statewide and metropolitan transportation planning has been expanded. Title 23 CFR Part 450.324(j) provides the list of interested parties that shall be provided with a reasonable opportunity to comment on the RTP using the Public Participation Plan developed under 450.316(a). The MPO shall provide the following interested parties with reasonable opportunity to comment on the proposed RTP:

1. Individuals;
2. Affected public agencies;
3. Representatives of public transportation employees;
4. Public ports;
5. Freight shippers;
6. Private providers of transportation;
7. Representatives of users of public transportation;
8. Representatives of users of pedestrian walkways and bicycle transportation facilities;
9. Representatives of people with disabilities;
10. Providers of freight transportation services; and,
11. Other interested parties.

Consistent with SB 375, the MPO shall adopt a Public Participation Plan in advance of developing an SCS and/or APS to also include consultation with congestion management agencies, transportation agencies, and transportation commissions. Reference Section 4.4 for Public Participation requirements and Section 4.5 for Private Sector Involvement. The remaining sections of this chapter provide more detailed requirements for RTP/SCS input, consultation and coordination.

Requirements (Shalls)
Federal: Consulting with interested parties on plans, programs and projects shall include individuals or organizations that are mentioned in Title 23 CFR Part 450.316(a). Title 23 CFR Part 450.316(d) requires MPOs to consult with federal land use management agencies as appropriate during the development of RTP. Title 23 CFR part 450.324(g) states that MPOs shall consult as appropriate with state and local agencies responsible for land use management, natural resources, environmental protection, conservation and historic preservation during the development of their RTP. Title 23 CFR Part 450.324(j) provides the list of interested parties that shall be provided with a reasonable opportunity to comment on the RTP using the Public Participation Plan developed under 450.316(a).

State: Government Code Section 65080

Planning Practice Examples: Available in Appendix L

4.7 Input & Consultation on SCS Development

This section applies only to federally-designated MPOs that are required to prepare a SCS, and APS, if applicable.

Existing federal regulations require MPOs to ensure the general public, resource agencies and Native American Tribal Governments are consulted during the development of the RTP. As a result of SB 375, this input and consultation requirement has been expanded.

SCS Public Participation Plan

Consistent with SB 375, the MPO shall adopt a Public Participation Plan in advance of developing an SCS and/or APS to include:

- Outreach efforts encouraging the active participation of a broad range of stakeholders in the planning process, consistent with the MPO's adopted Federal Public Participation Plan. This includes, but is not limited to, affordable housing advocates, transportation advocates, neighborhood and community groups, environmental advocates, home builder representatives, broad-based business organizations, landowners, commercial property interests, and homeowner associations.
- Consultation with congestion management agencies, transportation agencies, and transportation commissions.
- Regional public workshops with information and tools providing a clear understanding of policy choices and issues. At least one workshop in each county. At least three workshops for counties with a population greater than 500,000. To the extent practicable, each workshop shall include urban simulation computer modeling to create visual representations of the SCS and APS.
- Preparation and circulation of a draft SCS (and APS, if one is prepared) not less than 55 days before adoption of a final RTP.

- For multiple-county MPOs at least three public hearings shall be held on the draft SCS in the RTP (and APS, if any). For a single county MPO, at least two public hearings shall be held. To the maximum extent feasible, the hearings shall be in different parts of the region to maximize the opportunity for participation by members of the public throughout the region.
- A process enabling the public to provide a single request to receive notices, information and updates.

Pursuant to Government Code Section 65080 (b)(2)(A)(ii), the MPO shall hold at least one public workshop within the region, after receiving the Regional Targets Advisory Committee (RTAC) recommendation report regarding methods and factors for setting regional GHG targets (which was released on September 29, 2009).

This public participation plan is not required to be reviewed or approved by any state agency, but it is recommended that a summary discussion of the RTP/SCS public participation process be included in the RTP. However, the MPO should maintain a record of its public participation efforts relative to the SCS and APS if applicable, and therefore, it is recommended these additional requirements should be included in the federally required public participation plan.

Consultation with Local Elected Officials

During the development of the SCS (and APS if applicable), the MPO must conduct at least two informational meetings in each county for members of the board of supervisors and city councils. Only one informational meeting is needed in each county if it is attended by representatives of the county board of supervisors and city councils that represent a majority of the cities representing a majority of the population in the incorporated areas of that county. The purpose of this meeting (or meetings) shall be to discuss the SCS (and APS if applicable), including the key land use and planning assumptions, with the members of the board of supervisors and city council members in that county and to solicit and consider their input and recommendations. Notices of these meetings are to be sent to the clerk of the board of supervisors and city councils.

Continuing with a collaborative transportation planning process, MPOs work and consult with local elected officials as key stakeholders in the regional transportation system. While local elected officials serve on regional agency boards, expanded consultation is required pursuant to Government Code Section 65080(b)(2)(E) and (F) to provide outreach to all local elected officials and their member jurisdictions affected by the SCS (and APS if applicable). This is particularly significant in those regions where not all cities and counties have a permanent seat on the MPO board. Early consultation with all member agencies may avoid future conflicts with implementation of the RTP including the SCS (and APS, if applicable).

Pursuant to Government Code Section 65080(b)(2)(G), in preparing an SCS, the MPO shall consider spheres of influence that have been adopted by Local Agency Formation Commissions (LAFCOs) within the region. MPOs should also consult with LAFCOs regarding special districts within the region that provide property-related services such as water or wastewater services, and should consult with these regional special districts, as appropriate, during development of an SCS (and APS if applicable).

Consultation with School Districts

Additionally, MPOs should consider consultation with school districts within their region during development of the RTP. School-related trips constitute a significant portion of all vehicle trips. For that reason, MPOs are encouraged to share data on growth projections and consult with school districts in the development of the SCS (and APS if applicable), especially with respect to land uses and the regional transportation system. Where possible, an SCS should incorporate current and future school needs into the RTP. Some school districts use School Facilities Master Plans (SFMP) as a way to compile comprehensive data on the district's long-term facilities including the general location of planned new schools and the expansion, revitalization and reuse of existing schools. A SFMP may also contain Board of Education adopted policies related to joint use and the district's sustainability efforts which can dovetail with community and regional efforts (e.g. infill, reuse, busing, pedestrian/bike safe routes to schools, etc.).

For additional information on the consultation process please refer to Section 4.1, 4.9, and 4.10.

4.8 Interagency Coordination on SCS Development

As the MPO works on RTP development and approval, interagency coordination with both federal and State agencies provides necessary information for the RTP, and notification to all interested parties. Advanced and continuous coordination with all appropriate agencies is highly recommended. MPO development of the RTP should include interagency coordination with, but not limited to, the following entities:

1. Federal agencies including: Federal Highways Administration (FHWA), Environmental Protection Agency (EPA), and Federal Transit Administration (FTA)
2. California Department of Housing and Community Development (HCD)
3. California Air Resources Board (ARB)
4. California Department of Transportation (Caltrans)
5. Appropriate Resources Agencies (see list in Section 4.10)
6. Adjacent MPOs with which the MPO shares a significant amount of interregional travel.

ARB must exchange technical information with Caltrans, MPOs, local air districts, and local governments in developing the regional GHG reduction targets for the MPOs. MPOs are strongly encouraged to participate in the target update process by providing ARB with region-specific target recommendations supported by modeling, technical data and analysis.

The California Transportation Commission (CTC) also encourages State agencies to work with the MPOs to provide the best data and information available as they develop their GHG emissions modeling methodology together with ARB.

MPOs are also encouraged to work with HCD to incorporate the appropriate RHNA within their RTPs.

A Sequencing Flowchart showing the RTP development and approval process for MPOs as they work with these entities is located in Section 2.8 of the RTP Guidelines.

4.9 Native American Tribal Government Consultation & Coordination

During the development of the RTP, Tribal Government ***consultation*** can be described as the meaningful and timely process of seeking, discussing, and considering carefully the views of leaders of federally recognized Tribal Governments and, where feasible, seeking agreement on important matters. The MPO can do this by sharing information and conducting meetings with leaders of the federally recognized Tribal Governments during the preparation of the RTP prior to taking action(s) on the plan and by making sure to consider input from the tribe as decisions are made. Consultation should be conducted in a way that is mutually respectful of each party's sovereignty. Tribal Government ***coordination*** is the comparison of the MPOs transportation plans, programs, projects and schedules with similar documents prepared by the tribe. The MPO needs to ensure consistency with tribal plans and the RTP.

Currently there are 109 federally recognized tribes in California. The federally recognized Tribal Governments hold inherent power of limited sovereignty and are charged with the same responsibility as other governmental authorities. In addition, California is home to the largest Native American population in the country, including non-federally recognized tribes, and urban Indian communities.

When the MPO region includes California Indian Tribal Lands (reservations, Rancherias, and allotments) the MPO shall appropriately involve the federally recognized Native American Tribal Government(s) in the development of the RTP. The MPO should also seek input even from tribes that are not federally recognized or from other "interested parties" that may have a background and/or history of Native American culture within the region. In addition, AB 52 mandates that agencies must consult with tribes regarding impacts to Tribal Cultural Resources as an impact under CEQA.

The MPO should include a discussion of consultation, coordination and communication with federally recognized Tribal Governments when the tribes are located within the boundary of an MPO/RTPA. The MPO should establish a government-to-government relationship with each tribe in the region. This refers to the protocol for communicating between the MPOs and the Tribal Governments as sovereign nations. This consultation process should be documented in the RTP. The initial point of contact for Tribal Governments should be the Chairperson for the tribe.

The MPO should develop protocol and communication methods for outreach and consultation with the Tribal Governments. However these protocol and communication methods should be re-evaluated if the agencies are un-successful in obtaining a response during the development of the RTP.

It is important to ensure that efforts in establishing channels of communication are documented in the RTP. For further information and assistance in the consultation process, contact the Caltrans Native American Liaison Branch (NALB) at: http://dot.ca.gov/hq/tpp/offices/ocp/nalb. The NALB webpage also provides contact information for the Caltrans Districts' Native American Liaisons.

As mentioned above, California is home to many non-federally recognized tribes as well as Native Americans living in urban areas. MPOs should involve the Native American communities in the public participation processes. Establishing and maintaining government-to-government relations with federally recognized Tribal Governments through consultation is separate from, and precedes the public participation process.

Requirements (Shalls)
Federal: Title 23 CFR part 450.316(c) requires MPOs to involve the federally recognized Native American Tribal Government in the development of the RTP and FTIP. Title 23 CFR part 450.316 (a)(1), the participation plan shall be developed by the MPO in consultation with all interested parties and shall, at a minimum, describe explicit procedures, strategies and desired outcomes. The requirement of including interested parties in the development of the participation plan and the RTP would include federally recognized or non-federally recognized tribes.

State: Public Resources Code Section 5097.94, and Sections 21073 through 21084.3.
AB 52 added Tribal Cultural Resources as an impact under CEQA and required consultation to mitigate those impacts with the California Native American tribes as defined in California Public Resources Code Section 21073. Because RTPs are subject to CEQA and a program EIR is prepared to analyze the impacts of implementing an RTP, AB 52 means that MPOs must consult with tribes with regards to Tribal Cultural Resources as part of the CEQA process.

Planning Practice Examples: Available in Appendix L

4.10 Consultation with Resource Agencies

Current federal regulations require MPOs to consult with resource agencies, State and local agencies responsible for land use management, environmental protection, conservation, and historic preservation concerning the development of the RTP. As part of SCS development, MPOs must gather and consider the best available scientific information on resource areas and farmlands within the region which may be impacted by the RTP. State and federal resource agencies may be able to assist MPOs by providing data, maps, or other information.

The consultation efforts shall involve:

1. Comparing transportation plans with State conservation plans, maps and other data, if available; and,

2. Comparing transportation plans with inventories of natural and historic resources, if available.

Federal requirements seek to receive input/comments from resource agencies early in the planning process. The reason for proactive consultation and engagement is to prevent project delays at a later time. In other words, coordinating and consulting with resources agencies early in the planning process, may lead to better coordination, minimal litigation, possible project cost savings and an upfront understanding of resource agency issues.

Some examples of resource agencies that could be included in a more seamless multi-agency process, but are not limited to California Environmental Protection Agency (CalEPA), California Coastal Commission, and U.S. Fish and Wildlife, U.S. Army Corp of Engineers, California Department of Fish and Wildlife and California Department of Parks and Recreation.

The FHWA Eco-Logical and Integrated Ecological Framework and the state Regional Advance Mitigation Planning model provides a process by which early consultation with resource agencies and conservation non-profit organizations to develop regional greenprints or conservation plans that identify of areas of conservation value can satisfy federal requirements for early consultation and result in benefits for both transportation agencies and environmental protection. Programmatic mitigation plans, Natural Communities Conservation Plans and Habitat Conservation Plans can provide early consultation and identification of natural resources that need to be avoided or minimized in order to reduce risk and streamline project delivery. For additional information related to coordination of regional mitigation activities with other planning processes, see Chapter 5.

An MPO shall coordinate and consult with resource agencies on data or information sharing, if available. The following is a preliminary list of resource agencies that should be consulted in the development of the RTP:

1. Federal Highway Administration;
2. Federal Transit Administration;
3. U.S. Environmental Protection Agency;
4. U.S. Army Corps of Engineers;
5. NOAA Fisheries Services;
6. U.S. National Park Service;
7. U.S. National Marine and Fishery Service;
8. U.S. Fish and Wildlife Service;
9. California Coastal Commission;
10. California Ocean Protection Council;
11. California Energy Commission;
12. California Office of Planning and Research;
13. California Environmental Protection Agency;
14. California Natural Resources Agency;
15. California Water Resources Control Board;
16. California Regional Water Quality Control Board;
17. California Department of Fish and Wildlife;
18. California Department of Resources, Recycling, and Recovery;
19. California Air Resources Board;
20. California Department of Parks and Recreation;
21. California Department of Conservation;
22. California State Mining and Geology Board;
23. Any additional California environmental, energy, resource and permit agencies;
24. Bay Conservation and Development Commission (Bay Area);
25. Regional Air Quality Management Districts, and;
26. California Office of Historic Preservation.

It may be challenging to obtain timely responses and comments to the RTP, its programs and projects, when the commenting period is announced to the general public and stakeholders. It is understandable that these efforts will depend on the specific region. MPOs in the Sacramento Valley and Southern California have chosen a targeted approach and send letters to specific stakeholders requesting comment/s on plans, programs and projects. When responses are not received, these MPOs follow-up on the request by asking for a reason from the resource agency as to why a response was not received.

Interagency Consultation for Transportation Conformity – The transportation conformity rule requires that State and local agencies establish formal procedures to ensure interagency coordination on critical transportation conformity issues. Nonattainment and maintenance areas have adopted consultation procedures to meet these requirements. These procedures are federally enforceable and must be followed for each conformity determination.

Additional guidance regarding federally required consultation with resource agencies during the RTP development process is available in Section 5.2 Federal Environmental Requirements.

Requirements (Shalls)
Federal: Title 23 CFR part 450.324(g)(1) & (g)(2) requires that the MPO shall consult, as appropriate, with State and local agencies responsible for land use management, natural resources, environmental protection, conservation, and historic preservation concerning the development of the transportation plan. The consultation shall involve, as appropriate: (1) Comparison of transportation plans with State conservation plans or maps, if available; or (2) Comparison of transportation plans to inventories of natural or historic resources, if available. In addition, the discussion of mitigation activities required by 23 CFR 450.324(f)(10) (and described more fully in Section 5.2) shall be developed in consultation with Federal, State, and Tribal land management, and regulatory agencies. 23 CFR 93.105 for interagency consultation for transportation conformity.

State: California Environmental Quality Act (CEQA), consultation with agencies, governments or individuals that could potentially be impacted by transportation projects in the RTP. Government Code Section 65080(b)(2)(B)(v) requires that MPOs develop a SCS (which is part of the RTP) that shall gather and consider the best practically available scientific information regarding "resource areas" and "farmland" as defined in subdivisions (a) and (b) of Government Code Section 65080.01.

Planning Practice Examples: Available in Appendix L

4.11 Coordinated Public Transit/Human Services Transportation Plans

The aim of the Coordinated Public Transit/Human Services Transportation Plan is to improve transportation services for persons with disabilities, older adults and individuals with lower incomes by ensuring that communities coordinate the available transit resources. Coordination enhances transportation access, minimizes duplication of services and facilitates the most appropriate cost-effective transportation system possible with available resources.

Federal transit law requires that projects selected for funding under the following FTA programs be derived from a coordinated plan: Enhanced Mobility of Seniors and Individuals with Disabilities Program (Title 49 U.S.C. Section 5310). Information on this program can be found at:

http://www.dot.ca.gov/hq/MassTrans

MPOs are not required to be the lead agency in the development of the coordinated plan. Federal guidance states that the coordinated plan may be developed separately or as a part of the metropolitan transportation planning process. In any case, MPOs should ensure that the plan is coordinated and consistent with their regions' metropolitan transportation planning process.

The coordinated plan must be developed through a process that includes representatives of public, private, and non-profit transportation and human services providers and participation by members of the public. The public participation requirements may be shared with those for the development of the RTP.

As with all FTA programs, transit projects selected for funding must be consistent with the RTP and FTIP. Further, the annual list of obligated projects is a planning requirement that will necessitate active involvement by the MPO in those programs.

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.306(h) states the regional planning process should be coordinated and consistent with the preparation of the coordinated public transit-human services transportation plan as required by Title 49 U.S.C. Section 5310.

Chapter 5

RTP Environmental Considerations

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RTP ENVIRONMENTAL CONSIDERATIONS

5.0 <u>Introduction</u>

This section will briefly discuss the context for environmental requirements, options for RTP environmental document preparation, federal requirements and recommendations outlined in the Statewide and Nonmetropolitan Transportation Planning *and* Metropolitan Transportation Planning Final Rule (FHWA/FTA Planning Final Rule), key resource areas for avoidance and mitigation and finally, a description of air quality and transportation conformity will be provided.

The federal government has shown its commitment to the environment through the passage of the National Environmental Policy Act (NEPA) in 1969, which requires federal agencies to consider the environmental impacts of their actions. In a similar vein, California passed the California Environmental Quality Act (CEQA) in 1970, which was designed to ensure that public agencies consider the environmental impacts of their decisions.

In California, the environmental review associated with the RTP and the subsequent project delivery process is two-fold. MPOs are responsible for the planning contained in the RTP that precedes project delivery. Typically a local government, consultant or Caltrans is responsible for the actual construction of the project i.e. project delivery. CEQA applies to the planning document (RTP) while both NEPA and CEQA may apply to the individual projects that implement the RTP during the project delivery process. Likewise, all RTP CEQA Analysis and subsequent transportation project CEQA analysis assess all environmental issue areas identified in the CEQA Guidelines Environmental Checklist Form, Appendix G.

A change to transportation analysis in environmental review under CEQA occurred with the Governor's approval of SB 743 which requires an update in the metrics of transportation impact used in CEQA from Level of Service and vehicle delay to one that promotes the reduction of GHGs, the development of multimodal transportation networks, and a diversity of land uses for transit priority areas. Except any of the events specified in Public Resources Code Section 21166, a residential, employment center, or mixed-use development project, including a subdivision or any zoning change is exempted from SB 743 requirements if the project is (a) within a transit priority area; (b) to implement and consistent with a specific plan for which an EIR has been certified; (c) consistent with the general use designation, density, building intensity, and applicable policies specified for the project area in an ARB-accepted SCS/APS (Public Resources Code Sections 21155.4 and 21099; Government Code Section 65080). Per ARB Vision Model results, reductions in VMT growth and widespread transportation electrification are needed to achieve sufficient GHG emissions reduction for climate stabilization, as reflected in executive orders on 2030 and 2050 GHG targets. The regulatory language (CEQA Guidelines changes) to implement the law are pending, though VMT has been identified by the Governor's Office as a potential metric to determine significant impacts. A future update of the RTP Guidelines will capture any "shoulds" or "shalls" resulting from the formal rulemaking process. Lead agencies should refer to current CEQA statutes, regulations, and case law when performing CEQA analysis for their RTPs/SCSs.

Given that protection of the environment is an important public policy goal and it is an important aspect of public acceptance during project delivery, best regional planning practices would seek to plan and implement transportation projects that would avoid or minimize environmental impacts.

5.1 Environmental Documentation

The RTP planning document as well as the projects listed in it are considered to be projects for the purposes of CEQA. Subsequent RTP amendments or updates are discretionary actions that can also trigger CEQA compliance. As defined in CEQA statute section 21065, a project means "an activity which may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment, and which is any of the following: (a) An activity directly undertaken by any public agency or (b) An activity undertaken by a person which is supported, in whole or in part, through contracts, grants, subsidies, loans, or other forms of assistance from one or more public agencies".

To initiate CEQA compliance, the MPO as the lead agency determines if the proposed action is a project and whether the project is statutorily or categorically exempt. If the project is not exempt from CEQA, an Initial Study or equivalent environmental assessment is completed. Based on the outcome of the Initial Study the appropriate type of environmental document is then prepared. The Initial Study can indicate the use of an Environmental Impact Report (EIR), a Mitigated Negative Declaration (MND) or a Negative Declaration (ND). Additionally, there are several types of EIRs such as a Master EIR, a Project EIR or a Program EIR. Information regarding the CEQA process and guidelines for implementation can be found at:

www.opr.ca.gov
http://opr.ca.gov/index.php?a=ceqa/index.html
http://resources.ca.gov/ceqa/
http://www.califaep.org/policy
http://ag.ca.gov/globalwarming/ceqa.php

California Air Pollution Control Officers Association (CAPCOA) White Paper on CEQA and Green House Gases:
http://www.capcoa.org/wp-content/uploads/2012/03/CAPCOA-White-Paper.pdf

Program EIR

Many MPOs prepare a Program Environmental Impact Report (PIER) to analyze the environmental impacts of implementing their RTP. The purpose of the PEIR is to enable the MPO to examine the overall effects of the RTP i.e. broad policy alternatives, program wide mitigation, growth inducing impacts and cumulative impacts can be considered at a time when the agency has greater flexibility to avoid unnecessary adverse environmental effects. The PEIR is a device that was originally developed by federal agencies under NEPA. The County of Inyo v. Yorty court case established its use under CEQA.

Additionally, environmental documents subsequently prepared for the individual projects contained in the RTP can be tiered off of the PEIR thus saving time and reducing duplicative analysis. Tiering refers to environmental review of sequential actions, where general matters and environmental effects are examined in a broad EIR for a decision such as adoption of a policy, plan, program, or ordinance, and subsequent narrower or site-specific EIRs are prepared that incorporate by reference the prior EIR and concentrate on environmental effects that can be mitigated or that were not analyzed in the prior EIR. In such instances, the later narrow EIR "tiers" off the prior broad EIR. If a project-specific EIR tiers off from a broader prior EIR such as the PEIR prepared for a RTP, it could help eliminate repetitive discussions of the same environmental issues; facilitate project-level impact analysis by focusing on issues specific to the later project; reduce the burdens from duplicative reconsiderations of a program, plan or policy with a certified EIR; and, reduce CEQA delay and paperwork at project level. (See Appendix J Glossary for a definition of ‘tiering’)

Changes to the RTP/FTIP

When the MPO modifies its RTP/FTIP, it must determine whether the proposed changes have the potential to impact the environment and trigger CEQA review. As a lead agency under CEQA, it is the responsibility of each MPO to analyze the potential environmental affects that proposed changes of their RTP may have on the environment. This should be done by providing substantial evidence that proposed changes to the RTP would be "minor" or "technical" in nauture, if there would be "new" or "more severe" significant environmental impacts, if "circumstances" of the project or "new environmental information" is discovered, or if "substantial" or "major changes" to the RTP are proposed. An abbreviated or focused type of CEQA document will usually suffice. The most common alternatives to an EIR, MND or ND are an Addendum, a Supplement, or a Subsequent environmental document.

Addendum

An Addendum may be prepared when minor technical changes or additions are made to the RTP. The Addendum makes the prior EIR, MND or ND adequate when the proposed changes to the RTP do not create any new or substantially more severe significant environmental impacts. An addendum does not require public circulation.

Supplement

A Supplement to the EIR need contain only the information necessary to make the previous EIR adequate for the project as revised. The supplement only needs to meet the circulation and public review requirements of a *draft* EIR.

Subsequent

A Subsequent EIR, MND or ND is used when there are substantial or major changes in the project, in the circumstances of the project or when new environmental information is discovered. A subsequent EIR, MND or ND is intended to be a complete environmental document and it requires the same full level of circulation and public review as the previous EIR, MND or ND.

NEPAs Applicability to the RTP

NEPA does not apply to the RTP. In the *Atlanta Coalition on the Transportation Crisis, Inc. v. Atlanta Regional Commission*, 559 F.2d 1333 (5th Cir. 1979) court case, federal judges found that “Congress did not intend NEPA to apply to state, local or private actions…” The courts recognized the development of the RTP and TIP as a matter of state and local sovereignty.

However, NEPA review does apply to the individual projects identified in the RTP during the project delivery process when the individual projects are federally funded and/or a federal approval is required (e.g. a permit for wetlands impacts). When NEPA review is required, implementing agencies should reference the Federal Council on Environmental Quality’s (CEQ) memorandum published on August 1, 2016 entitled, *Final Guidance for Federal Departments* *and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA reviews.* Section 6.28 provides further guidance for GHG reduction and Section 6.30 provides guidance for addressing adaption of the regional transportation system to climate change. The full CEQ guidance is available at:

https://ceq.doe.gov/current_developments/ceq_guidance_nepa-ghg-climate_final_guidance.html.

Requirements (Shall)
State: Public Resources Code 21000 et seq, Environmental Protection, and CEQA guidelines section 15000 et seq.

5.2 FHWA/FTA Planning Final Rule – Federal Environmental Requirements

Federal requirements are intended to enhance the consideration of environmental issues in the transportation planning process. Pursuant to Title 23 CFR Part 450.324, the RTP must provide a discussion of potential environmental mitigation activities and areas, including those mitigation activities that might maintain or restore the environment that is affected by the plan. This mitigation discussion must happen in consultation with Federal, State and Tribal land management and wildlife regulatory agencies. Additionally, federal regulations contain a planning process mandate that requires the MPO to compare the RTP with available state conservation plans or maps and inventories of natural or historic resources. This comparison is facilitated by the requirement to "consult as appropriate with state and local agencies responsible for land use management, natural resources, environmental protection, conservation and historic preservation". For additional information related to consultation with resource agencies on regional mitigation activities, see Section 4.10.

Requirements (Shall)
Federal:
Title 23 CFR Part 450.324(f)(10):
Requires that the RTP shall include a discussion of types of potential environmental mitigation activities and potential areas to carry out these activities, including activities that may have the greatest potential to restore and maintain the environmental functions affected by the metropolitan transportation plan. The discussion shall be developed in consultation with Federal, State, and Tribal land management, wildlife, and regulatory agencies.
Title 23 CFR Part 450.324(g)(1) and (2):
Requires that the MPO shall consult, as appropriate, with State and local agencies responsible for land use management, natural resources, environmental protection, conservation, and historic preservation concerning the development of the transportation plan. The consultation shall involve, as appropriate: (1) Comparison of transportation plans with State conservation plans or maps, if available; or (2) Comparison of transportation plans to inventories of natural or historic resources, if available.
Title 23 CFR Part 450.306(b)(5):
Requires that the metropolitan transportation planning process shall be continuous, cooperative, and comprehensive, and provide for consideration and implementation of projects, strategies, and services that will address the following factors: Protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and State and local planned growth and economic development

patterns. See Section 5.4 for key resource areas for avoidance and mitigation as well as planning practice examples in Appendix L.

Planning Practice Examples: Available in Appendix L

5.3 FHWA/FTA Planning Final Rule – Federal Environmental Recommendations

Appendix A - Linking the Transportation Planning and NEPA processes

Appendix A of Title 23 CFR Part 450 encourages environmental information developed during the transportation planning process to be applied to the project delivery process. The goal is to make planning decisions more sustainable and to maximize the effectiveness of mitigation strategies. Appendix A is optional. It provides details on how the information and analysis from the RTP can be incorporated into and relied upon in the NEPA documents prepared for the individual projects that will implement the RTP in the future. Appendix A presents environmental review as a continuum of sequential study, refinement, and expansion of information. The actual text of Appendix A to Title 23 CFR Part 450 is contained in Appendix D of this document. More guidance is available in Appendix E, which addresses the legal aspects of integrating planning and project delivery. Implementation of the strategies contained in Appendix A of Title 23 CFR Part 450 is a state of the art practice.

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.318 and Appendix A to Part 450 "Linking Planning and NEPA" describes the steps for streamlining the project delivery process by providing environmental information in the RTP.

Programmatic Mitigation

Recently updated federal regulations governing the development of metropolitan transportation plans include an updated section on programmatic mitigation. In particular, Title 23 CFR Sections 450.214 (State) and 450.320 (MPO), on the development of programmatic mitigation plans, indicate that "a State/MPO may utilize the optional framework to develop programmatic mitigation plans as part of the statewide transportation planning process to address the potential environmental impacts of future transportation projects." The FHWA supports an ecological approach to planning infrastructure and transportation projects and provides guidance on establishing a Regional Ecological Framework (REF). *Eco-logical* is a nine-step, voluntary framework that identifies an ecosystem approach to developing infrastructure projects. It outlines a framework for partners to integrate their planning processes, share data, and prioritize areas of ecological significance in order to harmonize economic, environmental, and social needs and objectives. Regionally significant resources like fish passage, terrestrial and aquatic habitat connectivity, migration corridors, and coastal trails can be incorporated into the regional transportation planning process. In addition, regional and local planning stakeholders can coordinate on mitigation strategies and conservation priorities as part of the regional transportation planning process. If the region elects to include the preparation of a REF or programmatic mitigation plan as part of the Regional Transportation Plan update, the region can notify other stakeholders to allow for a more collaborative partnering and planning effort. This environmental review toolkit is available at:

https://www.environment.fhwa.dot.gov/ecological/ImplementingEcoLogicalApproach/.

5.4 Key Resource Areas for Avoidance and Mitigation

Taking these environmental resources and laws into account during the transportation planning process can expedite the delivery of the projects that are contained in the RTP. The transportation planning process and the NEPA environmental analysis required during project delivery can work in tandem with the results of the transportation planning process informing the NEPA process. The RTP can identify plan-level environmental constraints and consider potential impacts that could allow projects in the plan to be modified to avoid or minimize impacts. Additional information regarding environmental planning considerations can be found in Section 2.7 and Appendix L. For a more in-depth discussion of potential environmental impact and resource areas, please see Volume 1 of the Standard Environmental Reference at:

http://www.dot.ca.gov/ser/vol1/vol1.htm

During project delivery SAFETEA-LU Section 6002 (23 U.S.C. Section 139, Efficient Environmental Reviews for Project Decision-making) set forth a new environmental review process. MAP-21/FAST Act made revisions to 23 U.S.C. 139 although the revisions are minor. The first step under Efficient Environmental Reviews for Project Decision-making is to initiate the environmental review process by notifying FHWA's Secretary of the type of work, termini, length, general location of the project, and a listing of anticipated federal permits. One means of initiating the process is to include the required information in the discussion of each EIS-level project that is contained in the RTP. The resource areas of concern are enumerated below.

Wetlands

Wetlands and other waters are protected under a number of laws and regulations, including the federal Clean Water Act, federal Executive Order for the Protection of Wetlands (E.O. 11990), and state Porter-Cologne Water Quality Control Act and parts of the state Fish and Wildlife Code. Section 404 of the Clean Water Act establishes a permit program that prohibits any discharge of dredged or fill material into wetlands or other "waters of the United States" if a practicable alternative exists that is less damaging to the aquatic environment or if the nation's waters would be significantly degraded. The Section 404 permit program is run by the U.S. Army Corps of Engineers (ACOE) with oversight by the U.S. EPA.

The Executive Order for the Protection of Wetlands (EO 11990) states that a federal agency, such as the FHWA, cannot undertake or provide assistance for new construction located in wetlands unless the head of the agency finds that there is no practicable alternative to the construction and the proposed project includes all practicable measures to minimize harm. Strategic retreat or relocation shall be one alternative to be considered.

At the state level, primarily the Department of Fish and Wildlife (CDFW) and the Regional Water Quality Control Boards (RWQCB) regulate wetlands and waters. (In certain circumstances, the California Coastal Commission or Bay Conservation and Development Commission may also be involved.) Impacts on wetlands, lakes, streams or rivers may require a Lake or Streambed Alteration agreement with CDFW. The RWQCB issues water quality certifications in compliance with Section 401 of the Clean Water Act.

Parks, Refuges, Historic Sites

Section 4(f) of the DOT Act (Title 49 U.S.C. Section 303) states that FHWA and FTA may not approve the use of land from a significant publicly-owned park, recreation area, wildlife and waterfowl refuge, or any significant historic site unless a determination is made that there is no other feasible and prudent alternative to the use of that land. Section 4(f) evaluations require the development of an avoidance alternative, however, if no feasible choices exist, extensive planning must be done to minimize harm to the property resulting from such use.

http://www.parks.ca.gov/

Cultural Resources

Cultural Resources are protected under a number of laws and regulations, including the National Historic Preservation Act (Section 106) and CEQA and the California Public Resources Code (PRC) 5024 et seq. Under Section 106 of the NHPA, federal agencies are mandated to take into account the effect of federal undertakings on historic properties affected by federally funded or federally approved undertakings. If avoidance is not an option, then minimization of impacts and mitigation of the effects are required. Under CEQA, a project which may cause a substantial adverse change in the significance of a historical resource would require mitigation of the project effects by the project's lead CEQA agency.

California Coastal Trail (CCT)

The CCT is a state-mandated trail system pursuant to the passage of SB 908 in 2001. AB 1396 in 2007 added Section 65080.1 to the Government Code, which mandates that provision for the CCT be provided in each RTP for those MPOs located along the coast. More information and guidance relative to the CCT can be found in Section 6.11 and at:

http://www.scc.ca.gov/

www.coastal.ca.gov

http://www.scc.ca.gov/webmaster/pdfs/CCT_Siting_Design.pdf

Floodplains

Executive Order 11988 (Floodplain Management) directs all federal agencies to refrain from conducting, supporting, or allowing actions in floodplains unless it is the only practicable alternative.

Threatened and Endangered Species

The primary federal law protecting threatened and endangered species is the federal Endangered Species Act (ESA) (Title 16 U.S.C. Section 1531 et seq.). This act provides for the conservation of endangered and threatened species and the ecosystems upon which they depend. Under Section 7 of this act, federal agencies, such as the FHWA, are required to consult with the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries

Service (NOAA Fisheries) to ensure that they are not taking actions likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat.

California has enacted a similar law at the state level, the California Endangered Species Act (CESA) (Fish and Game Code, 2050, et seq.). CESA emphasizes early consultation to avoid potential impacts to rare, endangered, and threatened species and to develop appropriate planning to offset project caused losses of listed species populations and their essential habitats.

http://www.dfg.ca.gov/

http://bios.dfg.ca.gov/

Cumulative Impacts

As defined in CEQA, cumulative impacts refer to "two or more individual impacts that, when considered together, are considerable or that compound or increase other environmental impacts". Because the RTP addresses long-range future transportation improvements, cumulative impacts are inherent and need to be fully discussed within the environmental document. Guidance on preparing cumulative impact analysis is available at:

http://www.dot.ca.gov/ser/cumulative_guidance/approach.htm.

Habitat Connectivity

Section 1797.5 of the California Fish and Game Code expresses the State's policy to promote the voluntary protection of wildlife corridors and habitat strongholds in order to enhance the resiliency of wildlife and their habitats to climate change, protect biodiversity, and allow for the migration and movement of species by providing connectivity between habitat lands. In order to further these goals, it is the policy of the State to encourage voluntary steps to protect the functioning of wildlife corridors through various means, such as the acquisition or protection of wildlife corridors as open space through conservation easements; the installation of wildlife-friendly or directional fencing; siting of mitigation and conservation banks in areas that provide habitat connectivity for affected fish and wildlife resources; and the provision of roadway undercrossings, overpasses, oversized culverts, or bridges to allow for fish passage and the movement of wildlife between habitat areas. Transportation facilities should be designed, engineered, planned, and programmed with habitat connectivity in mind in keeping with these State goals in order to maintain healthy ecological function and climate change resiliency in and between habitat areas.

AB 2087 (Chapter 455, Statutes of 2016) established a conservation planning tool called a Regional Conservation Investment Strategy to promote the conservation of species, habitats and other natural resources and enable advance mitigation for public infrastructure projects, including transportation. An RCIS provides a non-regulatory assessment and analysis of conservation needs in a region including habitat connectivity and climate resilience. Transportation agencies can use an approved RCIS to secure mitigation credit for conservation investments consistent with the RCIS.

Below are tools that can help speed along habitat corridor projects in a cost-effective way during the initial phases of project planning and design:

California Water Action Plan: 2016 Update:
http://resources.ca.gov/docs/california_water_action_plan/Final_California_Water_Action_Plan.pdf

California Essential Habitat Connectivity Project:
https://www.wildlife.ca.gov/conservation/planning/connectivity/CEHC

Western Governors Association's Crucial Habitat Assessment Tool:
http://www.wafwachat.org/map

California State Wildlife Action Plan: https://www.wildlife.ca.gov/SWAP/Final

Growth-Related Indirect Impacts

Growth-related indirect impacts are those impacts associated with a project or plan that would encourage or facilitate development or would change the location, rate, or type, or amount of growth. RTPs typically contain proposed actions that will be built along a new alignment and/or provide new access and those are the types of projects that will typically require a growth-related impact analysis. Where such impacts are identified, appropriate and reasonable steps to avoid or minimize indirect impacts can be considered early in the process, and incorporated into the RTP and its associated environmental document. Additional guidance on growth-related indirect impacts is available at:

www.dot.ca.gov/ser/Growth-related_IndirectImpactAnalysis/gri_guidance.htm

Air Quality Impacts

The Clean Air Act as amended in 1990 is the primary federal law that governs air quality. This law mandates the U.S. EPA to establish national air quality standards. The U.S. EPA must review the standards every five years and revise them as necessary to protect public health and welfare. RTPs for MPOs in nonattainment/maintenance areas are required to show compliance with the federal Clean Air Act through the transportation conformity process.

There is a California Clean Air Act in the Health and Safety Code that is generally similar in concept to the Federal Clean Air Act. Under the California Clean Air Act, the California Air Resources Board sets and updates State air quality standards. The California Clean Air Act requires attainment as expeditiously as practicable, but does not require RTPs to demonstrate conformity like the federal Clean Air Act.

Reducing emissions is critical to achieving improved health outcomes and meeting air quality standards. The regional planning process provides an excellent forum to promote measures to improve health and reduce emissions. When practicable, RTPs may discuss the public health impact associated with the operations of on-road passenger and freight vehicles, and seek to promote the implementation of the lowest emission technologies available to provide the needed utility for a proposed transportation network.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.306(b)(5) requires that the metropolitan planning process addresses protection and enhancement of the environment, among other planning factors

State: Government Code Section 65080(b)(2)(B)(v) requires that MPOs develop a sustainable communities strategy (which is part of the RTP) that shall gather and consider the best practically available scientific information regarding resource areas and farmland in the region as defined in subdivisions (a) and (b) of Government Code Section 65080.01.

Recommendations (Shoulds)
Federal: Title 23 CFR 450.318 and Appendix A to Part 450 "Linking Planning and NEPA" describe the steps for streamlining the project delivery process by providing environmental information in the RTP.

Planning Practice Examples: Available in Appendix L

5.5 Project Intent Statements/Plan Level Purpose & Need Statements

The 2003 RTP Guidelines Supplement referred to "**Project Intent Statements**" which were defined as **Plan Level Statements of Purpose and Need**. A Plan Level Statement of Purpose and Need is a short statement, which serves as a justification for a project or a group of projects. These brief plan level justifications would be contained in the RTP. An example of a Plan Level Statement of Purpose and Need would be the problem of reducing congestion on a specific route. The Plan Level Statements of Purpose and Need briefly identify the transportation needs or problems and describe the intended outcome of the project(s) that would meet these needs or solve the identified problems.

A more detailed, project specific **Project level Purpose and Need Statement** is written during the project delivery process and is contained in the project initiation document (Project Study Report) and the subsequent environmental document.

MPOs may wish to prepare Plan Level Statements of Purpose and Need during the development of the RTP for the following reasons:

1. To provide justification for the lead agency's projects in the RTIP
2. To justify expenditure of transportation funds to the public and the CTC
3. During project selection, to provide the rationale for selecting specific projects over other projects
4. To provide the foundation for Project Level Purpose and Need information in the environmental documents.
5. To provide consistent project justification from planning through project Implementation.

Recommendations (Shoulds)
State: The 2003 RTP Guidelines Supplement states that the RTP should include a project justification that identifies the specific need for the project and describes how these needs or problems will be addressed.

Planning Practice Examples: Available in Appendix L

5.6 Air Quality & Transportation Conformity

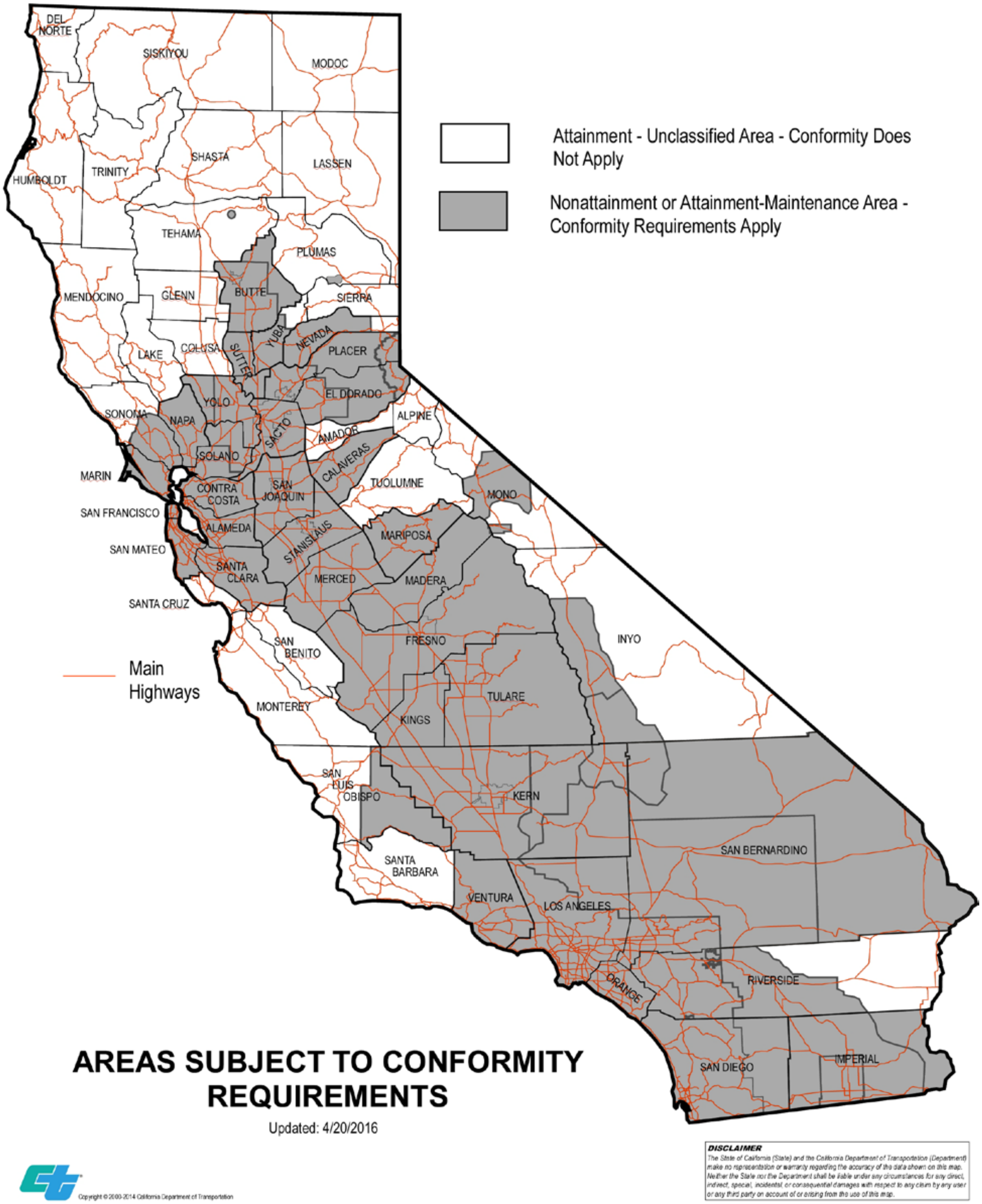
Federal and State Clean Air Act

The Clean Air Act as amended in 1990 is the primary federal law that governs air quality. This law mandates the U.S. EPA to establish the standards for the concentrations of pollutants that can be in the air. The U.S. EPA must review the standards every five years and revise them as necessary to protect public health and welfare. These standards are called National Ambient Air Quality Standards (NAAQS). Standards have been established for six criteria pollutants that have been linked to health concerns; the criteria pollutants are: carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM), lead (Pb), and sulfur dioxide (SO_2). The State Implementation Plan (SIP) is the statewide plan for achieving the goals of the Clean Air Act and describes how the NAAQS will be met. The SIP has both statewide and regional components. The California Air Resources Board is responsible for submitting the SIP to the U.S. EPA, and for developing and implementing statewide control measures such as those related to on-road mobile sources (vehicle emission controls). Local air pollution control and air quality management districts (APCD or AQMD) are responsible for regional control measures, which may also include measures that affect mobile sources (e.g., fleet rules, indirect source review requirements).

There is a California Clean Air Act in the Health and Safety Code that is generally similar in concept to the Federal Clean Air Act. Under the California Clean Air Act, the California Air Resources Board sets and updates State air quality standards. The State air quality standards are usually more stringent than the Federal, but the State air quality planning structure does not include the fixed attainment deadlines and conformity process found in the Federal program.

APCD or AQMD perform regional air quality planning in consultation with the MPO, including development of on-road mobile source emission budgets that are part of the SIP required by the Federal Clean Air Act. APCDs and AQMDs are the main implementation agencies for stationary source emission control programs.

The U.S. EPA designates an area as "attainment" if the area meets the NAAQS mandated by the Clean Air Act. If the area does not meet the NAAQS, it is designated as a nonattainment area. The area must then submit an attainment plan showing how the area will meet the NAAQs. Once a nonattainment area attains a NAAQS, the area may develop a maintenance SIP and submit a re-designation request, the U.S. EPA can re-designate the area as a "maintenance" area. The shaded areas on the map below illustrate the areas of the State that have not attained, or have attained with a maintenance SIP, the NAAQS. All of California except Lake County fails to attain one or more of the State ambient air quality standards.



Attainment - Unclassified Area - Conformity Does Not Apply
Nonattainment or Attainment-Maintenance Area - Conformity Requirements Apply
Main Highways
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
LAKE
COLUSA
SUTTER
YUBA
NEVADA
PLACER
YOLO
EL DORADO
SONOMA
NAPA
SACTO
ALPINE
AMADOR
SOLANO
CALAVERAS
MARIN
CONTRA COSTA
SAN JOAQUIN
TUOLUMNE
MONO
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA CLARA
MERCED
MADERA
SANTA CRUZ
FRESNO
INYO
SAN BENITO
MONTEREY
TULARE
KINGS
SAN LUIS OBISPO
KERN
SANTA BARBARA
SAN BERNARDINO
VENTURA
LOS ANGELES
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
AREAS SUBJECT TO CONFORMITY REQUIREMENTS
Updated: 4/20/2016
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SIP Transportation Conformity Requirement

Transportation conformity is required by section 176(c) of the 1990 Federal Clean Air Act. Transportation conformity to a SIP means that on-road transportation activities will not produce new air quality violations, worsen existing violations, or delay timely attainment of the NAAQS. In nonattainment and maintenance areas, federal regulations require that RTPs, FTIPs and Federally funded or approved highway and transit activities demonstrate transportation conformity. Under the 1990 Federal Clean Air Act Amendments, the U.S. DOT cannot fund, authorize, or approve Federal actions to support programs or projects that are not first found to conform to the SIP (Clean Air Act Section 176 (c), codified in 42 U.S.C. 7506(c)). The U.S. EPA has issued extensive regulations covering how conformity is determined for transportation planning, programming, and projects in 40 CFR 93 Subpart A. Under the EPA regulations, the RTP's regional transportation conformity analysis must include all regionally significant transportation (road and transit) activities regardless of funding source.

RTP Conformity

Transportation conformity is intended to ensure that Federal funding and approval are given to those transportation activities that support the purpose and goals of the SIP. Conformity ensures that these transportation activities do not degrade air quality and that they support attainment of the NAAQS. The MPO and the U.S. DOT (FHWA/FTA) have a responsibility to ensure that the RTP conforms to the SIP.

Transportation conformity requirements apply to all U.S. EPA designated nonattainment and maintenance areas. When areas are designated as nonattainment for the first time, or for a new NAAQS, a conformity determination must be made within one year of the effective date of the designation. RTP and FTIP amendments, Federal project approvals and Federal funding are all contingent upon the conformity determination that shows that the total emissions projected in the RTP and FTIP are within the motor vehicle emission limits or 'budgets' established in the SIP. Before budgets are established in the SIP, "interim" emission tests are also available. The conformity regulations also contain specific requirements for fiscal constraint and assumptions to be used in the emissions analysis.

No new transportation conformity requirements were created by MAP-21/FAST Act. However, previous requirements were modified to shorten or lengthen the time period for conformity determinations and re-determinations, to add or substitute transportation control measures (TCMs) in an approved SIP, and to adjust the frequency of conformity determinations. The Clean Air Act section 176(c) (42 U.S.C. 7506(c)) was amended, and U.S. EPA regulations at 40 CFR 93 Subpart A have been amended to conform to the Clean Air Act changes, as noted below.

RTPs are subject to regional conformity, while RTP projects not exempt from conformity are subject to project level conformity. Project cost, scope, and schedule must be consistent with the RTP. MPOs are encouraged to work closely with project sponsors to ensure no project delivery delays result from development of project level conformity determinations.

For more detailed information about transportation conformity please see the following key websites:
http://www.dot.ca.gov/hq/env/air/index.htm
http://www.epa.gov/otaq/stateresources/transconf/index.htm

Requirements (Shalls):
Federal: RTPs prepared by MPOs in areas subject to transportation conformity requirements shall meet the requirements of Title 42 U.S.C. Section 7506(c) and Title 40 CFR Part 93 Subpart A regarding transportation conformity. All of the specific conformity requirements are listed in CFR Section 93.100-129 and apply to all nonattainment and maintenance areas.

Title 40 CFR Part 93.104(b)(3) and (c)(3) sets the required frequency of transportation conformity determinations for RTPs and FTIPs at four years; Title 42 U.S.C. Section 7506(c)(2)(E) and Title 40 CFR Part 93.104(e) provide two years to determine conformity after new SIP motor vehicle emissions budgets are either found adequate, approved or promulgated; Title 42 U.S.C. Section 7506(c)(9) adds a one-year grace period before the consequences of a conformity lapse apply; Title 42 U.S.C. Section 7506(c)(4)(e) and Title 40 CFR Part 93.105 streamline requirements for conformity SIPs; and, Title 42 U.S.C. Section 7506(c)(8), Title 40 CFR Part 93.113, and EPA's policy January 2009 guidance (EPA420-B-09-002) identify procedures for areas to use in substituting or adding transportation control measures (TCMs) to approved SIPs.

Transportation Control Measures

The RTP shall discuss ways in which activities in the plan will conform to the SIP, including TCM implementation. To achieve consistency between the RTP and the SIP, all TCMs identified in the SIP and approved by U.S. EPA must be identified in the RTP by MPOs in areas subject to conformity requirements (Title 40 CFR Part 93.113).

The conformity analysis prepared for the RTP shall describe both completed TCMs and TCMs that are underway. TCMs that are included in the SIP must be implemented in a timely fashion. Implementation of the TCMs must be coordinated with the SIP implementation schedule. When there is a delay in TCM implementation, the conformity analysis document must describe the measure and the steps that the MPO is taking to address the delay. TCM projects must receive priority for funding.

Interagency Consultation

There is a formal interagency consultation requirement in areas subject to conformity requirements; see Title 40 CFR Parts 93.105 and 93.112. Consultation for key decisions related to the conformity analysis (and to many individual projects in areas subject to conformity because of particulate matter NAAQS nonattainment or maintenance) must include FHWA, FTA, U.S. EPA, ARB, Caltrans, the MPO, and local transit providers. The air pollution control/air quality management districts(s) shall also be included. Identifying the consultation partners and defining the form of local consultation procedures is the core of the "Conformity SIP" required by Title 40 CFR Part 51.390.

State: None. There is no conformity process in the California Clean Air Act. However, air quality is normally addressed as part of the CEQA environmental documentation for the RTP.

Recommendations (Shoulds)
Federal: Title 42 U.S.C. Section 7506(c)(7)(A) and Title 40 CFR Part 93.106 provide an option for reducing the time period addressed by conformity determinations. Normally, a regional

conformity analysis must cover at least 20 years, but under certain circumstances the time period covered may be reduced to not less than 10 years.

Planning Practice Examples: Available in Appendix L

5.7 Analysis of GHGs & Achievement of SB 375 GHG Targets

Pursuant to Public Resources Code Section 21083.05 and Sections 15064 and 15064.4 of the California Code of Regulations, the California Environmental Quality Act (CEQA) Guidelines require analysis of the potential direct, indirect, and cumulative greenhouse (GHG) emissions impacts and mitigation of any significant impacts. California Government Code Section 65080 requires that an MPO demonstrate that its SCS would, if implemented, achieve the GHG reduction targets set by ARB. These targets are established for each MPO region, for the years 2020 and 2035. MPOs are required to submit their final SCSs and quantification of the GHG emissions reductions to ARB for review and concurrence with the MPO's determination. If the SCS would not achieve the targets, then the MPO must prepare and adopt an Alternative Planning Strategy, describing the obstacles to achievement of the targets and alternative measures that would need to be taken to achieve the targets. Integration of climate change policies in the RTP coupled with analysis of climate impacts, and mitigation of significant impacts identified in the environmental document, supports the statewide effort to reduce GHG emissions and combat the effects of climate change. Additional information regarding state goals and policies relating to climate change is available in Section 2.2.

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Chapter 6

RTP Contents

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RTP CONTENTS

6.1 <u>Summary of RTP Components</u>

The development of the RTP is based on state and federal statutory and regulatory requirements in addition to CTC policy direction. As per Government Code 65080, each MPO shall prepare and adopt an RTP directed at achieving a coordinated and balanced regional transportation system including, but not limited to, mass transportation, highway, railroad, maritime, bicycle, pedestrian, goods movement and aviation. In addition, the RTP shall be action oriented and pragmatic, considering both short-term (0-10 years) and long-term (10-20 years) periods. The RTP shall be an internally consistent document and shall include all of the following:

The Policy Element

The purpose of the Policy Element is to identify legislative, planning, financial and institutional issues and requirements, as well as any areas of regional consensus. Consider referring to the CTP policy framework which provides goals and policies that can help with development of policies and strategies at the most regional level. The Policy Element presents guidance to decision-makers of the implications, impacts, opportunities, and foreclosed options that will result from implementation of the RTP. Moreover, the Policy Element is a resource for providing input and promoting consistency of action among state, regional and local agencies including; transit agencies, congestion management agencies, employment development departments, the California Highway Patrol, private and public groups, tribal governments, etc. California statutes state that each RTP shall (Government Code Section 65080 (b)) include a Policy Element that:

1. Describes the transportation issues in the region;
2. Identifies and quantifies regional needs expressed within both short and long-range planning horizons (Government Code Section 65080 (b)(1)); and,
3. Maintains internal consistency with the Financial Element and fund estimates.

State law requires that the objectives shall (Government Code Section 65080 (b)(1)) be linked to short-range and long-range transportation implementation goals or horizons. Each objective should be consistent with the needs identified in the RTP as a means of strengthening the linkage between statewide system planning and ultimate project implementation. The RTP shall consider factors specified in Section 134 of Title 23 of the United States Code.

The Policy Element should clearly convey the region's transportation policies and supportive strategies and related land use forecast assumptions. These land-use assumptions take into account the latest planning documents and associated policies of the local jurisdictions. As part of this Element, the discussion should: (1) relay how these policies were developed, (2) identify any significant changes in the policies from the previous plans and (3) provide the reason for any changes in policies from previous plans. The Policy Element should clearly describe the SCS strategies, including land use, transportation, and other measure intended to reduce per capita GHG emissions from passenger vehicles. It should also explain how the financial commitments are consistent with and support the land use pattern and personal mobility objectives of the RTP.

Although not required by law, MPOs should identify a set of indicators that will be used to assess the performance of the RTP. In addition, the RTP should identify the criteria that the MPO or RTPA/County Transportation Commission used to select the transportation projects on the constrained and unconstrained project lists. More information for performance measurement is available in Chapter 7.

The Sustainable Communities Strategy (SCS)

The second component of the RTP (for MPOs only) is a Sustainable Communities Strategy (SCS), as required by Government Code Section 65080(b)(2)(B). The SCS is statutorily required to:

1. Identify the general location of uses, residential densities, and building intensities within the region.
2. Identify areas within the region sufficient to house all the population of the region, including all economic segments of the population over the course of the planning period of the regional transportation plan taking into account net migration into the region, population growth, household formation and employment growth.
3. Identify areas within the region sufficient to house an eight-year projection of the regional housing need for the region pursuant to Government Code Section 65584.
4. Identify a transportation network to service the transportation needs of the region.
5. Gather and consider the best practically available scientific information regarding resource areas and farmland in the region as defined in subdivisions (a) and (b) of Government Code Section 65080.01.
6. Consider the state housing goals specified in Sections 65580 and 65581.
7. Utilize the most recent planning assumptions, considering local general plans and other factors (see Section 6.25 for additional guidance).
8. Set forth a forecasted development pattern for the region, which, when integrated with the transportation network, and other transportation measures and policies, will reduce the GHG emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the GHG emission reduction targets approved by the ARB.
9. Provide consistency between the development pattern and allocation of housing units within the region (Government Code 65584.04(i)(1)
10. Allow the regional transportation plan to comply with Section 176 of the federal Clean Air Act (42 U.S.C. Section 7506)

The Action Element

The third major component as required in Government Code Section 65080 states that RTPs shall have an Action Element. The Action Element of the RTP must describe the programs and actions necessary to implement the RTP, including the SCS, and assigns implementation responsibilities. The action element may describe the transportation projects proposed to be completed during the RTP plan horizon, and must consider congestion management activities within the region. All transportation modes (highways, local streets and roads, mass transportation, rail, maritime, bicycle, pedestrian and aviation facilities and services) are addressed. The action element is critical to providing clear direction about the roles and responsibilities of the MPO and other agencies to follow through on the RTP's policies and projects. It consists of short and long-term activities that address regional transportation issues and needs. In addition, the Action Element should also identify investment strategies, alternatives and project priorities beyond what is already programmed.

The Action Element is divided into two sections. The first section includes a discussion of the preparatory activities such as identification of existing needs, assumptions, and forecasting and potential alternative actions. The second section addresses the data and conclusions.

The Financial Element

The Financial Element is also statutorily required. The Financial Element is fundamental to the development and implementation of the RTP. It identifies the current and anticipated revenue sources and financing techniques available to fund the planned transportation investments described in the Action Element. The intent of the Financial Element is to define realistic financing constraints and opportunities. Finally, with this financing information, alternatives are developed and used by State and local decision-makers to determine which projects should be planned for funding.

There are six major components that constitute the Financial Element:

1. Summary of costs to operate and maintain the current transportation system;
2. Estimate of costs and revenues to implement the projects identified in the Action Plan;
3. Inventory of existing and potential transportation funding sources;
4. List of candidate projects if funding becomes available;
5. Potential funding shortfalls; and,
6. Identification of alternative policy directions that affect the funding of projects.

Government Code Section 65080 (b)(4)(C) states that the MPO or county transportation agency, whichever entity is appropriate, shall consider financial incentives for cities and counties that have resource areas or farmland, as defined in Government Code Section 65080.01, for the purposes of, for example, transportation investments for the preservation and safety of the city street or county road system and farm to market and interconnectivity transportation needs. The MPO or county transportation agency, whichever entity is appropriate, shall also consider financial assistance for counties to address countywide service responsibilities in counties that contribute towards the GHG emission reduction targets by implementing policies for growth to occur within their cities.

It is very important that RTPs reflect the transportation needs of the specific region. There are State statutory content requirements for the SCS, Policy, Action and Financial Elements of the RTP; however, there is flexibility in choosing a format for the presentation of this information. Most MPOs/RTPAs use the categories of Policy, Action and Financial to organize their RTP.

Consistency between the SCS & the RTP Policy, Financial & Action Elements

The RTP shall be an “internally consistent” document. This means that the contents of the Policy, Action, Financial Elements, and Sustainable Communities Strategy shall be consistent with one another. As a result, transportation investments and the forecasted development pattern in the SCS should be complementary and not contradictory. For information regarding transportation projects exempt from the internal consistency provisions of SB 375 pursuant to Government Code Section 65080(b)(2)(L) please refer to Section 6.16 of these Guidelines.

For more detailed information regarding the contents of an SCS please refer to Section 6.25 of the RTP Guidelines.

Other RTP Contents

The RTP should also include the following:

1. Executive Summary – An Executive Summary of the RTP as an introductory chapter. The Executive Summary should provide a regional perspective, and identify the challenges and transportation objectives to be achieved.
2. Reference to regional environmental issues and air quality documentation needs.
3. Discussion of types of potential environmental mitigation activities that might maintain or restore the environment that is affected by the RTP (refer to Section 5.2 for Federal Environmental Requirements)

Requirements (Shalls)
Federal: Title 23 CFR Part 450.324
State: California Government Code Section 65080

6.2 <u>Financial Overview</u>

Federal statute and regulations and California State statute requires RTPs to contain an estimate of funds available for the 20-year planning horizon. This discussion of financial information is fundamental to the development and implementation of the RTP. The financial portions of the RTP identify the current and anticipated revenue sources and financing techniques available to fund the planned transportation investments described in other portions of the RTP. The intent is to define realistic financing constraints and opportunities. All projects, except illustrative projects i.e. unconstrained projects, must be fully funded in order to be included in the RTP. With this financing information, alternatives are developed and used by the MPO, local agencies and State decision-makers in funding transportation projects. During programming and project implementation the total cost of the project is refined and broken out by cost per phase.

Federal law requires each transportation plan and each transportation improvement program prepared by the MPO to include a financial plan that demonstrates how the adopted Plan and TIP can be implemented. The Financial Plan should also indicate resources from public and private sources that are reasonably expected to be made available to carry out the transportation plan and FTIP, identify innovative financing techniques to finance projects, programs and strategies, and recommend any additional financing strategies for needed projects and programs. The Federal statutory requirements are codified in Title 23 U.S.C. Section 134(i)(2)(C) and 134(j)(2)(B). Federal regulations pertaining to financial planning and constraint for statewide and metropolitan transportation plans and programs are codified in Title 23 CFR Part 450.

There are six major components that should be addressed in the financial portion of the RTP:

1. <u>Projected Available Funds</u> – The MPO, public transit operators and the State shall cooperatively develop estimates of funds that will reasonably be available to support RTP implementation. All anticipated public and private financial resources available over the next 20 years, including estimated highway, local streets and roads, bicycle and pedestrian and transit funds, shall be identified. The financial plan shall include

recommendations for additional financing strategies. New funding sources and strategies shall also be identified. All revenue estimates for the financial plan must use an inflation rate that reflects the "year of expenditure dollars" developed cooperatively by the MPO, State and transit operators.

2. Projected Costs – The MPO shall take into account all projects and strategies proposed for funding with Federal, State, local and private fund sources in developing the financial plan. Estimate of costs to implement the projects identified in the four year FTIP and the RTP must be included. Both the revenue and construction cost estimates must use inflation rates to reflect "year of expenditure dollars" based on reasonable financial principles and information developed cooperatively by the MPO State and public transportation operators.

3. Projected Operation and Maintenance Costs – The financial plan shall contain system level estimates of costs and revenue sources that are reasonably expected to be available to adequately operate and maintain Federal-aid highways and public transportation. Planning practice examples in developing the RTP financial plan would also include revenue sources for the operation and maintenance of local streets and roads as well as bicycle and pedestrian facilities. A summary of costs to operate and maintain the current transportation system should be included. This should be identified by mode and include the cumulative cost of deferred maintenance on the existing infrastructure. Financial plans that support the RTP process must assess capital investment and other measures necessary to ensure the preservation of:

   A) The existing transportation system, including requirements for operational improvements;
   B) Resurfacing, restoration, and rehabilitation of existing and future major roadways, as well as operations, maintenance, modernization, and rehabilitation of existing and future transit facilities.

4. Constrained RTP - Financially constrained list of candidate projects with the available funding (short and long-term). MPOs are encouraged to provide the timing or year of construction for major investments, as practicable.

5. Un-Constrained (Illustrative) List of Projects - Un-constrained (Illustrative) list of candidate projects if additional funding becomes available (short and long-term). The financial plan may include additional projects that would be included in the adopted transportation plan if additional resources were to become available.

6. Potential Funding Shortfall. The short and long-term needs for system operation, preservation, and maintenance can be enormous. Simply maintaining the existing system can demand a huge investment, while system expansion demands investments of a similar scale. At times, the combination of these competing demands can cause temporary shortfalls to an MPOs budget. To the extent there appear to be shortfalls, the MPO must identify a strategy to address these gaps in funding prior to the adoption of a new RTP - or the amendment of an existing RTP. The strategy should include an action plan that describes the steps to be taken that will make funding available within the time frame shown in the financial plan and needed to implement the projects in the long-range transportation plan. There should be, among other things, a range of options to address projected shortfalls. The strategy may rely upon the MPO or transit operators'

past record of obtaining funding. If it relies on new funding sources, the MPO must demonstrate that these funds are reasonably expected to be available.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.324(f)(11)
State: California Government Code Section 65080(b)

Planning Practice Examples: Available in Appendix L

6.3 Fiscal Constraint

Fiscal constraint is the demonstration of sufficient funding (Federal, State, local and private) to operate and maintain transportation facilities and services and to implement planned and programmed transportation system improvements. Fiscal constraint can also be thought of as the description of fully funded projects in the RTP based on the projected available revenues during the 20 plus year planning horizon.

Title 23 CFR Part 450.104 provides the following definition of fiscal constraint or fiscally constrained: "(it) means that the metropolitan transportation plan, TIP, and STIP includes sufficient financial information for demonstrating that projects in the metropolitan transportation plan, TIP and STIP can be implemented using committed, available or reasonably available revenue sources, with reasonable assurance that the federally supported transportation system is being adequately operated and maintained. For the TIP and the STIP, financial constraint/fiscal constraint applies to each programming year. Additionally, projects in air quality nonattainment and maintenance areas can be included in the first two years of the TIP or STIP only if funds are 'available' or 'committed'."

To support air quality planning under the 1990 Clean Air Act Amendments, a special requirement has been placed on air quality nonattainment and maintenance areas, as designated by the U.S. EPA. Specifically, projects in air quality nonattainment and maintenance areas can be included in the first two years of the FTIP only if funds are "available or committed" (Title 23 CFR Part 450.324(e)). Available funds include those derived from an existing source of funds dedicated to or historically used for transportation purposes. For Federal funds, authorized and/or appropriated funds and the extrapolation of formula and discretionary funds at historic rates of increase are considered "available." Committed funds include funds that have been bound or obligated for transportation purposes. For State funds that are not dedicated to or historically used for transportation purposes, only those funds over which the Governor has control may be considered as "committed." For local and private sources not dedicated to or historically used for transportation purposes, a commitment in writing/letter of intent by the responsible official or body having control of the funds constitutes a "commitment." Additionally, EPA's transportation conformity regulations specify that an air quality conformity determination can only be made on a fiscally constrained RTP and FTIP (Title 40 CFR Part 93.108). New funding for RTP projects from a proposed gas tax increase, a proposed regional sales tax, or a major funding increase still under consideration would not qualify as "available or committed" until it has been enacted by legislation or referendum i.e. the period of time between the sunset date of the current regional sales tax and before the next legislative or referendum action to restore or increase funding. Therefore, nonattainment and maintenance areas may rely on existing revenue, newly approved tax revenue, or other newly approved revenue sources for the first two years of the FTIP.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.324(f)(11)
State: California Government Code Section 65080(b)

Planning Practice Examples: Available in Appendix L

6.4 Listing of Constrained & Un-constrained Projects

In addition to the current list of financially constrained projects identified in the RTP, each Plan should contain a list of needed unconstrained projects (Illustrative projects). Illustrative projects are additional transportation projects that may (but is not required to) be included in the RTP if reasonable additional resources were to become available. This unconstrained list will identify projects that are recommended by the MPO without a funding source identified. The list should be included separately from the financially constrained project list. It is also preferred that projects on the unconstrained list be identified by transportation corridor within the region.

The following is accomplished by including a list of regionally desired un-funded (Illustrative) transportation projects in the RTP:

1. Identifies projects that could be funded, should additional funding become available.
2. Allows for a more accurate determination of overall transportation needs.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.324(f)(11) Requires a fiscally constrained list of projects.

Recommendations (Shoulds)
Federal: Title 23 CFR part 450.324(f)(11)(vii) For illustrative purposes, the list of projects may include additional projects if an additional source of funds is located.

Planning Practice Examples: Available in Appendix L

6.5 Revenue Identification & Forecasting

Revenue forecasts for RTPs can take into account new funding sources that are "reasonably expected to be available." New funding sources are revenues that do not currently exist or that may require additional steps before the MPO or transit agency can commit such funding to transportation projects. As codified in federal regulations, strategies for ensuring the availability of these planned new revenue sources must be clearly identified. Future revenues may be projected based on historical trends, including consideration of past legislative or executive actions. The level of uncertainty in projections based on historical trends is generally greatest for revenues in the "outer years" (10 years or more) of an RTP.

According to Title 23 CFR Part 450.324(f)(11)(iv), the MPO shall take into account all projects and strategies proposed for funding under Title 23 U.S.C.; Title 49 U.S.C. Chapter 53; other Federal funds; State transportation funds; local funding sources and private sources of funds for transportation projects. Beginning December 11, 2007, funding estimates contained in the RTP must use an inflation rate to reflect “year of expenditure dollars”.

Title 23 CFR Part 450.324(f)(11)(viii) states: “In cases that the FHWA and the FTA find a metropolitan transportation plan to be fiscally constrained and a revenue source is subsequently removed or substantially reduced (i.e. by legislative or administrative actions), the FHWA and FTA will not withdraw the original determination of fiscal constraint; however, in such cases, the FHWA and FTA will not act on an updated or amended metropolitan transportation plan that does not reflect the changed revenue situation.” The same policy applies if project costs or operations/maintenance cost estimates change after an RTP or FTIP is adopted. Such a change in cost estimates does not invalidate the adopted transportation plan or program. However, the revised costs must be provided in new or amended RTPs and FTIPs. In such cases, FHWA will expect the MPO to identify alternative sources of revenue as soon as possible. In such cases the FHWA/FTA will not act on new or amended RTPs or FTIPs unless they reflect the changed revenue and project cost situation. If FHWA and FTA find an RTP or FTIP to be fiscally constrained and the planned/programmed projects are included based on outdated or invalid cost estimates, then FHWA/FTA will not make funding or environmental approval actions for the listed project(s) unless the RTP and FTIP are updated or amended to reflect the latest project cost estimate.

The estimated revenue by existing revenue source (local, State, Federal and private) available for transportation projects shall be determined and any shortfalls identified. Proposed new revenues and/or revenue sources to cover shortfalls shall be identified, including strategies for ensuring their availability for proposed investments. Existing and proposed revenues shall cover all forecasted capital, operating, and maintenance costs. All cost and revenue projections shall be based on the data reflecting the existing situation and historical trends. For nonattainment and maintenance areas, the financial plan element shall address the specific financial strategies required to ensure the implementation of projects and programs (TCMs) to reach air quality compliance

Requirements (Shalls)
Federal: Title 23 CFR Part 450.324(f)(11)
State: California Government Code Section 65080(b)

Planning Practice Examples: Available in Appendix L

6.6 Estimating Future Transportation Costs

Federal regulations require that (Title 23 CFR Part 450.324(f)(11)(iv)) costs of future transportation projects must use “year of expenditure dollars” rather than “constant dollars” in cost and revenue estimates to better reflect the time-based value of money. MPOs must ensure project costs identified in both the RTP and FTIP are in year of expenditure dollars. This is particularly crucial for large-scale projects with construction/implementation dates stretching into the future. For those MPOs located in air quality nonattainment and maintenance areas the financial plan developed by the MPO shall address the specific financial strategies and funding sources required to ensure the implementation of TCMs whether or not the TCMs are identified in the SIP pursuant to Title 23 CFR Part 450.324(f)(11)(vi).

Reporting the costs in year of expenditure dollars will provide the proper context to express a more realistic estimate of future construction costs. After cost estimates are prepared for the RTP and FTIP, the costs should be expressed in year of expenditure dollars. This can be done by assigning an inflation rate per year to the proposed midpoint of construction. Make certain that the selected year of expenditure reflects a realistic scenario, taking into account project planning and development durations, as well as construction. Inflation rates may be different for specific cost elements (e.g. construction vs. right-of-way). The RTP should clearly specify how inflation is considered in the estimate and clearly State that the estimate is expressed in year of expenditure dollars. Consider multiple sources for determining the inflation rate, including nationwide and local references. Include consideration of any locality-specific cost factors that may reflect a growth rate significantly in excess of the inflation rate, such as land acquisition costs in highly active markets. The inflation rate(s) should be based on sound, reasonable financial principles and information, developed cooperatively by the MPO and transit agencies. To ensure consistency, similar financial forecasting approaches ideally should be used for both the RTP and FTIP. In addition, the financial forecast approaches, assumptions, and results should be clear and well documented.

Revenues and related cost estimates for operations and maintenance should be based on a reasonable, documented process. Some accepted practices include:

Trend analysis - A functional analysis based on expenditures over a given duration, in which costs or revenues are increased by inflation, as well as a growth percentage based on historic levels. This analysis could be linear or exponential. When using this approach, however, it is important to be aware of new facilities or improvements to existing facilities. Transit operations and maintenance costs will vary with the average age of the bus or rail car fleet.

Cost per unit of service – Examples include: lane-mile costs; centerline mile costs; traffic signal cost; transit peak vehicles by vehicle type; revenue hours; and vehicle-miles by vehicle type.
Regardless of the methodology employed, the assumptions should be adequately documented by the MPO and transit agency. Estimating current and reasonably available new revenues and required operations and maintenance costs over a 20-year planning horizon is not an exact science. To provide discipline and rigor, MPOs and transit operators should attempt to be as realistic as possible, as well as ensure that all costs assumptions are publicly documented.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.324(f)(11)
State: California Government Code Section 65080(b)

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.324(f)(11)(v) authorizes the option to use aggregate cost ranges or bands in the outer years of the RTP.

Planning Practice Examples: Available in Appendix L

6.7 Asset Management

The transportation system in California continues to experience substantial wear and tear from increased vehicle miles traveled, growing population, and greater congestion to aging infrastructure and escalating operating costs. These challenging circumstances put greater demands than ever on the transportation system. The goal of asset management is to minimize the life-cycle costs for managing and maintaining transportation assets, including roads, transit, bridges, tunnels, runways, rails, and roadside features.

As the state becomes more multimodal, consideration of policies from the CTP regarding the importance of evaluating the multimodal life cycle cost can help preserve and maintain transportation facilities. These policies can also assist in developing a strategic approach to assess and prioritize transit assets helping to select projects most in need of funding.

The American Association of State Highway and Transportation Officials (AASHTO) define asset management as:

> *"A strategic and systematic process of operating, maintaining, upgrading, and expanding physical assets effectively through their life cycle. It focuses on business and engineering practices for resource allocation and utilization, with the objective of better decision making based upon quality information and well defined objectives."*

Through the use of asset management systems, engineering and economic analysis, and other tools, MPOs and transit operators can more comprehensively view the big picture and evaluate collected data before making decisions as to how specific resources should be deployed. Asset management principles and techniques should be applied throughout the planning process, from initial goal setting and long-range planning to development of the TIP and then through operations, preservation, and maintenance.

MPOs should ensure the transportation system is managed to meet both current and future condition and performance demands and that expenditures are optimal. Asset management principles and techniques are valuable tools that can be applied by an MPO and result in more effective decision making. The MPO role in a successful asset management program includes defining performance measures for assets through public involvement, serving as a repository for asset data, and promoting standard data collection technology applications, and making investment decisions based on measured performance relative to established goals. MPOs can also educate the public and decision makers and work cooperatively with stakeholders across transportation modes.

Title 23 CFR Part 450.306(e) states the following concerning asset management:

> *"In carrying out the metropolitan transportation planning process, MPOs, States, and public transportation operators may apply asset management principles and techniques in establishing planning goals, defining TIP priorities, and assessing transportation investment decisions, including transportation system safety, operations, preservation, and maintenance, as well as strategies and policies to support homeland security and to safeguard the personal security of all motorized and non-motorized users."*

MPOs should consider including asset management principles in the development of their RTPs. The following are the benefits of applying transportation asset management during the planning process:

1. Maximize transportation system performance.
2. Improve customer satisfaction.
3. Minimize life-cycle costs.
4. Mitigate system vulnerabilities.

5. Match service provided to public expectations.
6. Make more informed, cost-effective program decisions and
7. Better use of existing transportation assets.

Additional information is available from the FHWA at:

http://www.fhwa.dot.gov/infrastructure/asstmgmt/tpamb.cfm

Requirements (Shalls)
Federal: MAP-21/FAST Act establish limitations on federal funding flexibility if the aggregate bridge condition in California does not meet certain minimum conditions for National Highway System (NHS) bridges. Caltrans or the appropriate entity shall monitor the current structurally deficient bridge deck area and make the necessary investment decisions that result in less than 10% of the agencies' NHS bridge deck area being structurally deficient.

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.306(e) - MPOs, States, and public transportation operators may apply asset management principles and techniques in establishing planning goals, defining TIP priorities, and assessing transportation investment decisions.
State: None

Planning Practice Examples: Available in Appendix L

Modal Discussion

The RTP is the key document prepared by the MPO that reflects future plans of the transportation system for the region. This future vision includes all modes of transportation and is one of the key functions of the RTP.

Both federal regulations and state statute require RTPs to address each transportation mode individually. Title 23 CFR Part 450.324(b) states: "*the transportation plan shall include strategies/actions that lead to the development of an integrated multimodal transportation system to facilitate the safe and efficient movement of people and goods in addressing current and future transportation demand*."

It is also important for MPOs to integrate modal considerations to enable the development of a complete and connected multimodal transportation system. As modes often overlap (e.g. transit vehicles and private vehicles use the same modes, and people and goods use multiple modes), consider how all transportation modes interact with one another, and how improvements in one mode can benefit the entire transportation system.

SB 375 requires MPOs to meet GHG per capita reduction targets, if feasible. It allows discretion in scenario development. Transportation infrastructure investment, among many other factors, affect travel patterns, mode choice, and VMT. In general, the RTP Guidelines recognize that some studies suggest that investments in roadway capacity tend to cause increases in VMT and GHGs; however, there are exceptions depending on project location and the current transportation network.

These studies are summarized in materials available on the following Caltrans and ARB websites:

National Center for Sustainable Transportation Research Brief:
http://www.dot.ca.gov/newtech/researchreports/reports/2015/10-12-2015-NCST_Brief_InducedTravel_CS6_v3.pdf
Air Resources Board Brief:
http://www.arb.ca.gov/cc/sb375/policies/hwycapacity/highway_capacity_brief.pdf
Air Resources Board Technical Background Document:
http://www.arb.ca.gov/cc/sb375/policies/hwycapacity/highway_capacity_bkgd.pdf

Title 23 CFR Part 450.324(f)(2) requires that RTPs address both existing and proposed transportation facilities such as major roadways, transit lines (both rail and primary bus routes), multimodal and intermodal connector facilities, pedestrian walkways and bicycle facilities.

California Government Code Section 65080(a) states that transportation planning agencies shall prepare and adopt an RTP directed at achieving a coordinated and balanced regional transportation system that includes mass transportation, highway, railroad, maritime, bicycle, pedestrian, goods movement, and aviation facilities.

6.8 Highways

The section of the RTP discussing highways should consider the following:

1. An overview of the primary highway and arterial road system within the region;
2. National and State highway system, and regionally significant streets and roads;
3. Any corridor preservation processes for possible future transportation projects (i.e. right of way, historic highways, abandoned highways or rails);
4. Maintenance of State highways;
5. Data collection and other infrastructure requirement for ITS;
6. Unmet highway needs;
7. Consider CTP policy suggesting strategic investing to optimize performance;
8. Consider CTP policy suggesting the application of sustainable preventative maintenance and rehabilitation strategies;
9. Consider investing in HOV-related emerging technologies and by promoting the use of zero-emission vehicles on the highway network to reduce GHG emissions;
10. Consider investing strategically to advance widespread transportation electrification; and,
11. Consider emissions from highways, and their impact on adjacent communities.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.324(b) requires short and long-range strategies for an integrated multimodal transportation system.
State: Government Code Section 65080(a) requires that the RTP shall be directed at achieving a coordinated and balanced regional transportation system.

6.9 Local Streets & Roads

Local streets and roads are critical to provide an interconnected, multi-modal transportation system where every trip begins and ends. Investment in local streets and roads is an investment in public safety, economic growth, goods movement and farm to market needs. According to 2013 California Public Road Data compiled by Caltrans Division of Research, Innovation & System Information, counties and cities maintain 81 percent of the maintained miles within the State of California and carry 45 percent of the total annual miles of vehicle travel. The condition of local streets and roads continue to deteriorate due to the funding shortfalls and will be further challenged by the escalating repair costs in future years. Adequately investing in the local system is critical to protect the public's current investment. The local system will become ever more important in supporting the goals of climate change and building sustainable communities, as local streets and roads serve as the right-of-way for transit, bicycle and pedestrian travel.

The section of the RTP discussing local streets and roads should consider the following:

1. The preservation needs for the local road system, including but not limited to pavement and essential components to support travel by bicycle, bus, pedestrian, or automobile (including the unmet need for maintaining and preserving the existing local streets and road, public transit, bicycling and pedestrian transportation system);
2. Bi-annual Data collection and periodic collaborative efforts to update system-wide local streets and road preservation needs (including deferred maintenance);
3. Encouraging all agencies to utilize Pavement Management Software (PMS) in their data collection efforts;
4. The benefits of achieving Best Management Practices (BMPs) for the local streets and roads and maintaining them at that level;
5. The issue of declining local streets and roads maintenance revenues in connection with rising maintenance costs and achieving SB 375 goals;
6. System preservation assessments such as bridges, safety, traffic signals, transit stop, signage, lane and crosswalk striping, sidewalks, curb ramps, lighting, drainage, landscaping, and other elements within the road right-of-way to support a functioning and integrated multi-modal system; and,
7. The benefits of active transportation and how the RTP supports active transportation planning.

References
1. 2013 California Public Road Data – Statistical Information derived from the Highway Performance Monitoring System. Prepared by Caltrans Division of Research, Innovation & System Information. Available online at:

   http://www.dot.ca.gov/hq/tsip/hpms/datalibrary.php

Requirements (Shalls)
Federal: Title 23 CFR Part 450.324(b) requires short and long-range strategies for an integrated multimodal transportation system.
State: Government Code Section 65080(a) requires that the RTP shall be directed at achieving a coordinated and balanced regional transportation system.

6.10 Transit

Transit plays a key role in the regional effort to reduce traffic congestion, VMT and vehicle emissions particularly in urbanized areas. The increased use of transit is a key element to meeting legislative requirements such as AB 32 and SB 375 that aim to reduce GHG emissions that contribute to global warming. Transit systems also play an important role in the mobility for those who are unable to drive, including youth and the elderly, as well as low-income individuals, and people with disabilities. Given these reasons, it is crucial for MPOs to engage in a continual and comprehensive dialogue with the transit operators within their region. The CTP highlights the positive impacts of public transportation and suggests the integration of multimodal transportation and land use development which can help establish areas within regions that can be possible locations for Transit Oriented Developments (TODs).

The section of the RTP addressing mass transportation issues (including regional transit services and urban rail systems) should address:

1. Identification of passenger transit modes within the region (bus, light and heavy rail, etc.);
2. Integration with transit, highway, street and road projects (including identification of priorities);
3. Implementation plans, operational strategies and schedule for future service (including construction and procurement);
4. Operational integration between transit fleets, and other modes (passenger rail, aviation, taxis, etc.);
5. First/last mile transit connectivity considerations;
6. Summation of the short and long range transit plans along with the capital finance plans for the 20-year period of the RTP;
7. Short and long-range transit plans and capital finance plans for the 20-year RTP period;
8. Inventory of bus fleets by fuel type (diesel, natural gas, and other alternative fuels);
9. Unmet transit needs;
10. Urban and commuter rail project priorities;
11. ITS elements to increase efficiency, safety and level of service;
12. Integration with local land use plans that could increase ridership; and,
13. A measure of transit capacity utilization for peak and off-peak service to evaluate service effectiveness.

In addition, MAP-21/FAST Act added a new requirement for RTPs to also include transportation and transit enhancement activities, including consideration of the role that intercity buses may play in reducing congestion, pollution, and energy consumption in a cost-effective manner and strategies and investments that preserve and enhance intercity bus systems, including systems that are privately owned and operated, including transportation alternatives, as defined in 23 U.S.C. 101(a), and associated transit improvements, as described in 49 U.S.C. 5302(1), as appropriate. The timeline for implementation of this MAP-21/FAST Act planning requirement is outlined in 23 CFR Part 450.340. Prior to May 27, 2018, an MPO may adopt an RTP that has been developed using the SAFETEA-LU requirements or the provisions of the Statewide and Nonmetropolitan Transportation Planning *and* Metropolitan Transportation Planning Final Rule (23 CFR Part 450 and 771 and 49 CFR Part 613). On or after May 27, 2018, an MPO may not adopt an RTP that has not been developed according to the provisions of MAP-21/FAST Act as specified in the Planning Final Rule. MPOs are encouraged to communicate with Caltrans and FHWA/FTA to discuss schedules for RTP adoption.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.324(b) requires short and long-range strategies for an integrated multimodal transportation system. 23 CFR 450.325(f)(8) is an added requirement for the RTP pursuant to MAP-21/FAST Act to include consideration of the role that intercity buses play in reducing congestion, pollution, and energy consumption.
State: Government Code Section 65080(a) the RTP shall be directed at achieving a coordinated and balanced regional transportation system.

Planning Practice Examples: Available in Appendix L

6.11 Bicycle & Pedestrian – Including AB 1396 California Coastal Trail

The use of bicycles and walking as a means of transportation has increased dramatically in California over the last 20 years. Both modes of transportation promote a healthy lifestyle and reduce environmental impacts. Higher levels of physical activity are associated with well-connected transportation networks that are coordinated with land use development. The CTP acknowledges that viable and equitable multimodal choices are created through Complete Streets and high quality transit access in communities. The CTP can be a helpful resource for MPOs to refer to during their RTP development. Additional information regarding the Complete Streets planning process which emphasizes bicycle and pedestrian access and circulation is available in Section 2.7. The RTP section discussing bicycle and pedestrian issues should identify the following:

1. A well-connected transportation network within the region that includes routes with all types of bicycle and pedestrian facilities on local streets which provide trips to destinations;
2. Policies, plans and programs used to promote the usage of bikes and walking;
3. Transit and rail interface with bicyclists and pedestrians;
4. Unmet bicycle and pedestrian needs; and,
5. Existing and potential California Coastal Trail (CCT) network segments and linkages, as well as gaps and related coastal access trail needs.

AB 1396 – California Coastal Trail

Enacted in 2007, AB 1396 added Section 65080.1 to the Government Code which requires transportation planning agencies whose jurisdictions include a portion of the California Coastal Trail (or property designated for the coastal trail) to coordinate with specified agencies regarding development of the coastal trail. The law also requires that RTPs include provisions for the coastal trail. As RTPs are updated, the CCT provisions from each respective certified Local Coastal Program Land Use Plan’s policies, programs and maps should be integrated into the RTP update.

Provisions for the CCT should include identification of existing and potential trail network segments and linkages as well as gaps and related coastal access trail needs. Coastal access trail needs could include identification of accommodations for non-motorized modes, critical linkages to parking, bicycle racks, bathrooms and other support facilities, and connections to CCT trailheads. Any necessary trail alignment near motorized traffic should provide for adequate separation. Prioritization of projects within RTPs could include consideration of connecting the CCT across identified critical gaps in the coastal trail system.

Additional information and maps regarding the California Coastal Trail is available from the State Coastal Conservancy and the California Coastal Commission at:

www.yourcoast.org

http://scc.ca.gov/2010/01/07/the-california-coastal-trail/

http://coastal.ca.gov/access/ctrail-access.html.

http://www.coastal.ca.gov/access/accndx.html

http://www.coastal.ca.gov/access/coastal-trail-map.pdf

Requirements (Shalls)
Federal: Title 23 CFR Part 450.324(f)(12) requires MPOs to include a discussion of pedestrian walkways and bicycle transportation facilities in accordance with Title 23 U.S.C. Section 217(g)
State: Government Code Section 65080(a) requires that the RTP shall be directed at achieving a coordinated and balanced regional transportation system.
Government Code Section 65080.1 requires that transportation planning agencies whose boundaries include a portion of the California Coastal Trail or property designated for the trail, coordinate with appropriate agencies including the State Coastal Conservancy, the California Coastal Commission and Caltrans regarding development of the California Coastal Trail, and include provisions for the California Coastal Trail in their Regional Transportation Plan.

Planning Practice Examples: Available in Appendix L

6.12 Goods Movement (Maritime/Rail/Trucking/Aviation)

Developing, operating and maintaining a robust goods movement transportation system is vital to California's economy. For many reasons, including its proximity to Asian markets and Mexican near-shoring markets, its strong agricultural economy, and its large population, high volumes of goods are moved within and through California. With the diversity of products being moved, and the complexity of origins and destinations, the transportation system that supports goods movement within California must be multimodal. The system spans the entire state, and the needs for urban and rural goods movement infrastructure can differ between, and within, regions. However, throughout the state, goods movement has both positive and negative impacts. Through the regional planning process, MPOs can create strategies for improving the regional goods movement transportation system so positive impacts (e.g. job creation, access to goods and product diversity, improvements to truck speed and reliability, freight bottleneck relief) are maximized and negative impacts (e.g. land use conflicts, air pollution, roadway congestion and delays, disproportionately high and adverse impact on low income or disadvantaged communities) are minimized.

MPO must plan for the goods movement infrastructure in the same way they plan the transportation infrastructure for the movement of people to support projected population growth and economic development. Goods movement planning is in the public interest because of the potential benefits to the regional economy, environment, public health, and community well-being. Improvements to the goods movement transportation system can result in co-benefits to the overall system when California's economic, equity, and environmental goals are simultaneously considered. For example, as a rail improvement project could ideally take trucks off the highway, congestion could be reduced and potentially reduce GHG emissions. The CTP recognizes the importance of enhancing freight mobility, reliability, efficiency, and global competitiveness, which is why MPOs should consider deploying, as appropriate and feasible, cost-effective technologies that can help expedite goods movement and reduce congestion at our ports, including ports of entry. A seamless, efficient, low-emitting, and well-maintained multi-modal transportation system is paramount to the state's economic strength and its residents' quality of life. Planning this system involves a broad base of stakeholders, including affected community representatives, local organizations, agencies in charge of seaports and airports, trucking associations, Class I and short line railroads, freight carriers and shippers, local air districts, electric and gas utilities, and multiple State agencies (e.g., ARB, California Energy Commission, Caltrans, California Public Utilities Commission).

The RTP section discussing goods movement should include the following:

1. A discussion of the role of goods movement within the region (the types and the magnitudes of goods moved through the region and their economic importance);
2. An inventory of all major highway and roadway routes consistent with the National Highway Freight Network, including critical urban freight corridors;
3. An inventory of seaport facilities, air cargo facilities, freight rail lines, and major warehouses and freight transfer facilities within the region;
4. An analysis of the efficiency of the overall freight transportation system capacity, including existing land side freight transportation infrastructure (e.g. bottlenecks, gaps, etc.) and identification of expansion or improvement needs at seaport and airport facilities that handle cargo and issues regarding land side access to these facilities;
5. Specific projections, by mode, of future freight demand;
6. Identification of freight-related highway and roadway improvement needs;
7. Identification of expansion or improvement needs for freight rail lines within the region;
8. Identification of intermodal connection issues between different modes (e.g. freight, rail and seaport facilities), as applicable;
9. Identification of U.S.A./Mexico border crossing issues, if applicable;
10. Discussion of ITS and advanced technology opportunities for goods movement, with the aim of maximizing operational efficiencies and minimizing emissions;
11. Identification of opportunities or innovations that improve freight efficiency and support the State's freight system efficiency target as established in the California Sustainable Freight Action Plan; and,
12. Identification of opportunities or innovations that reduce GHG emissions and criteria air pollutant emissions associated with freight.

California Sustainable Freight Action Plan

In July 2015, Governor Brown issued Executive Order B-32-15 which prioritizes California's transition to a more efficient and less polluting freight transportation system. This transition of California's freight transportation system is essential to supporting the State's economic competitiveness in the coming decades while reducing GHG emissions and air quality impacts. The Executive Order directed State agencies to develop an integrated action plan by July 2016 that established clear targets to improve freight efficiency, transition to zero-emission technologies, and increase the competitiveness of California's freight system. It is suggested that regional transportation agencies consult the California Sustainable Freight Action Plan when developing the freight-related strategies in their respective RTPs.

California Freight Mobility Plan

The state's California Freight Mobility Plan (CFMP) is a policy and action agenda document that supports the improvement of California's goods movement infrastructure while preserving the environment. MPOs are encouraged to review the CFMP for guidance, and ensure consistency while addressing goods movement within their RTPs. The RTPs and the CFMP will ideally function in a feedback loop, as the goods movement strategies and projects identified in RTPs will be incorporated into the next update of the CFMP.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.324(b) requires short and long-range strategies for an integrated multimodal transportation system to facilitate the safe and efficient movement of people and goods. Title 23 CFR Part 450.324(f)(1) states that the RTP shall include the €§§§projected transportation demand of persons and goods in the metropolitan planning area over the period of the plan, and Title 23 CFR Part 450.324(f)(3) states that the RTP shall include operational and management strategies to improve the performance of existing transportation facilities to relieve vehicular congestion and maximize the safety and mobility of people and goods. Title 23 CFR Part 450.324(j) and Title 23 Part 450.316(a) require that the MPO shall provide freight shippers and providers of freight transportation services, among other stakeholders, a reasonable opportunity to comment on the RTP using the adopted Public Participation Plan. Title 23 U.S.C. Section 134 reflects similar requirements in federal statutes.
State: Government Code Section 65080(a) requires that the RTP shall be directed at achieving a coordinated and balanced regional transportation system.

Recommendations (Shoulds)
Federal: The FAST Act continues the Metropolitan Planning program. The Program establishes a cooperative, continuous, and comprehensive framework for making transportation management decisions in metropolitan areas. Program oversight is a joint FHWA/FTA responsibility, FAST Act § 1201; 23 U.S.C. 134. The FAST Act continues to encourage MPOs to consult with officials responsible for other types of planning activities, including freight.

The FAST Act directs the Department of Transportation to establish a National Multimodal Freight Network to:

- Assist States in strategically directing resources toward improved system performance for the efficient movement of freight on the Network;
- Inform freight transportation planning;
- Assist in the prioritization of Federal investment; and
- Assess and support Federal investments to achieve the goals of the National Multimodal Freight Policy established in 49 U.S.C. 70101 and of the National Highway Freight Program described in 23 U.S.C. 167.

The FAST Act established a National Highway Freight Network (NHFN). The NHFN includes the following subsystems of roadways:

- **Primary Highway Freight System (PHFS):** This is a network of highways identified as the most critical highway portions of the U.S. freight transportation system determined by measurable and objective national data. The network consist of 41,518 centerline miles, including 37,436 centerline miles of Interstate and 4,082 centerline miles of non-Interstate roads.

- **Other Interstate portions not on the PHFS:** These highways consist of the remaining portion of Interstate roads not included in the PHFS. These routes provide important continuity and access to freight transportation facilities. These portions amount to an estimated 9,511 centerline miles of Interstate, nationwide, and will fluctuate with additions and deletions to the Interstate Highway System.
- **Identification and Designation of Critical Urban Freight Corridors (CUFCs):** These are public roads in urbanized areas which provide access and connection to the PHFS and the Interstate with other ports, public transportation facilities, or other intermodal transportation facilities.

Planning Practice Examples: Available in Appendix L

6.13 Regional Aviation System

Aviation contributes to California's triple bottom line (people, prosperity, and planet) at all levels from local to global. Aviation gives the State's multimodal transportation system access, range, and speed. California's aviation system consists of 246 public-use airports made up of both commercial and general aviation airports, 68 special-use airports, 8 sea plane bases, 356 hospital and/or corporate, police, fire, or private heliports, 22 military/NASA bases, and 1 joint-use facility. (Division of Aeronautics Aviation in California: Fact Sheet (May 2016)

Aviation improves mobility options, generates tax revenue, saves lives through emergency response, medical, and firefighting services, produces over $170 billion in air cargo revenues annually, and generates over $14 billion to the State's tourism industry. The Division of Aeronautics Economic study, *Aviation in California: Benefits to Our Economy and Way of Life* (2003), reports that aviation creates almost 9 percent to the State's jobs (1.7 million jobs), and generates revenues totaling ($110.7 billion). The report is available on line at:
http://dot.ca.gov/hq/planning/aeronaut/publication.htmhttp://dot.ca.gov/hq/planning/aeronaut/publication.htm

The 2014 Caltrans Airport Forecasting Study, T*he Role of California Airports in Smart Growth and Economic Vitality* created tools for communities and regions to use for developing their local airports to their full economic potential. Airports can be used to help locate new business opportunities for a region, and improve quality of life by providing a unique access opportunity. The study includes planning practice examples, available at:
http://www.dot.ca.gov/aeronaut/index.htm

To preserve the economic and access benefits aviation contributes to California, airports must be protected through comprehensive planning practices at all levels of government. A large part of protecting airports comes from policies that protect airports from encroachment from incompatible land uses. Every county in California having an airport that is "operated for the benefit of the general public" (PUC Section 21670(b) must have an airport land use commission (ALUC) whose function is accomplish proper airport land use compatibility planning. The PUC recognizes six types of ALUC. Counties are free to select the type of ALCU that works best for their needs. The PUC further specifies the types of powers and duties reserved for ALCU (PUC Section 21674). ALUCs do not have jurisdiction over airports, but their airport land use compatibility plans (ALUCP) are developed from an airport's layout plan or master plan. And, general plans shall be consistent with ALUCPs, (PUC Sections 21674(c) and 21675).

Federal laws (Title 23 CFR Part 450.324(g) and Title 23 CFR Part 450.316(a) (1)) requires MPOs to consult with stakeholders responsible for land use management, as appropriate. Although not specifically named in statute, airports and ALUCs meet this criteria, and should be included in the consultation process during the RTP development. See Chapter 4 for guidance on the consultation process. State law (California Government Code Section 65080(a) and California Government Code Section 65080(a)) requires a coordinated and balanced regional transportation system. State law further requires RTPAs that have a primary air carrier airport (i.e. an airport with over 10,000 annual enplanements) within their jurisdiction shall have an Airport Ground Access Improvement Program (AGAIP). Annual passenger enplanement and air cargo reports are available from either the Caltrans Division of Aeronautics or from the Federal Aviation Administration (FAA), Airports Office: Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports. See the Division of Aeronautics web site for annual reports of both enplanement and cargo data at**:**
http://dot.ca.gov/hq/planning/aeronaut/documents/statistics/paxstats.htm

Requirements (Shalls)
Federal: Title 23 CFR 450.324, Development, and Content of the Metropolitan Transportation Plan. Subsection (b) requires short and long-range strategies for an integrated multimodal transportation system**.** Title 23 CFR Part 450.324(g) states that MPOs shall consult as appropriate with stakeholders and local agencies responsible for land use management, natural resources, environmental protection, conservation, and historic preservation during the development of the RTPs. Title 23 CFR Part 450.316(a) (1) also requires that public participation plans be developed by MPOs in consultation with all interested parties and describe explicit procedures, strategies, and desired outcomes.

State: California Government Code Section 65080(a) states that "Each transportation planning agency…shall prepare and adopt a regional transportation plan directed at achieving a coordinated and balanced regional transportation system, including…aviation facilities and services." Government Code Section 65081.1(b) requires consideration of highway, rail, and mass transportation and states that, "The program shall address the development and extension of mass transit systems, including passenger rail service, major arterial, and highway widening and extension projects, and any other ground access improvement projects the planning agency deems appropriate."

Recommendations (Shoulds)
State: MPOs should consider the needs of public-use airports, special-use heliports and military airfields when planning transportation and infrastructure projects (i.e. by consulting with the sponsors) to further sustainable and compatible land use and circulation patterns.

Planning Practice Examples: Available in Appendix L

Military Airfields and Installations

California's military installations are vital to America's national security, and the State is home to some of the Department of Defense's (DOD) most important military installations globally. All five of the services (Army, Navy, Air Force, Marines, and Coast Guard) have a major presence in the State. They are major contributors to the State's triple bottom line (people, prosperity, place), and users of the transportation system. In 2009 California's DOD installations employed over 354,769 civilian and military personnel, with a payroll of over $56 billion. Military expenditures and contracts awarded to California companies totaled almost $99 billion. Source: DOD in California brochure. Military installations are subject to strict environmental regulation, and vulnerable to climate change impacts, and sea level rise. Each installation has plans that address environmental and sustainability needs for their installation and practices in place that protect the environment and ensure the Service's ability to execute their mission.

Military transportation needs can be broken down into three broad categories, troop transport, military cargo, and installation employees commuter needs. These needs include surge capabilities as needed. Military facilities are spread throughout California, in all sizes of communities from rural locations to heavily urbanized areas. They share the same transportation needs as their neighboring communities. Although not specifically named in planning statue and codes, the requirement to consult with all users of the transportation system apply to the military as well, see Chapter 4 RTP Consultation and Coordination for detailed discussion of users and the consultation process. In addition to transportation needs, military installations also need protection from encroachment of incompatible land uses that could hamper the facilities ability to meet its mission needs. Military installations with airfields are required by DOD to prepare Air Installation Compatible Use Zone Plan (AICUZ) that address their compatibility needs. ALUC are required to develop an ALUCP for the airfield that is consistent with the AICUZ. The federal government, Transportation Research Board, and some states (Texas, Colorado, North Carolina, New Jersey, and Virginia) offer guidance and planning practice examples regarding how to address land use compatibility issues for military installations. General plans must be consistent with the AICUZ and ALUCP for the military airfields in their jurisdiction. California's Office of Planning and Research (OPR) publishes a guide for how to incorporate land use compatibility planning for military installations in the State. https://www.opr.ca.gov/docs/Military_GPG_Supplement.pdf.

Requirements (Shalls)
Federal: Consulting with interested parties on plans, programs, and projects shall include individuals or organization that are mentioned in Title 23 CFR Part 450.316(a). Title 23 CFR Part 450.316(d) requires MPOs to consult with federal land use management agencies as appropriate during the development of RTP. Title 23 CFR part 450.324(g) states that MPOs shall consult as appropriate with stakeholders and local agencies responsible for land use management, natural resources, environmental protection, conservation, and historic preservation during the development of the RTPs. Title 23 CFR Part 450.316(a) (1) also requires that public participation plans be developed by MPOs in consultation with all interested parties and describe explicit procedures, strategies, and desired outcomes.

Recommendations (Shoulds)
State: MPOs should consider the needs of public-use airports, and heliports and military airfields when planning transportation and infrastructure projects (i.e. by consulting with the sponsors) to further encourage sustainable and compatible land use and circulation patterns.

Planning Practice Examples: Available in Appendix L

Programming/Operations

6.14 Transportation System Management & Operations

The RTP shall address management and operations strategies aimed at improving the performance of the existing regional transportation system in order to reduce transportation congestion issues and maximize the safety and mobility of people and goods. Examples of operational and management include: (a) Traffic incident management, (b) Travel information services, (c) Roadway weather information, (d) Freeway management, (e) Traffic signal coordination, and (f) Bicycle and transit trip planning.

Although operational and management strategies may be implemented on a regional, area-wide, or project-specific basis, those strategies included in an RTP should typically be those that have importance on a regional level.

RTPs shall include existing and proposed transportation facilities (including major roadways, transit, multimodal and intermodal facilities, pedestrian walkways and bicycle facilities and connectors) that should function as an integrated regional transportation system with emphasis on those facilities that serve important national and regional needs.
If applicable, the locally preferred alternative selected from an Alternative Analysis under the FTA's Capital Investment Grant Program (Section 5309) needs to be adopted as part of the RTP as a condition for funding under Title 49 U.S.C. Section 5309.

Requirements (Shalls)
Federal: Title 23 U.S.C. Section 134 and Title 23 CFR Part 450.324(f)(5) requires strategies for improving the regional transportation system and reducing congestion.

Planning Practice Examples: Available in Appendix L

6.15 Coordination with Programming Documents

The Federal Transportation Improvement Program (FTIP) is a four-year prioritized listing of federally funded and non-federally funded regionally significant transportation projects that is developed and formally adopted by an MPO as part of the metropolitan transportation planning process. MPOs work cooperatively with public transportation agencies as well as other local, state, and federal agencies to propose projects for inclusion in the FTIP. Each project or project phase in the FTIP must be consistent with the approved RTP. The FTIP must be updated at least every four years. MPOs may also refer to the FTIP as the Metropolitan Transportation Improvement Program (MTIP). Specific requirements for the development and content of the FTIP are contained in Title 23 CFR Part 450.326.

As with the RTP, some MPOs refer to their four-year FTIP by other terms. Below is a table outlining the various terms used by federal, state and the MPOs to refer to the same documents:

Federal Term Used	State Term Used	Terms Used by MPOs
TIP	FTIP	TIP, MTIP, FTIP, RTIP
STIP	FSTIP	FSTIP

Projects included in the FTIP may include projects from two other State programming documents: (1) the State Highways Operation and Protection Program (SHOPP), and (2), the State Transportation Improvement Program (STIP). The purpose of the SHOPP program is to maintain safety, operational integrity and rehabilitation of the State Highway System. The STIP is a five-year capital improvement program of transportation projects on and off the State Highway System funded with revenues from the State Highway Account and other sources. Caltrans manages the SHOPP program, while the CTC manages the STIP. The STIP is a five-year document and is updated every other year. The SHOPP is a ten-year document and is adopted by the CTC in August of each odd numbered year. These two programs are major components of the FTIP.

The Federal Statewide Transportation Improvement Program (FSTIP) is a compilation of the FTIPs prepared by the 18 MPOs. It also includes projects in rural areas of the state not represented by an MPO (Caltrans programs projects in the FSTIP for the rural areas). The FSTIP is prepared by Caltrans and submitted to the FHWA and FTA for approval. The FSTIP covers a four-year period and must be updated at least every four years. States have the option to update more frequently, if desired. Federally funded projects or non-federally funded regionally significant projects cannot be added to the FTIP or FSTIP unless they are included in the RTP. Specific requirements for the development and content of the FSTIP are contained in Title 23 CFR Part 450.218.

The diagram in Appendix B illustrates the federal/state programming process.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.326(a) requires MPOs to prepare a transportation improvement program (TIP). Title 23 CFR Part 450.218(k) states that each project or project phase included in the STIP shall be consistent with the long range statewide transportation plan developed under Title 23 CFR Part 450.216 and, in metropolitan planning areas, consistent with the approved metropolitan transportation plan developed under Title 23 CFR Part 450.324.

6.16 <u>Transportation Projects Exempted from Senate Bill 375</u>

Government Code Section 65080 (b)(2)(L) provides that projects programmed for funding on or before December 31, 2011, are not required to be subject to the provisions required in Government Code Section 65080 (b)(2), a Sustainable Communities Strategy and Alternative Planning Strategy, if they are:

- Contained in the 2007 or 2009 Federal Statewide Transportation Improvement Program, or
- Funded pursuant to the Highway Safety, Traffic Reduction, Air Quality, and Port Security Bond Act of 2006, Chapter 12.49 (commencing with Section 8879.20) of Division 1 of Title 2, or
- Were specifically listed in a ballot measure prior to December 31, 2008, approving a sales tax increase for transportation projects.

Nothing in Government Code Section 65080 (b)(2)(L) shall require a transportation sales tax authority to change the funding allocations approved by the voters for categories of transportation projects in a sales tax measure adopted prior to December 31, 2010. For purposes of this subparagraph of the Government Code, a transportation sales tax authority is a district, as defined in Section 7252 of the Revenue and Taxation Code that is authorized to impose a sales tax for transportation purposes.

Programmed for funding refers to the inclusion of funding in the 2007 or 2009 FSTIP; the approval of funding by the State Legislature or appropriate administrative agency; or the approval of funding by voters in a sales tax expenditure plan.

For the purposes of Government Code Section 65080 (b)(2)(H), prior to adopting a SCS, the MPO shall quantify the reduction in GHG emissions projected to be achieved by the SCS and set forth the difference, if any, between the amount of that reduction and the target for the region established by the ARB. As a result, an MPO shall include exempted projects in their SCS for purposes of modeling the impacts of the RTP on regional GHG emissions.

Pursuant to Government Code Section 65080(b), the RTP is required to be an internally consistent document. This means the contents of the Policy, Action, Financial elements, and the Sustainable Communities Strategy must be consistent with one another and with the Goals, Policies, and Objectives of the RTP as adopted by the MPO.

Projects meeting the criteria in this section, however, are exempt from these internal consistency requirements. In other words, these projects may be included in the RTP even if they are inconsistent with the SCS or other policies to reduce regional GHG emissions.

However, exempted projects must meet all federal consistency requirements. In particular, pursuant to 23 CFR. 450.306 (b)(5), the RTP "planning process shall . . . promote consistency between transportation improvements and State and local planned growth and economic development"; and pursuant to 23 CFR 450.306 (f), "An MPO shall carry out the metropolitan transportation planning process in coordination with the statewide transportation planning process required by 23 U.S.C. 135 and 49 U.S.C. 5304," and pursuant to 23 CFR 450.104, "*Coordination* means the cooperative development of plans, programs, and schedules among agencies and entities with legal standing and adjustment of such plans, programs, and schedules to achieve general consistency, as appropriate."

A project's status as exempt does not preclude an MPO from evaluating it for inclusion in the RTP and ultimately excluding it from the RTP at its discretion based on financial constraint, policy, or other considerations.

Requirements (Shalls)
Federal: None
State: California Government 7Code Section 65080 (b)(2)(H) and (L)

6.17 <u>Regionally Significant Projects</u>

Title 40 CFR Part 93.101 defines regionally significant projects as follows:

> *"Regionally significant project means a transportation project (other than an exempt project) that is on a facility which serves regional transportation needs (such as access to and from the area outside of the region, major activity centers in the region, major planned developments such as new retail malls, sports complexes, etc., or*

transportation terminals as well as most terminals themselves) and would normally be included in the modeling of a metropolitan area's transportation network, including at a minimum all principal arterial highways and all fixed guide way transit facilities that offer an alternative to regional highway travel."

All regionally significant projects must be included in an RTP air quality conformity determination by the MPO and FHWA regardless of its funding source. These regionally significant projects should be specifically identified and noted in the project-listing portion of RTP.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.326(f) requires all regionally significant projects be included in the TIP regardless if the projects are to be funded with federal funds or not.

6.18 Regional ITS Architecture

Intelligent transportation systems (ITS) encompass a broad range of wireless and wire line communications-based information and electronics technologies. When integrated into the transportation system's infrastructure, and in vehicles themselves, these technologies relieve congestion and improve safety. ITS is one way to increase the efficiency, safety and security of a transportation system. ITS involves the use of advanced computer, electronic and communications technologies and emphasizes *enhancing travel on existing infrastructure* (highways, streets, bridges, trains). Some examples of ITS technologies include advanced traffic signals, roadway and weather monitoring stations, bus and maintenance vehicle location systems, electronic roadside information signs and automated vehicle control systems.

The National ITS Program was established by ISTEA in 1991. Further federal regulations focused on extending ITS to regional planning efforts and training transportation professionals to deal with the range of issues associated with the adoption of advanced transportation technology. The development of the regional ITS architecture is not meant to compete with the formal transportation planning process. In fact, key ITS projects and initiatives are targeted early in the planning process. When updating RTPs, MPOs should be sure to comply with current federal regulations. Title 23 CFR Part 450.306(g) states, "*The metropolitan transportation planning process shall, to the maximum extent practicable, be consistent with the development of applicable regional intelligent transportation systems (ITS) architectures, as defined in Title 23 CFR Part 940."*

Title 23 CFR Part 940 establishes the protocol for developing a regional architecture plan that, in turn, conforms to national ITS architecture standards. The ITS regulations defines the responsibilities for creating and maintaining Regional ITS Architecture (RA) frameworks. Architecture maintenance is the process of updating a regional architecture with references to new projects and activities, new stakeholders; additions, retirement or replacement of equipment; and, changes to standards and protocols. Maintenance is an ITS program responsibility under Title 23 CFR Part 940.

The intent of the federal ITS requirement is to encourage reciprocal consistency. Title 23 CFR Part 940.5, Intelligent transportation system architecture and standards, calls for the "development of the regional ITS architecture (to) be consistent with the (Metropolitan) transportation planning process…". It is important to coordinate the general RTP planning efforts with plans for specific projects that entail the use of ITS technology. These 'nested' plans should be developed in an open forum and they should be consistent. The resultant plans would reflect consideration of both documents during the planning process.

The National ITS Architecture and other related resources can be found at the U.S. DOT Architecture website:

http://www.its.dot.gov/arch/arch.htm

Requirements (Shalls)
Federal: Title 23 CFR Part 450.306(g) states that the RTP shall (to the extent practicable) be consistent with the development of applicable regional ITS architectures as defined in Title 23 CFR Part 940.

6.19 Future of Transportation & New Technology

While maintaining the current transportation network is often a priority for MPOs, MPOs need to be planning ahead for a future in which technology will transform the way that people move and live. MPOs are ideally positioned to anticipate and be responsive to the needs of future generations. This section provides a summary of federal and State legislation to prepare for new technologies and innovations for the future of transportation.

Connected Vehicle Program

There are several activities related to the national Connected Vehicle Program that will certainly impact regional and local transportation agencies, in addition to Caltrans. Since 90% of the roadways in California are owned and operated by local agencies, including the 58 counties and more than 500 incorporated cities, it is critically important for them to be aware of and to plan for the implementation of connected vehicles.

MPOs should be aware of the pending rule being considered by the National Highway Traffic Safety Administration (NHTSA) to mandate that equipment for vehicle-to-vehicle (V2V) communications, using a technology called “Dedicated Short-Range Communications” (DSRC), be installed in the light-duty passenger car fleet to enable applications that improve vehicle safety. As the government regulator for auto industry safety, NHTSA is expected to adopt this rule, as it did for other safety systems such as seat belts, airbags, and anti-lock brakes. A future update of the RTP Guidelines will capture any “shoulds” or “shalls” resulting from the rulemaking process.

MPOs should also be aware of the pending guidance from the FHWA to transportation infrastructure owner/operators (Caltrans; counties; and cities) on what equipment they should consider installing in their infrastructure to support both V2V and vehicle-to-infrastructure (V2I) communications, again using DSRC. The best example of this equipment is the DSRC radios. These radios provide the communication capability that is essential for V2I applications. Roadside processors may also be necessary in some cases where the applications demands heavier computing requirements.

Unlike connected vehicles, the development of which is being led by the federal government, in partnership with state DOT’s, regional transportation agencies, and the auto industry, automated vehicles are being developed by the technology industry, including companies such as Google, Tesla, and Delphi. So far, their philosophy has been to avoid dependence on the infrastructure. However it is difficult to achieve vehicle automation and connected vehicle (CV) applications without appropriate support from the infrastructure. The infrastructure needs to be upgraded with DSRC radios and roadside processors. The roadside processors are not an absolute requirement but may be required in some cases.

Title 23 U.S.C. Section 518 requires the U.S. DOT Secretary establishing guidance for recommended implementation path for V2V and V2I communication system deployment. Title 23 U.S.C. Section 519 ensures that funds are available for the development of Intelligent Transportation System (ITS) Infrastructure, equipment and systems.

Planning Practice Examples: Available in Appendix L

Transportation Electrification

Pursuant to PUC 740.12(a)(2), it is the policy of the state and the intent of the legislature to encourage transportation electrification as a means to achieve ambient air quality standards and the state's climate goals. Agencies designing and implementing regulation, guidelines, plans, and funding programs to reduce GHG emissions shall take the findings described in paragraph (1) of PUC Section 740.12 into account.

MPOs are encouraged to support widespread transportation electrification and partner with state agencies to advance California toward the standards and goals outlined in Public Utilities Code Section 740.12(a)(1). These include:

- Reducing emissions of GHGs to 40 percent below 1990 levels by 2030 and to 80 percent below 1990 levels by 2050.
- Achieving the goals of the Charge Ahead California Initiative (Chapter 8.5 (commencing with Section 44258) of Part 5 of Division 26 of the Health and Safety Code).
- Meeting air quality standards, reducing petroleum use, improving public health, and achieving GHG emission reduction goals.
- Attracting investments and high quality jobs.

See Appendix L for examples of how MPOs are planning for transportation electrification.

Planning Practice Examples: Available in Appendix L

6.20 <u>Transportation Safety</u>

While Caltrans supports consideration of security as separate from safety as a planning area, it also recognizes that security and emergency responses efforts are often inextricably linked. Clearly both are linked to ensuring system security and availability of emergency response services in the event of a natural or human-caused disaster. Due to unexpected large-scale security incidents or natural disasters, the potential for the necessity of a wide scale evacuation exists in almost every area of California. MPOs can use the CTP as a resource for *recommendations for public safety and security improvements, such as supporting the* implementation of Positive Train Control (PTC) into existing intercity rail cars.

Under a prior federal surface transportation reauthorization known as TEA-21, safety and security were lumped together in one federal planning factor. SAFETEA-LU changed this in order to signal the importance of these two items. Safety and security were again updated with MAP-21/FAST Act and are separate federal planning factors. According to Title 23 CFR Part 450.306(b), these two planning factors are:

1. Increase the safety of the transportation system for all motorized and non-motorized users; and,
2. Increase the security of the transportation system for motorized and non-motorized users.

The public expects, and demands, that the transportation system be safe and efficient for all users. Addressing the improvement of transportation safety can help alleviate a myriad of health, financial, and quality-of-life issues for travelers. Fatalities and injuries from motor vehicles crashes are a major public health problem. Historically, transportation safety has not been included as part of the transportation planning process. A clear need has developed for safety to be considered as part of planning process instead of as a reactionary consideration as it has been. To be adequately addressed, safety must be a key goal within the process. Improving the safety of the transportation network requires an active, conscious approach to monitoring the transportation system for safety problems and anticipating problems before they occur.

Strategic Highway Safety Plan

Federal law requires MPOs to draw a strong link between the Strategic Highway Safety Planning process described in Title 23 U.S.C. Section 148 and the regional planning process. Federal regulations also require MPOs to summarize the priorities, goals, countermeasures or projects of the Strategic Highway Safety Plan (SHSP) in their RTPs. SHSPs were first required under SAFETEA-LU, which established the Highway Safety Improvement Program (HSIP) as a core federal program. The FAST Act continues the HSIP as a core Federal-aid program and the requirement for States to develop, implement, evaluate and update an SHSP that identifies and analyzes highway safety problems and opportunities on all public roads no less than every five years. Each State must have a Strategic SHSP in place to receive its full share of federal transportation funds.

Each MPO should review the California SHSP during the preparation of the portion of the RTP addressing safety. The SHSP:

1. Highlights challenges to roadway user safety on California's roads;
2. Provides a descriptive account of fatalities experienced on California's roads;
3. Proposes high-level strategies to reduce fatalities for each challenge; and,
4. Includes a five-year guide for the implementation of specific projects and activities.

The California SHSP is available on the Caltrans website at:

http://www.dot.ca.gov/hq/traffops/survey/SHSP/

Safety Performance Measures

The MAP-21/FAST Act established Safety Performance Management (PM) as part of the overall Transportation Performance Management (TPM) program, which FHWA defines as a strategic approach that uses system information to make investment and policy decision to achieve national performance goals. Refer to Section 7.1 for more information.

Requirements (Shall)
Federal: Title 23 CFR Part 450.306(b)(2) states the planning process will address the safety of the transportation system for the public.
State: None

Recommendations (Should)
Federal: Title 23 CFR Part 450.306(d)(4) states that RTPs should be consistent with the California Strategic Highway Safety Plan (SHSP) and other transit safety and security planning and review processes. Title 23 CFR Part 450.324(h) states the RTP should include a safety element that incorporates or summarizes the priorities, goals, countermeasures or projects for the MPOs region contained in the SHSP.

6.21 Transportation Security

A report was prepared by the American Highway Users Alliance titled "*Emergency Evacuation Report Card 2006*". The report stated: *"The principal resources of urban evacuation are private cars and publicly provided highways. As a result of the threat of terrorism, the interstate system is reasserting itself as a major element of national security (and defense), principally due to its capacity for handling mass evacuations."* The report conducted an initial evacuation capacity evaluation for the 37 largest urbanized areas in the United States. These urbanized areas were graded from "A" to "F". Of the four California urbanized areas identified in the report, three (San Diego, San Francisco and Los Angeles) received a grade of "F". Sacramento, the fourth California city identified in this report received a "D".

Due to unexpected large-scale security incidents or natural disasters, the potential for the necessity of a wide scale evacuation exists in almost every area of California. One of the lessons learned from the terrorist attack on the World Trade Center in New York City was that effective coordination and communication among the many different operating agencies in a region is absolutely essential. Such coordination is needed to allow law enforcement and safety responses to occur in an expeditious manner, while at the same time still permitting the transportation system to handle the possibly overwhelming public response to the incident. Complementary to this is the need to make sure the public has clear and concise information about the situation and what actions they should take.

Although the immediate organizational response to security incidents and disasters will be the responsibility of law enforcement/safety agencies, there is an important role that MPOs can play in promoting coordinated planning among first responders and transit agencies in anticipation of unexpected events or natural disasters. In addition, MPOs could also provide a centralized location of information on transportation system conditions and the responses that might be useful in an emergency.

In developing the RTP, MPOs are required to consult with agencies and officials responsible for other planning activities with in the region including natural disaster risk reduction. The RTP should identify the primary agencies responsible for preparing the necessary plans should a wide scale evacuation be necessary. The MPO should consult the appropriate emergency plan for the region to determine what evacuation plans are in place. Examples of strategies that could be addressed in regional mass evacuation plans could include:

1. Signaling – Allows traffic signals to extend for up to four minutes in either red or green to allow large amounts of vehicles or pedestrians to proceed in one direction;
2. Traffic Control Guides – Deploy traffic control personnel to problem intersections to manually direct traffic;
3. Roadblocks and Barricades – Deploy various methods such as portable signs, cones or barrels;
4. Electronic Signage – Changeable message signs have been installed along a number of major routes that could be used to provide information to evacuees;
5. Lane Expansion – Involves the use of using road shoulders to increase vehicle capacity of evacuation routes;
6. Contra flow Lanes – Contra flow or lane reversal involves directing traffic to use lanes in both directions to move a large amount of vehicles in one direction;
7. Use of Mass Transit – Transit could be used to assist in the evacuation of the public should it become necessary; and,
8. Airport Use – Airports can be used as staging areas for medical and food supplies as well as evacuation.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.306(b)(3) states the planning process will address the security of the transportation system for the public. 23 CFR 450.316(b) requires MPOs to consult with agencies and officials responsible for planning natural disaster risk reduction.

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.324(h) states that RTPs should be consistent with emergency relief and disaster preparedness plans, strategies and policies that support homeland security and safeguard the personal security of all motorized and non-motorized users.

6.22 Assessment of Capital Investment & Other Strategies

MAP-21/FAST Act added a new requirement for RTPs to also include an assessment of capital investment and other strategies to:
1. Preserve the existing and projected transportation infrastructure;
2. Provide for multimodal capacity increases based on regional priorities and needs; and,
3. Reduce the vulnerability of the existing transportation infrastructure to natural disasters.

The timeline for implementation is outlined in 23 CFR Part 450.340(a). Prior to May 27, 2018, an MPO may adopt an RTP that has been developed using the SAFETEA-LU requirements or the provisions of the Statewide and Nonmetropolitan Transportation Planning *and* Metropolitan Transportation Planning Final Rule (23 CFR Part 450 and 771 and 49 CFR Part 613). On or after May 27, 2018, an MPO may not adopt an RTP that has not been developed according to the provisions of MAP-21/FAST Act as specified in the Planning Final Rule. MPOs are encouraged to communicate with Caltrans and FHWA/FTA to discuss schedules for RTP adoption.

The RTP may consider projects and strategies that address areas or corridors where current or projected congestions threatens the efficient functioning of key elements of the metropolitan area's transportation system.

Requirements (Shalls)
Federal: 23 CFR 450.324(f)(7)

6.23 <u>Congestion Management Process</u>

The RTP shall describe and identify the transportation system management (TSM) and operations strategies, actions and improvements it will employ to manage and operate the urban freeway system, its corridors and major local parallel arterials for highest or increased productivity. Increased productivity can include all modes, including transit, bicycles, and pedestrians. There may be many ways to increase mobility without increasing GHG emissions. One way may be to improve the efficiency and productivity of the corridor through operational, transit and highway projects. TSM and operations strategies, actions and improvements shall include at a minimum traffic detection, traffic control, incident response and traveler information. Transportation demand strategies shall also be identified and can include, but are not limited to: Pricing, Transportation Planning, and Investment Strategies. Section 6.28 and Appendix L of the Guidelines contain additional information on strategies that can be used to manage congestion and reduce regional GHG emissions. The approach to TSM and operations shall be integrated into system planning documents.

Coordination of Project Programming

Programming of projects shall be scheduled so that project sequencing in a corridor achieves the most effective performance results. In State Highway System corridors the system planning documents should identify the most effective project sequencing, including projects identified for major local arterials. System planning strategies to address performance issues can include: system evaluation and monitoring, maintenance and preservation, smart land use and demand management, Intelligent Transportation Systems, operational capacity strategies, multimodal and Complete Streets concepts.

Congestion Management Process in the RTP

The RTP should identify urban freeway corridors with current and projected recurrent daily vehicle hours of delay that are a priority for preparing CSMPs and TCRs. The RTP should include by corridor all multimodal strategies, actions and improvements identified in the adopted TCR or CSMP that are needed to provide for safe and effective integrated management and operation of the multimodal transportation system across jurisdictions and modes to improve corridor performance based upon performance measurement. Approaches to improving corridor performance can include new and existing facilities, improved maintenance and operation of existing infrastructure, invest in and encouraging the use of alternative modes (such as transit, rail, bicycling and walking), encouraging smart land use, integrated corridor management strategies, among others.

The RTP should describe roles and relationships among units of local government, modal agencies, Caltrans and related agencies for managing the corridor for highest mobility benefits and for measuring and evaluating performance.

Title 23 CFR Part 450.322 applies only to the MPOs below and are federally designated Transportation Management Areas (TMAs). These TMAs shall develop a congestion management process that results in a multimodal system performance measures and strategies that can be reflected in the RTP. TMAs are defined as an urbanized area with a population over 200,000 as defined by the U.S. Census Bureau. California MPOs that are currently designated TMAs are:

1. Southern California Association of Governments (SCAG);
2. Metropolitan Transportation Commission (MTC);
3. San Diego Association of Governments (SANDAG);
4. Sacramento Area Council of Governments (SACOG);
5. Fresno County Council of Governments (FCOG);
6. Kern Council of Governments (KCOG);
7. San Joaquin Council of Governments (SJCOG);
8. Stanislaus Council of Governments (StanCOG);
9. Tulare County Association of Governments (TCAG); and,
10. Santa Barbara County Association of Governments (SBCAG)

Congestion Management Plan

Effective with the MAP-21/FAST Act, MPOs serving a TMA may develop a congestion management plan that includes projects and strategies that will be considered in the FTIP. If developed, the MPO shall consult with employers, private and nonprofit providers of public transportation, transportation management organizations, and organizations that provide job access reverse commute projects or job-related services to low-income individuals.

If an MPO elects to develop the congestion management plan, it shall consist of the following:

- Develop regional goals to reduce VMT during peak commuting hours and improve transportation connections between areas with high job concentration and high concentrations of low-income households;
- Identify existing public transportation services, employer based commuter programs, and other existing transportation services that support access to jobs in the region; and,
- Identify proposed projects and programs to reduce congestion and increase job access opportunities.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.322(d) states the congestion management process shall be developed, established and implemented as part of the planning process.

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.322(b) states the congestion management process should result in performance measures that can be reflected in the RTP. 23 CFR 450.322(h) provides MPOs the framework for developing a congestion management plan.

Regional GHG Emissions Requirements & Considerations in the RTP

6.24 GHG Emissions & Targets Background

Current law requires that the California Air Resources Board (ARB) update the regional GHG emission reduction targets every eight years. In 2017, ARB plans to update each MPO's targets for automobile and light trucks for 2020 and 2035, with these updated targets being effective on January 1, 2018 to meet the eight year requirement. In the resolution adopting the scoping plan, the ARB stated its intent that the SB 375 GHG emissions reduction targets will be the most ambitious achievable. In 2010, the first targets were established with consideration given to methodology recommendations from an appointed Regional Targets Advisory Committee (RTAC). The RTAC released its Recommendation Report entitled: *Recommendations of the Regional Targets Advisory Committee (RTAC) Pursuant to SB 375* on September 29, 2009 which is available at the following link:

http://www.arb.ca.gov/cc/sb375/rtac/report/092909/finalreport.pdf

6.25 Contents of the Sustainable Communities Strategy (SCS)

SCS Background

Integrating transportation, land use, and housing, in the planning process is vital to reducing regional GHG emissions from cars and light trucks. The Sustainable Communities Strategy or SCS, was added as a new component of the RTP following the passage of SB 375 in September 2008, pursuant to Government Code Section 65080(b)(2).

For over 30 years, the primary purpose of the RTP has been to identify the transportation projects, programs and services needed to address both current conditions as well as future regional growth and to specify the major transportation projects to be programmed given the financial resources available. Pursuant to Government Code Section 65080(b)(2)(B) the SCS requires MPOs to work with local land use authorities and other appropriate entities to address regional land uses, regional housing needs, regional resource areas and farmland, as well as regional transportation needs in the RTP.

Government Code Section 65080(b)(2)(B)(vii) requires the SCS to set forth a forecasted development pattern for the region that when integrated with the transportation network, and other transportation measures and policies, will reduce regional GHG emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the regional GHG emission reduction target set by ARB. Government Code Section 65080.01(c) defines feasible as "capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors. In its advisory report to the ARB board, the RTAC stated that, "if a SCS for a region cannot meet its target, the SCS should still be a substantial improvement over Business As Usual (BAU) land use and transportation planning and that their regions and member cities would see substantial co-benefits as a result of implementing the SCS as planned."

If the RTP, including the SCS, does not achieve the regional GHG reduction target, the MPO can elect to either revise the SCS or prepare an Alternative Planning Strategy (APS) that is separate from the RTP. If a region must prepare an APS, that alternative scenario must describe why the development pattern, measures, and policies in the APS are the most practicable choices for achievement of the GHG emissions reduction targets as required by Government Code Section 65080(b)(2)(I)(iii).

Government Code Section 65080(b) requires that the RTP be an internally consistent document. This means that the contents of the Policy, Action, Financial, and Sustainable Communities Strategy elements of the RTP shall be consistent with one another. As a result, transportation investments and the forecasted development pattern in the SCS should be complementary and not contradictory. For information regarding transportation projects exempt from the internal consistency provisions of SB 375 pursuant to Government Code Section 65080(b)(2)(L) please refer to Section 6.16 of these Guidelines.

Requirements of a Sustainable Communities Strategy (SCS)

California Government Code Section 65080(b)(2)(B) requires that all MPOs shall prepare a Sustainable Communities Strategy, subject to the requirements of Part 450 of Title 23, and Part 93 of Title 40 of the CFR, including the requirement to utilize the most recent planning assumptions considering local general plans and other factors. The SCS shall:

1. Identify the general location of uses, residential densities, and building intensities within the region;
2. Identify areas within the region sufficient to house all the population of the region, including all economic segments of the population, over the course of the planning period of the regional transportation plan taking into account net migration into the region, population growth, household formation and employment growth;
3. Identify areas within the region sufficient to house an eight-year projection of the regional housing need for the region pursuant to Government Code Section 65584;
4. Identify a transportation network to service the transportation needs of the region;
5. Gather and consider the best practically available scientific information regarding resource areas and farmland in the region as defined in Government Code Section 65080.01(a) and (b);
6. Consider the state housing goals specified in Government Code Sections 65580 and 65581;
7. Set forth a forecasted development pattern for the region, which, when integrated with the transportation network, and other transportation measures and policies, will reduce the GHG emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the GHG emission reduction targets approved by the state board;
8. Allow the regional transportation plan to comply with Section 176 of the federal Clean Air Act (Title 42 U.S.C. 7506)

In addition, Government Code Section 65584.01(i)(1) states that it is the intent of the Legislature that housing planning be coordinated and integrated with the regional transportation plan. To achieve this goal the allocation plan shall allocate housing units within the region consistent with the development pattern included in the sustainable communities strategy.

Requirements (Shall):
Federal: Title 23 CFR Part 450 and Title 40 CFR Part 93
State: Government Code Section 65080, and 65584.04(i)(1)

6.26 SCS Development

This section is intended to describe methods for the implementation of the statutory requirements for the development of an SCS recognizing that there is great variation among the 18 MPOs within the state and that flexibility is an important component in SCS development. The SCS shall be prepared in such a way as to allow for the quantification of regional GHG emissions reduction required pursuant to Government Code Section 65080(b)(2)(H).

Visualization & Mapping

Pursuant to Title 23 CFR Part 450.316(a), an RTP is required to include visualization techniques such as GIS-based information, graphs, maps, charts, and other visual aids that are useable and understandable to the public. Additionally, Government Code Section 65080(b)(2)(F)(iii) requires that public workshops held during the development of the SCS, to the extent practicable, shall include urban simulation computer modeling to create visual representations of the SCS, and APS if applicable. Visualization techniques associated with SCS development should be documented and included in the final SCS. These visualization techniques may build upon existing federal and state requirements for the RTP and could include maps, illustrations, diagrams, and other visual aids which illustrate the SCS requirements as outlined in Government Code Section 65080(b)(2)(B).

SCS Planning Assumptions

As required by Government Code Section 65080(b)(2)(B)(i) and (vii), the SCS shall identify the general location of uses, residential densities, and building intensities within the region as well as a forecasted development pattern for the region that is based upon the most recent planning assumptions considering local general plans and other factors. In addition, according to Government Code Section 65080(b)(2)(viii), the SCS must allow the RTP to comply with Section 176 of the Federal Clean Air Act (42 U.S.C. Section 7506). Federal air quality conformity regulations require that land use, population and employment model assumptions are based upon the best available information and that there is a reasonable relationship between the expected land use and the envisioned transportation system. The reasonableness of a particular planning assumption is determined through consultation involving the FHWA and EPA in addition to state, local, and MPO representatives. MPOs should refer to Title 23 CFR Part 450 and Title 40 CFR Part 93 as well as the EPA document *Guidance for the Use of Latest Planning Assumptions in Transportation Conformity Determinations (Revision to January 18, 2001 Guidance Memorandum)* (see link provided below) for more information about consultation and the use of current planning assumptions.

https://www.fhwa.dot.gov/environment/air_quality/conformity/policy_and_guidance/lpa_guid08.pdf

Pursuant to Government Code Section 65080(b)(2)(K), neither the SCS nor the APS regulates the use of land, and does not supersede the land use authority of cities and counties within the region. City and county land use policies and regulations, including general plans, are not required to be consistent with the RTP, SCS or the APS.

In developing an SCS, an MPO shall consult with cities and counties about their existing general plans and foreseeable changes to their general plans over the period covered by the RTP, including RHNA, residential zoning, and programmatic actions addressed in the local housing element and status of housing element update requirements MPOs are also required by Government Code Section 65080(b)(2)(G) to consider spheres of influence that have been adopted by the Local Agency Formation Commissions (LAFCOs) within the region during development of the SCS. Further, MPOs should consult with LAFCOs within the region regarding municipal service review boundaries, foreseeable changes to those boundaries and service capacities over the period covered by the RTP as well as any local LAFCO adopted policies regarding preservation of agricultural and open space land, island annexations, annexations, service extensions and sphere changes. MPOs are also encouraged to request the most recent Municipal Service Reviews for local agencies providing services in the region, as well as, LAFCO-prepared GIS maps, if available, for all local agency boundaries and spheres of influence in the region.

The legislative findings for SB 375 identify that: “greenhouse gas emissions from automobiles and light trucks can be substantially reduced by new vehicle technology and by the increased use of low carbon fuel. However, even taking these measures into account, it will be necessary to achieve significant additional greenhouse gas reductions from changed land use patterns and improved transportation. Without improved land use and transportation policy, California will not be able to achieve the goals of AB 32.” The legislative findings of SB 375 also recognize that: “California local governments need a sustainable source of funding to be able to accommodate patterns of growth consistent with the state’s climate, air quality, and energy conservation goals.” (Chapter 728, Statutes of 2008, Section 1(c) and (i))

In addition to the need for the SCS to be designed to achieve GHG emissions reductions, there are many other reasons why planning assumptions can be different than historical trends or existing plans and boundaries. The following is a non-exclusive list of circumstances when it may be appropriate or necessary to make an assumption that is different from historical trends or existing plans and boundaries:

1. The assumption accounts for new demographic, market, regulatory, or environmental trends that are likely to influence development choices, particularly in circumstances when it has been several years since a general plan has been updated.
2. The assumption accounts for adopted blueprints, habitat conservation plans or other plans which may accurately reflect likely future growth patterns.
3. The assumption accounts for general uses and densities within general plans that may be required to comply with state law. Examples required pursuant to Article 10.6 of the Planning and Zoning Law (housing element law) include: achieving an adequate housing site inventory for the previous or new planning period in order to meet the housing needs of all economic segments of the population; existing general plans do not yet include land use designations with zoning to accommodate the existing RHNA and cannot accommodate the next RHNA without amendment of land use designations and rezoning; local governments have not yet completed a scheduled rezoning program of an adopted housing element; or existing plans reflect ordinances, policies, voter-approved measures, or other standards which prevent the jurisdiction from accommodating the RHNA.
4. The assumption accounts for differences in the time horizons between the RTP (20 to 40 years or more) and local general plans (often 15 - 20 years).
5. The assumption accounts for increases or decreases in state, federal, or local funding of programs that influence the extent to which a program may or may not be implemented.
6. The assumption accounts for statutory requirements or other reasons identified through consultation with federal, state, and local agencies.

When planning and land use assumptions are made that are significantly different than historical trends, federal, state, and local agencies should be consulted as to whether the assumptions are reasonable, best available, and consistent with the transportation system set forth in the plan. The MPO should base its assumptions on the most reasonable forecasts taking into account changing population demographics and market demand over the life of the RTP. To the extent that they are reasonable and consistent with federal requirements, an MPO may base an SCS on planning assumptions that differ from historical trends, existing plans and boundaries. The MPO should document the assumptions made to develop the SCS.

Addressing Housing Needs in the SCS

The passage of SB 375 increased the linkage of the Regional Housing Need Allocation (RHNA) process required by State Housing Element Law with the RTP development and adoption process. Regional Transportation Plans are to be updated at least every four years for nonattainment areas, and every five years for attainment areas unless an election was made to update every four years pursuant to GC 65580(b)(2)(M). Housing element updates are now to be adopted every 8 years for jurisdictions within nonattainment areas, except for those which must update every four years if they fail to adopt their housing element update within 120 days of the due date pursuant to Government Code Section 65588(e)(4). Housing elements for jurisdictions within attainment area MPOs not within MPOs are to continue to be adopted every 5 years except in those regions that elect to adopt an RTP every four years pursuant to Government Code Section 65080 (b)(2)(M).

The SCS shall accommodate the RHNA pursuant to Government Code Section 65584 and consider the state housing goals specified in Government Code Section 65580 and 65581. The development pattern of the SCS shall consider existing residential zoning obligations to accommodate the RHNA of the current housing element planning period as well as residential density implications for the pending RHNA with which the SCS is being coordinated. The SCS development pattern shall not preclude an individual community from accommodating its existing or pending RHNA.

Pursuant to Government Code Section 65080(b)(2)(B)(ii), the SCS shall identify areas within the region sufficient to house all the population of the region, including all economic segments of the population, over the course of the planning period of the regional transportation plan, taking into account net migration into the region, population growth, household formation, and employment growth. This is separate from the requirement pursuant to 65080(b)(2)(B)(iii) to identify areas sufficient to house an eight year projection of the housing need pursuant to the RHNA process in Section 65584 *et seq.*

Unlike the RHNA process which allocates a minimum amount and economic distribution of housing to be accommodated within the housing element planning period, there are not comparable, formal parameters for the entire RTP planning period. The planning period for the RTP is at least 12 years longer than the housing element planning period accommodated in the RTP.

Thus, MPOs should include an analysis within the SCS that looks forward over the entire planning period and reasonably addresses what the housing need may be and where the region can meet its housing needs for all economic segments of the population over the course of the RTP planning period. This analysis should assume a variety of housing types and densities including multi-family densities in each jurisdiction. Documentation to support this analysis should be prepared and may include a narrative description, map, data, or other resources (or any combination thereof) that identifies where within the region this need can be met. Like all planning assumptions, assumptions related to identifying housing needs beyond the RHNA allocation period should be reevaluated each time the RTP is updated.

Government Code Section 65080(b) (2)(B)(iii) requires that the SCS identify areas within the region sufficient to house the projection of the regional housing need for the region pursuant to Government Code Section 65584. The RHNA process establishes a minimum amount of housing development capacity for each city's and county's housing element. Each city and county must demonstrate this capacity with adequate sites, and development standards and programs to accommodate the RHNA within the planning period of an updated housing element. The RHNA process includes many steps and statutorily required deadlines which are included in more detail in Appendix I. Key steps of the RHNA process for Councils of Governments (COGs) which are MPOs, or which are within or coterminous with MPO boundaries, are as follows:

1. Consultation with HCD regarding HCD's determination of RHNA (at least 26 months) prior to local governments' housing element due date: The regional planning agency is required to distribute RHNA shares to each local government at least 12 months prior to local governments' housing element due date.
2. Methodology Development for COG's RHNA Plan (more than 24 months before housing element due date): the COG, with survey information and participation of its local governments, develops methodology for allocation of the region's housing need determination.
3. Distribution of draft RHNA (at least 18 months before the due date for adoption of the housing element): the COG, based on the Draft RHNA Plan, distributes the draft RHNA of housing unit need to each city and county government in the region. The Draft RHNA Plan is first subjected to requests for revision followed by opportunity for local government appeals. This plan is developed concurrently with development of the RTP, including the SCS.
4. RHNA Plan Adoption (adopted at least one year before the housing element due date): the COG is required to adopt a Final RHNA Plan within three days submit the RHNA Plan to HCD.
5. HCD Approval of Final RHNA Plan (HCD's finding for the Final RHNA Plan is due within 60 days of receipt): the final RHNA Plan is subject to review and approval by HCD for consistency of the plan with its (prior) housing need determination for the region. If not, HCD is authorized to revise the COG allocations for a Final RHNA Plan.
6. Local Government Housing Elements (must be updated within 18 months of adoption of the RTP): each local government within the region must adopt an updated housing element specifying housing sites, policies, and programs that will accommodate its allocation of units from the Final RHNA Plan approved by HCD.

For the eight-year planning period for housing element revisions, the COG shall allocate housing units to cities and counties within the region consistent with the development pattern included in the SCS as required by Government Code Section 65584.04 (i). Government Code Section 65584.09 (a)(b)(c) also requires that if a city or county in the prior planning period failed to identify or make available adequate sites to accommodate that portion of the regional housing need allocated pursuant to Section 65584, then the city or county shall, within the first year of the planning period of the new housing element, zone or rezone adequate sites to accommodate the un-accommodated portion of the RHNA from the prior planning period. Further, the law requires that this shall be in addition to any zoning or rezoning required to accommodate the jurisdiction's share of the regional housing need pursuant to Section 65584 for the new planning period.

Requirements (Shall):
Federal: Title 23 CFR Part 450 and Title 40 CFR Part 93
State: Government Code 65080, Government Code 65584.01 (c) & (d), Government Code 65583.2 (c), Government Code 65584.04 (d), (f) & (i), Government Code 65584.05 (g) & (h)

Relevant Links:

Appendix 1 of HCD Memorandum: Amendment of State Housing Element Law – AB 2348, Listing of Default Densities by Jurisdiction:

http://www.hcd.ca.gov/hpd/hrc/plan/he/ab2348stat04ch724.pdf

Addressing Regional Transportation Needs

Government Code Section 65080 (b)(2)(B)(iv) requires that an SCS identify a transportation system to service the transportation needs of the region. While the SCS requirements for the RTP do not change the process used to establish transportation needs for the region, the SCS forecasted development pattern and transportation network, measures, and policies should complement one another to reduce regional GHG emissions from light duty trucks and automobiles. Decisions to expand or modify the transportation system should be made in recognition of the effects of transportation on development location and density, and also in recognition of the following relationships between land use and transportation:

- Transit investments need supporting levels of land use density and intensity.
- The speed of the network and the cost of travel may influence the location choices of new development.
- Placing land uses closer together and minimizing unnecessary barriers to circulation increases travel choices such that transit, walking, and bicycling become viable while also reducing transportation sector energy use and GHG emissions.

The SCS may also include transportation policies designed to reduce GHG emissions such as strategies for Transportation Demand Management (TDM) and Transportation System Management (TSM). Additional information regarding TDM, TSM and other strategies is available in Section 6.28 and Appendix L.

Addressing Resource Areas and Farmland

The SCS is required pursuant to Government Code Section 65080(b)(2)(B)(v) to gather and consider the best practically available scientific information regarding resource areas and farmland in the region as defined in Government Code Section 65080.01 (a) and (b), listed below:

(a) “Resource areas” include:

(1) All publicly owned parks and open space;

(2) Open space or habitat areas protected by natural community conservation plans, habitat conservation plans, and other adopted natural resource protection plans;
(3) Habitat for species identified as candidate, fully protected, sensitive, or species of special status by local, state, or federal agencies or protected by the federal Endangered Species Act of 1973, the California Endangered Species Act, or the Native Plan Protection Act;
(4) Lands subject to conservation or agricultural easements for conservation or agricultural purposes by local governments, special districts, or nonprofit 501(c)(3) organizations, areas of the state designated by the State Mining and Geology Board as areas of statewide or regional significance pursuant to Section 2790 of the Public Resources Code, and lands under Williamson Act contracts;
(5) Areas designated for open-space or agricultural uses in adopted open-space elements or agricultural elements of the local general plan or by local ordinance;
(6) Areas containing biological resources as described in Appendix G of the CEQA Guidelines that may be significantly affected by the sustainable communities strategy or the alternative planning strategy; and
(7) An area subject to flooding where a development project would not, at the time of development in the judgment of the agency, meet the requirements of the National Flood Insurance Program or where the area is subject to more protective provisions of state law or local ordinance.

(b) "Farmland" means farmland that is outside all existing city spheres of influence or city limits as of January 1, 2008, and is one of the following:

(1) Classified as prime or unique farmland or farmland of statewide importance.
(2) Farmland classified by a local agency in its general plan that meets or exceeds the standards for prime or unique farmland or farmland of statewide importance.

The SCS may include a narrative description, map, data, or other resources (or any combination thereof), developed in consultation with the appropriate resource agencies including cities and counties, which identifies regional resource areas and farmland.

Additionally Sections 5.3, 5.4, and Appendix L of the Guidelines include more information regarding the consideration of regional environmental resource areas and farmland and advanced resource mitigation planning in RTP development.

Designing a Forecasted Development Pattern in the SCS

MPOs are required to develop a forecasted development pattern for the region that, when integrated with the regional transportation network and other transportation measures and policies, will reduce regional GHG emissions from cars and light trucks to achieve, if there is a feasible way to do so, the regional targets set by ARB. In preparing the forecasted development pattern, empirical relationships between land use, transportation and the resulting GHG emissions should be considered. Such factors may include, but are not limited to:

- Destination-proximity, or the accessibility of an area to other activities.
- Density and clustering of land uses, typically measured by the number of dwelling units, shops, and/or employees per acre or square mile, floor area ratio (FAR), and other similar measurements.

- Diversity or mixture of land uses, including residential, commercial, and business land uses within buildings and/or in proximity to one another.
- Distance to transit, including rail, bus, and/or ferry.
- Design and layout of an area's transportation facilities to accommodate multiple modes of transportation.

In developing the forecasted development pattern for the SCS, local context should also be considered. MPOs, local jurisdictions, and other stakeholders should strive to create a supportive consensus on an SCS, so that the SCS may guide local jurisdictions in future general plan updates.

Considering Social Equity in the SCS

The inclusion of the entire range of community interests in the development of the RTP (including the SCS) is a key element in the process, and is required by state and federal law. Providing more transportation and mobility choices such as increased transit, bicycle, and pedestrian facilities, as well as appropriate housing choices near job centers increases opportunities for all segments of the population at all income levels. Each MPO is encouraged to develop, enhance, and use visioning tools during the SCS development process enabling the public and policy makers to clearly see social equity impacts of various planning scenarios and make informed choices. Some MPOs include disadvantaged groups that are not defined by the traditional parameters of the low income and minority groups, such as groups identified as disadvantaged due to environmental impacts identified under CalEnvironScreen (established pursuant to SB 535, Chapter 830, Statutes of 2012) Social equity impacts include air quality, access to transit, access to electric vehicle charging, household transportation costs, housing costs and overall housing supply. Additional information regarding specific statutory requirements for Title VI and environmental justice considerations in the RTP is available in Section 4.2 and additional information regarding social equity factors in the public participation process is available in Section 4.3.

Considering Rural Communities in the SCS

Regulatory and financing mechanisms such as Government Code Section 65080, Greenhouse Gas Reduction Fund programs, CEQA incentives etc. provide a framework and incentives for infill and transit oriented development policies and projects that contribute to the achievement of regional per capita GHG emissions reductions in the RTP/SCS. The consideration of rural communities within the region in the development of the RTP (including the SCS) is a key element in the process, to ensure that regional GHG reductions and associated co-benefits such as improved access to jobs and services are not achieved at the expense of small towns and rural communities where high frequency transit and/or high density development is not feasible. The RTP process should consider policies and programs for investments in rural communities that improve sustainability and access to jobs and services and that protect resource areas, farmland, and agricultural economies. For additional information on addressing resource areas and farmland in the RTP, please see the preceding section entitled "Addressing Resource Areas and Farmland."

Government Code Section 65080 (b)(4)(C) states that the MPO or county transportation agency, whichever entity is appropriate, shall consider financial incentives for cities and counties that have resource areas or farmland, as defined in Government Code Section 65080.01, for the purposes of, for example, transportation investments for the preservation and safety of the city street or county road system and farm to market and interconnectivity transportation needs. The MPO or county transportation agency, whichever entity is appropriate, shall also consider financial assistance for counties to address countywide service responsibilities in counties that contribute towards the GHG emission reduction targets by implementing policies for growth to occur within their cities.

In recognition of limited regional financial resources, MPOs are encouraged to pursue and assist their partner agencies in the pursuit of discretionary state and other funding sources to address resource areas, farmland, and rural sustainability in the RTP process.

Requirements (Shall):
Federal: None
State: Government Code Section 65080

Specific SCS Development Requirements for MPOs in Multi-County Regions

There are five Multi-County MPO's within California:

- Association of Monterey Bay Area Governments (AMBAG): covers a three county region.
- Metropolitan Transportation Commission (MTC): covers a nine county region in the San Francisco Bay Area.
- Southern California Association of Governments (SCAG): covers a six county region.
- Sacramento Area Council of Governments (SACOG): covers a six county region.
- Tahoe Metropolitan Planning Organization (TMPO): covers a portion of Placer and El Dorado Counties.

Government Code Section 65080(b)(2)(C), (D) and (N) assigns certain responsibilities and collaboration requirements or options for the development of an SCS in multi-county MPO regions and in the San Joaquin Valley. The AMBAG and SACOG multi-county MPO regions are not specifically addressed in 65080(b)(2)(C), (D) or (N) however, **RTPAs** within these regions should work closely with the appropriate MPO when developing their RTPs for inclusion in the MPOs RTP, as these multi-county MPO regions are still required to fully comply with the SCS requirements outlined in 65080(b)(2)(B).

San Francisco Bay Area – Pursuant to Government Code Section 65080(b)(2)(C)(i), within the nine county San Francisco Bay Area region, the Association of Bay Area Governments (ABAG) is responsible for the land use and housing related issues in the SCS. The Metropolitan Transportation Commission is responsible for identifying the regional transportation needs. ABAG and MTC are jointly responsible for setting forth a forecasted development pattern for the region that, when integrated with the transportation network, measures and policies, will reduce GHG emissions from passenger vehicles and if, feasible, achieve GHG reduction targets set by the ARB.

Southern California Association of Governments (SCAG) – Within the SCAG region, there are six County Transportation Commissions (CTCs) and fourteen sub-regional COGs. Government Code Section 65080(b)(2)(C) allows a COG and a CTC to jointly develop a SCS and APS (if needed). SCAG has developed a document titled: "*Framework and Guidelines by the Southern California Association of Governments for the Development of a Sub-Regional SCS/APS*". This document is intended to provide guidance for the development of a sub-regional SCS or APS, and should be consulted prior to any SCS/APS related work. SCAG shall include the sub-regional work within their overall SCS contained in SCAG's RTP, to the extent that the sub-regional work is consistent with the provisions of Government Code 65080 and federal law. Please see Government Code 65080 (b)(2)(C) for specific requirements.

San Joaquin Valley - The following eight counties constitute the MPOs located in the San Joaquin Valley: Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus and Tulare. These eight counties are located in one air quality basin and the MPOs have a long history of collaborating on the preparation of their respective RTPs particularly as it relates to the federal air quality conformity determination. Government Code section 65080 (N) stipulates that two or more of these MPOs may work together on the development of a joint SCS or APS, should they choose to do so.

Tahoe Metropolitan Planning Organization (TMPO) – Pursuant to Government Code Section 65080(b)(2)(C)(ii), within the jurisdiction of the Tahoe Regional Planning Agency, as defined in Sections 66800 and 66801, TMPO shall use the Regional Plan for the Lake Tahoe Region as the sustainable community strategy, provided it complies with Government Code Section 65080(b)(2)(B)(vii) and (viii).

Requirements (Shall):
Federal: Title 23 CFR Part 450, Title 40 CFR Part 93, and Title IV of the Civil Rights Act of 1964
State: Government Code Sections 11135 and 65080

6.27 SCS Process, Review & Acceptance

Regional GHG Emissions Reduction Targets

State statute requires the ARB to set regional GHG emissions reduction targets for each MPO. Before setting the target for a region, ARB will exchange technical information with each MPO and the respective air quality management district. The MPO may recommend a target for its region during this process. Advanced and continuous communication and consultation between ARB and each MPO is highly recommended until the final target is adopted.

Questions regarding regional GHG emission reduction targets should be directed to ARB.

SCS Public Participation & Input/Consultation with Local Elected Officials

SB 375 increased the minimum level of public participation in the regional transportation planning process as well as the consultation required with local elected officials during the development of a SCS (and APS, if applicable). For more detailed information regarding these requirements for the development of an SCS (and an APS, if applicable) please refer to Sections 4.7 and 4.8 of the RTP Guidelines.

California Air Resources Board Review of the SCS

Prior to starting the public participation process adopted pursuant to Government Code 65080 (b)(2)(F), the MPO shall submit a description to the state board of the technical methodology it intends to use to estimate the GHG emissions from its SCS and, if appropriate, its APS. ARB shall respond to the MPO in a timely manner with written comments about the technical methodology, including specifically describing any aspects of the methodology it concludes will not yield accurate estimates of GHG emissions, and suggested remedies. The MPO is encouraged to work with the ARB until the state board concludes that the technical methodology operates accurately.

After adoption of the RTP, a MPO shall submit a SCS or an APS, if one has been adopted, to the ARB for review, including the quantification of the GHG emission reductions the strategy would achieve and a description of the technical methodology used to obtain that result. Review by the ARB shall be limited to acceptance or rejection of the MPO's determination that the strategy submitted would, if implemented, achieve the GHG emission reduction targets established by ARB. The ARB shall complete its review within 60 days.

If ARB determines that the strategy submitted would not, if implemented, achieve the GHG emissions reduction targets, the MPO shall revise its strategy or adopt an APS, if not previously adopted, and submit the strategy for review pursuant to the paragraph above. At a minimum, the MPO must obtain ARB acceptance that an APS would, if implemented, achieve the GHG emission reduction targets established for that region by the state board.

Advanced and continuous communication and consultation between each MPO and ARB is encouraged until the final SCS, or APS if applicable, is adopted.

A flowchart depicting the RTP Development/Approval Process for MPOs including ARB review of the SCS, and APS if applicable, is available in Section 2.8. For additional information on the SCS Review process please refer to the California Air Resources Board SB 375 Implementation website:

https://www.arb.ca.gov/cc/sb375/sb375.htm

6.28 Land Use & Transportation Strategies to Address Regional GHG Emissions

Better land use and transportation strategies will continue to be important to MPOs in developing their RTPs to meet local, regional and statewide mobility and economic needs while meeting the requirements of SB 375 and AB 32 to reduce regional GHG emissions. MPOs can encourage well-designed and sustainable local and regional projects that encourage reductions in GHG emissions by considering and implementing land use and transportation strategies. The strategies set forth below and in Appendix L are suggested methods that may help the MPO to reduce regional GHG emissions.

Land use strategies can include, but are not limited to:

- Mixed use, infill, and higher density development projects.
- Public transit incorporated into project design.
- Open space, parks, existing trees, and replacement trees.
- "Brownfields" and other underused property near existing public transportation and jobs developed.
- Pedestrian and bicycle-only streets and plazas within developments.
- Consideration of current and future school sites and needs regarding school-related trips.

Transportation strategies can include, but are not limited to:

- Promote ride sharing programs
- Employer-sponsored shuttle services
- Encourage or use low or zero-emission vehicles
- Create car sharing programs
- Provide shuttle service to public transit
- Incorporate bicycle-friendly intersections into street design
- Create active transportation plans
- A school district may provide bussing to students based on the distance from a school, other hazards to walking to the school, or other district criteria. Consider opportunities to incorporate existing and planned school district busing to supplement and complement public transit options.
- Consider opportunities to protect or improve designated and proposed school district safe routes to school in community wide transportation strategies and investments (e.g. transit improvements bifurcating neighborhoods near schools disrupting pedestrian/bike access).

Additional strategies include, but are not limited to:

- Pricing Strategies (can include Congestion Pricing, Road Tolling, HOT lanes and toll roads, Parking Pricing and Alternative Mode Programs)
- Transportation Planning and Investment Strategies in the Smart Mobility Framework
- Urban and suburban infill, clustered development, mixed land uses, New Urbanist design, transit-oriented development, and other "smart-growth" strategies: Strategies incorporating the "D factors" (See Professor Robert Cervero's research as noted in Cervero, R. and K. Kockelman (1997) "Travel Demand and the 3Ds: Density, Diversity, and Design," *Transportation Research D*, Vol. 2, pp. 199-219. Other resources used to define these factors include Fehr & Peers' *Accurate Trip Generation Estimates for Mixed-Use Projects,* and Cervero and Lee's *The Effect of Housing Near Transit Stations on Vehicle Trip Rates and Transit Trip Generation.)*
- Congestion Management improving traffic circulation to reduce vehicle idling (coordinate controlled intersections for traffic to pass more efficiently through congested areas)
- Transportation Demand Management

As regions explore various land use and transportation strategies to reduce GHG emissions in the Sustainable Communities Strategy, MPOs should consider identifying and to the extent possible, quantifying the co-benefits associated with GHG emissions reduction strategies throughout the RTP implementation processes. Co-benefits are positive externalities that result from reducing GHGs such as increased mobility, reduced air and water pollution, economic opportunities, and healthier, more equitable and sustainable communities.

The strategy suggestions listed above, and in more detail in Appendix L are applicable to MPOs. Links to various planning practice examples are also available in Appendix L.

Planning Practice Examples: Available in Appendix L

6.29 Alternative Planning Strategy (APS) Overview

Pursuant to California Government Code Section 65080(b)(2)(H), if the SCS, prepared in compliance with 65080(b)(2)(B) or (C), is unable to reduce GHG emissions to achieve the GHG emission target established by the ARB, the MPO shall prepare an APS to the SCS showing how that GHG emissions target would be achieved through alternative development patterns, infrastructure, or additional transportation measures and policies. The APS shall be a separate document from the RTP. In preparing the APS, the MPO:

1. Shall identify the principal impediments to achieving the targets within the SCS
2. May include an alternative development pattern for the region pursuant to 65080 (b)(2)(B) to (F) inclusive,
3. Shall describe how the GHG emissions reduction targets would be achieved by the APS, and why the development pattern, measures, and policies in the APS are the most practicable choices for achievement of the GHG emission reduction targets,
4. An alternative development pattern set forth in the APS shall comply with Part 450 of Title 23 of, and Part 93 of Title 40 of, the Code of Federal Regulations, except to the extent that compliance will prevent achievement of the GHG emission reduction targets approved by the ARB,
5. For purposes of the California Environmental Quality Act (CEQA), an APS shall not constitute a land use plan, policy or regulation, and the inconsistency of a project with an alternative planning strategy shall not be a consideration in determining whether a project may have an environmental effect.

For additional information on the APS please refer to Appendix H.

6.30 Adaptation of the Regional Transportation System to Climate Change

This section is intended to provide background on climate adaptation for MPOs to consider in the development of RTPs. First, an overview of climate adaptation is provided for informational purposes. Next, executive orders on climate change are discussed to provide a critical framework for MPOs. While the executive orders are directed at State agencies, they are provided to inform MPOs in the development of RTPs. State legislation is also discussed that may provide important context for MPOs to consider in development of RTPs. Lastly, several resources are provided for MPOs to consider in adaptation planning.

In 2014, the Intergovernmental Panel on Climate Change concluded that further effects of climate change are inevitable despite planned and implemented mitigation efforts. To help regions prepare for these effects, Caltrans' 2013 report "Addressing Climate Change Adaptation in Regional Transportation Plans: A Guide for California MPOs and RTPAs[1]" and Caltrans Vulnerability Assessments provide methods to incorporate impacts of climate change into future long-range transportation planning and decisions. A number of studies (Risky Business[2], Pacific Institute[3], UC Merced and RAND Corporation[4], American Society of Civil Engineers[5], Next10 and U.C. Berkeley[6]) quantify the high costs associated with climate impacts such as rising sea levels, changing wind and precipitation patterns, increasing temperatures, and wildfire damage resulting from changes in the climate.

Adaptation planning is very important for cities and counties across California. Because of its natural and geographic diversity, California is extremely susceptible to a wide range of climate change effects – many of which we have already begun experiencing. Examples include: rising maximum and minimum temperatures, less snowpack and earlier snowpack melt, drought and other changing precipitation patterns, increased severity of wildfires, sea-level rise, extreme weather events, which will lead to numerous changes and effects on biodiversity and habitats.

Building on decades of successful actions to reduce pollution, increase energy efficiency and mitigate the effects of climate change, California has long been at the forefront of global and national efforts to reduce the threat of a changing climate. The increasing likelihood of severe, pervasive and irreversible impacts are expected to have potentially catastrophic impacts on the transportation system resulting in flooded airports, interstate highways and roads, landslides that disrupt traffic flow and rail lines, heat waves and subsidence causing roadways to buckle; and, increased costs of transportation infrastructure operations and maintenance due to fire damage, erosion and inundation. The degree of risk for the State's transportation infrastructure system is uncertain and since climate impacts are location-specific, it makes sense to address concerns regionally.

The potential for consequences to life, health and safety, the environment, economic well-being, and other values need to be assessed in terms of probable risks and exposures, the likelihood of an event occurring (probability), and the anticipated damages that would result if it did occur (consequences).

In 2015, the Governor's Executive Order B-30-15 created a roadmap for climate adaptation progress around the foundation of prior state efforts to build climate preparedness and reduce GHG emissions. Public resources code 71155 requires that State agencies shall take into account the current and future impacts of climate change when planning, designing, building, operating, maintaining and investing in state infrastructure. The Executive Order provides further context to this statute and directs:

1. All State agencies with jurisdiction over sources of GHG emissions shall implement measures pursuant to statutory authority, to achieve reductions of GHG emissions to meet the 2030 and 2050 GHG emissions reduction targets.
2. The preparation of implementation plans for the actions recommended in California's Adaptation Strategy, the Safeguarding California Plan[7] and sector reports to the *California Natural Resources Agency* describing progress towards implementation.
3. State agencies to employ the following guiding principles in all planning and investment decisions:
   - Prioritize actions that both build climate preparedness and reduce GHG emissions;
   - Where possible, choose flexible and adaptive approaches to prepare for uncertain climate impacts;
   - Protect the state's most vulnerable populations; and,
   - Prioritize natural infrastructure solutions, as defined in Public resources code 71154(c)(3) (e.g., flood plain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planning to reduce high heat days).
4. State agencies shall take climate change into account in their planning and investment decisions, and employ full life-cycle cost accounting on infrastructure projects to evaluate and compare investments and alternatives.

5. All infrastructure projects included in the state's annual Five-Year Infrastructure Plan must take into account the current and future impacts of climate change.
6. The establishment of a Technical Advisory Group through the *Governor's Office of Planning and Research* (OPR) to help State agencies incorporate climate change impacts into planning and investment decisions.

Additionally, three laws were signed in 2015 that are intended to provide important context for State agencies to collaborate with MPOs, to consider climate impacts as they formulate their RTPs:

- **AB 1482** directs ongoing updates to the Safeguarding California Plan (beginning in 2017) and requires future updates (every three years) to describe the vulnerabilities from climate change in a minimum of nine specific sectors, and the priority actions needed to reduce climate risks in each of those sectors.
- **SB 246** establishes the Integrated Climate Adaptation and Resilience Program at the *Governor's Office of Planning and Research* to coordinate regional and local efforts with the state's climate adaptation strategies; and to establish a climate adaptation clearinghouse that centralizes best scientific evidence, available climate data and information for use in planning and implementing state, regional, and local climate adaptation projects. This bill also directs the *Office of Emergency Services* to update the California Adaptation Planning Guide, within one year of an update to the Safeguarding California Plan, to provide current tools and guidance to regional and local governments and agencies that are adopting and implementing climate adaptation and community resiliency plans and projects.
- **SB 379** requires local hazard mitigation plans to incorporate climate impacts by 2021; through coordination with an update to local jurisdictions' General Plan Safety Element (see OPR's 2016 edition of the General Plan Guidelines[8]).

The state has developed tools and resources to help inform and empower local decision-makers to incorporate climate impacts into their work. Cal-Adapt.org[9] is an online platform created in 2011 by the California Energy Commission to synthesize the best available climate science and generate spatially-explicit visualizations for local policymakers and the general public. Planners can find sophisticated locality-specific projections for many temperature metrics, wind and precipitation patterns, wildfire risk, snowpack and sea-level rise. The Adaptation Planning Guide[10], released by the Natural Resources Agency in 2012, helps regions and communities prepare for those projected impacts. *The Governor's Office of Planning and Research* has incorporated these resources into the 2016 General Plan Guidelines to create comprehensive planning processes for local governments.

MPOs should begin to address climate change adaptation in their long-range transportation plans in collaboration with State agencies, as transportation infrastructure projects that do not consider the impacts of climate may not be eligible to receive state funds. The following Caltrans documents and other resources are useful for climate adaptation planning, including "Addressing Climate Change Adaptation in Regional Transportation Plans: A Guide for California MPOs and RTPAs, Cal-Adapt.org, and other state resources (see Climate Adaptation Resources table below). Design and planning standards should be re-evaluated to address future conditions. MPOs should consult Safeguarding California's transportation chapter, the California Coastal Commission Sea Level Rise Policy Guidance, and where possible, local

General Plan safety elements and Hazard Mitigation Plan documents, as well as other relevant local, regional, and state plans, resources and documents.

References:

1. http://www.dot.ca.gov/hq/tpp/offices/orip/climate_change/documents/FR3_CA_Climate_Change_Adaptation_Guide_2013-02-26_.pdf#zoom=65
2. http://riskybusiness.org/site/assets/uploads/2015/09/California-Report-WEB-3-30-15.pdf
3. http://www.pacinst.org/reports/sea_level_rise/
4. http://www.energy.ca.gov/2009publications/CEC-500-2009-048/CEC-500-2009-048-D.PDF
5. http://ascelibrary.org/doi/pdfplus/10.1061/9780784479193
6. http://www.energy.ca.gov/2009publications/CEC-500-2009-014/CEC-500-2009-014-D.PDF
7. http://resources.ca.gov/docs/climate/safeguarding/Transportation%20Sector%20Plan.pdf
8. https://www.opr.ca.gov/s_generalplanguidelines.php
9. http://cal-adapt.org/
10. http://resources.ca.gov/climate/safeguarding/adaptation_policy_guide/

Planning Practice Examples: Available in Appendix L

Climate Adaptation Resources for RTPAs and MPOs		
Title of Resource	*Origin and Use*	*Website*
2013 - Addressing Climate Change Adaptation in Regional Transportation Plans*: A Guide for California MPOs and RTPAs*	Caltrans	http://www.dot.ca.gov/hq/tpp/offices/orip/climate_change/documents/FR3_CA_Climate_Change_Adaptation_Guide_2013-02-26_.pdf#zoom=65
Guidance on Incorporating Sea Level Rise: For use in the planning and development of Project Initiation Documents	Caltrans	http://www.dot.ca.gov/hq/tpp/offices/orip/climate_change/documents/guide_incorp_slr.pdf#zoom=65
Cal-Adapt.org	Energy Commission	www.cal-adapt.org
Adaptation Planning Guide	Office of Emergency Services	http://resources.ca.gov/climate/safeguarding/adaptation_policy_guide/
2014 Safeguarding California Plan (California's Adaptation Strategy)	Natural Resources Agency	http://resources.ca.gov/docs/climate/Final_Safeguarding_CA_Plan_July_31_2014.pdf
2016 Safeguarding California: Implementation Action Plans, Transportation Sector	Natural Resources Agency and the State Transportation Agency	http://resources.ca.gov/docs/climate/safeguarding/Transportation%20Sector%20Plan.pdf
State of California Sea-Level Rise Document	Ocean Protection Council	http://www.opc.ca.gov/2013/04/update-to-the-sea-level-rise-guidance-document/
2016 General Plan Guidelines	Governor's Office of Planning and Research	https://www.opr.ca.gov/s_generalplanguidelines.php
California Coastal Commission Sea Level Rise Policy Guidance	California Coastal Commission	http://www.coastal.ca.gov/climate/slrguidance.html

Chapter 7

Transportation Performance Management

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TRANSPORTATION PERFORMANCE MANAGEMENT

7.0 Introduction

Performance management provides the opportunity to ensure efficient and effective investment of transportation funds by refocusing on established goals, increasing accountability and transparency, and improving project decision-making. This chapter is intended to provide an overview of Federal and State requirements and recommendations for performance management applications in the RTP. MAP-21/FAST Act require States and MPOs to implement a performance-based approach in the scope of the statewide and nonmetropolitan *and* metropolitan transportation planning process. In addition to federal performance-based planning, the State of California has articulated through statute, regulation, executive order, and legislative intent language, numerous state policies and goals for the transportation system, the environment, the economy, and social equity.

There are different applications of performance management – performance measures, performance targets, and performance monitoring indicators or metrics. Performance measures are used to model travel demand and allow the long-range forecasting of transportation network and system-level performance (e.g. Walk, bike, transit, and carpool mode share, corridor travel times by mode, percentage of population within 0.5 mile of a high frequency transit stop). Performance targets are numeric goals established to enable the quantifiable assessment of performance measures. Performance monitoring indicators or metrics include field data such as vehicle miles traveled, mode share, fatalities/injuries, transit access, change in agricultural land, and CO_2 emissions.

7.1 Federal Performance Goals & Measures

The cornerstone of the federal highway program transformation is the transition to a performance and outcome-based program. MAP-21/FAST Act integrate performance into many federal transportation programs and contains several performance elements. States and MPOs will invest resources in projects to achieve individual targets that collectively will make progress toward national goals. The national performance goals for the Federal highway programs as established in MAP-21, 23 U.S.C. Section 150(b), are as follows:

- Safety - To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.
- Infrastructure Condition - To maintain the highway infrastructure asset system in a state of good repair.
- Congestion Reduction - To achieve a significant reduction in congestion on the National Highway System.
- System Reliability - To improve the efficiency of the surface transportation system
- Freight Movement and Economic Vitality - To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.
- Environmental Sustainability - To enhance the performance of the transportation system while protecting and enhancing the natural environment.
- Reduced Project Delivery Delays - To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project

completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices.

The national performance measures will assess the progress toward the national goals listed above. National performance measures [23 U.S.C. Section 150(c) and 49 U.S.C. Section 5326(c) and Section 5329(d)] will address the following issues:

- For the National Highway Performance Program (NHPP):
    - Pavement conditions on the Interstate system and remainder of the National Highway System,
    - Bridge conditions on the NHS,
    - Performance of the Interstate system and remainder of the NHS
- For the Highway Safety Improvement Program (HSIP):
    - Number and rate per vehicle mile traveled of fatalities
    - Number and rate per vehicle mile traveled of serious injuries
- For the Congestion Mitigation and Air Quality Improvement Program (CMAQ):
    - Traffic congestion
    - On-road mobile source emissions
    - Freight movement on the Interstate system
- Public transportation:
    - State of good repair
    - Safety

The FHWA/FTA have developed final rules to implement the MAP-21/FAST Act Transportation Management Program (TPM), as summarized below. Section 1203 of MAP-21 identifies the national transportation goals and requires the U.S. DOT Secretary to promulgate a rule to establish performance measures in specified Federal-aid highway program areas listed above. The FHWA has issued three separate rules to meet this requirement: (1) Safety Performance Measures; (2) Pavement and Bridge Condition Measures; and, (3) System Performance Measures. These three rules together will establish a set of performance measures for Caltrans and MPOs to use as required by MAP-21. FTA is responsible for developing rules related to public transportation and transit asset management. The FHWA and FTA work together on additional rules for: Statewide and Nonmetropolitan Transportation Planning *and* Metropolitan Transportation Planning; Additional Authorities for Planning and Environmental Linkages; and, MPO Coordination & Planning Area Reform. A future update of the RTP Guidelines will capture any “shoulds” or “shalls” resulting from the rulemaking process.

Safety Performance Measures

The MAP-21/FAST Act established Safety Performance Management (PM) as part of the overall Transportation Performance Management (TPM) program, which FHWA defines as a strategic approach that uses system information to make investment and policy decision to achieve national performance goals. The first in a series of three related rules, the Safety PM final rule, was published on March 16, 2016 with an effective date of April 14, 2016. This final rule supports the HSIP, as it establishes safety performance measure requirements for the purpose of carrying out the HSIP and to assess fatalities and serious injuries on all public roads.

The Safety PM establishes five performance measures as the five-year rolling averages for:

1. Number of Fatalities
2. Rate of Fatalities per 100 million Vehicle Miles Traveled (VMT)

3. Number of Serious Injuries
4. Rate of Serious Injuries per 100 million VMT, and
5. Number of Non-motorized Fatalities and Non-motorized Serious Injuries.

The Safety PM regulation also establishes the process for Caltrans and MPOs to establish and report their safety targets, and the process that FHWA will use to assess whether Caltrans has met or made significant progress toward meeting their safety targets.

The California HSIP is available at:

http://dot.ca.gov/hq/LocalPrograms/hsip.html

Pavement & Bridge Condition Measures

The second final rule, Pavement & Bridge Condition was published on January 18, 2017 with an effective date of February 17, 2017 and established measures for Caltrans to use to carry out the NHPP and to assess the condition of the following: pavements on the NHS (excluding the Interstate System), bridges on the NHS, and pavements on the Interstate System. The NHPP is a core Federal-aid highway program that provides support for the condition and performance of the NHS and the construction of new facilities on the NHS, and ensures that investments of Federal-aid funds in highway construction are directed to support progress toward the achievement of performance targets established in a State's asset management plan for the NHS. This rule provides regulations for the new performance aspects of the NHPP, which address: measures, targets, and reporting. Caltrans shall coordinate with relevant MPOs on the selection of targets in accordance with 23 U.S.C. 135(d)(2)(B)(i)(II) to ensure consistency to maximum extent practicable.

The Pavement & Bridge Condition final rule establishes six performance measures:

Four Measures of Pavement Condition:

Two Measures for Interstate System Pavement Condition:

1. Percentage of Pavements on the Interstate System in Good Condition;
2. Percentage of Pavements on the Interstate System in Poor Condition;

Two Measures for NHS Pavement Condition:

3. Percentage of Pavements on the NHS (excluding the Interstate System) in Good Condition;
4. Percentage of Pavements on the NHS (excluding the Interstate System) in Poor Condition;

Two Measures of Bridge Condition:

5. Percentage of NHS Bridges in Good Condition; and,
6. Percentage of NHS Bridges in Poor Condition.

System Performance Measures

The third in a series of three related rules, System Performance Measures, was published on January 18, 2017 with an effective date of February 17, 2017. Caltrans and MPOs will implement the regulation to assess the performance of the Interstate and non-Interstate NHS for the purpose of carrying out the NHPP; to assess freight movement on the Interstate System; and to assess traffic congestion and on-road mobile source emissions for the purpose of carrying out the CMAQ Program. This third performance measure rule also includes a discussion that summarizes all three of the national performance management measures final rules and the comprehensive regulatory impact analysis to include all three final rules.

Caltrans will be expected to use the information and data generated as a result of the new regulations to make better informed transportation planning and programming decisions. The new performance aspects of the Federal-aid program will allow FHWA/FTA to better communicate a national performance story and more reliably assess the impacts of Federal funding investments. Caltrans shall coordinate with relevant MPOs on the selection of targets in accordance with 23 U.S.C. 135(d)(2)(B)(i)(II) to ensure consistency to maximum extent practicable.

The System Performance Measures final rule establishes seven performance measures:

Three Measures of System Performance:

1. Percentage of Reliable Person-Miles Traveled on the Interstate;
2. Percentage of Reliable Person-Miles Traveled on the non-Interstate NHS;
3. Percent Change in CO_2 emissions from 2017, generated by on-road mobile sources on the NHS;

4. A measure that will evaluate truck travel time reliability on the Interstate system (average truck reliability index);

Three measures that will assess the CMAQ Program:

5. Total emissions reductions for applicable criteria pollutants, for non-attainment and maintenance areas;

Two measures to assess traffic congestion:

6. Annual Hours of Peak Hour Excessive Delay Per Capita; and,
7. Modal Share; Specifically, the percent of non-single occupancy vehicle travel, including travel avoided by telecommuting.

Transit Asset Management

The Transit Asset Management final rule was published on July 26, 2016 with an effective date of October 1, 2016. This final rule establishes state good repair standards and four state of good repair performance measures:

- Equipment: (non-revenue) service vehicles;
- Rolling stock;
- Infrastructure: rail fixed-guideway, track, signals, and systems; and,
- Facilities.

As similarly required in the Safety PM for the target setting process, to the extent practicable, transit providers must coordinate with Caltrans and MPOs in the selection of State and MPO performance targets.

7.2 Federal Performance-Based Approach & RTP Requirements

The Statewide and Nonmetropolitan Transportation Planning *and* Metropolitan Transportation Planning Final Rule was published May 27, 2016 with an effective date of June 27, 2016. This final rule requires MPOs to implement the performance-based approach in the scope of the metropolitan transportation planning process. First, MPOs, in coordination with the State and public transportation providers, will establish, to the maximum extent practicable, an appropriate target setting framework. Federal regulations define the implementation timeline for satisfying the new requirements for MPOs as two years from the effective date of each rule establishing performance measures under 23 U.S.C. 150(c), 49 U.S.C. 5326, and 49 U.S.C. 5329 FHWA/FTA. Two years on or after the effective date of each rule establishing performance measures, an MPO may only adopt an RTP that has been developed according to the provisions and requirements of MAP-21/FAST Act as specified in the respective Final Rules.

This section is intended to provide a summary of the additional requirements specific to RTP development. The federally required performance-based approach specifically added two components to the RTP:

1. A description of the performance measures and performance targets used in assessing the performance of the transportation system in accordance with 23 CFR 450.306(d); and,
2. A system performance report and subsequent updates evaluating the condition and performance of the transportation system with respect to the performance targets described in 23 CFR 450.306(d), including –
    a. Progress achieved by the MPO in meeting the performance targets in comparison with system performance recorded in previous reports, including baseline data; and,
    b. For MPOs that voluntarily elect to develop multiple scenarios, an analysis of how the preferred scenario has improved the conditions and performance of the transportation system and how changes in local policies an investments have impacted the costs necessary to achieve the identified performance targets.

It is important to note that failure to consider any factor specified in the Performance-Based Approach, 23 CFR 450.306 (d), shall not be reviewable by any court under Title 23 U.S.C., 49 U.S.C. Chapter 53, Subchapter II of Title 5 U.S.C. Chapter 5, or Title 5 U.S.C. Chapter 7 in any matter affecting an RTP, TIP, a project or strategy, or the certification of a metropolitan transportation planning process.

The FHWA maintains a Performance Based Planning and Programming Guidebook to help identify potential packages of strategies to achieve performance-based objectives, as well as the data and tools used to determine which strategies may be most effective, available at:

http://www.fhwa.dot.gov/planning/performance_based_planning/pbpp_guidebook/page06.cfm

Requirements (Shall)
Federal: 23 CFR 450.306; 23 CFR 450.324(f)(3) & (4); 23 CFR 450.340(e) & (f)

7.3 State Goals & Performance Measures

Pursuant to 23 CFR 450.324(f)(3), every RTP shall include a description of the performance measures and performance targets used in assessing the performance of the transportation system in accordance with §450.306(d) which requires that the long-range planning process provide for the establishment and use of a performance-based approach to transportation decision-making to support national goals. Additionally, SB 375 requires MPOs to demonstrate how to achieve regional GHG emissions reduction targets, if feasible, established by ARB. SB 743 revised CEQA to "[m]ore appropriately balance the needs of congestion management with statewide goals related to infill development, promotion of public health through active transportation, and reduction of GHGs." Pursuant to SB 743, the Governor's Office of Planning and Research is required to provide an alternative to Level of Service (LOS) for analyzing transportation impacts under CEQA to more appropriately balance the needs of congestion management with statewide goals related to infill development, promotion of public health through active transportation, and reduction of GHG emissions. To accomplish this, OPR is currently updating the CEQA Guidelines. Please see Chapter 5 for more information on incorporating CEQA requirements into the RTP process. MPOs shall identify performance measures, according to available resources and capacity. As part of the public process of developing the RTP, MPOs are strongly encouraged to consider and discuss regional performance measures that integrate established state policies and goals, according to the region's available resources and capacity.

Regional Transportation Plans are developed to reflect regional and local priorities and goals and they are also instruments that can be used by federal and state agencies to demonstrate how regional agency efforts contribute to those federal and state agencies meeting their own transportation system goals. A clear articulation of regional goals helps regions select projects in furtherance of their own goals, but also helps the federal and state government understand how the regional plans will contribute to statewide or nationwide goals. The RTP vision, goals and related performance measures are developed through a bottom-up process that involves input from stakeholders in the region, including the MPO member jurisdictions and the public. The RTP, including goals and performance measures, are formally adopted at the discretion of the MPO governing board. Some regional performance measures are based on the regional Blueprint plans which were the predecessors of the SCS under SB 375. The number and type of measures that a region chooses can vary widely depending on the region's unique vision, goals and an assessment of feasibility to measure. Tradeoffs between performance measure thresholds should be clearly identified and priorities set to avoid confusion about plan objectives, because some of these measures may compete or conflict with one another. The following are state policies and goals that MPOs are encouraged to use in the development of their performance measures. This is not an exclusive list, and MPOs may establish additional measures appropriate to the region.

- Preserve transportation infrastructure
- Improve mobility and accessibility
- Reduce GHG and improve air quality
- Improve public health, e.g., increase physical activity
- Conserve land and natural resources
- Encourage sustainable land use patterns
- Increase supply of affordable housing
- Improve jobs and housing balance
- Improve mobility and accessibility for low-income and disadvantaged communities

- Support economic development
- Increase safety and security of the transportation system for motorized and non-motorized users

If existing modeling and data are a limitation for some MPOs, qualitative goals may be used instead of quantitative measures. The Policy element of the RTP would include the goals and objectives, and the Action element is what would provide the result/s. For example, the Action element would provide a comparison of what is being measured, how it is measured and the results and analysis of the eventual outcomes. In small urban areas, to support performance-based planning consistent with federal law, developing partnerships with neighboring jurisdictions, and collecting data and information is recommended.

The goals and objectives in the FTIP/RTIP and ITIP should be linked and consistent with the goals and objectives of the RTP. Performance measures in the RTP set the context for judging the effectiveness of the FTIP as a program, by furthering the RTP goals and objectives, whereas, the STIP Guidelines address performance measures of specific projects. Government Code Section 14530.1 (b)(5) requires more detailed project specific "objective criteria for meeting system performance and cost effectiveness of candidate projects" in the STIP Guidelines (Section 19). For additional information on the STIP and the Fund Estimate (FE), please refer to Caltrans Division of Transportation Programming website at:

http://www.dot.ca.gov/hq/transprog/ctcliaison.htm.

In the context of SB 375, performance measures are essential to assessing and comparing alternative transportation and land use scenarios before selecting the preferred RTP/SCS scenario that, if feasible, not only meets the region's GHG reduction target, but also provides substantive co-benefits while supporting social equity. They are also critical for tracking the progress of an SCS. ARB staff analyzes performance measures that are related to the land use and transportation strategies in the SCS to determine whether they provide supportive, qualitative evidence that the SCS could meet its GHG targets. The more robust the MPO's performance measurement, the better an MPO can substantiate its GHG determinations. MPOs are encouraged to clearly communicate the elements of the SCS (both strategies and investments) that are driving change in the region and resulting in the forecasted outcomes.

On highway projects, Caltrans considers system condition and performance measurements for interregional planning and the setting of State planning and programming activities. The State and MPO performance measures will focus on interregional trips between, into and through the regions. Caltrans coordinates its performance measure activity with MPOs. MPOs are encouraged to develop and implement their own performance measures above and beyond the federal requirements for regional roads, transit, rail, bicycle and pedestrian facilities, etc.

Requirements (Shalls)
State: California Government Code Section 65080(b)(2) (SB 375 Targets)

Planning Practice Examples: Available in Appendix K and Appendix L

7.4 Performance Monitoring

Regions should also consider using performance monitoring indicators to measure plan performance. Pursuant to Government Code 65080(b)(1)(A-F), the Policy element of MPOs with populations that exceed 200,000 persons may quantify a set of indicators including, but not limited to measures of mobility and traffic congestion; road and bridge maintenance and rehabilitation needs; means of travel; safety reliability and security; and, equity and accessibility. The level of detail and qualitative or quantitative nature of the indicators should be determined by modeling capacity and data availability. The requirements of Government Code Section 65080(b)(1)(A-F) specify that this section may be met utilizing existing sources of information. No additional traffic counts, household surveys, or other sources of data shall be required.

In 2011, the San Diego Association of Governments (SANDAG) received grant funding from the Strategic Growth Council to collaborate with other California MPOs and state agencies to identify common statewide performance monitoring indicators related to SB 375 implementation. While performance measures rely mostly on modeled or forecasted data, performance monitoring indicators rely directly on observed data. MPOs use travel demand models or Geographic Information Systems analyses to forecast performance measures. Ideally monitoring indicators would be considered together and be consistent with modeling performance measures. The following table identifies nine indicators that can be monitored using statewide and regional data sources as reflected in the *Statewide Performance Monitoring Indicators for Transportation Planning Final Report* (SANDAG, 2013), available at:

http://www.dot.ca.gov/hq/tpp/offices/ocp/ATLC/documents/august_15_2013/document_links/indicator.pdf.

ID	Inventory Ref. (Appendix B)	MAP-21 Category	Statewide Performance Monitoring Observed Data	Performance Measure (Model Based)	Referenced In
Table 1: Proposed Performance Monitoring Indicators					
		Congestion Reduction			
1	**A-8 / A-1**	VMT a. VMT per capita*	√	√	SB 375 & MAP-21
		b. Percent of Congested Freeway/ Highway Vehicle Miles **[PeMS]**	√	√	SB 375 & MAP-21
2	**A-16/A-18**	Mode Share (Travel to work)*	√	√	SB 375 & MAP-21
		Infrastructure Condition			
3	**-**	State of Good Repair a. Highways b. Local Streets c. Highway Bridges d. Transit Assets	√		MAP-21
		System Reliability			
4	**A-65**	Freeway/Highway Buffer Index **[PeMS]**	√	√	MAP-21
		Safety			
5	**A-39**	Fatalities/Serious Injuries a. Fatalities/Serious Injuries per capita* b. Fatalities/Serious Injuries per VMT*	√	√	MAP-21
		Economic Vitality			
6	**C-33**	Transit Accessibility (Housing and jobs within 0.5 miles of transit stops with frequent transit service)*	√	√	SB 375
7	**A-84**	Travel Time to Jobs	√	√	SB 375 & MAP-21
		Environmental Sustainability			
8	**B-1/B-5**	Change in Agricultural Land*	√	√	SB 375
9	**E-5**	CO_2 Emissions Reduction per capita (modeled data)*		√	SB 375 & MAP-21
	*	Indicator relates to Public Health	**[PeMS]**	Indicator for MPOs that have access to PeMS data	

The following table provides a summary of potential performance metrics for rural county Regional Transportation Planning Agencies as outlined in the report, *Transportation Performance Measures for Rural Counties in California* (Rural Counties Task Force, 2015), at:

http://www.ruralcountiestaskforce.org/Assets/Resources/PerformanceMeasures/Final_Report-PerfMonIndicators_StudySept2015.pdf.

These metrics were developed according to the following criteria:

- Measurement-based rather than model-based;
- Alignment with California state transportation goals and objectives;
- Capability of informing current goals and objectives of each rural and small-urban RTPA;
- Applicability across all rural and small-urban regions;
- Capability of being linked to specific decisions on transportation investments; and
- Normalized for population to provide equitable comparisons to urban regions.

Metric	Source	Website
Vehicle Miles Traveled (VMT) Per Capita By Locality By Facility Ownership Local vs. Tourist	Mobility Reporting	http://www.dot.ca.gov/hq/traffops/sysmgtpl/MPR/index.htm
	California DOF	http://www.dof.ca.gov/research/demographic/reports/estimates/e-2/view.php
	HPMS	http://www.dot.ca.gov/hq/tsip/hpms/hpmslibrary/prd/2013prd/2013PRD-revised.pdf
Peak V/C Ratio or Thresholds	Traffic Counts: K and D Factors	http://traffic-counts.dot.ca.gov/
Journey to Work Mode Share	American Community Survey	http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml
Total Accident Cost Per VMT Per Capita	Transportation Injury Mapping System	http://tims.berkeley.edu/login.php?next=/tools/bc/main1.php#
	SWITRS TASAS	http://iswitrs.chp.ca.gov/Reports/jsp/userLogin.jsp Caltrans Public Information Request Form
Transit Operating Cost per Revenue Mile	Local Transit Providers	
Distressed Lane Miles Total and % Total By Jurisdiction By Facility Type	Federal Highway Administration	http://www.fhwa.dot.gov/tpm/rule/pmfactsheet.pdf
	Regional or local pavement management system	https://www.federalregister.gov/articles/2015/01/05/2014-30085/national-performance-management-measures-assessing-pavement-condition-for-the-national-highway
Pavement Condition Index (PCI) for Local Roads	Regional or local pavement management system	
Land Use Efficiency	Farmland Mapping and Monitoring Program (FMMP) DOF Annual population estimates	http://www.conservation.ca.gov/dlrp/fmmp

Recommendation (Shoulds)
State: California Government Code Section 65080.

Planning Practice Examples: Available in Appendix L

APPENDICES

A. Federal and State Transportation Planning Flowchart

B. State and Federal Programming Process Flowchart

C. Regional Transportation Plan Checklist (to be completed by MPO prior to submitting the draft and final RTP to Caltrans and CTC)

D. Title 23 CFR Part 450 Appendix A – Linking Transportation Planning and NEPA Processes

E. Integration of the Planning and NEPA Processes

F. MPO Air Quality Conformity Checklist

G. SB 375 and SB 575 Statutory Language

H. Alternative Planning Strategy (APS)

I. RHNA and RTP Development Information

J. Glossary of Transportation Terms

K. AB 441 – Promoting Health and Health Equity in MPO RTPs

L. Planning Practice Examples

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Appendix A

Federal and State Transportation Planning Process Flowchart

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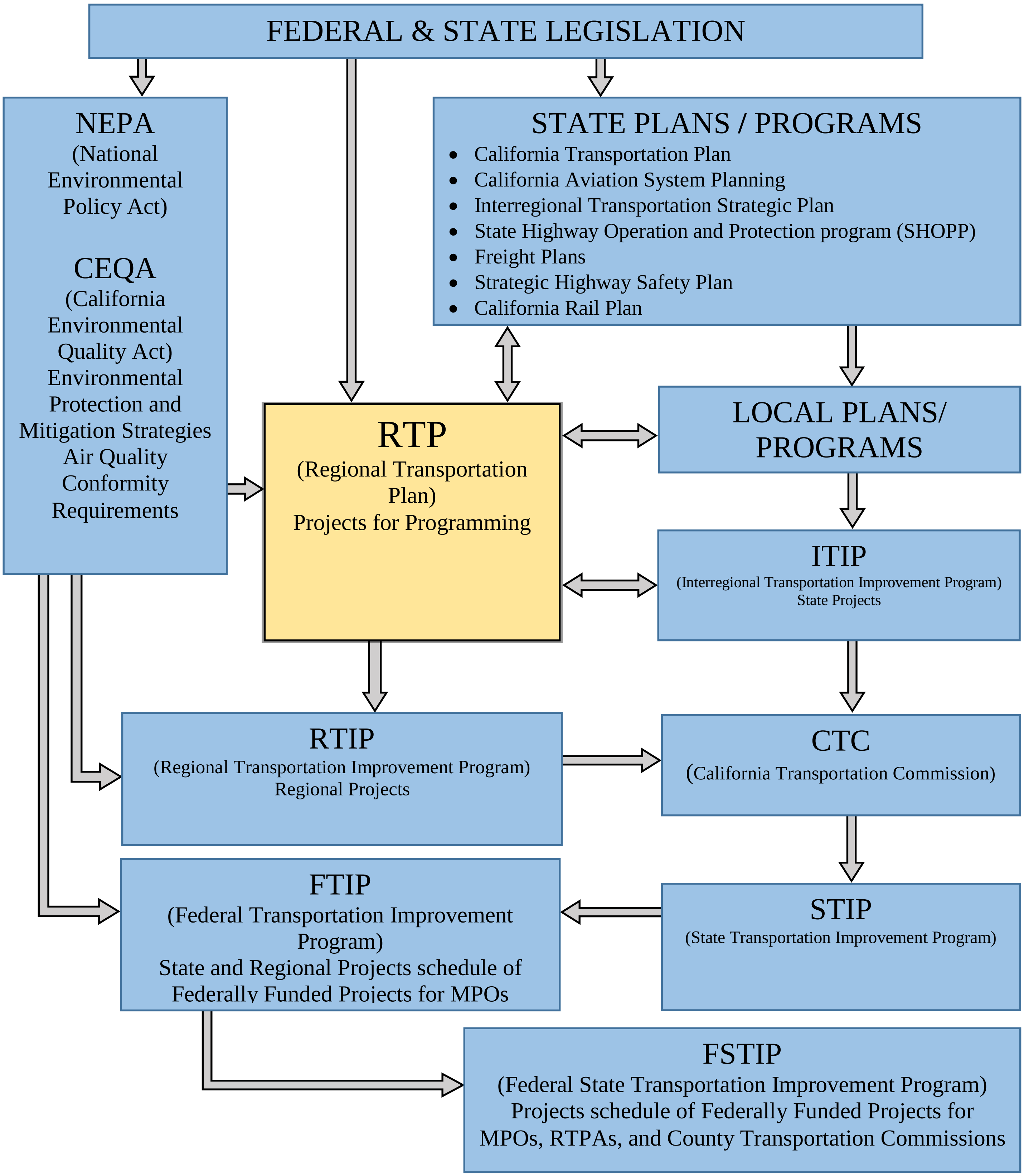
Regional Transportation Planning and Programming Process



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Appendix B

State and Federal Programming Process Flowchart

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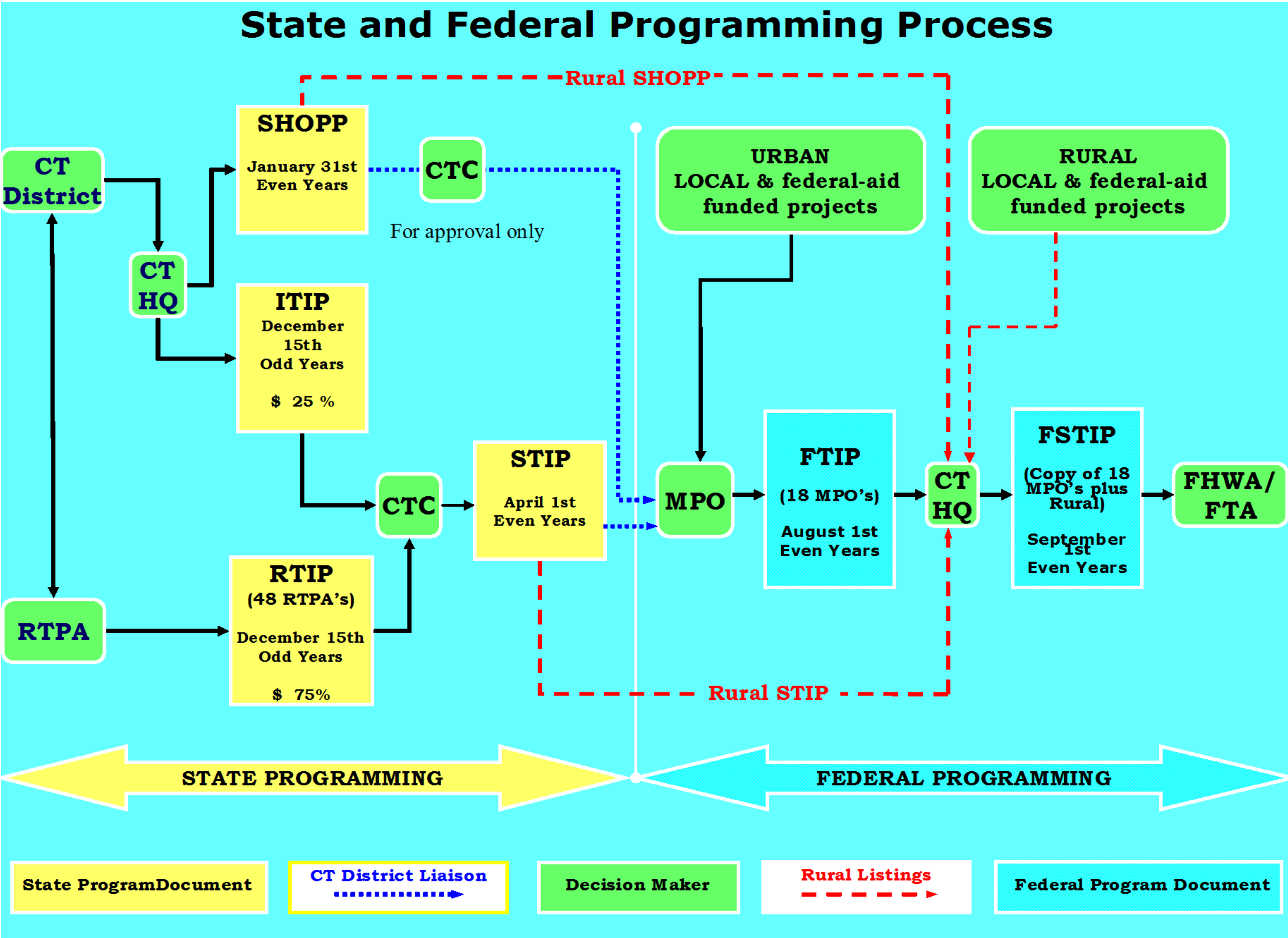
State and Federal Programming Process
Rural SHOPP
CT District
CT HQ
SHOPP
January 31st
Even Years
CTC
For approval only
ITIP
December 15th
Odd Years
$ 25 %
URBAN
LOCAL & federal-aid funded projects
RURAL
LOCAL & federal-aid funded projects
CTC
STIP
April 1st
Even Years
MPO
FTIP
(18 MPO's)
August 1st
Even Years
CT HQ
FSTIP
(Copy of 18 MPO's plus Rural)
September 1st
Even Years
FHWA/ FTA
RTPA
RTIP
(48 RTPA's)
December 15th
Odd Years
$ 75%
Rural STIP
STATE PROGRAMMING
FEDERAL PROGRAMMING
State ProgramDocument
CT District Liaison
Decision Maker
Rural Listings
Federal Program Document

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Appendix C

Regional Transportation Plan Checklist

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Regional Transportation Plan Checklist

(Revised December 2016)

(To be completed electronically in Microsoft Word format by the MPO and submitted along with the draft and final RTP to Caltrans)

Name of MPO: ____

Date Draft RTP Completed: __________________________________

RTP Adoption Date: __________________________________

What is the Certification Date of the Environmental Document (ED)? ____________________________

Is the ED located in the RTP or is it a separate document? ____________________________

By completing this checklist, the MPO verifies the RTP addresses all of the following required information within the RTP.

Regional Transportation Plan Contents

General

		Yes/No	Page #
1.	Does the RTP address no less than a 20-year planning horizon? (23 CFR 450.324(a))		
2.	Does the RTP include both long-range and short-range strategies/actions? (23 CFR 450.324(b))		
3.	Does the RTP address issues specified in the policy, action and financial elements identified in California Government Code Section 65080?		
4.	Does the RTP address the 10 issues specified in the Sustainable Communities Strategy (SCS) component as identified in Government Code Sections 65080(b)(2)(B) and 65584.04(i)(1)?		
	a. Identify the general location of uses, residential densities, and building intensities within the region?		
	b. Identify areas within the region sufficient to house all the population of the region, including all economic segments of the population over the course of the planning period of the regional transportation plan taking into account net migration into the region, population growth, household formation and employment growth?		
	c. Identify areas within the region sufficient to house an eight-year projection of the regional housing need for the region pursuant to Government Code Section 65584?		

	Yes/No	Page #
d. Identify a transportation network to service the transportation needs of the region?		
e. Gather and consider the best practically available scientific information regarding resource areas and farmland in the region as defined in subdivisions (a) and (b) of Government Code Section 65080.01?		
f. Consider the state housing goals specified in Sections 65580 and 65581?		
g. Utilize the most recent planning assumptions, considering local general plans and other factors?		
h. Set forth a forecasted development pattern for the region, which, when integrated with the transportation network, and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the ARB?		
i. Provide consistency between the development pattern and allocation of housing units within the region (Government Code 65584.04(i)(1)?		
j. Allow the regional transportation plan to comply with Section 176 of the federal Clean Air Act (42 U.S.C. Section 7506)?		
4. Does the RTP include Project Intent i.e. Plan Level Purpose and Need Statements?		
5. Does the RTP specify how travel demand modeling methodology, results and key assumptions were developed as part of the RTP process? (Government Code 14522.2)		

Consultation/Cooperation

	Yes/No	Page #
1. Does the RTP contain a public involvement program that meets the requirements of Title 23, CFR 450.316(a)?		
(i) Providing adequate public notice of public participation activities and time for public review and comment at key decision points, including a reasonable opportunity to comment on the proposed metropolitan transportation plan and the TIP;		
(ii) Providing timely notice and reasonable access to information about transportation issues and processes;		
(iii) Employing visualization techniques to describe metropolitan transportation plans and TIPs;		
(iv) Making public information (technical information and meeting notices) available in electronically accessible formats and means, such as the World Wide Web;		
(v) Holding any public meetings at convenient and accessible locations and times;		
(vi) Demonstrating explicit consideration and response to public input received during the development of the metropolitan transportation plan and the TIP;		

Item	Yes/No	Page #
(vii) Seeking out and considering the needs of those traditionally underserved by existing transportation systems, such as low-income and minority households, who may face challenges accessing employment and other services;		
(viii) Providing an additional opportunity for public comment, if the final metropolitan transportation plan or TIP differs significantly from the version that was made available for public comment by the MPO and raises new material issues that interested parties could not reasonably have foreseen from the public involvement efforts;		
(ix) Coordinating with the statewide transportation planning public involvement and consultation processes under subpart B of this part; and		
(x) Periodically reviewing the effectiveness of the procedures and strategies contained in the participation plan to ensure a full and open participation process.		
2. Does the RTP contain a summary, analysis, and report on the disposition of significant written and oral comments received on the draft metropolitan transportation plan as part of the final metropolitan transportation plan and TIP that meets the requirements of 23 CFR 450.316(a)(2), as applicable?		
3. Did the MPO/RTPA consult with the appropriate State and local representatives including representatives from environmental and economic communities; airport; transit; freight during the preparation of the RTP? (23 CFR 450.316(b))		
4. Did the MPO/RTPA who has federal lands within its jurisdictional boundary involve the federal land management agencies during the preparation of the RTP? (23 CFR 450.316(d))		
5. Where does the RTP specify that the appropriate State and local agencies responsible for land use, natural resources, environmental protection, conservation and historic preservation consulted? (23 CFR 450.324(g))		
6. Did the RTP include a comparison with the California State Wildlife Action Plan and (if available) inventories of natural and historic resources? (23 CFR 450.324(g)(1&2))		
7. Did the MPO/RTPA who has a federally recognized Native American Tribal Government(s) and/or historical and sacred sites or subsistence resources of these Tribal Governments within its jurisdictional boundary address tribal concerns in the RTP and develop the RTP in consultation with the Tribal Government(s)? (23 CFR 450.316(c))		
8. Does the RTP address how the public and various specified groups were given a reasonable opportunity to comment on the plan using the participation plan developed under 23 CFR part 450.316(a)? (23 CFR 450.316(a)(i))		
9. Does the RTP contain a discussion describing the private sector involvement efforts that were used during the development of the plan? (23 CFR 450.316(a))		

No.	Question	Yes/No	Page #
10.	Does the RTP contain a discussion describing the coordination efforts with regional air quality planning authorities? (23 CFR 450.316(a)(2)) **(MPO nonattainment and maintenance areas only)**		
11.	Is the RTP coordinated and consistent with the Public Transit-Human Services Transportation Plan? (23 CFR 450.306(h))		
12.	Were the draft and adopted RTP posted on the Internet? (23 CFR 450.324(k))		
13.	Did the RTP explain how consultation occurred with locally elected officials? (Government Code 65080(D))		
14.	Did the RTP outline the public participation process for the sustainable communities strategy? (Government Code 65080(E))		
15.	Was the RTP adopted on the estimated date provided in writing to State Department of Housing and Community Development to determine the Regional Housing Need Allocation and planning period (start and end date) and align the local government housing element planning period (start and end date) and housing element adoption due date 18 months from RTP adoption date? (Government Code 65588(e)(5))		

Title VI and Environmental Justice

No.	Question	Yes/No	Page #
1.	Does the public participation plan describe how the MPO will seek out and consider the needs of those traditionally underserved by existing transportation system, such as low-income and minority households, who may face challenges accessing employment and other services? (23 CFR 450.316 (a)(1)(vii))		
2.	Has the MPO conducted a Title VI analysis that meets the legal requirements described in Section 4.2?		
3.	Has the MPO conducted an Environmental Justice analysis that meets the legal requirements described in Section 4.2?		

Modal Discussion

No.	Question	Yes/No	Page #
1.	Does the RTP discuss intermodal and connectivity issues?		
2.	Does the RTP include a discussion of highways?		
3.	Does the RTP include a discussion of mass transportation?		
4.	Does the RTP include a discussion of the regional airport system?		
5.	Does the RTP include a discussion of regional pedestrian needs?		

		Yes/No	Page #
6.	Does the RTP include a discussion of regional bicycle needs?		
7.	Does the RTP address the California Coastal Trail? (Government Code 65080.1) (For MPOs and RTPAs located along the coast only)		
8.	Does the RTP include a discussion of rail transportation?		
9.	Does the RTP include a discussion of maritime transportation (if appropriate)?		
10.	Does the RTP include a discussion of goods movement?		

<u>Financial</u>

1.	Does the RTP include a financial plan that meets the requirements identified in 23 CFR part 450.324(f)(11)?		
2.	Does the RTP contain a consistency statement between the first 4 years of the fund estimate and the 4-year STIP fund estimate? (65080(b)(4)(A))		
3.	Do the projected revenues in the RTP reflect Fiscal Constraint? (23 CFR part 450.324(f)(11)(ii))		
4.	Does the RTP contain a list of financially constrained projects? Any regionally significant projects should be identified. (Government Code 65080(4)(A))		
5.	Do the cost estimates for implementing the projects identified in the RTP reflect "year of expenditure dollars" to reflect inflation rates? (23 CFR part 450.324(f)(11)(iv))		
6.	After 12/11/07, does the RTP contain estimates of costs and revenue sources that are reasonably expected to be available to operate and maintain the freeways, highway and transit within the region? (23 CFR 450.324(f)(11)(i))		
7.	Does the RTP contain a statement regarding consistency between the projects in the RTP and the ITIP? (2016 STIP Guidelines Section 33)		
8.	Does the RTP contain a statement regarding consistency between the projects in the RTP and the RTIP? (2016 STIP Guidelines Section 19)		
9.	Does the RTP address the specific financial strategies required to ensure the identified TCMs from the SIP can be implemented? (23 CFR part 450.324(f)(11)(vi) (**nonattainment and maintenance MPOs only**)		

Environmental

		Yes/No	Page #
1.	Did the MPO/RTPA prepare an EIR or a program EIR for the RTP in accordance with CEQA guidelines?		
2.	Does the RTP contain a list of projects specifically identified as TCMs, if applicable?		
3.	Does the RTP contain a discussion of SIP conformity, if applicable?		
4.	Does the RTP specify mitigation activities? (23 CFR part 450.324(f)(10))		
5.	Where does the EIR address mitigation activities?		
6.	Did the MPO/RTPA prepare a Negative Declaration or a Mitigated Negative Declaration for the RTP in accordance with CEQA guidelines?		
7.	Does the RTP specify the TCMs to be implemented in the region? **(federal nonattainment and maintenance areas only)**		

I have reviewed the above information and certify that it is correct and complete.

______________________________ (Must be signed by MPO Executive Director or designated representative)

______________________________ Date

______________________________ Print Name

______________________________ Title

Appendix D

Title 23 CFR Part 450 Appendix A – Linking Transportation Planning and NEPA Processes

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Appendix A to Title 23 CFR Part 450--Linking the Transportation Planning and NEPA Processes

Background and Overview

This Appendix provides additional information to explain the linkage between the transportation planning and project development/National Environmental Policy Act (NEPA) processes. It is intended to be non-binding and should not be construed as a rule of general applicability.

For 40 years, the Congress has directed that Federally funded highway and transit projects must flow from metropolitan and Statewide transportation planning processes (pursuant to 23 U.S.C. 134-135 and 49 U.S.C. 5303-5306). Over the years, the Congress has refined and strengthened the transportation planning process as the foundation for project decisions, emphasizing public involvement, consideration of environmental and other factors, and a Federal role that oversees the transportation planning process but does not second-guess the content of transportation plans and programs.

Despite this statutory emphasis on transportation planning, the environmental analyses produced to meet the requirements of the NEPA of 1969 (42 U.S.C. 4231 et seq.) have often been conducted de novo, disconnected from the analyses used to develop long-range transportation plans, Statewide and metropolitan Transportation Improvement Programs (STIPs/TIPs), or planning-level corridor/subarea/feasibility studies. When the NEPA and transportation planning processes are not well coordinated, the NEPA process may lead to the development of information that is more appropriately developed in the planning process, resulting in duplication of work and delays in transportation improvements.

The purpose of this Appendix is to change this culture, by supporting congressional intent that Statewide and metropolitan transportation planning should be the foundation for highway and transit project decisions. This Appendix was crafted to recognize that transportation planning processes vary across the country. This document provides details on how information, analysis, and products from transportation planning can be incorporated into and relied upon in NEPA documents under existing laws, regardless of when the Notice of Intent has been published. This Appendix presents environmental review as a continuum of sequential study, refinement, and expansion performed in transportation planning and during project development/NEPA, with information developed and conclusions drawn in early stages utilized in subsequent (and more detailed) review stages.

The information below is intended for use by State departments of transportation (State DOTs), metropolitan planning organizations (MPOs), and public transportation operators to clarify the circumstances under which transportation planning level choices and analyses can be adopted or incorporated into the process required by NEPA. Additionally, the FHWA and the FTA will work with Federal environmental, regulatory, and resource agencies to incorporate the principles of this Appendix in their day-to-day NEPA policies and procedures related to their involvement in highway and transit projects.

This Appendix does not extend NEPA requirements to transportation plans and programs. The Transportation Efficiency Act for the 21st Century (TEA-21) and the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) specifically exempted transportation plans and programs from NEPA review. Therefore, initiating the NEPA process as part of, or concurrently with, a transportation planning study does not subject transportation plans and programs to NEPA.

Implementation of this Appendix by States, MPOs, and public transportation operators is voluntary. The degree to which studies, analyses, or conclusions from the transportation planning process can be incorporated into the project development/NEPA processes will depend upon how well they meet certain standards established by NEPA regulations and guidance. While some transportation planning processes already meet these standards, others will need some modification.

The remainder of this Appendix document utilizes a ``Question and Answer'' format, organized into three primary categories (``Procedural Issues,'' ``Substantive Issues,'' and ``Administrative Issues'').

I. Procedural Issues:

1. In what format should the transportation planning information be included?

To be included in the NEPA process, work from the transportation planning process must be documented in a form that can be appended to the NEPA document or incorporated by reference. Documents may be incorporated by reference if they are readily available so as to not impede agency or public review of the action. Any document incorporated by reference must be ``reasonably available for inspection by potentially interested persons within the time allowed for comment.'' Incorporated materials must be cited in the NEPA document and their contents briefly described, so that the reader understands why the document is cited and knows where to look for further information. To the extent possible, the documentation should be in a form such as official actions by the MPO, State DOT, or public transportation operator and/or correspondence within and among the organizations involved in the transportation planning process.

2. What is a reasonable level of detail for a planning product that is intended to be used in a NEPA document? How does this level of detail compare to what is considered a full NEPA analysis?

For purposes of transportation planning alone, a planning-level analysis does not need to rise to the level of detail required in the NEPA process. Rather, it needs to be accurate and up-to-date, and should adequately support recommended improvements in the Statewide or metropolitan long-range transportation plan.

The SAFETEA-LU requires transportation planning processes to focus on setting a context and following acceptable procedures. For example, the SAFETEA-LU requires a ``discussion of the types of potential environmental mitigation activities'' and potential areas for their implementation, rather than details on specific strategies. The SAFETEA-LU also emphasizes consultation with Federal, State, and Tribal land management, wildlife, and regulatory agencies.

However, the Environmental Assessment (EA) or Environmental Impact Statement (EIS) ultimately will be judged by the standards applicable under the NEPA regulations and guidance from the Council on Environmental Quality (CEQ). To the extent the information incorporated from the transportation planning process, standing alone, does not contain all of the information or analysis required by NEPA, then it will need to be supplemented by other information contained in the EIS or EA that would, in conjunction with the information from the plan, collectively meet the requirements of NEPA. The intent is not to require NEPA studies in the transportation planning process. As an option, the NEPA analyses prepared for project development can be integrated with transportation planning studies (see the response to Question 9 for additional information).

3. What type and extent of involvement from Federal, Tribal, State, and local environmental, regulatory, and resource agencies is needed in the transportation planning process in order for planning-level decisions to be more readily accepted in the NEPA process?

Sections 3005, 3006, and 6001 of the SAFETEA-LU established formal consultation requirements for MPOs and State DOTs to employ with environmental, regulatory, and resource agencies in the development of long-range transportation plans. For example, metropolitan transportation plans now ``shall include a discussion of the types of potential environmental mitigation activities and potential areas to carry out these activities, including activities that may have the greatest potential to restore and maintain the environmental functions affected by the [transportation] plan,'' and that these planning-level discussions ``shall be developed in consultation with Federal, State, and Tribal land management, wildlife, and regulatory agencies.'' In addition, MPOs ``shall consult, as appropriate, with State and local agencies responsible for land use management, natural resources, environmental protection, conservation, and historic preservation concerning the development of a long-range transportation plan,'' and that this consultation ``shall involve, as appropriate, comparison of transportation plans with State conservation plans or maps, if available, or comparison of transportation plans to inventories of natural or historic resources, if available.'' Similar SAFETEA-LU language addresses the development of the long-range Statewide transportation plan, with the addition of Tribal conservation plans or maps to this planning-level ``comparison.''

In addition, section 6002 of the SAFETEA-LU established several mechanisms for increased efficiency in environmental reviews for project decision-making. For example, the term ``lead agency'' collectively means the U. S. Department of Transportation and a State or local governmental entity serving as a joint lead agency for the NEPA process. In addition, the lead agency is responsible for inviting and designating ``participating agencies'' (i.e., other Federal or non-Federal agencies that may have an interest in the proposed project). Any Federal agency that is invited by the lead agency to participate in the environmental review process for a project shall be designated as a participating agency by the lead
agency unless the invited agency informs the lead agency, in writing, by the deadline specified in the invitation that the invited agency:

(a) Has no jurisdiction or authority with respect to the project; (b) has no expertise or information relevant to the project; and (c) does not intend to submit comments on the project.

Past successful examples of using transportation planning products in NEPA analysis are based on early and continuous involvement of environmental, regulatory, and resource agencies. Without this early coordination, environmental, regulatory, and resource agencies are more likely to expect decisions made or analyses conducted in the transportation planning process to be revisited during the NEPA process. Early participation in transportation planning provides environmental, regulatory, and resource agencies better insight into the needs and objectives of the locality. Additionally, early participation provides an important opportunity for environmental, regulatory, and resource agency concerns to be identified and addressed early in the process, such as those related to permit applications. Moreover, Federal, Tribal, State, and local environmental, regulatory, and resource agencies are able to share data on particular resources, which can play a critical role in determining the feasibility of a transportation solution with respect to environmental impacts. The use of other agency planning outputs can result in a transportation project that could support multiple goals (transportation, environmental, and community). Further, planning decisions by these other agencies may have impacts on long-range transportation plans and/or the STIP/TIP, thereby providing important input to the transportation planning process and advancing integrated decision-making.

4. What is the procedure for using decisions or analyses from the transportation planning process?

The lead agencies jointly decide, and must agree, on what processes and consultation techniques are used to determine the transportation planning products that will be incorporated into the NEPA process. At a minimum, a robust scoping/early coordination process (which explains to Federal and State environmental, regulatory, and resource agencies and the public the information and/or analyses utilized to develop the planning products, how the purpose and need was developed and refined, and how the design concept and scope were determined) should play a critical role in leading to informed decisions by the lead agencies on the suitability of the transportation planning information, analyses, documents, and decisions for use in the NEPA process. As part of a rigorous scoping/early coordination process, the FHWA and the FTA should ensure that the transportation planning results are appropriately documented, shared, and used.

5. To what extent can the FHWA/FTA provide up-front assurance that decisions and additional investments made in the transportation planning process will allow planning-level decisions and analyses to be used in the NEPA process?

There are no guarantees. However, the potential is greatly improved for transportation planning processes that address the ``3-C'' planning principles (comprehensive, cooperative, and continuous); incorporate the intent of NEPA through the consideration of natural, physical, and social effects; involve environmental, regulatory, and resource agencies; thoroughly document the transportation planning process information, analysis, and decision; and vet the planning results through the applicable public involvement processes.

6. What considerations will the FHWA/FTA take into account in their review of transportation planning products for acceptance in project development/NEPA?

The FHWA and the FTA will give deference to decisions resulting from the transportation planning process if the FHWA and FTA determine that the planning process is consistent with the ``3-C'' planning principles and when the planning study process, alternatives considered, and resulting decisions have a rational basis that is thoroughly documented and vetted through the applicable public involvement processes. Moreover, any applicable program-specific requirements (e.g., those of the Congestion Mitigation and Air Quality Improvement Program or the FTA's Capital Investment Grant program) also must be met.

The NEPA requires that the FHWA and the FTA be able to stand behind the overall soundness and credibility of analyses conducted and decisions made during the transportation planning process if they are incorporated into a NEPA document. For example, if systems-level or other broad objectives or choices from the transportation plan are incorporated into the purpose and need Statement for a NEPA document, the FHWA and the FTA should not revisit whether these are the best objectives or choices among other options. Rather, the FHWA and the FTA review would include making sure that objectives or choices derived from the transportation plan were: Based on transportation planning factors established by Federal law; reflect a credible and articulated planning rationale; founded on reliable data; and developed through transportation planning processes meeting FHWA and FTA statutory and regulatory requirements. In addition, the basis for the goals and choices must be documented and included in the NEPA document. The FHWA/FTA reviewers do not need to review whether assumptions or analytical methods used in the studies are the best available, but, instead, need to assure that such assumptions or analytical methods are reasonable, scientifically acceptable, and consistent with goals, objectives, and policies set forth in long-range transportation plans. This review would include determining whether: (a) Assumptions have a rational basis and are up-to-date and (b) data, analytical methods, and modeling techniques are reliable, defensible, reasonably current, and meet data quality requirements.

II. Substantive Issues

General Issues To Be Considered:

7. What should be considered in order to rely upon transportation planning studies in NEPA?

The following questions should be answered prior to accepting studies conducted during the transportation planning process for use in NEPA. While not a ``checklist,'' these questions are intended to guide the practitioner's analysis of the planning products:

a. How much time has passed since the planning studies and corresponding decisions were made?

b. Were the future year policy assumptions used in the transportation planning process related to land use, economic development, transportation costs, and network expansion consistent with those to be used in the NEPA process?

c. Is the information still relevant/valid?

d. What changes have occurred in the area since the study was completed?

e. Is the information in a format that can be appended to an environmental document or reformatted to do so?

f. Are the analyses in a planning-level report or document based on data, analytical methods, and modeling techniques that are reliable, defensible, and consistent with those used in other regional transportation studies and project development activities?

g. Were the FHWA and FTA, other agencies, and the public involved in the relevant planning analysis and the corresponding planning decisions?

h. Were the planning products available to other agencies and the public during NEPA scoping?

i. During NEPA scoping, was a clear connection between the decisions made in planning and those to be made during the project development stage explained to the public and others? What was the response?

j. Are natural resource and land use plans being informed by transportation planning products, and vice versa?

Purpose and Need:

8. How can transportation planning be used to shape a project's purpose and need in the NEPA process?

A sound transportation planning process is the primary source of the project purpose and need. Through transportation planning, State and local governments, with involvement of stakeholders and the public, establish a vision for the region's future transportation system, define transportation goals and objectives for realizing that vision, decide which needs to address, and determine the timeframe for addressing these issues. The transportation planning process also provides a potential forum to define a project's purpose and need by framing the scope of the problem to be addressed by a proposed project. This scope may be further refined during the transportation planning process as more information about the transportation need is collected and consultation with the public and other stakeholders clarifies other issues and goals for the region.

23 U.S.C. 139(f), as amended by the SAFETEA-LU Section 6002, provides additional focus regarding the definition of the purpose and need and objectives. For example, the lead agency, as early as practicable during the environmental review process, shall provide an opportunity for involvement by participating agencies and the public in defining the purpose and need for a project. The Statement of purpose and need shall include a clear Statement of the objectives that the proposed action is intended to achieve, which may include: (a) Achieving a transportation objective identified in an applicable Statewide or metropolitan transportation plan; (b) supporting land use, economic development, or growth objectives established in applicable Federal, State, local, or Tribal plans; and (c) serving national defense, national security, or other national objectives, as established in Federal laws, plans, or policies.

The transportation planning process can be utilized to develop the purpose and need in the following ways:

(a) Goals and objectives from the transportation planning process may be part of the project's purpose and need Statement;

(b) A general travel corridor or general mode or modes (e.g., highway, transit, or a highway/transit combination) resulting from planning analyses may be part of the project's purpose and need Statement;

(c) If the financial plan for a metropolitan transportation plan indicates that funding for a specific project will require special funding sources (e.g., tolls or public-private financing), such information may be included in the purpose and need Statement; or

(d) The results of analyses from management systems (e.g., congestion, pavement, bridge, and/or safety) may shape the purpose and need Statement.

The use of these planning-level goals and choices must be appropriately explained during NEPA scoping and in the NEPA document. Consistent with NEPA, the purpose and need Statement should be a Statement of a transportation problem, not a specific solution. However, the purpose and need Statement should be specific enough to generate alternatives that may potentially yield real solutions to the problem at-hand. A purpose and need Statement that yields only one alternative may indicate a purpose and need that is too narrowly defined.

Short of a fully integrated transportation decision-making process, many State DOTs develop information for their purpose and need Statements when implementing interagency NEPA/Section 404 process merger agreements. These agreements may need to be expanded to include commitments to share and utilize transportation planning products when developing a project's purpose and need.

9. Under what conditions can the NEPA process be initiated in conjunction with transportation planning studies?

The NEPA process may be initiated in conjunction with transportation planning studies in a number of ways. A common method is the ``tiered EIS,'' in which the first-tier EIS evaluates general travel corridors, modes, and/or packages of projects at a planning level of detail, leading to the refinement of purpose and need and, ideally, selection of the design concept and scope for a project or series of projects. Subsequently, second-tier NEPA review(s) of the resulting projects would be performed in the usual way. The first-tier EIS uses the NEPA process as a tool to involve environmental, regulatory, and resource agencies and the public in the planning decisions, as well as to ensure the appropriate consideration of environmental factors in these planning decisions.

Corridor or subarea analyses/studies are another option when the long-range transportation plan leaves open the possibility of multiple approaches to fulfill its goals and objectives. In such cases, the formal NEPA process could be initiated through publication of a NOI in conjunction with a corridor or subarea planning study. Similarly, some public transportation operators developing major capital projects perform the mandatory planning Alternatives Analysis required for funding under FTA's Capital Investment Grant program [49 U.S.C. 5309(d) and (e)] within the NEPA process and combine the planning Alternatives Analysis with the draft EIS.

Alternatives:

10. In the context of this Appendix, what is the meaning of the term ``alternatives''?

This Appendix uses the term ``alternatives'' as specified in the NEPA regulations (40 CFR 1502.14), where it is defined in its broadest sense to include everything from major modal alternatives and location alternatives to minor design changes that would mitigate adverse impacts. This Appendix does not use the term as it is used in many other contexts (e.g., ``prudent and feasible alternatives'' under Section 4(f) of the Department of Transportation Act, the ``Least Environmentally Damaging Practicable Alternative'' under the Clean Water Act, or the planning Alternatives Analysis in 49 U.S.C. 5309(d) and (e)).

11. Under what circumstances can alternatives be eliminated from detailed consideration during the NEPA process based on information and analysis from the transportation planning process?

There are two ways in which the transportation planning process can begin limiting the alternative solutions to be evaluated during the NEPA process: (a) Shaping the purpose and need for the project; or (b) evaluating alternatives during planning studies and eliminating some of the alternatives from detailed study in the NEPA process prior to its start. Each approach requires careful attention, and is summarized below.

(a) Shaping the Purpose and Need for the Project: The transportation planning process should shape the purpose and need and, thereby, the range of reasonable alternatives. With proper documentation and public involvement, a purpose and need derived from the planning process can legitimately narrow the alternatives analyzed in the NEPA process. See the response to Question 8 for further discussion on how the planning process can shape the purpose and need used in the NEPA process.

For example, the purpose and need may be shaped by the transportation planning process in a manner that consequently narrows the range of alternatives that must be considered in detail in the NEPA document when:

(1) The transportation planning process has selected a general travel corridor as best addressing identified transportation problems and the rationale for the determination in the planning document is reflected in the purpose and need Statement of the subsequent NEPA document;

(2) The transportation planning process has selected a general mode (e.g., highway, transit, or a highway/transit combination) that accomplishes its goals and objectives, and these documented determinations are reflected in the purpose and need Statement of the subsequent NEPA document; or

(3) The transportation planning process determines that the project needs to be funded by tolls or other non-traditional funding sources in order for the long-range transportation plan to be fiscally constrained or identifies goals and objectives that can only be met by toll roads or other non-traditional funding sources, and that determination of those goals and objectives is reflected in the purpose and need Statement of the subsequent NEPA document.

(b) Evaluating and Eliminating Alternatives During the Transportation Planning Process: The evaluation and elimination of alternatives during the transportation planning process can be incorporated by reference into a NEPA document under certain circumstances. In these cases, the planning study becomes part of the NEPA process and provides a basis for screening out alternatives. As with any part of the NEPA process, the analysis of alternatives to be incorporated from the process must have a rational basis that has been thoroughly documented (including documentation of the necessary and appropriate vetting through the applicable public involvement processes). This record should be made available for public review during the NEPA scoping process.

See responses to Questions 4, 5, 6, and 7 for additional elements to consider with respect to acceptance of planning products for NEPA documentation and the response to Question 12 on the information or analysis from the transportation planning process necessary for supporting the elimination of an alternative(s) from detailed consideration in the NEPA process.

For instance, under FTA's Capital Investment Grant program, the alternatives considered in the NEPA process may be narrowed in those instances that the planning Alternatives Analysis required by 49 U.S.C. 5309(e) is conducted as a planning study prior to the NEPA review. In fact, the FTA may be able to narrow the alternatives considered in detail in the NEPA document to the No-Build (No Action) alternative and the Locally Preferred Alternative. Alternatives must meet the following criteria if they are deemed sufficiently considered by a planning Alternatives Analysis under FTA's Capital Investment Grant program conducted prior to NEPA without a programmatic NEPA analysis and documentation:

During the planning Alternatives Analysis, all of the reasonable alternatives under consideration must be fully evaluated in terms of their transportation impacts; capital and operating costs; social, economic, and environmental impacts; and technical considerations;

There must be appropriate public involvement in the planning Alternatives Analysis;

The appropriate Federal, State, and local environmental, regulatory, and resource agencies must be engaged in the planning Alternatives Analysis;

The results of the planning Alternatives Analysis must be documented;

The NEPA scoping participants must agree on the alternatives that will be considered in the NEPA review; and

The subsequent NEPA document must include the evaluation of alternatives from the planning Alternatives Analysis.

The above criteria apply specifically to FTA's Capital Investment Grant process. However, for other transportation projects, if the planning process has included the analysis and stakeholder involvement that would be undertaken in a first tier NEPA process, then the alternatives screening conducted in the transportation planning process may be incorporated by reference, described, and relied upon in the project-level NEPA document. At that point, the project-level NEPA analysis can focus on the remaining alternatives.

12. <u>What information or analysis from the transportation planning process is needed in an EA or EIS to support the elimination of an alternative(s) from detailed consideration</u>?

The section of the EA or EIS that discusses alternatives considered but eliminated from detailed consideration should:

(a) Identify any alternatives eliminated during the transportation planning process (this could include broad categories of alternatives, as when a long-range transportation plan selects a general travel corridor based on a corridor study, thereby eliminating all alternatives along other alignments);

(b) Briefly summarize the reasons for eliminating the alternative; and

(c) Include a summary of the analysis process that supports the elimination of alternatives (the summary should reference the relevant sections or pages of the analysis or study) and incorporate
it by reference or append it to the NEPA document.

Any analyses or studies used to eliminate alternatives from detailed consideration should be made available to the public and participating agencies during the NEPA scoping process and should be reasonably available during comment periods.

Alternatives passed over during the transportation planning process because they are infeasible or do not meet the NEPA ``purpose and need'' can be omitted from the detailed analysis of alternatives in the NEPA document, as long as the rationale for elimination is explained in the NEPA document. Alternatives that remain ``reasonable'' after the planning-level analysis must be addressed in the EIS, even when they are not the preferred alternative. When the proposed action evaluated in an EA involves unresolved conflicts concerning alternative uses of available resources, NEPA requires that appropriate alternatives be studied, developed, and described.

Affected Environment and Environmental Consequences:

13. <u>What types of planning products provide analysis of the affected environment and environmental consequences that are useful in a project-level NEPA analysis and document</u>?

The following planning products are valuable inputs to the discussion of the affected environment and environmental consequences (both its current State and future State in the absence of the proposed action) in the project-level NEPA analysis and document:

Regional development and growth analyses;
Local land use, growth management, or development plans; and
Population and employment projections.

The following are types of information, analysis, and other products from the transportation planning process that can be used in the discussion of the affected environment and environmental consequences in an EA or EIS:

(a) Geographic information system (GIS) overlays showing the past, current, or predicted future conditions of the natural and built environments;

(b) Environmental scans that identify environmental resources and environmentally sensitive areas;

(c) Descriptions of airsheds and watersheds;

(d) Demographic trends and forecasts;

(e) Projections of future land use, natural resource conservation areas, and development; and

(f) The outputs of natural resource planning efforts, such as wildlife conservation plans, watershed plans, special area management plans, and multiple species habitat conservation plans.

However, in most cases, the assessment of the affected environment and environmental consequences conducted during the transportation planning process will not be detailed or current enough to meet NEPA standards and, thus, the inventory and evaluation of affected resources and the analysis of consequences of the alternatives will need to be supplemented with more refined analysis and possibly site-specific details during the NEPA process.

14. What information from the transportation planning process is useful in describing a baseline for the NEPA analysis of indirect and cumulative impacts?

Because the nature of the transportation planning process is to look broadly at future land use, development, population increases, and other growth factors, the planning analysis can provide the basis for the assessment of indirect and cumulative impacts required under NEPA. The consideration in the transportation planning process of development, growth, and consistency with local land use, growth management, or development plans, as well as population and employment projections, provides an overview of the multitude of factors in an area that are creating pressures not only on the transportation system, but on the natural ecosystem and important environmental and community resources. An analysis of all reasonably foreseeable actions in the area also should be a part of the transportation planning process. This planning-level information should be captured and utilized in the analysis of indirect and cumulative impacts during the NEPA process.

To be used in the analysis of indirect and cumulative impacts, such information should:

(a) Be sufficiently detailed that differences in consequences of alternatives can be readily identified;
(b) Be based on current data (e.g., data from the most recent Census) or be updated by additional information;
(c) Be based on reasonable assumptions that are clearly Stated; and/or
(d) Rely on analytical methods and modeling techniques that are reliable, defensible, and reasonably current.

Environmental Mitigation:

15**.** How can planning-level efforts best support advance mitigation, mitigation banking, and priorities for environmental mitigation investments?

A lesson learned from efforts to establish mitigation banks and advance mitigation agreements and alternative mitigation options is the importance of beginning interagency discussions during the transportation planning process. Development pressures, habitat alteration, complicated real estate transactions, and competition for potential mitigation sites by public and private project proponents can encumber the already difficult task of mitigating for ``like'' value and function and reinforce the need to examine mitigation strategies as early as possible.

Robust use of remote sensing, GIS, and decision support systems for evaluating conservation strategies are all contributing to the advancement of natural resource and environmental planning. The outputs from environmental planning can now better inform transportation planning processes, including the development of mitigation strategies, so that transportation and conservation goals can be optimally met. For example, long-range transportation plans can be screened to assess the effect of general travel corridors or density, on the viability of sensitive plant and animal species or habitats. This type of screening provides a basis for early collaboration among transportation and environmental staffs, the public, and regulatory agencies to explore areas where impacts must be avoided and identify areas for mitigation investments. This can lead to mitigation strategies that are both more economical and more effective from an environmental stewardship perspective than traditional project-specific mitigation measures.

III. Administrative Issues:

16. Are Federal funds eligible to pay for these additional, or more in depth, environmental studies in transportation planning?

Yes. For example, the following FHWA and FTA funds may be utilized for conducting environmental studies and analyses within transportation planning: FHWA planning and research funds, as defined under 23 CFR Part 420 (e.g., Metropolitan Planning (PL), Statewide Planning and Research (SPR), National Highway System (NHS), Surface Transportation Program (STP), and Equity Bonus); and FTA planning and research funds (49 U.S.C. 5303 and 49 U.S.C. 5313(b)), urban formula funds (49 U.S.C. 5307), and (in limited circumstances) transit capital investment funds (49 U.S.C. 5309).

The eligible transportation planning-related uses of these funds may include: (a) Conducting feasibility or subarea/corridor needs studies and (b) developing system-wide environmental information/inventories (e.g., wetland banking inventories or standards to identify historically significant sites). Particularly in the case of PL and SPR funds, the proposed expenditure must be closely related to the development of transportation plans and programs under 23 U.S.C. 134-135 and 49 U.S.C. 5303-5306.

For FHWA funding programs, once a general travel corridor or specific project has progressed to a point in the preliminary engineering/NEPA phase that clearly extends beyond transportation planning, additional in-depth environmental studies must be funded through the program category for which the ultimate project qualifies (e.g., NHS, STP, Interstate Maintenance, and/or Bridge), rather than PL or SPR funds.

Another source of funding is FHWA's Transportation Enhancement program, which may be used for activities such as: conducting archeological planning and research; developing inventories such as those for historic bridges and highways, and other surface transportation-related structures; conducting studies to determine the extent of water pollution due to highway runoff; and conducting studies to reduce vehicle-caused wildlife mortality while maintaining habitat connectivity.

The FHWA and the FTA encourage State DOTs, MPOs, and public transportation operators to seek partners for some of these studies from environmental, regulatory, and resource agencies, non-government organizations, and other government and private sector entities with similar data needs, or environmental interests. In some cases, these partners may contribute data and expertise to the studies, as well as funding.

17. What staffing or organizational arrangements may be helpful in allowing planning products to be accepted in the NEPA process?

Certain organizational and staffing arrangements may support a more integrated approach to the planning/NEPA decision-making continuum. In many cases, planning organizations do not have environmental expertise on staff or readily accessible. Likewise, the review and regulatory responsibilities of many environmental, regulatory, and resource agencies make involvement in the transportation planning process a challenge for staff resources.

These challenges may be partially met by improved use of the outputs of each agency's planning resources and by augmenting their capabilities through greater use of GIS and remote sensing technologies (see http://www.gis.fhwa.dot.gov/ for additional information on the use of GIS). Sharing databases and the planning products of local land use decision-makers and State and Federal environmental, regulatory, and resource agencies also provide efficiencies in acquiring and sharing the data and information needed for both transportation planning and NEPA work.

Additional opportunities such as shared staff, training across disciplines, and (in some cases) reorganizing to eliminate structural divisions between planning and NEPA practitioners may also need to be considered in order to better integrate NEPA considerations into transportation planning studies. The answers to the following two questions also contain useful information on
training and staffing opportunities.

18. <u>How have environmental, regulatory, and resource agency liaisons (Federally- and State DOT-funded positions) and partnership agreements been used to provide the expertise and interagency participation needed to enhance the consideration of environmental factors in the planning process</u>?

For several years, States have utilized Federal and State transportation funds to support focused and accelerated project review by a variety of local, State, Tribal, and Federal agencies. While Section 1309(e) of the TEA-21 and its successor in SAFETEA-LU section 6002 speak specifically to transportation project streamlining, there are other authorities that have been used to fund positions, such as the Intergovernmental Cooperation Act (31 U.S.C. 6505). In addition, long-term, on-call consultant contracts can provide backfill support for staff that are detailed to other parts of an agency for temporary assignments. At last count (as of 2003), 246 positions were being funded. Additional information on interagency funding agreements is available at: http://environment.fhwa.dot.gov/strmlng/igdocs/index.htm.

Moreover, every State has advanced a variety of stewardship and streamlining initiatives that necessitate early involvement of environmental, regulatory, and resource agencies in the project development process. Such process improvements have: addressed the exchange of data to support avoidance and impact analysis; established formal and informal consultation and review schedules; advanced mitigation strategies; and resulted in a variety of programmatic reviews. Interagency agreements and work plans have evolved to describe performance objectives, as well as specific roles and responsibilities related to new streamlining initiatives. Some States have improved collaboration and efficiency by co-locating environmental, regulatory, and resource and transportation agency staff.

19. What training opportunities are available to MPOs, State DOTs, public transportation operators and environmental, regulatory, and resource agencies to assist in their understanding of the transportation planning and NEPA processes?

Both the FHWA and the FTA offer a variety of transportation planning, public involvement, and NEPA courses through the National Highway Institute and/or the National Transit Institute. Of particular note is the Linking Planning and NEPA Workshop, which provides a forum and facilitated group discussion among and between State DOT; MPO; Federal, Tribal, and State environmental, regulatory, and resource agencies; and FHWA/FTA representatives (at both the executive and program manager levels) to develop a State-specific action plan that will provide for strengthened linkages between the transportation planning and NEPA processes.

Moreover, the U.S. Fish and Wildlife Service offers Green Infrastructure Workshops that are focused on integrating planning for natural resources (``green infrastructure'') with the development, economic, and other infrastructure needs of society (``gray infrastructure'').

Robust planning and multi-issue environmental screening requires input from a wide variety of disciplines, including information technology; transportation planning; the NEPA process; and regulatory, permitting, and environmental specialty areas (e.g., noise, air quality, and biology). Senior managers at transportation and partner agencies can arrange a variety of individual training programs to support learning curves and skill development that contribute to a strengthened link of the transportation planning and NEPA processes. Formal and informal mentoring on an intra-agency basis can be arranged. Employee exchanges within and between agencies can be periodically scheduled, and persons involved with professional leadership programs can seek temporary assignments with partner agencies.

IV. Additional Information on this Topic

Valuable sources of information are FHWA's environment website (http://www.fhwa.dot.gov/environment/index.htm) and FTA's environmental streamlining website (http://www.environment.fta.dot.gov).

Another source of information and case studies is NCHRP Report 8-38 (Consideration of Environmental Factors in Transportation Systems Planning), which is available at http://www4.trb.org/trb/crp.nsf/All+Projects/NCHRP+8-38.

In addition, AASHTO's Center for Environmental Excellence website is continuously updated with news and links to information of interest to transportation and environmental professionals (www.transportation.environment.org).

Appendix E

Integration of the Planning and NEPA Processes

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Date:	February 22, 2005
Subject:	Integration of Planning and NEPA Processes
In Reply Refer To:	HCC-30
From:	D.J. Gribbin /s/ Chief Counsel, Federal Highway Administration Judith S. Kaleta /s/ Acting Chief Counsel, Federal Transit Administration
To:	Cindy Burbank, Associate Administrator Office of Planning, Environment and Realty, FHWA David A. Vozzolo, Deputy Associate Administrator Office of Planning and Environment, FTA

I. Issue

You have asked for guidance regarding the extent to which the results of the transportation planning process can be used in and relied upon in the NEPA process.

In response to your request, this memorandum outlines the current law; describes the transportation planning products that can be used in the NEPA process and under what conditions; and explains the roles of Federal agencies and the public in reviewing transportation planning products used in NEPA analyses and documents.

II. Background

The transportation planning process required by 23 U.S.C. 134 and 135 and 49 U.S.C. 5303-5306 sets the stage for future development of transportation projects. As part of the transportation planning process, States and local metropolitan planning organizations (MPOs) must develop long-range transportation plans to address projected transportation needs. In addition, they must create transportation improvement programs (TIPs or STIPs), which identify a list of priority projects to be carried out in the next three years to implement the plan. To receive Federal funding, transportation projects must come from a TIP or STIP. As a result, much of the data and decision making undertaken by state and local officials during the planning process carry forward into the project development activities that follow the TIP or STIP. This means that the planning process and the environmental assessment required during project development by the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4231 *et seq.*) should work in tandem, with the results of the transportation planning process feeding into the NEPA process. Congress has put great emphasis on the transportation planning process for shaping transportation decisions, and has retained and refined that emphasis in surface transportation law over decades.

In practice, though, the environmental analyses produced during the NEPA process are sometimes disconnected from the analyses used to prepare transportation plans, transportation improvement programs, and supporting corridor or subarea studies.

Analyses and decisions occurring during transportation planning can be ignored or redone in the NEPA process, resulting in a duplication of work and delays in implementation of transportation projects. The sharp separation between the work done during the transportation planning process and the NEPA analysis and documentation process is not necessary. In fact, current law provides authority for and even encourages the integration of the information and products developed in highway and transit planning process into the NEPA process. This memorandum provides guidance on how this information and these products can be incorporated into and relied upon in NEPA analyses and documents under existing laws.

III. Legal Analysis of Current Law on Integrating Planning and NEPA

The transportation planning process is a detailed, Congressionally mandated procedure for developing long-range transportation plans and shorter-range transportation improvement programs. These procedures were initially enacted in the 1960s and were codified in Title 23 and Title 49 of the U.S. Code. See 23 U.S.C. 134 and 135 and 49 U.S.C. 5303-5306. In 1991, the Intermodal Surface Transportation Efficiency Act of 1991 substantially expanded the planning provisions. They have been subsequently revisited and refined by Congress in various transportation bills, but the basic framework has remained intact. The procedures identify the State and local agencies with primary responsibility for transportation planning. They also identify agencies and other interested parties who should be given an opportunity to participate in the transportation planning process and describe their appropriate level of involvement. The statute spells out the planning factors that must be considered, including, among other factors, the protection and enhancement of the environment. 23 U.S.C. 134(f) and 135(c).[1] The transportation planning process undertaken by States and MPOs is periodically reviewed and, if found to be adequate, certified by FHWA and FTA. The Federal government does not approve the transportation plans developed by State or local officials, and although FTA and FHWA jointly approve the Statewide TIP such an approval does not constitute a Federal action subject to review under NEPA.[2] This is the process that Congress constructed to shape transportation decisions for Federally funded projects.

In order to be eligible for Federal funding, projects must come from a plan created by this process. Federal action subject to NEPA is needed to approve these Federal aid projects. Because of the continuity between the planning and project development processes, the NEPA analysis for a transportation project needs to be reviewed in the context of this transportation planning process.

NEPA and the government-wide regulations that carry out NEPA (40 C.F.R. Parts 1500 *et seq.*) clearly contemplate the integration of the NEPA process with planning processes. Specifically, Section 102(2)(A) of NEPA direct all Federal agencies to "utilize a systemic, interdisciplinary approach which will insure the integrated use of natural and social sciences and the environmental design arts in *planning* and decision making. [Emphasis added] The regulations issued by the President's Council on Environmental Quality (CEQ) amplify the statutory directive:

- 40 C.F.R. 1501.1(a) requires decision makers to "integrate[e] the NEPA process *into early planning* to ensure appropriate consideration of NEPA's policies and to eliminate delay;

- 40 C.F.R. 1501.1(b) emphasizes the need for "cooperative consultation among agencies *before the environmental impact statement is prepared*, rather than "submission of adversary comments on a completed document;
- 40 C.F.R. 1501.1(d) emphasizes the importance of "[I]identifying at an early stage the significant environmental issues deserving of study, by de-emphasizing "insignificant issues and "narrowing the scope of the environmental impact statement accordingly;
- 40 C.F.R. 1501.2 requires that Federal agencies "integrate the NEPA process with *other planning at the earliest possible time* to ensure that planning and [agency] decisions reflect environmental values. . .

Likewise, the NEPA regulations adopted by the Federal Transit Administration (FTA) and the Federal Highway Administration (FHWA) emphasize the tie between NEPA and transportation planning:

- 23 C.F.R. 771.105(a) provides that "To the fullest extent possible, all environmental investigations, reviews and consultations be coordinated as a single process. . . and
- 23 C.F.R. 771.105(b) directs that "Alternative courses of action be evaluated and decisions be made in the best overall public interest based upon a balanced consideration of the need for safe and efficient transportation; of the social, economic and environmental impacts of the proposed transportation improvement; and of national, State and local environmental protection goals.

Thus, the organic statute, the government-wide NEPA regulations, and the specific FHWA and FTA regulations all strongly support the integration of the NEPA process with the transportation planning process.

Case law on the issue of the use of transportation planning studies and decisions in the NEPA process is not extensive. However, to the extent they exist, court decisions have consistently supported the reliance in the NEPA process on work done in the planning process. For example, in *North Buckhead Civic Association v. Skinner*, 903 F. 2d 1533 (11th Cir. 1990), the Plaintiffs challenged the purpose and need articulated in the EIS for a multi-lane limited access highway connecting two existing highways. The purpose and need was derived from a series of planning studies conducted by the Atlanta Regional Commission. Plaintiffs argued that the purpose and need was crafted in a way that the proposed highway was "conclusively presumed to be required and a rail alternative perfunctorily dismissed for its failure to fully satisfy the objectives of the project. The Court of Appeals disagreed with the Plaintiffs, stating that their objections reflected "a fundamental misapprehension of the role of federal and state agencies in the community planning process established by the Federal-Aid Highway Act. The Court went on to explain that the Federal-Aid Highway Act contemplated "a relationship of cooperation between federal and local authorities; each governmental entity plays a specific role in the development and execution of a local transportation project. The Court emphasized that federal agencies did not have responsibility for long range local planning, and found that the "federal, state and local officials complied with federally mandated regional planning procedures in developing the need and purpose section of the EIS. 903 F.3d at 1541-42. Although the Court in *Buckhead* acknowledged the validity of a purpose and need based on the results of the planning study, it did not in any way scale back the holdings of other cases relating to purpose and need which caution agencies not to write purpose and need statements so narrowly as to "define competing 'reasonable alternatives' out of consideration (and even out of existence). *Simmons v. U.S. Army Corps of Engineers*, 120 F.3d 664 (7th Cir. 1997). (In this case, the Army Corps of Engineers failed to question city's insistence on one approach for supplying water and gave no independent thought to the feasibility of alternatives, both single source and separate source supply options. On this basis, the EIS was found to be inadequate.)

In *Carmel-by-the-Sea v. U.S. DOT*, 123 F.3d 1142 (9th Cir. 1997), the Plaintiffs challenged the sufficiency of an EIS for failing to adequately consider the proposed project's growth-inducing effects. The Ninth Circuit disagreed, finding that the EIS satisfied this requirement by referencing several local planning documents that specifically included construction of the highway in their growth plans and which discussed overall growth targets and limits. In addition, the Court found that achieving "Level of Service C, an objective derived from the local congestion management plan, was an appropriate part of the purpose and need statement (although ultimately the EIS was found inadequate on cumulative impact grounds). Similarly, in *Laguna Greenbelt, Inc. v. U.S. DOT*, 42 F.3d 517 (9th Cir. 1994), the court held that the absence of a more thorough discussion in an EIS of induced growth, an issue that was sufficiently analyzed in referenced state materials, does not violate NEPA. However, regardless of the source, the analysis of induced growth must be in sufficient detail and must provide an analytical basis for its assumptions in order to be adequate under NEPA. See *Senville v. Peters*, 327 F.Supp.2d 335, 349 (Vt. 2004) (In this case, the District Court found an FEIS, before it was supplemented by FHWA, to be inadequate because it contained only a "sketchy discussion of induced growth and failed to support its assumptions with any analysis.)

In *Utahns for Better Transportation v. U.S. DOT*, 305 F.3d 1152 (10th Cir. 2002), *as modified on rehearing*, 319 F.3rd 1207 (10th Cir. 2003), Plaintiffs contended that the FEIS was inadequate because it failed to consider reducing travel demand through alternative land use scenarios in combination with mass transit. Noting that "reasonable alternatives must be non-speculative, the Tenth Circuit found that Plaintiffs had not demonstrated a deficiency in the FEIS on this basis (although it was ultimately found inadequate on other grounds). The Court stated that "Land use is a local and regional matter, and that, in this case, the corridor at issue would involve the jurisdiction of several local and regional governmental entities whose cooperation would be necessary to make an alternative land use scenario a reality. The fact that these entities had clearly declined to alter their land use plans in such a way was justification for not considering this alternative. 305 F.3d at 1172. [3]

In *Sierra Club v. U.S. Department of Transportation*, 310 F.Supp.2d 1168 (D. Nevada 2004), Plaintiffs made several challenges to the EIS for a proposed highway project. One of these challenges alleged that FHWA relied on understated population and traffic forecasts. However, the Nevada District Court found that FHWA's reliance on the forecasts and modeling efforts of the designated metropolitan planning organization responsible for developing transportation plans and programs for the area was reasonable. In addition, Plaintiffs argued that the EIS had improperly rejected a fixed guideway as a reasonable alternative under NEPA. The Court disagreed, finding that FHWA reasonably relied on a "major investment study[4] conducted as part of its planning process to establish that such an alternative (1) would not meet the project's purpose and need, even when considered as part of a transportation strategy, (2) was too costly and (3) depended on connections to other portions of such a system for which construction was uncertain.[5]

As demonstrated by these cases, Courts have sanctioned the use of information from the planning process in a NEPA analysis and document. This is consistent with the opening language in NEPA advocating the integration of environmental considerations in both planning and decision-making. Consequently, products from the transportation planning process can be used in the NEPA analysis and documentation prepared for a transportation project.

IV. Legal Guidance on How Products from the Planning Process Can Be Used In the NEPA Process

For studies, analyses or conclusions from the transportation planning process to be used in the NEPA process, they must meet certain standards established by NEPA. This is because the information and products coming from the planning process must be sufficiently comprehensive that the Federal government may reasonably rely upon them in its NEPA analysis and documentation. Transportation planning processes vary greatly from locality to locality. Some transportation planning processes will already meet these standards, while others might need some modification to do so. Below is a discussion of where products from the transportation planning process might be incorporated into a NEPA analysis and documentation (purpose and need, alternatives, affected environment, and, to a more limited extent, environmental consequences in terms of land use, indirect and cumulative impacts, etc.), along with the NEPA standards they must first meet.

In addition to what is discussed below, these planning products must come from a transportation planning process that complied with current transportation planning requirements (e.g., provided an opportunity for public involvement and considered relevant planning factors). Interested State, local, tribal and Federal agencies should be included in the transportation planning processes, and must be given a reasonable opportunity to comment upon the long range transportation plan and transportation improvement program. Finally, any work from the planning process must have been documented and available for public review during the planning process. Such documentation should be in a form that can easily be appended to the NEPA document or incorporated by reference.[6]

Purpose and Need

The "purpose and need statement in a NEPA document is where the planning process and the NEPA process most clearly intersect. A sound planning process is a primary source of the project purpose and need. It is through the planning process that state and local governments determine what the transportation needs of an area are, which of transportation needs they wish to address, and in what time frame they wish to address them. Indeed, that is what the law requires from the planning process and actually prevents projects that do not come from the planning process from going forward.

The purpose and need statement, at a minimum, is a statement of the transportation problem to be solved by the proposed project. It is often presented in two parts: broad goals and objectives, and a description of the transportation conditions (congestion, safety, etc.) underlying the problem. The long-range transportation plan also includes goals and objectives similar to "purpose and need but on a broader scale, since it typically covers a wider area and spans at least twenty years. These goals and objectives are often identified through extensive public outreach, sometimes called "visioning or "alternative futures exercises. The purpose and need statement for a transportation project should be consistent with and based on the goals and objectives developed during the planning process.

Getting input from Federal agencies as transportation goals and objectives are developed during the planning process is advisable and would be consistent with the cooperative relationship envisioned by statute and reinforced by courts. Such participation would give Federal agencies a better insight into the needs and objectives of the locality and would also provide an important opportunity for Federal concerns to be identified and addressed early in the process. These concerns could include issues that might be raised by Federal agencies in considering permit applications for projects designed to implement the transportation plan. However, the responsibility for local planning lies with the metropolitan planning organization or the State, not the Federal government.

In many cases, the goals and objectives in the transportation plan are supported by a needs assessment and problem statement describing current transportation problems to be addressed. Although the goals and objectives in the long-range transportation plan will be broader than what is appropriate for a specific project, they can be the foundation for the purpose and need to be used in a NEPA document. For example, they can be used to generate corridor-level purpose and need statements, during planning, for use in NEPA documents. The challenge is to ensure what comes from the long-range transportation plan is not so general as to generate a range of alternatives that are not responsive to the problem to be solved.

NEPA calls for a purpose and need statement to briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action. A purpose and need statement can be derived from the transportation planning process. The purpose and need statement:

- Should be a statement of the transportation problem (not a statement of a solution);
- Should be based on articulated planning factors and developed through a certified planning process;
- Should be specific enough so that the range of alternatives developed will offer real potential for solutions to the transportation problem;
- Must not be so specific as to "reverse engineer a solution; and
- May reflect other priorities and limitations in the area, such as environmental resources, growth management, land use planning, and economic development.

Alternatives

Under NEPA, an EIS must rigorously explore and objectively evaluate all reasonable alternatives, and briefly explain the rationale for eliminating any alternatives from detailed study.7 "Reasonable alternatives are described in Council on Environmental Quality (CEQ) guidance as including "those that are practical or feasible from the technical and economic standpoint and using common sense. *Forty Most Asked Questions Concerning CEQ's NEPA Regulations*, Question #2a (March 23, 1981). An alternative is not "reasonable if it does not satisfy the purpose and need,8 but it may be reasonable even if it is outside the jurisdiction of the proposing agency to implement.

The transportation planning process frequently takes steps to refine the purpose and need statement that results in narrowing or screening the range of alternatives. Regional planning considerations may be the basis for refining the purpose and need statement, which might then have the effect of eliminating some alternatives from detailed consideration. For example, network connectivity across a geographic barrier such as a river may dictate a particular transportation mode or a general alignment. The plan may also identify where a locality wants housing, commercial development, agriculture, etc.—all of which might drive the need for transportation improvements in particular corridors.

When a long- range transportation plan leaves open the possibility of multiple approaches to fulfill its goals and objectives, a subarea or corridor study could be conducted to "zoom in on a particular area. This study would evaluate alternative investment strategies, engineering constraints, fiscal constraints, and environmental considerations in this area, and could narrow the range of possible alternatives to those that will meet the goals and objectives of the broader long-range transportation plan in that particular subarea or corridor. At the conclusion of such a study, the remaining alternatives might simply consist of a single corridor or mode choice with location and design options.

On a broad scale, a decision about whether projects located in particular subareas or corridors would satisfy the transportation goals and objectives of a locality can be made in these subarea or corridor studies. These studies can therefore be used in and relied on in an EIS to refine the purpose and need statement, thereby narrowing the range of alternatives to be considered by eliminating some alternatives from further detailed study. When conducting subarea or corridor screening studies during the planning process, State and local agencies should keep in mind the principles of NEPA and should be sure to document their procedures and rationales. To be incorporated into an EIS, the analysis of alternatives conducted in the subarea or corridor study should be consistent with the standard of NEPA requiring consideration of reasonable alternatives. Alternatives that remain "reasonable after the planning level analysis must be addressed in the NEPA process, even when they are clearly not the preferred alternative.9 Alternatives passed over during the transportation planning process because they are infeasible or because they do not meet the NEPA "purpose and need can be omitted from the detailed analysis of alternatives in the NEPA analyses and documentation, so long as the rationale for omitting them is documented in the NEPA document. That documentation can either be appended to the EIS or the specific transportation planning documents can be summarized in the EIS and incorporated by reference. The NEPA review would then have to consider the alternatives that survive the planning study, plus any additional reasonable alternatives identified during NEPA scoping that may not have been considered during the planning process. All reasonable alternatives considered in the draft and final EIS should be presented in a "comparative form that sharply defines the issues and provides a clear basis for a choice by the decision maker and the public. 40 C.F.R. 1502.14.

Finally, any planning study being relied upon as a basis for eliminating alternatives from detailed study should be identified during the NEPA scoping process and available for public review. Since a major purpose of the scoping process is to identify alternatives to be evaluated, the public should be given the opportunity to comment on determinations made in the planning process to eliminate alternatives.

Therefore, if the planning process is used to screen or narrow the range of alternatives, by excluding certain alternatives from detailed study or by prescribing modes or corridors for transportation development which results in eliminating alternative modes or corridors from detailed study, then the planning-based analysis of alternatives:

- Should describe the rationale for determining the reasonableness of the alternative or alternatives;
- Should include an explanation of why an eliminated alternative would not meet the purpose and need or was otherwise unreasonable; and
- Should be made available for public review during the NEPA scoping process and comment period.

Under FTA's New Starts program, the alternatives considered during the NEPA process may be narrowed even further by eliminating alternatives from detailed study in those instances when the Alternatives Analysis required by 49 U.S.C. 5309(e) is conducted as a planning study prior to the NEPA review.10 In fact, FTA may narrow the alternatives considered in detail in the NEPA analysis and documentation to the No-Build (No-Action) alternative and the "Locally Preferred Alternative". The following criteria must be met if alternatives are eliminated from detailed study by a planning Alternatives Analysis conducted prior to the NEPA review:

- During the planning Alternatives Analysis, all of the reasonable alternatives under consideration must be fully evaluated in terms of their transportation impacts, capital and operating costs, social, economic, and environmental impacts, and technical considerations;
- There must be appropriate public involvement in the planning Alternatives Analysis;
- The appropriate Federal, State, and local resource agencies must be engaged in the planning Alternatives Analysis;
- The results of the planning Alternatives Analysis must be documented;
- The NEPA scoping participants must agree on the alternatives that will be considered in the NEPA review; and
- The NEPA document must incorporate by reference the evaluation of alternatives from the planning Alternatives Analysis.

If, during the NEPA process, new reasonable alternatives not considered during the planning Alternatives Analysis are identified or new information about eliminated alternatives comes to light, those alternatives must be evaluated during the NEPA process.

Affected Environment and Environmental Consequences

The EIS must present a description of the environment in the area that would be affected by the proposed action and alternatives and their environmental consequences. 40

C.F.R. 1502.15 and 1502.16. In the development of the long-range transportation plan and a corridor or subarea studies, a similar assessment of the environment in the area and environmental consequences should typically have been conducted. Such planning-level assessments might include developing and utilizing geographic information system overlays of the area; providing information on air- and water-sheds; identifying the location of environmental resources with respect to the proposed project and alternatives; conducting environmental "scans of the area of impact; and utilizing demographic trends and forecasts developed for the area. The discussion in the planning process of development growth, and consistency with local land use, growth management or development plans, as well as population and employment projections, would be particularly valuable for use in determining the affected environment and the scope of cumulative impacts assessment and possible indirect impacts of the proposed transportation improvement. Any relevant parts of such transportation planning process analysis, conducted in the planning process or by other sources and used in plan development, can be incorporated by reference and relied upon in the NEPA analysis and documentation.

The CEQ regulations require the action agency preparing an EIS to assess the environmental consequences of the proposed action and any reasonable alternatives. The CEQ regulation contains a detailed list of all of the types of environmental consequences that must be discussed, including direct, indirect and cumulative impacts and their significance, as well as means to mitigate adverse environmental impacts. These consequences must be discussed for each alternative and should be presented in a comparative form. 40 C.F.R. 1502.16. In transportation planning, the development of transportation plans and programs is guided by seven planning factors (23 U.S.C. 134(f)(1) and 23 U.S.C. 135(c)(1)), one of which is to "protect and enhance the environment, promote energy conservation, and improve the quality of life. As such, there generally is a broad consideration of the environmental effects of transportation decisions for a region.11 To the extent relevant, this analysis can be incorporated into the "environmental consequences section of an environmental assessment or impact statement performed under NEPA. However, in most cases the assessment of environmental consequences conducted during the planning process will not be detailed enough to meet NEPA standards and thus will need to be supplemented.

Nonetheless, the planning process often can be a source of information for the evaluation of cumulative and indirect impacts required under NEPA. 40 C.F.R. 1502.16, 1508.7 and 1508.8. The nature of the planning process is to look broadly at future land use, development, population increases, and other growth factors. This analysis could provide the basis for the assessment of cumulative and indirect impacts required under NEPA. Investigating these impacts at the planning level can also provide insight into landscape, watershed or regional mitigation opportunities that will provide mitigation for multiple projects.

An EIS may incorporate information regarding future land use, development, demographic changes, etc. from the transportation planning process to form a common basis for comparing the direct, indirect and cumulative impacts of all alternatives. When an analysis of the environmental consequences from the transportation planning process is incorporated into an EIS it:

- Should be presented in a way that differentiates among the consequences of the proposed action and other reasonable alternatives;
- Should be in sufficient detail to allow the decision maker and the public to ascertain the comparative merits and demerits of the alternatives; and
- Must be supplemented to the extent it does not adequately address all of the elements required by the CEQ and FHWA/FTA NEPA regulations.

V. Legal Guidance on Weight to be Given to Planning Products Incorporated into NEPA Analyses and Documents

Responsibility for NEPA analyses and documents on Federally funded or approved highway and transit projects ultimately rests with FHWA and FTA, since they are taking the federal action subject to NEPA. FHWA and FTA have an obligation to independently evaluate and review a NEPA analysis and document, even when some of the information contained in it has been prepared by the State or other local agency. 42 U.S.C. 4332(2)(D); 40 C.F.R. 1506.5 Under NEPA and other relevant environmental laws such as the Endangered Species Act, the Clean Water Act, or the Clean Air Act, other agencies also must be given an opportunity to review and comment on NEPA documents and analysis. Federal agencies that have jurisdiction by law have an independent responsibility under NEPA and, upon the request of the lead agency, shall be "cooperating agencies.12 Tribes and state and local agencies with jurisdiction by law and all agencies with special expertise may, upon the request of the lead agency, be "cooperating agencies in the NEPA process. 40 C.F.R. 1501.6 and 1508.5.

However, while imposing on Federal agencies the obligation to independently evaluate information in NEPA analyses and documents, Congress also affirmed that NEPA does not apply to the transportation planning process because it is not a Federal action:

"Since plans and programs described in this [transportation planning] section are subject to a reasonable opportunity for public comment, since individual projects included in the plans and programs are subject to review under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.), and since decisions by the Secretary concerning plans and programs described in this section have not been reviewed under such Act as of January 1, 1997, any decision by the Secretary concerning a plan or program described in this section shall not be considered to be a Federal action subject to review under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.)."

23 U.S.C 134(o) and 135(i). The transportation planning process is a local function, which, by statute, is undertaken by State and local governments. The Department of Transportation has an oversight role, but it does not conduct the process and, therefore, there is no Federal action to trigger the application of NEPA. This is different than the "big picture planning processes undertaken by other Federal agencies with respect to lands that they manage, where action by the Federal agency is involved and NEPA applies.13

The affirmation in Sections 134(o) and 135(i) that the decisions made by State and local governments during the transportation planning process are exempt from NEPA is based on a Fifth Circuit decision, *Atlanta Coalition on the Transportation Crisis, Inc. v. Atlanta Regional Commission*, 599 F.2d 1333 (5th Cir. 1979). In this case, plaintiffs sought declaratory judgment that an EIS was required for a regional transportation plan developed by the Atlanta Regional Commission in compliance with the FHWA and FTA planning regulations. The plan proposed a comprehensive transportation system for the Atlanta area. It included an analysis of projected regional transportation needs through the year 2000 and identified the general location and the mode (i.e. highway or transit) for recommended transportation corridors to meet those needs. The Fifth Circuit denied plaintiff's request for an EIS, finding that "Congress did not intend NEPA to apply to state, local or private actions; hence, the statute speaks only to ‘federal agencies' and requires impact statements only as to ‘major federal actions.' 559 F.2d at 1344. Specifically, the Court stated:

"The fact is that the [regional plan] was developed by ARC in conjunction with state and local authorities, and no federal agency had any significant hand in determining, or made any decision concerning, its substantive aspects. Under the statutes, those decisions are entrusted to the state and local agencies, not FHWA or [FTA]. Moreover, the plan, as a plan will never be submitted to a federal agency for review or approval. And while the planning process was so structured so as to preserve the eligibility for federal funding of projects included within the resulting plan, it has been consistently held that the possibility of federal funding in the future does not make the project or projects ‘major federal action' during the planning stage."

[Cites omitted] 599 F.2d at 1346. The Court further found that certification or funding of the planning process by FHWA and FTA did not amount to a "major federal action as defined in the NEPA regulations. 559 F.3d at 1344; 40 C.F.R. 1508.18. The Court concluded by again emphasizing: "We have no doubt but that the [regional plan] embodies important decisions concerning the future growth of the Atlanta area that will have a continuing and significant effect on the human environment. But at the risk of belaboring the point, we reemphasize that those decisions have been made by state and local authorities, will not be reviewed by any federal agency, and obligate no federal funds. The defendants therefore need not prepare an impact statement on the [regional plan]. 559 F.3d at 1349.

This theme is echoed in other court decisions involving local planning processes. Early in the development of NEPA law, Courts recognized that deference to local planning was appropriate in the NEPA process. In *Maryland-National Capital Park and Planning Commission v. U.S. Postal Service*, 487 F.2d 1029 (U.S. App. D.C. 1973), the Postal Service determined that the construction of a bulk mail facility would have no significant impact since, under the locality's zoning laws, the postal facility was a "permitted use at the location proposed by the Postal Service. In analyzing this issue, the Court noted: "The question of significance takes on a distinctive case in the context of land use planning. The Court went on to state: "When local zoning regulations and procedures are followed in site location decisions by the Federal Government, there is an assurance that such ‘environmental' effects as flow from the special uses of land—the safety of the structures, cohesiveness of neighborhoods, population density, crime control, and esthetics-will be no greater than demanded by the residents acting through their elected representatives. 487 F.2d at 165-66. The Court acknowledged, however, that local planning was not sufficient to effectuate NEPA, and that actions of the Federal government might have implications beyond those evaluated in the planning process: "For example, whereas the Federal Government might legitimately defer to New York City zoning in matters of, say, population density, a different issue would be posed by the location within the city of an atomic reactor. Its peculiar hazards would not be limited to the citizens of New York, nor could they control them. 487 F.2d at 166. *See also Preservation Coalition, Inc. v. Pierce*, 667 F.2d 851 (C.A. Idaho 1982) (citing *Maryland-National Capital Park* and upholding a finding of no significant impact when a Federal project conformed to existing land use patterns, zoning and local plans).

The Fifth Circuit followed a similar line of reasoning in *Isle of Hope Historical Association v. U.S. Army Corps of Engineers*, 646 F. 2d 215 (5th Cir. 1981). In this case, the Court held that, in preparing an EIS, the Corps of Engineers properly relied on information and answers from the local government regarding planning and zoning issues. The Corps had consulted with county officials to determine whether planning documents had been adopted and whether there was any inconsistency between the proposed project and the local zoning regulations. Plaintiffs challenged this part of the EIS, alleging that it had not adequately discussed the planning documents at issue nor disclosed inconsistencies between the zoning regulations and the proposed project. The Court upheld the Corps' reliance on the county officials' responses, stating that "For the Corps in this case to follow planning documents which the county had not adopted or to engage independent analysis of inconsistencies which those specifically charged with zoning enforcement did not find would make the Corps in effect a planning and zoning review board. . . The proper function of the Corps was to assess the environmental impact of the [proposed project], not to act as a zoning interpretation or appeal board. 646 F.2d at 221.14

This respect for local sovereignty in making planning decisions has been reinforced more recently in the context of transportation planning. In *North Buckhead Civic Association v. Skinner* (discussed previously in Section III of this Memorandum), the 11th Circuit emphasized that "NEPA does not confer the power or responsibility for long range local planning on Federal or state agencies. 903 F. 3d at 1541-42. See also *Sierra Club v. U.S. Department of Transportation*, 350 F.Supp.2d 1168, 1193 (D. Nevada 2004), where the Court said: "[A] federal agency does not violate NEPA by relying on prior studies and analyses performed by local and state agencies. This approach is also consistent with the statutory provision describing the Federal-State relationship for the Federal-aid highway program: "The authorization of the appropriation of Federal funds or their availability for expenditure under this chapter shall in no way infringe on the sovereign rights of the States to determine which projects shall be federally financed. 23 U.S.C.

145(a). In conducting its NEPA analysis, FHWA and FTA must take into account Congressional direction regarding its statutory authority to act. See *Citizens Against Burlington, Inc. v. Busey*, 938 F.2d 190 (C.A.D.C. 1991).15

When it enacts a provision of law, Congress is presumed to have in mind previous laws relating to the same subject matter. To the greatest extent possible, new statutes should be read in accord with prior statutes, and should be construed together in harmony. N. Singer, *Statutes and Statutory Construction*, 6th Ed., Vol. 2B, Sec. 51.02. A Federal agency's independent obligation to evaluate planning products incorporated into the NEPA process must be performed in a way that is consistent with the Congressional direction that NEPA does not apply to local transportation planning and consistent with court decisions recognizing the sovereignty of local governments in making local transportation planning decisions. Federal agencies should ensure transportation planning decisions have a rational basis and are based on accurate data, but should not use the NEPA process as a venue for substituting federal judgment for local judgment by requiring reconsideration of systems-level objectives or choices that are properly made during the local transportation planning process.16

The transportation planning process and the NEPA process work in harmony when the planning process provides the basis or foundation for the purpose and need statement in a NEPA document. To the extent regional or systems-level analyses and choices in the transportation planning process help to form the purpose and need statement for a NEPA document, such planning products should be given great weight by FHWA and FTA, consistent with Congressional and Court direction to respect local sovereignty in planning. This approach is also consistent with a letter to Secretary Mineta dated May 12, 2003, from James Connaughton, Chairman of CEQ, on purpose and need statements in NEPA documents:

"Federal courts generally have been deferential in their review of a lead agency's ‘purpose and need' statements, absent a finding that an agency acted in an arbitrary or capricious manner. They have recognized that federal agencies should respect the role of local and state authorities in the transportation planning process and appropriately reflect the results of that process in the federal agency's NEPA analysis of purpose and need [citing to *North Buckhead*]."

Further, in his letter, the Chairman states that, even though other Federal agencies must be provided an opportunity to comment, they "should afford substantial deference to the transportation agency's articulation of purpose and need when the proposal is a transportation project.17

Therefore, if transportation planning studies and conclusions have properly followed the transportation planning process, then they can be incorporated into the purpose and need statement and, further, can be used to help draw bounds around alternatives that need to be considered in detail. For example, if systems-level or other broad objectives or choices18 from the transportation plan are incorporated into the purpose and need statement used in a NEPA document, FHWA and FTA should not revisit whether these are the best objectives or choices among other options. Rather, their review would include making sure that objectives or choices derived from the transportation plan were based on transportation planning factors established by federal law; reflect a credible and articulated planning rationale; are founded on reliable data; and were developed through a transportation planning process meeting FHWA and FTA statutory and regulatory requirements. In addition, the basis for the objectives and choices must be documented and included in the NEPA document. In such cases, alternatives falling outside a purpose and need statement derived from objectives or choices identified in the planning process do not need to be considered in detail.

FHWA and FTA should independently review regional analyses or studies of transportation needs conducted during the transportation planning process at a similar level. FHWA and FTA reviewers do not need to review whether assumptions or analytical methods used in the studies are the best available, but, instead, need to assure that such assumptions or analytical methods are reasonable and scientifically acceptable. This review would include determining whether assumptions have a rational basis and are up-to-date and data, analytical methods, and modeling techniques are reliable, defensible, and reasonably current. This approach preserves the sovereignty of *state and local governments in making local planning decisions but in a way that is consistent with the principles and procedures of NEPA.*

Nonetheless, additional scrutiny may be required if the results of the planning process are more specific than needed for regional or systems-level planning. Such results might actually be part of project development, which is outside of the planning jurisdiction of local agencies. Project development often involves a Federal action and therefore would be subject to NEPA. See 23 U.S.C. 134(o) and 135(i). In addition, the information the Federal agencies rely upon in the NEPA process based on underlying transportation planning work cannot be inaccurate, false or misleading. See *Sierra Club v. U.S. Army Corps of Engineers,* 701 F. 2d 1011, 1035 (where the court required a supplementation or re-evaluation of the NEPA analyses and documentation where the Corps unquestioningly relied on inaccurate information and did not investigate, on its own, the accuracy of the fisheries data submitted to it to support a permit for a landfill in the Hudson river to accommodate the Westway highway project.)

In conducting reviews under NEPA, Federal agencies should defer to planning products incorporated into the NEPA process to the extent that they involve decisions or analysis within the jurisdiction of the local planning agency. The focus of the Federal agency's review should be whether the planning information is adequate to meet the standards of NEPA, not whether the decisions made by the planning authority are correct. This would be consistent with the specific roles assigned by Congress to local and Federal authorities and consistent with court decisions admonishing Federal agencies to respect the sovereignty of local authorities in developing local plans.

VI. Conclusion

This memorandum provides guidance on how transportation planning level information and products may be used to focus the documentation prepared to comply with NEPA when Federal approvals are needed to build a transportation project. Federal law and regulations and best practices ensure that much information that is relevant to the NEPA process is in fact developed during the planning process. Both Federal transportation law and NEPA law strongly suggest that to the extent practicable, the NEPA process should use and build on the decision made and information developed during the planning process. Of course, where the transportation planning process fails to address or document issues, the NEPA analyses and documentation may have to supplement the information developed during the planning process.

Original signed by D.J. Gribbin and Judith S. Kaleta

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1 Protection of the environment is reinforced in the FHWA and FTA regulations clarifying the factors to be considered in the transportation planning process (e.g., States and MPOs must analyze the "overall social, economic, energy and environmental effects of transportation decisions. . . 23 CFR 450.208 and 450.316.

2 As stated in the planning provisions of Title 23, "any decision by the Secretary concerning a plan or program described in this section shall not be considered to be a Federal action subject to review under NEPA. 23 U.S.C. 134(o); see also 23 U.S.C. 135(i). These provisions are discussed more fully in Section V of this memorandum.

3 Note, however, an alternative is not "speculative or "unreasonable merely because it is outside the jurisdiction of the proposing agency. 40 C.F.R. 1402.14 (c). In some cases, an agency might be required to consider an alternative outside its jurisdiction. For example, in *Muckleshoot Indian Tribe v. United States Forest Service*, 177 F.3d 800 (9th Cir. 1999), the Ninth Circuit Court of Appeals found that the lack of funds for an alternative was not sufficient to render it "speculative when the Forest Service could have at least made a request for additional funding. The facts in the *Muckleshoot* case are different than the *Utahns* case, where the local agencies had clearly declined to exercise the alternative.

4 Corridor-level "Major Investment Studies were for a time required under FTA and FHWA's planning regulations where a need for a major metropolitan transportation investment was identified and Federal funds were potentially involved. Major investment studies were intended to refine the system-wide transportation plan and lead to decisions on the design concept and scope of the project, in consultation with other interested agencies. In addition, they were intended to be used as input to EISs and EAs. 23 C.F.R. 450.318. In Section 1308 of the Transportation Equity Act for the 21st Century, the Secretary was directed to eliminate the separate requirement for major investment studies and instead to integrate it with the planning analyses required under the FTA and FHWA planning statutes "as part of the analyses required to be undertaken pursuant to the planning provisions of Title 23, United States Code and Chapter 53 of Title 49, United States Code, and the National Environmental Policy Act of 1959 (42 U.S.C. 4321 et seq.) for Federal-aid highway and transit projects.. Pub.. 105-178 (June 9, 1998). Although no longer required, "major investment studies continue to be allowed at the discretion of the State or local agency.

It is telling, however, that a good many State and local agencies continue to prepare "major investment studies (and similar corridor and sub-area analyses) on their own volition, because they have found it very valuable to vet the merits and weaknesses of various alternatives—both modal and alignment--before they even initiate the NEPA analyses and documentation. Moreover, FTA requires Metropolitan Planning Organizations and/or transit agencies contemplating major capital investment ("new starts) projects to prepare a planning-level corridor study, know as an "Alternatives Analysis, either before or during a Draft Environmental Impact Statement for the purpose of narrowing the range of alternatives for study in a subsequent NEPA analysis and document(s) by eliminating some alternatives from further detailed study. See also footnote 10.

5 Plaintiffs have appealed this decision, and the Ninth Circuit has stayed further construction on the project pending the outcome of the appeal. *Order Granting Stay*, Ninth Circuit Court of Appeals, No. CV-02-00578-PMP (July 27, 2004).

6 Documents may be incorporated by reference if they do not impede agency or public review of the action. Any document incorporated by reference must be "reasonably available for inspection by potentially interested persons within the time allowed for comment. Incorporated materials must be cited in the NEPA document and their contents briefly described. 40 C.F.R. 1502.21.

7 40 C.F.R. 1502.14 The term "alternatives is also used in many other contexts (for example, "prudent and feasible alternatives under Section 4(f) of the Department of

Transportation Act, the "Least Environmentally Damaging Practicable Alternative under the Clean Water Act, or the "Alternatives Analysis under FTA's New Starts program). This memorandum only uses the term as defined under NEPA. At the planning stage of any project, however, a determination should be made as to whether the alternatives to be considered will need to be used to satisfy multiple requirements at the planning and NEPA review stages. If so, during planning the alternatives chosen for consideration and the analysis of those alternatives should reflect the multiple statutory objectives that must be addressed.

8 In some cases, an alternative may be reasonable even if it just partially satisfies the purpose and need. See *NRDC v. Morton*, 458 F.2d 827, 836 (C.A.D.C. 1972).

9 Under the requirements for FTA's New Starts Program, however, under the appropriate circumstances, reasonable alternatives may be eliminated from detailed study during a rigorous planning-level Alternatives Analysis (including an evaluation of environmental consequences) conducted before the issuance of a NEPA Notice of Intent to prepare an Environmental Impact Statement. This is discussed later in this section.

10 FTA offers applicant sponsors the opportunity to conduct the Alternatives Analysis before NEPA begins or alternatively, to conduct the Alternatives Analysis concurrently with the NEPA DEIS.

11 Specifically, the FHWA/FTA transportation planning regulations (23 C.F.R. Part 450 and 49 C.F.R. Part 613) require inclusion of the overall social, economic, energy and environmental effects of transportation decisions (including consideration of the effects and impacts of the plan on human, natural and man-made environment such as housing, employment and community development, consultation with appropriate resource and permit agencies to ensure early and continued coordination with environmental resource protection and management plans, and appropriate emphasis on transportation-related air quality problems). 23 C.F.R. 450.316(a)(13).

12 Nonetheless, a cooperating agency may, in response to a lead agency's request for assistance in preparing an EIS, reply that other program commitments preclude any involvement or the degree of involvement requested in the action that is subject to the EIS. 40 C.F.R. 1501.6(c).

13 For example, NEPA applies to the general management plans prepared and approved by the National Park Service for each unit of the National Park System (Chapter 2, "Management Policies, at www.nps.gov/policy/mp/chapter2.htm), and applies to resource management plans prepared and approved by the Bureau of Land Management to maximize resource values of federal lands and resources (43 C.F.R. 1601.0-6).

14 Of course, the reliance on the underlying local plan does not excuse the analysis of the impacts of the project within the context of that plan. Cf. *Sierra Club Illinois Chapter v. U.S. Department of Transportation*, 962 F. 2d 1037, 1042 (N.D. Ill. 1997).

15 In this case, plaintiffs challenged the Federal Aviation Administration's EIS on an application by the Toledo Port Authority for a cargo hub in Toledo. Plaintiffs alleged that the FAA should have considered alternatives outside of Toledo. The Court disagreed,

finding that Congress had made clear that the location of cargo hubs was to be made by local authorities and not by the Federal government, stating: "Where the Federal government acts, not as a proprietor, but to approve and support a project being sponsored by a local government or private applicant, the Federal agency is necessarily more limited. In the latter instance, the Federal government's consideration of alternatives may accord substantial weight to the preferences of the applicant and/or sponsor in the sitting and design of the project. 938 F.2d at 197.

16 This would not constrain the Environmental Protection Agency's authority under Section 309 of the Clean Air Act to refer concerns to the President's Council on Environmental Quality regarding impacts on public health or welfare or environmental quality. 42 U.S.C. 7609*.*

17 See, also, *Citizens Against Burlington, Inc. v. Busey*, *id*., At 938 F.2d 190, 195-96 (C.A.D.C. 1991), stating "When an agency is asked to sanction a specific plan, see 40 C.F.R. § 1508.18(b)(4), the agency should take into account the needs and goals of the parties involved in the application. [Citations omitted]; *Louisiana Wildlife Federation, Inc. v. York*, 761 F.2d 1044 (5th Cir. 1985), stating "Under [the Corps'] Guidelines, therefore, not only is it permissible for the Corps to consider the applicant's objective; the Corps has a duty to take into account the objectives of the applicant's project. Indeed, it would be bizarre if the Corps were to ignore the purpose for which the applicant seeks a permit and to substitute a purpose it deems more suitable.

18 Examples of such planning objectives or choices that courts have accepted for use in the purpose and need statement for a NEPA document are (1) the need for a multi-lane highway connecting two other highways (*North Buckhead Civic Association v. Skinner*, 903 F.2d at 1537) and (2) the need for a particular level of service (*Carmel-by-the-Sea v. U.S. DOT,* 123 F.3d at 1156). In *Atlanta Coalition on the Transportation Crisis v. Atlanta Regional Commission*, the court discusses the distinction between "systems planning and "project planning, and describes the Atlanta "systems plan as "an analysis of projected regional transportation needs through the year 2000 [identifying] the general location and the mode (i.e., highway or mass transit) of recommended transportation corridors to meet those needs. 599 F.2d at fn.2 and at 1341

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Appendix F

MPO Air Quality Conformity Checklist

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Conformity Analysis Documentation
Checklist for MPO TIPs/RTPs

40 CFR	Criteria	Page	Comments
§93.102	Document the applicable pollutants and precursors for which EPA designates the area as nonattainment or maintenance. Describe the nonattainment or maintenance area and its boundaries.		
§93.104 (b, c)	Document the date that the MPO officially adopted, accepted or approved the TIP/RTP and made a conformity determination. Include a copy of the MPO resolution. Include the date of the last prior conformity finding.		
§93.104 (e)	If the conformity determination is being made to meet the timelines included in this section, document when the new motor vehicle emissions budget was approved or found adequate.		
§93.106	If the metropolitan planning area is in a serious, severe, or extreme ozone nonattainment area and/or serious carbon monoxide nonattainment area and contains an urbanized population over 200,000, then RTP must specifically describe the transportation system envisioned for future years called "horizon years."		
§93.106 (a)(2)ii	Describe the regionally significant additions or modifications to the existing transportation network that are expected to be open to traffic in each analysis year. Document that the design concept and scope of projects allows adequate model representation to determine intersections with regionally significant facilities, route options, travel times, transit ridership and land use.		
§93.108	Document the TIP/RTP is fiscally constrained consistent with DOT's metropolitan planning regulations at (23 CFR 450) in order to be found in conformity.		
§93.109 (a, b)	Document that the TIP/RTP complies with any applicable conformity requirements of air quality implementation plans (SIPs) and court orders.		
§93.109 (c-k)	Provide either a table or text description that details, for each pollutant and precursor, whether the interim emissions tests and/or the budget test apply for conformity. Indicate which emissions budgets have been found adequate by EPA, and which budgets are currently applicable for what analysis years.		
§93.110 (a, b)	Document the use of latest planning assumptions (source and year) at the "time the conformity analysis begins," including current and future population, employment, travel and congestion. Document the use of the most recent available vehicle registration data. Document the date upon which the conformity analysis was begun.		
USDOT/EPA guidance	Documents planning assumptions are less than 5 years old at the time the conformity analysis begins. If assumptions are older than 5 years documents justification for not reviewing and updating assumptions at least every 5 years.		
§93.110 (c,d,e,f)	Document any changes in transit operating policies and assumed ridership levels since the previous conformity determination. Document the use of the latest transit fares and road and bridge tolls. Document the use of the latest information on the effectiveness of TCMs and other SIP measures that have been implemented. Document the key assumptions and show that they were agreed to through Interagency and public consultation.		
§93.111	Document the use of the latest emissions model approved by EPA.		

40 CFR	Criteria	Page	Comments
§93.112	Document fulfillment of the interagency and public consultation requirements outlined in a specific implementation plan according to §51.390 or, if a SIP revision has not been completed, according to §93.105 and 23 CFR 450. Include documentation of consultation on conformity tests and methodologies as well as responses to written comments.		
§93.113	Document timely implementation of all TCMs in approved SIPs. Document that implementation is consistent with schedules in the applicable SIP and document whether anything interferes with timely implementation. Document any delayed TCMs in the applicable SIP and describe the measures being taken to overcome obstacles to implementation.		
§93.114	Document that the conformity analyses performed for the TIP is consistent with the analysis performed for the Plan, in accordance with 23 CFR 450.324(f)(2).		
§93.115	Describe how the projects come from a conforming RTP and TIP. If this criterion is not satisfied, the project must satisfy all criteria in Table 1 of §93.109(b) for a project not from a RTP and TIP.		
§93.118 (a, c, e)	For areas with SIP budgets: Document that emissions from the transportation network for each applicable pollutant and precursor, including projects in any associated donut area that are in the Statewide TIP and regionally significant non-Federal projects, are consistent with any adequate or approved motor vehicle emissions budget for all pollutants and precursors in applicable SIPs.		
§93.118 (b)	Document for which years consistency with motor vehicle emissions budgets must be shown.		
§93.118 (d)	Document the use of the appropriate analysis years in the regional emissions analysis for areas with SIP budgets, and the analysis results for these years. Document any interpolation performed to meet tests for years in which specific analysis is not required.		
§93.119 [1]	For areas without applicable SIP budgets: Document that emissions from the transportation network for each applicable pollutant and precursor, including projects in any associated donut area that are in the Statewide TIP and regionally significant non-Federal projects, are consistent with the requirements of the “Action/Baseline”, “Action/1990” and/or “Action/2002” interim emissions tests as applicable.		
§93.119 (g)	Document the use of the appropriate analysis years in the regional emissions analysis for areas without applicable SIP budgets. The regional emissions analysis must be performed for analysis years that are no more than ten years apart. The first analysis year must be no more than five years beyond the year in which the conformity determination is being made. The last year of the timeframe of the conformity determination (as described under §93.106(d)) must also be an analysis year.		
§93.119 (h,i)	Document how the baseline and action scenarios are defined for each analysis year.		
§93.122 (a)(1)	Document that all regionally significant federal and non-Federal projects in the nonattainment/maintenance area are explicitly modeled in the regional emissions analysis. For each project, identify by which analysis it will be open to traffic. Document that VMT for non-regionally significant Federal projects is accounted for in the regional emissions analysis		

40 CFR	Criteria	Page	Comments
§93.122 (a)(2, 3)	Document that only emission reduction credits from TCMs on schedule have been included or that partial credit has been taken for partially implemented TCMs. Document that the regional emissions analysis only includes emissions credit for projects, programs, or activities that require regulatory action if: the regulatory action has been adopted; the project, program, activity or a written commitment is included in the SIP; EPA has approved an opt-in to the program, EPA has promulgated the program, or the Clean Air Act requires the program (indicate applicable date). Discuss the implementation status of these programs and the associated emissions credit for each analysis year.		
§93.122 (a)(4,5,6)	For nonregulatory measures that are not included in the STIP, include written commitments from appropriate agencies. Document that assumptions for measures outside the transportation system (e.g. fuels measures) are the same for baseline and action scenarios. Document that factors such as ambient temperature are consistent with those used in the SIP unless modified through interagency consultation.		
§93.122 (b)(1)(i) [2]	Document that a network-based travel model is in use that is validated against observed counts for a base year no more than 10 years before the date of the conformity determination. Document that the model results have been analyzed for reasonableness and compared to historical trends and explain any significant differences between past trends and forecasts (for per capita vehicle-trips, VMT, trip lengths mode shares, time of day, etc.).		
§93.122 (b)(1)(ii) [2]	Document the land use, population, employment, and other network-based travel model assumptions.		
§93.122 (b)(1)(iii) [2]	Document how land use development scenarios are consistent with future transportation system alternatives, and the reasonable distribution of employment and residences for each alternative.		
§93.122 (b)(1)(iv) [2]	Document use of capacity sensitive assignment methodology and emissions estimates based on a methodology that differentiates between peak and off-peak volumes and speeds, and bases speeds on final assigned volumes.		
§93.122 (b)(1)(v) [2]	Document the use of zone-to-zone travel impedances to distribute trips in reasonable agreement with the travel times estimated from final assigned traffic volumes. Where transit is a significant factor, document that zone-to-zone travel impedances used to distribute trips are used to model mode split.		
§93.122 (b)(1)(vi) [2]	Document how travel models are reasonably sensitive to changes in time, cost, and other factors affecting travel choices.		
§93.122 (b)(2) [2]	Document that reasonable methods were used to estimate traffic speeds and delays in a manner sensitive to the estimated volume of travel on each roadway segment represented in the travel model.		
§93.122 (b)(3) [2]	Document the use of HPMS, or a locally developed count-based program or procedures that have been chosen through the consultation process, to reconcile and calibrate the network-based travel model estimates of VMT.		
§93.122 (d)	In areas not subject to §93.122(b), document the continued use of modeling techniques or the use of appropriate alternative techniques to estimate vehicle miles traveled		
§93.122 (e, f)	Document, in areas where a SIP identifies construction-related PM10 or PM 2.5 as significant pollutants, the inclusion of PM10 and/or PM 2.5 construction emissions in the conformity analysis.		
§93.122 (g)	If appropriate, document that the conformity determination relies on a previous regional emissions analysis and is consistent with that analysis.		

40 CFR	Criteria	**Page**	**Comments**
§93.126, §93.127, §93.128	Document all projects in the TIP/RTP that are exempt from conformity requirements or exempt from the regional emissions analysis. Indicate the reason for the exemption (Table 2, Table 3, traffic signal synchronization) and that the interagency consultation process found these projects to have no potentially adverse emissions impacts.		

[1] Note that some areas are required to complete both interim emissions tests.

[2] 40 CFR 93.122(b) refers only to serious, severe and extreme ozone areas and serious CO areas above 200,000 population

Disclaimers

This checklist is intended solely as an informational guideline to be used in reviewing Transportation Plans and Transportation Improvement Programs for adequacy of their conformity documentation. It is in no way intended to replace or supercede the Transportation Conformity regulations of 40 CFR Parts 51 and 93, the Statewide and Metropolitan Planning Regulations of 23 CFR Part 450 or any other EPA, FHWA or FTA guidance pertaining to transportation conformity or statewide and metropolitan planning. This checklist is not intended for use in documenting transportation conformity for individual transportation projects in nonattainment or maintenance areas. 40 CFR Parts 51 and 93 contain additional criteria for project-level conformity determinations.

Appendix G

SB 375 and SB 575 STATUTORY LANGUAGE

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SB 375 Statutory Language (signed September 30, 2008)
and
SB 575 Statutory Language (signed October 11, 2009)
(these changes are shown in underlined text)

Government Code Section 14522

14522. In cooperation with the regional transportation planning agencies, the commission may prescribe study areas for analysis and evaluation by such agencies and guidelines for the preparation of the regional transportation plans.

Government Code Section 14522.1

CTC Maintains RTP Guidelines

14522.1. (a) (1) The commission, in consultation with the department and the State Air Resources Board, shall maintain guidelines for travel demand models used in the development of regional transportation plans by federally designated metropolitan planning organizations.

(2) Any revision of the guidelines shall include the formation of an advisory committee that shall include representatives of the metropolitan planning organizations, the department, organizations knowledgeable in the creation and use of travel demand models, local governments, and organizations concerned with the impacts of transportation investments on communities and the environment. Before amending the guidelines, the commission shall hold two workshops on the guidelines, one in northern California and one in southern California. The workshops shall be incorporated into regular commission meetings.

(b) The guidelines shall, at a minimum and to the extent practicable, taking into account such factors as the size and available resources of the metropolitan planning organization, account for all of the following:

(1) The relationship between land use density and household vehicle ownership and vehicle miles traveled in a way that is consistent with statistical research.

(2) The impact of enhanced transit service levels on household vehicle ownership and vehicle miles traveled.

(3) Changes in travel and land development likely to result from highway or passenger rail expansion.

(4) Mode splitting that allocates trips between automobile, transit, carpool, and bicycle and pedestrian trips. If a travel demand model is unable to forecast bicycle and pedestrian trips, another means may be used to estimate those trips.

(5) Speed and frequency, days, and hours of operation of transit service.

Government Code Section 14522.2

Travel Demand Models

14522.2. (a) A metropolitan planning organization shall disseminate the methodology, results, and key assumptions of whichever travel demand models it uses in a way that would be useable and understandable to the public.

(b) Transportation planning agencies other than those identified in paragraph (1) of subdivision (a) of Section 14522.1, cities, and counties are encouraged, but not required, to utilize travel demand models that are consistent with the guidelines in the development of their regional transportation plans.

Government Code Section 65080

RTP Development

65080. (a) Each transportation planning agency designated under Section 29532 or 29532.1 shall prepare and adopt a regional transportation plan directed at achieving a coordinated and balanced regional transportation system, including, but not limited to, mass transportation, highway, railroad, maritime, bicycle, pedestrian, goods movement, and aviation facilities and services. The plan shall be action-oriented and pragmatic, considering both the short-term and long-term future, and shall present clear, concise policy guidance to local and state officials. The regional transportation plan shall consider factors specified in Section 134 of Title 23 of the United States Code. Each transportation planning agency shall consider and incorporate, as appropriate, the transportation plans of cities, counties, districts, private organizations, and state and federal agencies.

RTP Contents

(b) The regional transportation plan shall be an internally consistent document and shall include all of the following:

(1) A policy element that describes the transportation issues in the region, identifies and quantifies regional needs, and describes the desired short-range and long-range transportation goals, and pragmatic objective and policy statements. The objective and policy statements shall be consistent with the funding estimates of the financial element. The policy element of transportation planning agencies with populations that exceed 200,000 persons may quantify a set of indicators including, but not limited to, all of the following:

(A) Measures of mobility and traffic congestion, including, but not limited to, daily vehicle hours of delay per capita and vehicle miles traveled per capita.

(B) Measures of road and bridge maintenance and rehabilitation needs, including, but not limited to, roadway pavement and bridge conditions.

(C) Measures of means of travel, including, but not limited to, percentage share of all trips (work and nonwork) made by all of the following:

(i) Single occupant vehicle.

(ii) Multiple occupant vehicle or carpool.

(iii) Public transit including commuter rail and intercity rail.

(iv) Walking.

(v) Bicycling.

(D) Measures of safety and security, including, but not limited to, total injuries and fatalities assigned to each of the modes set forth in subparagraph (C).

(E) Measures of equity and accessibility, including, but not limited to, percentage of the population served by frequent and reliable public transit, with a breakdown by income bracket, and percentage of all jobs accessible by frequent and reliable public transit service, with a breakdown by income bracket.

(F) The requirements of this section may be met utilizing existing sources of information. No additional traffic counts, household surveys, or other sources of data shall be required.

ARB Develops Regional Greenhouse Gas Emission Targets

(2) A sustainable communities strategy prepared by each metropolitan planning organization as follows:

(A) No later than September 30, 2010, the State Air Resources Board shall provide each affected region with greenhouse gas emission reduction targets for the automobile and light truck sector for 2020 and 2035, respectively.

Role of the Regional Targets Advisory Committee

(i) No later than January 31, 2009, the state board shall appoint a Regional Targets Advisory Committee to recommend factors to be considered and methodologies to be used for setting greenhouse gas emission reduction targets for the affected regions. The committee shall be composed of representatives of the metropolitan planning organizations, affected air districts, the League of California Cities, the California State Association of Counties, local transportation agencies, and members of the public, including homebuilders, environmental organizations, planning organizations, environmental justice organizations, affordable housing organizations, and others. The advisory committee shall transmit a report with its recommendations to the state board no later than September 30, 2009. In recommending factors to be considered and methodologies to be used, the advisory committee may consider any relevant issues, including, but not limited to, data needs, modeling techniques, growth forecasts, the impacts of regional jobs-housing balance on interregional travel and greenhouse gas emissions, economic and demographic trends, the magnitude of greenhouse gas reduction benefits from a variety of land use and transportation strategies, and appropriate methods to describe regional targets and to monitor performance in attaining those targets. The state board shall consider the report prior to setting the targets.

(ii) Prior to setting the targets for a region, the state board shall exchange technical information with the metropolitan planning organization and the affected air district. The metropolitan planning organization may recommend a target for the region. The metropolitan planning organization shall hold at least one public workshop within the region after receipt of the report from the advisory committee. The state board shall release draft targets for each region no later than June 30, 2010.

(iii) In establishing these targets, the state board shall take into account greenhouse gas emission reductions that will be achieved by improved vehicle emission standards, changes in fuel composition, and other measures it has approved that will reduce greenhouse gas emissions in the affected regions, and prospective measures the state board plans to adopt to reduce greenhouse gas emissions from other greenhouse gas emission sources as that term is defined in subdivision (i) of Section 38505 of the Health and Safety Code and consistent with the regulations promulgated pursuant to the California Global Warming Solutions Act of 2006 (Division 12.5(commencing with Section 38500) of the Health and Safety Code).

(iv) The state board shall update the regional greenhouse gas emission reduction targets every eight years consistent with each metropolitan planning organization's timeframe for updating its regional transportation plan under federal law until 2050. The state board may revise the targets every four years based on changes in the factors considered under clause (iii) above. The state board shall exchange technical information with the Department of Transportation, metropolitan planning organizations, local governments, and affected air districts and engage in a consultative process with public and private stakeholders prior to updating these targets.

(v) The greenhouse gas emission reduction targets may be expressed in gross tons, tons per capita, tons per household, or in any other metric deemed appropriate by the state board.

Preparation of the SCS

(B) Each metropolitan planning organization shall prepare a sustainable communities strategy, subject to the requirements of Part 450 of Title 23 of, and Part 93 of Title 40 of, the Code of Federal Regulations, including the requirement to utilize the most recent planning assumptions considering local general plans and other factors. The sustainable communities strategy shall (i) identify the general location of uses, residential densities, and building intensities within the region; (ii) identify areas within the region sufficient to house all the population of the region, including all economic segments of the population, over the course of the planning period of the regional transportation plan taking into account net migration into the region, population growth, household formation and employment growth; (iii) identify areas within the region sufficient to house an eight-year projection of the regional housing need for the region pursuant to Section 65584; (iv) identify a transportation network to service the transportation needs of the region; (v) gather and consider the best practically available scientific information regarding resource areas and farmland in the region as defined in subdivisions (a) and (b) of Section 65080.01; (vi) consider the state housing goals specified in Sections 65580 and 65581; (vii) set forth a forecasted development pattern for the region, which, when integrated with the transportation network, and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emission reduction targets approved by the state board; and (viii) allow the regional transportation plan to comply with Section 176 of the federal Clean Air Act (42 U.S.C. Sec. 7506).

Role of ABAG in the San Francisco Bay Area

(C)(i)Within the jurisdiction of the Metropolitan Transportation Commission, as defined by Section 66502, the Association of Bay Area Governments shall be responsible for clauses (i), (ii), (iii), (v), and (vi), the Metropolitan Transportation Commission shall be responsible for clauses (iv) and (viii); and the Association of Bay Area Governments and the Metropolitan Transportation Commission shall jointly be responsible for clause (vii) of subparagraph (B).

Use of Regional Plan for the Lake Tahoe Region

(ii) Within the jurisdiction of the Tahoe Regional Planning Agency, as defined in Sections 66800 and 66801, the Tahoe Metropolitan Planning Organization shall use the Regional Plan for the Lake Tahoe Region as the sustainable community strategy, provided it complies with clauses (vii) and (viii) of subparagraph (B).

Role of Subregions in the Development of an SCS

(D) In the region served by the multicounty transportation planning agency described in Section 130004 of the Public Utilities Code, a subregional council of governments and the county transportation commission may work together to propose the sustainable communities strategy and an alternative planning strategy, if one is prepared pursuant to subparagraph (I), for that subregional area. The metropolitan planning organization may adopt a framework for a subregional sustainable communities strategy or a subregional alternative planning strategy to address the intraregional land use, transportation, economic, air quality, and climate policy relationships. The metropolitan planning organization shall include the subregional sustainable communities strategy for that subregion in the regional sustainable communities strategy to the extent consistent with this section and federal law and approve the subregional alternative planning strategy, if one is prepared pursuant to subparagraph (I), for that subregional area to the extent consistent with this section. The metropolitan planning organization shall develop overall guidelines, create public participation plans pursuant to subparagraph (F), ensure coordination, resolve conflicts, make sure that the overall plan complies with applicable legal requirements, and adopt the plan for the region.

MPO Consults with Local Elected Officials

(E) The metropolitan planning organization shall conduct at least two informational meetings in each county within the region for members of the board of supervisors and city councils on the sustainable communities strategy and alternative planning strategy, if any. The metropolitan planning organization may conduct only one informational meeting if it is attended by representatives of the county board of supervisors and city council members representing a majority of the cities representing a majority of the population in the incorporated areas of that county. Notice of the meeting or meetings shall be sent to the clerk of the board of supervisors and to each city clerk. The purpose of the meeting or meetings shall be to discuss the sustainable communities strategy and the alternative planning strategy, if any, including the key land use and planning assumptions to the members of the board of supervisors and the city council members in that county and to solicit and consider their input and recommendations.

SCS Public Participation Plan and Public Input

(F) Each metropolitan planning organization shall adopt a public participation plan, for development of the sustainable communities strategy and an alternative planning strategy, if any, that includes all of the following:

(i) Outreach efforts to encourage the active participation of a broad range of stakeholder groups in the planning process, consistent with the agency's adopted Federal Public Participation Plan, including, but not limited to, affordable housing advocates, transportation advocates, neighborhood and community groups, environmental advocates, home builder representatives, broad-based business organizations, landowners, commercial property interests, and homeowner associations.

(ii) Consultation with congestion management agencies, transportation agencies, and transportation commissions.

(iii) Workshops throughout the region to provide the public with the information and tools necessary to provide a clear understanding of the issues and policy choices. At least one workshop shall be held in each county in the region. For counties with a population greater than 500,000, at least three workshops shall be held. Each workshop, to the extent practicable, shall include urban simulation computer modeling to create visual representations of the sustainable communities strategy and the alternative planning strategy.

(iv) Preparation and circulation of a draft sustainable communities strategy and an alternative planning strategy, if one is prepared, not less than 55 days before adoption of a final regional transportation plan.

(v) At least three public hearings on the draft sustainable communities strategy in the regional transportation plan and alternative planning strategy, if one is prepared. If the metropolitan transportation organization consists of a single county, at least two public hearings shall be held. To the maximum extent feasible, the hearings shall be in different parts of the region to maximize the opportunity for participation by members of the public throughout the region.

(vi) A process for enabling members of the public to provide a single request to receive notices, information, and updates.

SCS – Spheres of Influence

(G) In preparing a sustainable communities strategy, the metropolitan planning organization shall consider spheres of influence that have been adopted by the local agency formation commissions within its region.

Comparing SCS Reductions to ARB Targets

(H) Prior to adopting a sustainable communities strategy, the metropolitan planning organization shall quantify the reduction in greenhouse gas emissions projected to be achieved by the sustainable communities strategy and set forth the difference, if any, between the amount of that reduction and the target for the region established by the state board.

APS Development

(I) If the sustainable communities strategy, prepared in compliance with subparagraph (B) or (D), is unable to reduce greenhouse gas emissions to achieve the greenhouse gas emission reduction targets established by the state board, the metropolitan planning organization shall prepare an alternative planning strategy to the sustainable communities strategy showing how those greenhouse gas emission targets would be achieved through alternative development patterns, infrastructure, or additional transportation measures or policies. The alternative planning strategy shall be a separate document from the regional transportation plan, but it may be adopted concurrently with the regional transportation

plan. In preparing the alternative planning strategy, the metropolitan planning organization:
(i) Shall identify the principal impediments to achieving the targets within the sustainable communities strategy.
(ii) May include an alternative development pattern for the region pursuant to subparagraphs (B) to (G), inclusive.
(iii) Shall describe how the greenhouse gas emission reduction targets would be achieved by the alternative planning strategy, and why the development pattern, measures, and policies in the alternative planning strategy are the most practicable choices for achievement of the greenhouse gas emission reduction targets.
(iv) An alternative development pattern set forth in the alternative planning strategy shall comply with Part 450 of Title 23 of, and Part 93 of Title 40 of, the Code of Federal Regulations, except to the extent that compliance will prevent achievement of the greenhouse gas emission reduction targets approved by the state board.
(v) For purposes of the California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public Resources Code), an alternative planning strategy shall not constitute a land use plan, policy, or regulation, and the inconsistency of a project with an alternative planning strategy shall not be a consideration in determining whether a project may have an environmental effect.

MPOs Technical Methodology for Estimating Its Regional GHG Emissions
(J) (i) Prior to starting the public participation process adopted pursuant to subparagraph (F) of paragraph (2) of subdivision (b) of Section 65080, the metropolitan planning organization shall submit a description to the state board of the technical methodology it intends to use to estimate the greenhouse gas emissions from its sustainable communities strategy and, if appropriate, its alternative planning strategy. The state board shall respond to the metropolitan planning organization in a timely manner with written comments about the technical methodology, including specifically describing any aspects of that methodology it concludes will not yield accurate estimates of greenhouse gas emissions, and suggested remedies. The metropolitan planning organization is encouraged to work with the state board until the state board concludes that the technical methodology operates accurately.

ARB Review of the SCS or APS
(ii) After adoption, a metropolitan planning organization shall submit a sustainable communities strategy or an alternative planning strategy, if one has been adopted, to the state board for review, including the quantification of the greenhouse gas emission reductions the strategy would achieve and a description of the technical methodology used to obtain that result. Review by the state board shall be limited to acceptance or rejection of the metropolitan planning organization's determination that the strategy submitted would, if implemented, achieve the greenhouse gas emission reduction targets established by the state board. The state board shall complete its review within 60 days.
(iii) If the state board determines that the strategy submitted would not, if implemented, achieve the greenhouse gas emission reduction targets, the metropolitan planning organization shall revise its strategy or adopt an alternative planning strategy, if not previously adopted, and submit the strategy for review pursuant to clause (ii). At a

minimum, the metropolitan planning organization must obtain state board acceptance that an alternative planning strategy would, if implemented, achieve the greenhouse gas emission reduction targets established for that region by the state board.

Local Land Use Authority

(K) Neither a sustainable communities strategy nor an alternative planning strategy regulates the use of land, nor, except as provided by subparagraph (I), shall either one be subject to any state approval. Nothing in a sustainable communities strategy shall be interpreted as superseding the exercise of the land use authority of cities and counties within the region. Nothing in this section shall be interpreted to limit the state board's authority under any other provision of law. Nothing in this section shall be interpreted to authorize the abrogation of any vested right whether created by statute or by common law. Nothing in this section shall require a city's or county's land use policies and regulations, including its general plan, to be consistent with the regional transportation plan or an alternative planning strategy. Nothing in this section requires a metropolitan planning organization to approve a sustainable communities strategy that would be inconsistent with Part 450 of Title 23 of, or Part 93 of Title 40 of, the Code of Federal Regulations and any administrative guidance under those regulations. Nothing in this section relieves a public or private entity or any person from compliance with any other local, state, or federal law.

Exemption of Transportation Projects - Programming

(L) Nothing in this section requires projects programmed for funding on or before December 31, 2011, to be subject to the provisions of this paragraph if they (i) are contained in the 2007 or 2009 Federal Statewide Transportation Improvement Program, (ii) are funded pursuant to Chapter 12.49 (commencing with Section 8879.20) of Division 1 of Title 2, or (iii) were specifically listed in a ballot measure prior to December 31, 2008, approving a sales tax increase for transportation projects. Nothing in this section shall require a transportation sales tax authority to change the funding allocations approved by the voters for categories of transportation projects in a sales tax measure adopted prior to December 31, 2010. For purposes of this subparagraph, a transportation sales tax authority is a district, as defined in Section 7252 of the Revenue and Taxation Code, that is authorized to impose a sales tax for transportation purposes.

Adoption of RTPs

(M) A metropolitan planning organization, or a regional transportation planning agency not within a metropolitan planning organization, that is required to adopt a regional transportation plan not less than every five years, may elect to adopt the plan not less than every four years. This election shall be made by the board of directors of the metropolitan planning organization or regional transportation planning agency no later than June 1, 2009, or thereafter 54 months prior to the statutory deadline for the adoption of housing elements for the local jurisdictions within the region, after a public hearing at which comments are accepted from members of the public and representatives of cities and counties within the region covered by the metropolitan planning organization or regional transportation planning agency. Notice of the public hearing shall be given to the general public and by mail to cities and counties within the region no later than 30 days prior to the date of the public hearing. Notice of election shall be promptly given to the Department of Housing and Community Development. The metropolitan planning organization or the regional transportation planning agency shall complete its next regional transportation plan within three years of the notice of election.

San Joaquin Valley – SCS/APS

(N) Two or more of the metropolitan planning organizations for Fresno County, Kern County, Kings County, Madera County, Merced County, San Joaquin County, Stanislaus County, and Tulare County may work together to develop and adopt multiregional goals and policies that may address interregional land use, transportation, economic, air quality, and climate relationships. The participating metropolitan planning organizations may also develop a multiregional sustainable communities strategy, to the extent consistent with federal law, or an alternative planning strategy for adoption by the metropolitan planning organizations. Each participating metropolitan planning organization shall consider any adopted multiregional goals and policies in the development of a sustainable communities strategy and, if applicable, an alternative planning strategy for its region.

RTPs Action Element

(3) An action element that describes the programs and actions necessary to implement the plan and assigns implementation responsibilities. The action element may describe all transportation projects proposed for development during the 20-year or greater life of the plan. The action element shall consider congestion management programming activities carried out within the region.

RTPs Financial Element

(4) (A) A financial element that summarizes the cost of plan implementation constrained by a realistic projection of available revenues. The financial element shall also contain recommendations for allocation of funds. A county transportation commission created pursuant to Section 130000 of the Public Utilities Code shall be responsible for recommending projects to be funded with regional improvement funds, if the project is consistent with the regional transportation plan. The first five years of the financial element shall be based on the five-year estimate of funds developed pursuant to Section 14524. The financial element may recommend the development of specified new sources of revenue, consistent with the policy element and action element.

(B) The financial element of transportation planning agencies with populations that exceed 200,000 persons may include a project cost breakdown for all projects proposed for development during the 20-year life of the plan that includes total expenditures and related percentages of total expenditures for all of the following:

(i) State highway expansion.
(ii) State highway rehabilitation, maintenance, and operations.
(iii) Local road and street expansion.
(iv) Local road and street rehabilitation, maintenance, and operation.
(v) Mass transit, commuter rail, and intercity rail expansion.
(vi) Mass transit, commuter rail, and intercity rail rehabilitation, maintenance, and operations.
(vii) Pedestrian and bicycle facilities.

(viii) Environmental enhancements and mitigation.
(ix) Research and planning.
(x) Other categories.

Incentives to Cities and Counties to Comply for SB 375

(C) The metropolitan planning organization or county transportation agency, whichever entity is appropriate, shall consider financial incentives for cities and counties that have resource areas or farmland, as defined in Section 65080.01, for the purposes of, for example, transportation investments for the preservation and safety of the city street or county road system and farm to market and interconnectivity transportation needs. The metropolitan planning organization or county transportation agency, whichever entity is appropriate, shall also consider financial assistance for counties to address countywide service responsibilities in counties that contribute towards the greenhouse gas emission reduction targets by implementing policies for growth to occur within their cities.

Other Factors of Local Significance

(c) Each transportation planning agency may also include other factors of local significance as an element of the regional transportation plan, including, but not limited to, issues of mobility for specific sectors of the community, including, but not limited to, senior citizens.

RTP Adoption Dates and RTP Guidelines

(d) Except as otherwise provided in this subdivision, each transportation planning agency shall adopt and submit, every four years, an updated regional transportation plan to the California Transportation Commission and the Department of Transportation. A transportation planning agency located in a federally designated air quality attainment area or that does not contain an urbanized area may at its option adopt and submit a regional transportation plan every five years. When applicable, the plan shall be consistent with federal planning and programming requirements and shall conform to the regional transportation plan guidelines adopted by the California Transportation Commission. Prior to adoption of the regional transportation plan, a public hearing shall be held after the giving of notice of the hearing by publication in the affected county or counties pursuant to Section 6061.

Definitions

65080.01. The following definitions apply to terms used in Section 65080:

(a) "Resource areas" include (1) all publicly owned parks and open space; (2) open space or habitat areas protected by natural community conservation plans, habitat conservation plans, and other adopted natural resource protection plans; (3) habitat for species identified as candidate, fully protected, sensitive, or species of special status by local, state, or federal agencies or protected by the federal Endangered Species Act of 1973, the California Endangered Species Act, or the Native Plan Protection Act; (4) lands subject to conservation or agricultural easements for conservation or agricultural purposes by local governments, special districts, or nonprofit 501(c)(3) organizations, areas of the state designated by the State Mining and Geology Board as areas of statewide or regional significance pursuant to Section 2790 of the Public Resources Code, and lands under Williamson Act contracts; (5) areas designated for open-space or agricultural uses in adopted open-space elements or agricultural elements of the local general plan or by local ordinance; (6) areas containing biological resources as described in Appendix G of the CEQA Guidelines that may be significantly affected by the sustainable communities strategy or the alternative planning strategy; and (7) an area subject to flooding where a development project would not, at the time of development in the judgment of the agency, meet the requirements of the National Flood Insurance Program or where the area is subject to more protective provisions of state law or local ordinance.

(b) "Farmland" means farmland that is outside all existing city spheres of influence or city limits as of January 1, 2008, and is one of the following:

(1) Classified as prime or unique farmland or farmland of statewide importance.

(2) Farmland classified by a local agency in its general plan that meets or exceeds the standards for prime or unique farmland or farmland of statewide importance.

(c) "Feasible" means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors.

(d) "Consistent" shall have the same meaning as that term is used in Section 134 of Title 23 of the United States Code.

(e) "Internally consistent" means that the contents of the elements of the regional transportation plan must be consistent with each other.

Redesignation of RTPAs

65080.1. Once preparation of a regional transportation plan has been commenced by or on behalf of a designated transportation planning agency, the Secretary of the Business, Transportation and Housing Agency shall not designate a new transportation planning agency pursuant to Section 29532 for all or any part of the geographic area served by the originally designated agency unless he or she first determines that redesignation will not result in the loss to California of any substantial amounts of federal funds.

RTPs - California Coastal Trail

65080.1. Each transportation planning agency designated under Section 29532 or 29532.1 whose jurisdiction includes a portion of the California Coastal Trail, or property designated for the trail, that is located within the coastal zone, as defined in Section 30103 of the Public Resources Code, shall coordinate with the State Coastal Conservancy, the California Coastal Commission, and the Department of Transportation regarding development of the California Coastal Trail, and each transportation planning agency shall include provisions for the California Coastal Trail in its regional plan, under Section 65080.

RTPs – Alternative Planning Scenario

65080.3. (a) Each transportation planning agency with a population that exceeds 200,000 persons may prepare at least one "alternative planning scenario" for presentation to local officials, agency board members, and the public during the development of the triennial regional transportation plan and the hearing required under subdivision (c) of Section 65080.

(b) The alternative planning scenario shall accommodate the same amount of population growth as projected in the plan but shall be based on an alternative that attempts to reduce the growth in traffic congestion, make more efficient use of existing transportation infrastructure, and reduce the need for costly future public infrastructure.

(c) The alternative planning scenario shall be developed in collaboration with a broad range of public and private stakeholders, including local elected officials, city and county employees, relevant interest groups, and the general public. In developing the scenario, the agency shall consider all of the following:

(1) Increasing housing and commercial development around transit facilities and in close proximity to jobs and commercial activity centers.

(2) Encouraging public transit usage, ridesharing, walking, bicycling, and transportation demand management practices.

(3) Promoting a more efficient mix of current and future job sites, commercial activity centers, and housing opportunities.

(4) Promoting use of urban vacant land and "brownfield" redevelopment.

(5) An economic incentive program that may include measures such as transit vouchers and variable pricing for transportation.

(d) The planning scenario shall be included in a report evaluating all of the following:

(1) The amounts and locations of traffic congestion.

(2) Vehicle miles traveled and the resulting reduction in vehicle emissions.

(3) Estimated percentage share of trips made by each means of travel specified in subparagraph (C) of paragraph (1) of subdivision (b) of Section 65080.

(4) The costs of transportation improvements required to accommodate the population growth in accordance with the alternative scenario.

(5) The economic, social, environmental, regulatory, and institutional barriers to the scenario being achieved.

(e) If the adopted regional transportation plan already achieves one or more of the objectives set forth in subdivision (c), those objectives need not be discussed or evaluated in the alternative planning scenario.

(f) The alternative planning scenario and accompanying report shall not be adopted as part of the regional transportation plan, but it shall be distributed to cities and counties within the region and to other interested parties, and may be a basis for revisions to the transportation projects that will be included in the regional transportation plan.

(g) Nothing in this section grants transportation planning agencies any direct or indirect authority over local land use decisions.

(h) This section does not apply to a transportation plan adopted on or before September 1, 2001, proposed by a transportation planning agency with a population of less than 1,000,000 persons.

Caltrans May Prepare an RTP

65080.5. (a) For each area for which a transportation planning agency is designated under subdivision (c) of Section 29532, or adopts a resolution pursuant to subdivision (c) of Section 65080, the Department of Transportation, in cooperation with the transportation planning agency, and subject to subdivision (e), shall prepare the regional transportation plan, and the updating thereto, for that area and submit it to the governing body or designated policy committee of the transportation planning agency for adoption. Prior to adoption, a public hearing shall be held, after the giving of notice of the hearing by publication in the affected county or counties pursuant to Section 6061. Prior to the adoption of the regional transportation improvement program by the transportation planning agency if it prepared the program, the transportation planning agency shall consider the relationship between the program and the adopted plan. The adopted plan and program, and the updating thereto, shall be submitted to the California Transportation Commission and the department pursuant to subdivision (b) of Section 65080.

(b) In the case of a transportation planning agency designated under subdivision (c) of Section 29532, the transportation planning agency may prepare the regional transportation plan for the area under its jurisdiction pursuant to this chapter, if the transportation planning agency, prior to July 1, 1978, adopts by resolution a declaration of intention to do so.

(c) In those areas that have a county transportation commission created pursuant to Section 130050 of the Public Utilities Code, the multicounty designated transportation planning agency, as defined in Section 130004 of that code, shall prepare the regional transportation plan and the regional transportation improvement program in consultation with the county transportation commissions.

(d) Any transportation planning agency which did not elect to prepare the initial regional transportation plan for the area under its jurisdiction, may prepare the updated plan if it adopts a resolution of intention to do so at least one year prior to the date when the updated plan is to be submitted to the California Transportation Commission.

(e) If the department prepares or updates a regional transportation improvement program or regional transportation plan, or both, pursuant to this section, the state-local share of funding the preparation or updating of the plan and program shall be calculated on the same basis as though the preparation or updating were to be performed by the transportation planning agency and funded under Sections 99311, 99313, and 99314 of the Public Utilities Code.

Government Code Section 65081

RTPs – Air Carrier Airports

65081.1. (a) After consultation with other regional and local transportation agencies, each transportation planning agency whose planning area includes a primary air carrier airport shall, in conjunction with its preparation of an updated regional transportation plan, include an airport ground access improvement program.

(b) The program shall address the development and extension of mass transit systems, including passenger rail service, major arterial and highway widening and extension projects, and any other ground access improvement projects the planning agency deems appropriate.

(c) Highest consideration shall be given to mass transit for airport access improvement projects in the program.

(d) If federal funds are not available to a transportation planning agency for the costs of preparing or updating an airport ground access improvement program, the agency may charge the operators of primary air carrier airports within its planning area for the direct costs of preparing and updating the program. An airport operator against whom charges are imposed pursuant to this subdivision shall pay the amount of those charges to the transportation planning agency.

MTCs Special Corridors

65081.3. (a) As a part of its adoption of the regional transportation plan, the designated county transportation commission, regional transportation planning agency, or the Metropolitan Transportation Commission may designate special corridors, which may include, but are not limited to, adopted state highway routes, which, in consultation with the Department of Transportation, cities, counties, and transit operators directly impacted by the corridor, are determined to be of statewide or regional priority for long-term right-of-way preservation.

(b) Prior to designating a corridor for priority acquisition, the regional transportation planning agency shall do all of the following:

(1) Establish geographic boundaries for the proposed corridor.

(2) Complete a traffic survey, including a preliminary recommendation for transportation modal split, which generally describes the traffic and air quality impacts of the proposed corridor.

(3) Consider the widest feasible range of possible transportation facilities that could be located in the corridor and the major environmental impacts they may cause to assist in making the corridor more environmentally sensitive and, in the long term, a more viable site for needed transportation improvements.

(c) A designated corridor of statewide or regional priority shall be specifically considered in the certified environmental impact report completed for the adopted regional transportation plan required by the California Environmental Quality Act, which shall include a review of the environmental impacts of the possible transportation facilities which may be located in the corridor. The environmental impact report shall include a survey within the corridor boundaries to determine if there exist any of the following:

(1) Rare or endangered plant or animal species.

(2) Historical or cultural sites of major significance.

(3) Wetlands, vernal pools, or other naturally occurring features.

RTPAs/MPOs Designation of Corridors for Priority Acquisition

(d) The regional transportation planning agency shall designate a corridor for priority acquisition only if, after a public hearing, it finds that the range of potential transportation facilities to be located in the corridor can be constructed in a manner which will avoid or mitigate significant environmental impacts or values identified in subdivision (c), consistent with the California Environmental Quality Act and the state and federal Endangered Species Acts.

(e) Notwithstanding any other provision of this section, a corridor of statewide or regional priority may be designated as part of the regional transportation plan only if it has previously been specifically defined in the plan required pursuant to Section 134 and is consistent with the plan required pursuant to Section 135 of Title 23 of the United States Code.

Government Code Section 65588

RTP Updates and Housing Element Revisions

65588. (a) Each local government shall review its housing element as frequently as appropriate to evaluate all of the following:

(1) The appropriateness of the housing goals, objectives, and policies in contributing to the attainment of the state housing goal.

(2) The effectiveness of the housing element in attainment of the community's housing goals and objectives.

(3) The progress of the city, county, or city and county in implementation of the housing element.

(b) The housing element shall be revised as appropriate, but no less often than required by subdivision (e), to reflect the results of this periodic review. Nothing in this section shall be construed to excuse the obligations of the local government to adopt a revised housing element in accordance with the schedule specified in this section.

(c) The review and revision of housing elements required by this section shall take into account any low- or moderate-income housing provided or required pursuant to Section 65590.

(d) The review pursuant to subdivision (c) shall include, but need not be limited to, the following:

(1) The number of new housing units approved for construction within the coastal zone after January 1, 1982.

(2) The number of housing units for persons and families of low or moderate income, as defined in Section 50093 of the Health and Safety Code, required to be provided in new housing developments either within the coastal zone or within three miles of the coastal zone pursuant to Section 65590.

(3) The number of existing residential dwelling units occupied by persons and families of low or moderate income, as defined in Section 50093 of the Health and Safety Code, that have been authorized to be demolished or converted since January 1, 1982, in the coastal zone.

(4) The number of residential dwelling units for persons and families of low or moderate income, as defined in Section 50093 of the Health and Safety Code, that have been required for replacement or authorized to be converted or demolished as identified in paragraph (3). The location of the replacement units, either onsite, elsewhere within the locality's jurisdiction within the coastal zone, or within three miles of the coastal zone within the locality's jurisdiction, shall be designated in the review.

(e) Each city, county, and city and county shall revise its housing element according to the following schedule:

(1) (A) Local governments within the regional jurisdiction of the Southern California Association of Governments: June 30, 2006, for the fourth revision.

(B) Local governments within the regional jurisdiction of the Association of Bay Area Governments: June 30, 2007, for the fourth revision.

(C) Local governments within the regional jurisdiction of the Council of Fresno County Governments, the Kern County Council of Governments, and the Sacramento Area Council of Governments: June 30, 2002, for the third revision, and June 30, 2008, for the fourth revision.

(D) Local governments within the regional jurisdiction of the Association of Monterey Bay Area Governments: December 31, 2002, for the third revision, and June 30, 2009, for the fourth revision.

(E) Local governments within the regional jurisdiction of the San Diego Association of Governments: June 30, 2005, for the fourth revision.

(F) All other local governments: December 31, 2003, for the third revision, and June 30, 2009, for the fourth revision.

(2) (A) All local governments within a metropolitan planning organization in a region classified as nonattainment for one or more pollutants regulated by the federal Clean Air Act (42 U.S.C. Sec. 7506), except those within the regional jurisdiction of the San Diego Association of Governments, shall adopt the fifth revision of the housing element no later than 18 months after adoption of the first regional transportation plan to be adopted after September 30, 2010.

(B) (i) All local governments within the regional jurisdiction of the San Diego Association of Governments shall adopt the fifth revision of the housing element no later than 18 months after adoption of the first regional transportation plan update to be adopted after September 30, 2010.

(ii) Prior to or concurrent with the adoption of the fifth revision of the housing element, each local government within the regional jurisdiction of the San Diego Association of Governments shall identify adequate sites in its inventory pursuant to Section 65583.2 or rezone adequate sites to accommodate a prorated portion of its share of the regional housing need for the projection period representing the period from July 1, 2010, to the deadline for housing element adoption described in clause (i).

(I) For the fifth revision, a local government within the jurisdiction of the San Diego Association of Governments that has not adopted a housing element for the fourth revision by January 1, 2009, shall revise its housing element not less than every four years, beginning on the date described in clause (i), in accordance with paragraph (4), unless the local government does both of the following:

(ia) Adopts a housing element for the fourth revision no later than March 31, 2010, which is in substantial compliance with this article.

(ib) Completes any rezoning contained in the housing element program for the fourth revision by June 30, 2010.

(II) For the sixth and subsequent revisions, a local government within the jurisdiction of the San Diego Association of Governments shall be subject to the dates described in clause (i), in accordance with paragraph (4).

(C) All local governments within the regional jurisdiction of a metropolitan planning organization or a regional transportation planning agency that has made an election pursuant to subparagraph (L) of paragraph (2) of subdivision (b) of Section 65080 by June 1, 2009, shall adopt the fifth revision of the housing element no later than 18 months after adoption of the first regional transportation plan update following the election.

(D) All other local governments shall adopt the fifth revision of the housing element five years after the date specified in paragraph (1).

(3) Subsequent revisions of the housing element shall be due as follows:

(A) For local governments described in subparagraphs (A), (B), and (C) of paragraph (2), 18 months after adoption of every second regional transportation plan update, provided that the deadline for adoption is no more than eight years later than the deadline for adoption of the previous eight-year housing element.

(B) For all other local governments, at five-year intervals after the date specified in subparagraph (D) of paragraph (2).

(C) If a metropolitan planning organization or a regional transportation planning agency subject to the five-year revision interval in subparagraph (B) makes an election pursuant to subparagraph (L) of paragraph (2) of subdivision (b) of Section 65080 after June 1, 2009, all local governments within the regional jurisdiction of that entity shall adopt the next housing element revision no later than 18 months after adoption of the first regional transportation plan update following the election. Subsequent revisions shall be due 18 months after adoption of every second regional transportation plan update, provided that the deadline for adoption is no more than eight years later than the deadline for adoption of the previous eight-year housing element.

(4) (A) A local government that does not adopt a housing element within 120 days of the applicable deadline described in subparagraph (A), (B), or (C) of paragraph (2) or subparagraph (A) or (C) of paragraph (3) shall revise its housing element not less than every four years until the local government has adopted at least two consecutive revisions by the statutory deadline.

(B) If necessary, the local government shall adopt three consecutive four-year revisions by the statutory deadline to ensure that when the local government adopts its next housing element covering an eight-year planning period, it does so at the deadline for adoption for other local governments within the region also covering an eight-year planning period.

(C) The deadline for adoption of every second four-year revision shall be the same as the deadline for adoption for other local governments within the region.

(5) The metropolitan planning organization or a regional transportation planning agency for a region that has an eight-year revision interval pursuant to paragraph (3) shall notify the department and the Department of Transportation in writing of the estimated adoption date for its next regional transportation plan update at least 12 months prior to the estimated adoption date. The Department of Transportation shall maintain and publish on its Internet Web site a current schedule of the estimated regional transportation plan adoption dates. The department shall maintain and publish on its Internet Web site a current schedule of the estimated and actual housing element due dates. Each council of governments shall publish on its Internet Web site the estimated and actual housing element due dates, as published by the department, for the jurisdictions within its region and shall send notice of these dates to interested parties. For purposes of determining the existing and projected need for housing within a region pursuant to Sections 65584 to 65584.08, inclusive, the date of the next scheduled revision of the housing element shall be deemed to be the estimated adoption date of the regional transportation plan update described in the notice provided to the Department of Transportation plus 18 months.

(6) The new projection period shall begin on the date of December 31 or June 30 that most closely precedes the end of the previous projection period.

Definitions

(f) For purposes of this article, the following terms have the following meanings:

(1) "Planning period" shall be the time period between the due date for one housing element and the due date for the next housing element.

(2) "Projection period" shall be the time period for which the regional housing need is calculated.

(g) For purposes of this section, "regional transportation plan update" shall mean a regional transportation plan adopted to satisfy the requirements of subdivision (d) of Section 65080.

Sustainable Communities and Climate Protection Act

Chapter 728 of the Statutes of 2008 shall be known and may be cited as the Sustainable Communities and Climate Protection Act.

Appendix H

ALTERNATIVE PLANNING STRATEGY (APS)

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Appendix H

Alternative Planning Strategy

Background

California Government Code Section 65080(H) states MPOs shall prepare an APS if the MPO determines the region will not be able to achieve ARB's regional GHG emission reduction targets through the sustainable communities strategy (SCS). It should be noted that an SCS must be prepared as part of the RTP - regardless if the MPO can achieve the regional GHG emission reduction target or not. The APS however is not a part of an RTP.

APS Statutory Language

Below is the specific statutory language from California Government Code Section 65080(H) relating to the preparation of an APS:

> Calif. Government Code Section 65080(H)
> (H) If the sustainable communities strategy, prepared in compliance with subparagraph (B) or (C), is unable to reduce greenhouse gas emissions to achieve the greenhouse gas emission reduction targets established by the state board, the metropolitan planning organization shall prepare an alternative planning strategy to the sustainable communities strategy showing how those greenhouse gas emission targets would be achieved through alternative development patterns, infrastructure, or additional transportation measures or policies. The alternative planning strategy shall be a separate document from the regional transportation plan, but it may be adopted concurrently with the regional transportation plan. In preparing the alternative planning strategy, the metropolitan planning organization:
>
> (i) Shall identify the principal impediments to achieving the targets within the sustainable communities strategy.
> (ii) May include an alternative development pattern for the region pursuant to subparagraphs (B) to (F), inclusive.
> (iii) Shall describe how the greenhouse gas emission reduction targets would be achieved by the alternative planning strategy, and why the development pattern, measures, and policies in the alternative planning strategy are the most practicable choices for achievement of the greenhouse gas emission reduction targets.
> (iv) An alternative development pattern set forth in the alternative planning strategy shall comply with Part 450 of Title 23 of, and Part 93 of Title 40 of, the Code of Federal Regulations, except to the extent that compliance will prevent achievement of the greenhouse gas emission reduction targets approved by the state board.
> (v) For purposes of the California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public Resources Code), an alternative planning strategy shall not constitute a land use plan, policy, or regulation, and the inconsistency of a project with an alternative planning strategy shall not be a consideration in determining whether a project may have an environmental effect.

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Appendix I

RHNA AND RTP DEVELOPMENT INFORMATION

The following table was prepared by the California Department of Housing and Community Development (HCD). Questions regarding the RHNA process should be directed to HCD using the contact information located at:

http://hcd.ca.gov/contact.html

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RHNA/Housing Element & RTP Statutory Process Timelines

Regional Housing Need Allocation (RHNA) *Government Code (GC) Sections 65584-65589*	**Regional Transportation Plan (RTP)** **(Sustainable Communities Strategy -SCS)**
A. REGIONAL CONSULTATION & DETERMINATION *1.* COG/MPO provides HCD written notice of estimated RTP adoption date: at least 12 months prior to estimated adoption date. GC 65588(e)(5). *NOTE: RTP adoption later than estimated date can cause (1) misalignment between RHNA projection period (based on "estimated" adoption date) & HE planning period & due date (18 months from "actual" adoption date) & (2) shortage of required housing unit allocation over period past "estimated" adoption date. GC 65588(e)(2)* 2. HCD & COG/MPO begin RHNA consultation: at least 26 months before due date of local government Housing Element (HE). GC 65584.01(c)(1). *(COG Subregion optional formation and notification: at least 28 months before HE due date. GC 65584.03.)* 3. HCD issues final RHNA**:** at least 24 months before HE due date. GC 65584(b). **B. COG/MPO RHNA DISTRIBUTION METHODOLOGY & PLAN** 4. COG/MPO begins developing distribution methodology: at least 24 months before HE due date *(allowing 60-day public comment period & public hearing)*. GC 65584.04(a). 5. COG/MPO adopts final distribution methodology for all income category RHNA consistent with development pattern of Regional Transportation Plan Sustainable Communities Strategy. GC 65584.04(h). **C. COG/MPO ISSUES DRAFT RHNA DISTRIBUTIONS** 6. COG/MPO distributes Draft RHNAs: at least 18 months before HE due date. GC 65584.05(a). 7. Jurisdictions may request draft RHNA revision: within 60 days from receipt of draft RHNA. GC 65585.05(b)-(c) **D. JURISDICTION APPEAL PROCESS & COG/MPO ACTION** 8. Jurisdictions may appeal draft RHNA: within 60 days from date COG/MPO establishes to hear appeals at public hearing. GC 65585.05(d)-(e) 9. COG/MPO reviews and responds to appeal requests and issues proposed Final RHNA (at least equal to HCD income category RHNA): within 45 days after appeal hearing. GC 65584.05(f)-(g). **10.** COG/MPO holds Public Hearing and adopts and submits Final RHNA Plan: Adopt Plan within 45 days from issuing proposed Final RHNA distribution Plan. Submit Plan within 3 days from adoption to HCD to review/approve within 60 days from receipt. GC 65584.05(h). **E. HCD REVIEW & APPROVAL OF COG/MPO RHNA PLAN** 11. Review of Final RHNA by HCD: within 60 days of receipt of COG's Final RHNA Plan (*HCD may revise COG's RHNA Plan if not consistent with initial regional determination)* GC 65584.05(h)	*(Regional variations exist for some MPOs in San Joaquin Valley, Bay Area, and Southern California and for congestion management agency-subregion processes)* 1. MPO gathers data, develops models, begins update of regional growth forecast 2. MPO adopts public participation plan for SCS and possibly an APS 3. Prior to public participation process, MPO submits proposed methodology for estimating GHG reduction from its SCS (and APS, if desired) to ARB for review and comment 4. MPO conducts outreach & public workshops, at least 1-3 workshops per county 5. MPO conducts inter-agency consultation pursuant to federal conformity requirements 6. MPO prepares draft SCS which must accommodate HCD's RHNA determination 7. Draft EIR/RTP is prepared & reviewed by public and agencies for comment *MPO must issue Draft SCS not less than 55 days before RTP adoption; must hold SCS public hearing (for single-county at least 2 public hearings& for multi-county at least 3 hearings)* 8. MPO makes any revisions to Draft SCS/responds to DEIR comments 9. MPO Certifies EIR & Adopts RTP within either 4 years of its prior conformity date, or 5 years. of its prior adoption date, if attainment MPO 10. MPO submits RTP to FHWA/FTA for conformity 11. After adoption, MPO submits SCS for review to ARB. ARB has 60 days to accept or reject the MPO's determination that strategy, if implemented, will achieve region's GHG target *** *For non-attainment regions, subsequent SCS (4 yrs. hence) must integrate with prior RHNA as RHNA determinations are made for 8-yr intervals (every other 4-yr RTP update).*
JURISDICTION 8-YEAR HOUSING ELEMENT DUE DATE: within 18 months from *actual* RTP adoption date. *NOTE: consequence for late adoption past 120 days from due date is interruption of 8-year HE cycle and 4-yr update by due date for at least two consecutive 4-year intervals.* GC 65588(e)(4)	*If approved by FHWA, FTA & EPA, federal approval starts RTP update timetable for non-attainment MPOs: RTP must be updated within 4 years*

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Appendix J

Glossary of Transportation Terms

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APCD	Air Pollution Control District, a county agency that adopts regulations to meet State and Federal air quality standards.
AQMD	Air Quality Management District, a regional agency formed by 2 or more counties, which adopts regulations to meet State and Federal air quality standards.
ATTAINMENT AREA	Attainment Area, is any geographic area in which levels of a given criteria air pollutant (e.g., ozone, carbon monoxide, PM10, PM2.5, and nitrogen dioxide) meet the health-based National Ambient Air Quality Standards (NAAQS) for that pollutant. An area may be an attainment area for one pollutant and a nonattainment area for others. A "maintenance area" (see definition below) is not considered an attainment area for transportation planning purposes.
BLUEPRINT PLANNING	Blueprint Planning, is a Caltrans sponsored voluntary discretionary competitive grant program designed to assist MPOs in developing a regional vision that considers transportation, land use, housing, environmental protection, economic development and equity.
CAPACITY	Capacity, is a transportation facility's ability to accommodate a moving stream of people or vehicles in a given time period.
CARB	California Air Resources Board, the State agency responsible for implementation of the Federal and State Clean Air Acts. Provides technical assistance to air districts preparing attainment plans; reviews local attainment plans and combines portions of them with State measures for submittal of the State Implementation Plan (SIP) to U.S. EPA.
CASP	California Aviation System Plan, prepared by Caltrans Division of Aeronautics every five years as required by PUC Section 21701. The CASP integrates regional aviation system planning on a Statewide basis.
CEQA	California Environmental Quality Act, State law that requires the environmental effects associated with proposed plans, programs and projects to be fully disclosed.
CMA	Congestion Management Agency, the county agency responsible for developing, coordinating and monitoring the Congestion Management Program.
CMP	Congestion Management Program is a countywide integrated program that addresses congestion in a coordinated and

cooperative manner. The program contains 5 elements: a Level of Service element, a transit standards element, a TDM and trip reduction element, a land use analysis element, and a capitol improvement program element. To effectively address this goal, the appropriate land use, transportation and air quality agencies need to integrate their planning processes, share information and respond to congestion using a coordinated approach. In 1996 AB 2419 amended government code section 65088.3 to allow counties to opt out of this previously mandatory program.

CTC — California Transportation Commission, a decision making body established by AB 402(Alquist / Ingalls) of 1977 to advise and assist the Secretary of Transportation and the legislature in formulating and evaluating State policies and plans for transportation programs.

CTP — California Transportation Plan, The CTP is a long-range transportation policy plan that is submitted to the Governor. The CTP is developed in collaboration with partners, presents a vision for California's future transportation system, and defines goals, policies, and strategies to reach the vision. It is developed in consultation with the State's regional transportation planning agencies, is influenced by the regional planning process, and provides guidance for developing future RTPs. RTPs should be consistent with and implement the vision and goals of the CTP. As defined by State statute, the CTP is not project specific.

DSMP — District System Management Plan, a District's long-range plan for management of the State highway transportation system in its jurisdiction.

FAA — Federal Aviation Administration, the agency of the U.S. Department of Transportation charged with regulating air commerce to promote its safety and development, encouraging and developing civil aviation, air traffic control and air navigation, and promoting the development of the national airport system.

EMISSIONS BUDGET — Emissions Budget, is the part of the State Implementation Plan (SIP) that identifies the allowable emissions levels, mandated by the National Ambient Air Quality Standards (NAAQS), for certain pollutants from mobile, stationary, and area sources. The emissions levels are used for meeting emission reduction milestones.

FHWA — Federal Highway Administration, a component of the U.S. Department of Transportation, established to ensure development of an effective national road and highway transportation system. FHWA and FTA, in consultation with US EPA, make Federal Clean Air Act Conformity findings for

Regional Transportation Plans, Transportation Improvement Programs, and Federally funded projects.

FISCAL CONSTRAINT — Fiscal constraint, the metropolitan transportation plan, TIP, and STIP includes sufficient financial information for demonstrating that projects in the metropolitan transportation plan, TIP, and STIP can be implemented using committed, available, or reasonably available revenue sources, with reasonable assurance that the Federally supported transportation system is being adequately operated and maintained. For the TIP and the STIP, financial constraint/fiscal constraint applies to each program year. Additionally, projects in air quality nonattainment and maintenance areas can be included in the first two years of the TIP and STIP only if funds are ''available'' or ''committed.''

FTA — Federal Transit Administration, a component of the U.S. Department of Transportation, responsible for administering the Federal transit program under the Federal Transit Act, as amended, and SAFETEA-LU.

FSTIP — Federal State Transportation Improvement Program is a multi-year Statewide, financially constrained, intermodal program of projects that is consistent with the Statewide transportation plan (CTP) and regional transportation plans (RTPs). The FSTIP is developed by the California Department of Transportation and incorporates all of the MPOs *and* RTPAs FTIPs by reference. Caltrans then submits the FSTIP to FHWA.

FTIP — Federal Transportation Improvement Program is a constrained 4-year prioritized list of all transportation projects that are proposed for *Federal and local* funding. The FTIP is developed and adopted by the MPO/RTPA and is updated every 4 years. It is consistent with the RTP and it is required as a prerequisite for Federal funding.

IIP — Interregional Improvement Program is one of two component funding source programs that ultimately make up the State Transportation Improvement program. The IIP receives 25% of the funds from the State Highway account. The IIP is the source of funding for the ITIP.

ILLUSTRATIVE PROJECT — An illustrative project means an additional transportation project that may (but is not required to)be included in a financial plan for the RTP or FTIP if reasonable additional resources were to become available.

INTERMODAL — Intermodal refers to the connections between modes of transportation.

ITIP — Interregional Transportation Improvement Program is a Statewide program of projects, developed by Caltrans for interregional projects that are primarily located outside of urbanized areas. The ITIP has a 4-year planning horizon and is updated every two years. It is submitted to the CTC along with the FTIP and taken together they are known as the STIP.

ITS — Intelligent Transportation Systems are electronics, photonics, communications, or information processing used singly or in combination to improve the efficiency or safety of a surface transportation system.

ITSP — Interregional Transportation Strategic Plan describes the framework in which the State will carry out its responsibilities for the Interregional Transportation Improvement Program (ITIP).

MIS — Major Investment Study was a Federally mandated study required for major transportation improvements under ISTEA. An MIS was a planning analysis done on a corridor or sub-regional area that included social, economic and environmental considerations early in the planning process and integrated these considerations into the project development stage. Although SAFETEA-LU has deleted this requirement, Section 450.318(a) and Appendix A retains the option to link early environmental considerations in the RTP to the subsequent project specific environmental review that takes place during the project delivery process.

MODE — Mode is a specific form of transportation, such as automobiles, buses, trains or planes.

MPO — Metropolitan Planning Organization, a planning organization created by Federal legislation charged with conducting regional transportation planning to meet Federal mandates.

NATIONAL AMBIENT AIR QUALITY STANDARDS — NAAQS are the acceptable limits that are set for various pollutants by the US EPA. Air quality standards have been established for the following six criteria pollutants: ozone, carbon monoxide, particulate matter, nitrogen dioxide, lead and sulfur dioxide.

NEPA — National Environmental Policy Act is Federal legislation that created a national policy and procedures that require Federal agencies to consider the environmental effects of their actions and to inform the public that their decisions reflect this environmental consideration. NEPA applies to most transportation projects because they are jointly funded with a combination of Federal, State and sometimes local money.

NONATTAINMENT Nonattainment, any geographic region of the United States that has been designated by the EPA as a nonattainment area under section 107 of the Clean Air Act for any pollutants for which an NAAQS exists.

PERFORMANCE MEASURES Performance measures are used to model travel demand and allow the long-range forecasting of transportation network and system-level performance (e.g. Walk, bike, transit, and carpool mode share, corridor travel times by mode, percentage of population within 0.5 mile of a high frequency transit stop).

PERFORMANCE MONITORING INDICATORS/METRICS Performance monitoring indicators or metrics include field data such as vehicle miles traveled, mode share, fatalities/injuries, transit access, change in agricultural land, and CO2 emissions.

PERFORMANCE TARGETS Performance targets are numeric goals established to enable the quantifiable assessment of performance measures.

RIP Regional Improvement Program is one of two component funding source programs that ultimately make up the State Transportation Improvement program. The RIP receives 75% of the funds from the State Highway account. This 75% is then distributed to the MPOs and RTPAs by a formula. The RIP is the source of funding for the FTIP.

RTIP Regional Transportation Improvement Program, is a program proposal of projects prepared by the regions in coordination with Caltrans for inclusion in the STIP.

RTP Regional Transportation Plan, a Federal and State mandated planning document prepared by MPOs and RTPAs. The plan describes existing and projected transportation needs, conditions and financing affecting all modes within a 20-year horizon.

RTPA Regional Transportation Planning Agency, a State designated single or multi-county agency responsible for regional transportation planning. RTPAs are also known as Local Transportation Commissions or Councils of Governments and are usually located in rural or exurban areas.

SHA State Highway Account, the SHA account is the State's primary source of funding for transportation improvements. The SHA account is composed of revenues from the State's gasoline and diesel fuel tax, truck weight fees and Federal highway funds. The

SHA is primarily used for STIP, SHOPP and local assistance projects as well as non-capitol projects such as maintenance, operations, and support.

SHOPP — State Highway Operations and Protection Program is a legislatively created program to maintain the integrity of the State highway system. It is tapped for safety and rehabilitation projects. SHOPP is a multi-year program of projects approved by the Legislature and Governor. It is separate from the STIP.

SIP — State Implementation Plan, as defined in section 302(q) of the Clean Air Act (CAA), the portion (or portions) of the implementation plan, or most recent revision thereof, which has been approved under section 110 of the CAA, or promulgated under section 110(c) of the CAA, or promulgated or approved pursuant to regulations promulgated under section 301(d) of the CAA and which implements the relevant requirements of the CAA.

SMART GROWTH — Smart Growth, is a set of policies designed by local governments to protect, preserve and economically develop established communities as well as natural and cultural resources. Smart growth encompasses a holistic view of development.

SPRAWL — Sprawl is an urban form based on the movement of people from the central city to the suburbs. Concerns associated with sprawl include loss of farmland and open space due to low-density land development, increased public service costs including transportation, and environmental degradation.

STIP — State Transportation Improvement Program, a Statewide or bundled prioritized list of transportation projects covering a period of four years that is consistent with the long-range Statewide transportation plan, metropolitan transportation plans and FTIPs, and required for projects to be eligible for funding under Title 23 U.S.C. and title 49 U.S.C. Chapter 53.

TCM — Transportation Control Measures, any measure that is specifically identified and committed to in the applicable SIP that is either one of the types listed in section 108 of the Clean Air Act or any other measure for the purpose of reducing emissions or concentrations of air pollutants from transportation sources by reducing vehicle use or changing traffic flow or congestion conditions. Notwithstanding the above, vehicle technology-based, fuel-based, and maintenance-based measures that control the emissions from vehicles under fixed traffic conditions are not TCMs.

TIERING — Section 15385 of the CEQA guidelines defines tiering as the coverage of general matters in broader EIRs with subsequent narrower EIRs incorporating by reference the general discussions and concentrating solely on the issue specific to the EIR that is being subsequently prepared. Tiering allows agencies to deal with broad environmental issues in EIRs at the planning stage and then to provide a more detailed examination of specific effects in EIRs for later development projects that are consistent with or that implement the plan.

TITLE VI Title VI of the Civil Rights Act of 1964, prohibits discrimination in any program or project receiving Federal financial assistance.

TDM Transportation Demand Management refers to policies, programs and actions that encourage the use of transportation alternatives to driving alone and reduce vehicle miles traveled.

TSM Transportation System Management refers to the use of relatively inexpensive transportation improvements that are used to increase the efficiency of transportation facilities. TSM can include carpool and vanpool programs, parking management, traffic flow improvements, high occupancy vehicle lanes, and park-and-ride lots.

US EPA United States Environmental Protection Agency is the Federal agency that approves the SIP and the emissions budgets that are the basis of the RTP conformity assessments.

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Appendix K

AB 441 - Promoting Health and Health Equity in MPO RTPs

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Appendix K Contents

Purpose of Appendix K

Assembly Bill 441 (2012, Monning) requires the RTP Guidelines to identify innovative planning practices that can serve as models for MPOs and their partner agencies in undertaking a regional transportation planning process that promotes the health and well-being of all Californians. Appendix K has been prepared to serve as voluntary guidance to highlight cutting-edge examples of policies, programs, projects, and tools that MPOs are employing to address public health and health equity in the regional transportation planning process. It is important to note that this appendix is not intended to provide a "one size fits all" approach. In light of the diversity of California MPOs, and the varying level of financial resources and technical capabilities to undertake the long range regional transportation planning process, this appendix offers examples from both rural and urban regions, and recognizes the importance of a regionally-appropriate approach to addressing health and health equity in the RTP. It is also important to acknowledge that improving the built environment is one of many factors in improving public health. This Appendix is meant to provide examples of how the RTP can contribute to improved public health and is not meant to imply that by implementing these recommendations, all public health needs will be addressed.

Introduction: Public Health and Transportation Planning

Many factors combine to affect the health of individuals and communities. Within the public health field the circumstances and conditions in which people are born, grow up, live, work, play and age are called the social determinants of health (SDoH) and are recognized to have a significant impact on health outcomes and health equity.[1] These social determinants of health include socioeconomic status, education, employment, social support networks, and the built environment and have been shown to have a greater impact on health than health care or genetics.[2] Transportation is a key social determinant of health and the Regional Transportation Plans determine long-term investments in the built environment over extensive geographies. These plans can impact public health through multiple pathways, including economic opportunity, access to essential destinations, and the safety of communities and transportation options, as illustrated in the graphic below.

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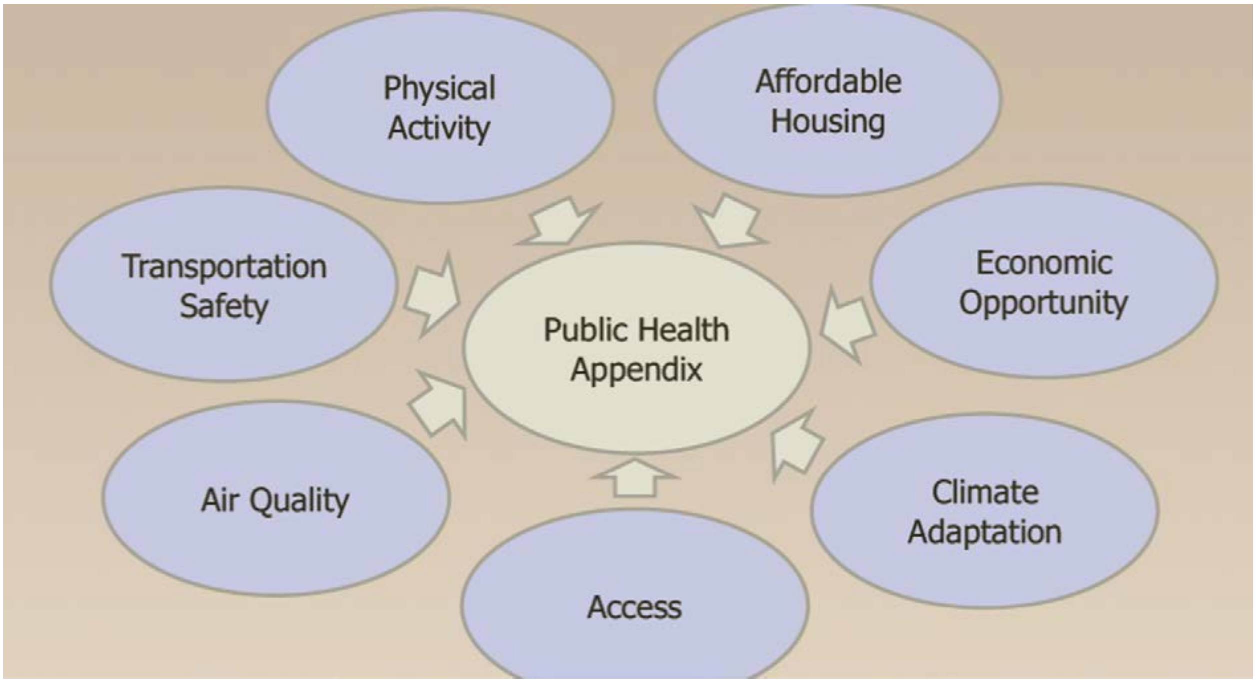
[1] Mark R. Cullen, Clint Cummins, and Victor R. Fuchs, "Geographic and Racial Variation in Premature Mortality in the U.S.: Analyzing the Disparities," *PLoS ONE* 7, no. 4 (April 17, 2012): e32930, doi:10.1371/journal.pone.0032930.

[2] Schroeder, SA (2007). We can Do Better---Improving the Health of American People. NEJM. 357:12221-8.



Credit: Southern California Association of Governments 2016-2040 RTP/ SCS Public Health Appendix

A 2012 report, "*Creating Healthy Regional Transportation Plans: A Primer for California's Public Health Community on Regional Transportation Plans and Sustainable Communities Strategies,"*[1] (2012, TransForm & CA Dept. of Public Health) identified direct and indirect effects of transportation projects and policies that are developed at both the regional and local level:

Direct Effects

- **Physical Activity and Active Transportation.** Active transportation (walking, biking, and wheeling to destinations) has a direct health benefit, and can reduce the risk of heart disease, improve mental health, lower blood pressure, and reduce the risk of overweight and obesity-related chronic disease such as Type 2 Diabetes. Public transit is considered active transportation because it generally involves an active mode at the beginning or the end of the trip.

- **Collision Injuries and Fatalities**. Motor vehicle collisions are a major cause of death and injury, and are the leading cause of death among those ages 5-34. In 2009, traffic injuries caused 3,063 deaths, 25,328 hospitalizations, and 221,454 emergency department treatments in California. 18 percent of deaths, 19 percent of the hospitalizations, and 9 percent of the emergency department treatments were pedestrians and bicyclists. Road design, "Complete Streets," speed reduction, and other strategies can all reduce the toll of motor vehicle collisions.

- **Air Pollution**. Auto emissions impact air quality and contribute to impaired lung development, lung cancer, asthma and other chronic respiratory problems, and heart disease. Cleaner fuels and more efficient vehicles can reduce emissions, but strategies that reduce driving are also important for air quality because some pollutants, like particulate matter from re-entrained road dust, are directly related to how much people drive.

- **Climate Change**. The transportation sector causes 38 percent of California's total gross greenhouse gas emissions. Minimizing transportation's contribution to climate change will limit the health effects of climate change, such as heat illness, effects of higher ozone levels, impacts of extreme weather events, and changes in vector-borne diseases.

- **Stress and Mental Health**. Commuting during rush-hour traffic can be highly stressful for drivers. Unreliable and infrequent transit service can also cause stress, especially for low-income employees who depend solely on transit to get to their jobs on time. Reducing commute times and increasing public transportation reliability through effective transportation planning can reduce stress and improve mental health.

Indirect Effects

- **Access to Jobs**. For low-income families who cannot afford a car, public transit can be a lifeline to jobs. Social service agencies have found that inadequate transportation is one of the top three barriers to the transition from welfare to work. Transportation planning can help residents reach jobs, education, social services, and medical care by walking, biking or public transportation in a timely manner.

- **Access to Services and Medical care**. When getting to health care or other essential services is difficult—and this is especially true for lower-income residents, seniors, and people with disabilities, who don't have access to a car or effective public transportation—patients often miss appointments or delay care until a condition deteriorates and requires emergency attention.

- **Household Expenses**. The Average American Family spends an astounding 32 percent of household income on housing and 19 percent on getting from place A to place B[3]. Low-income families are hit the hardest because housing and transportation expenses account for a larger proportion of their income. This leaves much less for savings or investing in education, healthful food, etc. Regions can support increased economic stability and access to community necessities by assuring that all populations, and especially vulnerable populations such as youth, older adults, and low-income residents, have access to affordable and accessible transportation options. Affordable transportation

[3] http://wwh.fhwa.dot.gov/livability/fact_sheets/transandhousing.cfm

options enable low income households to invest in savings, education, and healthier food options—all factors that contribute to greater individual and community health.

- **Displacement/Gentrification**. Transportation improvements, especially new rail lines and stations to low-income communities, can increase access to opportunities. But they can also result in much higher property values and an increase in the cost of owning and renting property, inadvertently displacing existing residents and businesses. Being forced to leave a home is a stressful, costly and traumatic life event, especially when affordable housing is so limited. There is a growing recognition of tools and strategies that can be implemented alongside community investments to reduce displacement.

- **Social Cohesion and Social Networks**. Transportation planning and community design that facilitates active transportation, including public transportation, tends to increase social interaction and community cohesion. Increased neighborly interactions can help reduce crime, depression, and poverty, provide support and safety, and increase property values. Community cohesion and supportive transportation services are particularly important for vulnerable populations, including the elderly and disabled.

Health-focused transportation plans can help reduce the number of injuries and fatalities from collisions. When streets are designed to safely accommodate walking and biking, more people may do so, and as more people walk and bike the rate of collisions actually goes down as pedestrians and bicyclists become more visible to motorists. In addition, more people out walking and biking in a neighborhood has an important public safety benefit, as it means there are more “eyes on the street” to deter criminal activity. Taking this a step further, studies have shown that people who live in neighborhoods with less traffic and higher rates of walking, bicycling, and transit use know more of their neighbors, visit their neighbor’s homes more often, and are less fearful of their neighbors.[4] When streets are inhospitable to pedestrians and bicyclists, residents don’t feel safe walking or biking to nearby transit and their ability to access regional educational and employment opportunities is hampered. In short, improving traffic safety results in better public health beyond simply reduced injuries and fatalities.

While local governments have primary control over streets and roads in their jurisdictions, and county transportation agencies can generate funding by placing transportation sales taxes before voters, the interaction of transportation and land use happens most profoundly at a regional scale. Many health, equity and environmental benefits of smarter planning and investment – from creating access to jobs for low-income communities, to protecting open space, to reducing air pollution – can be

[4] “At the Intersection of Active Transportation and Equity.” Safe Routes to School National Partnership. 2015. <http://saferoutespartnership.org/sites/default/files/resource_files/at-the-intersection-of-activetransportation-and-equity.pdf>.

realized at a regional scale through the collaborative planning process between regional and local governments. MPOs play a significant role in engaging residents and stakeholders in the regional transportation planning process to ensure the improvement of health outcomes for all segments of the population. A timely opportunity to address public health outcomes is early during the RTP development process and MPOs are encouraged to consider health priorities in selection of projects for the RTP.

Policies, Programs, and Projects that Promote Health and Health Equity in RTPs

This section serves to identify examples of innovative policies, programs, and projects that California MPOs of varying size have employed to consider health and health equity in the RTP. This section encourages a regionally-appropriate approach to addressing health and health equity in the planning process. For example, regions with limited resources, especially rural regions, may be best served by selecting a few high-priority strategies where there is greatest opportunity to affect regional outcomes.

Goals and Policies

Health in All Policies

The identification of regional goals and policies is an important part of the RTP development process. The Health in All Policies (HiAP) approach is one mechanism that facilitates the consideration of health in the RTP. HiAP is a collaborative strategy that aims to improve public health outcomes by including health considerations in the planning process across sectors and policy areas. The five key tenets of HiAP as defined by the California Department of Public Health include:

- Promote Health Equity and Sustainability
- Support Inter-Agency Collaboration
- Benefit Multiple Partners
- Engage Stakeholders
- Create Structural or Procedural Change

Urban MPO Example:

The regional planning process serves as a valuable forum for inter-agency collaboration and is uniquely suited for a HiAP approach. The Southern California Association of Governments (SCAG) incorporated the use of the HiAP policy framework in its 2016-2040 RTP/SCS. SCAG identified seven focus areas for further analysis and implementation related to the built environment’s impact on health outcomes:

1. Access to Essential Destinations
2. Affordable Housing
3. Air Quality

4. Climate Adaptation

5. Economic Opportunities

6. Physical Activity

7. Transportation Safety

SCAG developed a comprehensive Public Health Appendix which features an in-depth discussion of the focus areas, a simple and clear graphic connecting the RTP goals to each of these focus areas, identification of the challenges and opportunities in these areas, adoption of guiding principles for the integration of public health considerations in the plan, a detailed report of plan performance in the public health focus areas, and examples of regional and local initiatives. For more information:

http://scagrtpscs.net/Documents/2016/final/f2016RTPSCS_PublicHealth.pdf

Regional and Local Active Transportation Planning

Active Transportation planning promotes bicycling and walking as a means to decrease auto dependency, reduce traffic congestion, facilitate development of new sidewalks and trails, and improve connectivity. Infrastructure that welcomes walking and biking as modes of transportation provides opportunity for increased physical activity and associated health benefits and contributes to an environment that is ultimately safer for those traveling by bicycle or on foot. Local and regional governments have expanded the level of planning and investment in active transportation. Some examples of regional and local active transportation planning throughout California are highlighted below:

Large/Urban MPO Examples:

SCAG 2016 RTP/SCS

Chapter 5 and the Active Transportation Appendix to the 2016 RTP/SCS, represents how the region plans to use active transportation to help meet these challenges over the next 25 years, including longer-trip strategies for commuters and active recreation, integrating active transportation with transit, short-trip strategies for utilitarian trips (shopping, school, local retail), and safety/encouragement. It presents the background, existing conditions, progress since the 2012 RTP/SCS, new strategies, and actions making it easier and safer to walk and bike in Southern California.

For more information see: http://scagrtpscs.net/Pages/FINAL2016RTPSCS.aspx

SANDAG's Active Transportation Grant Program (ATGP)

The *TransNet* sales tax measure Extension Ordinance provides funding for two competitive grant programs that support local efforts to increase walking, biking, and transit usage throughout the region: the Smart Growth Incentive Program (SGIP) and the Active Transportation Grant Program (ATGP). The ATGP also is funded with Transit Development Act (TDA) funds.

The goal of the ATGP is to encourage local jurisdictions to plan and build facilities that promote multiple travel choices for residents and connectivity to transit, schools, retail centers, parks, work, and other community gathering places. The grant program also encourages local jurisdictions to provide bicycle parking, education, encouragement, and awareness programs that support pedestrian and bicycle infrastructure.

It is important to note that not all MPO's have local discretionary funding resources to develop and administer a program such as SANDAG's ATGP. More information on the ATGP is available at:

http://www.sandag.org/index.asp?classid=12&projectid=491&fuseaction=projects.detail

Small/Medium/Rural MPO Examples:

Linking Tahoe Active Transportation Plan

The Tahoe Metropolitan Planning Organization (TMPO) and Tahoe Regional Planning Agency (TRPA) prepared the "Linking Tahoe Active Transportation Plan" (ATP). The ATP is a toolbox for planning, designing, constructing and maintaining a safe, comfortable and efficient roadway for users of all ages and abilities such as pedestrians, bicyclists, transit riders, motorists, commercial and emergency vehicles. The ATP helps plan a network that provides connectivity, improves safety, supports consistent project implementation and increases awareness. For more information visit: http://www.trpa.org/transportation/plans-projects-and-programs/ and http://www.trpa.org/ActiveTransportationPlan/

StanCOG Bicycle/Pedestrian Advisory Committee (BPAC)

The BPAC is one of the StanCOG Standing Committees. This committee, created in 2009, advises the Policy Board on bicycle and pedestrian-related issues. It reviews transportation projects and recommends planning efforts that enhance non-motorized transportation opportunities in the Stanislaus region. For more information visit: http://www.stancog.org/bpac-committee.shtm

Walk 'n' Bike Tulare County Active Transportation Plan

The Tulare County Association of Governments (TCAG) has begun to develop the first Regional Active Transportation Plan (RATP) for the county, called "Walk 'n Bike Tulare County." The plan seeks to make walking and biking in Tulare County safer and more convenient. Most importantly, it will identify the highest priority pedestrian and bicycle improvements for the County and its eight cities for the next ten years, and will aim to position those projects to compete well for grant funds. Also, the plan will make up the pedestrian and bicycle component of the Tulare County Regional Transportation Plan. For more information visit: http://www.tularecounty.ca.gov/rma/index.cfm/whats-going-on/walk-n-bike-tulare-county-regional-active-transportation-plan/

Local Government General Plans and Policies

Local jurisdictions are instrumental partners in the preparation of the RTP/SCS and are vital to its successful implementation. Local governments have exclusive land use authority and general plans are the mechanism by which long range planning is conducted to provide for the public health and welfare of cities and counties within MPO regions. Local general plans serve as critical sources of information in the development of the RTP/SCS. The 2016 Draft General Plan Guidelines (GPG) prepared by the Governor's Office of Planning and Research (OPR) acknowledge this relationship and provides guidance on the relationship between the General Plan and regional plans.

The general plan development process has evolved to include elements beyond the seven mandated areas of land use, circulation, and housing, open space, air quality, safety, and noise – for example, elements dedicated to health and equity. Chapter 5 of the 2016 Draft General Plan Guidelines (GPG) prepared by the Governor's Office of Planning and Research (OPR) identifies the following health considerations for the General Plan development process:

1. Health and Economic Opportunity
2. A Changing Climate and Resiliency
3. Active Living and Recreation
4. Social Connection and Safety
5. Housing
6. Nutrition and Food Systems
7. Environmental Health; and
8. Health and Human Services

The GPG also provide guidance, strategies and approaches for:

1. Incorporating Health Considerations into General Plans
2. Innovative Partnerships and Collaboration
3. Sources of Support and Information for Health Considerations
4. Health Data and Mapping; and
5. OPR Recommended Policies

Chapter 6 of the GPG addresses Social Equity, Environmental Justice, and Community Resilience in the General Plan including relevant statutory requirements and definitions, examples of incorporating a social equity "lens" for the plan, government funding perspectives, data, mapping, and tools, examples of community engagement, incorporation of supportive policies and strategies for addressing community resilience.

Given the recent passage of SB 1000 (Leyva, 2016), the GPG will be updated to provide guidance for local jurisdictions, who will be required to include an environmental justice element or environmental justice goals, policies, and objectives in other elements of the general plan. The General Plan process is distinct and separate from the RTP/SCS and is carried out by local agencies, however it serves as an important opportunity for engagement to address regional goals and the plans themselves are foundational documents for the RTP/SCS. MPOs are encouraged to collaborate closely with local jurisdiction long-range planning staff, and share data and resources where appropriate to facilitate local and regional policy considerations and investments that promote health, health equity, and environmental justice in the RTP/SCS.

General Plan Guidelines information is available at:

https://www.opr.ca.gov/s_generalplanguidelines.php

Additional resources and information regarding local government policies and programs that promote health are available through the "Healthy Eating Active Living" (HEAL) campaign:

http://www.healcitiescampaign.org/http://www.healcitiescampaign.org/toolkit.html

Programs

Collaboration with Non-Transportation Agencies

Data development and technical analyses to consider public health and health equity in the RTP are very resource intensive and are often beyond the fiscal reach of small and rural agencies. One practical and non-resource intensive approach MPOs can use to understand regional public health and health equity issues is to engage in focused consultation with the local public health community and county public health departments, representatives from local school districts, community based organizations, and other non-transportation agencies This type of outreach can yield valuable insight regarding identifying regional needs, opportunities for greatest impact, areas of existing community and decision-maker support as well as alignment with current and emerging policy direction and funding programs. This consultation should happen early in the development of the RTP/SCS to ensure that feedback from public health practitioners can be meaningfully integrated into the RTP/SCS, especially any data analysis, identification of performance measures, scenario modeling and selection of transportation projects for funding.

Urban MPO Example:

Public Health in Southern California:

To address public health more broadly in its planning process, SCAG has established a Public Health Subcommittee, a Public Health Workgroup, and developed a Public Health Work Plan:

- The Public Health Subcommittee, outlined recommendations addressing the promotion of active transportation, enhancement of public health data, and engagement in collaborations.
- In accordance with the recommendations of the Public Health Subcommittee, SCAG formed a Public Health Workgroup to collaborate with regional stakeholders to develop a Work Plan of policy recommendations that further define SCAG's role in public health.
- For more information please visit the SCAG Public Health Program webpage: http://www.scag.ca.gov/programs/Pages/Programs/PublicHealth.aspx

The *Alliance for a Healthy Orange County* is an example of a successful partnership among various stakeholders to leverage resources and funding to promote positive public health outcomes. For more information visit:

http://www.ochealthalliance.org/

Small/Medium/Rural MPO Example:

The Shasta Regional Transportation Agency (SRTA) partners with public health organizations and agencies such as *Healthy Shasta* and the Shasta County Health and Human Services Agency in the development of the RTP, see the SRTA Public Participation Plan available at: http://www.srta.ca.gov/166/Public-Participation

National Examples:

Health & Well Being in Regional Planning – Nashville, Tennessee:

Developed in 2015, the Nashville MPO Regional Transportation Plan (RTP) increased its commitment to prioritizing transportation projects that improve health. Through the endorsed goals and objectives for the RTP, the MPO is committed to helping local communities grow in a healthy and sustainable way by:

- Aligning transportation decisions with economic development initiatives, land use planning, and open space conservation efforts.
- Integrating healthy community design strategies and promote active transportation to improve the public health outcomes of the built environment.
- Encouraging the deployment of context-sensitive solutions to ensure that community values are not sacrificed for a mobility improvement.
- Incorporating the arts and creative place-making into planning and public works projects to foster innovative solutions and to enhance the sense of place and belonging.
- Pursuing solutions that promote social equity and contain costs for transportation and housing.
- Minimizing the vulnerability of transportation assets to extreme weather events.

The three major strategies to achieve these outcomes are:

- Fund and implement the Regional Vision for Mass Transit
- Develop active transportation options for walkable communities

- Reinvest in strategic roadway corridors

The MPO also updated the scoring criteria used to evaluate projects. 80 of the 100 points help to ensure that projects are prioritized around improving health by increasing physical activity, improving air quality and reducing crashes for all modes. In addition, projects were evaluated for location within Health Priority Areas, which are defined by areas with high rates of at least three of the following: low income, unemployed, carless and populations over age.

By prioritizing active transportation facilities such as transit, sidewalks and bikeway, and placing these facilities in areas where they are most needed, the MPO is working to using transportation as a prevention strategy to improve health and prevent disease. For more information, see the Plan's website:
http://www.nashvillempo.org/regional_plan/health/

Health in Transportation Planning - Puget Sound, Washington Regional Council

VISION 2040, the region's long-range growth management, economic and transportation strategy, calls for a transportation system that creates more travel choices while preserving environmental quality and open space. Health is featured prominently in VISION 2040's multicounty planning policies. PSRC works with regional partners to discover how health outcomes in VISION 2040 can better be achieved.

VISION 2040's triple bottom line (people, prosperity, and planet) is viewed by the public health partners as recognizing the link between a healthy environment, healthy economy, and healthy people. In addition to continuing PSRC's interest in safety, VISION 2040 calls out other health-related topics, including the built environment and health, air and water pollution from vehicles, and chronic diseases related to exposure to pollutants, physical inactivity and lack of access to healthy foods. In addition, the plan calls for ensuring mobility choices and minimizing negative impacts for disadvantaged populations and people with special needs.

For more information, see the Plan's website:
http://www.psrc.org/transportation/bikeped/health-in-transportation-planning/

Affordable Housing

The California Department of Housing and Community Development (HCD) reviews and certifies the General Plan Housing Elements of local jurisdictions that are responsible for the siting and permitting of affordable housing. MPOs can serve as a forum for regional discussion regarding housing affordability to identify data, tools, and services that could be provided to local partners.

Large/Urban MPO Example:

SCAG Regional Housing Summit and 2016 RTP/SCS

In October 2016 SCAG, in partnership with numerous stakeholders, held a Regional Housing Summit. The Summit provided a forum to discuss critical housing issues facing Southern California and the entire state including: the chronic shortage of housing and a lack of housing affordability throughout California; the fact that major institutions, employers, and startups cite lack of housing options as a serious impediment to recruiting and retaining talent; the impact of housing affordability as a critical challenge to local, regional, and Statewide economies, particularly as people from all income groups are increasingly frustrated with the lack of affordable options to rent or buy and instead opt to develop their careers in more affordable areas.

The Summit discussed solutions and strategies for decision-makers to build housing in their local communities. For more information please visit:
http://www.scag.ca.gov/SiteAssets/HousingSummit/index.html

Additionally, SCAG discussed Housing Affordability and Economic Impacts in the 2016 RTP SCS Public Health Appendix:
http://scagrtpscs.net/Documents/2016/final/f2016RTPSCS_PublicHealth.pdf

Calling the Bay Area Home: Tackling the Affordable Housing and Displacement Challenge

This forum was jointly held in February 2016 by the Association of Bay Area Governments (ABAG) and the Metropolitan Transportation Commission (MTC) to facilitate a timely and important dialogue among a diverse array of stakeholders on the role that Bay Area local governments and regional agencies — as well as the state and federal governments — can play in addressing skyrocketing housing costs and the accompanying displacement of long-time residents. Held in Oakland, the forum brought together Bay Area housing and transportation policymakers, city planners, community and business leaders, housing developers and advocates. For more information please see: http://mtc.ca.gov/whats-happening/news/recap-calling-bay-area-home-tackling-affordable-housing-and-displacement

Interagency Consultation Process: Near-Road Air Quality Considerations for MPOs

The association between respiratory and other health effects and proximity to high traffic roadways is addressed in ARB's Air Quality and Land Use Handbook. Diesel exhaust and other vehicle emissions, known as mobile source air toxics (MSATs), are associated with many diseases. ‘‘Sensitive land uses," including residences, schools, daycare centers, playgrounds, and medical facilities, deserve special attention because children, pregnant women, the elderly, and those with existing health problems are especially vulnerable to the effects of air pollution. Agencies participating in the interagency consultation process are encouraged to work closely with transportation project sponsors to ensure that siting and design decisions consider MSAT health risk and exposure reduction near sensitive land uses. Pollutant exposure reduction strategies for projects can be an important preventative action.

ARB's Air Quality and Land Use Handbook is available at: https://www.arb.ca.gov/ch/landuse.htm

Examples of near-road pollutant reduction strategies are included in the General Plan Guidelines update, at https://www.opr.ca.gov/s_generalplanguidelines.php.

Near-Road Air Quality Analysis and Mitigation

While transportation agencies must conduct analysis of the air quality impacts of their proposed projects through the NEPA or CEQA processes, the RTP planning process also offers an opportunity for MPOs to consider the cumulative near-roadway air quality impacts of the existing transportation system as well as potential impacts of new transportation projects on sensitive lands uses. An example of this type of analysis is the "Emissions Impacts Along Freeways and Highly Traveled Corridors" that SCAG included in the Environmental Justice Appendix of its 2016/2040 RTP. This analysis looked at the emissions exposure in areas within 500 feet of freeways and high volume roads in the SCAG region, and cross-referenced this information with demographic information about people residing in those areas to determine potential environmental justice impacts. SCAG also included in this Appendix an "Environmental Justice Toolbox" that included examples of potential mitigation for air quality impacts along freeways and heavily traveled corridors, and potential mitigation for public health impacts that transportation agencies could use as mitigation options for project impacts.

Bicycle and Pedestrian Non-Infrastructure Programs

Non-infrastructure programs that promote public health, especially safe walking and biking, are just as essential as infrastructure projects that improve the built environment. Many people are uncomfortable or unfamiliar with how to navigate their communities on foot or bike, or feel unsafe doing so. Non-infrastructure programs are also essential to reducing greenhouse gas emissions because they make users more comfortable and familiar with how to walk and bike, thereby taking more cars and school buses off the road. Programs such as Safe Routes to School, bike safety education programs and Vision Zero are some examples of non-infrastructure programs that can advance public health in the RTP.

Safe Routes to School

The Safe Routes to School movement is focused around six "E"s: engineering, education, encouragement, enforcement, evaluation and equity. The first E, engineering, is focused on infrastructure projects that improve the built environment around schools. This is of particular importance in the RTP process given its focus on identifying transportation projects for funding. The second and third Es are the heart of the non-infrastructure work with Safe Routes to School, and focus on getting more children to understand how to walk and bike safely to school and in their communities, and have fun doing it. Enforcement focuses on making sure existing traffic safety laws are enforced, and partnering with law enforcement and regulatory agencies to create safer environments for walking and bicycling. Evaluation looks at how effective the overall Safe Routes to School efforts are at increasing walking and bicycling. Finally, equity focuses on ensuring that students of all backgrounds and abilities can walk and bike safely, with a particular focus on disadvantaged communities, where there are often higher rates of students walking and biking, as well as higher rates of injuries and fatalities.

Safe Routes to School non-infrastructure efforts can be integrated into RTPs in several ways. First, MPOs can create Regional Safe Routes to School Plans that identify strategies for increasing walking and bicycling to school across the region. These plans would identify routes that are safe and convenient for walking and bicycling, as well as infrastructure improvements that could improve the commute for students making these trips. The plans would then be a resource when MPOs make decisions about where to prioritize transportation funding. Second, MPOs can integrate Safe Routes to School into the active transportation and complete streets sections of their RTPs, identifying strategies to increase walking and bicycling and improve safety as part of the overall active transportation goals. Third, Safe Routes to School can be a primary strategy to improve public health and health equity, because they focus on children and future generations living within the region.

Safe Routes to School is a mechanism to promote physical activity and thereby reduce obesity. It can also be a land use consideration in the SCS process, since the location of schools is a primary driver of how many students can walk or bike instead of being driven in a car or school bus. Safe Routes to School can also be a part of VMT reduction strategies, since around 10-14% of morning congestion is attributable to cars and buses driving children to school. Finally, MPOs can create distinct Safe Routes to School funding programs to allocate resources to communities and schools to run Safe Routes to School education and encouragement activities, as well as infrastructure improvements. It is important to note that many regions do not have the financial resources to undertake such a program; however, MPOs are encouraged to strategically partner and pursue discretionary funding from the Active Transportation Program or other sources to develop non-infrastructure plans and programs to address regional health and health equity issues. Many more strategies can be found in the Safe Routes to School National Partnership's Primer for Regional Governments.

Safety Education Programs.

Vision Zero. "Vision Zero" is a campaign to reduce the number of pedestrian deaths to zero. It involves a culture change to reclaim streets for people rather than cars, and relies on significant collaboration across agencies, organizations, and community residents to work towards improving street safety. Vision Zero campaigns are an emerging non-infrastructure strategy; as of this writing, no Vision Zero initiatives have been adopted by an MPO. SCAG is working in partnership to support the City of Los Angeles' Vision Zero campaign by sharing data, tracking efforts, assisting in the pursuit of funding, and including supportive language in the RTP. This is an example of one way in which an MPO could support local jurisdictions efforts in this area. http://visionzero.lacity.org/

Urban MPO Examples

SCAG “Go Human”

“Go Human” is a community outreach and advertising campaign with the goals of reducing traffic collisions in Southern California and encouraging people to walk and bike more. The program seeks to create safer and healthier cities through education, advocacy, information sharing and events that help residents re-envision their neighborhoods. Go Human is a collaboration between SCAG and the health departments and transportation commissions from the counties of Imperial, Los Angeles, Orange, Riverside, San Bernardino, and Ventura. Go Human was launched with a $2.3 million grant from the 2014 Active Transportation Program.

MTC One Bay Area Grant Program

The MTC One Bay Area Grant (OBAG2) Program provides specific funding opportunities for jurisdictions in the nine-county Bay Area region to invest in Safe Routes to School projects. Under OBAG2, MTC provides $5 million per year, distributed to each of the nine counties based on school enrollment for Safe Routes to School infrastructure projects and Non-Infrastructure programs. Each County CMA determines the details on how the SRTS funds are spent. It should be noted that this example is unique to a large urbanized MPO with substantial discretionary funding sources. Not all regions have the fiscal resources to undertake this type of program

Rural MPO Example:

Healthy Shasta

Shasta Regional Transportation Agency collaborates with the “Healthy Shasta” partnership to promote healthy and active living among north state residents through increased biking and walking. For more information please visit: http://healthyshasta.org/

Complete Streets Programs

The term “Complete Streets” refers to a transportation network that is planned, designed, constructed, operated and maintained to provide safe mobility for all users, including bicyclists, pedestrians, transit and rail riders, commercial vehicles and motorists appropriate to the function and context of the facility.

MPOs should encourage all jurisdictions and agencies within the region to ensure that their circulation elements and street and road standards, including planning, design, construction, operations, and maintenance procedures address the needs of all users. Streets, roads and highways should also be safe for convenient travel in a manner that is suitable within the context of Complete Streets. To the maximum extent feasible, MPO funded transportation system projects, corresponding Complete Street facilities, and improvements should meet the needs in project areas to maximize connectivity, convenience and safety for all users.

Large/Urban MPO Examples:

SANDAG Complete Streets Policies

The SANDAG Board of Directors adopted a Regional Complete Streets Policy in December 2014. The policy defines complete streets as it will be used to guide SANDAG in its role as an implementer of regional transportation projects. The policy includes implementation action items to provide the tools, training and procedures necessary to ensure all projects implemented by SANDAG consider local complete streets initiatives and accommodate the needs of all travel modes: http://www.sandag.org/index.asp?classid=12&projectid=521&fuseaction=projects.detail

MTC Complete Streets Policies

MTC's Complete Streets policy requires jurisdictions that wish to be eligible for One Bay Area Grant funding to update its general plan circulation element to include Complete Street elements, or pass a policy resolution with nine specified elements. Essentially all of the Bay Area's 101 jurisdictions have done so over the last few years.

Taking Back the Streets and Sidewalks Report

Many aspects of Complete Streets policies also contribute to achieving the tenets of community violence prevention through infrastructure design. Taking Back the Streets and Sidewalks Report can serve as a reference for those in the planning community working on violence prevention. The report examines ways in which Safe Routes to School and community safety efforts overlap and complement each other. The report primarily focuses on approaches to support personal safety for children and teens during the trip to and from school, but broader community strategies are also discussed in the course of providing background and exploring more comprehensive solutions to violence in communities. The report's overall goal is to increase the safety and health of children and youth, and ensure that communities become more equitable places. The report is available at: http://saferoutespartnership.org/resources/report/taking-back-streets-and-sidewalks

Small/Medium/Rural MPO Examples

Linking Tahoe: Active Transportation Plan – Complete Streets Resource Guide

This appendix presents an overview of bicycle and pedestrian facility designs, based on appropriate Manual on Uniform Traffic Control Devices and Highway Design Manuals, and is supplemented by national best practices developed by FHWA and the National Association of City Transportation Officials, as well as state standards and Tahoe-specific design guidelines. The appendix is intended to provide readers and project designers with an understanding of the facility types that are proposed in the Plan, and with specific treatments that are recommended or required region-wide. This appendix also acts as a stand-alone document for implementing agencies to use as a reference guide for designing projects that provide for all roadway user mobility and safety. For more information see: http://tahoempo.org/activetransportationplan/docs/appendices/Appendix%20A_Complete%20Street%20Resource%20Guide.pdf

Strengthening Stakeholder Engagement in Communities Affected by Health Inequities

MPOs can strengthen stakeholder engagement in communities most affected by health inequities by identifying and proactively seeking the input of these households and by making meetings as accessible as possible. Engagement strategies may include:

- Proactively working with and/or providing financial support (if feasible) to community-based and membership organizations across the region to help engage low-income residents and residents of color in the public process and to jointly plan public workshops or other engagement opportunities.
- Forming an advisory group on environmental justice, social equity and/or disadvantaged communities that includes policy and community-based organizations that are focused on social equity in the region to provide feedback throughout the RTP process.
- Creating resident advisory committees or roles within existing committees with decision-making authority and identify opportunities for disadvantaged communities to serve as representatives on decision-making bodies.
- Ensuring that community residents have the opportunity to deliberate together to achieve consensus on their most pressing needs and recommendations.
- Creating a feedback loop to provide community members information about how their input was included in any drafts and reasons for including/excluding the input;
- Ensuring that there is agreement between residents and the local planning authority about what community engagement includes.
- Educating and building capacity of community members on issues such as data, evaluation, storytelling, and mentoring community members new to the process.
- Ensuring Meetings are Convenient and Accessible:
    - ✓ Hold multiple public meetings at times and locations that allow a diverse range of individuals and organizations, including communities with various family and work schedules, to attend such as meetings in the evening and on the weekends.
    - ✓ Consider holding meetings at public facilities such as libraries, community centers, or neighborhood organizations that people are already familiar with and which are convenient to other destinations they may have to go before or after the meeting.
    - ✓ Avoid holding public meetings during the day if feedback from the community is sought.
    - ✓ Avoid government office buildings that require photo ID and security to enter.
    - ✓ Ensure that interpreters are available when holding meetings in communities with a large population of people with English as a second language or who do not speak English at all.
    - ✓ Translate materials, including electronic communications and invitations, to Spanish and other languages where appropriate.
    - ✓ Provide childcare, food, and other amenities, or resource local community groups to do so.

- Adding to the meeting agendas of neighborhood/community based organizations to facilitate a meeting where residents will be available, providing resources to the organization to assist.
- Using meeting locations within access to public transportation, walking and biking routes in addition to parking when selecting a facility. Many times agencies choose locations based on access to parking and busy routes like freeways, which are not as convenient for people who depend on public transportation or other modes. Neighborhood and community based organizations and schools may let you use their meeting space.
- Considering neutral professional facilitation of public meetings to manage conflict and keep the meetings running on time.
- As part of public process, providing materials ahead of time and sharing draft work product.
- Public participation should also include ability to access underlying data on populations (household and person files) and travel patterns (trip lists with time and distances of trip segments) to statistically describe the baseline and alternative scenarios by mode and other characteristics. This approach may better address specific questions of the public and complement limited analytic resources of MPOs.
- Expanding the list of potential partners to include: schools, the faith community, agriculture and food hubs, local business or chambers of commerce, health providers and public health sectors, funders/philanthropy, academia, and environmental health/justice advocates, libraries, law enforcement, parks and recreation, and the technology industry.
- Using a community health worker or promotora model to identify resident leaders.
- Using facilitators with experience in race and power inequities at community meetings.
- Working with community-based and membership organizations across the region to jointly plan public workshops on the RTP, especially the Title VI and Environmental Justice analyses. They know the communities impacted by the RTP transportation projects and can assist with recruiting residents, businesses and other affected stakeholders. Be proactive in asking for their participation instead of waiting for them to come to you.
- Ensuring meetings are attended by MPO decision makers in addition to MPO staff.

MPO Example:

FresnoCOG Community-Based Outreach Program

To help ensure diverse and direct input from all populations especially those with the most potential to be affected by health inequities, Fresno Council of Governments (FresnoCOG) administers a "Community-Based Mini-Grant Outreach Program[5]," which

[5] Administered as a contractual arrangement with community based consultants for outreach services that is subject to the federal procurement process. See: http://www.fresnocog.org/sites/default/files/publications/RTP/RTP_Mini_grant_app_Fresno_COG.pdf

competitively awards mini-grants ($1,000 - $3,000) to community-based organizations, schools, and other groups to conduct outreach to individuals not typically involved in the regional transportation planning process. The selected organizations conduct outreach activities such as organizing and tailoring meetings, customizing presentations materials, building trust and removing barriers to participation to secure public involvement from stakeholders in their communities and the populations they currently serve, engaging them in the planning process and generating feedback on the development of the RTP and SCS.

Additional statewide examples of stakeholder engagement strategies are also compiled in the following report developed by ClimatePlan:

Leading the Way: Policies and Practices for Sustainable Communities

Programs that Serve Rural Transportation Needs

The California Vanpool Authority (CalVans) is the lead agency in the Agricultural Industry Transportation Services (AITS) project which seeks to provide safe, reliable transportation for agricultural industry workers and to serve low-density rural areas and inter-county commuters. This multi-county partnership has grown to include 18 counties. The project is managed out of the Hanford office in Kings County with satellite offices in Ventura and Monterey. Approximately 450 vanpools provide transportation to farm workers traveling to one of many agricultural worksites within California and to Yuma and Imperial Valley in Arizona. For more information see: http://www.calvans.org/

Fresno COG Measure C Farmworker Vanpool Program provides vouchers to help farm laborers pay for their transportation to various job sites when they ride in an approved Farmworker Vanpool. For more information see: http://www.fresnocog.org/measure-c-farmworker-vanpools-0

Promoting Public Transit Connectivity to Essential Destinations and Low Income Communities

First-mile and last-mile connections to public transit are fundamentally important to providing access to essential destinations and increasing transit mode share which can contribute to improving public health outcomes through improved access to health care and services and enhancing active transportation opportunities.

Los Angeles County Metropolitan Transportation Authority developed a First and Last Mile Strategic Plan which identified strategies and potential funding sources for improving the areas surrounding transit stations to make it easier and safer for people to access them. More information regarding the plan is available at:

https://www.metro.net/projects/countywide-planning/

http://media.metro.net/docs/First_Last_Mile_Strategic_Plan.pdf

http://media.metro.net/docs/sustainability_path_design_guidelines.pdf

MPOs are encouraged to work with transit operators and local jurisdictions to address first mile-last mile connections. For example, SCAG served as a funding partner and provided technical assistance to LA Metro in the development of the First and Last Mile Strategic Plan referenced above.

Another mechanism by which MPOs can promote public transit connectivity is through RTP policies that promote Safe Routes to Transit. For example, SANDAG provided the following guiding language in Chapter 2 of the 2015 San Diego Forward RTP: Safe Routes to Transit projects can include bike and pedestrian access improvements at transit stations and within station areas, including improved access to nearby schools, jobs and commercial and residential areas. These projects can make walking or riding a bike between transit stops or stations safer and more comfortable. The projects can be built into future transit capital project or retrofitted into existing ones.

Public Health Planning Activities and Projects

Using a Health and Health Equity Lens in Decision-Making[6]

Using a "health lens" is a systematic way of finding opportunities to improve health and equity and embed these principles in decision-making. The utilization of a health lens simply means providing evidence that allows people to consider the positive and negative health and equity consequences of their decisions during the decision-making process. It can be carried out at a high level to identify broad connections with health, or can address the potential adverse or beneficial health consequences of a policy or program at a more detailed level.

Analysis using a health lens can take many forms and the approach will vary depending on the circumstances. The choice between more or less structured analyses rests in many cases on resources, including availability of staff with appropriate skills, or funding to obtain such staff. One example of a more structured analysis is a Health Impact Assessment.

Health Impact Assessment

A Health Impact Assessment (HIA) is "a process that helps evaluate the potential health effects of a plan, project, or policy before it is built or implemented. HIA brings potential positive and negative public health impacts and considerations to the decision-making process for plans, projects, and policies that fall outside traditional public health arenas, such as transportation and land use. An HIA provides practical recommendations to increase positive health effects and minimize negative health effects."[7]

The major steps in conducting an HIA include:

- Screening (identifying plan, project, or policy decisions for which an HIA would be useful).

[6] Rudolph, L., Caplan, J., Ben-Moshe, K., & Dillon, L. (2013). Health in All Policies: A Guide for State and Local Governments. Washington, DC and Oakland, CA: American Public Health Association and Public Health Institute.
[7] Centers for Disease Control & Prevention, https://www.cdc.gov/healthyplaces/hia.htm.

- Scoping (planning the HIA and identifying what health risks and benefits to consider).
- Assessment (identifying affected populations and quantifying health impacts of the decision).
- Recommendations (suggesting practical actions to promote positive health effects and minimize negative health effects).
- Reporting (presenting results to decision makers, affected communities, and other stakeholders).
- Monitoring and evaluation (determining the HIA's impact on the decision and health status).

Nationally, there are local and state laws that support the examination of health impacts in decision making and a few explicitly require the use of HIA. HIA is different from a public health assessment, a health risk assessment, and an environmental impact assessment. Learn more about the different types of health assessments.

Resources on HIAs include:

Human Impact Partners, who have conducted many HIAs in California:
http://www.humanimpact.org/

U.S. Centers for Disease Control & Prevention:
https://www.cdc.gov/healthyplaces/hia.htm

World Health Organization: http://www.who.int/hia/en/

Pew Charitable Trusts, Health Impact Project:
http://www.pewtrusts.org/en/projects/health-impact-project/health-impact-assessment

American Planning Association, 2016. *The State of Health Impact Assessment in Planning*: https://planning-org-uploaded-media.s3.amazonaws.com/document/State-of-Health-Impact-Assessment-in-Planning.pdf

Examples:

Atlanta Regional Plan 2040 HIA (2012): This was the first-ever MPO to include a health impact assessment as part of its RTP development process: http://www.pewtrusts.org/en/multimedia/data-visualizations/2015/hia-map/state/georgia/atlanta-plan-2040

Other case studies are available here:

http://www.pewtrusts.org/en/projects/health-impact-project/health-impact-assessment/case-studies

Data, Tools, and Metrics that Promote Health and Health Equity in RTPs

While this is a dynamic and evolving policy area, research has demonstrated a clear connection between public health and transportation. Accordingly, the tools and strategies to promote health in transportation continue to be improved, and it is recommended that state, regional and local agencies all integrate the consideration of public health into their transportation and planning policies, programs, and projects as appropriate.

MPOs are encouraged to include strategies and policies in the RTP to obtain data and develop tools which would facilitate health and equity analysis and measurements. Agencies are also encouraged to build partnerships to leverage financial and technical resources as appropriate. Regions with limited resources, especially rural regions, may be best served by selecting a few high-priority strategies where there is greatest opportunity to affect performance metrics/outcomes over a larger geographic region, or taking a more comprehensive approach over a smaller, more focused geographical area. Appropriate scale is important for the effective application of resources to quantitatively address public health and health equity in the planning process.

Performance Measures/Metrics/Indicators for Health and Health Equity

One critical opportunity though which health and equity considerations into an RTP is development of health related performance measures that can be used in comparing alternative scenarios. Extensive research and early applications have demonstrated that physical activity as measured through active transportation (i.e. minutes of walking and biking) can reap substantial public health benefits, in addition to other co-benefits such as reducing greenhouse gas emissions. Further, physical activity as measured by minutes of active transportation is also one of the easiest health impacts to measure using existing tools and methods. Activity Based Models can provide outputs of bicycle and pedestrian trips that serve as key inputs into health models (such as those listed above in the “Modeling Tools to Capture Health and Health Equity Impacts” section). Additionally, if and when MPOs evaluate specific projects and scenarios based on cost effectiveness, including increased active transportation per dollar invested, those projects that increase active transportation are found to have substantial, and sometime larger, monetary benefits compared with traditional transportation performance measure such as vehicles hours of delay.

The significant monetary benefit of increased physical activity is based on extensive evidence from the public health research that increasing active transportation and therefore physical activity reduces rates of colon cancer, breast cancer, lung cancer, respiratory disease, diabetes and dementia. These diseases are among the top causes of death in the United States.

Resources: Projects with health and transportation indicators:

- ✓ USDOT Transportation and Health Tool
- ✓ CDPH Healthy Communities Data and Indicators Project (HCI)
- ✓ CDC: Community Health Status Indicators (CHSI 2015)
- ✓ California Health Disadvantage Index
- ✓ CalBRACE Climate Change and Health Vulnerability Indicators
  (Anticipated release January 2017)

Resource: Report on how to incorporate health and equity performance measures:

- ✓ Transportation 4 America: Planning for a Healthier Future

Additionally, health departments, both at the local and state level, have access to a variety of other public health data sets (e.g. chronic disease rates, behavior risk factors), survey results (e.g. California Household Travel Survey), and peer reviewed literature. Health departments can also provide guidance on health data and in some cases may be able to assist with data analysis.

Examples of how large/urban MPO's have included public health and equity performance measurement in their RTPs:

SCAG 2016 RTP/SCS Performance Measures and Public Health Appendices:
http://scagrtpscs.net/Documents/2016/final/f2016RTPSCS_PerformanceMeasures.pdf
http://scagrtpscs.net/Documents/2016/final/f2016RTPSCS_PublicHealth.pdf

MTC adopted thirteen performance targets for Plan Bay Area 2040, the nine-county Bay Area's RTP/SCS. This plan is currently under development and is anticipated to be adopted by fall 2017. MTC conducted a project level cost/benefit analysis, as well as a qualitative assessment for each of the thirteen targets. Both scores, for cost/benefit and target results, informed the selection of projects to include in the scenario analysis process. For more information see: http://planbayarea.org/the-plan/plan-details.html

Appendix N of SANDAG's Regional Transportation Plan describes Performance Measures which include various public health indicators (benefits [7E and 7F] and a burden measure [9]). The appendix is located here:
http://www.sdforward.com/pdfs/RP_final/AppendixN-EvaluatingthePerformanceoftheTransportationNetwork.pdf

Modeling Tools to Capture Health and Health Equity Impacts

This section provides background information on some modeling tools currently being used to capture health and equity impacts in the regional transportation planning process. It is important to note that these tools are dynamic and continually evolving. The tools below are described for informational purposes only and MPO's are encouraged to use the most regionally appropriate tools and approach, taking into consideration regional demographics, as well as the technical and fiscal capacity of their agency. It is also important to note that models capturing the impacts of public health are oftentimes only as good as the inputs provided by regional travel demand models. **Chapter 3** of the RTP Guidelines provides technical detail and additional planning practice examples regarding travel models used in RTP development.

Health Economic Assessment Tool (HEAT)

The Health Economic Assessment Tool (HEAT) was developed by the World Health Organization (WHO) to assist in economic assessment of the health benefits of walking or bicycling. The tool estimates the value of reduced mortality that results from specified amounts of walking or bicycling. HEAT is best used for planning new bicycle or walking infrastructure, evaluating the reduced mortality from past and/or current levels of bicycling or walking, and providing input for health impact assessments (HIA). The data needed to run HEAT are: an estimate of how many people are walking or bicycling, an estimate of the average time spent walking or bicycling, mortality rate, and a value of statistical life number. The tool is designed for adult populations between the ages of 20-65 years old due to the fact that the model is designed to be used for activities such as commuting. The segment of the population age 65 and older is considered to be retirement age and not participating in a regular commuting and walking/bicycling routine.

Uses	HEAT estimates the economic value of reduced mortality rates from increased walking and bicycling for a given population. The model is not calibrated to any country or region so the results should be used appropriately. The online tool models the effects of cycling or walking on the levels of physical activity in a population group. Based on these estimates, the tool estimates the mortality benefits from current levels of cycling or walking for a neighborhood or city. Results from the tool can provide input into more comprehensive cost–benefit analyses, or prospective health impact assessments: for instance, to estimate the mortality benefits from achieving national targets to increase cycling or walking, or to illustrate potential cost consequences of a decline in current levels of cycling or walking.
Data Inputs Needed	Average duration of trip by walking or biking (in minutes) per day/week/month; and number of adults below the age of 65 years in the population.
Lowest Applicable Level of Geography	Population size across any geography
Resources/Contact	http://www.euro.who.int/en/health-topics/environment-and-health/Transport-and-health/activities/guidance-and-tools/health-economic-assessment-tool-heat-for-cycling-and-walking

Examples/Case Studies of HEAT

MTC adopted thirteen performance targets for Plan Bay Area 2040, the nine-county Bay Area's RTP/SCS. This plan is currently under development and is anticipated to be adopted by fall 2017. MTC conducted a project level cost/benefit analysis, as well as a qualitative assessment for each of the thirteen targets. Both scores, for cost/benefit and target results, informed the selection of projects to include in the scenario analysis process.

For the health target (reduce adverse health impacts by 10%), MTC used the HEAT tool to estimate the relative health benefits or impacts of each project on the region's population. Given that MTC evaluated around 80 different projects, this simple tool allowed for a quantitative assessment of potential health outcomes in the region.

Small MPOs and rural agencies with minimal financial and technical resources may find this tool helpful for modeling health outcomes.

Here is a link to the World Health Organization's examples of the use of HEAT for cycling:

http://www.euro.who.int/en/health-topics/environment-and-health/Transport-and-health/activities/guidance-and-tools/health-economic-assessment-tool-heat-for-cycling-and-walking/examples-of-applications-of-heat.

Integrated Transport and Health Impact Model (ITHIM)

The Integrated Transport and Health Impact Model (ITHIM) was developed at the University of Cambridge, England, in 2009. ITHIM is a scenario-based health risk analysis tool that models three health pathways related to travel behavior: physical activity from active transportation, road traffic injuries, and Particulate Matter (PM) 2.5 concentrations. Health outcomes are expressed in terms of change in deaths and years of life-shortening and of living with disability from major chronic diseases and road traffic injuries. ITHIM has 15 inputs aggregated from travel and health surveys, travel demand and air pollution models, mortality and disease data, and road traffic injuries. ITHIM is a free, open-source, spreadsheet tool (Excel) with detailed technical documentation for use, calibration, and integration with travel demand models. Extensions are available for cost-benefit, equity, and downscaling. Analysis can be conducted at the county or regional scale.

The California version of ITHIM was co-developed in 2011 by the California Department of Public Health and the University of Cambridge with assistance from the University of California, Davis. ITHIM has been calibrated for the major MPO regions of California (MTC, SACOG, SCAG, SANDAG, San Joaquin Valley), incorporating the latest data from the California Household Transportation Survey 2012.

ITHIM has been field-tested on behalf or in collaboration with several California MPOs. These include SANDAG, MTC, and FresnoCOG. In carrying out this work, interfaces between MPO travel demand models and ITHIM have been created. The use-cases of ITHIM include quantifying MPO preferred and alternative scenarios during SCS development. At MTC, where a specific health goal was set for project performance, ITHIM was used to quantify the health benefits of achieving that goal. MTC has also used ITHIM to assess health and equity impacts of scenarios on high and low income groups. ITHIM has examined the health impacts of scenarios using backcasted goals for physical activity based on the U.S. Surgeon General's recommendation for daily physical activity for adults and for specific carbon reductions. UC Davis has participated in local implementations of ITHIM in Fresno and Sacramento counties with community-based organizations.

Outside of California, ITHIM has been in routine use since 2012 in Oregon by the Oregon state health department and the Oregon Department of Transportation (GreenStep model). In collaboration with the Centers for Disease Control, the Nashville, TN MPO implemented ITHIM as part of their 2013 regional transportation plan update. Different types of technical and development support are being provided by the California Department of Public Health, other state health departments, MPOs that have implemented ITHIM, and an international ITHIM developer's group, which include academic and independent researchers.

The following table provides general information and resources for ITHIM:

Uses	Estimates how changes in active and motorized travel across a population will impact premature mortality, chronic disease, and road traffic injuries, due to changes in physical activity, traffic-related fine particulate pollution, and traffic collisions. The model monetizes prevented deaths and disability using two different methods: cost of illness and value of a statistical life
Data Inputs Needed	ITHIM uses regional data from health surveys, traffic collision databases, vital statistics, and the results of regional models for travel demand, vehicle emissions, and air pollution.
Lowest Applicable Level of Geography	The model has been calibrated for the major regions in California that correspond to the counties served by MTC, SCAG, SANDAG, and SACOG. There is a Fresno County and San Joaquin Valley versions. Regional results can be geographically downscaled to counties and city level. The model is not yet suitable for project level assessments, but has used output of travel demand models to assess equity of health outcomes in economically disadvantaged subpopulations within regions.
Resources/Contact	CA Dept. of Public Health - Office of Health Equity cchep@cdph.ca.gov

California Statewide Public Health Assessment Model (C-PHAM)

The California Statewide Public Health Assessment Model (C-PHAM) was developed by Urban Design 4 Health (UD4H). It is a neighborhood/city scale public health scenario modeling tool for California's five major urban centers: San Francisco Bay Area, Los Angeles, San Diego, Sacramento, and Fresno. C-PHAM can be run from the land-use matrix developed using the Urban Footprint Scenario Planning tool, allowing quick approximations of public health co-benefit from land use changes suggested through local or MPO planning processes. C-PHAM is an evolving tool and currently the model does not include potential health risks from air pollution exposure and potential bicycle/pedestrian injury. At present, the model uses adult data but expansion to include the demographic cohorts of children and seniors is being pursued.

Uses	Provides rough, small area estimates of health benefits from land use and transportation changes.
Data Inputs Needed	-Urban Footprint Scenario Planning model forecasted land use changes OR -Minutes of Transportation-related physical activity in baseline and plan/project scenario.
Lowest Applicable Level of Geography	-ballpark estimates can be provided at a very small (neighborhood level) geography. Results are more reliable at larger (zip code) geographies.
Resources/Contacts	Urban Design 4 Health info@ud4h.com

Key Terms

a. **Community Resilience:** A measure of the sustained ability of a community to utilize available resources to respond to, withstand, and recover from adverse situations[8].

b. **Disadvantaged Community:** See Vulnerable Populations definition. Disadvantaged Community refers to communities that are currently experiencing or have experienced historic disadvantage due to income, race, ethnicity, language, residency status, environment, education, or other indicators of social status. Today in California, the term Disadvantaged Community is being used by state, regional, and some local agencies to allocate funding.

c. **SB 535 Disadvantaged Community:** Senate Bill 535 (De Leon, Chapter 830, Statutes of 2012) added Section 39711 of the Health and Safety Code which specifies that Disadvantaged Communities are identified based on geographic, socioeconomic, public health, and environmental hazard criteria, and may include, but are not limited to, either of the following:

    (a) Areas disproportionately affected by environmental pollution and other hazards that can lead to negative public health effects, exposure, or environmental degradation.

    (b) Areas with concentrations of people that are of low income, high unemployment, low levels of homeownership, high rent burden, sensitive populations, or low levels of educational attainment.

d. **Displacement:** Displacement manifests itself in many forms from physical (i.e. demolition, evictions or service disruption) to economic (i.e. rent increases). Displacement can result from gentrification when neighborhoods become out of reach for people or can occur at earlier stages through disinvestment, increasing vacancies and facilitating demographic turnover[9]. The detrimental effects of displacement include relocation costs, longer commutes, disruptions to health care, loss of community support networks, and homelessness. All of this impacts mental and psychological well-being[10].

e. **Environmental Justice:** Efforts to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of programs, policies, and activities on low-income and minority populations. Environmental justice at FHWA means "*identifying and addressing disproportionately high and adverse effects of the agency's programs, policies, and activities on minority and low-income populations to achieve an equitable distribution of benefits and burdens. This includes the full and fair participation by all potentially affected communities in the transportation decision-making process.*"

f. **Gentrification:** Gentrification is generally described as that which happens in neighborhoods that are seeing decreases in the number of low-income people and

[8] Community Resilience. RAND Corporation. http://www.rand.org/topics/community-resilience.html

[9] http://www.urbandisplacement.org/resources

[10] "Development without Displacement: Resisting Gentrification in the Bay Area." Causa Justa :: Just Cause and Alameda County Public Health Department, Place Matters Team. August 2014.

people of color due to an influx of high-income individuals and families who are willing and able to pay higher rents.[11]

g. **Health:** Refers to physical, mental, and oral health.[12]
h. **Health Equity:** Efforts to ensure that all people have full and equal access to opportunities that enable them to lead healthy lives.[13]
i. **Health Inequity:** Disparities in health that are not only unnecessary and avoidable but, in addition, are considered unfair and unjust.[14] Health inequities are rooted in social and environmental injustices that make some population groups more vulnerable to poor health than other groups.[15]
j. **Healthy Communities:** A healthy community as described by the U.S. Department of Health and Human Services Healthy People 2010 report is one that continuously creates and improves both its physical and social environments, helping people to support one another in aspects of daily life and to develop to their fullest potential. Healthy places are those designed and built to improve the quality of life for all people who live, work, worship, learn, and play within their borders -- where every person is free to make choices amid a variety of healthy, available, accessible, and affordable options.[16]
k. **Social Equity:** The just and fair inclusion into a society in which all can participate, prosper, and reach their full potential[17].
l. **Vulnerable Population:** Includes the economically disadvantaged, racial and ethnic minorities, the uninsured, low-income children, the elderly, the homeless, those with human immunodeficiency virus (HIV), and those with other chronic health conditions, including severe mental illness[18].

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[11] "Development without Displacement: Resisting Gentrification in the Bay Area." Causa Justa :: Just Cause and Alameda County Public Health Department, Place Matters Team. August 2014.
[12] "The Landscape of Opportunity: Cultivating Health Equity in California." California Pan-Ethnic Health Network. October 2016.
[13] http://www.cdph.ca.gov/programs/Documents/CDPHOHEDisparityReportAug2015.pdf
[14] "The Concepts and Principles of Equity and Health." World Health Organization Regional Office for Europe. 2000.
[15] "The Concepts and Principles of Equity and Health." World Health Organization Regional Office for Europe. 2000.
[16] "Health and Healthy Places." U.S. Centers for Disease Control & Prevention. https://www.cdc.gov/healthyplaces/about.htm
[17] PolicyLink, Equity Definition: http://www.policylink.org/about
[18] "Vulnerable Populations: Who Are They?" American Journal of Managed Care, 2006. http://www.ajmc.com/journals/supplement/2006/2006-11-vol12-n13suppl/nov06-2390ps348-s352

Resources and Citations

http://sgc.ca.gov/pdf/HiAP_Task_Force_Report-_Dec_2010.pdf

https://www.cdph.ca.gov/programs/Documents/Healthy_Community_Indicators_Core_
list10-17-14Table1-5.pdf

https://www.cdph.ca.gov/Documents/CDPH_Healthy_Community_Indicators1pager5-
16-12.pdf

https://www.cdph.ca.gov/programs/Pages/HealthyCommunityIndicators.aspx#TechInfo

https://planning-org-uploaded-media.s3.amazonaws.com/document/State-of-Health-
Impact-Assessment-in-Planning.pdf

https://www.transportation.gov/transportation-health-tool

https://www.transportation.gov/mission/health/strategies-interventions-policies

http://phasocal.org/ca-hdi/

http://scagrtpscs.net/Documents/2016/proposed/pf2016RTPSCS_PublicHealth032816.
pdf

http://t4america.org/docs/planning-for-a-healthier-future-0616.pdf

http://www.transformca.org/sites/default/files/Healthy%20RTP%20-%20FULL%20-
%202013-02-19%20Color.pdf

http://narc.org/wp-content/uploads/Public-Health-and-Transportation-Info-0606121.pdf

http://www.fhwa.dot.gov/planning/health_in_transportation/resources/healthy_comm
unities/mpohealth12122012.pdf

http://www.fhwa.dot.gov/planning/health_in_transportation/resources/movinghealthy.pdf

http://www.trbhealth.org/

http://sgc.ca.gov/pdf/HiAP_Task_Force_Report-_Dec_2010.pdf

https://www.cdph.ca.gov/programs/Documents/Healthy_Community_Indicators_Core_lis
t10-17-14Table1-5.pdf

https://www.cdph.ca.gov/Documents/CDPH_Healthy_Community_Indicators1pager5-16-12.pdf

https://www.cdph.ca.gov/programs/Pages/HealthyCommunityIndicators.aspx#TechInfo

https://planning-org-uploaded-media.s3.amazonaws.com/document/State-of-Health-Impact-Assessment-in-Planning.pdf

https://www.transportation.gov/transportation-health-tool

https://www.transportation.gov/mission/health/strategies-interventions-policies

http://phasocal.org/ca-hdi/

http://scagrtpscs.net/Documents/2016/proposed/pf2016RTPSCS_PublicHealth032816.pdf

http://www.sdforward.com/pdfs/RP_final/AppendixQ-WhitePapers.pdf

http://t4america.org/docs/planning-for-a-healthier-future-0616.pdf

http://www.transformca.org/sites/default/files/Healthy%20RTP%20-%20FULL%20-%202013-02-19%20Color.pdf

http://narc.org/wp-content/uploads/Public-Health-and-Transportation-Info-0606121.pdf

http://www.fhwa.dot.gov/planning/health_in_transportation/resources/healthy_communities/mpohealth12122012.pdf

http://www.fhwa.dot.gov/planning/health_in_transportation/resources/movinghealthy.pdf

http://www.trbhealth.org/

http://www.saferoutespartnership.org/sites/default/files/pdf/CaseStudy_ActiveTransportationPlanningattheRegionalLevel.pdf

http://www.saferoutespartnership.org/sites/default/files/pdf/The_Final_Active_Primer.pdf

http://saferoutespartnership.org/sites/default/files/pdf/RegionalGovernmentPrimer-v5.pdf

http://www.saferoutespartnership.org/sites/default/files/pdf/Local_Policy_Guide_2011.pdf

http://saferoutespartnership.org/resources/report/intersection-active-transportation-equity http://www.apha.org/topics-and-issues/transportation/public-health-and-equity-principles-for-transportation

https://saferoutescalifornia.files.wordpress.com/2012/11/hip_healthequitymetrics_impacts_table_11_16_12.pdf

http://www.psrc.org/transportation/bikeped/health-in-transportation-planning/

http://www.nashvillempo.org/regional_plan/health/

http://www.mapc.org/public-health

http://www.changelabsolutions.org/sites/default/files/Health_Transport_Factsheet_FINAL_20110713_%28rebrand_20130409%29.pdf

http://portal.hud.gov/hudportal/HUD?src=/program_offices/economic_resilience/sustainable_communities_regional_planning_grants

https://www.sustainablecommunities.gov/

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Appendix L

Planning Practice Examples

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Appendix L Contents

Introduction

This appendix aggregates planning practice examples and resource information into a single location organized by topic area. The examples contained in this appendix are not intended to establish baseline standards but rather serve to highlight exemplary, state of the art planning practices that Metropolitan Planning Organizations (MPOs) can seek to emulate in their planning processes as financial and technical resources allow.

Efforts have been made to highlight planning practices that are being undertaken by large, medium, and small MPOs in both rural and urban areas throughout the state. It is important to note that this appendix represents a snapshot of available resources and planning practices representative of the time at which these guidelines were prepared.

Coordination with Other Planning Processes

Regional Transportation Plans (RTPs) are prepared within the context of many other planning processes conducted by federal, state, and local agencies. This section provides resources associated with planning processes that are used by state, federal and local agencies such as Caltrans, the Federal Highway Administration, and local jurisdictions to further their respective goals and objectives associated with the California Transportation Plan, the federal Partnership for Sustainable Communities, and local General Plans. As the RTP is bound by fiscal constraint, the strategies, actions, and improvements described in this section are intended to inform the development of the RTP and should be considered to the maximum extent feasible.

Please see **Section 2.7** in the RTP Guidelines for additional information on these areas.

Smart Mobility Framework

The Caltrans Smart Mobility Framework (SMF) is a key strategic tool for integrating transportation with land use, to develop healthy and livable communities through multi-modal travel options, reliable travel times, and safety for all users of the transportation system. Additional Smart Mobility Framework information and resources are available at the following links:

http://www.dot.ca.gov/transplanning/ocp/sm-framework.html

http://smartmobilityca.org/

Planning for Public Health and Health Equity

Please see **Section 2.3** and **Appendix L** for resources and planning practice information regarding the consideration of public health and health equity in the regional transportation planning process.

Complete Streets

The term “Complete Street” refers to a transportation network that is planned, designed, constructed, operated, and maintained to provide safe mobility for all users including: bicyclists, pedestrians, transit and rail riders, as well as commercial vehicles and motorists appropriate to the function and context of the facility. Complete Streets policies and practices are best implemented with a comprehensive and integrated approach of all agencies involved, taking advantage of opportunities for synergies and cost savings such as restriping when repaving.

General Complete Streets background, resources, and practice information at the state and national level:

Smart Growth America offers an interactive resources data base which offers information and case studies on a variety of mobility topics including Complete Streets: https://smartgrowthamerica.org/resources/

The National Complete Streets Coalition provides success stories, frequently asked questions, examples, and resources including sample presentations here: http://www.completestreets.org/

The National Complete Streets Coalition provides a map with states and local jurisdictions that have adopted complete streets policies: https://smartgrowthamerica.org/program/national-complete-streets-coalition/

Safe Routes to Schools National Partnership Complete Streets resources are available here: http://saferoutespartnership.org/state/bestpractices/completestreets

The guide Complete Streets: Making Roads Safe and Accessible for All Users (Safe Routes to Schools National Partnership, 2013) provides information on Complete Streets policies in underserved communities.

A Complete Intersections Guide can be downloaded from the Caltrans Pedestrian Safety Resources website: http://nacto.org/docs/usdg/complete_intersections_caltrans.pdf

Accommodating Bicycle and Pedestrian Travel: A Recommended Approach is a policy statement adopted by the United States Department of Transportation (USDOT). USDOT hopes that public agencies, professional associations, advocacy groups, and others will also adopt this approach as a way to promote the integration of bicycling and walking into the transportation main stream: http://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/design.cfm

The American Planning Association Knowledge Center offers Complete Streets applied research resources: http://planning.org/research/streets/

The AARP Complete Streets Archive provides reports, case studies, presentations and more.

State-Level Plans addressing Complete Streets:

http://www.californiatransportationplan2040.org/

http://www.cabikepedplan.org/

Regional Planning Practice Examples of Complete Streets Policies:

Large/Urban MPO Examples:

The following link contains a case study in the SCAG region of how MPOs can integrate neighborhood electric vehicles into a complete streets policy:

http://www.scag.ca.gov/sb375/pdfs/FS/cs-SouthBayStrategy.pdf

The following links contains planning practice examples of integrating Complete Streets Policies in the Metropolitan Transportation Commission (MTC) bay-area region and the San Diego Region:

http://mtc.ca.gov/our-work/plans-projects/bicycle-pedestrian-planning/complete-streets

http://www.sandag.org/index.asp?classid=12&projectid=521&fuseaction=projects.detail

Small/Medium and Rural MPO Examples:

Tahoe Metropolitan Planning Organization and the Tahoe Regional Planning Agency developed the following Complete Street Resource Guide:

http://tahoempo.org/activetransportationplan/docs/appendices/Appendix%20A_Complete%20Street%20Resource%20Guide.pdf

Local Planning Guidance for Complete Streets

Governor's Office of Planning and Research General Plan Guidelines:

https://www.opr.ca.gov/s_generalplanguidelines.php

Regional Travel Demand Modeling & Analysis

Please see **Section 3.5** for resources and planning practice information regarding travel demand modeling and analysis for the preparation of an RTP.

RTP Consultation and Coordination

Public Participation Plan

The purpose of the Public Participation Plan is to establish the process by which the public can participate in the development of regional transportation plans and programs. Please see **Section 4.1** in the RTP Guidelines for Statutory requirements associated with Public Participation Plan development and the public input process for preparing the RTP.

Exemplary planning practice examples of MPO Public Participation plans and processes include incorporating public participation strategies in the RTP that ensure members of the public are engaged throughout the development of the RTP. Given the complex nature of transportation planning, MPOs can use public participation as a way to ensure local residents and community-based organizations are active participants at each step of the process. Open-invite roundtables and/or on-going advisory committees are one way that MPOs can seek public input throughout the process.

Various MPOs have developed on-going advisory committees that included a wide range of interests including representation from historically underserved communities and rural areas. These advisory committees met regularly throughout the development of the RTP to ensure the document reflected the goals of the community. Other MPOs used on-line educational survey tools and games in addition to workshops, roundtables, and phone surveys, to allow the public to balance their priorities for the region. Additional information and specific examples are provided below:

Large/Urban MPO Examples:

Metropolitan Transportation Commission Public Participation Plan
http://www.mtc.ca.gov/get_involved/participation_plan.htm

Sacramento Area Council of Governments Public Participation Plan
http://www.sacog.org/sites/main/files/file-attachments/public_participation_plan_2013.pdf

SANDAG Public Involvement Plan:
http://www.sandag.org/uploads/projectid/projectid_428_15559.pdf

Small/Medium/Rural MPO Example:

Kern Council of Governments Online Educational Survey Game
http://www.directionsto2050.com/

To the extent that it is practicable and resources are available, the Draft RTP as well as any comments received to the draft could be posted on the MPO website in a way that is easily accessible to the public. The table below provides links to the websites of all eighteen California MPO's:

MPO Name	Website
Association of Monterey Bay Area Governments	www.ambag.org
Butte County Association of Governments	www.bcag.org
Fresno Council of Governments	www.fresnocog.org
Kings County Association of Governments	www.kingscog.org
Kern Council of Governments	www.kerncog.org
Merced County Association of Governments	www.mcagov.org
Madera County Transportation Commission	www.maderactc.org
Metropolitan Transportation Commission	www.mtc.ca.gov
Sacramento Area Council of Governments	www.sacog.org
San Diego Association of Governments	www.sandag.org
San Joaquin Council of Governments	www.sjcog.org
San Luis Obispo Council of Governments	www.slocog.org
Santa Barbara County Association of Governments	www.sbcag.org
Shasta Regional Transportation Agency	www.srta.ca.gov
Southern California Association of Governments	www.scag.ca.gov
Stanislaus Council of Governments	www.stancog.org
Tulare County Association of Governments	www.tularecog.org
Tahoe Metropolitan Planning Organization	http://www.trpa.org/transportation/

Title VI, Environmental Justice, and Social Equity Considerations in the RTP

This section includes planning practices relevant to the requirements described in Chapter 4, especially sections 4.2, 4.3 and 4.4. These requirements include conducting a social equity analysis to ensure that any planned regional transportation improvements do not have a disproportionately high and adverse impact on low income or minority populations, and to ensure that the plan will not result in the denial of, reduction in, or significant delay in the receipt of benefits by minority or low-income populations.

In order to identify and address (if further mitigation measures or alternatives are feasible that would reduce the disproportionately high and adverse effects) disproportionately high and adverse effects of programs, policies, and activities on minority and low-income populations to achieve an equitable distribution of benefits and burdens in the RTP, MPOs are called upon to (1) *identify which populations and communities are low income or minority*, and to (2) *determine what metrics they will use to measure the benefits* and burdens to those populations and communities. They are then called up to (3) *conduct an appropriate social equity analysis*, as discussed in section 4.2. Finally, (4) *a public participation* is required to ensure that the RTP planning process succeeds in "seeking out and considering the needs of low-income and minority households."

Planning practices relevant to each of these requirements are collected here:

1.) Identifying protected communities:

FTA Circular 4703.1 emphasizes the importance of understanding a community when addressing environmental justice, both in identifying low income and minority communities through the use of Census data and in engaging with potentially impacted residents and community-based organizations. In defining a unit of geographic analysis, a study area "must be appropriate to the scope of the plan, program, or project to determine disproportionate burdens on EJ versus non-EJ populations." As such, MPOs ought to "make reasonable efforts to identify the presence of distinct minority and/or low-income communities residing both within, and in close proximity to, the proposed project or activity and to identify those minority and/or low income groups who use or are dependent upon natural resources that could be potentially affected by the proposed action." This may involve analysis that summarizes impacts for areas with the highest concentration of EJ populations or potential burdens within an MPO's service area.

One particular approach, pioneered by the U.S. Department of Housing and Urban Development (HUD), for identifying especially impacted communities, is known as "Racially Concentrated Areas of Poverty." HUD's definition is "a geographic area with significant concentrations of poverty and minority populations." The concept is flexible and can be readily adapted to local conditions. For instance, in Minnesota's Twin City region, the Metropolitan Council provides a two-step definition for Areas of Concentrated Poverty. The first, contiguous census tracts where at least 40% of residents live in households with incomes below 185% of the federal poverty line. The second, a refinement of HUD's concept which further identifies, as particularly vulnerable, Areas of Concentrated Poverty where at least 50% of the residents are people of color.

2.) Defining "benefits" and "burdens" to those protected communities:

While there is some federal guidance on candidate social equity performance measures, the measures can vary according to regional goals. Examples of performance measures that have been used by California MPOs are:

- Share of population within 1/4 or 1/2 mile of transit
- Travel Time
- Active Transportation' infrastructure
- Share of transportation system usage by population type
- Physical activity (time or distance) walking/biking
- Distribution of investments
- Combined housing / transportation affordability
- Gentrification / displacement
- Access to employment
- Access to parks or open space
- Access to medical or health care facilities
- Access to primary or secondary schools
- Access to higher education
- Access to grocery stores
- Air quality - localized (near roads, ports, rail yards, etc.)
- Traffic safety - active modes
- Air quality - regional distribution
- Roadway noise

Some of these performance measures are intended to help evaluate whether a particular population will be more heavily burdened than others if the RTP is implemented, while others are intended to indicate whether some groups will glean more benefits than others if the RTP is implemented. Based on factors such as community input, availability of the necessary data, technical capabilities of the MPO, and likely accuracy of the results of the analysis, each MPO through outreach to and consultation with residents of affected communities can choose these or other measures best suited to its region.

In addition, non-governmental organizations have identified planning examples from other contexts. One example is guidance the California Air Resources Board (ARB) has provided on the implementation of SB 535 (De León).[19] ARB's GGRF Funding Guidelines require implementing agencies to "give priority to those [investments] that maximize benefits to disadvantaged communities" by "favor[ing the] projects which provide … the most significant benefits" to them. More specifically, the Guidelines require that every investment intended to benefit a disadvantaged community "provide[] direct, meaningful, and assured benefits to one or more disadvantaged communities."

[19] That statute requires that "a minimum of 25 percent" of moneys in the Greenhouse Gas Reduction Fund go "to projects that provide benefits to" disadvantaged communities and "a minimum of 10 percent … to projects located within" those communities. Health & Saf. Code § 39713.

ARB's Funding Guidelines[20] define the benefit a GGRF investment must provide under SB 535 as "a benefit that *meaningfully addresses an important community need*" in a disadvantaged community.[21] ARB's definition of "benefit" is also directly relevant to the crafting of an equity and EJ analysis of the RTP, as discussed in the next section. In addition, ARB's Funding Guidelines require that "projects be designed to *avoid substantial burdens*, such as physical or economic displacement of low-income disadvantaged community residents and businesses or increased exposure to toxics or other health risks."[22]

3.) Conducting the social equity analysis:

Many California MPOs have conducted environmental justice and social equity analyses in their respective RTP/SCS reports. Federal and state agencies have also compiled best practices in environmental justice and equity analysis in various topic areas from RTPs across the nation[23]. Efforts are underway by SANDAG[24], in partnership with other regional transportation planning agencies and Caltrans, to develop a Social Equity Analysis Method (SEAM) and a Social Equity Analysis Tool (SEAT) to assist with RTP development. This project, which is partly funded by a Caltrans Partnership Planning grant, will produce a tool that MPOs and RTPAs could use when assessing benefits and burdens on various 'social equity focus' (SEF) populations (e.g. low income and minority groups) that are expected to occur if the programs and projects in an RTP are implemented. The final version of the SEAT is expected to be complete in the first quarter of 2018 and will include up to eight performance measures – some of which will measure relative benefits and others that will measure relative burdens. The goal is to provide an analysis tool with functionality in a GIS-based application that can be used by agencies throughout the state.

MPOs also can work with environmental justice and social equity stakeholders through the RTP/SCS outreach process to develop additional measures and analyses to illustrate and identify the historical and current conditions of transportation and land use for low income and minority communities to ensure future transportation investments will not further cause disproportional impacts to those communities.

As MPOs seek to respond to the needs and concerns of low-income and minority communities, a planning practice from another (non-RTP) context that MPOs may incorporate comes from the U.S. Department of Housing and Community Development (HUD) rule on "affirmatively furthering fair housing" (or AFFH). AFFH looks at

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[20] Air Resources Board, Cap-and-Trade Auction Proceeds Funding Guidelines for Agencies that Administer California Climate Investments (Dec. 2015), p. 2.A-6, available at http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/fundingguidelines.htm

[21] *Id*., p. 2-6. *See id*., p. 1.A-12 (requiring reporting on "disadvantaged community benefits and … strategies the agency will use to maximize benefits" to them).

[22] *Id*. p. 2-12.

[23] Examples include: http://dot.ca.gov/hq/LocalPrograms/saferoutes/EnvironmentalJusticeDeskGuideJan2003.pdf, http://www.fhwa.dot.gov/environment/environmental_justice/resources/, http://www.fhwa.dot.gov/environment/environmental_justice/case_studies/

[24] SANDAG Statewide Social Equity project description: http://sdforward.com/ContinuingActions/SocialEquityEnvJustice.aspx.

neighborhood-level transportation and transit access, educational and economic opportunity, and environmental health factors.[25]

The AFFH begins with assessing "the elements and factors that cause, increase, contribute to, maintain, or perpetuate segregation, racially or ethnically concentrated areas of poverty, significant disparities in access to opportunity, and disproportionate housing needs."[26] The basic methodology for HUD's AFFH rule includes the following steps:

1. Identify, with robust community engagement, current patterns and conditions of segregation, racially concentrated poverty, disparities in access to opportunity, and disproportionate housing needs, utilizing data HUD provides and other relevant regional data;
2. Identify key contributing factors of the patterns and conditions identified;
3. Prioritize the most significant contributing factors and set goals that will meaningfully address the high priority factors, with "metrics and milestones" for each goal;
4. Tailor near-term actions and investments consistent with those goals; and
5. Measure progress over the near term. (24 C.F.R. § 5.154(d) (2), (3), (4), (5) and (7).)

The HUD rule is discussed in a recent letter that the Secretary of the U.S. Department of Transportation issued with the Secretaries of HUD and the U.S. Department of Education.[27] That letter emphasized the relevance of transportation to the issues of segregation, access to opportunity, and racially-concentrated poverty, and encouraged transportation agencies (including MPOs) nationally to integrate the principles and goals of AFFH into their decision-making. In particular, the letter called on transportation agencies to "identify impediments to accessing opportunity" and to "coordinate efforts to address" issues of segregation and opportunity.[28] In considering whether to align its equity analysis with the Assessment its local jurisdictions are called up to conduct, an MPO will have the opportunity to ensure coordination regionally of local actions to identify and address current conditions of inequity.

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[25] HUD, Assessment Tool (Public Dec. 31, 2015) at 8, available online at https://www.huduser.gov/portal/sites/default/files/pdf/Assessment-of-Fair-Housing-Tool.pdf (last accessed July 12, 2016).

[26] 24 C.F.R. § 5.154 (a).

[27] The Tri-Agency letter, issued on June 3, 2016, is available at https://www2.ed.gov/documents/press-releases/06032016-dear-colleagues-letter.pdf.

[28] The letter states: "Today, our agencies are calling on local education, transportation, and housing leaders to work together on issues at the intersection of our respective missions in helping to guarantee full access of opportunity across the country. Our goals are to identify impediments to accessing opportunity; to coordinate efforts to address these issues and to provide broad-reaching benefits; and to ensure that every child and family is provided with transportation, housing, and education tools that promote economic mobility. The new process in which communities are engaging under the Affirmatively Furthering Fair Housing rule (AFFH rule) from HUD provides an opportunity for cross-agency collaboration and strong community involvement. We urge you to take full advantage of the community participation process of the AFFH rule, so that regional planning promotes economic mobility and equal access to the many benefits provided by affordable housing, great schools, and reliable transportation."

Public Engagement Practices for "Seeking Out and Considering the Needs of Low-income and Minority Households":

Building on the emphasis of public engagement outlined in FTA Circular 4703.1, it is recommended that MPOs "ensure the full and fair participation by all potentially affected communities in the transportation decision-making process….Understanding the needs and priorities of environmental justice populations will also help…to balance the benefits of the proposed project against its adverse effects." If an adverse effect is "predominantly borne by an EJ population, or will be suffered by the EJ population and is appreciably more severe or greater in magnitude than the adverse effect that will be suffered by the non-EJ population", engagement with an affected community can help to identify an appropriate strategy to mitigate, reduce, avoid, and/or offset adverse effects. Public outreach is, therefore, an essential component of an MPO's environmental justice efforts and should employ strategies to increase engagement in the transportation decision-making process from low income and minority populations. Specific strategies covering location, timing, content, format, noticing, and accessibility requirements of public outreach meetings are detailed in Chapter III of FTA Circular 4703.1.

MPOs can encourage the involvement of low-income communities and communities of color by proactively seeking the input of these households and by making public meetings as accessible as possible. Public engagement strategies to promote inclusion of these communities may include:

- Conduct education and outreach before beginning the formal input process;
- Provide all materials related to the update with adequate time for public review and input.
- Provide early and ongoing drafts for public review to ensure transparency.
- Proactively work with and/or provide financial support, as resources allow, to community-based and membership organizations across the region to help engage low-income residents and residents of color in the public process and to jointly plan public workshops or other engagement opportunities.
- Form an advisory group on Environmental Justice, Social Equity and/or Disadvantaged Communities that includes policy and community-based organizations that are focused on social equity in the region to provide feedback throughout the RTP process.
- Ensure that community residents have the opportunity to deliberate together to achieve consensus on their most pressing needs and recommendations.
- Hold meetings at accessible locations and outside of traditional working hours (e.g. evenings and weekends);
- Locate meetings in low-income communities and communities of color;
- Locate meetings at sites accessible via affordable transit;
- Translate meeting materials for non-English speakers;
- Consider the needs to low-income and individuals with limited English proficiency when translating outreach materials and ensuring that documents are easy to understand (i.e. evaluate the reading level of the materials and quality of translations);
- Technology and the Internet can reach many people, but recognize that not everyone has access to the Internet and an email address and that efforts should be made to reach individuals in other ways;
- Provide interpretation at meetings for non-English speakers;

- Create resident advisory committees or roles within existing committees with decision-making authority and identify opportunities for disadvantaged communities to serve as representatives on decision-making bodies;
- Expand the list of potential partners to include: schools, the faith community, agriculture and food hubs, local business or chambers of commerce, health providers and public health sectors, funders/philanthropy, academia, and environmental health/justice advocates, libraries, law enforcement, parks and recreation, and the technology industry;
- Create a feedback loop to provide community members information about how their input was included in any drafts and reasons for including/excluding the input;
- Make sure that there is agreement between residents and the local planning authority about what community engagement includes;
- Educate and build capacity of community members on issues such as data, evaluation, storytelling, and mentoring community members new to the process;
- Use a community health worker or promotora model to identify resident leaders;
- Use facilitators with experience in race and power inequities at community meetings;
- Work with community-based and membership organizations across the region to jointly plan public workshops on the RTP, especially the Title VI and Environmental Justice analyses. They know the communities impacted by the RTP transportation projects and can assist with recruiting residents, businesses and other affected stakeholders. Be proactive in asking for their participation instead of waiting for them to come to you; and,
- Ensure meetings are attended by MPO decision makers in addition to MPO staff.

Exemplary planning practice examples of MPO efforts to address Title VI, Environmental Justice, and Social Equity Considerations in the RTP are provided below:

Large/Urban MPO Examples:

http://planbayarea.org/the-plan/plan-details/equity-analysis.html

http://www.scag.ca.gov/programs/Pages/EnvironmentJustice.aspx

http://www.sdforward.com/pdfs/RP_final/AppendixH-SocialEquityEngagementandAnalysis.pdf

Statewide Social Equity Analysis Tool:

SANDAG, through a Caltrans Strategic Partnership Grant, is collaborating with large and small MPOs and RTPAs in the state to develop a tool that can be used for conducting Social Equity Analyses for regional plans throughout the state of California.
Currently agencies use varied approaches when conducting a social equity analyses of regional plans such as RTPs and the SCSs required by SB 375. There is not a widely accepted tool used by regional and local agencies to model the burdens and benefits of regional plans and the projects they encompass to consistently evaluate environmental justice outcomes expected to result from a plan or project. This project calls for identification of best practices being used by regional agencies to analyze proposed plans and covered projects and development of a Social Equity Analysis Methodology

(SEAM) and Social Equity Analysis Tool (SEAT) for statewide use. For more information visit: http://sdforward.com/ContinuingActions/SocialEquityEnvJustice.aspx

Small/Medium and Rural MPO Examples:

To help ensure diverse and direct input from all populations especially those with the most potential to be affected by health inequities, Fresno Council of Governments (FresnoCOG) administers a "Community-Based Mini-Grant Outreach Program[29]," which competitively awards mini-grants ($1,000 - $3,000) to community-based organizations, schools, and other groups to conduct outreach to individuals not typically involved in the regional transportation planning process. The selected organizations conduct outreach activities such as organizing and tailoring meetings, customizing presentations materials, building trust and removing barriers to participation to secure public involvement from stakeholders in their communities and the populations they currently serve, engaging them in the planning process and generating feedback on the development of the RTP and SCS.

Additional statewide examples of stakeholder engagement strategies are also compiled in the following report developed by ClimatePlan:
Leading the Way: Policies and Practices for Sustainable Communities

Private Sector Involvement

Private sector involvement refers to engaging the goods movement industry and other business or commercial interests in the development of the RTP. Trucks, freight trains, taxis, limousines, and shared mobility companies all use the transportation network and are an integral part of the regional transportation system. Other examples of private sector entities to engage in the development of the RTP include Transportation Management Associations, private transit operators, developers, and Chambers of Commerce. Private sector involvement informs the regional transportation planning process can contribute to greater efficiency of the planned transportation network.

Exemplary planning practice examples of MPO efforts to engage the private sector in RTP development are provided below:

Large/Urban MPO Examples:

http://www.sacog.org/regional-plans

The National Highway Institute offers training on engaging the Private Sector in Freight Planning:
http://www.nhi.fhwa.dot.gov/training/course_search.aspx?sf=0&course_no=139009

[29] Administered as a contractual arrangement with community based consultants for outreach services that is subject to the federal procurement process. See: http://www.fresnocog.org/sites/default/files/publications/RTP/RTP_Mini_grant_app_Fresno_COG.pdf

Consultation with Interested Parties

The US DOT defines consultation as when: "*one or more parties confer with other identified parties in accordance with an established process and, prior to taking action(s), considers the views of the other parties and periodically informs them about action(s) taken*." Some areas of consultation could include transportation, land use, employment, economic development, housing, community development and environmental issues. Consultation requirements for the RTP are outlined in **Section 4.6**.

Large/Urban MPO Examples:

http://rtpscs.scag.ca.gov/Pages/default.aspx
Exemplary planning practice examples of MPO consultation efforts are provided below:

Small/Medium and Rural MPO Example:

http://www.sjcog.org/index.aspx?nid=181

Native American Tribal Government Consultation and Coordination

California is home to many non-federally recognized tribes as well as Native Americans living in urban areas. MPOs should involve the Native American communities in the public participation processes. Establishing and maintaining government-to-government relations with federally recognized Tribal Governments through consultation is separate from, and precedes the public participation process. Tribal Consultation requirements for the RTP are outlined in **Section 4.9**.

US DOT Order 5301.1 ensures that programs, policies and procedures administered by the US DOT are responsive to the needs and concerns of Native Americans. This Order provides a very thorough overview of the various Federal regulations and Executive Orders on this subject. This Order is available at:

http://environment.fhwa.dot.gov/guidebook/vol2/5301.1.pdf

It is recommended that federally and non-federally recognized Tribal Governments be consulted when historic, sacred sites, subsistence resources or traditional collecting properties are present in the MPOs jurisdiction.

An exemplary planning practice example of MPO Tribal Consultation efforts is provided below:

http://www.sdforward.com/pdfs/RP_final/AppendixG-TribalConsultationProcessforSanDiegoForward-CommunicationCooperationandCoordination.pdf

Consultation with Resource Agencies

Current federal regulations require MPOs to consult with resource agencies, State and local agencies responsible for land use management, environmental protection, conservation, and historic preservation concerning the development of the RTP. As part of SCS development, MPOs must gather and consider the best available scientific information on resource areas and farmlands within the region. State and federal resource agencies may be able to assist MPOs by providing data, maps, or other information. Detailed information regarding Resource Agency Consultation during RTP development is available in **Section 4.10**.

Transportation agencies and resource agencies have developed methods to better incorporate resource issues into transportation planning processes to benefit both transportation planning and project delivery as well as ecological outcomes. Two examples of processes are:

1) FHWA's *Eco-logical Approach* organizes current methods for addressing natural resource identification, avoidance, minimization and mitigation into a systematic, step-wise process that starts at the beginning of the transportation planning process and concludes with establishing programmatic approaches to recurring natural resource issues that are implemented at the project level. FHWA has developed an implementation approach called Integrated Eco-logical Framework (IEF), a nine-step, voluntary framework for partners to collaborate, share data, and prioritize areas of ecological significance. Implementing IEF at a regional scale during RTP development would allow for early coordination with resource agencies and other key stakeholders to establish a Regional Ecosystem Framework. This approach is also consistent with Regional Advance Mitigation Planning (RAMP) models developed by the RAMP Statewide Working Group.

   https://www.environment.fhwa.dot.gov/ecological/ImplementingEcoLogicalApproach/default.asp

   https://rampcalifornia.water.ca.gov/

2) AB 2087 (Levine, 2016) establishes a pilot study program for a conservation planning tool called a Regional Conservation Investment Strategy (RCIS). The purpose of the RCIS is to promote the conservation of species, habitats and other natural resources and enable advance mitigation for public infrastructure projects, including transportation. An RCIS provides a voluntary, non-regulatory assessment and analysis of conservation needs in a region including habitat connectivity and climate resilience. Transportation agencies can use an approved RCIS to secure mitigation credit for conservation investments consistent with the RCIS through a Mitigation Credit Agreement (MCA). Pursuant to AB 2087, an RCIS pilot study program is presently under development and all RCISs and MCAs must be approved prior to January 1, 2020.

Exemplary planning practice examples of Resource Agency consultation efforts and resulting planning products are provided below:

Large/Urban MPO Examples:

The San Diego Association of Governments' *TransNet* Environmental Mitigation Program (EMP), funded by local sales tax dollars, is unique in that it goes beyond traditional mitigation for transportation projects by including a funding allocation for habitat acquisition, management, and monitoring activities as needed to help implement the Multiple Species Conservation Program (MSCP) and the Multiple Habitat Conservation Program (MHCP) which are developed through extensive consultation with resource agencies. Information regarding the *TransNet* EMP is available at:

http://www.sandag.org/index.asp?projectid=263&fuseaction=projects.detail

The Southern California Association of Governments' (SCAG) recently approved SCS Appendix on Natural and Farm Lands is a prime example of successful consultation with environmental agencies and stakeholders. SCAG established an Open Space Conservation Working Group (which included resource agencies), developed a comprehensive database with resources for county transportation commissions, local governments and other planning agencies to use in their conservation and mitigation planning processes, along with a report to provide context. The SCAG SCS Appendix is available at:

www.scagrtpscs.net/Documents/2016/final/f2016RTPSCS_NaturalFarmLands.pdf

Small/Medium and Rural MPO Examples:

Butte County Association of Government's (BCAG) RTP/SCS and Regional Conservation Plan. BCAG adopted the Butte County Regional Conservation Plan (Plan), a regional Natural Community Conservation Plan/Habitat Conservation Plan (NCCP/HCP), to streamline the development and mitigation associated with public and private development in the planning area. BCAG's RTP/SCS is built around a set of general plans designed to be consistent with the Regional Conservation Plan. Preparation and adoption of the Regional Conservation Plan required extensive resource agency coordination with the planning signatories upon issuance of federal and state permits along with the Plan.

http://www.buttehcp.com/

Integrating Ecological Considerations into Transportation Planning and Project Delivery

This section discusses regionally important natural resources such as farmlands and habitat corridors that should be identified during the development and update process of RTPs, in order to more effectively implement transportation projects during the environmental review and permitting processes. This should not be considered a comprehensive list of environmental resources to consider in planning and early project development nor is this intended to include a comprehensive list for regulatory review. For a list of environmental resources to consider during environmental review, please see **Chapter 5** of these Guidelines.

Addressing Resource Areas and Farmland in the RTP

As a planning practice to comply with the requirements of CA Government Code 65080 (b)(2)(B), MPOs, based on locally and regionally significant considerations, are encouraged to develop a Regional Open Space and Conservation Area Framework that identifies and considers "resource areas" and "farmland" as defined in Government Code Section 65080.01(a) and (b). To demonstrate consideration of resource areas and farmland, the SCS could 1) identify regional priority areas for conservation and mitigation efforts, based upon existing publicly available information and developed in consultation with the appropriate resource agencies including cities and counties, 2) adopt a land use forecast structured around spatially explicit, complementary networks of priority conservation areas and priority development areas, and 3) commit discretionary funding for conservation and development incentives for such areas. For an example of this approach, see Plan Bay Area: http://planbayarea.org/the-plan/adopted-plan-bay-area-2013.html

Another way to demonstrate consideration of resource areas and farmland is to 1) incorporate layers representing all categories of "resource areas" listed in Government Code Section 65080.01(a) and (b), as well as other key resources identified in HCPs, NCCPs and input from leading conservation organizations, and 2) treat these layers as constraints to development in land use scenarios and the adopted land use forecast. This low-cost, straightforward approach was pioneered by the Santa Barbara County Association of Governments (using a "Regional Greenprint" of GIS layers representing habitat, agricultural resources and other open space areas), and the Tulare County Association of Governments (using layers from the San Joaquin Valley Greenprint).

Regional Conservation Planning Strategies to Address Potential Impacts

Landscape conservation planning takes a proactive approach, identifying priority mitigation and conservation areas in advance of impacts, with the goal of preserving larger areas of higher habitat quality and connectivity. This type of advance planning also results in a more efficient and streamlined permitting approach for development projects. Advance mitigation, Natural Community Conservation Planning, mitigation banking, and in-lieu fee programs are all examples of landscape conservation planning in California. Generally speaking, all take a long-range, regional approach to mitigation and conservation planning. By working on a regional level, rather than project-by-project, state and federal agencies can work together and in cooperation with regional and local agencies to offset the environmental impacts of several planned infrastructure projects at once. https://www.wildlife.ca.gov/Conservation/Planning

Policies and Regulations

The following is a list of national and state policies that support and enable regional conservation planning efforts in California:

National

- Department of the Interior, Order No. 3330 "Improving Mitigation Policies and Practices of the Department of the Interior (Secretary Sally Jewell, 2013);" and
- Presidential Memorandum "Mitigating Impacts on Natural Resources from Development and Encouraging Related Private Investment" (Nov 2015).
- FHWA policies to encourage integration of natural resources in the planning process: https://www.environment.fhwa.dot.gov/integ/index.asp

State

- California Endangered Species Act and Natural Community Conservation Planning Act (NCCP Act)

Tools and Frameworks

The following is a list of tools and frameworks available for regional conservation planning that can be integrated into planning processes at a regional scale:

- Regional Advance Mitigation Planning (RAMP) - Advance mitigation planning to identify areas for mitigation prior to project-by-project discussion is an exemplary planning practice. Regional Advance Mitigation Planning (RAMP) is an important example of such efforts. By coordinating early with agencies responsible for project-level permitting to evaluate the individual and cumulative impacts of one or several projects and focusing mitigation on regional priority conservation opportunities, ecosystem-scale conservation needs can be met, providing more effective conservation and mitigation. In addition, the time and cost inefficiency of project-by-project review, permitting, and mitigation can be avoided thereby making mitigation more efficient. MPOs may consider using RAMP in siting and mitigating for infrastructure projects, in order to maximize time efficiency, reduce mitigation costs, and protect regional natural resources;
- Regional Conservation Investment Strategies (RCIS) and Mitigation Credits Agreements (MCA) – Assembly Bill 2087 (Levine, 2016), established an RCIS pilot study program in California that is presently under development. An RCIS must be proposed by a public agency and would provide a voluntary process and framework to guide investments in natural resource conservation, infrastructure, and will identify priority locations for compensatory mitigation on a regional basis. Once an RCIS has been approved by the California Department of Fish and Wildlife as a pilot project, a Mitigation Credit Agreement can be established. Once established, RCISs and subsequent MCAs can provide a regional mitigation framework for RTPs and subsequent transportation projects. All RCISs and MCAs must be approved prior to January 1, 2020;
- For additional information regarding regional open space conservation please see the following EPA website - http://www.epa.gov/dced/openspace.htm.

The following is a list of regional Habitat Conservation Plan/NCCPs (HCP/NCCP) and other resources:

- CA Department of Fish and Game Natural Community Conservation Planning information - There are currently 13 approved NCCPs (includes 6 subarea plans) and 22 NCCPs in the active planning phase (includes 10 subarea plans), which together cover more than 7 million acres and will provide conservation for nearly 400 special status species and a wide diversity of natural community types throughout California - https://www.wildlife.ca.gov/Conservation/Planning/NCCP/Plans;
- USFWS Endangered Species Habitat Conservation Planning Information https://www.fws.gov/endangered/what-we-do/hcp-overview.html
- Pacific Southwest Region USFWS Offices for Ecological Information http://www.fws.gov/cno/es/
- Sacramento FWS Office list of Regional Habitat Conservation Plans - https://www.fws.gov/sacramento/es/Habitat-Conservation-Plans/es_hcp.htm

- Carlsbad FWS Office information regarding Regional Habitat Conservation Plans http://www.fws.gov/carlsbad/HCPs/CarlsbadCFWORegionalHCPs%20.html
- Ventura FWS Office information regarding Regional Habitat Conservation Plans https://www.fws.gov/ventura/endangered/habitatconservation/index.html
- Information regarding City and County Zoning Ordinances - https://www.opr.ca.gov/docs/PZD2012.pdf
- Information regarding Farmland Mapping and Williamson Act www.conservation.ca.gov/dlrp/fmmp;
- Information regarding adopted Open Space Elements is available through the Governor's Office of Planning and Research (OPR) California Planner's Book of Lists - https://www.opr.ca.gov/s_publications.php

Statewide Examples

Aggregated planning practice examples of the consideration of environmental resources in transportation planning from throughout California can be found in the Sustainable Communities Strategies and Conservation report:

http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/california/sustainable-communities-strategies-and-conservation.pdf

The following represent additional planning practice examples of how regions have conducted regional conservation planning efforts focusing on resource areas and farmland as part of their RTP process:

Large/Urban MPO Examples:

- SANDAG's Environmental Mitigation Program (EMP) - An excellent example of this approach is SANDAG's EMP, which is funded through the region's TransNet sales tax measure. The EMP directs mitigation resources to habitat identified in adopted conservation plans, leverages funding from conservation partners, and saves additional money by acquiring habitat "early, at lower prices, and in larger parcels" (http://www.keepsandiegomoving.com/EMP/EMP-intro.aspx). For more information, please see San Diego Forward: The Regional Plan http://www.sdforward.com/;
- Orange County Transportation Authority (OCTA) EMP http://www.octa.net/Projects-and-Programs/Measure-M/Measure-M2-(2011-2041)/Freeway-Mitigation/Conservation-Plan/;
- Rural-Urban Connections Strategy (RUCS) developed by SACOG: http://www.sacog.org/rucs/
- SCAG's preparation of a Conservation Framework and Assessment (Jan 2015)- http://sustain.scag.ca.gov/Sustainability%20Portal%20Document%20Library/SCAG%20Final%20Conservation%20Framework%20%20Assessment_Feb.pdf;
- SCAG's 2016 RTP/SCS preparation of Natural and Farm Lands Appendix - www.scagrtpscs.net/Documents/2016/final/f2016RTPSCS_NaturalFarmLands.pdf

Medium/Small/Rural MPO Examples:

- Butte County Association of Government's (BCAG) RTP/SCS and Regional Conservation Plan - BCAG adopted the Butte County Regional Conservation Plan (Plan), a regional Natural Community Conservation Plan/Habitat Conservation Plan (NCCP/HCP), adopted recently to streamline the development and mitigation associated with public and private development in the planning area. BCAG's RTP/SCS has identified Regional Conservation Plan development and implementation strategies during transportation projects. Preparation and adoption of the Regional Conservation Plan required extensive resource agency coordination with the planning signatories upon issuance of federal and state permits along with the Plan. For more information, see Butte County Metropolitan Transportation Plan & Sustainable Communities Strategy: http://www.bcag.org/Planning/RTP--SCS/index.html;
- AMBAG incorporated a Regional Greenprint Analysis into its 2014 MTP/SCS: http://www.ambag.org/programs-services/planning/metro-transport-plan;
- San Joaquin Valley Greenprint, sponsored by Fresno COG: www.fresnocog.org/san-joaquin-valley-greenprint-program;
- Tulare County Association of Governments (using layers from the San Joaquin Valley Greenprint) - 2014-2040 Regional Transportation Plan & Sustainable Communities Strategy for Tulare County http://www.tularecog.org/rtp2014/.
- Santa Barbara County Conservation Blueprint – A process led by the Land Trust of Santa Barbara County is underway and leading an effort of data gathering and community engagement process leading to a Conservation Blueprint that will provide a science based decision-making platform for conservation, including restoration and other land management decisions. The process is led by Land Trust for Santa Barbara County, Cachuma Resource Conversation District, and the Santa Barbara Foundation's LEAF Initiative, and is guided by a 12-member Steering Committee; http://www.aginnovations.org/project/santa-barbara-county-conservation-blueprint. For more information, see Santa Barbara's 2040 Regional Transportation Plan and Sustainable Communities Strategy: http://www.sbcag.org/rtp.html;
- The Land Trust of Santa Cruz County developed a Conservation Blueprint (http://www.landtrustsantacruz.org/blueprint/) for the county which is being integrated with Santa Cruz County's RTP and regional planning processes. Specifically, Santa Cruz County's Conservation Blueprint is the basis for developing an advance mitigation planning framework via an EMP within the 2014 RTP development process - http://sccrtc.org/funding-planning/long-range-plans/rtp/2014-plan.
- The Elkhorn Slough Early Mitigation Partnership (ESEMP) is a Caltrans-sponsored interagency effort to provide early mitigation for a series of future transportation improvement projects within the Elkhorn Slough Watershed. This project seeks to help address regional scale conservation in a manner that also can help facilitate project delivery by developing a process for identifying funding strategies and implementing conservation agreements earlier than would be possible through existing traditional channels - http://elkhornslough.ucdavis.edu/.

Aquatic and Terrestrial Habitat Connectivity

A functional network of connected wildlands is essential to the continued support of California's diverse natural communities in the face of human development and climate change. Natural and semi-natural components of the landscape must be large enough and connected enough to meet the needs of all species that use them, including species' continued need for movement, migration, and shifts in distribution. The California Essential Habitat Connectivity Project developed guidance for mitigating the fragmenting effects of roads and transportation corridors and a framework for developing regional and local connectivity plans (California Essential Habitat Connectivity Project 2010).

Policies and Regulations

The following is a list of national and state policies that support and enable habitat connectivity planning efforts in California:

National

- Federal Endangered Species Act and species recovery plans that identify habitat fragmentation and road mortality as risks to species recovery

State

- AB 498 (Levine, 2015) regarding Wildlife Conservation and Wildlife Corridors which amends California Fish and Game Code Sections 1797.5, 1930, and 1930.5;
- CEQA Guidelines and Migratory Species – "Will the project interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites;"
- California State Wildlife Action Plan and Transportation Companion Plan - https://www.wildlife.ca.gov/swap; and
- SB 857 (Kuehl, 2006) applies to State Highway System transportation projects and details requirements for assessing and remediating barriers to fish passage at stream crossings along the State Highway System. A coordinated and comprehensive fish passage improvement program is fundamental to restore unimpeded passage for aquatic organisms and for the success of habitat restoration activities.

Tools and Data

There are GIS habitat modeling tools and datasets that are available to consider and integrate into the RTP update process. These can be integrated into the RTP update itself as well as with future transportation projects identified in RTPs. The following is a list of tools and datasets available for planning decisions:

Statewide

- California Essential Connectivity Project (2010) https://www.wildlife.ca.gov/conservation/planning/connectivity/CEHC;
- California Protected Areas Database www.calands.org; and
- California Fish Passage Assessment Database (PAD) http://www.calfish.org/

Regional

- Bay Area Critical Linkages - http://www.scwildlands.org/;
- South Coast Linkages - http://www.scwildlands.org/;
- California Desert Connectivity Project - http://www.scwildlands.org/; and
- CDFW's Northern Sierra Nevada Foothill connectivity mapping project https://www.wildlife.ca.gov/Data/Analysis/Connectivity.

Examples

The following are examples of various RTPs and other long-range transportation plans that have integrated habitat connectivity resources and natural resource mapping into their planning processes:

- AMBAG's Monterey Bay Area Sensitive Resource Mapping Project with 2035 RTP/SCS Update. AMBAG received SHRP2 (C06) federal highway research funds to apply FHWA's Integrated Ecological Framework (IEF) to their Moving Forward Monterey Bay 2035 Plan and planning process. The goal was to identify sensitive resources in the AMBAG region to provide managers with a better understanding of potential conflicts and mitigation needs for transportation projects in the 2035 Plan. AMBAG created on on-line interactive GIS database with this project and developed 32 sensitive resource maps for the AMBAG region and used in the Environmental Mitigation section of the RTP/SCS 2035 Plan update;
- Caltrans District 5 Highway 17 Transportation Concept Report – http://www.dot.ca.gov/dist05/planning/sys_plan_docs/factsheets_datasheets/SR17/17_tcr.pdf;
- Caltrans District 5 Regional Wildlife and Habitat Connectivity Plan for the Central Coast Region of California – http://www.dot.ca.gov/dist05/planning/AdvWildlifeConnectivity.htm; and
- Santa Cruz County Regional Transportation Plan - Conservation planning efforts, such as the Conservation Blueprint, developed by the Land Trust of Santa Cruz County, and the Wildlife Habitat Connectivity GIS database, developed by Caltrans and partner agencies, support regional mitigation and can serve as a resource for future mitigation plans in Santa Cruz County. This data is being integrated into the RTP 2014 of Santa Cruz County and AMBAG's RTP/SCS.

RTP Financial Overview

Federal statute and regulations and California State statute requires RTPs to contain an estimate of funds available for the 20-year planning horizon. This discussion of financial information is fundamental to the development and implementation of the RTP. The financial portions of the RTP identify the current and anticipated revenue sources and financing techniques available to fund the planned transportation investments described in other portions of the RTP. The intent is to define realistic financing constraints and opportunities. All projects, except illustrative projects i.e. unconstrained projects, must be fully funded in order to be included in the RTP. With this financing information, alternatives are developed and used by the MPO, local agencies and State decision-makers in funding transportation projects. Detailed information regarding RTP financial requirements is available in **Sections 6.2 – 6.7**.

Fiscal Constraint

http://www.sandag.org/index.asp?projectid=292&fuseaction=projects.detail

http://www.scag.ca.gov/rtp2004/2004/FinalPlan.htm

Listing of Constrained and Un-constrained Projects

http://www.mtc.ca.gov/planning/2035_plan/

Revenue Identification and Forecasting

http://www.bcag.org/Planning/index.html

Estimating Future Transportation Costs

In keeping with the Federal and State efforts to streamline the project delivery and NEPA review process at the project level by providing environmental information at the earliest point in time, it is recommended that the RTP also include a preliminary cost estimate for the mitigation activities that are identified.

Asset Management

To ensure a sustainable transportation system, MPOs are encouraged to address existing infrastructure condition and performance prior to considering expansion of the system. This general approach is considered a best practice that will ensure that the agencies funding for the transportation will be adequate to sustain the system into the future.

RTP Modal Discussion

Transit

Los Angeles Metro, First and Last Mile Strategic Plan, identified strategies and potential funding sources for improving the areas surrounding transit stations to make it easier and safer for people to access them. SCAG incorporated some of these strategies into its 2016 RTP/SCS as well as short trips strategies to increase the number of trips under three miles that people take by foot or bike. The plan is available at:

http://media.metro.net/docs/sustainability_path_design_guidelines.pdf

Bicycle & Pedestrian

The use of bicycles and walking as a means of transportation has increased dramatically in California over the last 20 years. Both modes of transportation promote a healthy lifestyle and reduce environmental impacts.

Bicycle and Pedestrian planning practice information and resources are available at the following links:

"At the Intersection of Active Transportation & Equity" (Safe Routes to Schools National Partnership, 2015) http://saferoutespartnership.org/resources/report/intersection-active-transportation-equity

"Urban Bikeway Design Guide" (National Association of City Transportation Officials, 2014) http://nacto.org/publication/urban-bikeway-design-guide/

Local and Regional plans for bicycle and pedestrian trails and related facilities, including the California Coastal Trail should be supported by RTPs. Additional planning practice information regarding the California Coastal Trail is available at the following links:

Completing the California Coastal Trail Plan – California Coastal Conservancy
http://www.coastal.ca.gov/access/coastal-trail-report.pdf

Information regarding California Coastal Trail Definition and Design and Siting Standards is available at:
http://www.scc.ca.gov/webmaster/pdfs/CCT_Siting_Design.pdf

Goods Movement (Maritime/Rail/Trucking/Aviation)

MPOs are encouraged to consider developing or updating freight plans for their region, as these plans can help MPOs improve the efficiency and sustainability of goods movement in their regions.

http://www.dot.ca.gov/hq/tpp/offices/ogm/

http://rtpscs.scag.ca.gov/Pages/default.aspx

http://www.alamedactc.org/goodsmovement

http://www.ops.fhwa.dot.gov/Freight/infrastructure/nfn/index.htm

http://www.sandag.org/index.asp?classid=13&fuseaction=home.classhome

California Sustainable Freight Action Plan

In July 2015, Governor Brown issued Executive Order B-32-15 which prioritizes California's transition to a more efficient and less polluting freight transportation system. This transition of California's freight transportation system is essential to supporting the State's economic competitiveness in the coming decades while reducing greenhouse gas emissions and air quality impacts. The Executive Order directed State agencies to develop an integrated action plan by July 2016 that established clear targets to improve freight efficiency, transition to zero-emission technologies, and increase the competitiveness of California's freight system. It is suggested that regional transportation agencies consult the California Sustainable Freight Action Plan when developing the freight-related strategies in their respective RTPs. For more information see: http://www.dot.ca.gov/casustainablefreight/

California Freight Mobility Plan

The state's California Freight Mobility Plan (CFMP) is a policy and action agenda document that supports the improvement of California's goods movement infrastructure while preserving the environment. MPOs are encouraged to review the CFMP for

guidance, and ensure consistency while addressing goods movement within their RTPs. The RTPs and the CFMP will ideally function in a feedback loop, as the goods movement strategies and projects identified in RTPs will be incorporated into the next update of the CFMP. For more information see:
http://www.dot.ca.gov/hq/tpp/offices/ogm/cfmp.html

Regional Aviation System

MPOs should consider including the following aviation planning topics in the development of their RTPs:

1. An overview of the role that all public use airports including both commercial, and general aviation airports, heliports, and military airfields play in the region's multimodal transportation system.
2. Describe the functional relationship between the region's airports, and heliports, and explain specific RTP policies that support and preserve the long term viability of the region's airports.
3. Identify current airport conditions such as noise, safety, and future airport improvement projects that can be found in either an airport's layout plan, or master plans.
4. Provide a list of all public-use airports, including their State functional class developed by the Division of Aeronautics for all commercial and general aviation airports, and military installations in the region, and a description of their facilities and uses, and a map of their location.
5. Provide a discussion of any future airport(s) growth and improvement needs found in each airport's master plan or airport layout plan.
6. A discussion of multimodal ground access issues and any required ground access program or plan.
7. A separate list of short (5 year) and long-range (10 year) Airport Capital Improvement Plan (ACIP) projects within the region.
8. Identify which governing body serves as each county's ALUC for the region established pursuant to PUC 21670(a), as well as the title and date of the most current ALUCPs, Airport Master Plans or Airport Layout Plans; and military Air Installation Compatible Use Zone Plans.
9. Demonstrate consistency with the State of California Office of Planning and Research's document entitled *Community and Military Compatibility Planning; Supplement to the General Plan Guidelines* (December 2009) for military installations available at:
   https://www.opr.ca.gov/docs/Military_GPG_Supplement.pdf

Additional aviation planning practice information and case studies can be found at:

http://dot.ca.gov/hq/planning/aeronaut/publication.htm

http://www.faa.gov/airports/planning_capacity/ga_study

http://www.gao.gov/products/GAO-10-120

http://www.gao.gov/products/GAO-13-261

For questions and additional information regarding the state aviation program and its airport planning activities for a specific region, please visit the Caltrans Division of Aeronautics website: http://www.dot.ca.gov/aeronaut/index.html

For additional information regarding land use compatibility concerns affecting airports, please visit the Caltrans Division of Aeronautics website:
http://dot.ca.gov/hq/planning/aeronaut/documents/alucp/

Military Airfields and Installations

As a best practice, MPOs should include a discussion of military installations transportation and land use compatibility needs in their RTPs by addressing of the following:

1. A list and map of all military airfields and installations in the region.
2. An overview of the role that these military airfields and installations play in the region including a brief description of the installation's current and future mission(s).
3. Discuss multimodal ground access needs to installations for both people and freight, as well any needed ground access programs or plans that support its needs to complete its mission(s).
4. Demonstrate consistency with California's OPR document *Community and Military Compatibility Planning; Supplement to the General Plan Guidelines* (December 2009) available at: https://www.opr.ca.gov/docs/Military_GPG_Supplement.pdf.

Additional military installation planning practices can be found at:

http://www.napawash.org/2009/1378-strengthening-national-defense-countering-encroachment-through-military-community-collaboration.html

http://militarycouncil.ca.gov/s_economicdata.php

https://www.sdmac.org/ImpactStudy.htm

http://hrtpo.org/page/military-transportation-needs

http://www.nctcog.org/trans/aviation/jlus/JLUS_bkg.asp

http://hrtpo.org/page/military-transportation-needs

http://www.nceastmgtf.org/studies-and-analyses

For questions and additional information regarding the state aviation program and its airport planning activities for a specific region, please visit the Caltrans Division of Aeronautics website: http://www.dot.ca.gov/hq/planning/aeronaut/planners.htm

Transportation System Management and Operations

A US DOT document titled; "Management & Operations in the Metropolitan Transportation Plan: A Guidebook for Creating an Objectives-Driven, Performance-Based Approach" provides a very good overview on how to integrate transportation system management and operations into the planning process. See:

http://www.ops.fhwa.dot.gov/publications/moguidebook/index.htm

In addition, the US DOT document titled, "Traffic Signal Operations and Maintenance Staffing Guidelines," provides guidelines to estimate the staffing and resource needs required to effectively operate and maintain traffic signal systems. Specifically, Chapter 1.3.1 provides a suggestion on the level of maintenance that is necessary. See: http://ops.fhwa.dot.gov/publications/fhwahop09006/fhwahop09006.pdf

Future of Transportation and New Technology

While maintaining the current transportation network is often a priority for MPOs, MPOs need to be planning ahead for a future in which technology will transform the way that people move and live. This section provides a summary of federal and State legislation to prepare for new technologies and innovations for the future of transportation. MPOs are ideally positioned to anticipate and be responsive to the needs of future generations. In addition, RTPs can also identify how the transportation network has been designed to accommodate, and promote, new technology, alternative fuels, charging stations, zero-emission technology, and emerging technology such as automated vehicles; include a discussion about incentives and implementation of these measures; and, identify how the proposed transportation network is meeting the goals and objectives of the State's Zero Emission Vehicle Action Plan.

Connected Vehicle Program

There are several activities related to the national Connected Vehicle Program that will certainly impact regional and local transportation agencies, in addition to Caltrans. Since 90% of the roadways in California are owned and operated by local agencies, including the 58 counties and more than 500 incorporated cities, it is critically important for them to be aware of and to plan for the implementation of connected vehicles.

This document explains licensing requirements transparent and best practices accessible to any organization, public or private, seeking to deploy "Connected Vehicle" Dedicated Short Range Communications (DSRC) Roadside Units (RSU) and services that support vehicle-to-infrastructure (V2I) applications.

http://ntl.bts.gov/lib/56000/56900/56950/FHWA-JPO-16-267.pdf

This guidance is intended to assist system owner/operator staff to deploy V2I technology not only in terms Federal Aid Highway program requirements but also practices to help ensure interoperability and efficient and effective planning/procurement/operations.

http://www.its.dot.gov/meetings/pdf/V2I_DeploymentGuidanceDraftv9.pdf

SANDAG's "Off-Model GHG Reduction Methodology" provides calculations and planning practices for vehicle automation assumptions:
http://www.sdforward.com/pdfs/RP_final/AppendixA_B_C.pdf

Transportation Electrification

State law encourages MPOs to promote the development of transportation electrification and the deployment of electric vehicles in their RTPs. Section 740.12 of the Public Utilities Code describes the importance of transportation electrification for meeting greenhouse gas emission reduction targets and air quality standards.

Guidance for Zero-Emission Vehicles Readiness Planning Statewide

2016 Zero Emission Vehicle Action Plan
(Governor's Interagency Working Group on Zero-Emission Vehicles):
https://www.gov.ca.gov/docs/2016_ZEV_Action_Plan.pdf

Zero-Emission Vehicles in CA: Community Readiness Guidebook and Other Resources (Governor's Office of Planning and Research, OPR):
https://www.opr.ca.gov/docs/ZEV_Guidebook.pdf
https://www.opr.ca.gov/s_zero-emissionvehicles.php

A Toolkit for Community Plug-In Electric Vehicle Readiness and Additional Resources (California Plug-in Electric Vehicle Collaborative, PEV Collaborative):
http://www.pevcollaborative.org/sites/all/themes/pev/files/docs/toolkit_final_website.pdf
http://www.pevcollaborative.org/pev-readiness

Funding for Zero-Emission Vehicle Planning and Implementation

Zero-Emission Vehicle Regional Readiness and Planning (California Energy Commission):
http://www.energy.ca.gov/contracts/GFO-16-601/

Examples of Regional Readiness Plans (Zero-Emission Vehicles and Alternative Fuels)

Upstate Plug-In Electric Vehicle Readiness Project (Shasta, Siskiyou & Tehama Counties)
http://www.siskiyoucounty.org/pev/

AMBAG Electric Vehicle Infrastructure Plan for the Monterey Bay Area
http://www.ambag.org/programs-services/planning/electric-vehicle-planning

San Joaquin Valley Plug-In Electric Vehicle Readiness Plan
https://energycenter.org/sites/default/files/docs/nav/programs/pev-planning/san-joaquin/san_joaquin_valley_pev_readiness_plan-web.pdf

Bay Area – Experience Electric Initiative
http://mtc.ca.gov/whats-happening/news/experience-electric-initiative-brings-lastest-ev-models-people

SCAG RTP/SCS Mobility Innovations Appendix:
http://scagrtpscs.net/Documents/2016/draft/d2016RTPSCS_MobilityInnovations.pdf

SCAG Plug-In Electric Vehicle Readiness Plan
https://www.scag.ca.gov/Documents/SCAG-Southern%20CA%20PEV%20Readiness%20Plan.pdf

San Diego Regional Alternative Fuel Readiness Plan:
http://www.sandag.org/uploads/projectid/projectid_487_20274.pdf

San Diego Plug-In Electric Vehicle Readiness Plan:
http://www.sandag.org/uploads/publicationid/publicationid_1817_17061.pdf

Sustainable Communities Strategy (SCS) Contents and Development

Integrating transportation, land use, and housing, in the planning process is vital to reducing regional greenhouse gas (GHG) emissions from cars and light trucks. The Sustainable Communities Strategy or SCS, was added as a new component of the RTP following the passage of SB 375 in September 2008, pursuant to Government Code Section 65080(b)(2). Detailed information on the requirements for SCS Content and Development is available in **Section 6.24 and Section 6.25**.

MPOs are required to develop a forecasted development pattern for the region that, when integrated with the regional transportation network and other transportation measures and policies, will reduce regional greenhouse gas emissions from cars and light trucks to achieve, if there is a feasible way to do so, the regional targets set by ARB.

The RTP/SCS is required to be developed in an inclusive and transparent manner pursuant to a public participation plan that meets state and federal requirements. Consistent with SB 375 and Title 23 CFR Part 450.316, the RTP/SCS development process includes involvement by all interested parties, such as walking and bicycling representatives, public health departments and public health non-governmental organizations, affordable housing advocates, transportation advocates, neighborhood and community groups, environmental advocates, home builder representatives, broad-based business organizations, landowners, commercial property interests and homeowner associations, the Native American community, neighboring MPOs and the general public through a proactive public participation process.

As part of the RTP/SCS development process, MPOs generally prepare scenarios that illustrate different long-range visions for transportation and land-use in the region. MPOs balance public input from a variety of stakeholders in the development of their RTP scenarios. Examples of how MPOs have incorporated public input into their RTP scenario development processes can be found below:

ABAG/MTC modeled the stakeholder-developed *Enhanced Network of Communities (ENC) Scenario* and the *Equity, Environment, and Jobs (EEJ) Scenario.* The ENC project list largely overlapped with the preferred scenario identified by MTC and ABAG. The EEJ list cut a number of road expansion projects in order to redirect funding to bus service, while shifting some housing production to transit oriented suburban job centers that had not volunteered for significant growth.

Fresno COG modeled Scenario D, which was built around a more compact pattern of growth that would have conserved over 4,700 more acres of farmland, rangeland, and other open space than Fresno COG's preferred scenario, while directing more growth into existing communities, especially disadvantaged rural communities.

In response to community advocates' request for a "Balanced Growth Scenario," Kern COG developed the 33% Housing Mix Alternative, under which 33% of new residential development would have gone into existing communities, and the 100% Infill Alternative.

There are various approaches that MPOs can take to develop scenarios that reflect community input. Incorporating public feedback into scenario creation, as technical and financial resources allow, is considered an exemplary planning practice that MPOs should strive for.

As a planning practice to evaluate the implementation of the land use development plan in the SCS, an on-going monitoring program and periodic reporting program could be conducted. The monitoring program could be at a sufficient spatial and temporal level of detail to satisfy several objectives: a) identify regional or sub-regional growth patterns, b) provide jurisdiction level information needed to evaluate their role in the regional plan, and c) evaluate the consistency requirement for land use projects under SB 375 CEQA streamlining.

Another planning practice is for MPOs to provide financial incentives, as feasible, to those local governments that promote land-use and affordable housing production consistent with the SCS. Those incentives can make a portion of regional transportation funding available only to those local governments that (1) adopt an HCD-certified Housing Element and commit to implement its action programs and report annually on implementation progress, (2) produce a substantial portion of their lower-income RHNA need, and (3) adopt effective tenant protections and other anti-displacement policies to ensure that high-propensity transit riders are not displaced from transit-oriented locations.

MTC's OneBayArea Grant Program (OBAG) has implemented elements of this approach. While not all agencies have the financial resources necessary to fund a discretionary grant program such as OBAG, it is an exemplary practice for MPOs to learn from. As amended in July 2016, OBAG provides a policy framework for awarding federal funding to projects that reflect regional transportation priorities and that support the goals set forth in Plan Bay Area such as:

- Conservation planning and land protection in Priority Conservation Areas
- Incentives for focused, transit-oriented growth in Priority Development Areas
- Funding for active transportation projects designed to support complete streets and safe access to transit and schools
- Grants to reward cities for providing affordable housing and to protect affordable units in low-income communities

For visualization and mapping, Urban Footprint is a planning tool which can reveal outcomes ranging from household costs, water and energy use, to loss or retention of open space. SCAG employed Urban Footprint in the 2012 RTP/SCS, accessible at:

http://www.scag.ca.gov/Documents/UrbanFootprintTechnicalSummary.pdf

Addressing Resource Areas and Farmland in the SCS

As a planning practice to comply with the requirements of CA Government Code 65080 (b)(2)(B), MPOs, based on locally and regionally significant considerations, are encouraged to develop a Regional Open Space and Conservation Area Framework that identifies and considers "resource areas" and "farmland" as defined in Government Code Section 65080.01(a) and (b). To demonstrate consideration of resource areas and farmland, the SCS could 1) identify regional priority areas for conservation and mitigation efforts, based upon existing publicly available information and developed in consultation with the appropriate resource agencies including cities and counties, 2) adopt a land use forecast structured around spatially explicit, complementary networks of priority conservation areas and priority development areas, and 3) commit discretionary funding for conservation and development incentives for such areas. For an example of this approach, see Plan Bay Area: http://planbayarea.org/the-plan/adopted-plan-bay-area-2013.html

Another way to demonstrate consideration of resource areas and farmland is to 1) incorporate layers representing all categories of "resource areas" listed in Government Code Section 65080.01(a) and (b), as well as other key resources identified in HCPs, NCCPs and input from leading conservation organizations, and 2) treat these layers as constraints to development in land use scenarios and the adopted land use forecast. This low-cost, straightforward approach was pioneered by the Santa Barbara County Association of Governments (using a "Regional Greenprint" of GIS layers representing habitat, agricultural resources and other open space areas), and the Tulare County Association of Governments (using layers from the San Joaquin Valley Greenprint).

For more information, see Santa Barbara's 2040 Regional Transportation Plan and Sustainable Communities Strategy: http://www.sbcag.org/rtp.html and the 2014-2040 Regional Transportation Plan & Sustainable Communities Strategy for Tulare County http://www.tularecog.org/rtp2014/.

To support and expand upon these practices, MPOs are strongly encouraged to help local jurisdictions integrate HCPs, NCCPs and other conservation plans into their general plans, and incorporate the results into future land use forecasts. Prior to preparing its 2012 MTP/SCS, for example, the Butte County Association of Governments (BCAG) helped four of six local jurisdictions update their general plans to be consistent with one another, and with the Butte Regional Conservation Plan (BRCP) then in development. Based in part on these plans, its 2012 land use forecast directs most new growth into a network of Urban Permit Areas designed to minimize conflict with the BRCP. Thus, by working on a voluntary basis with those who have land use planning authority, BCAG was able to lay the groundwork for a land use pattern that will help protect some of its region's most important habitat and open space.

For more information, see Butte County Metropolitan Transportation Plan & Sustainable Communities Strategy: http://www.bcag.org/Planning/RTP--SCS/index.html.

The following represent additional planning practice examples of how MPOs have conducted regional conservation planning efforts focusing on resource areas and farmland:

North County Multiple Habitat Conservation Program (MHCP) coordinated by SANDAG: http://www.sandag.org/index.asp?projectid=97&fuseaction=projects.detail

Rural-Urban Connections Strategy (RUCS) developed by SACOG: http://www.sacog.org/rucs/

Natural and Farm Lands Appendix prepared by SCAG for its 2016 RTP/SCS: www.scagrtpscs.net/Documents/2016/final/f2016RTPSCS_NaturalFarmLands.pdf

Regional Greenprint Analysis prepared by AMBAG for its 2014 MTP/SCS: http://www.ambag.org/programs-services/planning/metro-transport-plan

San Joaquin Valley Greenprint, sponsored by Fresno COG: http://www.fresnocog.org/san-joaquin-valley-greenprint-program

To realize the benefits of natural resource assessments like these, it is essential that they be thoroughly incorporated into land use scenarios and transportation project selection. In addition to the approaches taken by the Bay Area, Santa Barbara County, Tulare County and Butte County, MPOs are encouraged to follow an approach set forth in SLOCOG's first RTP/SCS: "Give conservation plans as much weight as general plans when planning transportation investments." For more information, see http://www.slocog.org/programs/regional-planning/2014-rtpscs.

The following sources of information can assist MPOs in gathering and considering the best practically available scientific information regarding resource areas and farmland:

Survey of conservation best practices in SCSs, with sample language, implementation steps and suggested performance measures for specific practices:

Sustainable Communities Strategies and Conservation: Results from the First Round and Policy Recommendations for the Future Round (Southern Sierra Partnership) http://www.southernsierrapartnership.org/scs-policy-report.html

Natural Community Conservation and Habitat Conservation Planning Information:

CA Department of Fish and Game Natural Community Conservation Planning information
http://www.dfg.ca.gov/habcon/nccp/

USFWS Endangered Species Habitat Conservation Planning Information
https://www.fws.gov/endangered/what-we-do/hcp-overview.html

Pacific Southwest Region USFWS Offices for Ecological Information
http://www.fws.gov/cno/es/

Sacramento FWS Office list of Regional Habitat Conservation Plans https://www.fws.gov/sacramento/es/Habitat-Conservation-Plans/es_hcp.htm

Carlsbad FWS Office information regarding Regional Habitat Conservation Plans
http://www.fws.gov/carlsbad/HCPs/CarlsbadCFWORegionalHCPs%20.html

Ventura FWS Office information regarding Regional Habitat Conservation Plans
https://www.fws.gov/ventura/endangered/habitatconservation/index.html

Information regarding City and County Zoning Ordinances:
https://www.opr.ca.gov/docs/PZD2012.pdf

Information regarding Farmland Mapping and Williamson Act:
www.conservation.ca.gov/dlrp/fmmp

www.conservation.ca.gov/dlrp/pages/index.aspx

Information regarding adopted Open Space Elements is available through the Governor's Office of Planning and Research (OPR) California Planner's Book of Lists:
https://www.opr.ca.gov/s_publications.php

Land Use and Transportation Strategies to Address Regional Greenhouse Gas Emissions in the RTP

MPOs are encouraged to consider and incorporate those strategies that are likely to provide the greatest level of greenhouse gas emissions reduction considering feasibility of implementation as well as the unique characteristics and needs within the region.

This section provides several, but not a complete list of many and varied resources currently available to promote reductions in greenhouse gas emissions. MPOs are encouraged to connect and consult these resources as appropriate for their region, additional information is also available in **Section 6.24**.

Pricing Strategies

(Local/State Legislation is required to implement various pricing strategies and should be researched prior to incorporating into the RTP development process)

Pricing strategies are suggested to encourage reduced driving to reduce GHG emissions, and include, but are not limited to:

1. Using alternative mode programs, congestion pricing, toll roads, and parking pricing strategies. Examples are:
   i. Road pricing and High Occupancy Toll (HOT) lanes. To reduce VMT, MPOs should model adding pricing to existing lanes, not just as a means for additional expansion. Variable/congestion pricing should be considered.
   ii. User fees such as fuel taxes and parking charges.
   iii. Free or reduced fare transit fares.
   iv. Expansion of Parking Cash-Out Programs.

v. Strategies to reduce the impacts of pricing strategies on low-income individuals.
vi. Improve the cost-efficiency of transit investments and transit operations.

2. Consider utilizing revenues from these pricing strategies for projects, such as mass transit, that improve mobility without increasing VMT or GHG emissions.

Road pricing can be found at:

"Opportunities to Improve Air Quality through Transportation Pricing Programs", U.S. Environmental Protection Agency, September 1997.
http://www.epa.gov/oms/market/pricing.pdf

"Sacramento Transportation & Air Quality Collaborative Final Report, Volume III: Supplemental Text for Agreements", December 2005.
http://www.sacta.org/pdf/STAQC/FinalReportIII.pdf

Transportation Planning and Investment Strategies

1. Consider shifting transportation investments towards improving and expanding urban and suburban core transit, programs for walkability, bicycling and other alternative modes, transit access, housing near transit, and local blueprint plans that coincide with the regional blueprint and the SCS. Although not explicitly required by law, MPOs could identify a set of indicators that will be used to assess the performance of the RTP in reaching climate and other goals, and could identify the criteria that the MPO used to select the transportation projects on the constrained and unconstrained project lists. Some examples of MPOs that have undertaken this approach include efforts by MTC and SACOG, for more information see:

MTC Plan Bay Area and Transportation Project Performance Assessment
http://planbayarea.org/the-plan/plan-details/transportation.html
http://planbayarea.org/file10305.html

SACOG 2016 Metropolitan Transportation Plan/Sustainable Communities Strategy and Planning Process:
http://www.sacog.org/general-information/2016-mtpscs
http://www.sacog.org/sites/main/files/file-attachments/chapter_2_planning_process.pdf

2. Provide funds and technical assistance to local agencies to implement blueprint strategies and the SCS.

3. Implement operational efficiencies that reduce congestion in vehicle throughput on roadways or improve transit access or other alternative access without physical expansion of the roadways.

4. Consider consulting with school districts on the regional land use plan to facilitate coordination between school siting and other land uses. This coordination could effectively reduce driving in the region. Consider school districts' facilities master plans and transportation policies in the coordination of regional planning efforts.

5. For purposes of allocating transportation investments, recognize the rural contribution towards GHG reduction for counties that have policies that support development within their cities, and protect agriculture and resource lands. Consideration should be given to jurisdictions that contribute towards these goals for projects that reduce GHG or are GHG neutral, such as safety, rehabilitation, connectivity and for alternative modes.

6. In setting priorities, consider transportation projects that increase efficiency, connectivity and/or accessibility or provide other means to reduce GHG.

7. In setting priorities, consider transportation projects that provide public health co-benefits.

8. Employ "Fix It First" policies to ensure that preventive maintenance and repair of existing transit and roads are the highest priority for spending, to reduce overall maintenance costs, and to support development in existing centers and corridors.

Land Use Strategies that Can Help Reduce Rates of VMT and Per Person Household Greenhouse Gas (GHG) Emissions

(Strategies incorporating the "D factors" - Professor Robert Cervero research)

There have been various studies and research conducted on land use and transportation strategies regarding travel that reduces driving by walking, biking, and transit use. Some of this research is known as the "Ds factors" as the variables can be described as Density, land use; Diversity, pedestrian-scale; Design, access to regional Destinations, and Distance to transit.

Professor Robert Cervero's research efforts found that certain neighborhood characteristics significantly affect the amounts and modes of travel by residents, customers and employees.

Land use strategies that typically incorporate some or all of these "D factors" include:
urban and suburban infill, clustered development, mixed land uses, New Urbanist design, transit-oriented development, and other "smart-growth" strategies. When combined with good pedestrian and bicycle facilities and transit service, such strategies can contribute to a significant reduction in per household levels of GHG emissions (Reid Ewing, Keith Bartholomew, Steve Winkelman, Jerry Walters, and Don Chen, **Growing Cooler** – The Evidence on Urban Development and Climate Change, for the Urban Land Institute, 2008.)

The Ds are Destination (proximity), Density (or clustered development), Diversity (or mixture of land uses), Distance to transit, Design, and Development scale.

Transportation Demand Management (TDM)

The Victoria Transport Policy Institute at http://www.vtpi.org/tdm/index.php contains an Encyclopedia that is a comprehensive source of information about innovative management solutions to transportation problems. It provides detailed information on various demand management strategies, plus general information on TDM planning and evaluation techniques. It is produced by the Victoria Transport Policy Institute to increase understanding and implementation of TDM.

For example, TDM-related chapters include:

- Incentives to Use Alternative Modes and Reduce Driving
- Parking and Land Use Management
- TDM Programs and Program Support
- TDM Planning and Evaluation
- Innovative and Emerging Shared Mobility Services (i.e., bikeshare, carshare, and on-demand rideshare services)

RTP policies that support Smart Growth Land Use principles

Metropolitan Transportation Commission's Best Practice Examples related to strategies 1. and 2. listed below:

MTC's T2035 Plan called for modifying our Transportation for Livable Communities (TLC) program to support Priority Development Areas which were identified as a part of FOCUS, the Bay Area's blueprint planning process. The TLC program offers capital grants to cities, counties, and transit agencies to construct projects that support compact development near transit. See:

http://mtc.ca.gov/whats-happening/news/mtc-awards-44-million-new-grants-promote-livable-communities

MTC's Resolution 3434 TOD Policy ties regional discretionary funds for new transit extension projects (funded via Resolution 3434) to supportive land uses. This policy establishes targets for new housing units in each transit corridor and calls for station area plans and corridor working groups to help achieve the housing targets. Station area plans to meet the housing targets must be adopted by local municipalities prior to receiving MTC discretionary funding for construction of Resolution 3434 funds. See:

http://mtc.ca.gov/our-work/plans-projects/other-plans/regional-transit-expansion-program

As MPOs and RTPAs work towards achieving better linkages between land use and transportation planning within their regions, both MPOs and RTPAs are highly encouraged to include within their Policy Element the following:

1. Develop investments and programs that support local jurisdictions that make land use decisions that implement as appropriate, the SCS, regional blueprints, and other strategies that will help reduce greenhouse gas emissions and improve the quality of mobility throughout the region.
2. Emphasize transportation investments in areas where forecasted development patterns indicated may result in regional greenhouse gas emissions reduction.

Additional Planning Practice Examples

Attorney General list of mitigation measures:

http://ag.ca.gov/globalwarming/pdf/GW_mitigation_measures.pdf

CAPCOA CEQA and Climate Change paper:
http://www.capcoa.org/wp-content/uploads/2012/03/CAPCOA-White-Paper.pdf

US EPA highlighted case studies for Smart Growth illustrated through open space, mixed land use and transportation choices are available at:
http://www.epa.gov/dced/case.htm

SANDAG's Regional Parking Management Toolbox contains resources for parking and demand management. The Regional Parking Management Toolbox can be found here:

http://www.sandag.org/uploads/publicationid/publicationid_1910_18614.pdf

Adaptation of the Regional Transportation System to Climate Change

MPOs should begin to address climate change in their long range transportation plans using Caltrans guidance, Cal-Adapt.org and other state resources (see Climate Adaptation Resources table). Design and planning standards should be re-evaluated to address future conditions. Where possible, MPOs and RTPAs should consult *Safeguarding California*'s transportation chapter, local general plan safety elements, local hazard mitigation plans, and other relevant local, regional, and state resources and documents. See **Section 6.30** for additional information on Climate Change Adaptation planning.

In addition, MPOs should make use of models that predict climate impacts like sea level rise, and that estimate changes in carbon stocks from alternative project or land management activities. Recent research shows that changes in land use and management can generate GHG benefits by avoiding and reducing emissions, and by increasing carbon storage. MPOs are encouraged to refer to the Climate Action through Conservation (CATC): http://scienceforconservation.org/downloads/

The model, method and tool presented in this report is usable at the county or regional scale, and can help MPOs to provide a more comprehensive account of their progress toward meeting the state's GHG reduction goals.

Large/Urban Planning Practice Example:

Southern California Council of Government's (SCAG) has developed a section on Environmental Mitigation pursuant to 23 USC Section 134 into their RTP/SCS and planning process. SCAG has also developed a Sustainability Program focused on natural resources and climate change strategies.
http://sustain.scag.ca.gov/Pages/LinksResources.aspx
http://rtpscs.scag.ca.gov/Pages/2012-2035-RTP-SCS.aspx

MTC has been conducting climate resilience studies focused on impacts to specific communities, coastlines, and transportation assets:
http://mtc.ca.gov/our-work/plans-projects/climate-change-clean-vehicles/adapting-rising-tides

SANDAG prepared a Climate Change Mitigation and Adaptation White Paper prior to adopting the 2015 RTP/SCS:
http://www.sdforward.com/sites/sandag/files/Climate_Change_White%20Paper_fwe_07142014.pdf

SACOG, prior to preparing the 2016 MTP/SCS, partnered with CivicSpark to develop the Sacramento Region Transportation Climate Adaptation Plan (SRTCAP). This plan outlines key strategies and actions the Sacramento region can take to ensure its transportation assets are adaptable to potential climate related events:
http://www.sacog.org/sites/main/files/file-attachments/fullplanwithappendices.pdf

Performance Measures

Caltrans recommends using performance measures to measure the progress of regional projects. MPOs should take into account the benefits of using performance measures to establish a base of measurement and cross-reference the measurement with the performance measure outcome/results. These measurements can be used to justify the need for funding on specific projects. The scientific data may support regional needs and highlight the justification for funding a project that demonstrates the potential for improved performance on the Caltrans system or regional road network.

Although not explicitly required by law, MPOs could identify a set of indicators that will be used to assess the performance of the RTP. In addition, the RTP could identify the criteria that the MPO used to select the transportation projects on the constrained and unconstrained project lists. Caltrans has also developed a guidebook on how to implement performance measures in rural and small urban regions. This guidebook provides a toolbox from which to select appropriate methodologies for performance measures in rural or small urban area. The Guidebook on “Performance Measures for Rural Transportation Systems” can be accessed at:

http://www.dot.ca.gov/perf

In 2011, the San Diego Association of Governments (SANDAG) received grant funding from the Strategic Growth Council to collaborate with other California MPOs and state agencies to identify common statewide performance monitoring indicators related to SB 375 implementation. While performance measures rely mostly on modeled or forecasted data, performance monitoring indicators rely directly on observed data. MPOs use travel demand models or Geographic Information Systems analyses to forecast performance measures. Ideally monitoring indicators would be considered together and be consistent with modeling performance measures.

The following table identifies nine indicators that can be monitored using statewide and regional data sources as reflected in the *Statewide Performance Monitoring Indicators for Transportation Planning Final Report* (SANDAG, 2013), available at:

http://www.dot.ca.gov/hq/tpp/offices/ocp/ATLC/documents/august_15_2013/document_links/indicator.pdf.

Table 1: Proposed Performance Monitoring Indicators

ID	Inventory Ref. (Appendix B)	MAP-21 Category	Statewide Performance Monitoring Observed Data	Performance Measure (Model Based)	Referenced In
		Congestion Reduction			
1	A-8 / A-1	VMT a. VMT per capita*	√	√	SB 375 & MAP-21
		b. Percent of Congested Freeway/ Highway Vehicle Miles **[PeMS]**	√	√	SB 375 & MAP-21
2	A-16/A-18	Mode Share (Travel to work)*	√	√	SB 375 & MAP-21
		Infrastructure Condition			
3	-	State of Good Repair a. Highways b. Local Streets c. Highway Bridges d. Transit Assets	√		MAP-21
		System Reliability			
4	A-65	Freeway/Highway Buffer Index **[PeMS]**	√	√	MAP-21
		Safety			
5	A-39	Fatalities/Serious Injuries a. Fatalities/Serious Injuries per capita* b. Fatalities/Serious Injuries per VMT*	√	√	MAP-21
		Economic Vitality			
6	C-33	Transit Accessibility (Housing and jobs within 0.5 miles of transit stops with frequent transit service)*	√	√	SB 375
7	A-84	Travel Time to Jobs	√	√	SB 375 & MAP-21
		Environmental Sustainability			
8	B-1/B-5	Change in Agricultural Land*	√	√	SB 375
9	E-5	CO_2 Emissions Reduction per capita (modeled data)*		√	SB 375 & MAP-21
	*	Indicator relates to Public Health	**[PeMS]**	Indicator for MPOs that have access to PeMS data	

The following table provides a summary of potential performance metrics for rural county Regional Transportation Planning Agencies as outlined in the report, *Transportation Performance Measures for Rural Counties in California* (Rural Counties Task Force, 2015), at:
http://www.ruralcountiestaskforce.org/Assets/Resources/PerformanceMeasures/Final_Report-PerfMonIndicators_StudySept2015.pdf

These metrics were developed according to the following criteria:

- Measurement-based rather than model-based;
- Alignment with California state transportation goals and objectives;
- Capability of informing current goals and objectives of each rural and small-urban RTPA;
- Applicability across all rural and small-urban regions;
- Capability of being linked to specific decisions on transportation investments; and
- Normalized for population to provide equitable comparisons to urban regions.

Metric	Source	Website
Vehicle Miles Traveled (VMT) Per Capita By Locality By Facility Ownership Local vs. Tourist	Mobility Reporting	http://www.dot.ca.gov/hq/traffops/sysmgtpl/MPR/index.
	California DOF	http://www.dof.ca.gov/research/demographic/reports/estimates/e
	HPMS	http://www.dot.ca.gov/hq/tsip/hpms/hpmslibrary/prd/2013prd/20 13PRD-revised.pdf
Peak V/C Ratio or Thresholds	Traffic Counts: K and D Factors	http://traffic-counts.dot.ca.gov/
Journey to Work Mode	American Community Survey	http://factfinder.census.gov/faces/nav/jsf/pages/index.xht
Total Accident Cost Per VMT Per Capita	Transportation Injury Mapping	http://tims.berkeley.edu/login.php?next=/tools/bc/main1.
	SWIRS TASAS	http://iswitrs.chp.ca.gov/Reports/jsp/userLogin.jsp Caltrans Public Information Request Form
Transit Operating Cost per Revenue Mile	Local Transit Providers	
Distressed Lane Miles Total and % Total By Jurisdiction By Facility Type	Federal Highway	http://www.fhwa.dot.gov/tpm/rule/pmfactsheet.pdf
	Regional or local pavement management system	https://www.federalregister.gov/articles/2015/01/05/2014-30085/national-performance-management-measures-assessing-pavement-condition-for-the-national-highway
Pavement Condition Index (PCI) for Local Roads	Regional or local pavement management system	
Land Use Efficiency	Farmland Mapping and Monitoring Program (FMMP) DOF Annual population estimates	http://www.conservation.ca.gov/dlrp/fmmp

Additionally, the following documents contain planning practice examples for performance based planning:

- Transform report entitled "Creating Healthy Regional Transportation Plans" (2012) contains a chapter explaining what the RTP Guidelines are, how they support healthy outcomes, and best practices for public participation. http://www.transformca.org/resource/creating-healthy-regional-transportation-plans
- The Nature Conservancy report entitled "Sustainable Communities Strategies and Conservation" includes model policies and best practices for conservation policies in SCSs. http://www.southernsierrapartnership.org/scs-policy-report.html
- The ClimatePlan report entitled "Leading the Way: Policies and Practices for Sustainable Communities Strategies:" http://www.climateplan.org/wp-content/uploads/2016/10/Leading-the-Way-Full-Report.pdf
- US DOT: Management & Operations in the Metropolitan Transportation Plan: A Guidebook for Creating an Objectives-Driven, Performance-Based Approach http://www.ops.fhwa.dot.gov/publications/moguidebook/index.htm
- FHWA Model Long-Range Transportation Plans: A Guide for Incorporating Performance Based Planning (2014) http://www.fhwa.dot.gov/planning/performance_based_planning/mlrtp_guidebook/

2017 Regional Transportation Plan Guidelines for Regional Transportation Planning Agencies

California Transportation Commission

2017
Regional Transportation Plan Guidelines for Regional Transportation Planning Agencies

Adopted by the California Transportation Commission
on January 18, 2017

Pursuant to California Government Code Section 14522

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Chapter 1

Introduction

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INTRODUCTION

1.0 Applicability of the Regional Transportation Plan Guidelines

Every Regional Transportation Planning Agency (RTPA) is required by law to conduct long range planning to ensure that the region's vision and goals are clearly identified and to ensure effective decision making in furtherance of the vision and goals. The long range plan, known as the Regional Transportation Plan (RTP), is an important policy document that is based on the unique needs and characteristics of a region, helps shape the region's economy, environment and social future, and communicates regional and vision to the state and federal government. As fundamental building blocks of the State's transportation system, the RTP should also support state goals for transportation, environmental quality, economic growth, and social equity (California Government Code Section 65041.1).

The California Transportation Commission (Commission or CTC) is authorized to develop guidelines by Government Code Section 14522, which reads:

> *In cooperation with the regional transportation planning agencies, the commission may prescribe study areas for analysis and evaluation by such agencies and guidelines for the preparation of the regional transportation plans.*

These twenty six rural RTPAs, in alphabetical order, are:

Alpine County Transportation Commission (CTC), Amador CTC, Calaveras Council of Governments (COG), Colusa CTC, Del Norte Local Transportation Commission (LTC), El Dorado CTC, Glenn CTC, Humboldt County Association of Governments, Inyo LTC, Lake County/City Area Planning Council, Lassen CTC, Mariposa LTC, Mendocino COG, Modoc CTC, Mono LTC, Transportation Agency for Monterey County, Nevada CTC, Placer County Transportation Planning Agency, Plumas CTC, Council of San Benito County Governments, Santa Cruz County Regional Transportation Commission, Sierra LTC, Siskiyou CTC, Tehama CTC, Trinity CTC, and Tuolumne CTC.

While the guidelines include both state and federal requirements, RTPAs have the flexibility to be creative in selecting transportation planning options that best fit their regional needs. The guidelines recognize that "one size does not fit all." Solutions and techniques used by a larger RTPA will be different than those used by a smaller RTPA.

The 2017 RTP Guidelines continue to use the words "Shall" and "Should", a convention established by the previous RTP Guidelines. Where the RTP Guidelines reflect a state or federal statutory or regulatory requirement, the word "Shall" is used with a statutory or regulatory citation. The word "Should" is used where the Guidelines reflect a permissive or optional statutory reference such as "May" or "Should." Each section ends with federal and state requirements (Shalls), federal and state recommendations (Shoulds), and refers to Appendix H for Planning Practice Examples where appropriate. Planning practice examples are intended to highlight exemplary, state of the art planning practices that RTPAs can seek to emulate as financial and technical resources allow.

Changes to federal statute are implemented by the Code of Federal Regulations (CFRs) that are also known as the "final rules". On May 27, 2016, the Statewide and Nonmetropolitan Transportation Planning *and* Metropolitan Transportation Planning Final Rule was issued, with an effective date of June 27, 20116, for Title 23 CFR Parts 450 and 771 and Title 49 CFR Part 613. The Federal Highway Administration (FHWA)/Federal Transit Administration (FTA) are still in the process of finalizing the remaining rules for implementation of the Moving Ahead for Progress in the 21st Century Act (MAP-21) and the Fixing America's Surface Transportation (FAST) Act. Unless otherwise noted, the RTP Guidelines will show the CFRs for MAP-21/FAST Act. The majority of citations in these guidelines refer to the implementing regulations, i.e., the CFR section.

Pursuant to 23 CFR 450.202, the CTC requires RTPAs to address federal planning regulations during the preparation of their RTPs. The federal planning regulations address metropolitan planning organizations (MPOs) and statewide/nonmetropolitan transportation planning for the State of California and the 26 rural RTPA areas of the State. The State of California addresses some of the federal statewide planning regulations through the California Transportation Plan (CTP) and the Federal State Transportation Improvement Program (FSTIP). In cases where the statewide/nonmetropolitan federal regulations do not have the same requirements as the MPO regulations, the CFR for MPOs is cited and is clearly identified as a recommendation or "should" for RTPAs.

As RTPA RTPs are updated every four or five years (including Regional Housing Needs Allocation - RHNA cycle adjustments), there is a continuous cycle of RTPs in the development and adoption stages. As RTP development is a continuous process, consideration is given to RTPAs that will be too far along in the planning process to conform their RTPs to the 2017 RTP Guidelines. All RTP updates started after the 2017 RTP Guidelines are adopted by the CTC must use the new RTP Guidelines. Furthermore, federal regulations outline the timeline for complying with MAP-21/FAST Act transportation planning requirements. Prior to May 27, 2018, an RTPA may adopt an RTP that has been developed using the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) requirements or the provisions of the Statewide and Nonmetropolitan Transportation Planning *and* Metropolitan Transportation Planning Final Rule (23 CFR Part 450 and 771 and 49 CFR Part 613). On or after May 27, 2018, an RTPA may not adopt an RTP that has not been developed according to the provisions of MAP-21/FAST Act as specified in the Planning Final Rule. RTPAs are encouraged to communicate with Caltrans to discuss schedules for RTP adoption.

1.1 <u>Why Conduct Long-Range Transportation Planning</u>?

The long range transportation planning process in regional areas is uniquely suited to address a number of federal, state, regional, and local goals, from supporting economic growth to achieving environmental goals and promoting public health and quality of life. Not only does the transportation system provide for the mobility of people and goods, it also influences patterns of growth and economic activity through accessibility to land. Furthermore, the performance of this system affects such public policy concerns as air quality, greenhouse gas (GHG) emissions, natural resources, environmental protection and conservation, social equity, smart growth, housing affordability, jobs/housing balance, economic development, safety, and security. Transportation planning recognizes the critical links between transportation and other societal goals. The planning process is more than merely a listing of multimodal capital investments; it requires developing strategies for operating, managing, maintaining, funding, and financing the area's transportation system in such a way as to advance the area's long-term goals.

Over the past ten years combating climate change has emerged as a key goal for the state of California. Starting with the passage of Assembly Bill (AB) 32, The California Global Warming

Solutions Act of 2006, the state has set aggressive goals to reduce GHG emissions responsible for climate change. AB 32 requires a reduction in state GHG emission by limiting state GHG emissions in 2020 to no more than the 1990 state emission levels. On September 8, 2016, the California Global Warming Act of 2006, was amended by SB 32 (Chapter 249, Statutes of 2016), to require a further reduction of GHG emissions to achieve a 40 percent reduction below 1990 levels by 2030. Governor Schwarzenegger's Executive Order S-3-05 and Governor Brown's Executive Order B-30-15 target a reduction of GHG emission to achieve at least a reduction of 80 percent below 1990 levels by 2050. Enacted legislation, SB 391 (Chapter 585, Statutes of 2009) directs the California Department of Transportation (Caltrans) to model how to achieve the 80 percent reduction in GHG emissions by 2050, and that modeling was included in the CTP 2040, which was released in June 2016. According to the California Air Resources Board (ARB) 2016 Mobile Source Strategy, the transportation sector accounts for nearly 50 percent of GHG emissions in California[1]. As such, the long-range transportation planning process in regional areas is evolving to address climate change goals.

In 2008, transportation planning and land use planning became further linked following the passage of Senate Bill 375 (SB 375, Chapter 728, Statutes of 2008). Even though RTPAs were not a primary focus of SB 375, RTPAs can and do contribute to the reduction of GHG. In 2013, the connection between higher density development and GHG was strengthened further yet with the passage of SB 743 (Chapter 386, Statutes of 2013) that required an update in the California Environmental Quality Act (CEQA) transportation metrics to align with climate and planning goals.

In addition, Executive Order B-30-15 directs State agencies to take climate change into account in planning and investment decisions, and employ full life-cycle cost accounting to evaluate and compare infrastructure investments and alternatives. Planning and investment shall be guided by the following principles:

- Priority should be given to actions that both build climate preparedness and reduce GHG emissions;
- Where possible, flexible and adaptive approaches should be taken to prepare for uncertain climate impacts;
- Actions should protect the state's most vulnerable populations; and,
- Natural infrastructure solutions, as defined in Public resources code 71154(c)(3) (e.g., flood plain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planning to reduce high heat days), should be prioritized.

The RTP, also called a Long-Range Transportation Plan is the mechanism used in California by RTPAs to conduct long-range (minimum of 20 years) transportation planning, integrated with local jurisdiction's land use planning, in their regions to achieve local and regional goals, in consideration of state and federal goals. Because transportation infrastructure investments have effects on travel patterns, smart investments play a key role in meeting climate targets. As

[1] This number reflects a wheel-to-well GHG estimate from aviation, construction and mining equipment, buses, heavy duty trucks, passenger vehicles, light duty trucks, rail, ships and commercial harbor craft, and the petroleum refining for transportation fuel. State law provides limited authority to RTPAs/MPOs. Collaborative planning between the state and RTPAs/MPOs is needed to meet the state's GHG reduction goals.

a result of state legislation, as well as executive orders, GHG emission reduction, transportation electrification, climate resilience, improving transportation mobility, addressing federal air quality criteria pollutants, and ensuring that the statewide regional transportation system addresses tribal, local, regional, and statewide mobility and economic needs are key priorities in the statewide and regional transportation planning process.

Equally important to consider in long-range transportation planning is how transportation can affect human health in many ways, for example: safety – reduction of collisions; air quality – reduction of vehicle emissions; physical activity – increasing biking and walking; access to goods, services, and opportunities – increasing livability in communities; and noise – designing road improvements to decrease sound exposure. A timely opportunity to address public health outcomes is early during the RTP development process. RTPAs can consider health priorities in selection of projects for the RTP. RTPAs also can play a significant role in engaging residents and stakeholders in the regional transportation planning process to ensure the improvement of health outcomes for all segments of the population.

As interest in the link between transportation and health has grown, much cross-sector coordination and collaboration between transportation professionals and health practitioners has occurred at all levels of government, with input from public health and equity advocates, as well as active transportation stakeholders. The optimal result of this process is to improve transportation decisions and thereby improve access to healthy and active lifestyles. Public health is further discussed in Section 2.3.

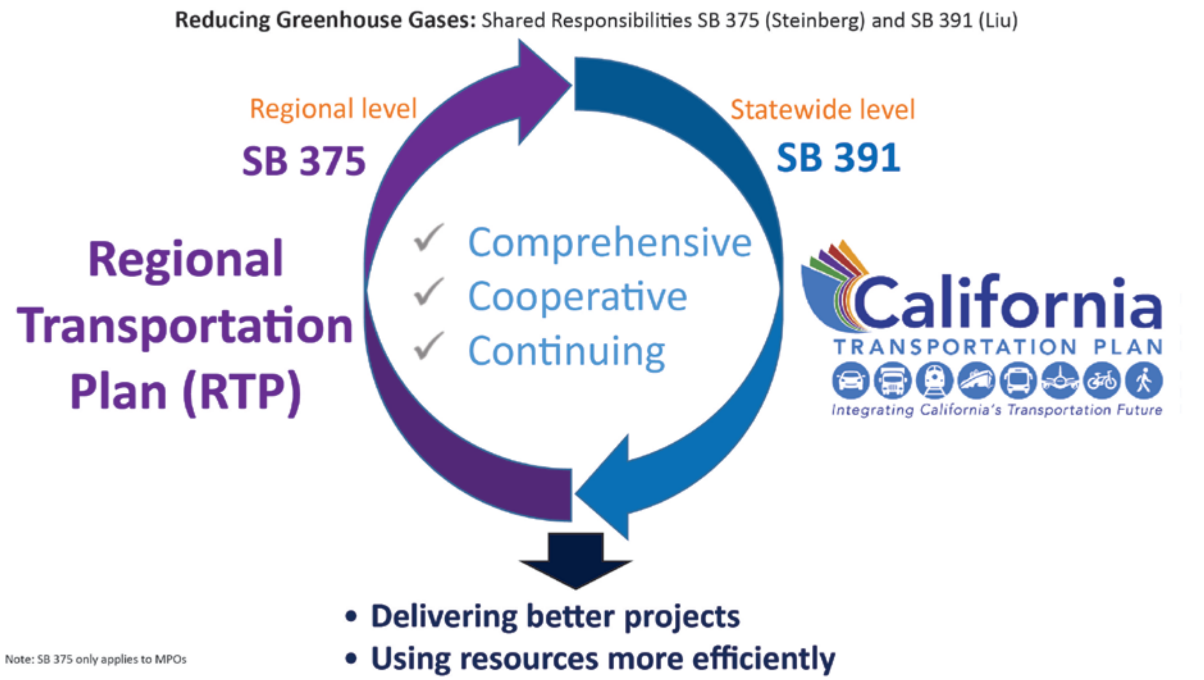
Lastly, long-range transportation planning provides the opportunity to compare alternative improvement strategies, track performance over time, and identify funding priorities. The CTP defines this as performance management that helps ensure efficient and effective investment of transportation funds by refocusing on established goals, increasing accountability and transparency, and improving project decision-making. To further reach this end, MAP-21/FAST Act requires the State, in collaboration with RTPAs, and MPOs to implement a performance-based approach in the scope of the statewide and nonmetropolitan *and* metropolitan transportation planning process. In addition to federal performance based planning, the State of California has articulated through statute, regulation, executive order, and legislative intent language, numerous state goals for the transportation system, the environment, the economy, and social equity. RTPs are developed to reflect regional and local priorities and goals, but they are also instruments that can be used by federal and state agencies to demonstrate how regional agency efforts contribute to those federal and state agencies meeting their own transportation system goals. Inclusion of goal setting in RTPs allows the federal and state governments to both understand regional goals, and track progress toward federal and state goals.

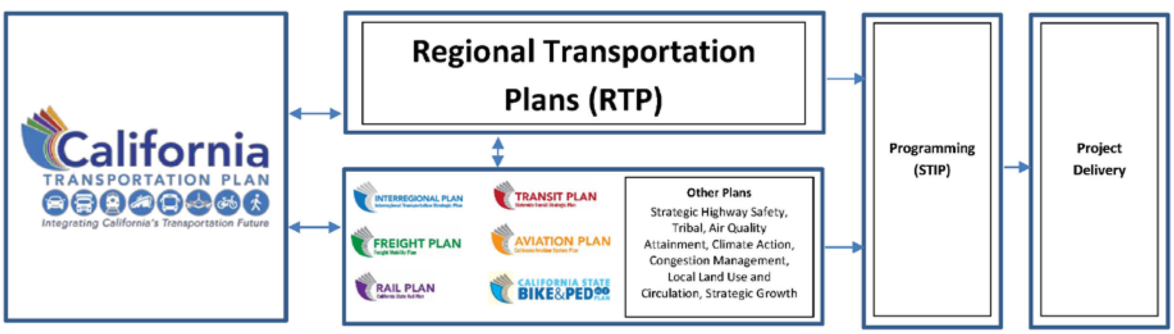
Performance-based planning is the application of performance management within the planning process to help the federal government, states and regional agencies achieve desired outcomes for the multimodal transportation system. The benefits of well-designed and appropriately used performance measures are transparency about the benefits of the RTP, not only for transportation system performance, but also for other regionally important priorities such as improved public health, housing affordability, farmland conservation, habitat preservation, and cost-effective infrastructure investment. As the performance-based approach is implemented at the federal and State levels, performance measures will continue to develop over the years to come. Transportation performance management and the performance-based approach are further discussed in Chapter 7.

1.2 RTPs & the California Transportation Plan

Similar to the SB 375 requirements for RTPs, SB 391 adds new requirements to the State's long-range transportation plan to meet California's climate change goals under AB 32. The bill requires the California Transportation Plan (CTP) to address how the state will achieve maximum feasible emissions reductions in order to attain a statewide reduction of GHG emissions to 1990 levels by 2020 and 80% below 1990 levels by 2050. The bill also requires the CTP to identify the statewide integrated multimodal transportation system needed to achieve these results and specifies that the plan take into consideration the use of alternative fuels, new vehicle technology, tail pipe emission reductions, and the expansion of public transit, commuter rail, intercity rail, bicycling, and walking. In addition, SB 391 required Caltrans to update the CTP by December 31, 2015, and every 5 years thereafter.

The CTP is a core document that addresses the applicable federal statewide and non-metropolitan transportation planning regulations and helps tie together several internal and external plans and programs to help define and plan transportation in California. Unlike the RTP, it is not project specific or subject to both federal air quality conformity regulations and CEQA, but it does look at how the implementation of the RTP/Sustainable Communities Strategy (SCS), prepared by MPOs only, and RTPs prepared by RTPAs will influence the statewide multimodal transportation system, as well as how the state will achieve sufficient emission reductions in order to meet AB 32 and SB 391. While the CTP is prepared by Caltrans, it is developed in collaboration with various stakeholders and public involvement. Furthermore, the CTP is a fiscally unconstrained aspirational policy document that integrates and builds upon six Caltrans modal plans (Interregional Plan, Freight Plan, Rail Plan, Aviation Plan, Transit Plan, and Bicycle and Pedestrian Plan) as well as the fiscally constrained RTPs prepared by the MPOs and the RTPAs. RTPAs and MPOs address transportation from a regional perspective, while the CTP, building on regional plans, addresses the connectivity and/or travel between regions and applies a statewide perspective for transportation system. Therefore, integration of CTP and RTP goals (where applicable and consistent with federal and state fiscal restraint requirements) may provide greater mobility choices for travelers not only within their regions but across the state. The CTP and the RTP can be developed in a cyclical pattern aligning one with another using comprehensive, cooperative and continuing planning. This should result in delivering better projects and using resources more efficiently. The following diagrams illustrate the relationship between the CTP and RTP.





1.3 <u>Background & Purpose of the RTP Guidelines</u>

The purposes of these Guidelines are to:

1. Promote an integrated, statewide, multimodal, regional transportation planning process and effective transportation investments;
2. Set forth a uniform transportation planning framework throughout California by identifying federal and state requirements and statutes impacting the development of RTPs;
3. Promote a continuous, comprehensive, and cooperative transportation planning process that facilitates the rapid and efficient development and implementation of projects that maintain California's commitment to public health and environmental quality; and,
4. Promote a planning process that considers the views of all stakeholders.

The purpose of RTPs is to encourage and promote the safe and efficient management, operation and development of a regional intermodal transportation system that, when linked with appropriate land use planning, will serve the mobility needs of goods and people. The RTP Guidelines are intended to provide guidance so that RTPAs will develop their RTPs to be consistent with federal and state transportation planning requirements. This is important because state and federal statutes require that RTPs serve as the foundation of the Federal State Transportation Improvement Program (FSTIP, which includes the State Transportation Improvement Program or STIP). The FSTIP is prepared by Caltrans in coordination with MPOs/RTPAs and identifies the next four years of transportation projects to be funded for construction. The CTC cannot program projects that are not identified in the RTP.

Since the mid-1970s, with the passage of AB 69 (Chapter 1253, Statutes of 1972), California state law has required the preparation of RTPs to address transportation issues and assist local and state decision-makers in shaping California's transportation infrastructure. The RTP Guidelines are to be developed pursuant to California Government Code Sections 14522 and 65080 which state:

"14522. In cooperation with the regional transportation planning agencies, the commission may prescribe study areas for analysis and evaluation by such agencies and guidelines for the preparation of the regional transportation plans."

"65080 (d) Except as otherwise provided in this subdivision, each transportation planning agency shall adopt and submit, every four years, an updated regional transportation plan to the CTC and the Department of Transportation. A transportation planning agency located in a federally designated air quality attainment area or that does not contain an urbanized area may at its option adopt and submit a regional transportation plan every five years. When applicable, the plan shall be consistent with federal planning and programming requirements and shall conform to the regional transportation plan guidelines adopted by the CTC. Prior to adoption of the regional transportation plan, a public hearing shall be held after the giving of notice of the hearing by publication in the affected county or counties pursuant to Section 6061."

The California RTP Guidelines were first adopted by the CTC in 1978 and subsequently revised in 1982, 1987, 1991, 1992, 1994, 1999, 2007, and 2010.

The 1999 revision of the Guidelines was prepared to achieve conformance with state and federal transportation planning legislation and was based on the Federal Transportation Equity Act for the 21st Century (TEA-21) and California SB 45 (Chapter 622, Statutes 1997). A 2003 Supplement was also prepared that was based on a 2003 RTP Evaluation Report completed for the CTC. The Federal surface transportation reauthorization bill called SAFETEA-LU was signed into law in 2005. The 2007 revision of the RTP Guidelines was prepared in order to address changes in the planning process resulting from SAFETEA-LU.

Subsequent to the passage of AB 32 (California Global Warming Solutions Act of 2006), an addendum to the 2007 RTP Guidelines was adopted by the CTC in May 2008 to address a request from the California Legislature to ensure climate change issues were incorporated in the RTP process. That addendum was adopted by the CTC prior to the September 2008 passage of SB 375.

The 2010 update was prepared to incorporate new planning requirements as a result of SB 375 and to incorporate the addendum to the 2007 RTP Guidelines. SB 375 requires the 18 MPOs in the state to identify a forecasted development pattern and transportation network that, if implemented, will meet GHG emission reduction targets specified by the ARB through their RTP planning processes. These requirements do not pertain to the 26 rural RTPAs that also prepare RTPs.

Since the 2010 update, two federal surface transportation reauthorization bills have been signed into law. First, the two-year bill with numerous extensions, MAP-21, was signed on July 6, 2012. Most recently, a longer term five-year funding bill, FAST, was signed on December 4, 2015.

2015 MPO RTP Review Report

The 2017 update was prepared to incorporate Recommendations that were included in the December 2015 MPO RTP Review Report. This Report can be found at: http://www.dot.ca.gov/hq/tpp/offices/orip/rtp/index.html. One of these Recommendations called for an RTPA focused RTP Guidelines document addressing just the requirements for RTPAs when developing, completing, adopting and implementing an RTP.

1.4 RTPAs in California

In cooperation with the Governor, 26 state statutorily created RTPAs prepare RTPs in California. Pursuant to 23 CFR 450.202, the CTC requires RTPAs to address federal planning regulations during the preparation of their RTPs. California statutes and the RTP Guidelines identify the RTP requirements for RTPAs.

The majority of state designated RTPAs (specifically those responsible for preparing RTPs) are described under California Government Code Section 29532 et seq. One of the core functions of an RTPA is to develop an RTP through the planning process.

An RTPA has five core functions:

1. Maintain a setting for regional decision-making;
2. Prepare an Overall Work Program (OWP);
3. Involve the public in this decision-making;
4. Prepare an RTP; and,
5. Develop a Regional Transportation Improvement Program (RTIP) and a list of federally funded or regionally significant projects for inclusion in the FSTIP.

Twenty-six designated RTPAs receive annual state planning funds called rural planning assistance (RPA) to carry out their respective regional transportation planning requirements.

The map below identifies the 18 MPOs (in darker shade) and the 26 RTPAs that prepare RTPs (in lighter shade or dot pattern).


CALIFORNIA
Metropolitan Planning Organizations(MPOs)
and
Regional Transportation Planning Agencies (RTPAs)
AMBAG[1] Association of Monterey Bay Area Governments
BCAG Butte County Association of Governments
FCOG Fresno Council of Governments
KCAG Kings County Association of Governments
KCOG Kern Council of Governments
MCAG Merced County Association of Governments
MCTC Madera County Transportation Commission
MTC[2] Metropolitan Transportation Commission
SACOG[3] Sacramento Area Council of Governments
SANDAG San Diego Association of Governments
SJCOG San Joaquin Council of Governments
SLOCOG San Luis Obispo Council of Governments
SBCAG Santa Barbara County Association of Governments
SRTA Shasta Regional Transportation Agency
SCAG[4] Southern California Association of Governments
StanCOG Stanislaus Council of Governments
TCAG Tulare County Association of Governments
TMPO[5] Tahoe Metropolitan Planning Organization
[1]AMBAG includes SCCRTC, TAMC, and SBtCOG. All retain RTPA status.
[2]MTC covers a nine county region.
[3]SACOG is the RTPA for Sacramento, Sutter, Yolo, and Yuba Counties. It is the MPO for the federally designated ozone non-attainment area in Sacramento, Yolo, Yuba, Sutter, Placer, and El Dorado Counties. Placer and El Dorado Counties retain RTPA status up to the crest of the Sierras.
[4]SCAG covers a six county region that serve as County Transportation Commissions: ICTC, LAMTA, OCTA, RCTC, SANBAG, and VCTC.
[5]TMPO is a multi-state MPO created by federal law. It covers portions of El Dorado and Placer counties as well as Washoe and Douglas counties in Nevada, and shares board members with the TRPA.
Del Norte LTC
Siskiyou CLTC
Modoc CTC
Humboldt CAG
Trinity CTC
SRTA
Lassen CTC
Tehama CTC
Plumas CTC
Mendocino COG
Glenn CTC
BCAG
Sierra LTC
Nevada CTC
Colusa CTC
Lake CCAPC
Yuba
Placer CTPA
TMPO
TRPA
Sutter
El Dorado CTC
Yolo
SACOG
Sonoma
Napa
Sacramento
Alpine LTC
Amador CTC
MTC
Solano
Marin
Calaveras COG
Tuolumne TCTC
Mono LTC
Contra Costa
SJCOG
San Francisco
Alameda
StanCOG
Mariposa LTC
San Mateo
Santa Clara
MCAG
MCTC
Santa Cruz County Regional Transportation Commission (SCCRTC)
FCOG
Inyo LTC
AMBAG
San Benito COG
Transportation Agency for Monterey County
TCAG
KCAG
SLOCOG
KCOG
San Bernardino Associated Governments
SBCAG
Ventura CTC
Los Angeles County MTA
SCAG
RTPAs within MPOs
MPO Areas
Non-MPO Rural RTPA Areas
Riverside CTC
Orange County Transportation Authority
SANDAG
Imperial County Transportation Commission
California Department of Transportation
Division of Transportation Planning
March 2016

1.5 Purpose of the RTP

RTPs are planning documents developed by RTPAs in cooperation with Caltrans and other stakeholders, including system users. The purpose of the RTP is to establish regional goals, identify present and future needs, deficiencies and constraints, analyze potential solutions, estimate available funding, and propose investments.

California statute refers to these documents as "Regional Transportation Plans" or RTPs. In California planning circles, these long range planning documents normally use the term "RTP".

Pursuant to Title 23 CFR Part 450.324 et seq. FHWA describes the development and contents of RTPs as follows:

> *"The transportation plan is the Statement of the ways the region plans to invest in the transportation system. The plan shall "include both long-range and short-range program strategies/actions that lead to the development of an integrated intermodal transportation system that facilitates the efficient movement of people and goods." The plan has several elements, for example: Identify policies, strategies, and projects for the future; Determine project demand for transportation services over 20 years; Focus at the systems level, including roadways, transit, non-motorized transportation, and intermodal connections; Articulate regional land use, development, housing, and employment goals and plans; Estimate costs and identify reasonably available financial sources for operation, maintenance, and capital investments); Determine ways to preserve existing roads and facilities and make efficient use of the existing system; Be consistent with the Statewide transportation plan; Be updated every five years or four years in air quality nonattainment and maintenance areas; and, should make special efforts to engage interested parties in the development of the plan."*

The regional transportation planning led by RTPAs is a collaborative process that is widely participated by the federal, state, tribal governments/agencies, as well as other key stakeholders and the general public. The process is designed to foster involvement by all interested parties, such as the business community, California Tribal Governments, community groups, environmental organizations, the general public, and local jurisdictions through a proactive public participation process conducted by the RTPA in coordination with the state and transit operators. It is essential to extend public participation to include people who have been traditionally underserved by the transportation system and services in the region. Neglecting public involvement early in the planning stage can result in delays during the project stage.

While new federal MAP-21/FAST Act requirements are addressed in Section 1.7 of these guidelines, the traditional steps undertaken during the regional planning process include:

1. Providing a long-term (20 year) visioning framework;
2. Monitoring existing conditions;
3. Forecasting future population and employment growth;
4. Assessing projected land uses in the region and identifying major growth corridors;
5. Identifying alternatives and needs and analyzing, through detailed planning studies, various transportation improvements;
6. Developing alternative capital and operating strategies for people and goods;

7. Estimating the impact of the transportation system on air quality within the region; and,
8. Developing a financial plan that covers operating costs, maintenance of the system, system preservation costs, and new capital investments.

The RTPs are developed to provide a clear vision of the regional transportation goals, objectives and strategies. This vision must be realistic and within fiscal constraints. In addition to providing a vision, the RTPs have many specific functions, including:

1. Providing an assessment of the current modes of transportation and the potential of new travel options within the region;
2. Projecting/estimating the future needs for travel and goods movement;
3. Identification and documentation of specific actions necessary to address regional mobility and accessibility needs;
4. Identification of guidance and documentation of public policy decisions by local, regional, state and federal officials regarding transportation expenditures and financing;
5. Identification of needed transportation improvements, in sufficient detail, to serve as a foundation for the: (a) Development of the Federal State Transportation Improvement Program (FSTIP, which includes the STIP), (b) Facilitation of the National Environmental Policy Act (NEPA)/404 integration process and (c) Identification of project purpose and need;
6. Employing performance measures that demonstrate the effectiveness of the system of transportation improvement projects in meeting the intended goals;
7. Promotion of consistency between the CTP, the RTP and other plans developed by cities, counties, districts, California Tribal Governments, and state and federal agencies in responding to statewide and interregional transportation issues and needs;
8. Providing a forum for: (1) participation and cooperation and (2) facilitation of partnerships that reconcile transportation issues which transcend regional boundaries; and,
9. Involving community-based organizations as part of the public, Federal, State and local agencies, California Tribal Governments, as well as local elected officials, early in the transportation planning process so as to include them in discussions and decisions on the social, economic, air quality and environmental issues related to transportation.

1.6 California Transportation Planning & Programming Process

The State of California and federal transportation agencies allocate millions of dollars of planning funds annually to help support California's transportation planning process. The RTP establishes the basis for programming local, state, and federal funds for transportation projects within a region. State and federal planning and programming legislation has been initiated and is periodically revised to provide guidance in the use of these funds to plan, maintain and improve the transportation system.

The RTP Guidelines include recommendations and suggestions for providing documentation that is needed to meet the project eligibility requirements of the Federal State Transportation Improvement Program (FSTIP, which includes the STIP). The FSTIP is defined as a constrained four-year prioritized list of regionally significant transportation projects that are proposed for *federal, state and local* funding. The FSTIP is developed by Caltrans in coordination with MPOs/RTPAs and approved by the FHWA/FTA and is updated every four years. It is consistent with the RTP and it is required as a prerequisite for federal programming of funding.

The planning and programming process is the result of state and federal legislation to ensure that:

1. The process is as open and transparent as possible;
2. Environmental considerations are addressed; and,
3. Funds are allocated in an equitable manner to address transportation needs.

The chart in Appendix A attempts to provide a simple diagram of a complex process. Each entity in the chart reflects extensive staff support and legislative direction. The result is the planning and programming process that reflects the legislative and funding support of the California transportation system. Additional information regarding the programming process is available in Sections 2.5 and 6.15.

1.7 MAP-21/FAST Act Items Impacting the Development of RTPs

This section is intended to outline the new federal requirements resulting from MAP-21/FAST Act and the Final Rule issued May 27, 2016 with an effective date of June 27, 2016 for Statewide and Nonmetropolitan Transportation Planning *and* Metropolitan Transportation Planning. Pursuant to 23 CFR 450.202, RTPAs are required to address federal planning regulations during the preparation of their RTPs. Only the items that have a direct impact on RTP development are listed. Other sections may contain optional requirements that could have impacts to the overall regional transportation planning *process*.

As specified in 23 CFR 450.226(a), prior to May 27, 2018, an RTPA may adopt an RTP that has been developed using the SAFETEA-LU requirements or the provisions and requirements of 23 CFR 450. On or after May 27, 2018, an RTPA may not adopt an RTP that has not been developed according to the provisions of 23 CFR 450. RTPAs are encouraged to communicate with Caltrans to discuss schedules for RTP adoption.

Two New Planning Factors (Section 2.4) – RTPAs shall consider and implement two new planning factors added to the scope of the transportation planning process: Improve resiliency and reliability of the transportation system and reduce or mitigate stormwater impacts of surface transportation; and enhance travel and tourism. 23 CFR 450.206 (b)(9) and (10)

Performance-Based Planning Approach (Section 7.2) – RTPAs are encouraged to collaborate with Caltrans to integrate the goals, objectives, performance measures, and targets described in other performance-based plans into their RTPs. The implementation timeline for States to satisfy the new requirements is two years from the effective date of each rule establishing performance measures under 23 U.S.C. 150(c), 49 U.S.C. 5326, and 49 U.S.C. 5329 FHWA/FTA. A future update of the RTP Guidelines will capture any “shoulds” or “shalls” resulting from the rulemaking process. 23 CFR 450.206; 23 CFR 450.216(f)(1) and (2)

Assessment of Capital Investment and Other Strategies (Section 6.21) – RTPAs are encouraged to include an assessment of capital investment and other strategies to: (1) preserve the existing and projected future transportation infrastructure, (2) provide for multimodal capacity increases based on regional needs and priorities, and (3) reduce vulnerability of the existing infrastructure to natural disasters. 23 CFR 450.324 (f)(7)

Consideration of Public Transportation Facilities and Intercity Bus Facilities (Section 6.10) – RTPs should also consider the role of intercity bus systems, including systems that are privately owned and operated, in reducing congestion, and including transportation alternatives. 23 CFR 450.216(b)

Interested Parties, Public Participation, and Consultation (Sections 4.4, 4.6, and 6.20) – In addition to the interested parties listed, RTPAs must also provide public ports with a reasonable opportunity to comment on the RTP. RTPAs may also consult with officials responsible for tourism and natural disaster risk reduction when developing RTPs and project lists. 23 CFR 450.210(a) and (b); 23 CFR 450.216(l)(2); 23 CFR 450.324(j)

Optional Scenario Planning – RTPAs may use scenario planning during the development of RTPs. Scenario planning is an analytical framework to inform decision-makers about the implications of various investments and policies on transportation system condition and performance during the development of their plan. 23 CFR 450.324(i)

1.8 Key Additions to the 2017 RTP Guidelines

Key Additions to the 2017 RTP Guidelines:

1. Separating RTP Guidelines, one for the MPOs and one for the RTPAs to better address the specific requirements for their RTPs.
2. Appendix C – Updates to the RTP Checklist statutory requirements for RTPAs, including a question for RTP/RHNA cycle alignments.
3. Appendix H, Planning Practice Examples – aggregates the former Appendix I, Land Use and Transportation Strategies to address Regional GHG Emissions, and the "Best Practices" component of RTP Guidelines as a new appendix, accessible by topic.
4. Updates for the MAP-21/FAST Act throughout the RTP Guidelines.
5. Section 1.0 – Provides guidance on applicability of the RTP Guidelines and defines "shalls" and "shoulds."
6. Section 1.2 – Defines the relationship between the RTP and the CTP.
7. Section 1.7 – Outlines MAP-21/FAST Act items with a direct impact on RTP development.
8. Section 2.2 – Includes updates to State Climate Change Legislation and Executive Orders.
9. Section 2.3 – Provides an overview of the role of transportation in public health and health equity.
10. Section 2.6 – Adds local, regional, and State prepared plans that RTPAs should consult with during RTP preparation.
11. Section 2.7 – Includes Planning and Environmental Linkages (PEL), updates Context Sensitive Solutions, and additional System Planning documents that are used in partnership with RTPAs in the transportation planning process.
12. Chapter 3 – Updates the Modeling Chapter from the 2010 version.
13. Chapter 4 – Includes new legislation highlighting the required Native American Tribal Government Consultation and Coordination process.
15. Section 4.2 – Describes Environmental Justice (EJ) & Title VI considerations in the RTP.
16. Section 4.4 – Includes Periodic Evaluation of the Public Involvement Process to evaluate the effectiveness of the procedures and strategies for developing the RTP.
17. Section 4.6 – Adds public ports to the list of interested parties.

18. Chapter 5 – Describes SB 743 (Chapter 386, Statutes of 2013) and the anticipated future change to transportation analysis for transit priority areas.
19. Section 5.4 – Adds Cultural Resources and Habitat Connectivity to the list of environmental resources that typically require avoidance alternative and mitigation.
20. Chapter 6 – Introduces the California Freight Mobility Plan and the California Sustainable Freight Action Plan.
21. Chapter 6 – Provides preliminary information on MAP-21/FAST Act impacts on Asset Management.
22. Section 6.10 – Adds first/last mile transit connectivity to the transit discussion of the RTP as well as the MAP-21/FAST Act recommendation to discuss the role of intercity buses in reducing congestion, pollution, and energy consumption.
23. Section 6.12 – Adds supporting the State's freight system efficiency target to the goods movement discussion of the RTP.
24. Section 6.18 – New Section 6.18 provides a summary of federal legislation to prepare for new technologies and innovations for the future of transportation.
25. Section 6.19 – Updates Transportation Safety for MAP-21/FAST Act.
26. Section 6.20 – Updates Transportation Security for the MAP-21/FAST Act recommendation for RTPAs to consult with agencies and officials responsible for natural disaster risk reduction.
27. Section 6.21 – Adds new RTP recommendation for RTPAs to include an Assessment of Capital Investment & Other Strategies.
28. Section 6.23 – Adds many transportation strategies to address regional GHG emissions, including employer-sponsored shuttle services, active transportation plans, and coordinating with school district plans and investments.
29. Section 6.25 – Updates for Climate Adaptation background, State legislation, executive orders, and planning resources for RTPAs.
30. Chapter 7 – A new chapter, Transportation Performance Management, provides the appropriate emphasis on the RTP as a performance-driven plan for which performance metrics may be developed and used by the RTPA for plan development, implementation, and monitoring. This chapter includes updates for MAP-21/FAST Act recommendations for RTPAs to implement the performance based approach into the scope of the statewide and nonmetropolitan planning process, including the RTP.

Chapter 2

RTP Process

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RTP PROCESS

2.1 State Requirements

California statute relating to the development of the RTP is primarily contained in Government Code Section 65080. State planning requirements apply to state designated RTPAs.

Just like federal legislation, Government Code Section 65080 requires that all RTPAs prepare RTPs to update their RTPs every four or five years (including RHNA adjustments).

When applicable, RTPs shall be consistent with federal planning and programming requirements and shall conform to the RTP Guidelines adopted by the CTC pursuant to Government Code Section 65080(d). In addition, the CTC cannot program projects in the State Transportation Improvement Program (STIP) that are not identified in an RTP.

Section 65080 states RTPs shall include the following:

1. Policy Element
2. Action Element
3. Financial Element

The following California Government Code Sections apply to the development of RTPs:

Government Code Section 65080.1 – Each RTPA whose jurisdiction includes a portion of the California Coastal Trail, or property designated for the trail shall coordinate with the State Coastal Conservancy, the California Coastal Commission and Caltrans regarding the development of the trail. The trail must be identified in the RTP.

Government Code Section 65080.3 - An RTPA with a population exceeding 200,000 persons may prepare at least one "alternative planning scenario" during the development of the RTP. The purpose of the alternative planning scenario is to address attempts to reduce growth in traffic congestion, make more efficient use of existing transportation infrastructure, and reduce the need for costly future public infrastructure.

Government Code Section 65080.5 - Prior to adoption of the RTP, a public hearing shall be held after publishing notice of the hearing. After the RTP is adopted by the RTPA, the plan shall be submitted to the CTC and Caltrans. One copy should be sent to the CTC. Two copies should be submitted to the appropriate Caltrans district office. The Caltrans district office will send one copy to the headquarters Division of Transportation Planning.

Government Code Section 65081.1 - Regions that contain a primary air carrier airport (defined by the Federal Aviation Administration as an airport having at least 10,000 annual scheduled passenger boardings) shall work collaboratively to include an airport ground access improvement program within the RTP. This program shall address airport access improvement projects, including major arterial and highway widening and extension projects, with special consideration given to mass transit.

Requirements (Shalls)
State: Government Code Sections 65080, 65080.1, 65081.1

2.2 Background on State Climate Change Legislation & Executive Orders

This section provides background for State climate change legislation and related executive orders. First, a description is provided for AB 32, SB 32, and SB 375 which have direct implications for MPOs only in the development of RTPs. Next, other state legislation that impacts State agencies is outlined to provide important context for RTPAs to consider in development of RTPs. Lastly, executive orders on climate change are discussed to provide a critical framework for RTPAs. While the executive orders are directed at State agencies, RTPAs are encouraged to integrate policies and strategies that support these state policies in the development of RTPs.

AB 32 – The California Global Warming Solutions Act of 2006

California established itself as a national leader in addressing climate change issues with the passage of Assembly Bill (AB) 32, the Global Warming Solutions Act of 2006. As a result of AB 32, California statute specifies that by the year 2020, GHG emissions within the state must be at 1990 levels. The ARB is the primary state agency responsible for implementing the necessary regulatory and market mechanisms to achieve reductions in GHG emissions to comply with the requirements of AB 32.

AB 32 identifies GHGs as specific air pollutants that are responsible for global warming and climate change. This is particularly relevant to the RTP Guidelines because, according to the ARB Mobile Source Strategy, the transportation sector represents nearly 50 percent of GHG emissions in California[2]. California has focused on six GHGs (CO2, Methane, Nitrous Oxide, Hydro fluorocarbons, perfluorocarbons, and Sulfur Hexafluoride). CO2 is the most prevalent GHG. All other GHGs are referenced in terms of a CO2 equivalent.

AB 32 directed the ARB to develop actions to reduce GHGs, including the preparation of a scoping plan to identify how best to reach the 2020 goal. According to the scoping plan, the framework for achieving GHG emissions reductions from land use and transportation planning includes implementation of SB 375.

SB 32 – California Global Warming Solutions Act of 2006: Emissions Limit

In recognition that GHG reduction is critical for the protection of all areas of the state, but especially for the state's most disadvantaged communities, as those communities are most affected by the adverse impacts of climate change, SB 32 (Chapter 249, Statutes of 2016) was signed into law on September 8, 2016. The bill extends AB 32's required reductions of GHG emissions by requiring a GHG reduction of at least 40 percent of 1990 levels no later than December 31, 2030. Furthermore, SB 32 authorizes ARB to adopt rules and regulations to achieve the maximum technologically feasible and cost-effective GHG emissions reductions. ARB shall carry out the process to achieve GHG emissions reductions in a manner that benefits

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[2] This number reflects a wheel-to-well GHG estimate from aviation, construction and mining equipment, buses, heavy duty trucks, passenger vehicles, light duty trucks, rail, ships and commercial harbor craft, and the petroleum refining for transportation fuel. State law provides limited authority to RTPAs/MPOs. Collaborative planning between the state and RTPAs/MPOs is needed to meet the state's GHG reduction goals.

the state's most disadvantaged communities and is transparent and accountable to the public and Legislature.

SB 375 – The Sustainable Communities and Climate Protection Act of 2008

SB 375 was signed into law in September 2008. The bill addressed five primary areas:

1. Requires the ARB to develop regional GHG emission reduction targets for cars and light trucks for each of the 18 MPOs in California.
2. Through their respective planning processes, each of the MPOs is required to prepare a SCS that will specify how the GHG emissions reduction target set by ARB for 2020 and 2035 can be achieved for the region. If the target cannot be met through the SCS, then an Alternative Planning Strategy (APS) shall be prepared.
3. Provides streamlining of California Environmental Quality Act (CEQA) requirements for specific residential and mixed-use developments that are consistent with an SCS or APS that has been determined by ARB to achieve the regional GHG emissions reduction target.
4. Synchronizes the Regional Housing Needs Assessment (RHNA) process with the RTP process; requires local governments to update the housing element of their general plans and to rezone consistent with the updated housing element generally within three years of adoption; and provides that RHNA allocations must be consistent with the development pattern in the SCS. Housing element updates are moved from five year cycles to eight year cycles for member jurisdictions of all MPOs, classified as nonattainment or maintenance (required to adopt an updated RTP every four years) and for jurisdictions within other MPOs and RTPAs that elect to change the RTP adoption schedule from five years to every four years pursuant to Government Code Section 65080 (b)(2)(M). MPOs should carefully estimate a realistic RTP adoption date in providing the 12 month notice to HCD and not adopt a RTP at a later date. RTP adoption past the estimated adoption date relied on by HCD in determining new housing unit allocation for a specific planning period creates a conflict and shifts the housing element planning period to an ending period that lacks a requisite housing unit allocation.
5. Requires the CTC to maintain guidelines for the use of travel demand models used in the development of RTPs that, taking into consideration MPO resources, account for: 1.) the relationship between land use density, household vehicle ownership, and vehicle miles traveled (VMT), consistent with statistical research, 2.) the impact of enhanced transit service on household vehicle ownership and VMT, 3.) likely changes in travel and land development from highway or passenger rail expansion, 4.) mode splitting that allocates trips between automobile, transit, carpool, bicycle and pedestrian trips, and 5.) speed and frequency, days, and hours of operation of transit service. (Government Code Section 14522.1)

The following State legislation is directed at State agencies. RTPAs are encouraged to consider and incorporate, where applicable and appropriate, the policies and strategies that support requirements placed on the State.

AB 1482 – Climate Adaptation

AB 1482 (Chapter 603, Statutes of 2015) addresses two areas:

1. Requires the Natural Resources Agency to update the state's Climate Adaptation Strategy (CAS) by July 1, 2017, and every three years thereafter.

2. Requires the Strategic Growth Council to identify and review activities and funding programs of state agencies that may be coordinated, including those that:
    a. Increase the availability of affordable housing, improve transportation, encourage sustainable land use planning, and revitalize urban and community centers in a sustainable manner.
    b. Meet the goals of the California Global Warming Solutions Act of 2006 and the strategies and priorities developed in the Safeguarding California Plan, the state's climate adaptation strategy.
    c. At a minimum, review and comment on the five-year infrastructure plan.

SB 246 – Climate Change Adaptation

SB 246 (Chapter 606, Statutes of 2015) establishes the Integrated Climate Adaptation and Resiliency Program through the Office of Planning and Research (OPR) to coordinate regional and local adaptation efforts with state climate adaptation strategies.

SB 350 – Clean Energy and Pollution Reduction Act of 2015

SB 350 (Chapter 547, Statutes of 2015) describes the importance of widespread transportation electrification for meeting climate goals and federal air quality standards. SB 350 focuses on "widespread" transportation electrification. The term "widespread" is important because adhering to existing patterns of investment in wealthier communities relative to low- or moderate-income communities would result in underinvestment in low-income communities and overinvestment in wealthier communities. SB 350 notes that "widespread transportation electrification requires increased access for disadvantaged communities, low- and moderate-income communities, and other consumers of zero-emission and near-zero-emission vehicles."

Pursuant to PUC 740.12(a)(2), it is the policy of the state and the intent of the legislature to encourage transportation electrification as a means to achieve ambient air quality standards and the state's climate goals. Agencies designing and implementing regulation, guidelines, plans, and funding programs to reduce GHG emissions shall take the findings described in paragraph (1) of PUC Section 740.12 into account. RTPAs may incorporate the directives from SB 350 in their planning processes.

Executive Orders on Climate Change Issues

The executive orders on climate change below are discussed to provide a critical framework for RTPAs. While these Executive Orders are directed at State agencies, integration of climate change policies in the RTP supports the State's effort to reduce per capita GHG emissions and combat the effects of climate change.

Three Governor Executive Orders were issued from 2005-2008 to address climate change: S-3-05 (June 1, 2005) that calls for a coordinated approach to address the detrimental air quality effects of GHGs; S-20-06 (October 17, 2006) that requires State agencies to continue their cooperation to reduce GHG emissions and to have the Climate Action Team develop a plan to outline a number of actions to reduce GHG; and S-13-08 (November 14, 2008) that directs the Natural Resources Agency to develop the State's first Climate Adaptation Strategy (CAS) guide. Information on climate change and California climate change activities can be found at the following links:

http://www.climatechange.ca.gov/
http://www.arb.ca.gov/cc/facts/facts.htm

More recently, Governor Executive Orders were issued in 2012 and 2015. Executive Order B-16-12 sets a 2050 GHG emissions reduction goal for the transportation sector to achieve 80 percent less than 1990 levels. Executive Order B-32-15 works toward achieving GHG reduction targets with the California Sustainable Freight Action Plan, an integrated plan that establishes clear targets to improve freight efficiency, transition to zero-emission technologies, and increase competitiveness of California's freight system.

In addition, Executive Order B-30-15 established a new interim statewide GHG emission reduction target to reduce GHG emissions to 40 percent below 1990 levels by 2030 to ensure California meets its target of reducing GHG emissions to 80 percent below 1990 levels by 2050. All state agencies with jurisdiction over sources of GHG emissions shall implement measures, pursuant to statutory authority, to achieve reductions of GHG emissions to meet the 2030 and 2050 GHG emissions reductions targets. Furthermore, State agencies shall take climate change into account in their planning and investment decisions, and employ full life-cycle cost accounting to evaluate and compare infrastructure investments and alternatives. State agencies' planning and investment shall be guided by the following principles:

- Priority should be given to actions that both build climate preparedness and reduce GHG emissions;
- Where possible, flexible and adaptive approaches should be taken to prepare for uncertain climate impacts;
- Actions should protect the states most vulnerable populations;
- Natural infrastructure solutions, as defined in Public resources code 71154(c)(3) (e.g., flood plain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planning to reduce high heat days), should be prioritized; and,
- Lastly, the State Five-Year Infrastructure Plan will take current and future climate change impacts into account in all infrastructure projects.

These Executive Orders are available at:

B-16-12: https://www.gov.ca.gov/news.php?id=17472
B-30-15: https://www.gov.ca.gov/news.php?id=18938
B-32-15: https://www.gov.ca.gov/news.php?id=19046

2.3 Promoting Public Health & Health Equity

Health-promoting policies are found throughout Regional Transportation Plans (RTPs). RTPs often incorporate many or all of the following: safe routes to school programs; complete streets strategies; equity considerations; transportation safety; and policies to promote transit, bicycling and walking. These kinds of transportation-related policies and programs, and others as well, foster more accessible, more livable, and healthier communities. Explicitly identifying their public health benefits can reinforce the role of RTPs in building stronger communities and regions. In addition, local health departments and other public health stakeholders can be valuable partners in RTP development, to increase understanding of the relationship between transportation and health. Their participation can help to maximize the RTP's public health and equity benefits and ensure that the RTP is responsive to community needs.

The role of transportation in public health is increasingly recognized by health advocates and transportation providers alike. Federal, state, regional, and local transportation agencies have long focused on improving both air quality and safety, which are very important to public health. More recently the understanding of the relationship of transportation and health has been expanding to include a much broader range of community needs. One fundamental example is the way in which transportation can encourage physical activity, such as walking and biking, often referred to as active transportation. There is a demonstrated relationship between increased physical activity and a wide range of health benefits. If a higher level of investment is made on active transportation, the walk and bike mode shares could be increased, which could help a community to lower its rates of obesity, hypertension, and other chronic diseases. However, local jurisdictions primarily lead the planning and implementing of active transportation infrastructure and supportive land uses, and land use patterns play at least as large a role in encouraging more active mode choices.

Transportation is also being seen not as an end in itself, but as a means of providing access to important destinations: access to jobs, education, healthy food, recreation, worship, community activities, healthcare, and more. Improved access to key destinations is especially critical for disadvantaged and underserved communities. The design of the transportation system, in combination with land use and housing decisions, also plays a role in public health. Coordinated planning of transportation and land use can promote public health through the development of livable, walkable, accessible communities. And as nations, states and regions shift away from fossil fuel dependent transportation modes, the benefits of reducing the effects of climate change will also help to reduce the public health risks from climate change effects such as extreme heat, storms, and drought. Transportation and public health providers can help one another to address all of these factors, learning from each other and joining their skills to improve transportation for better health outcomes for everyone.

Improving transportation infrastructure in ways that encourages walking and cycling is one of several effective ways to improve physical activity, decrease traffic collisions, and improve one's health status. But, transportation planning also has a tremendous impact on community health, safety, and neighborhood cohesion. For instance, health-focused transportation plans can help reduce the rate of injuries and fatalities from collisions. Some research suggests that there is a multiplier effect: when streets are designed to safely accommodate walking and biking, more people do so, and as more people walk and bike the rate of collisions actually goes down as pedestrians and bicyclists become more visible to motorists. In addition, more people out walking and biking in a neighborhood has an important public safety benefit, as it means there are more "eyes on the street" to deter criminal activity. Taking this a step further, studies have shown that people who live in neighborhoods with less traffic and higher rates of walking, bicycling, and transit use know more of their neighbors, visit their neighbor's homes more often, and are less fearful of their neighbors. When streets are inhospitable to pedestrians and bicyclists, residents don't feel safe walking or biking to nearby transit and their ability to access regional educational and employment opportunities is hampered. In short, improving traffic safety results in better public health beyond simply reduced injuries and fatalities.

Additional examples of how transportation planning can promote health include:

- Transportation planning can help residents reach jobs, education, social services, and medical care by walking, biking or public transportation in a timely manner.
- Reducing commute times and increasing public transportation reliability can reduce stress and improve mental health.
- Affordable transportation options enables low income households to invest in savings, education, and healthier food options—all factors that contribute to greater individual and community health.

2.4 Federal Requirements

Federal requirements for the development of RTPs are directed at States and RTPAs, as specified in 23 CFR 450.202. The primary federal requirements regarding RTPs are addressed in the statewide/nonmetropolitan transportation planning and metropolitan transportation planning rules – Title 23 CFR Part 450 and 771 and Title 49 CFR Part 613. These federal regulations incorporating both MAP-21/FAST Act changes were updated by FHWA and FTA and published in the May 27, 2016 Federal Register.

The final guidance is commonly referred to as the Final Rule. In the Final Rule, the statewide/nonmetropolitan transportation planning process provides for consideration of the following federal planning factors:

1. Support the economic vitality of the nonmetropolitan area, especially by enabling global competitiveness, productivity, and efficiency;
2. Increase the safety of the transportation system for motorized and non-motorized users;
3. Increase the security of the transportation system for motorized and non-motorized users;
4. Increase accessibility and mobility of people and freight;
5. Protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between (regional) transportation improvements and State and local planned growth and economic development patterns;
6. Enhance the integration and connectivity of the transportation system, across and between modes, for people and freight;
7. Promote efficient system management and operation;
8. Emphasize the preservation of the existing transportation system;
9. Improve the resiliency and reliability of the transportation system and reduce or mitigate stormwater impacts of surface transportation; and
10. Enhance travel and tourism.

It is important to note that failure to consider any factor specified in 23 CFR 450.206 (a) or (c), shall not be reviewable by any court under Title 23 U.S.C., 49 U.S.C. Chapter 53, Subchapter II of Title 5 U.S.C. Chapter 5, or Title 5 U.S.C. Chapter 7 in any matter affecting an RTP, TIP, a project or strategy, or the certification of a metropolitan transportation planning process.

Federal Clean Air Act conformity requirements pursuant to the Amendments of 1990, apply in all nonattainment and maintenance areas. Section 176(c) of the Clean Air Act (CAA), as amended (42 U.S.C. 7506(c), and the related requirements of 23 U.S.C. 109(j), “transportation conformity” requirement ensures that federal funding and approval are given to transportation plans, programs and projects that are consistent with the air quality goals established by a State Implementation Plan (SIP).

Title VI of the Civil Rights Act of 1964 ensures that all people have equal access to the transportation planning process. It is important that RTPAs receiving federal funds comply with this federal civil rights requirement during the RTP development process. Title VI states that: all people regardless of their race, sexual orientation or income level, will be included in the decision-making process. Additional information regarding equal access to the transportation planning process is available in Sections 4.2 and 4.3.

Requirements (Shalls)
Federal: Title 23 CFR Part 450 and 771; 49 CFR Part 613; and Title 40 CFR Part 93 and Title VI of the Civil Rights Act of 1964

2.5 Relationship between the RTP, OWP, FTIP, STIP (RTIP & ITIP), & FSTIP

The key planning documents produced by the RTPAs, County Transportation Commissions (CTCs) and Caltrans are:

1. Regional Transportation Plan – Looks out over a 20 plus-year period providing a vision for future demand and transportation investment within the region.

2. Overall Work Program – The OWP lists the transportation planning studies and tasks to be performed by the RTPA or member agency during that fiscal year.

Federal Program -MPOs Only:

3. Federal Transportation Improvement Program – The FTIP is a financially constrained four-year program listing all federally funded and regionally significant projects in the region.

State Program – RTPAs, County Transportation Commissions (CTCs), and Caltrans:

4. State Transportation Improvement Program – The STIP is a biennial program adopted by the CTC. Each STIP covers a five year period and includes projects proposed by regional agencies in their regional transportation improvement programs (RTIPs) and by Caltrans in its interregional transportation improvement program (ITIP).
    a. Regional Transportation Improvement Program – The RTIP is a five year program of projects prepared by the RTPAs and County Transportation Commissions. Each RTIP should be based on the RTP and a region wide assessment of transportation needs and deficiencies.
    b. Interregional Transportation Improvement Program – The ITIP is a five year list of projects that is prepared by Caltrans, in consultation with RTPAs. Projects included in the interregional program shall be consistent with the Interregional Transportation Strategic Plan and relevant adopted RTP(s).

State & Federal Program – MPOs, RTPAs, and Caltrans:

5. State Federal Transportation Improvement Program (FSTIP) - The FSTIP is a constrained four-year prioritized list of regionally significant transportation projects that are proposed for *federal, state and local* funding. The FSTIP is updated every four-years and is developed by Caltrans in coordination with MPOs/RTPAs and approved by the FHWA/FTA. It is consistent with the RTP and it is required as a prerequisite for federal programming of funding.

Key Planning & Programming Documents Produced by MPOs/RTPAs & County Transportation Commissions/Caltrans

	Time/Horizon	*Contents*	*Update Requirements*
RTP	*20+ Years*	*Future Goals, Strategies & Projects*	*RTPAs – Every 5 Years (State law allows option to change from 5 to 4 years)*
OWP	*1 Year*	*Planning Studies and Tasks*	*Annually*
FTIP (MPOs Only)	*4 Years*	*Transportation Projects*	*At least every 4 Years*
RTIP (RTPAs/CTCs)	*5 Years*	*Transportation Projects*	*Every 2 Years*
ITIP (Caltrans)	*5 Years*	*Transportation Projects*	*Every 2 Years*
FSTIP	*4 years*	*Transportation Projects*	*At least every 4 years*

Requirements (Shalls)
State: California Government Code Sections 65082, 14526, 14527 and 14529 require the preparation of the STIP, RTIPs and ITIP.

2.6 Consistency with Other Planning Documents

It is very important that the RTP be consistent with other plans prepared by local, state, federal agencies and Native American Tribal Governments. Consistency can be described as a balance and reconciliation between different policies, programs, and plans. This consistency will ensure that no conflicts would impact future transportation projects. RTPAs depend upon the collaborative process described in Chapter 4 for the numerous plans below to be incorporated or consulted with. RTPAs also rely on the aforementioned stakeholders to contribute to RTP development, according to their plans and areas of expertise. While preparing an updated RTP, RTPAs should, as appropriate, incorporate or consult such local/regionally prepared documents as:

1. General Plans (especially the Circulation and Housing Elements);
2. Airport Land Use Compatibility Plans;
3. Air quality State Implementation Plans (SIPs);
4. Short- and Long-Range Transit Plans;
5. Habitat Conservation Plans/Natural Community Conservation Plan including an integrated regional mitigation strategy (if applicable);
6. Urban Water Management Plans;
7. Local Coastal Programs (if applicable);
8. Public Agency Trail Plans (if applicable);
9. Local Public Health Plans;
10. Regional Bicycle and Pedestrian Plans
11. Americans with Disabilities Act Transition Plans;
12. Master Plans, Specific Plans;
13. Impact Fee Nexus Plans;

14. Local Capital Improvement Programs;
15. Mitigation Monitoring Programs;
16. Countywide Long-Range Transportation Plans (if applicable); and,
17. Tribal Transportation Plans.

RTPAs also should consult State/Federal prepared transportation planning documents such as:

1. California Transportation Plan;
2. California Rail Plan;
3. Interregional Transportation Strategic Plan;
4. Transportation Concept Reports;
5. District System Management Plans;
6. California Aviation System Plan;
7. Goods Movement Action Plan;
8. Sustainable Freight Action Plan;
9. California Freight Mobility Plan;
10. Strategic Highway Safety Plan;
11. California Strategic Highway Safety Plan, and Corridor System Management Plans; and,
12. Federal Lands Management Plans.

RTPAs should also consult State prepared environmental planning documents such as:

1. Draft Environmental Goals and Policy Report;
2. State Wildlife Action Plan;
3. Vulnerability Assessments;
4. California Climate Adaptation Planning Guide;
5. Safeguarding California Plan; and,
6. Safeguarding California: Implementation Action Plans.

Federal regulations require consultation with resource agencies during the development of the RTP. This consultation should include the development of regional mitigation and identification of key documents prepared by those resource agencies that may impact future transportation plans or projects (See Chapter 5 RTP Environmental Considerations). RTPA staff should make a concerted effort to ensure any actions in the RTP do not conflict with conservation strategies and goals of the resource agencies.

2.7 Coordination with Other Planning Processes

RTPs are prepared within the context of many other planning processes conducted by federal, tribal, state, regional and local agencies. This section provides background information, along with planning practice examples in Appendix H, for how RTPAs can integrate the planning processes associated with the Smart Mobility Framework, Complete Streets, Context Sensitive Solutions, Planning and Environmental Linkages, and system planning documents specifically Transportation Concept Reports (TCRs), Corridor System Management Plans (CSMPs), District System Management Plans (DSMPs), the Interregional Transportation Strategic Plan (ITSP), and other transportation plans into development of the RTP. These initiatives and implementation tools work toward achieving the CTP goals. They also align with the principles of the federal Partnership for Sustainable Communities. As the RTP is bound to fiscal constraints, the strategies, actions, and improvements described in this section are intended to provide guidance and should be considered to the maximum extent feasible in the development of the RTP.

Smart Mobility Framework

The Caltrans Smart Mobility Framework[3] (SMF) is a key strategic tool for integrating transportation with land-use, to develop healthy and livable communities through multi-modal travel options, reliable travel times, and safety for all users of the transportation system. The SMF supports the goals of climate change intervention and energy security while supporting the goals of the CTP, and the federal Livability Principles for Sustainable Communities[4].

The SMF integrates transportation and land use by applying principles of location efficiency, complete streets, connected and integrated multimodal networks, housing near destinations for all income levels, and protection of parks and open space. This framework is designed to help keep California communities livable and supportive of healthy life styles while allowing each to maintain its unique community identify.

The CTP reflects the understanding that a full set of transportation strategies includes initiatives to address land use and development. The SMF provides a framework to plan for the challenges of increased demands on an aging transportation system, climate change, and current and future generations' demands for multi-modal transportation choices.

In addressing the need for access to destinations for people and goods, the SMF provides guidance to incorporate new concepts and tools alongside well-established ones. It calls for participation and partnership by agencies at all levels of government, as well as private sector and community involvement.

One method for supporting the implementation of SMF is the SMF Learning Network, a series of educational forums and webinars designed to extend the reach of SMF to internal and external partners. The networks serves as an opportunity to share examples of Smart Mobility applications and strengthen strategic partnerships between Caltrans and other agencies. The information sharing and feedback that results from these forums will shape the future integration of Smart Mobility principles into Caltrans processes.

Complete Streets

The term "Complete Streets" refers to a transportation network that is planned, designed, constructed, operated and maintained to provide safe mobility for all users, including bicyclists, pedestrians, transit and rail riders, commercial vehicles and motorists appropriate to the function and context of the facility.

The California Complete Streets Act of 2008 (AB 1358) ensures that the general plans of California cities and counties meet the needs of all users, including pedestrians, transit, bicyclists, the elderly, motorists, movers of commercial goods, and the disabled. AB 1358 requires cities and counties to identify how the jurisdiction will provide accommodation of all users of roadways during the revision of the circulation element of their general plan. The Governor's Office of Planning and Research amended guidelines for the development of the circulation element to accommodate all users. A comprehensive update of the General Plan Guidelines in 2016 includes guidance on how cities and counties can modify the circulation element to plan for a balanced, integrated, multimodal transportation network that meets the

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[3] Smart Mobility Framework: http://www.dot.ca.gov/hq/tpp/offices/ocp/smf.html
[4] Livability Principles for Sustainable Communities: https://www.sustainablecommunities.gov/mission/livability-principles

needs of all users of the streets, roads, and highways for safe and convenient travel in a manner that is suitable to the rural, suburban, or urban context of the general plan.

The benefits of Complete Streets can include: Safety; Health; GHG Emission Reduction; and Economic Development and Cost Savings.

Multimodal transportation networks, using complete streets planning practice examples, can lead to safer travel for all roadway users. Designing streets and travel routes that consider safe travel for all modes can reduce the occurrence and severity of vehicular collisions with pedestrians and bicyclists. Streets and other transportation facility design considerations that accommodate a variety of modes and users abilities can contribute to a safer environment that makes all modes of travel more appealing.

Planning for Complete Streets will enable local governments to provide healthier lives by encouraging physical activity. Public health studies have demonstrated that people are more likely to walk in their neighborhood if it has sidewalks. Also, studies have found that people with safe walking environments within a 10 minute walking radius are more likely to meet recommended physical activity levels. The integration of sidewalks, bike lanes, transit and rail amenities, and safe crossings into initial design of projects is more cost-effective than making costly retrofits later. Complete Streets is also a key strategy in the reduction of GHG emissions. Providing community residents with an option that gets them out of their cars is a proven strategy for improving communities, reducing air pollution, and generating local business. Similarly, Complete Streets consider Safe Routes to School, a public health strategy connecting communities to schools, includes but is not limited to child safety, reducing traffic congestion, sidewalks, crosswalks and bicycle lanes.

Creating integrated, multimodal transportation networks can improve economic conditions for both business owners and residents. A network of Complete Streets can be safer and more appealing to residents and visitors, which can benefit retail and commercial development. Multimodal transportation networks can improve conditions for existing businesses by helping revitalize an area attracting new economic activity. Equally important to sustain economic vitality are commercial vehicles and their operational needs. Vibrant urban environments cannot function without commercial vehicles delivering goods that sustain the economic activities that take place.

Integrating the needs of all users can also be cost-effective by reducing public and private costs. Accommodating all modes reduces the need for larger infrastructure projects, such as additional vehicle parking and road widening, which can be more costly than Complete Streets retrofits.

While AB 1358 provides no statutory requirement for RTPAs, integration of Complete Streets policies support local agencies' requirements to address Complete Streets in circulation elements of their general plan.

RTPAs should also integrate Complete Streets policies into their RTPs, to identify the financial resources necessary to accommodate such policies, and should consider accelerating programming for projects that retrofit existing roads to provide safe and convenient travel by all users.

RTPAs should encourage all jurisdictions and agencies within the region to ensure that their circulation elements and street and road standards, including planning, design, construction, operations, and maintenance procedures address the needs of all users. Streets, roads and highways should also be safe for convenient travel in a manner that is suitable within the context of Complete Streets. To the maximum extent feasible, RTPA funded transportation system projects, corresponding Complete Street facilities, and improvements should meet the needs in project areas to maximize connectivity, convenience and safety for all users.

Along the shoreline of coastal counties, one element of the Complete Streets program should be the California Coastal Trail (CCT), for additional information regarding the CCT see Section 6.11.

Recommendations (Shoulds)
Federal: FAST Act Section 1442. Safety for users, encourages each State and Metropolitan Planning Organization to adopt standards for the design of Federal surface transportation projects that provide for the safe and adequate accommodation (as determined by the State) of all users of the surface transportation network, including motorized and non-motorized users, in all phases of project planning development and operation.

Development of Complete Streets policy guides assist member agencies in the adoption of Complete Streets policy for their jurisdictions. A policy guide can function as a template. It can provide flexibility and be revised to accommodate individual agency's needs.

Planning Practice Examples: Available in Appendix H

Context Sensitive Solutions

Context Sensitive Solutions (CSS) is the process of engaging stakeholders in addressing transportation goals with the community, economic, social and environmental context. It is an inclusive approach used during planning, designing, constructing, maintaining, and operating the transportation system. It integrates and balances community and stakeholder values with transportation safety, maintenance, and performance goals. Context sensitive solutions are reached through a collaborative, interdisciplinary process involving all stakeholders and requires careful, imaginative, and early planning, and continuous stakeholder involvement.

Goals, issues, and values of California Tribal Governments and tribal communities, if applicable, should also be defined identified and addressed through outreach, collaboration and consultation. This would assist with identification and protection of cultural resources, historic sites, and environmental justice issues as well as, transportation needs and strategies. The evolution of economic development for some California Tribes has created increased demand for improved transportation infrastructure (i.e. roads, traffic control, access, etc.) and increased need for collaboration and consensus building with these stakeholders to address these new demands.

In towns and cities across California, the State highway may also function as a community street. These communities may desire that their main street be an economic, social, and cultural asset as well as provide for the safe and efficient movement of people and goods. Addressing all these needs throughout the planning and development process will help ensure that transportation solutions meet more than transportation objectives.

More information is available at the following links:
http://www.dot.ca.gov/hq/LandArch/16_livability/css/index.htm

http://www.contextsensitivesolutions.org/

Planning and Environmental Linkages

Federal statute and regulations outline an optional process for incorporating transportation planning documents or other source material directly or by reference into subsequent environmental documents that are prepared in compliance with the National Environmental Policy Act (NEPA). Appendix A to Title 23 CFR Part 450 provides additional information to explain the linkage between the transportation planning and project development/NEPA processes; it supports congressional intent that statewide and metropolitan transportation planning should be the foundation for highway and transit project decisions. The results or decisions of transportation planning studies may be used as part of the overall project development process consistent with NEPA and associated implementing regulations. Federal law specifically states that this does not subject transportation plans and programs to NEPA.

Publicly available documents or other source material produced by, or in support of the transportation planning process, may be incorporated directly or by reference into subsequent NEPA documents in accordance with federal regulations. If an RTPA and its project delivery partner(s) decide to take advantage of this opportunity to streamline and simplify the overall project delivery process, they should coordinate regarding the conditions that must be met during regional transportation planning. Most of the conditions, though perhaps not all, are routinely met during preparation of the RTP.

Additional information to further explain the linkages between the transportation and project development/NEPA processes is provided in Section 5.3 and Appendix D.

NCHRP Report 541, Consideration of Environmental Factors in Transportation Systems Planning, is an additional resource, at:
http://environment.transportation.org/pdf/RT_1_RM_7.pdf.

The FHWA's Environmental Review Toolkit, Program Overview for Planning and Environmental Linkages, also provides information, available at:
https://www.environment.fhwa.dot.gov/integ/index.asp

Recommendations (Shoulds)
Federal: Title 23 U.S.C. 168 Integration of planning and environmental review; Title 23 CFR 450.318 Transportation planning studies and project development; Appendix A of Title 23 CFR Part 450 – Linking the Transportation Planning and NEPA Processes (Appendix D of this document).

System Planning Documents

District System Management Plans (DSMPs)

The DSMP is a long-range, 20-25 year, policy planning document that describes how the District envisions the transportation system will be maintained, preserved, managed, operated, and developed within the planning horizon. It provides a vehicle for the development of multimodal, intermodal, and multijurisdictional system strategies. These strategies are developed in partnership with related Caltrans functional units, Divisions, and Districts, as well as external partners, such as RTPAs, cities, counties, tribal governments, other partner agencies, and the public. The DSMP plays a major role in guiding the development of both the Transportation Concept Reports (TCRs) and the Corridor System Management Plans (CSMPs).

Interregional Transportation Strategic Plan (ITSP)

The ITSP is a Caltrans planning document that provides guidance for the identification and prioritization of interregional transportation projects identified on the State's Interregional Transportation System. The ITSP provides an overview of the interregional transportation system, including identification of the major Strategic Interregional Corridors and Priority Interregional Facilities, which are the corridors and transportation facilities that have the greatest impact on interregional travel. Concepts have been created for each Strategic Interregional Corridor that will be used by public agencies to plan and program transportation improvements.

Transportation Concept Reports (TCRs)

Caltrans prepares TCRs, long-range transportation planning documents that guide the development of California's State Highway System (SHS) as required by Government Code 65086, Title 23 CFR Part 450 Subpart B, and the transportation needs of the public, stakeholders, and SHS users. The comprehensive planning document for each highway route and the corresponding transportation corridor provides a focused look at the existing conditions and performance of the route, future transportation needs and demands, integrates and aligns with the State Wildlife Action Plan (SWAP), habitat conservation plans and regional green-prints (where applicable), and articulates improvements necessary to address those needs within the context of the communities and rural areas the highways traverse. Caltrans meets this need through the development of the TCRs. Each Caltrans District is delegated the responsibility to create a TCR for the SHS routes within their boundaries.

Corridor System Management Planning (CSMP)

A CSMP is a comprehensive, integrated management plan for optimizing efficient, effective multimodal system performance within a transportation corridor. A CSMP includes all travel modes in a defined corridor - highways and freeways, parallel and connecting roadways, public transit (bus, bus rapid transit, light rail, intercity rail) and bikeways and pedestrian facilities. A CSMP results in a listing and phasing plan of recommended operational improvements, Intelligent Transportation System (ITS) strategies, and system expansion projects to preserve or improve performance measures within the corridor. CSMPs are developed and implemented by Caltrans in partnership with regional and local transportation agencies and other partners.

A CSMP incorporates both capital and operational improvements and is developed through the following steps:

1) Corridor limits defined.
2) Corridor team established.
3) Performance objectives defined; preliminary assessment performed.
4) Comprehensive performance assessment performed; causation of performance issues identified.
5) Simulate and test improvement scenarios and alternatives for most effective mix of projects, strategies and actions.
6) Alternatives selected and CSMP prepared. The Plan should be accepted or adopted by Caltrans, the MPO/RTPA, cities and counties as a guide for corridor management.

Completed CSMPs and other Caltrans system planning documents can be viewed at: http://www.dot.ca.gov/hq/tpp/corridor-mobility/

With regard to corridor system planning, the RTP may:

- Include by corridor all strategies, actions and improvements identified in system planning documents taking into consideration statewide and regional objectives which can include but are not limited to: multi-modal mobility, accessibility, environmental protection, and GHG reduction.
- Describe how the corridor will be managed across jurisdictions and modes to preserve corridor productivity based upon performance measurement.
- Describe roles and relationships among units of local government, modal agencies, Caltrans and related agencies for managing the corridor for highest mobility benefits and for measuring and evaluating performance.

2.8 Adoption - Update Cycles & Amendments

Regional transportation planning is a dynamic process requiring continuous monitoring and periodic updating. Updating an RTP ensures the planning process is valid and consistent with current and forecasted transportation and land use conditions and trends for at least a 20-year planning horizon.

RTPAs may revise the transportation plan at any time using the procedures in this section without a requirement to extend the horizon year. The transportation plan (and any revisions or amendments) shall be approved by the RTPA's Board and submitted for informational purposes to the CTC and Caltrans. Copies of any revised or amended transportation plans must be provided to the FHWA and the FTA, as appropriate.

California state law, (Government Code Section 65080(d)) mirrors the federal update requirement. An RTPA that is not within an MPO, that is required to adopt a RTP not less than every five years, may elect to adopt the plan not less than every four years in order that their member cities and counties can revise their housing elements every 8 years pursuant to Government Code Sections 65080 (b)(2)(M) and 65588(b).

Non-MPO RTPAs are required by State statute to update their RTPs at least every five years, regardless of whether they are located in an air quality nonattainment or maintenance area. However, some non-MPO RTPAs may elect to synchronize their update schedule with the MPO to align with housing elements. Failure of an RTPA to adhere to the required update period could result in a lack of state and federal funding as projects that are programmed for state or federal funding in the STIP and Federal STIP must be included in the approved RTP.

RTPs can be amended or modified. The U.S. DOT identified two types of revision methods for an RTP (1) A major revision that is an "amendment" and, (2) A minor revision that is an "administrative modification." The definitions in Title 23 CFR Part 450.104 clarify major and minor amendments to RTPs. It is recommended that RTPAs coordinate with Caltrans district regional planners on reviewing, commenting and at times facilitating the determination of what constitutes an RTP Amendment or Administrative modification.

RTP Amendment (major)

RTPs must be amended whenever a plan revision takes place such as the addition or deletion of a project or a major change in project scope, cost and schedule. Other potential triggers for an RTP Amendment could include changing programmed project phases or any major change in design concept or design scope (e.g. changing project termini or the number of through traffic lanes). Amendments require public review for possible comments, and demonstration of fiscal constraint.

RTP Administrative Modification (minor)

Federal regulations define Administrative Modification as a minor revision to an RTP that includes minor changes to project/project phase costs, minor changes to funding sources of previously included projects, and other minor changes to projects/project phase initiation dates.

An RTP administrative modification is much more flexible and open to wide interpretation. An administrative modification is a revision that does not require public review and comment, re-demonstration of fiscal constraint, or a conformity determination (in nonattainment and maintenance areas).

Re-Adopting Existing RTPs

Re-adopting the existing RTP is an option if no significant factors have occurred within the region that would impact the existing RTP. However, this option would require close evaluation of the current status of the RTPs fiscal constraint, conformity determination and any changes to the project scope, cost and schedule of the RTPs. Re-adopting an RTP could mean that no new projects are presented in the document, nor will there be new projects in the current update cycle of the RTP.

Conformity Considerations

Isolated rural non-attainment and maintenance areas are not required to prepare a conformity determination on their RTP and must only conduct conformity analysis on non-exempt or regionally significant projects. For more information, see Section 5.6 Air Quality & Transportation Conformity.

Requirements (Shalls)
State: Government Code Section 65080(d), mandatory RTP update cycles for RTPAs

2.9 RTP Checklist

The RTP Checklist is contained in Appendix C of this document. The purpose of the RTP Checklist is to establish a minimum standard for developing the RTP. The checklist of transportation planning requirements has been updated in order to conform to federal and state RTP requirements.

RTPAs should include the page numbers indicating where the Checklist items are addressed in the region's RTP. This requirement of identifying page numbers will assist the general public, federal, state and local agencies to locate the information contained in the RTP.

The checklist should be completed by the RTPA and submitted to the CTC and Caltrans along with the **draft** and final RTP. This checklist is available electronically from Caltrans planning staff. Each RTPA is encouraged to complete the checklist electronically. Following its completion, the RTPA's Executive Director (or designated representative) must sign the checklist to indicate that the information is complete and correct.

Requirements (Shalls)
State: Pursuant to California Government Code Section 14032(a), which authorizes the CTC to request an evaluation of all RTPs statewide to be conducted by Caltrans. All RTPAs are required to submit an RTP Checklist with their **Draft** and **Final** RTP when the document is submitted to Caltrans and the CTC.

Chapter 3

RTP Analysis and Modeling

(Non-MPOs Only)

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RTP ANALYSIS AND MODELING

3.0 Introduction

While not required under federal or state law a number of RTPAs have developed travel demand models (TDM) to assist with their RTP analysis. The purpose of the guidance is to provide clear and relevant direction to those agencies and provide state, regional, and local agencies with consistent and transparent modeling methodology direction.

The majority of California's RTPAs are located outside of the boundaries of the federally designated MPOs. The RTPAs located within a federally designated MPO boundary may utilize the MPO's travel demand model to support their RTP analysis.

The California Transportation Commission (CTC) recognizes that RTPAs are not required to develop Sustainable Community Strategies as part of their RTP. Further, the California Department of Transportation is responsible (not the RTPAs) for performing project-level air quality conformity analysis on regionally significant federally funded projects in isolated rural nonattainment or maintenance areas. RTPAs are encouraged to follow the TDM guidelines (Gov. Code 14522.2(b)). This chapter reflects only RTPA planning practice examples, not federal/state statutory/regulatory requirements and recommendations and planning practice examples related to MPOs.

The 2017 RTP guidelines builds upon the 2010 guidelines, reflects changes in federal and state law, and encourages the best practices in transportation modeling. Achieving California's transportation, air quality, and climate objectives are in large part depend on effective modeling practices and consistency and coordination of modeling among state, regional and local agencies. This chapter reflects current modeling information.

Organization of this Chapter

- Sections 3.0 to 3.4 - Provides the background and context of regional transportation planning analysis as well as general descriptions of terminology, technical and policies tool, and planning practice examples.
- Section 3.5 – Lists federal and state statutory or regulatory requirements and recommendations.

Federal/State Requirements, Recommendations, and Planning Practice Examples Terminology

This chapter follows the convention for "Shalls," "Shoulds," and "Planning Practice Examples" as defined in Section 1.0.

"Shalls": reflect a federal or state statutory or regulatory requirement and are used with a statutory or regulatory citation.

"Shoulds": reflect a federal or state permissive, optional, or recommended statutory reference such as "may" or "should" and are used with a statutory or regulatory citation.

"Planning Practice Examples": reflect federal/state guidelines, the state of the practices, and good modeling practices. They are not federal or state statutory or regulatory requirements or recommendations. Where Chapter 3 reflects "planning practice examples," the words "encouraged to," "consider," and "can" are used.

3.1 Modeling in the RTP Development Process / Transportation and Land Use Models

Transportation planners and engineers utilize analytical tools to assist in the policy formation and decision-making process during the regional transportation planning process.

Policy Tools:

- Improve the decision-making process by assisting the public and decision-makers in evaluating and identifying strategies that best address the transportation needs of their jurisdiction.
- Used to present market strategies to the public/stakeholders. Some models such as Geographical Information Systems (GIS) have excellent graphical and animation displays that can show "what if" scenarios.

Technical Tools:

- Provide a clear explanation of the modeling and analytical techniques applied in assessing the implications of the land use scenarios or other alternatives studied as applicable.
- Demonstrate how various policy assumptions impact the forecast results. For example, they provide estimates of the elasticities and cross-elasticities of demand for various modes of travel with respect to critical variables such as access time, travel time, reliability, safety, and cost.
- Assist with the evaluation and prioritization of planning and operational alternatives.
- Assist in the operation and management of existing roadway capacity. Some models provide optimization capabilities, recommending the best design or control strategies to maximize the performance of a transportation facility.

3.2 Requirements for RTP Analysis

State law requires transportation agencies identified under California Government Code sections 29532 or 29532.1 to develop RTPs (Gov. Code, § 65080).

Travel Demand Model (TDM)

While not required by law, RTPA transportation planners and engineers can utilize a travel demand models to evaluate RTP strategies. A TDM utilizes a series of mathematical equations that forecast travel behavior and transportation services demand within a region. The inputs include but are not limited to population, employment, land use, and the transportation network. The outputs of a TDM are used to assist decision-makers in developing policies and strategies, to inform the public, and for the National Environmental Protection Act (NEPA) and the California Environmental Quality Act (CEQA) analysis.

California Statewide Travel Demand Model (CSTDM)

Interregional travel is the sum of the following:

1. Trips beginning outside a given RTPA's boundary and ending within it (X-I trip)
2. Trips beginning inside a given RTPA's boundary and ending outside it (I-X trip)
3. Trips beginning outside a given RTPA's boundary, traveling across some portion of the region and ending outside the boundary (X-X trip)

Regional transportation planning agencies may use this data if they do not have access to a TDM.

For more information see, http://www.dot.ca.gov/hq/tpp/offices/omsp/statewide_modeling/cstdm.html

Visualization Techniques and Sketch Modeling of Scenarios

RTPAs may utilize visualization techniques such as GIS-based information, maps charts, and other visual aids that are useable and understandable by the public.

3.3 TDM Quality Control & Consistency

Travel Demand Modeling consistency and quality control are essential for creating confidence in modeling results. Furthermore, it is essential that RTPAs, State Agencies, and technical experts, have a voice in developing and determining realistic, relevant, and transparent model input assumptions, variables and factors, and sensitivity.

Model Inputs and Assumptions

Model inputs and assumptions are a necessary part of running a TDM. The assumptions are derived from the most current estimates developed and approved by the RTPA or other agencies authorized to make the estimates.

Data

Modeling results are only as good as the data that goes into them. The CTC recognizes that obtaining data is especially difficult in the rural areas of California and that RTPAs may need assistance. If travel survey samples are limited to a given region, other available sources of data include the National Household Travel Survey, American Community Survey, and trip rates associated with a region that is similar in size such as demographic and socioeconomic characteristics. As new technology and data sources (i.e. “big data”) become available, regional transportation agencies are encouraged to consider ways to incorporate them into their analysis and modeling practices.

Model Calibration and Validation

Calibration is used to adjust the model parameters until the model matches observed regional travel patterns and demand. Validation involves testing the model's predictive capabilities (ability to replicate observed conditions (within reason)) before it is used to produce forecasts. The outputs and observed or empirical travel data are compared, and the model's parameters are adjusted until the outputs fall within an acceptable range of error. Static validation tests compare the model’s base year traffic volume estimates to traffic counts using statistical measures and threshold criteria.

Because emission estimates are sensitive to vehicle speed changes, U.S. EPA and U.S. DOT suggest that areas using network-based travel models compare the speeds estimated in the validation year with speeds empirically observed during the peak and off-peak periods. The significant sensitivity of emissions to highway speeds emphasizes the need to monitor and maintain the ability of the transportation model to provide accurate speed estimates.[5]

The U.S. EPA and U.S. DOT also suggest that every component of a model, as well as the entire model system, validated[6]. For conventional four-step travel models, may include the four major components – trip generation, trip distribution, mode choice, and mode-specific trip assignment.

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[5] Guidance for the Use of Latest Planning Assumptions in Transportation Conformity Determinations, Revision to January 18, 2001 Guidance Memorandum, EAP, December 2008, page 9

[6] Travel Model Validation and Reasonableness Checking Manual second edition, page 1-6, September 24, 2010

Static Validation Criteria

- Volume-to-count ratio – is computed by dividing the volume assigned by the model by the actual traffic count for individual roadways model-wide. It provides a general context for the relationship (e.g., high or low) between model volumes and counts.
- Percent of links with volume-to-count within Caltrans deviation allowance – the deviation is the difference between the model volume and the actual count divided by the actual count. The Caltrans deviation thresholds recognize that allowances shrink as the count increases (i.e., lower tolerance for differences between the model volume estimates and counts).
- Correlation coefficient – estimates the correlation (strength and direction of the linear relationship) between the actual traffic counts and the estimated traffic volumes from the model.
- Percent root mean square error (RMSE) – is the square root of the model volume minus the actual count squared divided by the number of counts. It is a measure similar to standard deviation in that it assesses the accuracy of the entire model.

RTPAs that develop TDMs are encouraged to meet the static validation and transit assignment validation thresholds below. Where a model does not meet the thresholds the RTPA is encouraged to clearly document the impediments.

Recommended Static Validation Thresholds

Validation Metric	Thresholds
Percent of links with volume-to-count ratios within Caltrans deviation allowance	At Least 75%
Correlation Coefficient	At Least 0.88
Percent Root Mean Squared Error (RMSE)	Below 40%

The table below specifies possible transit assignment validation criteria.

Recommended Transit Assignment Validation

Validation Metric	Thresholds
Difference between actual counts to model results for a given year by route group (e.g., local bus, express bus, etc.)	+/- 20%
Difference between actual counts to model results for a given year by Transit Mode (e.g., light rail, bus, etc.)	+/- 10%

For additional guidance see the FHWA's The Travel Model Validation and Reasonableness Checking Manual ‖ Second Edition, September 2010.

Model Sensitivity Analysis

Sensitivity testing is the application of the model and the model set using alternative input data or assumptions. Sensitivity analysis of individual model components can include the estimation of the elasticities and cross-elasticities of model coefficients. However, sensitivity analysis can also be applied to the entire set of models using alternative assumptions regarding the demographic and, socioeconomic input data, or changes in transportation system to determine if the model results are plausible and reasonable.

Sensitivity testing includes both disaggregate and aggregate checks. Disaggregate checks, such as the determination of model elasticities, are performed during model estimation. Aggregate sensitivity testing results from temporal validation. During sensitivity testing, reasonableness and logic checks can be performed. These checks also include the comparison of estimated (or calibrated) model parameters against those estimated in other regions with similar models. "Reasonableness and logic checks can also include "components of change" analyses and an evaluation of whether or not the models "tell a coherent story" as recommended by the FTA for New Starts analysis*." (Travel Model Validation and Reasonableness Checking Manual Second Edition, September 2010, 1-7)*

The output of sensitivity tests can include total VMT, mode share, the number of the person and vehicle trips by purpose, average trip length by mode, and transit boardings. Each RTPA is encouraged to improve model sensitivity and accuracy. However, the application of these quality control criteria will vary based on the size of the RTPA, severity of its nonattainment status, the sophistication of transit system, the degree of model sophistication, among other characteristics.

The following inputs can be changed as part of sensitivity tests:

- Highway Network: Add or delete lanes to a link, change link speeds, and change link capacities
- Land use: Residential and employment density (the households and the number of jobs), proximity to transit, regional accessibility, and land use mix

(For additional guidance see Federal Highway Administration, The Travel Model Validation and Reasonableness Checking Manual,‖ Second Edition, 10.2 Sensitivity Testing September 2010)

Calculating Vehicle Miles Traveled (VMT)

Vehicle miles traveled (VMT) is key data for highway planning and management, and a common measure of roadway use and travel demand. Regional transportation agencies use VMT, along with other data, in estimating congestion, air quality, and potential gas-tax revenues. RTPAs also use VMT or VMT stratified by speed, as inputs in the development of NEPA and CEQA (SB 743) documents, and for purposes other than RTP development.

Documentation

Quality documentation is key to providing planners, engineers, and decision-makers with a better understanding of the reliability of the tools used to produce the forecast. In addition to documenting the key modeling processes (model estimation, calibration, and validation), it is also important to identify model limitations and document how they are addressed within the post-processing model if an off-model strategy is used.

Model Peer Review / Peer Advisory Committee

RTPAs (that have models) are encouraged to formally seek out peer reviews from Californian transportation modelers from other agencies of similar size during model development or after a major modeling enhancement.

In addition to the committee, transportation modeling agencies are also encouraged to participate in statewide, regional, and local modeling forums and user groups as a way to share ideas, review model inputs and methodologies, and coordinate modeling activities.

3.4 RTP Modeling Improvement Program (MIP) / Planning Practice Examples

Many techniques for travel demand forecasting exist and each of them differs in complexity, cost, and level of effort, sophistication, and accuracy. RTPAs select analysis methods that best meets the needs of the analysis, the availability of current and historical data, the degree of accuracy desired, the forecast time period, the time available to complete the forecast analysis, and the value (cost/benefit) of the forecast to the agency and the public.

Analysis, forecasting tools, and transportation technologies are not static; therefore, it is important that state, regional, local, and air quality agencies have an on-going model improvement program that supports model calibration and validation activities by focusing on increasing model accuracy, policy sensitivity, and data development and acquisition.

The RTP MIP includes planning practice examples that take into account factors such as the size and available resources of the regional transportation agencies and consider modeling capabilities for the referenced counties groupings below. See the next section (3.5 RTP Travel Analysis Groupings) for the delineation of federal and state law requirements and recommendation for RTPAs.

Category - 1 with attainment Air Quality (AQ), slow growth in population and jobs, little or no congestion, and no significant capacity-enhancing projects or limited transit expansion plans or areas of non-attainment due to transport.

These counties are not required under federal or state statute or regulation to develop network travel model. Road congestion is not increasing rapidly. Emission changes from higher miles per gallon vehicles can be factored or derived from the ARB inventory.

Category - 2 with attainment AQ, slow to moderate growth, small population, and no urbanized area or transit having more than a minimal potential impact on VMT, plus rural isolated non-attainment areas due to transport.

These counties are not required under federal or state statute or regulation to develop a network travel model.

<u>Analysis Tools:</u>

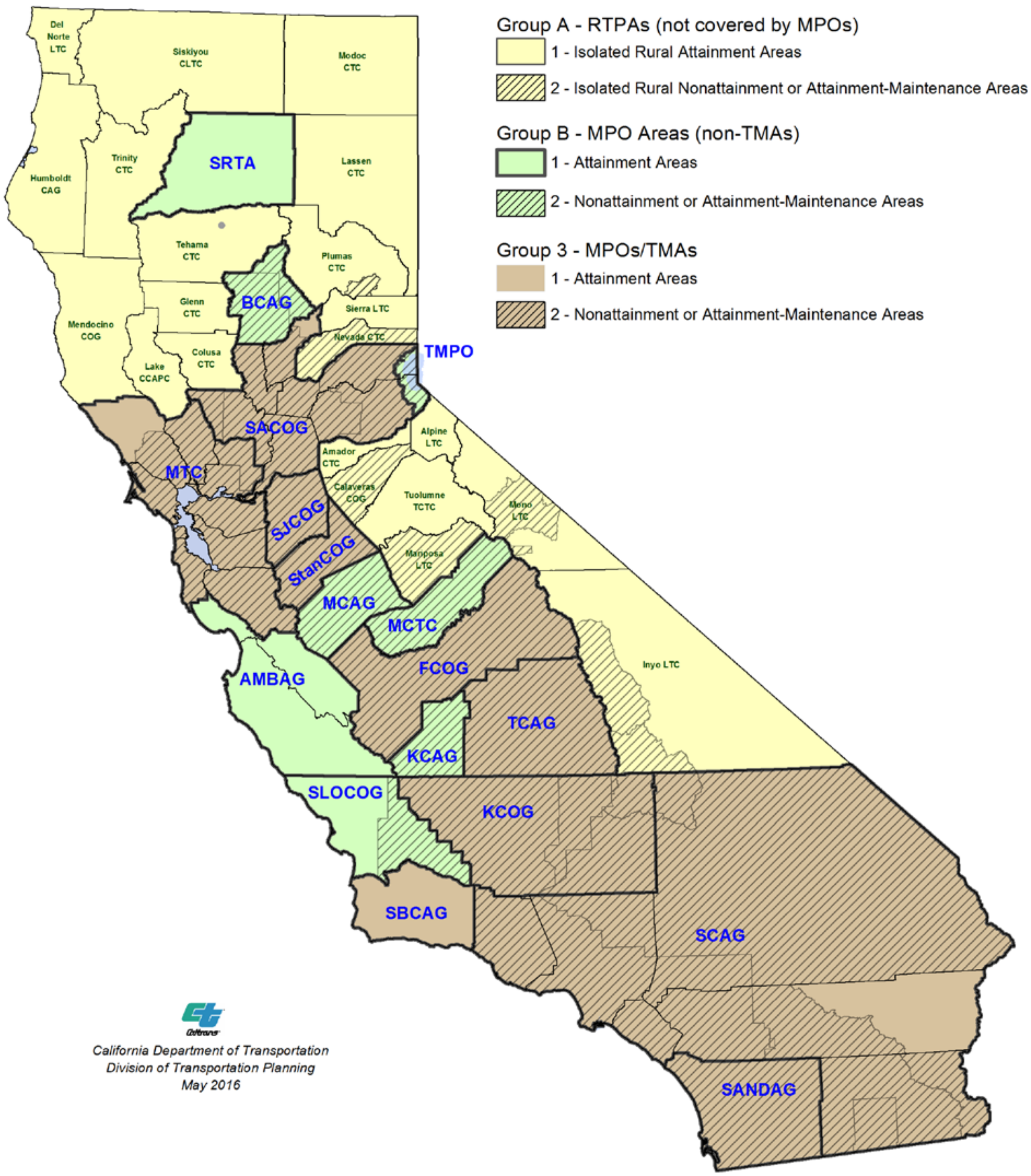
- If using a three-step model, consider running a reasonable convergence towards equilibrium.
- For models with a mode choice step, if the travel demand model is unable to forecast bicycle and pedestrian trips, consider another means to estimate those trips.
- Consider including speed and frequency, days, and hours of operation of service as inputs when modeling the transit mode.
- Consider using models that account for the effects of land use characteristics on travel, either by incorporating effects into the model process or by post-processing.

<u>Visualization Techniques and Sketch Modeling of Scenarios</u>

- Consider developing GIS capabilities that lead to simple land use models.
- Consider entering all natural resources data into the GIS.
- Consider developing parcel data and creating a land use data layer.
- Consider addressing changes in regional demographic patterns.

3.5 RTP Travel Analysis Groupings

MPOs, RTPAs, and congestion management agencies are organized into travel analysis groups based on federal and state laws (see map below). Group A includes Regional transportation planning agencies identified as Isolated Rural Attainment Areas (A1) and Isolated Rural Nonattainment or Maintenance Areas (A2). RTPAs that fall within the A grouping are not required to conduct federal air quality conformity analysis as part of their RTP development. Caltrans is required to perform project-level air quality conformity analysis for regionally significant federal funded projects.



Group B includes federally recognized MPOs not located within a metropolitan transportation area with a population over 200,000 and therefore, not designated transportation management areas (TMAs). This group includes two categories based on federal air quality conformity laws, (B1) Attainment Areas and (B2) Nonattainment or Maintenance Areas. Group C includes MPOs located within TMAs. This grouping includes (C1) Attainment Areas and (C2) Nonattainment or Maintenance Areas.

Group A1 Isolated Rural Attainment Areas -- Federal Requirements *(Shalls)*

None

Group A1: Isolated Rural Attainment Areas -- State Requirements *(Shalls)*

California Government Code

§65080(a) Each transportation planning agency designated under Section 29532 or 29532.1 shall prepare and adopt a regional transportation plan directed at achieving a coordinated and balanced regional transportation system, including, but not limited to, mass transportation, highway, railroad, maritime, bicycle, pedestrian, goods movement, and aviation facilities and services. The plan shall be action-oriented and pragmatic, considering both the short-term and long-term future, and shall present clear, concise policy guidance to local and state officials. The regional transportation plan shall consider factors specified in Section 134 of Title 23 of the United States Code. Each transportation planning agency shall consider and incorporate, as appropriate, the transportation plans of cities, counties, districts, private organizations, and state and federal agencies.

Group A1: Isolated Rural Attainment Areas -- Federal Recommendations *(Shoulds)*

None

Group A1: Isolated Rural Attainment Areas -- State Recommendations *(Shoulds)*

California Government Code

§14522.2(b) Transportation planning agencies other than those identified in paragraph (1) of subdivision (a) of Section 14522.1, cities, and counties are encouraged, but not required, to utilize travel demand models that are consistent with the guidelines in the development of their regional transportation plans.

§65080(c) Each transportation planning agency may also include other factors of local significance as an element of the regional transportation plan, including, but not limited to, issues of mobility for specific sectors of the community, including, but not limited to, senior citizens.

Group A2: Isolated Rural Nonattainment or Maintenance Areas -- Federal Requirements *(Shalls)*

Regional Transportation Planning Agencies are not required to perform federal air quality conformity analysis as part of their RTP development. Caltrans is the responsible agency for performing the project level air quality analysis requirements and recommendations listed in this grouping.

40 CFR §93

§93.109 Criteria and procedures for determining conformity of transportation plans, programs, and projects: General.

(g) Isolated rural nonattainment and maintenance areas. This paragraph applies to any nonattainment or maintenance area (or portion thereof) which does not have a metropolitan transportation plan or TIP and whose projects are not part of the emissions analysis of any MPO's metropolitan transportation plan or TIP. This paragraph does not apply to "donut" areas which are outside the metropolitan planning boundary and inside the nonattainment/maintenance area boundary.

(1) FHWA/FTA projects in all isolated rural nonattainment and maintenance areas must satisfy the requirements of §§93.110, 93.111, 93.112, 93.113(d), 93.116, and 93.117. Until EPA approves the control strategy implementation plan or maintenance plan for a rural CO nonattainment or maintenance area, FHWA/FTA projects must also satisfy the requirements of §93.116(b) ("Localized CO, PM10, and PM2.5 violations (hot spots)").

(2) Isolated rural nonattainment and maintenance areas are subject to the budget and/or interim emissions tests as described in paragraph (c) of this section, with the following modifications:

(i) When the requirements of §§93.106(d), 93.116, 93.118, and 93.119 apply to isolated rural nonattainment and maintenance areas, references to "transportation plan" or "TIP" should be taken to mean those projects in the statewide transportation plan or statewide TIP which are in the rural nonattainment or maintenance area. When the requirements of §93.106(d) apply to isolated rural nonattainment and maintenance areas, references to "MPO" should be taken to mean the state department of transportation.

(ii) In isolated rural nonattainment and maintenance areas that are subject to §93.118, FHWA/FTA projects must be consistent with motor vehicle emissions budget(s) for the years in the timeframe of the attainment demonstration or maintenance plan. For years after the attainment year (if a maintenance plan has not been submitted) or after the last year of the maintenance plan, FHWA/FTA projects must satisfy one of the following requirements:

(A) §93.118;

(B) §93.119 (including regional emissions analysis for NOX in all ozone nonattainment and maintenance areas, notwithstanding §93.119(f)(2)); or

(C) As demonstrated by the air quality dispersion model or other air quality modeling technique used in the attainment demonstration or maintenance plan, the FHWA/FTA project, in combination with all other regionally significant projects expected in the area in the timeframe of the statewide transportation plan, must not cause or contribute to any new violation of any standard in any areas; increase the frequency or severity of any existing violation of any standard in any area; or delay timely attainment of any standard or any required interim emission reductions or other milestones in any area. Control measures assumed in the analysis must be enforceable.

(iii) The choice of requirements in paragraph (g)(2)(ii) of this section and the methodology used to meet the requirements of paragraph (g)(2)(ii)(C) of this section must be determined through the interagency consultation process required in §93.105(c)(1)(vi) through which the relevant recipients of title 23 U.S.C. or Federal Transit Laws funds, the local air quality agency, the State air quality agency, and the State department of transportation should reach consensus about the option and methodology selected. EPA and DOT must be consulted through this process as well. In the event of unresolved disputes, conflicts may be escalated to the Governor consistent with the procedure in §93.105(d), which applies for any State air agency comments on a conformity determination.

Group A2: Isolated Rural Nonattainment or Maintenance Areas -- State Requirements *(Shalls)*

California Government Code

§65080(d) Except as otherwise provided in this subdivision, each transportation planning agency shall adopt and submit, every four years, an updated regional transportation plan to the California Transportation Commission and the Department of Transportation. A transportation planning agency located in a federally designated air quality attainment area or that does not contain an urbanized area may at its option adopt and submit a regional transportation plan every five years. When applicable, the plan shall be consistent with federal planning and programming requirements and shall conform to the regional transportation plan guidelines adopted by the California Transportation Commission. Prior to the adoption of the regional transportation plan, a public hearing shall be held after the giving of notice of the hearing by publication in the affected county or counties pursuant to Section 6061.

Group A2: Isolated Rural Nonattainment or Maintenance Areas -- Federal Recommendations *(Shoulds)*

None

Group A2: Isolated Rural Nonattainment or Maintenance Areas -- State Recommendations *(Shoulds)*

None

Chapter 4

RTP Consultation & Coordination

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RTP CONSULTATION & COORDINATION

4.1 Consultation & Coordination

Transportation planning is a collaborative process, led by the RTPA and other key stakeholders in the regional transportation system. Transportation planning activities include visioning, forecasting population/employment, identifying major growth corridors, projecting future land use in conjunction with local jurisdictions, assessing needs, developing capital and operating strategies to move people and goods, and developing a financial plan. The required planning processes are designed to foster involvement by all interested parties, such as the business community, community groups, walking and bicycling representatives, public health departments and public health non-governmental organizations, environmental organizations, the Native American community, neighboring RTPAs and the general public through a proactive public participation process. Review all sections of this chapter for detailed public participation requirements.

Coordination is the cooperative development of plans, programs and schedules among agencies and entities with legal standing in order to achieve general consistency. Consultation means that one or more parties confer with other identified parties in accordance with the established process and, prior to taking action(s), considers the views of the other parties and periodically informs them about action(s) taken. It is very important for the development of the RTP to be conducted both in coordination and consultation with interested parties.

In addition to having an extensive public participation process, each RTPA should coordinate its regional transportation planning activities with all transportation providers, facility operators such as airports, appropriate federal, state, local agencies, Native American Tribal Governments, environmental resource agencies, air districts, pedestrian and bicycle representatives and adjoining MPOs/RTPAs. The RTP shall (Title 23 CFR Part 450.216(j)) reflect consultation with resource and permit agencies to ensure early coordination with environmental resource protection and management plans, for additional information regarding consultation with resource agencies see Section 4.8. RTPAs that reside within MPO boundaries are encouraged to collaborate with their MPO to coordinate public involvement, as applicable and appropriate.

RTPs are required to be developed in coordination with local and regional air quality planning authorities and shall reflect specific consultation activities with air quality agencies on the development of the RTP (Title 40 CFR Part 93.105 (b)). RTPAs participate in air quality planning by providing travel activity data for emissions inventories. They may also implement Transportation Control Measures to reduce transportation related emissions. This participation helps lay the groundwork for future SIP conformity determinations.

Due to the importance of including a wide range of various parties in the development of the RTP, the 26 rural RTPAs will need to conform to the coordination and consultation requirements as outlined in 23 CFR 450.210 and 450.216(j). Development of the RTP shall include a documented public involvement process, consultation and coordination with all interested parties and shall, at a minimum, describe explicit procedures, strategies and desired outcomes. RTPAs that reside within MPO boundaries are encouraged to collaborate with their MPO to coordinate the consultation process.

In summary, the consultation process shall:

1. Provide adequate public notice and the opportunity to comment on proposed RTPs and public participation plans;
2. To the maximum extent practicable, employ visualization techniques to describe the RTP;
3. To the maximum extent practicable, make the RTP electronically accessible, such as placing it on the Internet;
4. To the maximum extent practicable, hold public hearings at convenient and accessible locations and times;
5. Demonstrate explicit consideration and response to public input on the RTP (documentation);
6. Seek out and consider the needs of those traditionally underserved by existing transportation systems, such as low income and minority households;
7. Provide additional opportunities to comment on the RTP, if the final version differs due to additional comments;
8. Coordinate with the state transportation planning and public involvement processes; and,
9. Periodically review intended RTP outcomes, products and/or services.

Requirements (Shalls)
Federal: Transportation Conformity Regulations of Title 40 CFR Part 93.105; 23 CFR 450.210 requires States to establish a documented public involvement process for development of the RTP. RTPAs shall comply as well.

Planning Practice Examples: Available in Appendix H

4.2 Title VI & Environmental Justice Considerations in the RTP

Evaluation of the entire range of a region's needs is a key element in the process of developing an RTP, and like consideration of public comment is required by both federal and state law. Providing more transportation and mobility choices such as increased transit, bicycle, and pedestrian facilities, as well as appropriate housing choices near job centers increases opportunities for all segments of the population at all income levels. Each region is required by federal regulation and state laws to plan for and implement transportation system improvements that will provide a fair share of benefits to all residents, regardless of race, ethnicity or income level. As discussed in Section 4.4, the public involvement process must provide for "Seeking out and considering the needs of those traditionally underserved by existing transportation systems, such as low-income and minority households as well as people with limited English proficiency, who may face challenges accessing employment and other services." This section discusses separate legal requirements that protect low-income and minority individuals: Title VI of the federal Civil Rights Act of 1964, Section 11135 of the California Government Code, and Presidential Executive Order 12898 on Environmental Justice (EJ) require RTPAs to be sensitive to how all residents, particularly low-income communities and minority communities, may be impacted by possible transportation and land use changes identified in the RTP. While Section 11135 of the California Government Code applies to all RTPAs, Title VI and EJ requirements apply to agencies that receive federal funds.

Title VI of the Civil Rights Act of 1964

Title VI of the Civil Rights Act of 1964 prohibits discrimination by recipients of federal funds on the basis of race, color or national origin. A similar prohibition applies to recipients of state funds under California Gov. Code section 11135, which prohibits discrimination on the basis of race, color or national origin, as well as ethnic group identification, religion, age, sex, sexual orientation, genetic information, or disability. When an RTPA receives federal funding for only a limited purpose, such as a specific service or project, it is still subject to Title VI in all of its "policies, programs or activities," whether or not they are directly supported with the federal funds.

The general prohibition of Title VI is far-reaching. While U.S. DOT's Title VI regulations (49 CFR § 21.5) enumerates specific prohibitions, they also state that "the enumeration of specific forms of prohibited discrimination in [the regulations] does not limit the generality of the prohibition." Among the numerous specific forms of discrimination the regulations call out are prohibitions on subjecting a person to segregation in any matter related to receipt of any benefit under the program; denying a person the opportunity to participate as a member of a planning, advisory, or similar body which is an integral part of the program; or utilizing any criteria or methods of administration that have the effect of subjecting persons to discrimination. Other discriminatory actions are specifically prohibited. Title VI and its implementing regulations (49 CFR § 21.5) state that the recipient of federal funds may not directly or through contractual or other arrangements, on the grounds of race, color, or national origin:

1. Deny a person any service, financial aid, or other benefit provided under the program;
2. Provide any service, financial aid, or other benefit to a person which is different, or is provided in a different manner, from that provided to others under the program;
3. Subject a person to segregation or separate treatment in any matter related to his receipt of any service, financial aid, or other benefit under the program;
4. Restrict a person in any way in the enjoyment of any advantage or privilege enjoyed by others receiving any service, financial aid, or other benefit under the program;
5. Treat a person differently from others in determining whether he satisfies any admission, enrollment, quota, eligibility, membership, or other requirement or condition which persons must meet in order to be provided any service, financial aid, or other benefit provided under the program;
6. Deny a person an opportunity to participate in the program through the provision of services or otherwise or afford him an opportunity to do so which is different from that afforded others under the program; or
7. Deny a person the opportunity to participate as a member of a planning, advisory, or similar body which is an integral part of the program.

Title VI Requirements

In addition to prohibiting discrimination, the Title VI regulation imposes affirmative obligations on recipients. Among other things, recipients are prohibited from denying a person an opportunity to participate in the program through the provision of services or otherwise afford him an opportunity to do so which is different from that afforded others under the program. The Title VI regulation also requires them to "take affirmative action to assure that no person is excluded from participation in or denied the benefits of the program or activity on the grounds of race, color, or national origin," and both as part of the Title VI report described below and more generally, to “have available for the Secretary racial and ethnic data showing the extent to which members of minority groups are beneficiaries of programs receiving Federal financial assistance.”

As described in FTA Circular 4702.1B, *“Title VI Requirements and Guidelines for FTA Recipients,”* the Title VI Plan (certifying compliance every three years) for RTPAs that receive federal funds includes the following information and is submitted to the State as the primary recipient of funding, separately from the RTP.

1. All general requirements set out in Chapter III of the Circular;
2. For agencies that provide fixed-route service, the service standards and policies contained in Chapter IV of the Circular must also be met. These standards and policies must address how service is distributed across the transit system and must ensure that the manner of the distribution affords users access to these assets.

The Circular includes the following related definitions:

1. Discrimination refers to any action or inaction, whether intentional or unintentional, in any program or activity of a Federal aid recipient, sub-recipient, or contractor that results in disparate treatment, disparate impact, or perpetuating the effects of prior discrimination based on race, color, or national origin.
2. Disparate impact refers to a facially neutral policy or practice that disproportionately affects members of a group identified by race, color, or national origin, where the recipient’s policy or practice lacks a substantial legitimate justification and where there exists one or more alternatives that would serve the same legitimate objectives but with less disproportionate effect on the basis of race, color, or national origin.
3. Disproportionate burden refers to a neutral policy or practice that disproportionately affects low-income populations more than non-low-income populations. A finding of disproportionate burden requires the recipient to evaluate alternatives and mitigate burdens where practicable.
4. Disparate treatment refers to actions that result in circumstances where similarly situated persons are intentionally treated differently (i.e., less favorably) than others because of their race, color, or national origin….
5. Minority population means any readily identifiable group of minority persons who live in geographic proximity and, if circumstances warrant, geographically dispersed/transient populations (such as migrant workers or Native Americans) who will be similarly affected by a proposed DOT program, policy, or activity.

Environmental Justice

Presidential Executive Order 12898 requires that “each federal agency shall conduct its programs, policies, and activities that substantially affect human health or the environment, in a manner that ensures such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under, such programs, policies, and activities, because of their race, color, or national origin.” It also requires federal executive agencies and the entities to which they extend financial support or project approval to “identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations.”

The U.S. DOT Order 5610.2(a) on EJ defines "adverse effects" as "the totality of significant individual or cumulative human *health or environmental effects*." That phrase is defined broadly as extending to "interrelated social and economic effects, which may include, but are not limited to: bodily impairment, infirmity, illness or death; air, noise, and water pollution and soil contamination; destruction or disruption of man-made or natural resources; destruction or diminution of aesthetic values; destruction or disruption of community cohesion or a community's economic vitality; destruction or disruption of the availability of public and private facilities and services; vibration; adverse employment effects; displacement of persons, businesses, farms, or nonprofit organizations; increased traffic congestion, isolation, exclusion or separation of minority or low-income individuals within a given community or from the broader community." That phrase also includes "the denial of, reduction in, or *significant delay in the receipt of, benefits* of DOT programs, policies, or activities."

Environmental Justice at FHWA means "*identifying and addressing disproportionately high and adverse effects of the agency's programs, policies, and activities on minority and low-income populations to achieve an equitable distribution of benefits and burdens. This includes the full and fair participation by all potentially affected communities in the transportation decision-making process".*

The FTA EJ Circular 4703.1 describes an EJ analysis to determine whether the activity will result in a "[d]isproportionately high and adverse effect on human health and environment." The DOT order prohibits, if further mitigation measures or alternatives that would reduce the disproportionately high and adverse effects are feasible, any "[d]isproportionately high and adverse effect on minority and low-income populations," defined as "an adverse effect that: (l) is *predominately borne by* a minority population and/or a low-income population, or (2) will be suffered by the minority population and/or low-income population and is *appreciably more severe or greater in magnitude* than the adverse effect that will be suffered by the non-minority population and/or non-low-income population."

DOT EJ Order 5610.2(a) and FTA EJ Circular 4703.1 provide guidance on EJ related to the responsibilities of RTPAs that are federal fund recipients. There are three federally established guiding EJ principles, summarized in FTA Circular 4703.1, to consider throughout transportation planning, public outreach and participation efforts conducted in development of the RTP:

- "To avoid, minimize, or mitigate disproportionately *high and adverse human health and environmental effects, including social and economic effects*, on minority populations and low-income populations.
- To ensure the *full and fair participation* by all potentially affected communities in the transportation decision-making process.
- To prevent the *denial of, reduction in, or significant delay in the receipt of benefits* by minority and low-income populations."

While Title VI and EJ are closely related, FTA Circular 4703.1, "*Environmental Justice Policy Guidance for FTA Recipients,"* provides an understanding of the overlap and distinction between the two. Title VI prohibits discrimination by recipients of federal assistance on the basis of race, color, and national origin. By contrast, the Executive Order on EJ extends its protections not only to "minority populations" but also to "low-income populations."

DOT EJ Order 5610.2(a) defines "Minority Population" to mean "any readily identifiable groups of minority persons who live in geographic proximity, and if circumstances warrant, geographically dispersed/transient persons (such as migrant workers or Native Americans) who will be similarly affected by a proposed DOT program, policy or activity." The U.S. DOT EJ Order similarly defines "Low-Income Population" as "any readily identifiable groups of low-income persons who live in geographic proximity, and if circumstances warrant, geographically dispersed/transient person (such as migrant workers or Native Americans) who will be similarly affected by a proposed DOT program, policy or activity." FTA's EJ Circular 4703.1 and FTA's 2012 Title VI Circular 4702.1B include similar definitions.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.210(a)(1); For federal fund recipients: portions of FTA Circular 4702.1B – Title VI Requirements and Guidelines for FTA Recipients; Presidential Executive Order 12898 on Environmental Justice (1994): portions of U.S. DOT Order 5610.2(a) (2012) and FHWA Order 6640.23A (2012)
State: Government Code Section 11135

Recommendations (Shoulds)
Federal: For federal fund recipients: FTA Circular 4703.1 – EJ Policy Guidance for FTA Recipients; U.S. DOT EJ Order 5610.2(a); portions of FTA Circular 4702.1B-Title VI Requirements and Guidance for FTA Recipients; portions of U.S. DOT EJ Order 5610.2(a), and FHWA Order 6640.23A (2012).

Planning Practice Examples: Available in Appendix H

4.3 <u>Social Equity Factors</u>

Social equity factors relevant to RTP development include, but are not limited to, housing and transportation affordability, access to transportation, displacement and gentrification, and the jobs/housing fit.

Title 23 CFR Part 450.210(a)(1)(viii) requires that a public involvement process describe explicit procedures, strategies and desired outcomes for seeking out and considering the needs of those traditionally underserved by existing transportation systems, such as low-income and minority households, who may face challenges accessing employment and other services.

RTPAs can encourage the involvement of low-income communities and communities of color by proactively seeking the input of these households and by making public meetings as accessible as possible. Public engagement strategies may include:

- Hold meetings at accessible locations and outside of traditional working hours (e.g. evenings and weekends);
- Locate meetings in low-income communities and communities of color;
- Locate meetings at sites accessible via affordable transit;
- Translate meeting materials for non-English speakers;
- Provide interpretation at meetings for non-English speakers; and,
- Ensure meetings are attended by RTPA decision makers in addition to RTPA staff.

In addition to the practices listed above, RTPAs are also encouraged, to the extent practicable, to develop partnerships with local, regional and state-wide organizations that can assist in achieving RTP participation goals.

Planning Practice Examples: Available in Appendix H

4.4 Public Involvement Process

Involving the public in planning and project development poses a major challenge as well as an opportunity. Many people are skeptical about whether they can truly influence the outcome of a transportation project. Others feel that transportation plans are too abstract and long-term to warrant attention.

The RTP is one of the key processes an RTPA undertakes. It is a primary avenue for public participation in the long-range transportation planning process. Title 23 CFR Part 450.210(a) states the following concerning participation and consultation (RTPAs shall comply as well):

"The State's public involvement process at a minimum shall establish early and continuous public involvement opportunities that provide timely information about transportation issues and decision-making processes to, affected public agencies, representatives of public transportation employees, public ports, freight shippers, private providers of transportation (including intercity bus operators), representatives of users of public transportation, representatives of users of pedestrian walkways and bicycle transportation facilities, representatives of the disabled, providers of freight transportation services, and other interested parties with reasonable opportunities to be involved in the long-range statewide transportation plan and STIP."

Title 23 CFR Part 450. 210(a)(1) also requires that public involvement process be developed in consultation with all interested parties and describe explicit procedures, strategies, and desired outcomes for:
(ii) Providing timely notice and reasonable access to information about transportation issues and processes;
(iii) Providing adequate public notice of public participation activities and time for public review and comment at key decision points, including but not limited to a reasonable opportunity to comment on the proposed RTP;
(iv) Holding any public meetings at convenient and accessible locations and times;
(viii) Seeking out and considering the needs of those traditionally underserved by existing transportation systems, such as low-income and minority households, who may face challenges accessing employment and other services.

The purpose of the RTPA's documented public involvement process is to establish the process by which the public can participate in the development of regional transportation plans and programs. The documented public involvement process should be designed to assist RTPA staff in implementing an effective public participation process through a variety of strategies. It provides RTPA staff with a menu of techniques or activities from which they can tailor their specific program's input process. RTPAs should also refer to the CTP Public Participation Plan document, or the CTP/FSTIP Public Participation Plan, which can provide the most effective methods for engaging with the public. This document can be accessed through the following link: http://www.dot.ca.gov/hq/tpp/offices/osp/ppp_files/CTPE_PPP_Final_052913_dg_29.pdf. Which public participation methods the RTPA uses will require a careful analysis of what is desired to be accomplished as well as the scope of the particular transportation project(s). Plenty of flexibility is available to RTPAs in developing specific public involvement programs. Every given situation or region in California is different, and each approach to a specific public involvement challenge will be unique.

When significant written and oral comments are received on the draft RTP and as a result of the participation process or the interagency consultation process required under the EPA transportation conformity regulations (Title 40 CFR Part 93), a summary, analysis, and report of the proposed comments should be made as part of the final RTP.

It is important to note that the documented public involvement process should be prepared prior to the development of the RTP. The documented public involvement procedures should have public input during its preparation and have a 45-day comment period before the RTPAs board adopts it. This enhanced documented public involvement process is a federal requirement.

Title 23 CFR Part 450.210(a)(1)(v) requires the documented public involvement process to use visualization techniques, to the maximum extent practicable, to describe the RTP. Visualization techniques range from a simple line drawing or hand written chart to technologically complex web cast public meetings, GIS modeling and computer generated maps. The specific type of visualization technique is determined by the RTPA.

The documented public involvement process, the draft and adopted RTP shall be posted on the RTPA's website to the maximum extent practicable and for the life of the RTP. It is also recommended that RTPAs place hard copies of the draft and adopted copies of RTPs in local libraries and other locations where the public would have access to these documents.

Public involvement programs for RTPs in California are required to follow state and federal requirements. If the minimum state and federal requirements are inadequate for the region, the RTPA may develop a more specialized public involvement program if that promises to be more effective.

In developing RTPs, the RTPA should consult with agencies and officials responsible for other planning activities within their region that are affected by transportation or at least coordinate the planning process to incorporate input. These areas include, but are not limited to, the listed examples:

1. State and local growth;
2. Public health;
3. Housing;
4. Economic development;
5. Environmental protection;
6. Tourism;
7. Natural disaster risk reduction;
8. Airport operations; and,
9. Goods Movement.

When the RTPA region includes California Indian Tribal Lands (reservations, Rancherias, and allotments) the RTPA shall appropriately involve the federally recognized Native American Tribal Government(s) in the development of the RTP. The RTPA should also seek input even from tribes that are not federally recognized or from other "interested parties" that may have a background and/or history of Native American culture within the region. In addition, AB 52 (Chapter 532, Statutes of 2014) mandates that agencies must consult with tribes regarding impacts to Tribal Cultural Resources as an impact under CEQA. See Section 4.7 Native American Tribal Government Consultation and Coordination for further discussion.

Similarly, when the RTPA region includes federal public lands, the RTPA shall appropriately involve the federal land management agencies in the development of RTP.

RTPA public participation efforts shall at minimum develop a documented process that outlines roles, responsibilities and provides outreach efforts to all sectors of the local community.

RTPAs may include a separate Public Participation Plan, however RTPAs shall at minimum include a detailed discussion of public participation efforts within the RTP. For example, public hearings, workshops, surveys, brochures and other methods that invite comments or input for the public participation efforts and RTP development.

RTPAs are also encouraged to involve the media, including ethnic media as appropriate, as a tool to promote public participation in the RTP development, review and commenting process.

Public participation and consultation for the development of the RTP remains an essential element of the overall RTP process. Mapping and visualization tools should be used, to the extent practicable, to create visual representations of proposed scenarios. A Public Participation Plan includes public outreach, public awareness, and public input beginning with the planning stage.

For additional information on the consultation process please refer to Sections 4.6, 4.7, and 4.8.

Periodic Evaluation of the Public Involvement Process

A periodic review of the public involvement process is important to evaluate the effectiveness of the procedures and strategies employed during the full and open participation process. This periodic review can help to ensure that the public involvement process, once adopted, is being implemented effectively and is achieving its goals of engaging low-income and minority residents in expressing and prioritizing their needs and their views on how the RTP can best meet those needs.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.210
State: Public Resources Code Section 5097.94, and Sections 21073 through 21084.3.

Planning Practice Examples: Available in Appendix H

4.5 <u>Private Sector Involvement</u>

Private sector involvement relates to how the goods movement industry and other business or commercial interests are represented in the development of the RTP. Trucks, freight trains, taxis, limousines all use the transportation network and are an integral part of the regional transportation system. Other examples of private sector involvement in the development of the RTP include Transportation Management Associations, private transit operators, developers, and Chambers of Commerce. Their absence in the regional transportation planning process adversely impacts the efficiency of the transportation network.

In urbanized areas of California, the number of trucks on the highway system has substantially increased. This has had a direct impact on traffic congestion within these areas. An increased level of truck activity has also had an impact in rural areas of the state, although primarily on the principal routes in rural counties. For these reasons, an RTP that does not include the “Private Sector” in the planning process is not a viable plan. The impact of the private freight sector on the transportation system is significant and must be included and documented in the RTP process.

Unfortunately, in many plans, the private sector is not identified as a planning partner. Where addressed, goods movement is discussed in the abstract with minimal long-range assumptions identified or assessed.

RTPAs should take necessary actions to ensure major trucking firms, large employers and business organizations are formally invited to participate in the preparation of the RTP. The RTPA should strive to include any major long-range plans of these organizations that may have an impact on the regional transportation system. The purpose is to provide private sector transportation providers a process of communication and involvement into the region's transportation planning process. The specific outreach techniques developed and ultimately used is dependent on the size and composition of the region. These efforts to solicit input into the long-range regional transportation planning process should be documented in the RTP.

Requirements (Shalls)
Federal: Federal regulations require private sector involvement as a component of the regional transportation planning process. Title 23 U.S.C. Part 134 (g)(4), Title 23 U.S.C. Section 135(e) and Title 23 CFR Part 450.210(a) require the transportation planning process include input from the goods movement industry and other transportation organizations.

Recommendations (Shoulds)
State: California Government Code Section 14000(d) recommends that a comprehensive multimodal transportation planning process should be established which involves all levels of government and the private sector in a cooperative process to develop coordinated transportation plans.

Planning Practice Examples: Available in Appendix H

4.6 Consultation with Interested Parties

The U.S. DOT defines consultation as when: "*one or more parties confer with other identified parties in accordance with an established process and, prior to taking action(s), considers the views of the other parties and periodically informs them about action(s) taken*." Some areas of consultation could include transportation, land use, employment, economic development, housing, community development and environmental issues.

The U.S. DOT definition of "interested parties" to be engaged in statewide/nonmetropolitan and metropolitan transportation planning has been expanded. The RTPA shall provide the following interested parties with reasonable opportunity to comment on the proposed RTP:

1. Individuals;
2. Affected public agencies;
3. Representatives of public transportation employees;
4. Public ports;
5. Freight shippers;
6. Private providers of transportation;
7. Representatives of users of public transportation;
8. Representatives of users of pedestrian walkways and bicycle transportation facilities;

9. Representatives of people with disabilities;
10. Providers of freight transportation services; and,
11. Other interested parties.

Requirements (Shalls)
Federal: Consulting with interested parties on plans, programs and projects shall include individuals or organizations that are mentioned in Title 23 CFR Part 450.210(a)(1)(i). Title 23 CFR Part 450.216(k) requires States to consult with federal land use management agencies, as appropriate during the development of RTP. RTPAs shall comply as well. Title 23 CFR Part 450.216(j) states that States shall consult as appropriate with state and local agencies responsible for land use management, natural resources, environmental protection, conservation and historic preservation during the development of their RTP. RTPAs shall comply with this as well.
State: None

Planning Practice Examples: Available in Appendix H

4.7 Native American Tribal Government Consultation & Coordination

During the development of the RTP, Tribal Government ***consultation*** can be described as the meaningful and timely process of seeking, discussing, and considering carefully the views of leaders of federally recognized Tribal Governments and, where feasible, seeking agreement on important matters. The RTPA can do this by sharing information and conducting meetings with leaders of the federally recognized Tribal Governments during the preparation of the RTP prior to taking action(s) on the plan and by making sure to consider input from the tribe as decisions are made. Consultation should be conducted in a way that is mutually respectful of each party's sovereignty. Tribal Government ***coordination*** is the comparison of the RTPAs transportation plans, programs, projects and schedules with similar documents prepared by the tribe. The RTPA needs to ensure consistency with tribal plans and the RTP.

Currently there are 109 federally recognized tribes in California. The federally recognized Tribal Governments hold inherent power of limited sovereignty and are charged with the same responsibility as other governmental authorities. In addition, California is home to the largest Native American population in the country, including non-federally recognized tribes, and urban Indian communities.

The RTPA should include a discussion of consultation, coordination and communication with federally recognized Tribal Governments when the tribes are located within the boundary of an RTPA. The RTPA should establish a government-to-government relationship with each tribe in the region. This refers to the protocol for communicating between the RTPAs and the Tribal Governments as sovereign nations. This consultation process should be documented in the RTP. The initial point of contact for Tribal Governments should be the Chairperson for the tribe.

The RTPA should develop protocol and communication methods for outreach and consultation with the Tribal Governments. However these protocol and communication methods should be re-evaluated if the agencies are un-successful in obtaining a response during the development of the RTP.

It is important to ensure that efforts in establishing channels of communication are documented in the RTP. For further information and assistance in the consultation process, contact the

California Department of Transportation Native American Liaison Branch (NALB) at: http://dot.ca.gov/hq/tpp/offices/ocp/nalb. The NALB webpage also provides contact information for the California Department of Transportation Districts' Native American Liaisons.

As mentioned above, California is home to many non-federally recognized tribes as well as Native Americans living in urban areas. RTPAs should involve the Native American communities in the public participation processes. Establishing and maintaining government-to-government relations with federally recognized Tribal Governments through consultation is separate from, and precedes the public participation process.

Requirements (Shalls)
Federal: Title 23 CFR part 450.216(j) requires States to involve the federally recognized Native American Tribal Government in the development of the RTP and project lists. RTPAs shall comply as well. The requirement of including interested parties in the development of the participation plan and the RTP would include federally recognized or non-federally recognized tribes.
State: Public Resources Code Section 5097.94, and Sections 21073 through 21084.3. AB 52 added Tribal Cultural Resources as an impact under CEQA and required consultation to mitigate those impacts with the California Native American tribes as defined in California Public Resources Code Section 21073. Because RTPs are subject to CEQA and a program EIR is prepared to analyze the impacts of implementing an RTP, AB 52 means that RTPAs must consult with tribes with regards to Tribal Cultural Resources as part of the CEQA process.

Planning Practice Examples: Available in Appendix H

4.8 Consultation with Resource Agencies

Consultation with resource agencies, State and local agencies responsible for land use management, environmental protection, conservation, and historic preservation is critical when concerning the development of the RTP.

The consultation efforts involve:

1. Comparing transportation plans with State conservation plans, maps and other data, if available; and,

2. Comparing transportation plans with inventories of natural and historic resources, if available.

Input/comments from resource agencies early in the planning process is critical. The reason for proactive consultation and engagement is to prevent project delays at a later time. In other words, coordinating and consulting with resources agencies early in the planning process, may lead to better coordination, minimal litigation, possible project cost savings and an upfront understanding of resource agency issues.

Some examples of resource agencies that could be included in a more seamless multi-agency process, but are not limited to California Environmental Protection Agency (CalEPA), California Coastal Commission, and U.S. Fish and Wildlife, U.S. Army Corp of Engineers, California Department of Fish and Wildlife and California Department of Parks and Recreation.

The FHWA Eco-Logical and Integrated Ecological Framework and the state Regional Advance Mitigation Planning model provides a process by which early consultation with resource agencies and conservation non-profit organizations to develop regional greenprints or conservation plans that identify of areas of conservation value can satisfy federal requirements for early consultation and result in benefits for both transportation agencies and environmental protection. Programmatic mitigation plans, Natural Communities Conservation Plans and Habitat Conservation Plans can provide early consultation and identification of natural resources that need to be avoided or minimized in order to reduce risk and streamline project delivery. For additional information related to coordination of regional mitigation activities with other planning processes, see Chapter 5.

An RTPA shall coordinate and consult with resource agencies on data or information sharing, if available. The following is a preliminary list of resource agencies that should be consulted in the development of the RTP:

1. Federal Highway Administration;
2. Federal Transit Administration;
3. U.S. Environmental Protection Agency;
4. U.S. Army Corps of Engineers;
5. NOAA Fisheries Services;
6. U.S. National Park Service;
7. U.S. National Marine and Fishery Service;
8. U.S. Fish and Wildlife Service;
9. California Coastal Commission;
10. California Ocean Protection Council;
11. California Energy Commission;
12. California Office of Planning and Research;
13. California Environmental Protection Agency;
14. California Natural Resources Agency;
15. California Water Resources Control Board;
16. California Regional Water Quality Control Board;
17. California Department of Fish and Wildlife;
18. California Department of Resources, Recycling, and Recovery;
19. California Air Resources Board;
20. California Department of Parks and Recreation;
21. California Department of Conservation;
22. California State Mining and Geology Board;
23. Any additional California environmental, energy, resource and permit agencies;
24. Bay Conservation and Development Commission (Bay Area);
25. Regional Air Quality Management Districts, and;
26. California Office of Historic Preservation.

It may be challenging to obtain timely responses and comments to the RTP, its programs and projects, when the commenting period is announced to the general public and stakeholders. It is understandable that these efforts will depend on the specific region.

Interagency Consultation for Transportation Conformity – The transportation conformity rule requires that State and local agencies establish formal procedures to ensure interagency coordination on critical transportation conformity issues. Nonattainment and maintenance areas have adopted consultation procedures to meet these requirements. These procedures are federally enforceable and should be followed for each conformity determination.

Additional guidance regarding federally required consultation with resource agencies during the RTP development process is available in Section 5.2 Federal Environmental Requirements.

Requirements (Shalls)
Federal: Title 23 CFR part 450.216(j) requires that the State shall consult, as appropriate, with State and local agencies responsible for land use management, natural resources, environmental protection, conservation, and historic preservation concerning the development of the transportation plan. RTPAs shall comply as well. The consultation shall involve, as appropriate: (1) Comparison of transportation plans with State conservation plans or maps, if available; or (2) Comparison of transportation plans to inventories of natural or historic resources, if available. In addition, the discussion of mitigation activities required by 23 CFR 450.216(k) (and described more fully in Section 5.2) shall be developed in consultation with Federal, State, and Tribal land management, wildlife, and regulatory agencies.

State: California Environmental Quality Act (CEQA), requires consultation with agencies, governments or individuals that could potentially be impacted by transportation projects in the RTP.

Planning Practice Examples: Available in Appendix H

4.9 Coordinated Public Transit/Human Services Transportation Plans

The aim of the Coordinated Public Transit/Human Services Transportation Plan is to improve transportation services for persons with disabilities, older adults and individuals with lower incomes by ensuring that communities coordinate the available transit resources. Coordination enhances transportation access, minimizes duplication of services and facilitates the most appropriate cost-effective transportation system possible with available resources.

Federal transit law requires that projects selected for funding under the following FTA programs be derived from a coordinated plan: Enhanced Mobility of Seniors and Individuals with Disabilities Program (Title 49 U.S.C. Section 5310). Information on this program can be found at:

http://www.dot.ca.gov/hq/MassTrans

RTPAs are not required to be the lead agency in the development of the coordinated plan. Federal guidance states that the coordinated plan may be developed separately or as a part of the transportation planning process. In any case, RTPAs should ensure that the plan is coordinated and consistent with their regions' transportation planning process.

The coordinated plan must be developed through a process that includes representatives of public, private, and non-profit transportation and human services providers with participation by members of the public. The public participation requirements may be shared with those for the development of the RTP.

As with all FTA programs, transit projects selected for funding must be consistent with the RTP and FTIP.

Recommendations (Shoulds)

Federal: Title 23 CFR Part 450.206(h) states the statewide planning process should be coordinated and consistent with the preparation of the coordinated public transit-human services transportation plan as required by Title 49 U.S.C. Section 5310.

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Chapter 5

RTP Environmental Considerations

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RTP ENVIRONMENTAL CONSIDERATIONS

5.0 Introduction

This section will briefly discuss the context for environmental requirements, options for RTP environmental document preparation, federal requirements and recommendations outlined in the Statewide and Nonmetropolitan Transportation Planning *and* Metropolitan Transportation Planning Final Rule (FHWA/FTA Planning Final Rule), key resource areas for avoidance and mitigation and finally, a description of air quality and transportation conformity will be provided.

The federal government has shown its commitment to the environment through the passage of the National Environmental Policy Act (NEPA) in 1969, which requires federal agencies to consider the environmental impacts of their actions. In a similar vein, California passed the California Environmental Quality Act (CEQA) in 1970, which was designed to ensure that public agencies consider the environmental impacts of their decisions.

In California, the environmental review associated with the RTP and the subsequent project delivery process is two-fold. RTPAs are responsible for the planning contained in the RTP that precedes project delivery. Typically a local government, consultant or Caltrans is responsible for the actual construction of the project i.e. project delivery. CEQA applies to the planning document (RTP) while both NEPA and CEQA may apply to the individual projects that implement the RTP during the project delivery process. Likewise, all RTP CEQA Analysis and subsequent transportation project CEQA analysis assess all environmental issue areas identified in the CEQA Guidelines Environmental Checklist Form, Appendix G.

A change to transportation analysis in environmental review under CEQA occurred with the Governor's approval of SB 743 which requires an update in the metric of transportation impact used in CEQA from Level of Service and vehicle delay to one that promotes the reduction of GHG emissions, the development of multimodal transportation networks, and a diversity of land uses for transit priority areas. Per ARB Vision Model results, reductions in VMT growth are needed to achieve sufficient GHG emissions reduction for climate stabilization, as reflected in executive orders on 2030 and 2050 GHG targets. The regulatory language (CEQA Guidelines changes) to implement the law are pending, though VMT has been identified by the Governor's Office as a potential metric to determine significant impacts. A future update of the RTP Guidelines will capture any "shoulds" or "shalls" resulting from the formal rulemaking process. Lead agencies should refer to current CEQA statutes, regulations, and case law when performing CEQA analysis for their RTPs/SCSs.

Given that protection of the environment is an important public policy goal and it is an important aspect of public acceptance during project delivery, best regional planning practices would seek to plan and implement transportation projects that would avoid or minimize environmental impacts.

5.1 Environmental Documentation

The RTP planning document as well as the projects listed in it are considered to be projects for the purposes of CEQA. Subsequent RTP amendments or updates are discretionary actions that can also trigger CEQA compliance. As defined in CEQA statute section 21065, a project means "an activity which may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment, and which is any of the following: (a) An activity directly undertaken by any public agency or (b) An activity undertaken by a person which is supported, in whole or in part, through contracts, grants, subsidies, loans, or other forms of assistance from one or more public agencies".

To initiate CEQA compliance, the RTPA as the lead agency determines if the proposed action is a project and whether the project is statutorily or categorically exempt. If the project is not exempt from CEQA, an Initial Study or equivalent environmental assessment is completed. Based on the outcome of the Initial Study the appropriate type of environmental document is then prepared. The Initial Study can indicate the use of an Environmental Impact Report (EIR), a Mitigated Negative Declaration (MND) or a Negative Declaration (ND). Additionally, there are several types of EIRs such as a Master EIR, a Project EIR or a Program EIR. Information regarding the CEQA process and guidelines for implementation can be found at:

www.opr.ca.gov
http://opr.ca.gov/index.php?a=ceqa/index.html
http://resources.ca.gov/ceqa/
http://www.califaep.org/policy
http://ag.ca.gov/globalwarming/ceqa.php

California Air Pollution Control Officers Association (CAPCOA) White Paper on CEQA and Climate Change:
http://www.capcoa.org/wp-content/uploads/2012/03/CAPCOA-White-Paper.pdf

Program EIR

Many RTPAs prepare a program Environmental Impact Report to analyze the environmental impacts of implementing their RTP. The purpose of the program EIR is to enable the RTPA to examine the overall effects of the RTP i.e. broad policy alternatives, program wide mitigation, growth inducing impacts and cumulative impacts can be considered at a time when the agency has greater flexibility to avoid unnecessary adverse environmental effects. The program EIR is a device that was originally developed by federal agencies under NEPA. The County of Inyo v. Yorty court case established its use under CEQA.

Additionally, environmental documents subsequently prepared for the individual projects contained in the RTP can be tiered off of the Program EIR thus saving time and reducing duplicative analysis. Tiering refers to environmental review of sequential actions, where general matters and environmental effects are examined in a broad EIR for a decision such as adoption of a policy, plan, program, or ordinance, and subsequent narrower or site-specific EIRs are prepared that incorporate by reference the prior EIR and concentrate on environmental effects that can be mitigated or that were not analyzed in the prior EIR. In such instances, the later narrow EIR "tiers" off the prior broad EIR. If a project-specific EIR tiers off from a broader prior EIR such as the PEIR prepared for a RTP, it could help eliminate repetitive discussions of the same environmental issues; facilitate project-level impact analysis by focusing on issues specific to the later project; reduce the burdens from duplicative reconsiderations of a program, plan or policy with a certified EIR; and, reduce CEQA delay and paperwork at project level. (See Appendix G Glossary for a definition of 'tiering')

Changes to the RTP/Project Lists

When the RTPA modifies its RTP/project lists, it must determine whether the proposed changes have the potential to impact the environment and trigger CEQA review. Lead agencies under CEQA are responsible for analyzing the potential environmental affects that proposed changes of their RTP may have on the environment. This should be done by providing substantial evidence that proposed changes to the RTP would be "minor" or "technical" in nature, if there would be "new" or "more severe" significant environmental impacts, if "circumstances" of the project or "new environmental information" is discovered, or if "substantial" or "major changes" to the RTP are proposed. An abbreviated or focused type of CEQA document will usually suffice. The most common alternatives to an EIR, MND or ND are an Addendum, a Supplement, or a Subsequent environmental document.

Addendum

An Addendum may be prepared when minor technical changes or additions are made to the RTP. The Addendum makes the prior EIR, MND or ND adequate when the proposed changes to the RTP do not create any new or substantially more severe significant environmental impacts. An addendum does not require public circulation.

Supplement

A Supplement to the EIR need contain only the information necessary to make the previous EIR adequate for the project as revised. The supplement only needs to meet the circulation and public review requirements of a *draft* EIR.

Subsequent

A Subsequent EIR, MND or ND is used when there are substantial or major changes in the project, in the circumstances of the project or when new environmental information is discovered. A subsequent EIR, MND or ND is intended to be a complete environmental document and it requires the same full level of circulation and public review as the previous EIR, MND or ND.

NEPAs Applicability to the RTP

NEPA does not apply to the RTP. In the *Atlanta Coalition on the Transportation Crisis, Inc. v. Atlanta Regional Commission*, 559 F.2d 1333 (5th Cir. 1979) court case, federal judges found that “Congress did not intend NEPA to apply to state, local or private actions…” The courts recognized the development of the RTP and TIP as a matter of state and local sovereignty.

However, NEPA review does apply to the individual projects identified in the RTP during the project delivery process when the individual projects are federally funded and/or a federal approval is required (e.g. a permit for wetlands impacts). When NEPA review is required, implementing agencies should reference the Federal Council on Environmental Quality’s (CEQ) memorandum published on August 1, 2016 entitled, *Final Guidance for Federal Departments and Agencies on Consideration of GHG Emissions and the Effects of Climate Change in NEPA reviews.* Section 6.23 provides further guidance for GHG reduction and Section 6.25 provides guidance for addressing adaption of the regional transportation system to climate change.

The full CEQ guidance is available at:

https://ceq.doe.gov/current_developments/ceq_guidance_nepa-ghg-climate_final_guidance.html.

Requirements (Shall)
State: Public Resources Code 21000 et seq, Environmental Protection, and CEQA guidelines section 15000 et seq.

5.2 FHWA/FTA Planning Final Rule – Federal Environmental Requirements

Pursuant to Title 23 CFR Part 450.216(k), the RTP must provide a discussion of potential environmental mitigation activities and areas, including those mitigation activities that might maintain or restore the environment that is affected by the plan. This mitigation discussion must happen in consultation with Federal, State and Tribal land management and wildlife regulatory agencies. Additionally, federal regulations contain a planning process mandate that requires the State to compare the RTP with available state conservation plans or maps and inventories of natural or historic resources. RTPAs shall comply as well. This comparison is facilitated by the requirement to "consult as appropriate with state and local agencies responsible for land use management, natural resources, environmental protection, conservation and historic preservation".

Requirements (Shalls)
Federal:
23 CFR Part 450.216(k): Requires that the RTP shall include a discussion of types of potential environmental mitigation activities and potential areas to carry out these activities, including activities that may have the greatest potential to restore and maintain the environmental functions affected by the RTP. The discussion shall be developed in consultation with Federal, State, and Tribal land management, wildlife, and regulatory agencies.
23 CFR Part 450.216(j): Requires consultation, as appropriate, with State and local agencies responsible for land use management, natural resources, environmental protection, conservation, and historic preservation concerning the development of the transportation plan. The consultation shall involve, as appropriate: (1) Comparison of transportation plans with State conservation plans or maps, if available; or (2) Comparison of transportation plans to inventories of natural or historic resources, if available.
23 CFR Part 450.206(a)(5): Requires that the transportation planning process shall be continuous, cooperative, and comprehensive, and provide for consideration and implementation of projects, strategies, and services that will address the following factors: Protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and State and local planned growth and economic development patterns. See Section 5.4 for key resource areas for avoidance and mitigation as well as planning practice examples in Appendix H.

Planning Practice Examples: Available in Appendix H

5.3 FHWA/FTA Planning Final Rule – Federal Environmental Recommendations

Appendix A - Linking the Transportation Planning and NEPA processes

Appendix A of Title 23 CFR Part 450 encourages environmental information developed during the transportation planning process to be applied to the project delivery process. The goal is to make planning decisions more sustainable and to maximize the effectiveness of mitigation strategies. Appendix A is optional. It provides details on how the information and analysis from the RTP can be incorporated into and relied upon in the NEPA documents prepared for the individual projects that will implement the RTP in the future. Appendix A presents environmental review as a continuum of sequential study, refinement, and expansion of information. The actual text of Appendix A to Title 23 CFR Part 450 is contained in Appendix D of this document. More guidance is available in Appendix E, which addresses the legal aspects of integrating planning and project delivery. Implementation of the strategies contained in Appendix A of Title 23 CFR Part 450 is a state of the art practice.

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.212 and Appendix A to Part 450 "Linking Planning and NEPA" describes the steps for streamlining the project delivery process by providing environmental information in the RTP.

Programmatic Mitigation

Recently updated federal regulations governing the development of metropolitan transportation plans include an updated section on programmatic mitigation. In particular, Title 23 CFR Sections 450.214 (State) and 450.320 (MPO), on the development of programmatic mitigation plans, indicate that "a State/MPO may utilize the optional framework to develop programmatic mitigation plans as part of the statewide transportation planning process to address the potential environmental impacts of future transportation projects." The FHWA supports an ecological approach to planning infrastructure and transportation projects and provides guidance on establishing a Regional Ecological Framework (REF). *Eco-logical* is a nine-step, voluntary framework that identifies an ecosystem approach to developing infrastructure projects. It outlines a framework for partners to integrate their planning processes, share data, and prioritize areas of ecological significance in order to harmonize economic, environmental, and social needs and objectives. Regionally significant resources like fish passage, terrestrial and aquatic habitat connectivity, migration corridors, and coastal trails can be incorporated into the regional transportation planning process. In addition, regional and local planning stakeholders can coordinate on mitigation strategies and conservation priorities as part of the regional transportation planning process. If the region elects to include the preparation of a REF or programmatic mitigation plan as part of the RTP update, the region can notify other stakeholders to allow for a more collaborative partnering and planning effort. This environmental review toolkit is available at:

https://www.environment.fhwa.dot.gov/ecological/ImplementingEcoLogicalApproach/

5.4 Key Resource Areas for Avoidance & Mitigation

Taking these environmental resources and laws into account during the transportation planning process can expedite the delivery of the projects that are contained in the RTP. The transportation planning process and the NEPA environmental analysis required during project delivery can work in tandem with the results of the transportation planning process informing the NEPA process. The RTP can identify plan-level environmental constraints and consider potential impacts that could allow projects in the plan to be modified to avoid or minimize impacts. Additional information regarding environmental planning considerations can be found in Section 2.7 and Appendix H. For a more in-depth discussion of potential environmental impact and resource areas, please see Volume 1 of the Standard Environmental Reference at:

http://www.dot.ca.gov/ser/vol1/vol1.htm

During project delivery SAFETEA-LU Section 6002 (23 U.S.C. Section 139, Efficient Environmental Reviews for Project Decision-making) set forth a new environmental review process. MAP-21/FAST Act made revisions to 23 U.S.C. 139 although the revisions are minor. The first step under Efficient Environmental Reviews for Project Decision-making is to initiate the environmental review process by notifying FHWA's Secretary of the type of work, termini, length, general location of the project, and a listing of anticipated federal permits. One means of initiating the process is to include the required information in the discussion of each EIS-level project that is contained in the RTP. The resource areas of concern are enumerated below.

Wetlands

Wetlands and other waters are protected under a number of laws and regulations, including the federal Clean Water Act, federal Executive Order for the Protection of Wetlands (E.O. 11990), and state Porter-Cologne Water Quality Control Act and parts of the state Fish and Game Code. Section 404 of the Clean Water Act establishes a permit program that prohibits any discharge of dredged or fill material into wetlands or other "waters of the United States" if a practicable alternative exists that is less damaging to the aquatic environment or if the nation's waters would be significantly degraded. The Section 404 permit program is run by the U.S. Army Corps of Engineers (ACOE) with oversight by the U.S. Environmental Protection Agency (U.S. EPA).

The Executive Order for the Protection of Wetlands (E.O. 11990) states that a federal agency, such as the FHWA, cannot undertake or provide assistance for new construction located in wetlands unless the head of the agency finds that there is no practicable alternative to the construction and the proposed project includes all practicable measures to minimize harm. Strategic retreat or relocation shall be one alternative to be considered.

At the state level, primarily the Department of Fish and Wildlife (CDFW) and the Regional Water Quality Control Boards (RWQCB) regulate wetlands and waters. (In certain circumstances, the California Coastal Commission or Bay Conservation and Development Commission may also be involved.) Impacts on wetlands, lakes, streams or rivers may require a Lake or Streambed Alteration agreement with CDFW. The RWQCB issues water quality certifications in compliance with Section 401 of the Clean Water Act.

Parks, Refuges, Historic Sites

Section 4(f) of the Department of Transportation Act (Title 49 U.S.C. Section 303) states that FHWA and FTA may not approve the use of land from a significant publicly-owned park, recreation area, wildlife and waterfowl refuge, or any significant historic site unless a determination is made that there is no other feasible and prudent alternative to the use of that land. Section 4(f) evaluations require the development of an avoidance alternative, however, if no feasible choices exist, extensive planning must be done to minimize harm to the property resulting from such use.

http://www.parks.ca.gov/

Cultural Resources

Cultural Resources are protected under a number of laws and regulations, including the National Historic Preservation Act (Section 106) and CEQA and the California Public Resources Code (PRC) 5024 et seq. Under Section 106 of the NHPA, federal agencies are mandated to take into account the effect of federal undertakings on historic properties affected by federally funded or federally approved undertakings. If avoidance is not an option, then minimization of impacts and mitigation of the effects are required. Under CEQA, a project which may cause a substantial adverse change in the significance of a historical resource would require mitigation of the project effects by the project's lead CEQA agency.

California Coastal Trail (CCT)

The CCT is a state-mandated trail system pursuant to the passage of SB 908 in 2001. AB 1396 in 2007 added Section 65080.1 to the Government Code, which mandates that provision for the CCT be provided in each RTP for those MPOs/RTPAs located along the coast. More information and guidance relative to the CCT can be found in Section 6.11 and at:

http://www.scc.ca.gov/

www.coastal.ca.gov

http://www.scc.ca.gov/webmaster/pdfs/CCT_Siting_Design.pdf

Floodplains

Executive Order 11988 (Floodplain Management) directs all federal agencies to refrain from conducting, supporting, or allowing actions in floodplains unless it is the only practicable alternative.

Threatened and Endangered Species

The primary federal law protecting threatened and endangered species is the federal Endangered Species Act (ESA) (Title 16 U.S.C. Section 1531 et seq.). This act provides for the conservation of endangered and threatened species and the ecosystems upon which they depend. Under Section 7 of this act, federal agencies, such as the FHWA, are required to consult with the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries

Service (NOAA Fisheries) to ensure that they are not taking actions likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat.

California has enacted a similar law at the state level, the California Endangered Species Act (CESA) (Fish and Game Code, 2050, et seq.). CESA emphasizes early consultation to avoid potential impacts to rare, endangered, and threatened species and to develop appropriate planning to offset project caused losses of listed species populations and their essential habitats.

http://www.dfg.ca.gov/

http://bios.dfg.ca.gov/

Cumulative Impacts

As defined in CEQA, cumulative impacts refer to "two or more individual impacts that, when considered together, are considerable or that compound or increase other environmental impacts". Because the RTP addresses long-range future transportation improvements, cumulative impacts are inherent and need to be fully discussed within the environmental document. Guidance on preparing cumulative impact analysis is available at:

http://www.dot.ca.gov/ser/cumulative_guidance/approach.htm.

Habitat Connectivity

Section 1797.5 of the California Fish and Game Code expresses the State's policy to promote the voluntary protection of wildlife corridors and habitat strongholds in order to enhance the resiliency of wildlife and their habitats to climate change, protect biodiversity, and allow for the migration and movement of species by providing connectivity between habitat lands. In order to further these goals, it is the policy of the State to encourage voluntary steps to protect the functioning of wildlife corridors through various means, such as the acquisition or protection of wildlife corridors as open space through conservation easements; the installation of wildlife-friendly or directional fencing; siting of mitigation and conservation banks in areas that provide habitat connectivity for affected fish and wildlife resources; and the provision of roadway undercrossings, overpasses, oversized culverts, or bridges to allow for fish passage and the movement of wildlife between habitat areas. Transportation facilities should be designed, engineered, planned, and programmed with habitat connectivity in mind in keeping with these State goals in order to maintain healthy ecological function and climate change resiliency in and between habitat areas. Below are tools that can help speed along habitat corridor projects in a cost-effective way during the initial phases of project planning and design:

California Water Action Plan: 2016 Update:
http://resources.ca.gov/docs/california_water_action_plan/Final_California_Water_Action_Plan.pdf

California Essential Habitat Connectivity Project:
https://www.wildlife.ca.gov/conservation/planning/connectivity/CEHC

Western Governors Association's Crucial Habitat Assessment Tool:
http://www.wafwachat.org/map

California State Wildlife Action Plan: https://www.wildlife.ca.gov/SWAP/Final

Growth-Related Indirect Impacts

Growth-related indirect impacts are those impacts associated with a project or plan that would encourage or facilitate development or would change the location, rate, or type, or amount of growth. RTPs typically contain proposed actions that will be built along a new alignment and/or provide new access and those are the types of projects that will typically require a growth-related impact analysis. Where such impacts are identified, appropriate and reasonable steps to avoid or minimize indirect impacts can be considered early in the process, and incorporated into the RTP and its associated environmental document. Additional guidance on growth-related indirect impacts is available at:

www.dot.ca.gov/ser/Growth-related_IndirectImpactAnalysis/gri_guidance.htm

Requirements (Shalls)
Federal: Title 23 CFR Part 450.206(a)(5) requires that the planning process addresses protection and enhancement of the environment, among other planning factors. RTPAs shall comply as well.

Recommendations (Shoulds)
Federal: Title 23 CFR 450.318 and Appendix A to Part 450 "Linking Planning and NEPA" describe the steps for streamlining the project delivery process by providing environmental information in the RTP.

Planning Practice Examples: Available in Appendix H

5.5 Project Intent Statements/Plan Level Purpose & Need Statements

The 2003 RTP Guidelines Supplement referred to "**Project Intent Statements**" which were defined as **Plan Level Statements of Purpose and Need**. A Plan Level Statement of Purpose and Need is a short statement, which serves as a justification for a project or a group of projects. These brief plan level justifications would be contained in the RTP. An example of a Plan Level Statement of Purpose and Need would be the problem of reducing congestion on a specific route. The Plan Level Statements of Purpose and Need briefly identify the transportation needs or problems and describe the intended outcome of the project(s) that would meet these needs or solve the identified problems.

A more detailed, project specific **Project level Purpose and Need Statement** is written during the project delivery process and is contained in the project initiation document (Project Study Report) and the subsequent environmental document.

RTPAs may wish to prepare Plan Level Statements of Purpose and Need during the development of the RTP for the following reasons:

1. To provide justification for the lead agency's projects in the RTP
2. To justify expenditure of transportation funds to the public and the CTC
3. During project selection, to provide the rationale for selecting specific projects over other projects

4. To provide the foundation for Project Level Purpose and Need information in the environmental documents.
5. To provide consistent project justification from planning through project Implementation.

Recommendations (Shoulds)
State: The 2003 RTP Guidelines Supplement states that the RTP should include a project justification that identifies the specific need for the project and describes how these needs or problems will be addressed.

5.6 <u>Air Quality & Transportation Conformity</u>

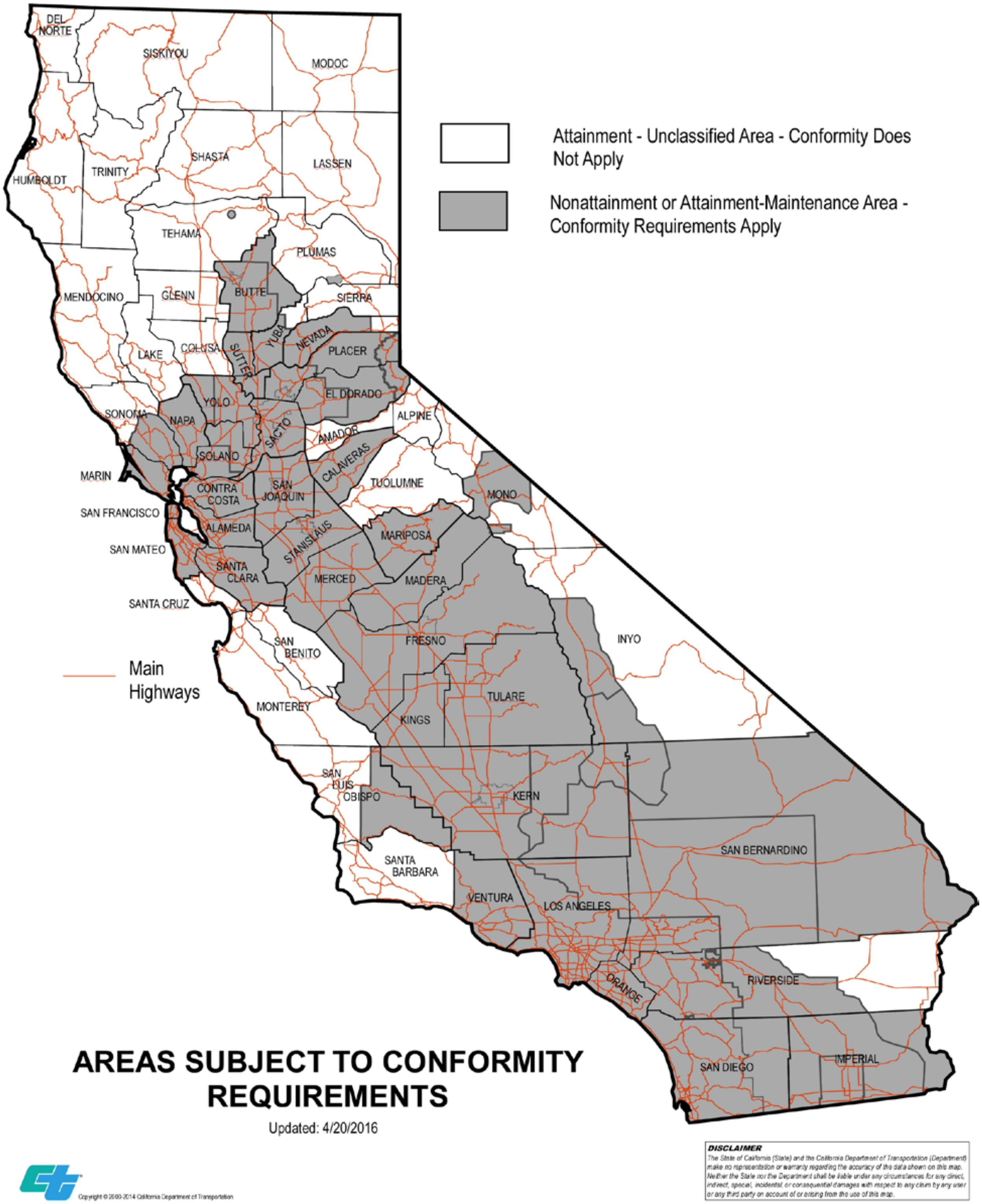
Federal and State Clean Air Act

The Clean Air Act as amended in 1990 is the primary federal law that governs air quality. This law mandates the U.S. Environmental Protection Agency (EPA) to establish the standards for the quantity of pollutants that can be in the air. The U.S. EPA must review the standards every five years and revise them as necessary to protect public health and welfare. These standards are called National Ambient Air Quality Standards (NAAQS). Standards have been established for six criteria pollutants that have been linked to health concerns; the criteria pollutants are: carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM), lead (Pb), and sulfur dioxide (SO_2). The State Implementation Plan (SIP) is the statewide plan for achieving the goals of the Clean Air Act and describes how the NAAQS will be met. The SIP has both statewide and regional components. The ARB is responsible for submitting the SIP to the U.S. EPA, and for developing and implementing statewide control measures such as those related to on-road mobile sources (vehicle emission controls). Local air pollution control and air quality management districts (APCD or AQMD) are responsible for regional control measures, which may also include measures that affect mobile sources (e.g., fleet rules, indirect source review requirements).

There is a California Clean Air Act in the Health and Safety Code that is generally similar in concept to the Federal Clean Air Act. Under the California Clean Air Act, the ARB sets and updates State air quality standards. The State air quality standards are usually more stringent than the Federal, but the State air quality planning structure does not include the fixed attainment deadlines and conformity process found in the Federal program.

APCD or AQMDs perform regional air quality planning in consultation with the RTPA, including development of on-road mobile source emission budgets that are part of the SIP required by the Federal Clean Air Act. APCDs and AQMDs are the main implementation agencies for stationary source emission control programs.

The U.S. EPA designates an area as “attainment” if the area meets the national ambient air quality standards (NAAQS) mandated by the Clean Air Act. If the area does not meet the NAAQS, it is designated as a non-attainment area. The area must then submit an attainment plan showing how the area will meet the NAAQs. Once a non-attainment area attains a NAAQS, the area may develop a maintenance SIP and submits a re-designation request, the U.S. EPA can re-designate the area as a “maintenance” area. The shaded areas on the map below illustrate the areas of the State that have not attained, or have attained with a maintenance SIP, the National Ambient Air Quality Standards. All of California except Lake County fails to attain one or more of the State ambient air quality standards.


DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
LAKE
COLUSA
SUTTER
YUBA
NEVADA
PLACER
YOLO
EL DORADO
SONOMA
NAPA
SACTO
AMADOR
ALPINE
SOLANO
CALAVERAS
MARIN
CONTRA COSTA
SAN JOAQUIN
TUOLUMNE
MONO
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA CLARA
MERCED
MADERA
SANTA CRUZ
SAN BENITO
FRESNO
INYO
MONTEREY
TULARE
KINGS
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
Attainment - Unclassified Area - Conformity Does Not Apply
Nonattainment or Attainment-Maintenance Area - Conformity Requirements Apply
Main Highways
AREAS SUBJECT TO CONFORMITY REQUIREMENTS
Updated: 4/20/2016
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SIP Transportation Conformity Requirement

In nonattainment and maintenance areas, federal regulations require that RTPs, FTIPs and Federally funded or approved highway and transit activities demonstrate transportation conformity. Under the 1990 Federal Clean Air Act Amendments, the U.S. DOT cannot fund, authorize, or approve Federal actions to support programs or projects that are not first found to conform to the SIP (Clean Air Act Section 176 (c), codified in 42 U.S.C. 7506(c)). The U.S. EPA has issued extensive regulations covering how conformity is determined for transportation planning, programming, and projects in 40 CFR 93 Subpart A. Under the EPA regulations, the RTP's regional transportation conformity analysis must include all regionally significant transportation (road and transit) activities regardless of funding source.

RTP Conformity

Transportation conformity is intended to ensure that Federal funding and approval are given to those transportation activities that support the purpose and goals of the SIP. Conformity ensures that these transportation activities do not degrade air quality and that they support attainment of the NAAQS. For an RTPA within the boundary of an MPO, the MPO and the U.S. DOT (FHWA/FTA) have a responsibility to ensure that the RTP conforms to the SIP.

Transportation conformity requirements apply to all U.S. EPA designated non-attainment and maintenance areas. When areas are designated as non-attainment for the first time, or for a new NAAQS, a conformity determination must be made within one year of the effective date of the designation for non-attainment areas. This is done at the regional (RTP) level and at the project level, for federally funded non-exempt transportation projects. Some projects (e.g., safety projects) are exempt from conformity altogether, and some are exempt from regional emissions analyses (See 40 CFR 93.126 – 93.128).

Isolated rural nonattainment and maintenance areas (non-MPO) are not required to do a conformity analysis on the RTP; however, a project-level conformity determination must be done only when a non-exempt federal transportation project needs approval. Unlike MPO areas, there are no requirements to update conformity determinations for projects in isolated rural nonattainment and maintenance areas on a 4-year cycle, or to meet other conformity triggers as required in 40 CFR §93.104.

For more detailed information about transportation conformity please see the following key websites:

http://www.dot.ca.gov/hq/env/air/index.htm
http://www.epa.gov/otaq/stateresources/transconf/index.htm

Transportation Control Measures

The RTP shall discuss ways in which activities in the plan will conform to the SIP, if applicable, including TCM implementation.

The RTP shall describe both completed TCMs and TCMs that are underway, if applicable. TCMs that are included in the SIP must be implemented in a timely fashion. Implementation of the TCMs must be coordinated with the SIP implementation schedule. When there is a delay in TCM implementation, the conformity analysis document must describe the measure and the steps that the RTPA is taking to address the delay. TCM projects must receive priority for funding.

Requirements (Shalls)

State: None. There is no conformity process in the California Clean Air Act. However, air quality is normally addressed as part of the CEQA environmental documentation for the RTP.

Recommendations (Shoulds)

Federal: Title 42 U.S.C. Section 7506(c)(7)(A) and Title 40 CFR Part 93.106 provide an option for reducing the time period addressed by conformity determinations. Normally, a regional conformity analysis must cover at least 20 years, but under certain circumstances the time period covered may be reduced to not less than 10 years.

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Chapter 6

RTP Contents

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RTP CONTENTS

6.1 Summary of RTP Components

The development of the RTP is based on state and federal statutory and regulatory requirements in addition to CTC policy direction. As per Government Code 65080, each RTPA shall prepare and adopt an RTP directed at achieving a coordinated and balanced regional transportation system including, but not limited to, mass transportation, highway, railroad, maritime, bicycle, pedestrian, goods movement and aviation. In addition, the RTP shall be action oriented and pragmatic, considering both short-term (0-10 years) and long-term (10-20 years) periods. The RTP shall be an internally consistent document and shall include all of the following:

The Policy Element

The purpose of the Policy Element is to identify legislative, planning, financial and institutional issues and requirements, as well as any areas of regional consensus. Consider referring to the CTP policy framework which provides goals and policies that can help with development of policies and strategies at the most regional level. The Policy Element presents guidance to decision-makers of the implications, impacts, opportunities, and foreclosed options that will result from implementation of the RTP. Moreover, the Policy Element is a resource for providing input and promoting consistency of action among state, regional and local agencies including; transit agencies, congestion management agencies, employment development departments, the California Highway Patrol, private and public groups, tribal governments, etc. California statutes state that each RTP shall (Government Code Section 65080 (b)) include a Policy Element that:

1. Describes the transportation issues in the region;
2. Identifies and quantifies regional needs expressed within both short and long-range planning horizons (Government Code Section 65080 (b)(1)); and,
3. Maintains internal consistency with the Financial Element and fund estimates.

State law requires that the objectives shall (Government Code Section 65080 (b)(1)) be linked to short-range and long-range transportation implementation goals or horizons. Each objective should be consistent with the needs identified in the RTP as a means of strengthening the linkage between statewide system planning and ultimate project implementation. The RTP shall consider factors specified in Section 134 of Title 23 of the United States Code.

The Policy Element should clearly convey the region’s transportation policies. As part of this Element, the discussion should: (1) relay how these policies were developed, (2) identify any significant changes in the policies from the previous plans and (3) provide the reason for any changes in policies from previous plans.

In addition, the RTP should identify the criteria that the RTPA/CTC used to select the transportation projects on the constrained and unconstrained project lists.

The Action Element

The second major component as required in Government Code Section 65080 states that RTPs shall have an Action Element. The Action Element of the RTP must describe the programs and actions necessary to implement the RTP and assigns implementation responsibilities. The action element may describe the transportation projects proposed to be completed during the RTP plan horizon, and must consider congestion management activities within the region. All transportation modes (highways, local streets and roads, mass transportation, rail, maritime, bicycle, pedestrian and aviation facilities and services) are addressed. The action element is critical to providing clear direction about the roles and responsibilities of the RTPA and other agencies to follow through on the RTP's policies and projects. It consists of short and long-term activities that address regional transportation issues and needs. In addition, the Action Element should also identify investment strategies, alternatives and project priorities beyond what is already programmed.

The Financial Element

The Financial Element is also statutorily required. The Financial Element is fundamental to the development and implementation of the RTP. It identifies the current and anticipated revenue sources and financing techniques available to fund the planned transportation investments described in the Action Element. The intent of the Financial Element is to define realistic financing constraints and opportunities. Finally, with this financing information, alternatives are developed and used by State and local decision-makers to determine which projects should be planned for funding.

There are six major components that constitute the Financial Element:

1. Summary of costs to operate and maintain the current transportation system;
2. Estimate of costs and revenues to implement the projects identified in the Action Plan;
3. Inventory of existing and potential transportation funding sources;
4. List of candidate projects if funding becomes available;
5. Potential funding shortfalls; and,
6. Identification of alternative policy directions that affect the funding of projects.

It is very important that RTPs reflect the transportation needs of the specific region. There are State statutory content requirements for the Policy, Action and Financial Elements of the RTP; however, there is flexibility in choosing a format for the presentation of this information. Most MPOs/RTPAs use the categories of Policy, Action and Financial to organize their RTP.

Other RTP Contents

The RTP should also include the following:

1. Executive Summary – An Executive Summary of the RTP as an introductory chapter. The Executive Summary should provide a regional perspective, and identify the challenges and transportation objectives to be achieved.
2. Reference to regional environmental issues and air quality documentation needs.
3. Discussion of types of potential environmental mitigation activities that might maintain or restore the environment that is affected by the RTP (refer to Section 5.2 for Federal Environmental Requirements)

Requirements (Shalls)
Federal: Title 23 CFR Part 450.216
State: California Government Code Section 65080

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.324

6.2 Financial Overview

Federal statute and regulations and California State statute requires RTPs to contain an estimate of funds available for the 20-year planning horizon. This discussion of financial information is fundamental to the development and implementation of the RTP. The financial portions of the RTP identify the current and anticipated revenue sources and financing techniques available to fund the planned transportation investments described in other portions of the RTP. The intent is to define realistic financing constraints and opportunities. All projects, except illustrative projects i.e. unconstrained projects, must be fully funded in order to be included in the RTP. With this financing information, alternatives are developed and used by the RTPA, local agencies and State decision-makers in funding transportation projects. During programming and project implementation the total cost of the project is refined and broken out by cost per phase.

Federal law requires each transportation plan prepared by the RTPA to include a financial plan that demonstrates how the adopted Plan can be implemented. The Financial Plan should also indicate resources from public and private sources that are reasonably expected to be made available to carry out the transportation plan, identify innovative financing techniques to finance projects, programs and strategies, and recommend any additional financing strategies for needed projects and programs. The Federal statutory requirements are codified in Title 23 U.S.C. Section 134(i)(2)(C) and 134(j)(2)(B). Federal regulations pertaining to financial planning and constraint for statewide/nonmetropolitan and metropolitan transportation plans and programs are codified in Title 23 CFR Part 450.

There are six major components that should be addressed in the financial portion of the RTP:

1. Projected Available Funds – The RTPA, public transit operators and the State shall cooperatively develop estimates of funds that will reasonably be available to support RTP implementation. All anticipated public and private financial resources available over the next 20 years, including estimated highway, local streets and roads, bicycle and pedestrian and transit funds, shall be identified. The financial plan shall include recommendations for additional financing strategies. New funding sources and strategies shall also be identified. Beginning December 11, 2007, all revenue estimates for the financial plan must use an inflation rate that reflects the "year of expenditure dollars" developed cooperatively by the RTPA, State and transit operators.

2. Projected Costs – Takes into account all projects and strategies proposed for funding with Federal, State, local and private fund sources in developing the financial plan. Estimate of costs to implement the projects identified in the RTP must be included. Beginning December 11, 2007, both the revenue and construction cost estimates must use inflation rates to reflect "year of expenditure dollars" based on reasonable financial

principles and information developed cooperatively by the RTPA, State and public transportation operators.

3. Projected Operation and Maintenance Costs – The financial plan shall contain system level estimates of costs and revenue sources that are reasonably expected to be available to adequately operate and maintain Federal-aid highways and public transportation. Planning practice examples in developing the RTP financial plan would also include revenue sources for the operation and maintenance of local streets and roads as well as bicycle and pedestrian facilities. A summary of costs to operate and maintain the current transportation system should be included. This should be identified by mode and include the cumulative cost of deferred maintenance on the existing infrastructure. Financial plans that support the RTP process must assess capital investment and other measures necessary to ensure the preservation of:

   A) The existing transportation system, including requirements for operational improvements;
   B) Resurfacing, restoration, and rehabilitation of existing and future major roadways, as well as operations, maintenance, modernization, and rehabilitation of existing and future transit facilities.

4. Constrained RTP - Financially constrained list of candidate projects with the available funding (short and long-term).

5. Un-Constrained (Illustrative) List of Projects - Un-constrained (Illustrative) list of candidate projects if additional funding becomes available (short and long-term). The financial plan may include additional projects that would be included in the adopted transportation plan if additional resources were to become available.

6. Potential Funding Shortfall. The short and long-term needs for system operation, preservation, and maintenance can be enormous. Simply maintaining the existing system can demand a huge investment, while system expansion demands investments of a similar scale. At times, the combination of these competing demands can cause temporary shortfalls to an RTPA's budget. To the extent there appear to be shortfalls, the RTPA should identify a strategy to address these gaps in funding prior to the adoption of a new RTP - or the amendment of an existing RTP. The strategy should include an action plan that describes the steps to be taken that will make funding available within the time frame shown in the financial plan and needed to implement the projects in the long-range transportation plan. There should be, among other things, a range of options to address projected shortfalls. The strategy may rely upon the RTPA's or transit operators' past record of obtaining funding. If it relies on new funding sources, the RTPA must demonstrate that these funds are reasonably expected to be available.

Requirements (Shalls)
State: California Government Code Section 65080(b)

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.216(m) and 450.324(f)(11)

Planning Practice Examples: Available in Appendix H

6.3 Fiscal Constraint

Fiscal constraint is the demonstration of sufficient funding (Federal, State, local and private) to operate and maintain transportation facilities and services and to implement planned and programmed transportation system improvements. Fiscal constraint can also be thought of as the description of fully funded projects in the RTP based on the projected available revenues during the 20 plus year planning horizon.

Title 23 CFR Part 450.104 provides the following definition of fiscal constraint or fiscally constrained: "(it) means that the metropolitan transportation plan, TIP, and STIP includes sufficient financial information for demonstrating that projects in the metropolitan transportation plan, TIP and STIP can be implemented using committed, available or reasonably available revenue sources, with reasonable assurance that the federally supported transportation system is being adequately operated and maintained. For the TIP and the STIP, financial constraint/fiscal constraint applies to each programming year. Additionally, projects in air quality nonattainment and maintenance areas can be included in the first two years of the TIP or STIP only if funds are 'available' or 'committed'."

To support air quality planning under the 1990 Clean Air Act Amendments, a special requirement has been placed on air quality nonattainment and maintenance areas, as designated by the U.S. Environmental Protection Agency (EPA). Specifically, projects in air quality nonattainment and maintenance areas can be included in the first two years of the FTIP only if funds are "available or committed" (Title 23 CFR Part 450.324(e)). Available funds include those derived from an existing source of funds dedicated to or historically used for transportation purposes. For Federal funds, authorized and/or appropriated funds and the extrapolation of formula and discretionary funds at historic rates of increase are considered "available." Committed funds include funds that have been bound or obligated for transportation purposes. For State funds that are not dedicated to or historically used for transportation purposes, only those funds over which the Governor has control may be considered as "committed." For local and private sources not dedicated to or historically used for transportation purposes, a commitment in writing/letter of intent by the responsible official or body having control of the funds constitutes a "commitment." Additionally, EPA's transportation conformity regulations specify that an air quality conformity determination can only be made on a fiscally constrained RTP and FTIP (Title 40 CFR Part 93.108). New funding for RTP projects from a proposed gas tax increase, a proposed regional sales tax, or a major funding increase still under consideration would not qualify as "available or committed" until it has been enacted by legislation or referendum i.e., the period of time between the sunset date of the current regional sales tax and before the next legislative or referendum action to restore or increase funding. Therefore, nonattainment and maintenance areas may rely on existing revenue, newly approved tax revenue, or other newly approved revenue sources for the first two years of the FTIP.

Requirements (Shalls)
State: California Government Code Section 65080(b)

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.206(m) and 450.324(f)(11)

Planning Practice Examples: Available in Appendix H

6.4 Listing of Constrained & Un-constrained Projects

In addition to the current list of financially constrained projects identified in the RTP, each Plan should contain a list of needed unconstrained projects (Illustrative projects). Illustrative projects are additional transportation projects that may (but is not required to) be included in the RTP if reasonable additional resources were to become available. This unconstrained list will identify projects that are recommended by the RTPA without a funding source identified. The list should be included separately from the financially constrained project list. It is also preferred that projects on the unconstrained list be identified by transportation corridor within the region.

The following is accomplished by including a list of regionally desired un-funded (Illustrative) transportation projects in the RTP:

1. Identifies projects that could be funded, should additional funding become available.
2. Allows for a more accurate determination of overall transportation needs.

Requirements (Shalls)
State: Government Code 65080(b)(4)(a)

Recommendations (Shoulds)
Federal: Title 23 CFR part 450.216(m), for illustrative purposes, the list of projects may include additional projects if an additional source of funds is located; and Title 23 CFR part 450.324(f)(11)

Planning Practice Examples: Available in Appendix H

6.5 Revenue Identification & Forecasting

Revenue forecasts for RTPs can take into account new funding sources that are "reasonably expected to be available." New funding sources are revenues that do not currently exist or that may require additional steps before the RTPA or transit agency can commit such funding to transportation projects. As codified in federal regulations strategies for ensuring the availability of these planned new revenue sources must be clearly identified. Future revenues may be projected based on historical trends, including consideration of past legislative or executive actions. The level of uncertainty in projections based on historical trends is generally greatest for revenues in the "outer years" (10 years or more) of an RTP.

According to Title 23 CFR Part 450.216(m), the RTP may take into account all projects and strategies proposed for funding under Title 23 U.S.C.; Title 49 U.S.C. Chapter 53; other Federal funds; State transportation funds; local funding sources and private sources of funds for transportation projects. Beginning December 11, 2007, funding estimates contained in the RTP must use an inflation rate to reflect “year of expenditure dollars”.

The estimated revenue by existing revenue source (local, State, Federal and private) available for transportation projects may be determined and any shortfalls identified. Proposed new revenues and/or revenue sources to cover shortfalls may be identified, including strategies for ensuring their availability for proposed investments. Existing and proposed revenues may cover all forecasted capital, operating, and maintenance costs. All cost and revenue projections may be based on the data reflecting the existing situation and historical trends. For nonattainment and maintenance areas, the financial plan element may address the specific financial strategies required to ensure the implementation of projects and programs (TCMs) to reach air quality compliance.

Requirements (Shalls)
State: California Government Code Section 65080(b)

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.216(m) and 450.324(f)(11)

Planning Practice Examples: Available in Appendix H

6.6 Estimating Future Transportation Costs

Federal regulations require that (Title 23 CFR Part 450.324(f)(11)(iv)), costs of future transportation projects must use "year of expenditure dollars" rather than "constant dollars" in cost and revenue estimates to better reflect the time-based value of money. This is an MPO requirement; however, RTPAs are encouraged to ensure project costs identified in the RTP are in year of expenditure dollars. This is particularly crucial for large-scale projects with construction/implementation dates stretching into the future.

Reporting the costs in year of expenditure dollars will provide the proper context to express a more realistic estimate of future construction costs. After cost estimates are prepared for the RTP, the costs should be expressed in year of expenditure dollars. This can be done by assigning an inflation rate per year to the proposed midpoint of construction. Make certain that the selected year of expenditure reflects a realistic scenario, taking into account project planning and development durations, as well as construction. Inflation rates may be different for specific cost elements (e.g. construction vs. right-of-way). The RTP should clearly specify how inflation is considered in the estimate and clearly State that the estimate is expressed in year of expenditure dollars. Consider multiple sources for determining the inflation rate, including nationwide and local references. Include consideration of any locality-specific cost factors that may reflect a growth rate significantly in excess of the inflation rate, such as land acquisition costs in highly active markets. The inflation rate(s) should be based on sound, reasonable financial principles and information, developed cooperatively by the RTPA and transit agencies. To ensure consistency, similar financial forecasting approaches ideally should be used for both the RTP and RTIP. In addition, the financial forecast approaches, assumptions, and results should be clear and well documented.

Revenues and related cost estimates for operations and maintenance should be based on a reasonable, documented process. Some accepted practices include:

Trend analysis - A functional analysis based on expenditures over a given duration, in which costs or revenues are increased by inflation, as well as a growth percentage based on historic levels. This analysis could be linear or exponential. When using this approach, however, it is important to be aware of new facilities or improvements to existing facilities. Transit operations and maintenance costs will vary with the average age of the bus or rail car fleet.

Cost per unit of service – Examples include: lane-mile costs; centerline mile costs; traffic signal cost; transit peak vehicles by vehicle type; revenue hours; and vehicle-miles by vehicle type.

Regardless of the methodology employed, the assumptions should be adequately documented by the RTPA and transit agency. Estimating current and reasonably available new revenues and required operations and maintenance costs over a 20-year planning horizon is not an exact science. To provide discipline and rigor, RTPAs and transit operators should attempt to be as realistic as possible, as well as ensure that all costs assumptions are publicly documented.

Requirements (Shalls)
State: California Government Code Section 65080(b)

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.324(f)(11); 450.324(f)(v) authorizes the option to use aggregate cost ranges or bands in the outer years of the RTP.
State: None

Planning Practice Examples: Available in Appendix H

6.7 Asset Management

The transportation system in California continues to experience substantial wear and tear from increased vehicle miles traveled, growing population, and greater congestion to aging infrastructure and escalating operating costs. These challenging circumstances put greater demands than ever on the transportation system. The goal of asset management is to minimize the life-cycle costs for managing and maintaining transportation assets, including roads, transit, bridges, tunnels, runways, rails, and roadside features.

As the state becomes more multimodal, consideration of policies from the CTP regarding the importance of evaluating the multimodal life cycle cost can help preserve and maintain transportation facilities. These policies can also assist in developing a strategic approach to assess and prioritize transit assets helping to select projects most in need of funding.

The American Association of State Highway and Transportation Officials (AASHTO) define asset management as:

> *"A strategic and systematic process of operating, maintaining, upgrading, and expanding physical assets effectively through their life cycle. It focuses on business and engineering practices for resource allocation and utilization, with the objective of better decision making based upon quality information and well defined objectives."*

Through the use of asset management systems, engineering and economic analysis, and other tools, RTPAs and transit operators can more comprehensively view the big picture and evaluate collected data before making decisions as to how specific resources should be deployed. Asset management principles and techniques should be applied throughout the planning process, from initial goal setting and long-range planning to development of the TIP and then through operations, preservation, and maintenance.

RTPAs should ensure the transportation system is managed to meet both current and future condition and performance demands and that expenditures are optimal. Asset management principles and techniques are valuable tools that can be applied by an RTPA and result in more effective decision making. The RTPA role in a successful asset management program includes defining performance measures for assets through public involvement, serving as a repository for asset data, and promoting standard data collection technology applications, and making investment decisions based on measured performance relative to established goals. RTPAs can also educate the public and decision makers and work cooperatively with stakeholders across transportation modes.

RTPAs should consider including asset management principles in the development of their RTPs. The following are the benefits of applying transportation asset management during the planning process:

1. Maximize transportation system performance.
2. Improve customer satisfaction.
3. Minimize life-cycle costs.
4. Mitigate system vulnerabilities.
5. Match service provided to public expectations.
6. Make more informed, cost-effective program decisions and
7. Better use of existing transportation assets.

Additional information is available from the FHWA at:

http://www.fhwa.dot.gov/infrastructure/asstmgmt/tpamb.cfm

Requirements (Shalls)
Federal: The Moving Ahead for Progress in the 21st Century (MAP 21) and Fixing America's Surface Transportation (FAST) Act establishes limitations on federal funding flexibility if the aggregate bridge condition in California does not meet certain minimum conditions for National Highway System (NHS) bridges being structurally deficient.
State: None

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.306(e) - States, and public transportation operators may apply asset management principles and techniques in establishing planning goals, defining TIP priorities, and assessing transportation investment decisions.

Planning Practice Examples: Available in Appendix H

Modal Discussion

The RTP is the key document prepared by the RTPA that reflects future plans of the transportation system for the region. This future vision includes all modes of transportation and is one of the key functions of the RTP.

Both federal regulations and state statute require RTPs to address each transportation mode individually. Title 23 CFR Part 450.324(b) states: "*the transportation plan shall include strategies/actions that lead to the development of an integrated multimodal transportation system to facilitate the safe and efficient movement of people and goods in addressing current and future transportation demand*."

It is also important for RTPAs to integrate modal considerations to enable the development of a complete and connected multimodal transportation system. As modes often overlap (e.g. transit vehicles and private vehicles use the same modes, and people and goods use multiple modes), consider how all transportation modes interact with one another, and how improvements in one mode can benefit the entire transportation system.

Title 23 CFR Part 450.324(f)(2) requires that RTPs address both existing and proposed transportation facilities such as major roadways, transit lines (both rail and primary bus routes), multimodal and intermodal connector facilities, pedestrian walkways and bicycle facilities.

California Government Code Section 65080(a) states that transportation planning agencies shall prepare and adopt an RTP directed at achieving a coordinated and balanced regional transportation system that includes mass transportation, highway, railroad, maritime, bicycle, pedestrian, goods movement, and aviation facilities.

6.8 Highways

The section of the RTP discussing highways should consider the following:

1. An overview of the primary highway and arterial road system within the region;
2. National and State highway system, and regionally significant streets and roads;
3. Any corridor preservation processes for possible future transportation projects (i.e. right of way, historic highways, abandoned highways or rails);
4. Maintenance of State highways;
5. Data collection and other infrastructure requirement for ITS;
6. Unmet highway needs.
7. Consider CTP policy suggesting strategic investing to optimize performance; and
8. Consider CTP policy suggesting for the application of sustainable preventative maintenance and rehabilitation strategies.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.216 requires the CTP to provide for the development and implementation of the multimodal transportation system for the State; RTPAs shall comply as well.
State: Government Code Section 65080(a) the RTP shall be directed at achieving a coordinated and balanced regional transportation system.

Recommendations (Shoulds)
Federal: 450.324(b) requires MPO RTPs to include short and long-range strategies for an integrated multimodal transportation system. RTPAs may comply as well.

6.9 Local Streets & Roads

Local streets and roads are critical to provide an interconnected, multi-modal transportation system where every trip begins and ends. Investment in local streets and roads is an investment in public safety, economic growth, goods movement and farm to market needs. According to 2013 California Public Road Data compiled by Caltrans Division of Research, Innovation & System Information, counties and cities maintain 81 percent of the maintained miles within the State of California and carry 45 percent of the total annual miles of vehicle travel. The condition of local streets and roads continue to deteriorate due to the funding shortfalls and will be further challenged by the escalating repair costs in future years. Adequately investing in the local system is critical to protect the public's current investment. The local system will become ever more important in supporting the goals of climate change and building sustainable communities, as local streets and roads serve as the right-of-way for transit, bicycle and pedestrian travel.

The section of the RTP discussing local streets and roads should consider the following:

1. The preservation needs for the local road system, including but not limited to pavement and essential components to support travel by bicycle, bus, pedestrian, or automobile (including the unmet need for maintaining and preserving the existing local streets and road, public transit, bicycling and pedestrian transportation system);
2. Bi-annual Data collection and periodic collaborative efforts to update system-wide local streets and road preservation needs (including deferred maintenance);
3. Encouraging all agencies to utilize Pavement Management Software (PMS) in their data collection efforts;
4. The benefits of achieving Best Management Practices (BMPs) for the local streets and roads and maintaining them at that level;
5. The issue of declining local streets and roads maintenance revenues in connection with rising maintenance costs and achieving SB 375 goals;
6. System preservation assessments such as bridges, safety, traffic signals, transit stop, signage, lane and crosswalk striping, sidewalks, curb ramps, lighting, drainage, landscaping, and other elements within the road right-of-way to support a functioning and integrated multi-modal system.

References

1. 2013 California Public Road Data – Statistical Information derived from the Highway Performance Monitoring System. Prepared by Caltrans Division of Research, Innovation & System Information. Available online at:

   http://www.dot.ca.gov/hq/tsip/hpms/datalibrary.php

Requirements (Shalls)

Federal: Title 23 CFR Part 450.216 requires the CTP to provide for the development and implementation of the multimodal transportation system for the State; RTPAs shall comply as well.

State: Government Code Section 65080(a) the RTP shall be directed at achieving a coordinated and balanced regional transportation system.

Recommendations (Shoulds)

Federal: 450.324(b) requires MPO RTPs to include short and long-range strategies for an integrated multimodal transportation system. RTPAs may comply as well.

6.10 Transit

Transit plays a key role in the regional effort to reduce traffic congestion, VMT and vehicle emissions particularly in urbanized areas. The increased use of transit is a key element to meeting legislative requirements such as AB 32 and SB 375 that aim to reduce GHG emissions that contribute to global warming. Transit systems also play an important role in the mobility for those who are unable to drive, including youth and the elderly, as well as low-income individuals, and people with disabilities. Given these reasons, it is crucial for RTPAs to engage in a continual and comprehensive dialogue with the transit operators within their region. The CTP highlights the positive impacts of public transportation and suggests the integration of multimodal transportation and land use development which can help establish areas within regions that can be possible locations for Transit Oriented Developments (TODs).

The section of the RTP addressing mass transportation issues (including regional transit services and urban rail systems) should address:

1. Identification of passenger transit modes within the region (bus, light and heavy rail, etc.);
2. Integration with transit, highway, street and road projects (including identification of priorities);
3. Implementation plans, operational strategies and schedule for future service (including construction and procurement);
4. Operational integration between transit fleets, and other modes (passenger rail, aviation, taxis, etc.);
5. First/last mile transit connectivity considerations;
6. Summation of the short and long range transit plans along with the capital finance plans for the 20-year period of the RTP;
7. Short and long-range transit plans and capital finance plans for the 20-year RTP period;
8. Inventory of bus fleets by fuel type (diesel, natural gas, and other alternative fuels);
9. Unmet transit needs;
10. Urban and commuter rail project priorities;
11. ITS elements to increase efficiency, safety and level of service;
12. Integration with local land use plans that could increase ridership; and,
13. A measure of transit capacity utilization for peak and off-peak service to evaluate service effectiveness.

In addition, MAP-21/FAST Act added a new recommendation for RTPs to also include transportation and transit enhancement activities, including consideration of the role that intercity buses may play in reducing congestion, pollution, and energy consumption in a cost-effective manner and strategies and investments that preserve and enhance intercity bus systems, including systems that are privately owned and operated, including transportation alternatives, as defined in 23 U.S.C. 101(a), and associated transit improvements, as described in 49 U.S.C. 5302(1), as appropriate. The timeline for implementation of this MAP-21/FAST Act planning requirement is outlined in 23 CFR Part 450.340. Prior to May 27, 2018, an RTPA may adopt an RTP that has been developed using the SAFETEA-LU requirements or the provisions of the Statewide and Nonmetropolitan Transportation Planning *and* Metropolitan Transportation Planning Final Rule (23 CFR Part 450 and 771 and 49 CFR Part 613). On or after May 27, 2018, an RTPA may not adopt an RTP that has not been developed according to the provisions of MAP-21/FAST Act as specified in the Planning Final Rule. RTPAs are encouraged to communicate with Caltrans and FHWA/FTA to discuss schedules for RTP adoption.

Requirements (Shalls)
State: Government Code Section 65080(a) the RTP shall be directed at achieving a coordinated and balanced regional transportation system.

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.216 recommends that the CTP consider the role of intercity busses as outlined above; 450.324(b) requires MPO RTPs to include short and long-range strategies for an integrated multimodal transportation system. RTPAs may comply as well.

6.11 Bicycle & Pedestrian – Including AB 1396 California Coastal Trail

The use of bicycles and walking as a means of transportation has increased dramatically in California over the last 20 years. Both modes of transportation promote a healthy lifestyle and reduce environmental impacts. Higher levels of physical activity are associated with well-connected transportation networks. The CTP acknowledges that viable and equitable multimodal choices are created through Complete Streets and high quality transit access in communities. The CTP can be a helpful resource for RTPAs to refer to during their RTP development. Additional information regarding the Complete Streets planning process which emphasizes bicycle and pedestrian access and circulation is available in Section 2.7. The RTP section discussing bicycle and pedestrian issues should identify the following:

1. A well-connected transportation network within the region that includes routes with all types of bicycle and pedestrian facilities on local streets which provide trips to destinations;
2. Policies, plans and programs used to promote the usage of bikes and walking;
3. Transit and rail interface with bicyclists and pedestrians;
4. Unmet bicycle and pedestrian needs; and,
5. Existing and potential California Coastal Trail (CCT) network segments and linkages, as well as gaps and related coastal access trail needs.

AB 1396 – California Coastal Trail

Enacted in 2007, AB 1396 added Section 65080.1 to the Government Code which requires transportation planning agencies whose jurisdictions include a portion of the CCT (or property designated for the coastal trail) to coordinate with specified agencies regarding development of the coastal trail. The law also requires that RTPs include provisions for the coastal trail. As RTPs are updated, the CCT provisions from each respective certified Local Coastal Program Land Use Plan's policies, programs and maps should be integrated into the RTP update.

Provisions for the CCT should include identification of existing and potential trail network segments and linkages as well as gaps and related coastal access trail needs. Coastal access trail needs could include identification of accommodations for non-motorized modes, critical linkages to parking, bicycle racks, bathrooms and other support facilities, and connections to CCT trailheads. Any necessary trail alignment near motorized traffic should provide for adequate separation. Prioritization of projects within RTPs could include consideration of connecting the CCT across identified critical gaps in the coastal trail system.

Additional information and maps regarding the California Coastal Trail is available from the State Coastal Conservancy and the California Coastal Commission at:

www.yourcoast.org

http://scc.ca.gov/2010/01/07/the-california-coastal-trail/

http://coastal.ca.gov/access/ctrail-access.html

http://www.coastal.ca.gov/access/accndx.html

http://www.coastal.ca.gov/access/coastal-trail-map.pdf

Requirements (Shalls)
State: Government Code Section 65080(a) requires that the RTP shall be directed at achieving a coordinated and balanced regional transportation system. Government Code Section 65080.1 requires that transportation planning agencies whose boundaries include a portion of the CCT or property designated for the trail, coordinate with appropriate agencies including the State Coastal Conservancy, the California Coastal Commission and the Department of Transportation regarding development of the California Coastal Trail, and include provisions for the CCT in their RTP.

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.216(a)

Planning Practice Examples: Available in Appendix H

6.12 Goods Movement (Maritime/Rail/Trucking/Aviation)

Developing, operating and maintaining a robust goods movement transportation system is vital to California's economy. For many reasons, including its proximity to Asian markets, its strong agricultural economy, and its large population, high volumes of goods are moved within and through California. With the diversity of products being moved, and the complexity of origins and destinations, the transportation system that supports goods movement within California must be multimodal. The system spans the entire state, and the needs for urban and rural goods movement infrastructure can differ between, and within, regions. However, throughout the state, goods movement has both positive and negative impacts. Through the regional planning process, RTPAs can create strategies for improving the regional goods movement transportation system so positive impacts (e.g. job creation, access to goods) are maximized and negative impacts (e.g. land use conflicts, air pollution and disproportionately high and adverse impact on low income or disadvantaged groups) are minimized.

RTPAs must plan for the goods movement infrastructure in the same way they plan the transportation infrastructure for the movement of people to support projected population growth and economic development. Goods movement planning is in the public interest because of the potential benefits to the regional economy, environment, public health, and community well-being. Improvements to the goods movement transportation system can result in co-benefits to the overall system when California's economic, equity, and environmental goals are simultaneously considered. For example, as a rail improvement project could ideally take trucks off the highway, congestion could be reduced and potentially reduce GHG emissions. The CTP recognizes the importance of enhancing freight mobility, reliability, efficiency, and global competitiveness, which is why RTPAs should consider deploying, as appropriate and feasible, cost-effective technologies that can help expedite goods movement and reduce congestion at our ports. A seamless, efficient, low-emitting and well-maintained, multi-modal transportation system is paramount to the state's economic strength and its citizens' quality of life. Planning this system involves a broad base of stakeholders, including affected community representatives, local organizations, agencies in charge of seaports and airports, trucking associations, Class I and short line railroads, and freight carriers and shippers, local air districts, electric and gas utilities, and multiple state agencies (e.g., ARB, California Energy Commission, Caltrans, California Public Utilities Commission).

The RTP section discussing goods movement should include the following:

1. A discussion of the role of goods movement within the region (the types and the magnitudes of goods moved through the region and their economic importance);
2. An inventory of all major highway and roadway routes consistent with the National Highway Freight Network, including critical urban freight corridors;
3. An inventory of seaport facilities, air cargo facilities, freight rail lines, and major warehouses and freight transfer facilities within the region;
4. An analysis of the efficiency of existing goods movement transportation infrastructure (e.g. bottlenecks, gaps, etc.) and identification of expansion or improvement needs at seaport and airport facilities that handle cargo and issues regarding land side access to these facilities;
5. Discussion of how the region's projected population growth will affect the demand for goods movement, and identification of land areas where goods movement facilities (such as intermodal facilities and warehouses) necessary to support this demand can and should be located;
6. Specific projections, by mode, of future freight demand;
7. Identification of freight-related highway and roadway improvement needs;
8. Identification of expansion or improvement needs for freight rail lines within the region;
9. Identification of intermodal connection issues between different modes (e.g. freight, rail and seaport facilities), as applicable;
10. Discussion of ITS and advanced technology opportunities for goods movement, with the aim of maximizing operational efficiencies and minimizing emissions.
11. Identification of opportunities or innovations that improve freight efficiency and support the State's freight system efficiency target as established in the California Sustainable Freight Action Plan.

California Sustainable Freight Action Plan

In July 2015, Governor Brown issued Executive Order B-32-15 which prioritizes California's transition to a more efficient and less polluting freight transportation system. This transition of California's freight transportation system is essential to supporting the State's economic competitiveness in the coming decades while reducing GHG emissions and air quality impacts. The Executive Order directed State agencies to develop an integrated action plan by July 2016 that established clear targets to improve freight efficiency, transition to zero-emission technologies, and increase the competitiveness of California's freight system. It is suggested that regional transportation agencies consult the California Sustainable Freight Action Plan when developing the freight related strategies in their respective RTPs.

California Freight Mobility Plan

The state's California Freight Mobility Plan (CFMP) is a policy and action agenda document that supports the improvement of California's goods movement infrastructure while preserving the environment. RTPAs are encouraged to review the CFMP for guidance, and ensure consistency while addressing goods movement within their RTPs. The RTPs and the CFMP will ideally function in a feedback loop, as the goods movement strategies and projects identified in RTPs will be incorporated into the next update of the CFMP.

Requirements (Shalls)
State: Government Code Section 65080(a) requires that the RTP shall be directed at achieving a coordinated and balanced regional transportation system.

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.216, the CTP may include short and long-range strategies for an integrated multimodal transportation system to facilitate the safe and efficient movement of people and goods. Title 23 CFR Part 450.324(f)(3) states that the MPO RTP shall include operational and management strategies to improve the performance of existing transportation facilities to relieve vehicular congestion and maximize the safety and mobility of people and goods. RTPAs are encouraged to comply, as feasible and appropriate.

The FAST Act directs the Department of Transportation to establish a National Multimodal Freight Network to:

- Assist States in strategically directing resources toward improved system performance for the efficient movement of freight on the Network;
- Inform freight transportation planning;
- Assist in the prioritization of Federal investment; and,
- Assess and support Federal investments to achieve the goals of the National Multimodal Freight Policy established in 49 U.S.C. 70101 and of the National Highway Freight Program described in 23 U.S.C. 167.

The FAST Act established a National Highway Freight Network (NHFN). The NHFN includes the following subsystems of roadways:

- **Primary Highway Freight System (PHFS):** This is a network of highways identified as the most critical highway portions of the U.S. freight transportation system determined by measurable and objective national data. The network consist of 41,518 centerlines miles, including 37,436 centerline miles of Interstate and 4,082 centerline miles of non-Interstate roads.
- **Other Interstate portions not on the PHFS:** These highways consist of the remaining portion of Interstate roads not included in the PHFS. These routes provide important continuity and access to freight transportation facilities. These portions amount to an estimated 9,511 centerline miles of Interstate, nationwide, and will fluctuate with additions and deletions to the Interstate Highway System.
- **Identification and Designation of Critical Rural Freight Corridors (CRFCs):** These are public roads **not** in an urbanized area which provide access and connection to the Primary Highway Freight System (PHFS), and the Interstate with other important ports, public transportation facilities, or other intermodal freight facilities.

Planning Practice Examples: Available in Appendix H

6.13 Regional Aviation System

Aviation contributes to California's triple bottom line (people, prosperity, and planet) at all levels from local to global. Aviation gives the State's multimodal transportation system access, range, and speed. California's aviation system consists of 246 public-use airports made up of both commercial and general aviation airports, 68 special-use airports, 8 sea plane bases, 356 hospital and/or corporate, police, fire, or private heliports, 22 military/NASA bases, and 1 joint-use facility. (Division of Aeronautics Aviation in California: Fact Sheet (MAY 2016))

Aviation improves mobility options, generates tax revenue, saves lives through emergency response, medical, and firefighting services, produces over $170 billion in air cargo revenues annually, and generates over $14 billion to the State's tourism industry. The Division of Aeronautics Economic Study, *Aviation in California: Benefits to Our Economy and Way of Life* (2003), reports that aviation creates almost 9 percent to the State's jobs (1.7 million jobs), and generates revenues totaling ($110.7 billion). The report is available on line at: http://dot.ca.gov/hq/planning/aeronaut/publication.htmhttp://dot.ca.gov/hq/planning/aeronaut/publication.htm

The 2014 Caltrans Airport Forecasting Study, T*he Role of California Airports in Smart Growth and Economic Vitality* created tools for communities and regions to use for developing their local airports to their full economic potential. Airports can be used to help locate new business opportunities for a region, and improve quality of life by providing a unique access opportunity. The study includes planning practice examples, available at: http://www.dot.ca.gov/aeronaut/index.htm

To preserve the economic and access benefits aviation contributes to California, airports must be protected through comprehensive planning practices at all levels of government. A large part of protecting airports comes from policies that protect airports from encroachment from incompatible land uses. Every county in California having an airport that is "operated for the benefit of the general public" described in Public Utilities Code (PUC) Section 21670(b) must have an Airport Land Use Commission (ALUC) who's function is accomplish proper airport land use compatibility planning. The PUC recognizes six types of ALUC. Counties are free to select the type of ALUC that works best for their needs. The PUC further specifies the types of powers and duties reserved for ALUC (PUC Section 21674). ALUCs do not have jurisdiction over airports, but their airport land use compatibility plans (ALUCP) are developed from an airport's layout plan or master plan. And, general plans shall be consistent with ALUCPs, (PUC Sections 21674(c) and 21675).

Federal laws (Title 23 CFR Part 450.216(j)) requires RTPAs to consult with stakeholders responsible for land use management, as appropriate. Although not specifically named in statute, airports and ALUCs meet this criteria, and should be included in the consultation process during the RTP development. See Chapter 4 for guidance on the consultation process. State law (California Government Code Section 65080(a) and California Government Code Section 65080(a)) requires a coordinated and balanced regional transportation system. State law further requires RTPAs that have a primary air carrier airport (i.e. an airport with over 10,000 annual enplanements) within their jurisdiction shall have an Airport Ground Access Improvement Program (AGAIP). Annual passenger enplanement and air cargo reports are available from either the Caltrans Division of Aeronautics or from the Federal Aviation Administration (FAA), Airports Office: Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports. See the Division of Aeronautics web site for annual reports of both enplanement and cargo data at:

http://dot.ca.gov/hq/planning/aeronaut/documents/statistics/paxstats.htm

Requirements (Shalls)
Federal: Title 23 CFR Part 450.216(j) states that States shall consult as appropriate with stakeholders and local agencies responsible for land use management, natural resources, environmental protection, conservation, and historic preservation during the development of the RTPs. RTPAs shall comply with this as well. Title 23 CFR Part 450.210(a)(1) also requires that public involvement process developed in consultation with all interested parties and describe explicit procedures, strategies, and desired outcomes.

State: California Government Code Section 65080(a) states that "Each transportation planning agency…shall prepare and adopt a regional transportation plan directed at achieving a coordinated and balanced regional transportation system, including…aviation facilities and services." California Government Code Section 65081.1(a) requires each RTPA with a primary air-carrier airport to have an Airport Ground Access Improvement Program (AGAIP). Government Code Section 65081.1(b) requires consideration of highway, rail, and mass transportation and states that, "The program shall address the development and extension of mass transit systems, including passenger rail service, major arterial, and highway widening and extension projects, and any other ground access improvement projects the planning agency deems appropriate." The Transportation Research Board Airport Cooperative Research Program Report 146 provides resources and guidance regarding the development of the AGAIP. It can be found on the web at: http://www.trb.org/Main/Blurbs/173350.aspx. An additional ACRP web only ground access guide is also available at: http://www.trb.org/Publications/Blurbs/173351.aspx

Recommendations (Shoulds)
State: RTPAs should consider the needs of all commercial and general aviation public-use airports, heliports and military airfields and installations when planning transportation and infrastructure projects (i.e. by consulting with the sponsors) to further sustainable and compatible land uses around these anchor locations and circulation patterns.

Planning Practice Examples: Available in Appendix H

Military Airfields and Installations

California's military installations are vital to America's national security, and the State is home to some of the Department of Defense's (DOD) most important military installations globally. All five of the services (Army, Navy, Air Force, Marines, and Coast Guard) have a major presence in the State. They are major contributors to the State's triple bottom line (people, prosperity, place), and users of the transportation system. In 2009 California's DOD installations employed over 354,769 civilian and military personnel, with a payroll of over $56 billion. Military expenditures and contracts awarded to California companies totaled almost $99 billion. Source: DOD in California brochure. Military installations are subject to strict environmental regulation, and vulnerable to climate change impacts, and sea leave rise. Each installation has plans that address environmental and sustainability needs for their installation and practices in place that protect the environment and ensure the Service's ability to execute their mission.

Military transportation needs can be broken down into three broad categories, troop transport, military cargo, and installation employees commuter needs. These needs include surge capabilities as needed. Military facilities are spread throughout California, in all sizes of communities from rural locations to heavily urbanized areas. They share the same transportation needs as their neighboring communities. Although not specifically named in planning statue and codes, the requirement to consult with all users of the transportation system apply to the military as well, see Chapter 4 RTP Consultation and Coordination for detailed discussion of users and the consultation process. In addition to transportation needs, military installations also need protection from encroachment of incompatible land uses that could hamper the facilities ability to meet its mission needs. Military installations with airfields are required by DOD to prepare Air Installation Compatible Use Zone Plan (AICUZ) that address their compatibility needs. ALUC are required to develop an ALUCP for the airfield that is consistent with the AICUZ. The federal government, Transportation Research Board, and some states (Texas, Colorado, North Carolina, New Jersey, and Virginia) offer guidance and planning practice examples regarding how to address land use compatibility issues for military installations. General plans must be consistent with the AICUZ and ALUCP for the military airfields in their jurisdiction. California's Office of Planning and Research (OPR) publishes a guide for how to incorporate land use compatibility planning for military installations in the State. https://www.opr.ca.gov/docs/Military_GPG_Supplement.pdf.

Requirements (Shalls)

Federal: Consulting with interested parties on plans, programs, and projects shall include individuals or organizations that are mentioned in Title 23 CFR Part 450.210(a). Title 23 CFR Part 450.216(j) requires States to consult with federal land use management agencies as appropriate during the development of RTP. RTPAs shall comply as well. Title 23 CFR Part 450.210(a)(1) also requires that public involvement process be developed in consultation with all interested parties and describe explicit procedures, strategies, and desired outcomes.

Recommendations (Shoulds)
State: RTPAs should consider the needs of public-use airports, and heliports and military airfields when planning transportation and infrastructure projects (i.e. by consulting with the sponsors) to further encourage sustainable and compatible land use and circulation patterns.

Planning Practice Examples: Available in Appendix H

Programming/Operations

6.14 Transportation System Management & Operations

The RTP shall address management and operations strategies aimed at improving the performance of the existing regional transportation system in order to reduce transportation congestion issues and maximize the safety and mobility of people and goods. Examples of operational and management include: (a) Traffic incident management (b) Travel information services(c) Roadway weather information (d) Freeway management (e) Traffic signal coordination and (f) Bicycle and transit trip planning.

Although operational and management strategies may be implemented on a regional, area-wide, or project-specific basis, those strategies included in an RTP should typically be those that have importance on a regional level.

RTPs shall include existing and proposed transportation facilities (including major roadways, transit, multimodal and intermodal facilities, pedestrian walkways and bicycle facilities and

connectors) that should function as an integrated regional transportation system with emphasis on those facilities that serve important national and regional needs.
If applicable, the locally preferred alternative selected from an Alternative Analysis under the FTA's Capital Investment Grant Program (Section 5309) needs to be adopted as part of the RTP as a condition for funding under Title 49 U.S.C. Section 5309.

Requirements (Should)
Federal: Title 23 U.S.C. Section 134 and Title 23 CFR Part 450.324(f)(5) requires MPO RTP strategies for improving the regional transportation system and reducing congestion. RTPAs are encouraged to comply as well, as feasible and appropriate.

Planning Practice Examples: Available in Appendix H

6.15 Coordination with Programming Documents

The Federal Transportation Improvement Program (FTIP) is a four-year prioritized listing of federally funded and non-federally funded regionally significant transportation projects that is developed and formally adopted by an MPO as part of the metropolitan transportation planning process. MPOs work cooperatively with public transportation agencies as well as other local, state, and federal agencies to propose projects for inclusion in the FTIP. Each project or project phase in the FTIP must be consistent with the approved RTP. The FTIP must be updated at least every four years.

Projects included in the FTIP may include projects from two other State programming documents: (1) The purpose of the SHOPP program is to maintain safety, operational integrity and rehabilitation of the State Highway System. (2) The STIP is a five-year capital improvement program of transportation projects on and off the State Highway System funded with revenues from the State Highway Account and other sources. Caltrans manages the SHOPP program, while the CTC manages the STIP. The STIP is a five-year document and is updated every other year. The SHOPP is a ten-year document and is adopted by the CTC in August of each odd numbered year. These two programs are major components of the FTIP.

The Federal Statewide Transportation Improvement Program (FSTIP) is a compilation of the FTIPs prepared by the 18 MPOs. It also includes projects in rural areas of the state not represented by an MPO (the Department programs projects in the FSTIP for the rural areas). The FSTIP is prepared by Caltrans and submitted to the FHWA and FTA for approval. The FSTIP covers a four-year period and must be updated at least every four years. States have the option to update more frequently, if desired. Federally funded projects or non-federally funded regionally significant projects cannot be added to the FSTIP unless they are included in the RTP. Specific requirements for the development and content of the FSTIP are contained in Title 23 CFR Part 450.218.

The diagram in Appendix B illustrates the federal/state programming process.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.218(k) states that each project or project phase included in the STIP shall be consistent with the long range statewide transportation plan developed under Title 23 CFR Part 450.214.

6.16 Regionally Significant Projects

Title 40 CFR Part 93.101 defines regionally significant projects as follows:

> *"Regionally significant project means a transportation project (other than an exempt project) that is on a facility which serves regional transportation needs (such as access to and from the area outside of the region, major activity centers in the region, major planned developments such as new retail malls, sports complexes, etc., or transportation terminals as well as most terminals themselves) and would normally be included in the modeling of a metropolitan area's transportation network, including at a minimum all principal arterial highways and all fixed guide way transit facilities that offer an alternative to regional highway travel."*

All regionally significant projects must be included in an RTP air quality conformity determination by the RTPA in coordination with Caltrans and FHWA regardless of its funding source. These regionally significant projects should be specifically identified and noted in the project-listing portion of RTP.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.216(h) requires all regionally significant projects be included in the TIP regardless if the projects are to be funded with federal funds or not.

6.17 Regional ITS Architecture

Intelligent transportation systems (ITS) encompass a broad range of wireless and wire line communications-based information and electronics technologies. When integrated into the transportation system's infrastructure, and in vehicles themselves, these technologies relieve congestion and improve safety. ITS is one way to increase the efficiency, safety and security of a transportation system. ITS involves the use of advanced computer, electronic and communications technologies and emphasizes *enhancing travel on existing infrastructure* (highways, streets, bridges, trains). Some examples of ITS technologies include advanced traffic signals, roadway and weather monitoring stations, bus and maintenance vehicle location systems, electronic roadside information signs and automated vehicle control systems.

The National ITS Program was established by ISTEA in 1991. Further federal regulations focused on extending ITS to regional planning efforts and training transportation professionals to deal with the range of issues associated with the adoption of advanced transportation technology. The development of the regional ITS architecture is not meant to compete with the formal transportation planning process. In fact, key ITS projects and initiatives are targeted early in the planning process. When updating RTPs, RTPAs should be sure to comply with current federal regulations. Title 23 CFR Part 450.208(g) states, "*The statewide transportation planning process shall, to the maximum extent practicable, be consistent with the development of applicable regional intelligent transportation systems (ITS) architectures, as defined in Title 23 CFR Part 940."*

Title 23 CFR Part 940 establishes the protocol for developing a regional architecture plan that, in turn, conforms to national ITS architecture standards. The ITS regulations defines the responsibilities for creating and maintaining Regional ITS Architecture (RA) frameworks. Architecture maintenance is the process of updating a regional architecture with references to new projects and activities, new stakeholders; additions, retirement or replacement of equipment; and, changes to standards and protocols. Maintenance is an ITS program responsibility under Title 23 CFR Part 940.

The intent of the federal ITS requirement is to encourage reciprocal consistency. Title 23 CFR Part 940.5, Intelligent transportation system architecture and standards, calls for the "development of the regional ITS architecture (to) be consistent with the transportation planning process…" It is important to coordinate the general RTP planning efforts with plans for specific projects that entail the use of ITS technology. These 'nested' plans should be developed in an open forum and they should be consistent. The resultant plans would reflect consideration of both documents during the planning process.

The National ITS Architecture and other related resources can be found at the United States Department of Transportation's (U.S. DOT's) Architecture website:

http://www.its.dot.gov/arch/arch.htm

Requirements (Shalls)
Federal: Title 23 CFR Part 450.208(g) states that the CTP shall (to the extent practicable) be consistent with the development of applicable regional ITS architectures as defined in Title 23 CFR Part 940. RTPAs shall comply as well.

6.18 Future of Transportation & New Technology

While maintaining the current transportation network is often a priority for RTPAs, RTPAs need to be planning ahead for a future in which technology will transform the way that people move and live. RTPAs are ideally positioned to anticipate and be responsive to the needs of future generations. This section provides a summary of federal legislation to prepare for new technologies and innovations for the future of transportation.

Connected Vehicle Program

There are several activities related to the national Connected Vehicle Program that will certainly impact regional and local transportation agencies, in addition to Caltrans. Since 90% of the roadways in California are owned and operated by local agencies, including the 58 counties and more than 500 incorporated cities, it is critically important for them to be aware of and to plan for the implementation of connected vehicles.

RTPAs should be aware of the pending rule being considered by the National Highway Traffic Safety Administration (NHTSA) to mandate that equipment for vehicle-to-vehicle (V2V) communications, using a technology called "Dedicated Short-Range Communications" (DSRC), be installed in the light-duty passenger car fleet to enable applications that improve vehicle safety. As the government regulator for auto industry safety, NHTSA is expected to adopt this rule, as it did for other safety systems such as seat belts, airbags, and anti-lock brakes. A future update of the RTP Guidelines will capture any "shoulds" or "shalls" resulting from the rulemaking process.

RTPAs should also be aware of the pending guidance from the FHWA to transportation infrastructure owner/operators (Caltrans; counties; and cities) on what equipment they should consider installing in their infrastructure to support both V2V and vehicle-to-infrastructure (V2I) communications, again using DSRC. The best example of this equipment is the DSRC radios. These radios provide the communication capability that is essential for V2I applications. Roadside processors may also be necessary in some cases where the applications demands heavier computing requirements.

Unlike connected vehicles, the development of which is being led by the federal government, in partnership with state DOT's, regional transportation agencies, and the auto industry, automated vehicles are being developed by the technology industry, including companies such as Google, Tesla, and Delphi. So far, their philosophy has been to avoid dependence on the infrastructure. However it is difficult to achieve vehicle automation and connected vehicle (CV) applications without appropriate support from the infrastructure. The infrastructure needs to be upgraded with DSRC radios and roadside processors. The roadside processors are not an absolute requirement but may be required in some cases.

Title 23 U.S.C. Section 518 requires the U.S. DOT Secretary establishing guidance for recommended implementation path for V2V and V2I communication system deployment. Title 23 U.S.C. Section 519 ensures that funds are available for the development of Intelligent Transportation System (ITS) Infrastructure, equipment and systems.

Planning Practice Examples: Available in Appendix H

6.19 <u>Transportation Safety</u>

While Caltrans supports consideration of security as separate from safety as a planning area, it also recognizes that security and emergency responses efforts are often inextricably linked. Clearly both are linked to ensuring system security and availability of emergency response services in the event of a natural or human-caused disaster. Due to unexpected large-scale security incidents or natural disasters, the potential for the necessity of a wide scale evacuation exists in almost every area of California. RTPAs can use the CTP as a resource for recommendations for public safety and security improvements, such as supporting the implementation of Positive Train Control (PTC) into existing intercity rail cars.

Under a prior federal surface transportation reauthorization known as TEA-21, safety and security were lumped together in one federal planning factor. SAFETEA-LU changed this in order to signal the importance of these two items. Safety and security were again updated with MAP-21/FAST Act and are separate federal planning factors. According to Title 23 CFR Part 450.306(b), these two planning factors are:

1. Increase the safety of the transportation system for all motorized and non-motorized users; and,
2. Increase the security of the transportation system for motorized and non-motorized users.

The public expects, and demands, that the transportation system be safe and efficient for all users. Addressing the improvement of transportation safety can help alleviate a myriad of health, financial, and quality-of-life issues for travelers. Fatalities and injuries from motor vehicles crashes are a major public health problem. Historically, transportation safety has not been included as part of the transportation planning process. A clear need has developed for safety to be considered as part of planning process instead of as a reactionary consideration as it as been. To be adequately addressed, safety must be a key goal within the process. Improving the safety of the transportation network requires an active, conscious approach to monitoring the transportation system for safety problems and anticipating problems before they occur.

Strategic Highway Safety Plan

Federal law requires MPOs to draw a strong link between the Strategic Highway Safety Planning process described in Title 23 U.S.C. Section 148 and the regional planning process. Federal regulations also require MPOs to summarize the priorities, goals, countermeasures or projects of the Strategic Highway Safety Plan (SHSP) in their RTPs. RTPAs will also be held to this same level of addressing safety during the development of their RTPs.

SHSPs were first required under SAFETEA-LU, which established the Highway Safety Improvement Program (HSIP) as a core federal program. The FAST Act continues the HSIP as a core Federal-aid program and the requirement for States to develop, implement, evaluate and update an SHSP that identifies and analyzes highway safety problems and opportunities on all public roads no less than every five years. Each State must have a Strategic SHSP in place to receive its full share of federal transportation funds.

Each RTPA should review the California SHSP during the preparation of the portion of the RTP addressing safety. The SHSP is guided by federal guidelines capitalizing on successes achieved to date and continue to create even greater improvements. It also addresses goals established by MAP-21:

1. Highlights challenges to roadway user safety on California's roads;
2. Provides a descriptive account of fatalities experienced on California's roads;
3. Proposes high-level strategies to reduce fatalities for each challenge; and,
4. Includes a five-year guide for the implementation of specific projects and activities.

The California SHSP is available on the Caltrans website at:

http://www.dot.ca.gov/hq/traffops/survey/SHSP/

Safety Performance Measures

The MAP-21/FAST Act established Safety Performance Management (PM) as part of the overall Transportation Performance Management (TPM) program, which FHWA defines as a strategic approach that uses system information to make investment and policy decision to achieve national performance goals. Refer to Section 7.1 for more information.

Requirements (Shall)
Federal: Title 23 CFR Part 450.206(a)(2) states the planning process will address the safety of the transportation system for the public.

Recommendations (Should)
Federal: Title 23 CFR Part 450.206(c)(4) states that RTPs should be consistent with the California Strategic Highway Safety Plan (SHSP) and other transit safety and security planning and review processes.

Title 23 CFR Part 450.216(3) states the RTP should integrate the priorities, goals, countermeasures or projects for the RTPAs region contained in the SHSP.

6.20 Transportation Security

A report was prepared by the American Highway Users Alliance titled "*Emergency Evacuation Report Card 2006*". The report stated: *"The principal resources of urban evacuation are private cars and publicly provided highways. As a result of the threat of terrorism, the interstate system is reasserting itself as a major element of national security (and defense), principally due to its capacity for handling mass evacuations."* The report conducted an initial evacuation capacity evaluation for the 37 largest urbanized areas in the United States. These urbanized areas were graded from "A" to "F". Of the four California urbanized areas identified in the report, three (San Diego, San Francisco and Los Angeles) received a grade of "F". Sacramento, the fourth California city identified in this report received a "D".

Due to unexpected large-scale security incidents or natural disasters, the potential for the necessity of a wide scale evacuation exists in almost every area of California. One of the lessons learned from the terrorist attack on the World Trade Center in New York City was that effective coordination and communication among the many different operating agencies in a region is absolutely essential. Such coordination is needed to allow law enforcement and safety responses to occur in an expeditious manner, while at the same time still permitting the transportation system to handle the possibly overwhelming public response to the incident. Complementary to this is the need to make sure the public has clear and concise information about the situation and what actions they should take.

Although the immediate organizational response to security incidents and disasters will be the responsibility of law enforcement/safety agencies, there is an important role that MPOs/RTPAs can play in promoting coordinated planning among first responders and transit agencies in anticipation of unexpected events or natural disasters. In addition, MPOs/RTPAs could also provide a centralized location of information on transportation system conditions and the responses that might be useful in an emergency.

In developing the RTP, RTPAs are required to consult with agencies and officials responsible for other planning activities with in the region including natural disaster risk reduction. The RTP should identify the primary agencies responsible for preparing the necessary plans should a wide scale evacuation be necessary. The RTPA should consult the appropriate emergency plan for the region to determine what evacuation plans are in place. Examples of strategies that could be addressed in regional mass evacuation plans could include:

1. Signaling – Allows traffic signals to extend for up to four minutes in either red or green to allow large amounts of vehicles or pedestrians to proceed in one direction;
2. Traffic Control Guides – Deploy traffic control personnel to problem intersections to manually direct traffic;
3. Roadblocks and Barricades – Deploy various methods such as portable signs, cones or barrels;
4. Electronic Signage – Changeable message signs have been installed along a number of major routes that could be used to provide information to evacuees;

5. Lane Expansion – Involves the use of using road shoulders to increase vehicle capacity of evacuation routes;
6. Contra flow Lanes – Contra flow or lane reversal involves directing traffic to use lanes in both directions to move a large amount of vehicles in one direction;
7. Use of Mass Transit – Transit could be used to assist in the evacuation of the public should it become necessary;
8. Alternative Routes – Rural areas typically do not have large scale highways and transit, which makes it critically important to identify alternate emergency evacuation routes; and,
9. Airport Use – Airports can be used as staging areas for medical and food supplies as well as evacuation.

Requirements (Shalls)
Federal: Title 23 CFR Part 450.206(a)(3) states the planning process will address the security of the transportation system for the public. Title 23 CFR Part 450.216(c) states that the CTP shall reference, summarize, or contain any applicable emergency relief and disaster preparedness plans, strategies and policies that support homeland security and safeguard the personal security of all motorized and non-motorized users. RTPAs shall also comply.

Recommendations (Shoulds)
Federal: Title 23 CFR 450.316(b) requires consultation with agencies and officials responsible for planning natural disaster risk reduction. RTPAs should also comply.

6.21 Assessment of Capital Investment & Other Strategies

MAP-21/FAST Act added a new requirement for MPO RTPs to also include an assessment of capital investment and other strategies to:

1. Preserve the existing and projected transportation infrastructure;
2. Provide for multimodal capacity increases based on regional priorities and needs; and,
3. Reduce the vulnerability of the existing transportation infrastructure to natural disasters.

The RTP may consider projects and strategies that address areas or corridors where current or projected congestions threatens the efficient functioning of key elements of the regional transportation system.

Recommendations (Shoulds)
Federal: 23 CFR 450.324(f)(7) requires MPOs to include an assessment of capital investment and other strategies; RTPAs are encouraged to comply as well.

6.22 Congestion Management Process

The RTP shall describe and identify the transportation system management (TSM) and operations strategies, actions and improvements it will employ to manage and operate the urban freeway system, its corridors and major local parallel arterials for highest or increased productivity. Increased productivity can include all modes, including transit, bicycles, and pedestrians. There may be many ways to increase mobility without increasing GHG emissions. One way may be to improve the efficiency and productivity of the corridor through operational, transit and highway projects. TSM and operations strategies, actions and improvements shall include at a minimum traffic detection, traffic control, incident response and traveler information. Transportation demand strategies shall also be identified and can include, but are not limited to: Pricing, Transportation Planning, and Investment Strategies. Section 6.23 and Appendix H of the Guidelines contain additional information on strategies that can be used to manage congestion and reduce regional GHG emissions. The approach to TSM and operations shall be integrated into system planning documents.

Coordination of Project Programming

Programming of projects shall be scheduled so that project sequencing in a corridor achieves the most effective performance results. In State Highway System corridors the system planning documents should identify the most effective project sequencing, including projects identified for major local arterials. System planning strategies to address performance issues can include: system evaluation and monitoring, maintenance and preservation, smart land use and demand management, Intelligent Transportation Systems, operational capacity strategies, multimodal and Complete Streets concepts.

Congestion Management Process in the RTP

The RTP should identify urban freeway corridors with current and projected recurrent daily vehicle hours of delay that are a priority for preparing CSMPs and TCRs. The RTP should include by corridor all multimodal strategies, actions and improvements identified in the adopted TCR or CSMP that are needed to provide for safe and effective integrated management and operation of the multimodal transportation system across jurisdictions and modes to improve corridor performance based upon performance measurement. Approaches to improving corridor performance can include new and existing facilities, improved maintenance and operation of existing infrastructure, investing and encouraging the use of alternative modes (such as transit, rail, bicycling and walking), encouraging smart land use, and integrated corridor management strategies, among others.

The RTP should describe roles and relationships among units of local government, modal agencies, Caltrans and related agencies for managing the corridor for highest mobility benefits and for measuring and evaluating performance.

Recommendations (Shoulds)
Federal: Title 23 CFR Part 450.322(b) outlines a process for MPOs and states the congestion management process should result in performance measures that can be reflected in the RTP. RTPAs may comply as well, as appropriate.

Regional GHG Emissions Considerations in the RTP

6.23 <u>Land Use & Transportation Strategies to Address Regional GHG Emissions</u>

Better land use and transportation strategies will continue to be important to both MPOs and RTPAs in developing their RTPs to meet local, regional and statewide mobility and economic needs while meeting the requirements of AB 32 to reduce regional GHG (GHG) emissions. RTPAs and MPOs can encourage well-designed and sustainable local and regional projects that encourage reductions in GHG emissions by considering and implementing land use and transportation strategies. The strategies set forth below and in Appendix H are suggested methods that may help the MPO and RTPA to reduce regional GHG emissions.

Land use strategies can include, but are not limited to:

- Mixed use, infill, and higher density development projects.
- Public transit incorporated into project design.
- Open space, parks, existing trees, and replacement trees.
- “Brownfields” and other underused property near existing public transportation and jobs developed.
- Pedestrian and bicycle-only streets and plazas within developments.
- Consideration of current and future school sites and needs regarding school-related trips.

Transportation strategies can include, but are not limited to:

- Promote ride sharing programs
- Employer-sponsored shuttle services
- Encourage or use low or zero-emission vehicles
- Create car sharing programs
- Provide shuttle service to public transit
- Incorporate bicycle-friendly intersections into street design
- Create active transportation plans
- A school district may provide bussing to students based on the distance from a school, other hazards to walking to the school, or other district criteria. Consider opportunities to incorporate existing and planned school district busing to supplement and complement public transit options.
- Consider opportunities to protect or improve designated and proposed school district safe routes to school in community wide transportation strategies and investments (e.g. transit improvements bifurcating neighborhoods near schools disrupting pedestrian/bike access).

Additional strategies include, but are not limited to:

- Pricing Strategies (can include Congestion Pricing, Road Tolling, HOT lanes and toll roads, Parking Pricing and Alternative Mode Programs)
- Transportation Planning and Investment Strategies in the Smart Mobility Framework
- Urban and suburban infill, clustered development, mixed land uses, New Urbanist design, transit-oriented development, and other “smart-growth” strategies: Strategies incorporating the “D factors” (See Professor Robert Cervero’s research as noted in Cervero, R. and K. Kockelman (1997) “Travel Demand and the 3Ds: Density, Diversity, and Design,” *Transportation Research D*, Vol. 2, pp. 199-219. Other resources used to define these factors include Fehr & Peers' *Accurate Trip Generation Estimates for Mixed-Use Projects,* and Cervero and Lee's *The Effect of Housing Near Transit Stations on Vehicle Trip Rates and Transit Trip Generation.)*
- Congestion Management improving traffic circulation to reduce vehicle idling (coordinate controlled intersections for traffic to pass more efficiently through congested areas)
- Transportation Demand Management

As regions explore various land use and transportation strategies to reduce GHG emissions, RTPAs should consider identifying and to the extent possible, quantifying the co-benefits associated with GHG emissions reduction strategies throughout the RTP implementation processes. Co-benefits are positive externalities that result from reducing GHGs such as increased mobility, reduced air and water pollution, economic opportunities, and healthier, more equitable and sustainable communities.

The strategy suggestions listed above, and in more detail in Appendix H are applicable to both MPOs and RTPAs. Links to various planning practice examples are also available in Appendix H.

Planning Practice Examples: Available in Appendix H

6.24 Non-MPO Rural RTPA Addressing GHG Emissions

Rural RTPAs have a unique set of challenges compared to urbanized areas to reduce regional transportation related GHG emissions. Lower land use densities, limited transit options, and higher VMT per household contribute to the challenges to reduce these emissions. More efficient vehicles and low-carbon fuels present the highest payoff for rural counties to reduce transportation related carbon dioxide emissions. Nonetheless rural RTPAs should strive to incorporate strategies to reduce their GHG emissions during their planning process.

RTPAs that are not located within a boundary of an MPO are not subject to the provisions of SB 375, or the resultant requirements to address regional GHG targets in their RTPs. This includes the requirement to prepare a SCS to meet a regional GHG emissions reduction target.

It is suggested that in preparing the environmental document for their RTP, RTPAs ensure that any GHG emissions during either construction or as a result of the project be addressed and mitigated, as appropriate.

The Rural Policy Research Institute prepared a brief paper titled: "Climate Change and Rural Counties in the U.S." dated August 2009. Although the paper does not specifically address transportation issues, it does help set the overall framework of rural GHG issues. The paper is located at the following link:

http://www.rupri.org/Forms/Climate_Change_Brief.pdf

Requirements (Shalls)
State: Public Resources Code, Section 21000, et seq.

6.25 Adaptation of the Regional Transportation System to Climate Change

This section is intended to provide background on climate adaptation for RTPAs to consider in the development of RTPs. First, an overview of climate adaptation is provided for informational purposes. Next, executive orders on climate change are discussed to provide a critical framework for RTPAs. While the executive orders are directed at State agencies, they are provided to inform RTPAs in the development of RTPs. State legislation is also discussed that may provide important context for RTPAs to consider in development of RTPs. Lastly, several resources are provided for RTPAs to consider in adaptation planning.

In 2014, the Intergovernmental Panel on Climate Change concluded that further effects of climate change are inevitable despite planned and implemented mitigation efforts. To help regions prepare for these effects, Caltrans' 2013 report "Addressing Climate Change Adaptation in Regional Transportation Plans: A Guide for California MPOs and RTPAs[1]" and Caltrans Vulnerability Assessments provide methods to incorporate impacts of climate change into future long-range transportation planning and decisions. A number of studies (Risky Business[2], Pacific Institute[3], UC Merced and RAND Corporation[4], American Society of Civil Engineers[5], Next10 and U.C. Berkeley[6]) quantify the high costs associated with climate impacts such as rising sea levels, changing wind and precipitation patterns, increasing temperatures, and wildfire damage resulting from changes in the climate.

Adaptation planning is very important for cities and counties across California. Because of its natural and geographic diversity, California is extremely susceptible to a wide range of climate change effects – many of which we have already begun experiencing. Examples include: rising maximum and minimum temperatures, less snowpack and earlier snowpack melt, drought and other changing precipitation patterns, increased severity of wildfires, sea-level rise, extreme weather events, which will lead to numerous changes and effects on biodiversity and habitats.

Building on decades of successful actions to reduce pollution, increase energy efficiency and mitigate the effects of climate change; California has long been at the forefront of global and national efforts to reduce the threat of a changing climate. The increasing likelihood of severe, pervasive and irreversible impacts are expected to have potentially catastrophic impacts on the transportation system resulting in flooded airports, interstate highways and roads, landslides that disrupt traffic flow and rail lines, heat waves and subsidence causing roadways to buckle; and, increased costs of transportation infrastructure operations and maintenance due to fire damage, erosion and inundation. The degree of risk for the State's transportation infrastructure system is uncertain and since climate impacts are location-specific, it makes sense to address concerns regionally.

The potential for consequences to life, health and safety, the environment, economic well-being, and other values needs to be assessed in terms of probable risks and exposures, the likelihood of an event occurring (probability), and the anticipated damages that would result if it did occur (consequences).

In 2015, the Governor's Executive Order B-30-15 created a roadmap for climate adaptation progress around the foundation of prior state efforts to build climate preparedness and reduce GHG emissions. Public Resources Code 71155 requires that State agencies shall take into account the current and future impacts of climate change when planning, designing, building, operating, maintaining and investing in state infrastructure. The Executive Order provides further context to this statute and directs:

1. All State agencies with jurisdiction over sources of GHG emissions shall implement measures pursuant to statutory authority, to achieve reductions of GHG to meet the 2030 and 2050 GHG emissions reduction targets.
2. The preparation of implementation plans for the actions recommended in California's Adaptation Strategy, the Safeguarding California Plan[7] and sector reports to the *California Natural Resources Agency* describing progress towards implementation.

3. State agencies to employ the following guiding principles in all planning and investment decisions:
   - Prioritize actions that both build climate preparedness and reduce GHG emissions;
   - Where possible, choose flexible and adaptive approaches to prepare for uncertain climate impacts;
   - Protect the state's most vulnerable populations; and,
   - Prioritize natural infrastructure solutions, as defined in Public resources code 71154(c)(3) (e.g., flood plain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planning to reduce high heat days).
4. State agencies shall take climate change into account in their planning and investment decisions, and employ full life-cycle cost accounting on infrastructure projects to evaluate and compare investments and alternatives.
5. All infrastructure projects included in the state's annual Five-Year Infrastructure Plan must take into account the current and future impacts of climate change.
6. The establishment of a Technical Advisory Group through the *Governor's Office of Planning and Research* (OPR) to help State agencies incorporate climate change impacts into planning and investment decisions.

Additionally, three laws were signed in 2015 that are intended to provide important context for State agencies to collaborate with RTPAs, to consider climate impacts as they formulate their RTPs:

- **AB 1482** directs ongoing updates to the Safeguarding California Plan (beginning in 2017) and requires future updates (every three years) to describe the vulnerabilities from climate change in a minimum of nine specific sectors, and the priority actions needed to reduce climate risks in each of those sectors.
- **SB 246** establishes the Integrated Climate Adaptation and Resilience Program at the *Governor's Office of Planning and Research* to coordinate regional and local efforts with the state's climate adaptation strategies; and to establish a climate adaptation clearinghouse that centralizes best scientific evidence, available climate data and information for use in planning and implementing state, regional, and local climate adaptation projects. This bill also directs the *Office of Emergency Services* to update the California Adaptation Planning Guide, within one year of an update to the Safeguarding California Plan, to provide current tools and guidance to regional and local governments and agencies that are adopting and implementing climate adaptation and community resiliency plans and projects.
- **SB 379** requires local hazard mitigation plans to incorporate climate impacts by 2021; through coordination with an update to local jurisdictions' General Plan Safety Element (see OPR's 2016 edition of the General Plan Guidelines[8]).

The state has developed tools and resources to help inform and empower local decision-makers to incorporate climate impacts into their work. Cal-Adapt.org[9] is an online platform created in 2011 by the California Energy Commission to synthesize the best available climate science and generate spatially-explicit visualizations for local policymakers and the general public. Planners can find sophisticated locality-specific projections for many temperature metrics, wind and precipitation patterns, wildfire risk, snowpack and sea-level rise. The Adaptation Planning

Guide[10], released by the Natural Resources Agency in 2012, helps regions and communities prepare for those projected impacts. *The Governor's Office of Planning and Research* has incorporated these resources into the 2016 General Plan Guidelines to create comprehensive planning processes for local governments.

RTPAs should begin to address climate change adaptation in their long-range transportation plans in collaboration with State agencies, as transportation infrastructure projects that do not consider the impacts of climate may not be eligible to receive state funds. The following Caltrans documents and other resources are useful for climate adaptation planning, including "Addressing Climate Change Adaptation in Regional Transportation Plans: A Guide for California MPOs and RTPAs, Cal-Adapt.org, and other state resources (see Climate Adaptation Resources table). Design and planning standards should be re-evaluated to address future conditions. RTPAs should consult Safeguarding California's transportation chapter, the California Coastal Commission Sea Level Rise Policy Guidance, and where possible, local General Plan safety elements and Hazard Mitigation Plan documents, as well as other relevant local, regional, and state plans, resources and documents.

References:

1. http://www.dot.ca.gov/hq/tpp/offices/orip/climate_change/documents/FR3_CA_Climate_Change_Adaptation_Guide_2013-02-26_.pdf#zoom=65
2. http://riskybusiness.org/site/assets/uploads/2015/09/California-Report-WEB-3-30-15.pdf
3. http://www.pacinst.org/reports/sea_level_rise/
4. http://www.energy.ca.gov/2009publications/CEC-500-2009-048/CEC-500-2009-048-D.PDF
5. http://ascelibrary.org/doi/pdfplus/10.1061/9780784479193
6. http://www.energy.ca.gov/2009publications/CEC-500-2009-014/CEC-500-2009-014-D.PDF
7. http://resources.ca.gov/docs/climate/safeguarding/Transportation%20Sector%20Plan.pdf
8. https://www.opr.ca.gov/s_generalplanguidelines.php
9. http://cal-adapt.org/
10. http://resources.ca.gov/climate/safeguarding/adaptation_policy_guide/

Planning Practice Examples: Available in Appendix H

Climate Adaptation Resources for RTPAs and MPOs		
Title of Resource	*Origin and Use*	*Website*
2013 - Addressing Climate Change Adaptation in Regional Transportation Plans*: A Guide for California MPOs and RTPAs*	Caltrans	http://www.dot.ca.gov/hq/tpp/offices/orip/climate_change/documents/FR3_CA_Climate_Change_Adaptation_Guide_2013-02-26_.pdf#zoom=65
Guidance on Incorporating Sea Level Rise: For use in the planning and development of Project Initiation Documents	Caltrans	http://www.dot.ca.gov/hq/tpp/offices/orip/climate_change/documents/guide_incorp_slr.pdf#zoom=65
Cal-Adapt.org	Energy Commission	www.cal-adapt.org
Adaptation Planning Guide	Office of Emergency Services	http://resources.ca.gov/climate/safeguarding/adaptation_policy_guide/
2014 Safeguarding California Plan (California's Adaptation Strategy)	Natural Resources Agency	http://resources.ca.gov/docs/climate/Final_Safeguarding_CA_Plan_July_31_2014.pdf
2016 Safeguarding California: Implementation Action Plans, Transportation Sector	Natural Resources Agency and the State Transportation Agency	http://resources.ca.gov/docs/climate/safeguarding/Transportation%20Sector%20Plan.pdf
State of California Sea-Level Rise Document	Ocean Protection Council	http://www.opc.ca.gov/2013/04/update-to-the-sea-level-rise-guidance-document/
2016 General Plan Guidelines	Governor's Office of Planning and Research	https://www.opr.ca.gov/s_generalplanguidelines.php
California Coastal Commission Sea Level Rise Policy Guidance	California Coastal Commission	http://www.coastal.ca.gov/climate/slrguidance.html

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Chapter 7

Transportation Performance Management

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TRANSPORTATION PERFORMANCE MANAGEMENT

7.0 Introduction

Performance management provides the opportunity to ensure efficient and effective investment of transportation funds by refocusing on established goals, increasing accountability and transparency, and improving project decision-making. This chapter is intended to provide an overview of Federal and State requirements and recommendations for performance management applications in the RTP. MAP-21/FAST Act require States, in collaboration with RTPAs, and MPOs to implement a performance-based approach in the scope of the statewide and nonmetropolitan *and* metropolitan transportation planning process. In addition to federal performance-based planning, the State of California has articulated through statute, regulation, executive order, and legislative intent language, numerous state policies and goals for the transportation system, the environment, the economy, and social equity.

There are different applications of performance management – performance measures, performance targets, and performance monitoring indicators or metrics. Performance measures are used to model travel demand and allow the long-range forecasting of transportation network and system-level performance (e.g. Walk, bike, transit, and carpool mode share, corridor travel times by mode, percentage of population within 0.5 mile of a high frequency transit stop). Performance targets are numeric goals established to enable the quantifiable assessment of performance measures. Performance monitoring indicators or metrics include field data such as vehicle miles traveled, mode share, fatalities/injuries, transit access, change in agricultural land, and CO_2 emissions.

7.1 Federal Performance Goals & Measures

The cornerstone of the federal highway program transformation is the transition to a performance and outcome-based program. MAP-21/FAST Act integrate performance into many federal transportation programs and contains several performance elements. States, in collaboration with RTPAs, and MPOs will invest resources in projects to achieve individual targets that collectively will make progress toward national goals. The national performance goals for the Federal highway programs as established in MAP-21, 23 U.S.C. Section 150(b), are as follows:

- Safety - To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.
- Infrastructure Condition - To maintain the highway infrastructure asset system in a state of good repair
- Congestion Reduction - To achieve a significant reduction in congestion on the National Highway System
- System Reliability - To improve the efficiency of the surface transportation system
- Freight Movement and Economic Vitality - To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.
- Environmental Sustainability - To enhance the performance of the transportation system while protecting and enhancing the natural environment.
- Reduced Project Delivery Delays - To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project

completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices.

The national performance measures will assess the progress toward the national goals listed above. National performance measures [23 U.S.C. Section 150(c) and 49 U.S.C. Section 5326(c) and Section 5329(d)] will address the following issues:

- For the National Highway Performance Program (NHPP):
  - o Pavement conditions on the Interstate system and remainder of the National Highway System,
  - o Bridge conditions on the NHS,
  - o Performance of the Interstate system and remainder of the NHS
- For the Highway Safety Improvement Program (HSIP):
  - o Number and rate per vehicle mile traveled of fatalities
  - o Number and rate per vehicle mile traveled of serious injuries
- For the Congestion Mitigation and Air Quality Improvement Program (CMAQ):
  - o Traffic congestion
  - o On-road mobile source emissions
  - o Freight movement on the Interstate system
- Public transportation:
  - o State of good repair
  - o Safety

The FHWA/FTA have developed final rules to implement the MAP-21/FAST Act Transportation Management Program (TPM), as summarized below. Section 1203 of MAP-21 identifies the national transportation goals and requires the U.S. DOT Secretary to promulgate a rule to establish performance measures in specified Federal-aid highway program areas listed above. The FHWA has issued three separate rules to meet this requirement: (1) Safety Performance Measures; (2) Pavement and Bridge Condition Measures; and, (3) System Performance Measures. These three rules together establish a set of performance measures for Caltrans and MPOs to use as required by MAP-21. FTA is responsible for developing rules related to public transportation and transit asset management. The FHWA and FTA work together on additional rules for: Statewide and Nonmetropolitan Transportation Planning *and* Metropolitan Transportation Planning; Additional Authorities for Planning and Environmental Linkages; and, MPO Coordination & Planning Area Reform. A future update of the RTP Guidelines will capture any “shoulds” or “shalls” resulting from the rulemaking process.

Safety Performance Measures

The MAP-21/FAST Act established Safety Performance Management (PM) as part of the overall Transportation Performance Management (TPM) program, which FHWA defines as a strategic approach that uses system information to make investment and policy decision to achieve national performance goals. The first in a series of three related rules, the Safety PM final rule, was published on March 16, 2016 with an effective date of April 14, 2016. This final rule supports the HSIP, as it establishes safety performance measure requirements for the purpose of carrying out the HSIP and to assess fatalities and serious injuries on all public roads.

The Safety PM establishes five performance measures as the five-year rolling averages for:

1. Number of Fatalities
2. Rate of Fatalities per 100 million Vehicle Miles Traveled (VMT)

3. Number of Serious Injuries
4. Rate of Serious Injuries per 100 million VMT, and
5. Number of Non-motorized Fatalities and Non-motorized Serious Injuries.

The Safety PM regulation also establishes the process for Caltrans, in collaboration with RTPAs, and MPOs to establish and report their safety targets, and the process that FHWA will use to assess whether Caltrans has met or made significant progress toward meeting their safety targets.

The California HSIP is available at:

http://dot.ca.gov/hq/LocalPrograms/hsip.html.

Pavement & Bridge Condition Measures

The second final rule, Pavement & Bridge Condition was published on January 18, 2017 with an effective date of February 17, 2017 and established measures for Caltrans to use to carry out the NHPP and to assess the condition of the following: pavements on the NHS (excluding the Interstate System), bridges on the NHS, and pavements on the Interstate System. The NHPP is a core Federal-aid highway program that provides support for the condition and performance of the NHS and the construction of new facilities on the NHS, and ensures that investments of Federal-aid funds in highway construction are directed to support progress toward the achievement of performance targets established in a State's asset management plan for the NHS. This rule provides regulations for the new performance aspects of the NHPP, which address: measures, targets, and reporting. Caltrans shall coordinate with relevant MPOs/RTPAs on the selection of targets in accordance with 23 U.S.C. 135(d)(2)(B)(i)(II) to ensure consistency to maximum extent practicable.

The Pavement & Bridge Condition final rule establishes six performance measures:

Four Measures of Pavement Condition:

Two Measures for Interstate System Pavement Condition:

1. Percentage of Pavements on the Interstate System in Good Condition;
2. Percentage of Pavements on the Interstate System in Poor Condition;

Two Measures for NHS Pavement Condition:

3. Percentage of Pavements on the NHS (excluding the Interstate System) in Good Condition;
4. Percentage of Pavements on the NHS (excluding the Interstate System) in Poor Condition;

Two Measures of Bridge Condition:

5. Percentage of NHS Bridges in Good Condition; and,
6. Percentage of NHS Bridges in Poor Condition.

System Performance Measures

The third in a series of three related rules, System Performance Measures, was published on January 18, 2017 with an effective date of February 17, 2017. Caltrans, in collaboration with RTPAs, and MPOs will implement the regulation to assess the performance of the Interstate and non-Interstate NHS for the purpose of carrying out the NHPP; to assess freight movement on the Interstate System; and to assess traffic congestion and on-road mobile source emissions for the purpose of carrying out the CMAQ Program. This third proposed performance measure rule also includes a discussion that summarizes all three of the national performance management measures final rules and the comprehensive regulatory impact analysis to include all three final rules.

Caltrans will be expected to use the information and data generated as a result of the new regulations to make better informed transportation planning and programming decisions. The new performance aspects of the Federal-aid program will allow FHWA/FTA to better communicate a national performance story and more reliably assess the impacts of Federal funding investments. Caltrans shall coordinate with relevant MPOs on the selection of targets in accordance with 23 U.S.C. 135(d)(2)(B)(i)(II) to ensure consistency to maximum extent practicable.

The System Performance Measures final rule establishes seven performance measures:

Three Measures of System Performance:

1. Percentage of Reliable Person-Miles Traveled on the Interstate;
2. Percentage of Reliable Person-Miles Traveled on the non-Interstate NHS;
3. Percent Change in CO_2 emissions from 2017, generated by on-road mobile sources on the NHS;

4. A measure that will evaluate truck travel time reliability on the Interstate system (average truck reliability index);

Three measures that will assess the CMAQ Program:

5. Total emissions reductions for applicable criteria pollutants, for non-attainment and maintenance areas;

Two measures to assess traffic congestion:

6. Annual Hours of Peak Hour Excessive Delay Per Capita; and,
7. Modal Share; Specifically, the percent of non-single occupancy vehicle travel, including travel avoided by telecommuting.

Transit Asset Management

The Transit Asset Management final rule was published on July 26, 2016 with an effective date of October 1, 2016. This final rule establishes state good repair standards and four state of good repair performance measures:

- Equipment: (non-revenue) service vehicles;
- Rolling stock;
- Infrastructure: rail fixed-guideway, track, signals, and systems; and,
- Facilities.

As similarly required in the Safety PM for the target setting process, to the extent practicable, transit providers must coordinate with Caltrans, in collaboration with RTPAs, and MPOs in the selection of State and MPO performance targets.

7.2 Federal Performance-Based Approach & RTP Recommendations

The Statewide and Nonmetropolitan Transportation Planning *and* Metropolitan Transportation Planning Final Rule was published May 27, 2016 with an effective date of June 27, 2016. This final rule requires States, in consultation with RTPAs, to implement the performance-based approach in the scope of the statewide and nonmetropolitan transportation planning process. First, Caltrans, in coordination with MPOs/RTPAs and public transportation providers, will establish, to the maximum extent practicable, an appropriate target setting framework. RTPAs are encouraged to participate in the State's target-setting process. RTPAs are also encouraged to align their performance monitoring indicators with the State's targets. Federal regulations define the implementation timeline for satisfying the new requirements for States as two years from the effective date of each rule establishing performance measures under 23 U.S.C. 150(c), 49 U.S.C. 5326, and 49 U.S.C. 5329 FHWA/FTA.

This section is intended to provide a summary of the additional requirements specific to MPO RTP development. RTPAs are encouraged to add these components to their RTPs, as appropriate. The federally required performance-based approach specifically added two components to the RTP:

1. A description of the performance measures and performance targets used in assessing the performance of the transportation system in accordance with 23 CFR 450.306(d); and,
2. A system performance report and subsequent updates evaluating the condition and performance of the transportation system with respect to the performance targets described in 23 CFR 450.306(d), including –
    a. Progress achieved by the RTPA in meeting the performance targets in comparison with system performance recorded in previous reports, including baseline data; and,
    b. For RTPAs that voluntarily elect to develop multiple scenarios, an analysis of how the preferred scenario has improved the conditions and performance of the transportation system and how changes in local policies an investments have impacted the costs necessary to achieve the identified performance targets.

It is important to note that failure to consider any factor specified in the Performance-Based Approach, 23 CFR 450.206(d), shall not be reviewable by any court under Title 23 U.S.C., 49 U.S.C. Chapter 53, Subchapter II of Title 5 U.S.C. Chapter 5, or Title 5 U.S.C. Chapter 7 in any matter affecting an RTP, TIP, a project or strategy, or the certification of a metropolitan transportation planning process.

The FHWA maintains a Performance Based Planning and Programming Guidebook to help identify potential packages of strategies to achieve performance-based objectives, as well as the data and tools used to determine which strategies may be most effective, available at:

http://www.fhwa.dot.gov/planning/performance_based_planning/pbpp_guidebook/page06.cfm

Requirements (Should)
Federal: 23 CFR 450.306; 23 CFR 450.324(f)(3) & (4); 23 CFR 450.340(e) & (f)

7.3 State Goals & RTPs

Regional Transportation Plans are developed to reflect regional and local priorities and goals and they are also instruments that can be used by federal and state agencies to demonstrate how regional agency efforts contribute to those federal and state agencies meeting their own transportation system goals. A clear articulation of regional goals helps regions select projects in furtherance of their own goals, but also helps the federal and state government understand how the regional plans will contribute to statewide or nationwide goals. The RTP vision and goals are developed through a bottom-up process that involves input from stakeholders in the region, including the RTPA member jurisdictions and the public. The RTP, including goals, are formally adopted at the discretion of the RTPA governing board. The following are state policies and goals that RTPAs are encouraged to use in the development of their RTP goals. This is not an exclusive list, and RTPAs may establish additional RTP goals appropriate to the region.

- Preserve transportation infrastructure
- Improve mobility and accessibility
- Reduce GHG and improve air quality
- Improve public health, e.g., increase physical activity
- Conserve land and natural resources
- Encourage sustainable land use patterns
- Increase supply of affordable housing
- Improve jobs and housing balance
- Improve mobility and accessibility for low-income and disadvantaged communities
- Support economic development
- Increase safety and security of the transportation system for motorized and non-motorized users

If existing modeling and data are a limitation for some RTPAs, qualitative goals may be used instead of quantitative measures. The Policy element of the RTP would include the goals and objectives, and the Action element is what would provide the result/s. For example, the Action element would provide a comparison of what is being monitored, how it is monitored and the results and analysis of the eventual outcomes. In small urban areas, to support performance-based planning consistent with federal law, developing partnerships with neighboring jurisdictions, and collecting data and information is recommended.

The goals and objectives in the RTIP and ITIP should be linked and consistent with the goals and objectives of the RTP. RTP goals set the context for judging the effectiveness of the RTP project lists as a program, by furthering the RTP goals and objectives, whereas, the STIP Guidelines address performance measures of specific projects. Government Code Section 14530.1 (b)(5) requires more detailed project specific "objective criteria for meeting system performance and cost effectiveness of candidate projects" in the STIP Guidelines (Section 19). For additional information on the STIP and the Fund Estimate (FE), please refer to Caltrans Division of Transportation Programming website at:

http://www.dot.ca.gov/hq/transprog/ctcliaison.htm.

On highway projects, Caltrans considers system condition and performance measurements for interregional planning and the setting of State planning and programming activities. The State performance measures will focus on interregional trips between, into and through the regions. Caltrans coordinates its performance measure activity with RTPAs.

Planning Practice Examples: Available in Appendix H

7.4 Performance Monitoring

Regions should also consider using performance monitoring indicators to measure plan performance. The following table provides a summary of potential performance metrics for rural county RTPAs as outlined in the report, ***Transportation Performance Measures for Rural Counties in California*** (Rural Counties Task Force, 2015), at:

http://www.ruralcountiestaskforce.org/Assets/Resources/PerformanceMeasures/Final_Report-PerfMonIndicators_StudySept2015.pdf

These metrics were developed according to the following criteria:

- Measurement-based rather than model-based;
- Alignment with California state transportation goals and objectives;
- Capability of informing current goals and objectives of each rural and small-urban RTPA;
- Applicability across all rural and small-urban regions;
- Capability of being linked to specific decisions on transportation investments; and
- Normalized for population to provide equitable comparisons to urban regions.

Metric	Source	Website
Vehicle Miles Traveled (VMT) Per Capita By Locality By Facility Ownership Local vs. Tourist	Mobility Reporting	http://www.dot.ca.gov/hq/traffops/sysmgtpl/MPR/index.htm
	California DOF	http://www.dof.ca.gov/research/demographic/reports/estimates/e-2/view.php
	HPMS	http://www.dot.ca.gov/hq/tsip/hpms/hpmslibrary/prd/2013prd/2013PRD-revised.pdf
Peak V/C Ratio or Thresholds	Traffic Counts: K and D Factors	http://traffic-counts.dot.ca.gov/
Journey to Work Mode Share	American Community Survey	http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml
Total Accident Cost Per VMT Per Capita	Transportation Injury Mapping System	http://tims.berkeley.edu/login.php?next=/tools/bc/main1.php#
	SWITRS TASAS	http://iswitrs.chp.ca.gov/Reports/jsp/userLogin.jsp Caltrans Public Information Request Form
Transit Operating Cost per Revenue Mile	Local Transit Providers	
Distressed Lane Miles Total and % Total By Jurisdiction By Facility Type	Federal Highway Administration	http://www.fhwa.dot.gov/tpm/rule/pmfactsheet.pdf
	Regional or local pavement management system	https://www.federalregister.gov/articles/2015/01/05/2014-30085/national-performance-management-measures-assessing-pavement-condition-for-the-national-highway
Pavement Condition Index (PCI) for Local Roads	Regional or local pavement management system	
Land Use Efficiency	Farmland Mapping and Monitoring Program (FMMP) DOF Annual population estimates	http://www.conservation.ca.gov/dlrp/fmmp

Planning Practice Examples: Available in Appendix H

APPENDICES

A. Federal and State Transportation Planning Flowchart

B. State and Federal Programming Process Flowchart

C. Regional Transportation Plan Checklist (to be completed by RTPA prior to submitting the draft and final RTP to Caltrans and CTC)

D. Title 23 CFR Part 450 Appendix A – Linking Transportation Planning and NEPA Processes

E. Integration of the Planning and NEPA Processes

F. Air Quality Conformity Checklist for Isolated Rural Non-Attainment/Maintenance Areas

G. Glossary of Transportation Terms

H. Planning Practice Examples

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Appendix A

Federal and State Transportation Planning Process Flowchart

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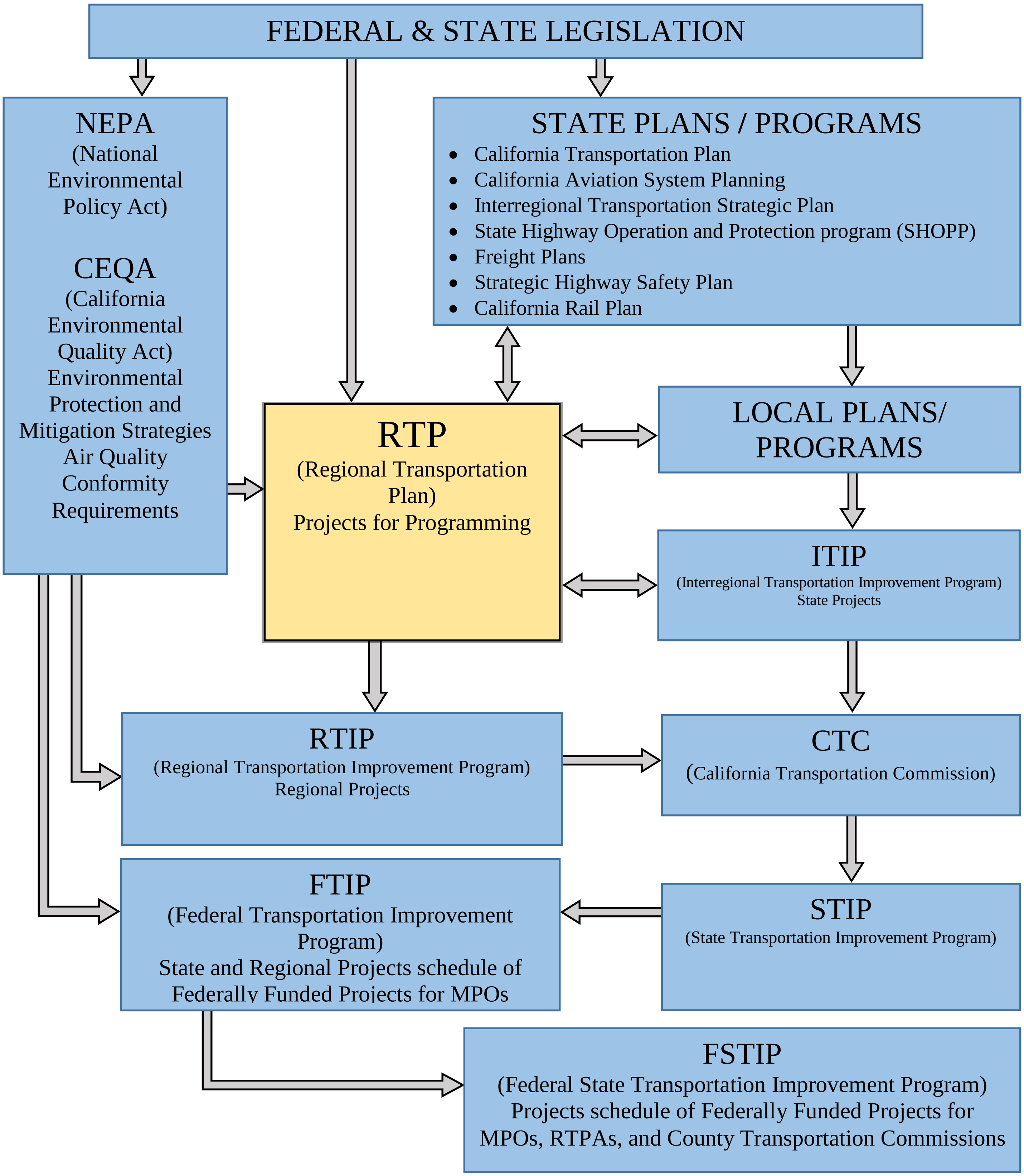
Regional Transportation Planning and Programming Process



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Appendix B

State and Federal Programming Process Flowchart

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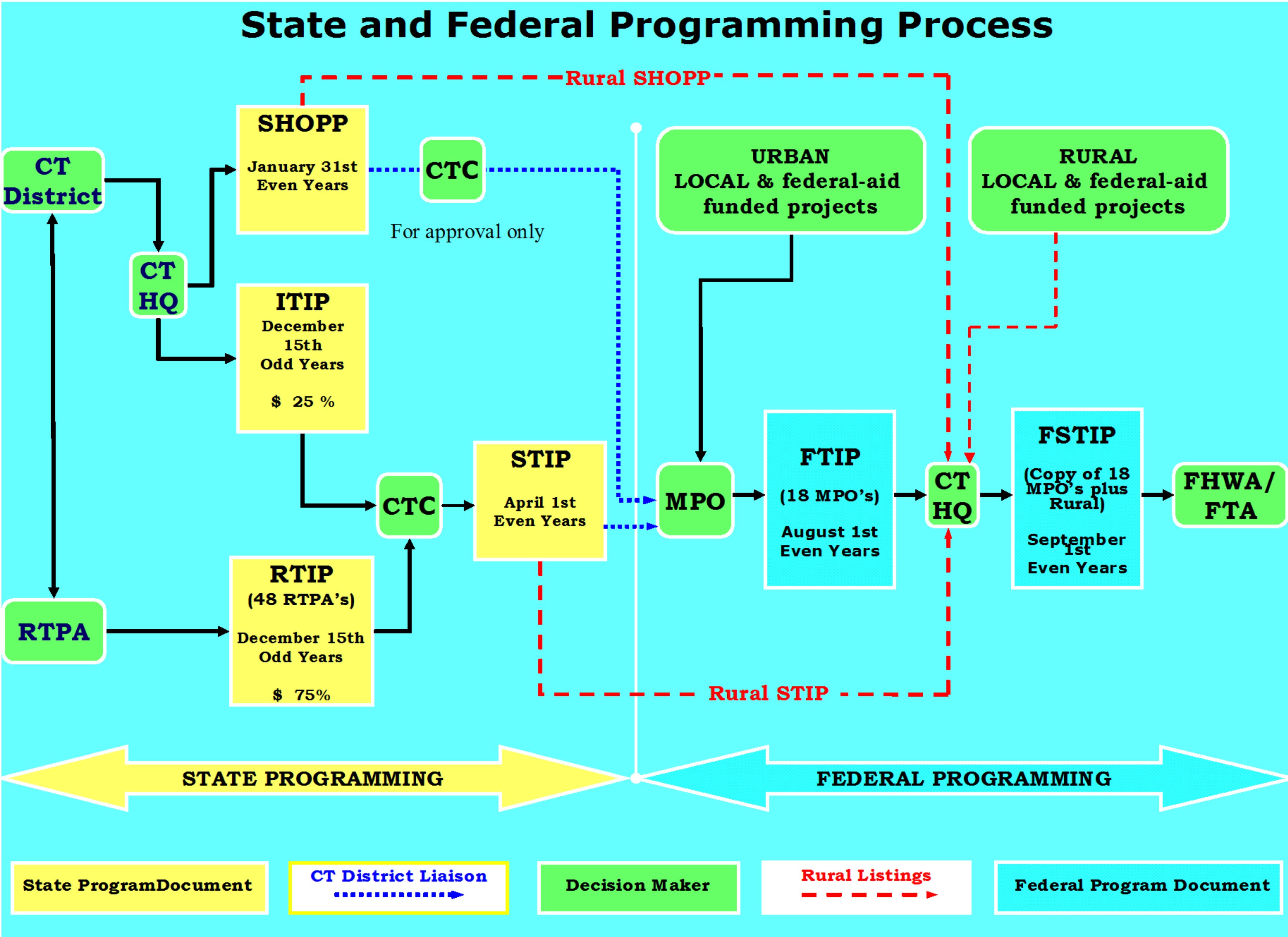
State and Federal Programming Process
Rural SHOPP
CT District
CT HQ
SHOPP
January 31st
Even Years
CTC
For approval only
ITIP
December 15th
Odd Years
$ 25 %
URBAN LOCAL & federal-aid funded projects
RURAL LOCAL & federal-aid funded projects
CTC
STIP
April 1st
Even Years
MPO
FTIP
(18 MPO's)
August 1st
Even Years
CT HQ
FSTIP
(Copy of 18 MPO's plus Rural)
September 1st
Even Years
FHWA/ FTA
RTPA
RTIP
(48 RTPA's)
December 15th
Odd Years
$ 75%
Rural STIP
STATE PROGRAMMING
FEDERAL PROGRAMMING
State ProgramDocument
CT District Liaison
Decision Maker
Rural Listings
Federal Program Document

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Appendix C

Regional Transportation Plan Checklist

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Regional Transportation Plan Checklist

(Revised December 2016)

(To be completed electronically in Microsoft Word format by the RTPA and submitted along with the draft and final RTP to Caltrans)

Name of RTPA: ______________________________

Date Draft RTP Completed: ______________________________

RTP Adoption Date: ______________________________

What is the Certification Date of the Environmental Document (ED)? ______________________________

Is the ED located in the RTP or is it a separate document? ______________________________

By completing this checklist, the RTPA verifies the RTP addresses all of the following required information within the RTP.

Regional Transportation Plan Contents

General

		Yes/No	Page #
1.	Does the RTP address no less than a 20-year planning horizon? (23 CFR 450.216(a))		
2.	Does the RTP include both long-range and short-range strategies/actions? (23 CFR 450.324(b) "Should" for RTPAs)		
3.	Does the RTP address issues specified in the policy, action and financial elements identified in California Government Code Section 65080?		
4.	Does the RTP include Project Intent i.e. Plan Level Purpose and Need Statements?		

Consultation/Cooperation

1.	Does the RTP contain a documented public involvement process that meets the requirements of Title 23, CFR part 450.210(a)?		
2	Does the documented public involvement process describe how the RTPA will seek out and consider the needs of those traditionally underserved by the existing transportation system, such as low-income and minority households, who may face challenges accessing employment and other services? (23 CFR 450.210(a)(1)(viii))		

	Question	Yes/No	Page #
3.	Was a periodic review conducted of the effectiveness of the procedures and strategies contained in the participation plan to ensure a full and open participation process? (23 CFR part 450.210(a)(1)(ix))		
4.	Did the RTPA consult with the appropriate State and local representatives including representatives from environmental and economic communities; airport; transit; freight during the preparation of the RTP? (23 CFR 450.316(b) "Should" for RTPAs)		
5.	Did the RTPA who has federal lands within its jurisdictional boundary involve the federal land management agencies during the preparation of the RTP? (23 CFR 450.216(j))		
6.	Where does the RTP specify that the appropriate State and local agencies responsible for land use, natural resources, environmental protection, conservation and historic preservation consulted? (23 CFR part 450.216(j))		
7.	Did the RTP include a comparison with the California State Wildlife Action Plan and (if available) inventories of natural and historic resources? (23 CFR part 450.216(j))		
8.	Did the RTPA who has a federally recognized Native American Tribal Government(s) and/or historical and sacred sites or subsistence resources of these Tribal Governments within its jurisdictional boundary address tribal concerns in the RTP and develop the RTP in consultation with the Tribal Government(s)? (23 CFR part 450.216(i))		
9.	Does the RTP address how the public and various specified groups were given a reasonable opportunity to comment on the plan using the public involvement process developed under 23 CFR part 450.210(a)? (23 CFR 450.210(a)(1)(iii))		
10.	Does the RTP contain a discussion describing the private sector involvement efforts that were used during the development of the plan? (23 CFR part 450.210(a))		
11.	Is the RTP coordinated and consistent with the Public Transit-Human Services Transportation Plan? (23 CFR part 450.208(h))		
12.	Were the draft and adopted RTP posted on the Internet? (23 CFR part 450.216(o))		
13.	If the RTPA made the election allowed by Government Code 65080(b)(2)(M) to change the RTP update schedule (from 5 to 4 years) and change the local government Housing Element update schedule (from 5 to 8 years), was the RTP adopted on the estimated date required to be provided in writing to State Department of Housing and Community Development pursuant to Government Code 65588(e)(5) to align the Regional Housing Need Allocation planning period established from the estimated RTP adoption date with the local government Housing Element planning period established from the actual RTP adoption date?		

Modal Discussion

	Question	Yes/No	Page #
1.	Does the RTP discuss intermodal and connectivity issues?		
2.	Does the RTP include a discussion of highways?		
3.	Does the RTP include a discussion of mass transportation?		
4.	Does the RTP include a discussion of the regional airport system?		
5.	Does the RTP include a discussion of regional pedestrian needs?		
6.	Does the RTP include a discussion of regional bicycle needs?		
7.	Does the RTP address the California Coastal Trail? (Government Code 65080.1) **(For RTPAs located along the coast only)**		
8.	Does the RTP include a discussion of rail transportation?		
9.	Does the RTP include a discussion of maritime transportation (if appropriate)?		
10.	Does the RTP include a discussion of goods movement?		

Programming/Operations

1.	Is the RTP consistent (to the maximum extent practicable) with the development of the regional ITS architecture? (23 CFR 450.208(g))		
2.	Does the RTP identify the objective criteria used for measuring the performance of the transportation system?		
3.	Does the RTP contain a list of un-constrained projects?		

Financial

1.	Does the RTP include a financial plan that meets the requirements identified in 23 CFR part 450.322(f)(10) ("Should" for RTPAs)?		
2.	Does the RTP contain a consistency statement between the first 4 years of the fund estimate and the 4-year STIP fund estimate? (Government Code 65080(b)(4)(A))		
3.	Do the projected revenues in the RTP reflect Fiscal Constraint? (Government Code 65080(b)(4)(A))		
4.	Does the RTP contain a list of financially constrained projects? Any regionally significant projects should be identified. (Government Code 65080(4)(A))		

		Yes/No	Page #
5.	Do the cost estimates for implementing the projects identified in the RTP reflect “year of expenditure dollars” to reflect inflation rates? (23 CFR part 450.324(f)(11)(iv)) (“Should” for RTPAs)		
6.	After 12/11/07, Does the RTP contain estimates of costs and revenue sources that are reasonably expected to be available to operate and maintain the freeways, highway and transit within the region? (65080(b)(4)(A) (23 CFR 450.324(f)(11)(i))		
7.	Does the RTP contain a statement regarding consistency between the projects in the RTP and the ITIP? (2016 STIP Guidelines Section 33)		
8.	Does the RTP contain a statement regarding consistency between the projects in the RTP and the RTIP? (2016 STIP Guidelines Section 19)		

Environmental

1.	Did the RTPA prepare an EIR or a program EIR for the RTP in accordance with CEQA guidelines?		
2.	Does the RTP contain a list of projects specifically identified as TCMs, if applicable?		
3.	Does the RTP specify mitigation activities? (23 CFR part 450.216(k))		
4.	Where does the EIR address mitigation activities?		
5.	Did the RTPA prepare a Negative Declaration or a Mitigated Negative Declaration for the RTP in accordance with CEQA guidelines?		
6.	Does the RTP specify the TCMs to be implemented in the region? **(federal nonattainment and maintenance areas only)**		

I have reviewed the above information and certify that it is correct and complete.

____
(Must be signed by RTPA Executive Director or designated representative)

____
Date

____
Print Name

____
Title

Appendix D

Title 23 CFR Part 450 Appendix A – Linking Transportation Planning and NEPA Processes

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Appendix A to Title 23 CFR Part 450--Linking the Transportation Planning and NEPA Processes

Background and Overview

This Appendix provides additional information to explain the linkage between the transportation planning and project development/National Environmental Policy Act (NEPA) processes. It is intended to be non-binding and should not be construed as a rule of general applicability.

For 40 years, the Congress has directed that Federally funded highway and transit projects must flow from metropolitan and Statewide transportation planning processes (pursuant to 23 U.S.C. 134-135 and 49 U.S.C. 5303-5306). Over the years, the Congress has refined and strengthened the transportation planning process as the foundation for project decisions, emphasizing public involvement, consideration of environmental and other factors, and a Federal role that oversees the transportation planning process but does not second-guess the content of transportation plans and programs.

Despite this statutory emphasis on transportation planning, the environmental analyses produced to meet the requirements of the NEPA of 1969 (42 U.S.C. 4231 et seq.) have often been conducted de novo, disconnected from the analyses used to develop long-range transportation plans, Statewide and metropolitan Transportation Improvement Programs (STIPs/TIPs), or planning-level corridor/subarea/feasibility studies. When the NEPA and transportation planning processes are not well coordinated, the NEPA process may lead to the development of information that is more appropriately developed in the planning process, resulting in duplication of work and delays in transportation improvements.

The purpose of this Appendix is to change this culture, by supporting congressional intent that Statewide and metropolitan transportation planning should be the foundation for highway and transit project decisions. This Appendix was crafted to recognize that transportation planning processes vary across the country. This document provides details on how information, analysis, and products from transportation planning can be incorporated into and relied upon in NEPA documents under existing laws, regardless of when the Notice of Intent has been published. This Appendix presents environmental review as a continuum of sequential study, refinement, and expansion performed in transportation planning and during project development/NEPA, with information developed and conclusions drawn in early stages utilized in subsequent (and more detailed) review stages.

The information below is intended for use by State departments of transportation (State DOTs), metropolitan planning organizations (MPOs), and public transportation operators to clarify the circumstances under which transportation planning level choices and analyses can be adopted or incorporated into the process required by NEPA. Additionally, the FHWA and the FTA will work with Federal environmental, regulatory, and resource agencies to incorporate the principles of this Appendix in their day-to-day NEPA policies and procedures related to their involvement in highway and transit projects.

This Appendix does not extend NEPA requirements to transportation plans and programs. The Transportation Efficiency Act for the 21st Century (TEA-21) and the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) specifically exempted transportation plans and programs from NEPA review. Therefore, initiating the NEPA process as part of, or concurrently with, a transportation planning study does not subject transportation plans and programs to NEPA.

Implementation of this Appendix by States, MPOs, and public transportation operators is voluntary. The degree to which studies, analyses, or conclusions from the transportation planning process can be incorporated into the project development/NEPA processes will depend upon how well they meet certain standards established by NEPA regulations and guidance. While some transportation planning processes already meet these standards, others will need some modification.

The remainder of this Appendix document utilizes a ``Question and Answer'' format, organized into three primary categories (``Procedural Issues,'' ``Substantive Issues,'' and ``Administrative Issues'').

I. Procedural Issues:

1. In what format should the transportation planning information be included?

To be included in the NEPA process, work from the transportation planning process must be documented in a form that can be appended to the NEPA document or incorporated by reference. Documents may be incorporated by reference if they are readily available so as to not impede agency or public review of the action. Any document incorporated by reference must be ``reasonably available for inspection by potentially interested persons within the time allowed for comment.'' Incorporated materials must be cited in the NEPA document and their contents briefly described, so that the reader understands why the document is cited and knows where to look for further information. To the extent possible, the documentation should be in a form such as official actions by the MPO, State DOT, or public transportation operator and/or correspondence within and among the organizations involved in the transportation planning process.

2. What is a reasonable level of detail for a planning product that is intended to be used in a NEPA document? How does this level of detail compare to what is considered a full NEPA analysis?

For purposes of transportation planning alone, a planning-level analysis does not need to rise to the level of detail required in the NEPA process. Rather, it needs to be accurate and up-to-date, and should adequately support recommended improvements in the Statewide or metropolitan long-range transportation plan.

The SAFETEA-LU requires transportation planning processes to focus on setting a context and following acceptable procedures. For example, the SAFETEA-LU requires a ``discussion of the types of potential environmental mitigation activities'' and potential areas for their implementation, rather than details on specific strategies. The SAFETEA-LU also emphasizes consultation with Federal, State, and Tribal land management, wildlife, and regulatory agencies.

However, the Environmental Assessment (EA) or Environmental Impact Statement (EIS) ultimately will be judged by the standards applicable under the NEPA regulations and guidance from the Council on Environmental Quality (CEQ). To the extent the information incorporated from the transportation planning process, standing alone, does not contain all of the information or analysis required by NEPA, then it will need to be supplemented by other information contained in the EIS or EA that would, in conjunction with the information from the plan, collectively meet the requirements of NEPA. The intent is not to require NEPA studies in the transportation planning process. As an option, the NEPA analyses prepared for project development can be integrated with transportation planning studies (see the response to Question 9 for additional information).

3. What type and extent of involvement from Federal, Tribal, State, and local environmental, regulatory, and resource agencies is needed in the transportation planning process in order for planning-level decisions to be more readily accepted in the NEPA process?

Sections 3005, 3006, and 6001 of the SAFETEA-LU established formal consultation requirements for MPOs and State DOTs to employ with environmental, regulatory, and resource agencies in the development of long-range transportation plans. For example, metropolitan transportation plans now ``shall include a discussion of the types of potential environmental mitigation activities and potential areas to carry out these activities, including activities that may have the greatest potential to restore and maintain the environmental functions affected by the [transportation] plan,'' and that these planning-level discussions ``shall be developed in consultation with Federal, State, and Tribal land management, wildlife, and regulatory agencies.'' In addition, MPOs ``shall consult, as appropriate, with State and local agencies responsible for land use management, natural resources, environmental protection, conservation, and historic preservation concerning the development of a long-range transportation plan,'' and that this consultation ``shall involve, as appropriate, comparison of transportation plans with State conservation plans or maps, if available, or comparison of transportation plans to inventories of natural or historic resources, if available.'' Similar SAFETEA-LU language addresses the development of the long-range Statewide transportation plan, with the addition of Tribal conservation plans or maps to this planning-level ``comparison.''

In addition, section 6002 of the SAFETEA-LU established several mechanisms for increased efficiency in environmental reviews for project decision-making. For example, the term ``lead agency'' collectively means the U. S. Department of Transportation and a State or local governmental entity serving as a joint lead agency for the NEPA process. In addition, the lead agency is responsible for inviting and designating ``participating agencies'' (i.e., other Federal or non-Federal agencies that may have an interest in the proposed project). Any Federal agency that is invited by the lead agency to participate in the environmental review process for a project shall be designated as a participating agency by the lead
agency unless the invited agency informs the lead agency, in writing, by the deadline specified in the invitation that the invited agency:

(a) Has no jurisdiction or authority with respect to the project; (b) has no expertise or information relevant to the project; and (c) does not intend to submit comments on the project.

Past successful examples of using transportation planning products in NEPA analysis are based on early and continuous involvement of environmental, regulatory, and resource agencies. Without this early coordination, environmental, regulatory, and resource agencies are more likely to expect decisions made or analyses conducted in the transportation planning process to be revisited during the NEPA process. Early participation in transportation planning provides environmental, regulatory, and resource agencies better insight into the needs and objectives of the locality. Additionally, early participation provides an important opportunity for environmental, regulatory, and resource agency concerns to be identified and addressed early in the process, such as those related to permit applications. Moreover, Federal, Tribal, State, and local environmental, regulatory, and resource agencies are able to share data on particular resources, which can play a critical role in determining the feasibility of a transportation solution with respect to environmental impacts. The use of other agency planning outputs can result in a transportation project that could support multiple goals (transportation, environmental, and community). Further, planning decisions by these other agencies may have impacts on long-range transportation plans and/or the STIP/TIP, thereby providing important input to the transportation planning process and advancing integrated decision-making.

4. What is the procedure for using decisions or analyses from the transportation planning process?

The lead agencies jointly decide, and must agree, on what processes and consultation techniques are used to determine the transportation planning products that will be incorporated into the NEPA process. At a minimum, a robust scoping/early coordination process (which explains to Federal and State environmental, regulatory, and resource agencies and the public the information and/or analyses utilized to develop the planning products, how the purpose and need was developed and refined, and how the design concept and scope were determined) should play a critical role in leading to informed decisions by the lead agencies on the suitability of the transportation planning information, analyses, documents, and decisions for use in the NEPA process. As part of a rigorous scoping/early coordination process, the FHWA and the FTA should ensure that the transportation planning results are appropriately documented, shared, and used.

5. To what extent can the FHWA/FTA provide up-front assurance that decisions and additional investments made in the transportation planning process will allow planning-level decisions and analyses to be used in the NEPA process?

There are no guarantees. However, the potential is greatly improved for transportation planning processes that address the ``3-C'' planning principles (comprehensive, cooperative, and continuous); incorporate the intent of NEPA through the consideration of natural, physical, and social effects; involve environmental, regulatory, and resource agencies; thoroughly document the transportation planning process information, analysis, and decision; and vet the planning results through the applicable public involvement processes.

6. What considerations will the FHWA/FTA take into account in their review of transportation planning products for acceptance in project development/NEPA?

The FHWA and the FTA will give deference to decisions resulting from the transportation planning process if the FHWA and FTA determine that the planning process is consistent with the ``3-C'' planning principles and when the planning study process, alternatives considered, and resulting decisions have a rational basis that is thoroughly documented and vetted through the applicable public involvement processes. Moreover, any applicable program-specific requirements (e.g., those of the Congestion Mitigation and Air Quality Improvement Program or the FTA's Capital Investment Grant program) also must be met.

The NEPA requires that the FHWA and the FTA be able to stand behind the overall soundness and credibility of analyses conducted and decisions made during the transportation planning process if they are incorporated into a NEPA document. For example, if systems-level or other broad objectives or choices from the transportation plan are incorporated into the purpose and need Statement for a NEPA document, the FHWA and the FTA should not revisit whether these are the best objectives or choices among other options. Rather, the FHWA and the FTA review would include making sure that objectives or choices derived from the transportation plan were: Based on transportation planning factors established by Federal law; reflect a credible and articulated planning rationale; founded on reliable data; and developed through transportation planning processes meeting FHWA and FTA statutory and regulatory requirements. In addition, the basis for the goals and choices must be documented and included in the NEPA document. The FHWA/FTA reviewers do not need to review whether assumptions or analytical methods used in the studies are the best available, but, instead, need to assure that such assumptions or analytical methods are reasonable, scientifically acceptable, and consistent with goals, objectives, and policies set forth in long-range transportation plans. This review would include determining whether: (a) Assumptions have a rational basis and are up-to-date and (b) data, analytical methods, and modeling techniques are reliable, defensible, reasonably current, and meet data quality requirements.

II. Substantive Issues

General Issues To Be Considered:

7. What should be considered in order to rely upon transportation planning studies in NEPA?

The following questions should be answered prior to accepting studies conducted during the transportation planning process for use in NEPA. While not a ``checklist,'' these questions are intended to guide the practitioner's analysis of the planning products:

a. How much time has passed since the planning studies and corresponding decisions were made?

b. Were the future year policy assumptions used in the transportation planning process related to land use, economic development, transportation costs, and network expansion consistent with those to be used in the NEPA process?

c. Is the information still relevant/valid?

d. What changes have occurred in the area since the study was completed?

e. Is the information in a format that can be appended to an environmental document or reformatted to do so?

f. Are the analyses in a planning-level report or document based on data, analytical methods, and modeling techniques that are reliable, defensible, and consistent with those used in other regional transportation studies and project development activities?

g. Were the FHWA and FTA, other agencies, and the public involved in the relevant planning analysis and the corresponding planning decisions?

h. Were the planning products available to other agencies and the public during NEPA scoping?

i. During NEPA scoping, was a clear connection between the decisions made in planning and those to be made during the project development stage explained to the public and others? What was the response?

j. Are natural resource and land use plans being informed by transportation planning products, and vice versa?

Purpose and Need:

8. How can transportation planning be used to shape a project's purpose and need in the NEPA process?

A sound transportation planning process is the primary source of the project purpose and need. Through transportation planning, State and local governments, with involvement of stakeholders and the public, establish a vision for the region's future transportation system, define transportation goals and objectives for realizing that vision, decide which needs to address, and determine the timeframe for addressing these issues. The transportation planning process also provides a potential forum to define a project's purpose and need by framing the scope of the problem to be addressed by a proposed project. This scope may be further refined during the transportation planning process as more information about the transportation need is collected and consultation with the public and other stakeholders clarifies other issues and goals for the region.

23 U.S.C. 139(f), as amended by the SAFETEA-LU Section 6002, provides additional focus regarding the definition of the purpose and need and objectives. For example, the lead agency, as early as practicable during the environmental review process, shall provide an opportunity for involvement by participating agencies and the public in defining the purpose and need for a project. The Statement of purpose and need shall include a clear Statement of the objectives that the proposed action is intended to achieve, which may include: (a) Achieving a transportation objective identified in an applicable Statewide or metropolitan transportation plan; (b) supporting land use, economic development, or growth objectives established in applicable Federal, State, local, or Tribal plans; and (c) serving national defense, national security, or other national objectives, as established in Federal laws, plans, or policies.

The transportation planning process can be utilized to develop the purpose and need in the following ways:

(a) Goals and objectives from the transportation planning process may be part of the project's purpose and need Statement;

(b) A general travel corridor or general mode or modes (e.g., highway, transit, or a highway/transit combination) resulting from planning analyses may be part of the project's purpose and need Statement;

(c) If the financial plan for a metropolitan transportation plan indicates that funding for a specific project will require special funding sources (e.g., tolls or public-private financing), such information may be included in the purpose and need Statement; or

(d) The results of analyses from management systems (e.g., congestion, pavement, bridge, and/or safety) may shape the purpose and need Statement.

The use of these planning-level goals and choices must be appropriately explained during NEPA scoping and in the NEPA document. Consistent with NEPA, the purpose and need Statement should be a Statement of a transportation problem, not a specific solution. However, the purpose and need Statement should be specific enough to generate alternatives that may potentially yield real solutions to the problem at-hand. A purpose and need Statement that yields only one alternative may indicate a purpose and need that is too narrowly defined.

Short of a fully integrated transportation decision-making process, many State DOTs develop information for their purpose and need Statements when implementing interagency NEPA/Section 404 process merger agreements. These agreements may need to be expanded to include commitments to share and utilize transportation planning products when developing a project's purpose and need.

9. Under what conditions can the NEPA process be initiated in conjunction with transportation planning studies?

The NEPA process may be initiated in conjunction with transportation planning studies in a number of ways. A common method is the ``tiered EIS,'' in which the first-tier EIS evaluates general travel corridors, modes, and/or packages of projects at a planning level of detail, leading to the refinement of purpose and need and, ideally, selection of the design concept and scope for a project or series of projects. Subsequently, second-tier NEPA review(s) of the resulting projects would be performed in the usual way. The first-tier EIS uses the NEPA process as a tool to involve environmental, regulatory, and resource agencies and the public in the planning decisions, as well as to ensure the appropriate consideration of environmental factors in these planning decisions.

Corridor or subarea analyses/studies are another option when the long-range transportation plan leaves open the possibility of multiple approaches to fulfill its goals and objectives. In such cases, the formal NEPA process could be initiated through publication of a NOI in conjunction with a corridor or subarea planning study. Similarly, some public transportation operators developing major capital projects perform the mandatory planning Alternatives Analysis required for funding under FTA's Capital Investment Grant program [49 U.S.C. 5309(d) and (e)] within the NEPA process and combine the planning Alternatives Analysis with the draft EIS.

Alternatives:

10. In the context of this Appendix, what is the meaning of the term ``alternatives''?

This Appendix uses the term ``alternatives'' as specified in the NEPA regulations (40 CFR 1502.14), where it is defined in its broadest sense to include everything from major modal alternatives and location alternatives to minor design changes that would mitigate adverse impacts. This Appendix does not use the term as it is used in many other contexts (e.g., ``prudent and feasible alternatives'' under Section 4(f) of the Department of Transportation Act, the ``Least Environmentally Damaging Practicable Alternative'' under the Clean Water Act, or the planning Alternatives Analysis in 49 U.S.C. 5309(d) and (e)).

11. <u>Under what circumstances can alternatives be eliminated from detailed consideration during the NEPA process based on information and analysis from the transportation planning process</u>?

There are two ways in which the transportation planning process can begin limiting the alternative solutions to be evaluated during the NEPA process: (a) Shaping the purpose and need for the project; or (b) evaluating alternatives during planning studies and eliminating some of the alternatives from detailed study in the NEPA process prior to its start. Each approach requires careful attention, and is summarized below.

(a) Shaping the Purpose and Need for the Project: The transportation planning process should shape the purpose and need and, thereby, the range of reasonable alternatives. With proper documentation and public involvement, a purpose and need derived from the planning process can legitimately narrow the alternatives analyzed in the NEPA process. See the response to Question 8 for further discussion on how the planning process can shape the purpose and need used in the NEPA process.

For example, the purpose and need may be shaped by the transportation planning process in a manner that consequently narrows the range of alternatives that must be considered in detail in the NEPA document when:

(1) The transportation planning process has selected a general travel corridor as best addressing identified transportation problems and the rationale for the determination in the planning document is reflected in the purpose and need Statement of the subsequent NEPA document;

(2) The transportation planning process has selected a general mode (e.g., highway, transit, or a highway/transit combination) that accomplishes its goals and objectives, and these documented determinations are reflected in the purpose and need Statement of the subsequent NEPA document; or

(3) The transportation planning process determines that the project needs to be funded by tolls or other non-traditional funding sources in order for the long-range transportation plan to be fiscally constrained or identifies goals and objectives that can only be met by toll roads or other non-traditional funding sources, and that determination of those goals and objectives is reflected in the purpose and need Statement of the subsequent NEPA document.

(b) Evaluating and Eliminating Alternatives During the Transportation Planning Process: The evaluation and elimination of alternatives during the transportation planning process can be incorporated by reference into a NEPA document under certain circumstances. In these cases, the planning study becomes part of the NEPA process and provides a basis for screening out alternatives. As with any part of the NEPA process, the analysis of alternatives to be incorporated from the process must have a rational basis that has been thoroughly documented (including documentation of the necessary and appropriate vetting through the applicable public involvement processes). This record should be made available for public review during the NEPA scoping process.

See responses to Questions 4, 5, 6, and 7 for additional elements to consider with respect to acceptance of planning products for NEPA documentation and the response to Question 12 on the information or analysis from the transportation planning process necessary for supporting the elimination of an alternative(s) from detailed consideration in the NEPA process.

For instance, under FTA's Capital Investment Grant program, the alternatives considered in the NEPA process may be narrowed in those instances that the planning Alternatives Analysis required by 49 U.S.C. 5309(e) is conducted as a planning study prior to the NEPA review. In fact, the FTA may be able to narrow the alternatives considered in detail in the NEPA document to the No-Build (No Action) alternative and the Locally Preferred Alternative. Alternatives must meet the following criteria if they are deemed sufficiently considered by a planning Alternatives Analysis under FTA's Capital Investment Grant program conducted prior to NEPA without a programmatic NEPA analysis and documentation:

During the planning Alternatives Analysis, all of the reasonable alternatives under consideration must be fully evaluated in terms of their transportation impacts; capital and operating costs; social, economic, and environmental impacts; and technical considerations;

There must be appropriate public involvement in the planning Alternatives Analysis;

The appropriate Federal, State, and local environmental, regulatory, and resource agencies must be engaged in the planning Alternatives Analysis;

The results of the planning Alternatives Analysis must be documented;

The NEPA scoping participants must agree on the alternatives that will be considered in the NEPA review; and

The subsequent NEPA document must include the evaluation of alternatives from the planning Alternatives Analysis.

The above criteria apply specifically to FTA's Capital Investment Grant process. However, for other transportation projects, if the planning process has included the analysis and stakeholder involvement that would be undertaken in a first tier NEPA process, then the alternatives screening conducted in the transportation planning process may be incorporated by reference, described, and relied upon in the project-level NEPA document. At that point, the project-level NEPA analysis can focus on the remaining alternatives.

12. What information or analysis from the transportation planning process is needed in an EA or EIS to support the elimination of an alternative(s) from detailed consideration?

The section of the EA or EIS that discusses alternatives considered but eliminated from detailed consideration should:

(a) Identify any alternatives eliminated during the transportation planning process (this could include broad categories of alternatives, as when a long-range transportation plan selects a general travel corridor based on a corridor study, thereby eliminating all alternatives along other alignments);

(b) Briefly summarize the reasons for eliminating the alternative; and

(c) Include a summary of the analysis process that supports the elimination of alternatives (the summary should reference the relevant sections or pages of the analysis or study) and incorporate
it by reference or append it to the NEPA document.

Any analyses or studies used to eliminate alternatives from detailed consideration should be made available to the public and participating agencies during the NEPA scoping process and should be reasonably available during comment periods.

Alternatives passed over during the transportation planning process because they are infeasible or do not meet the NEPA ``purpose and need'' can be omitted from the detailed analysis of alternatives in the NEPA document, as long as the rationale for elimination is explained in the NEPA document. Alternatives that remain ``reasonable'' after the planning-level analysis must be addressed in the EIS, even when they are not the preferred alternative. When the proposed action evaluated in an EA involves unresolved conflicts concerning alternative uses of available resources, NEPA requires that appropriate alternatives be studied, developed, and described.

Affected Environment and Environmental Consequences:

13. <u>What types of planning products provide analysis of the affected environment and environmental consequences that are useful in a project-level NEPA analysis and document</u>?

The following planning products are valuable inputs to the discussion of the affected environment and environmental consequences (both its current State and future State in the absence of the proposed action) in the project-level NEPA analysis and document:

Regional development and growth analyses;

Local land use, growth management, or development plans; and

Population and employment projections.

The following are types of information, analysis, and other products from the transportation planning process that can be used in the discussion of the affected environment and environmental consequences in an EA or EIS:

(a) Geographic information system (GIS) overlays showing the past, current, or predicted future conditions of the natural and built environments;

(b) Environmental scans that identify environmental resources and environmentally sensitive areas;

(c) Descriptions of airsheds and watersheds;

(d) Demographic trends and forecasts;

(e) Projections of future land use, natural resource conservation areas, and development; and

(f) The outputs of natural resource planning efforts, such as wildlife conservation plans, watershed plans, special area management plans, and multiple species habitat conservation plans.

However, in most cases, the assessment of the affected environment and environmental consequences conducted during the transportation planning process will not be detailed or current enough to meet NEPA standards and, thus, the inventory and evaluation of affected resources and the analysis of consequences of the alternatives will need to be supplemented with more refined analysis and possibly site-specific details during the NEPA process.

14. What information from the transportation planning process is useful in describing a baseline for the NEPA analysis of indirect and cumulative impacts?

Because the nature of the transportation planning process is to look broadly at future land use, development, population increases, and other growth factors, the planning analysis can provide the basis for the assessment of indirect and cumulative impacts required under NEPA. The consideration in the transportation planning process of development, growth, and consistency with local land use, growth management, or development plans, as well as population and employment projections, provides an overview of the multitude of factors in an area that are creating pressures not only on the transportation system, but on the natural ecosystem and important environmental and community resources. An analysis of all reasonably foreseeable actions in the area also should be a part of the transportation planning process. This planning-level information should be captured and utilized in the analysis of indirect and cumulative impacts during the NEPA process.

To be used in the analysis of indirect and cumulative impacts, such information should:

(a) Be sufficiently detailed that differences in consequences of alternatives can be readily identified;
(b) Be based on current data (e.g., data from the most recent Census) or be updated by additional information;
(c) Be based on reasonable assumptions that are clearly Stated; and/or
(d) Rely on analytical methods and modeling techniques that are reliable, defensible, and reasonably current.

Environmental Mitigation:

15**.** How can planning-level efforts best support advance mitigation, mitigation banking, and priorities for environmental mitigation investments?

A lesson learned from efforts to establish mitigation banks and advance mitigation agreements and alternative mitigation options is the importance of beginning interagency discussions during the transportation planning process. Development pressures, habitat alteration, complicated real estate transactions, and competition for potential mitigation sites by public and private project proponents can encumber the already difficult task of mitigating for ``like'' value and function and reinforce the need to examine mitigation strategies as early as possible.

Robust use of remote sensing, GIS, and decision support systems for evaluating conservation strategies are all contributing to the advancement of natural resource and environmental planning. The outputs from environmental planning can now better inform transportation planning processes, including the development of mitigation strategies, so that transportation and conservation goals can be optimally met. For example, long-range transportation plans can be screened to assess the effect of general travel corridors or density, on the viability of sensitive plant and animal species or habitats. This type of screening provides a basis for early collaboration among transportation and environmental staffs, the public, and regulatory agencies to explore areas where impacts must be avoided and identify areas for mitigation investments. This can lead to mitigation strategies that are both more economical and more effective from an environmental stewardship perspective than traditional project-specific mitigation measures.

III. Administrative Issues:

16. Are Federal funds eligible to pay for these additional, or more in depth, environmental studies in transportation planning?

Yes. For example, the following FHWA and FTA funds may be utilized for conducting environmental studies and analyses within transportation planning: FHWA planning and research funds, as defined under 23 CFR Part 420 (e.g., Metropolitan Planning (PL), Statewide Planning and Research (SPR), National Highway System (NHS), Surface Transportation Program (STP), and Equity Bonus); and FTA planning and research funds (49 U.S.C. 5303 and 49 U.S.C. 5313(b)), urban formula funds (49 U.S.C. 5307), and (in limited circumstances) transit capital investment funds (49 U.S.C. 5309).

The eligible transportation planning-related uses of these funds may include: (a) Conducting feasibility or subarea/corridor needs studies and (b) developing system-wide environmental information/inventories (e.g., wetland banking inventories or standards to identify historically significant sites). Particularly in the case of PL and SPR funds, the proposed expenditure must be closely related to the development of transportation plans and programs under 23 U.S.C. 134-135 and 49 U.S.C. 5303-5306.

For FHWA funding programs, once a general travel corridor or specific project has progressed to a point in the preliminary engineering/NEPA phase that clearly extends beyond transportation planning, additional in-depth environmental studies must be funded through the program category for which the ultimate project qualifies (e.g., NHS, STP, Interstate Maintenance, and/or Bridge), rather than PL or SPR funds.

Another source of funding is FHWA's Transportation Enhancement program, which may be used for activities such as: conducting archeological planning and research; developing inventories such as those for historic bridges and highways, and other surface transportation-related structures; conducting studies to determine the extent of water pollution due to highway runoff; and conducting studies to reduce vehicle-caused wildlife mortality while maintaining habitat connectivity.

The FHWA and the FTA encourage State DOTs, MPOs, and public transportation operators to seek partners for some of these studies from environmental, regulatory, and resource agencies, non-government organizations, and other government and private sector entities with similar data needs, or environmental interests. In some cases, these partners may contribute data and expertise to the studies, as well as funding.

17. What staffing or organizational arrangements may be helpful in allowing planning products to be accepted in the NEPA process?

Certain organizational and staffing arrangements may support a more integrated approach to the planning/NEPA decision-making continuum. In many cases, planning organizations do not have environmental expertise on staff or readily accessible. Likewise, the review and regulatory responsibilities of many environmental, regulatory, and resource agencies make involvement in the transportation planning process a challenge for staff resources.

These challenges may be partially met by improved use of the outputs of each agency's planning resources and by augmenting their capabilities through greater use of GIS and remote sensing technologies (see http://www.gis.fhwa.dot.gov/ for additional information on the use of GIS). Sharing databases and the planning products of local land use decision-makers and State and Federal environmental, regulatory, and resource agencies also provide efficiencies in acquiring and sharing the data and information needed for both transportation planning and NEPA work.

Additional opportunities such as shared staff, training across disciplines, and (in some cases) reorganizing to eliminate structural divisions between planning and NEPA practitioners may also need to be considered in order to better integrate NEPA considerations into transportation planning studies. The answers to the following two questions also contain useful information on
training and staffing opportunities.

18. How have environmental, regulatory, and resource agency liaisons (Federally- and State DOT-funded positions) and partnership agreements been used to provide the expertise and interagency participation needed to enhance the consideration of environmental factors in the planning process?

For several years, States have utilized Federal and State transportation funds to support focused and accelerated project review by a variety of local, State, Tribal, and Federal agencies. While Section 1309(e) of the TEA-21 and its successor in SAFETEA-LU section 6002 speak specifically to transportation project streamlining, there are other authorities that have been used to fund positions, such as the Intergovernmental Cooperation Act (31 U.S.C. 6505). In addition, long-term, on-call consultant contracts can provide backfill support for staff that are detailed to other parts of an agency for temporary assignments. At last count (as of 2003), 246 positions were being funded. Additional information on interagency funding agreements is available at: http://environment.fhwa.dot.gov/strmlng/igdocs/index.htm.

Moreover, every State has advanced a variety of stewardship and streamlining initiatives that necessitate early involvement of environmental, regulatory, and resource agencies in the project development process. Such process improvements have: addressed the exchange of data to support avoidance and impact analysis; established formal and informal consultation and review schedules; advanced mitigation strategies; and resulted in a variety of programmatic reviews. Interagency agreements and work plans have evolved to describe performance objectives, as well as specific roles and responsibilities related to new streamlining initiatives. Some States have improved collaboration and efficiency by co-locating environmental, regulatory, and resource and transportation agency staff.

19. What training opportunities are available to MPOs, State DOTs, public transportation operators and environmental, regulatory, and resource agencies to assist in their understanding of the transportation planning and NEPA processes?

Both the FHWA and the FTA offer a variety of transportation planning, public involvement, and NEPA courses through the National Highway Institute and/or the National Transit Institute. Of particular note is the Linking Planning and NEPA Workshop, which provides a forum and facilitated group discussion among and between State DOT; MPO; Federal, Tribal, and State environmental, regulatory, and resource agencies; and FHWA/FTA representatives (at both the executive and program manager levels) to develop a State-specific action plan that will provide for strengthened linkages between the transportation planning and NEPA processes.

Moreover, the U.S. Fish and Wildlife Service offers Green Infrastructure Workshops that are focused on integrating planning for natural resources (``green infrastructure'') with the development, economic, and other infrastructure needs of society (``gray infrastructure'').

Robust planning and multi-issue environmental screening requires input from a wide variety of disciplines, including information technology; transportation planning; the NEPA process; and regulatory, permitting, and environmental specialty areas (e.g., noise, air quality, and biology). Senior managers at transportation and partner agencies can arrange a variety of individual training programs to support learning curves and skill development that contribute to a strengthened link of the transportation planning and NEPA processes. Formal and informal mentoring on an intra-agency basis can be arranged. Employee exchanges within and between agencies can be periodically scheduled, and persons involved with professional leadership programs can seek temporary assignments with partner agencies.

IV. Additional Information on this Topic

Valuable sources of information are FHWA's environment website(http://www.fhwa.dot.gov/environment/index.htm) and FTA's environmental streamlining website (http://www.environment.fta.dot.gov).

Another source of information and case studies is NCHRP Report 8-38 (Consideration of Environmental Factors in Transportation Systems Planning), which is available at http://www4.trb.org/trb/crp.nsf/All+Projects/NCHRP+8-38.

In addition, AASHTO's Center for Environmental Excellence website is continuously updated with news and links to information of interest to transportation and environmental professionals (www.transportation.environment.org).

Appendix E

Integration of the Planning and NEPA Processes

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Date:	February 22, 2005
Subject:	Integration of Planning and NEPA Processes
In Reply Refer To:	HCC-30
From:	D.J. Gribbin /s/ Chief Counsel, Federal Highway Administration Judith S. Kaleta /s/ Acting Chief Counsel, Federal Transit Administration
To:	Cindy Burbank, Associate Administrator Office of Planning, Environment and Realty, FHWA David A. Vozzolo, Deputy Associate Administrator Office of Planning and Environment, FTA

I. Issue

You have asked for guidance regarding the extent to which the results of the transportation planning process can be used in and relied upon in the NEPA process.

In response to your request, this memorandum outlines the current law; describes the transportation planning products that can be used in the NEPA process and under what conditions; and explains the roles of Federal agencies and the public in reviewing transportation planning products used in NEPA analyses and documents.

II. Background

The transportation planning process required by 23 U.S.C. 134 and 135 and 49 U.S.C. 5303-5306 sets the stage for future development of transportation projects. As part of the transportation planning process, States and local metropolitan planning organizations (MPOs) must develop long-range transportation plans to address projected transportation needs. In addition, they must create transportation improvement programs (TIPs or STIPs), which identify a list of priority projects to be carried out in the next three years to implement the plan. To receive Federal funding, transportation projects must come from a TIP or STIP. As a result, much of the data and decision making undertaken by state and local officials during the planning process carry forward into the project development activities that follow the TIP or STIP. This means that the planning process and the environmental assessment required during project development by the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4231 *et seq.*) should work in tandem, with the results of the transportation planning process feeding into the NEPA process. Congress has put great emphasis on the transportation planning process for shaping transportation decisions, and has retained and refined that emphasis in surface transportation law over decades.

In practice, though, the environmental analyses produced during the NEPA process are sometimes disconnected from the analyses used to prepare transportation plans, transportation improvement programs, and supporting corridor or subarea studies.

Analyses and decisions occurring during transportation planning can be ignored or redone in the NEPA process, resulting in a duplication of work and delays in implementation of transportation projects. The sharp separation between the work done during the transportation planning process and the NEPA analysis and documentation process is not necessary. In fact, current law provides authority for and even encourages the integration of the information and products developed in highway and transit planning process into the NEPA process. This memorandum provides guidance on how this information and these products can be incorporated into and relied upon in NEPA analyses and documents under existing laws.

III. Legal Analysis of Current Law on Integrating Planning and NEPA

The transportation planning process is a detailed, Congressionally mandated procedure for developing long-range transportation plans and shorter-range transportation improvement programs. These procedures were initially enacted in the 1960s and were codified in Title 23 and Title 49 of the U.S. Code. See 23 U.S.C. 134 and 135 and 49 U.S.C. 5303-5306. In 1991, the Intermodal Surface Transportation Efficiency Act of 1991 substantially expanded the planning provisions. They have been subsequently revisited and refined by Congress in various transportation bills, but the basic framework has remained intact. The procedures identify the State and local agencies with primary responsibility for transportation planning. They also identify agencies and other interested parties who should be given an opportunity to participate in the transportation planning process and describe their appropriate level of involvement. The statute spells out the planning factors that must be considered, including, among other factors, the protection and enhancement of the environment. 23 U.S.C. 134(f) and 135(c).[1] The transportation planning process undertaken by States and MPOs is periodically reviewed and, if found to be adequate, certified by FHWA and FTA. The Federal government does not approve the transportation plans developed by State or local officials, and although FTA and FHWA jointly approve the Statewide TIP such an approval does not constitute a Federal action subject to review under NEPA.[2] This is the process that Congress constructed to shape transportation decisions for Federally funded projects.

In order to be eligible for Federal funding, projects must come from a plan created by this process. Federal action subject to NEPA is needed to approve these Federal aid projects. Because of the continuity between the planning and project development processes, the NEPA analysis for a transportation project needs to be reviewed in the context of this transportation planning process.

NEPA and the government-wide regulations that carry out NEPA (40 C.F.R. Parts 1500 *et seq.*) clearly contemplate the integration of the NEPA process with planning processes. Specifically, Section 102(2)(A) of NEPA direct all Federal agencies to "utilize a systemic, interdisciplinary approach which will insure the integrated use of natural and social sciences and the environmental design arts in *planning* and decision making. [Emphasis added] The regulations issued by the President's Council on Environmental Quality (CEQ) amplify the statutory directive:

- 40 C.F.R. 1501.1(a) requires decision makers to "integrate[e] the NEPA process *into early planning* to ensure appropriate consideration of NEPA's policies and to eliminate delay;

- 40 C.F.R. 1501.1(b) emphasizes the need for "cooperative consultation among agencies *before the environmental impact statement is prepared*, rather than "submission of adversary comments on a completed document;
- 40 C.F.R. 1501.1(d) emphasizes the importance of "[I]identifying at an early stage the significant environmental issues deserving of study, by de-emphasizing "insignificant issues and "narrowing the scope of the environmental impact statement accordingly;
- 40 C.F.R. 1501.2 requires that Federal agencies "integrate the NEPA process with *other planning at the earliest possible time* to ensure that planning and [agency] decisions reflect environmental values. . .

Likewise, the NEPA regulations adopted by the Federal Transit Administration (FTA) and the Federal Highway Administration (FHWA) emphasize the tie between NEPA and transportation planning:

- 23 C.F.R. 771.105(a) provides that "To the fullest extent possible, all environmental investigations, reviews and consultations be coordinated as a single process. . . and
- 23 C.F.R. 771.105(b) directs that "Alternative courses of action be evaluated and decisions be made in the best overall public interest based upon a balanced consideration of the need for safe and efficient transportation; of the social, economic and environmental impacts of the proposed transportation improvement; and of national, State and local environmental protection goals.

Thus, the organic statute, the government-wide NEPA regulations, and the specific FHWA and FTA regulations all strongly support the integration of the NEPA process with the transportation planning process.

Case law on the issue of the use of transportation planning studies and decisions in the NEPA process is not extensive. However, to the extent they exist, court decisions have consistently supported the reliance in the NEPA process on work done in the planning process. For example, in *North Buckhead Civic Association v. Skinner*, 903 F. 2d 1533 (11th Cir. 1990), the Plaintiffs challenged the purpose and need articulated in the EIS for a multi-lane limited access highway connecting two existing highways. The purpose and need was derived from a series of planning studies conducted by the Atlanta Regional Commission. Plaintiffs argued that the purpose and need was crafted in a way that the proposed highway was "conclusively presumed to be required and a rail alternative perfunctorily dismissed for its failure to fully satisfy the objectives of the project. The Court of Appeals disagreed with the Plaintiffs, stating that their objections reflected "a fundamental misapprehension of the role of federal and state agencies in the community planning process established by the Federal-Aid Highway Act. The Court went on to explain that the Federal-Aid Highway Act contemplated "a relationship of cooperation between federal and local authorities; each governmental entity plays a specific role in the development and execution of a local transportation project. The Court emphasized that federal agencies did not have responsibility for long range local planning, and found that the "federal, state and local officials complied with federally mandated regional planning procedures in developing the need and purpose section of the EIS. 903 F.3d at 1541-42. Although the Court in *Buckhead* acknowledged the validity of a purpose and need based on the results of the planning study, it did not in any way scale back the holdings of other cases relating to purpose and need which caution agencies not to write purpose and need statements so narrowly as to "define competing ‘reasonable alternatives' out of consideration (and even out of existence). *Simmons v. U.S. Army Corps of Engineers*, 120 F.3d 664 (7th Cir. 1997). (In this case, the Army Corps of Engineers failed to question city's insistence on one approach for supplying water and gave no independent thought to the feasibility of alternatives, both single source and separate source supply options. On this basis, the EIS was found to be inadequate.)

In *Carmel-by-the-Sea v. U.S. DOT*, 123 F.3d 1142 (9th Cir. 1997), the Plaintiffs challenged the sufficiency of an EIS for failing to adequately consider the proposed project's growth-inducing effects. The Ninth Circuit disagreed, finding that the EIS satisfied this requirement by referencing several local planning documents that specifically included construction of the highway in their growth plans and which discussed overall growth targets and limits. In addition, the Court found that achieving "Level of Service C, an objective derived from the local congestion management plan, was an appropriate part of the purpose and need statement (although ultimately the EIS was found inadequate on cumulative impact grounds). Similarly, in *Laguna Greenbelt, Inc. v. U.S. DOT*, 42 F.3d 517 (9th Cir. 1994), the court held that the absence of a more thorough discussion in an EIS of induced growth, an issue that was sufficiently analyzed in referenced state materials, does not violate NEPA. However, regardless of the source, the analysis of induced growth must be in sufficient detail and must provide an analytical basis for its assumptions in order to be adequate under NEPA. See *Senville v. Peters*, 327 F.Supp.2d 335, 349 (Vt. 2004) (In this case, the District Court found an FEIS, before it was supplemented by FHWA, to be inadequate because it contained only a "sketchy discussion of induced growth and failed to support its assumptions with any analysis.)

In *Utahns for Better Transportation v. U.S. DOT*, 305 F.3d 1152 (10th Cir. 2002), *as modified on rehearing*, 319 F.3rd 1207 (10th Cir. 2003), Plaintiffs contended that the FEIS was inadequate because it failed to consider reducing travel demand through alternative land use scenarios in combination with mass transit. Noting that "reasonable alternatives must be non-speculative, the Tenth Circuit found that Plaintiffs had not demonstrated a deficiency in the FEIS on this basis (although it was ultimately found inadequate on other grounds). The Court stated that "Land use is a local and regional matter, and that, in this case, the corridor at issue would involve the jurisdiction of several local and regional governmental entities whose cooperation would be necessary to make an alternative land use scenario a reality. The fact that these entities had clearly declined to alter their land use plans in such a way was justification for not considering this alternative. 305 F.3d at 1172. [3]

In *Sierra Club v. U.S. Department of Transportation*, 310 F.Supp.2d 1168 (D. Nevada 2004), Plaintiffs made several challenges to the EIS for a proposed highway project. One of these challenges alleged that FHWA relied on understated population and traffic forecasts. However, the Nevada District Court found that FHWA's reliance on the forecasts and modeling efforts of the designated metropolitan planning organization responsible for developing transportation plans and programs for the area was reasonable. In addition, Plaintiffs argued that the EIS had improperly rejected a fixed guideway as a reasonable alternative under NEPA. The Court disagreed, finding that FHWA reasonably relied on a "major investment study[4] conducted as part of its planning process to establish that such an alternative (1) would not meet the project's purpose and need, even when considered as part of a transportation strategy, (2) was too costly and (3) depended on connections to other portions of such a system for which construction was uncertain.5

As demonstrated by these cases, Courts have sanctioned the use of information from the planning process in a NEPA analysis and document. This is consistent with the opening language in NEPA advocating the integration of environmental considerations in both planning and decision-making. Consequently, products from the transportation planning process can be used in the NEPA analysis and documentation prepared for a transportation project.

IV. Legal Guidance on How Products from the Planning Process Can Be Used In the NEPA Process

For studies, analyses or conclusions from the transportation planning process to be used in the NEPA process, they must meet certain standards established by NEPA. This is because the information and products coming from the planning process must be sufficiently comprehensive that the Federal government may reasonably rely upon them in its NEPA analysis and documentation. Transportation planning processes vary greatly from locality to locality. Some transportation planning processes will already meet these standards, while others might need some modification to do so. Below is a discussion of where products from the transportation planning process might be incorporated into a NEPA analysis and documentation (purpose and need, alternatives, affected environment, and, to a more limited extent, environmental consequences in terms of land use, indirect and cumulative impacts, etc.), along with the NEPA standards they must first meet.

In addition to what is discussed below, these planning products must come from a transportation planning process that complied with current transportation planning requirements (e.g., provided an opportunity for public involvement and considered relevant planning factors). Interested State, local, tribal and Federal agencies should be included in the transportation planning processes, and must be given a reasonable opportunity to comment upon the long range transportation plan and transportation improvement program. Finally, any work from the planning process must have been documented and available for public review during the planning process. Such documentation should be in a form that can easily be appended to the NEPA document or incorporated by reference.6

Purpose and Need

The "purpose and need statement in a NEPA document is where the planning process and the NEPA process most clearly intersect. A sound planning process is a primary source of the project purpose and need. It is through the planning process that state and local governments determine what the transportation needs of an area are, which of transportation needs they wish to address, and in what time frame they wish to address them. Indeed, that is what the law requires from the planning process and actually prevents projects that do not come from the planning process from going forward.

The purpose and need statement, at a minimum, is a statement of the transportation problem to be solved by the proposed project. It is often presented in two parts: broad goals and objectives, and a description of the transportation conditions (congestion, safety, etc.) underlying the problem. The long-range transportation plan also includes goals and objectives similar to "purpose and need but on a broader scale, since it typically covers a wider area and spans at least twenty years. These goals and objectives are often identified through extensive public outreach, sometimes called "visioning or "alternative futures exercises. The purpose and need statement for a transportation project should be consistent with and based on the goals and objectives developed during the planning process.

Getting input from Federal agencies as transportation goals and objectives are developed during the planning process is advisable and would be consistent with the cooperative relationship envisioned by statute and reinforced by courts. Such participation would give Federal agencies a better insight into the needs and objectives of the locality and would also provide an important opportunity for Federal concerns to be identified and addressed early in the process. These concerns could include issues that might be raised by Federal agencies in considering permit applications for projects designed to implement the transportation plan. However, the responsibility for local planning lies with the metropolitan planning organization or the State, not the Federal government.

In many cases, the goals and objectives in the transportation plan are supported by a needs assessment and problem statement describing current transportation problems to be addressed. Although the goals and objectives in the long-range transportation plan will be broader than what is appropriate for a specific project, they can be the foundation for the purpose and need to be used in a NEPA document. For example, they can be used to generate corridor-level purpose and need statements, during planning, for use in NEPA documents. The challenge is to ensure what comes from the long-range transportation plan is not so general as to generate a range of alternatives that are not responsive to the problem to be solved.

NEPA calls for a purpose and need statement to briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action. A purpose and need statement can be derived from the transportation planning process. The purpose and need statement:

- Should be a statement of the transportation problem (not a statement of a solution);
- Should be based on articulated planning factors and developed through a certified planning process;
- Should be specific enough so that the range of alternatives developed will offer real potential for solutions to the transportation problem;
- Must not be so specific as to "reverse engineer a solution; and
- May reflect other priorities and limitations in the area, such as environmental resources, growth management, land use planning, and economic development.

Alternatives

Under NEPA, an EIS must rigorously explore and objectively evaluate all reasonable alternatives, and briefly explain the rationale for eliminating any alternatives from detailed study.7 "Reasonable alternatives are described in Council on Environmental Quality (CEQ) guidance as including "those that are practical or feasible from the technical and economic standpoint and using common sense. *Forty Most Asked Questions Concerning CEQ's NEPA Regulations*, Question #2a (March 23, 1981). An alternative is not "reasonable if it does not satisfy the purpose and need,8 but it may be reasonable even if it is outside the jurisdiction of the proposing agency to implement.

The transportation planning process frequently takes steps to refine the purpose and need statement that results in narrowing or screening the range of alternatives. Regional planning considerations may be the basis for refining the purpose and need statement, which might then have the effect of eliminating some alternatives from detailed consideration. For example, network connectivity across a geographic barrier such as a river may dictate a particular transportation mode or a general alignment. The plan may also identify where a locality wants housing, commercial development, agriculture, etc.—all of which might drive the need for transportation improvements in particular corridors.

When a long- range transportation plan leaves open the possibility of multiple approaches to fulfill its goals and objectives, a subarea or corridor study could be conducted to "zoom in on a particular area. This study would evaluate alternative investment strategies, engineering constraints, fiscal constraints, and environmental considerations in this area, and could narrow the range of possible alternatives to those that will meet the goals and objectives of the broader long-range transportation plan in that particular subarea or corridor. At the conclusion of such a study, the remaining alternatives might simply consist of a single corridor or mode choice with location and design options.

On a broad scale, a decision about whether projects located in particular subareas or corridors would satisfy the transportation goals and objectives of a locality can be made in these subarea or corridor studies. These studies can therefore be used in and relied on in an EIS to refine the purpose and need statement, thereby narrowing the range of alternatives to be considered by eliminating some alternatives from further detailed study. When conducting subarea or corridor screening studies during the planning process, State and local agencies should keep in mind the principles of NEPA and should be sure to document their procedures and rationales. To be incorporated into an EIS, the analysis of alternatives conducted in the subarea or corridor study should be consistent with the standard of NEPA requiring consideration of reasonable alternatives. Alternatives that remain "reasonable after the planning level analysis must be addressed in the NEPA process, even when they are clearly not the preferred alternative.9 Alternatives passed over during the transportation planning process because they are infeasible or because they do not meet the NEPA "purpose and need can be omitted from the detailed analysis of alternatives in the NEPA analyses and documentation, so long as the rationale for omitting them is documented in the NEPA document. That documentation can either be appended to the EIS or the specific transportation planning documents can be summarized in the EIS and incorporated by reference. The NEPA review would then have to consider the alternatives that survive the planning study, plus any additional reasonable alternatives identified during NEPA scoping that may not have been considered during the planning process. All reasonable alternatives considered in the draft and final EIS should be presented in a "comparative form that sharply defines the issues and provides a clear basis for a choice by the decision maker and the public. 40 C.F.R. 1502.14.

Finally, any planning study being relied upon as a basis for eliminating alternatives from detailed study should be identified during the NEPA scoping process and available for public review. Since a major purpose of the scoping process is to identify alternatives to be evaluated, the public should be given the opportunity to comment on determinations made in the planning process to eliminate alternatives.

Therefore, if the planning process is used to screen or narrow the range of alternatives, by excluding certain alternatives from detailed study or by prescribing modes or corridors for transportation development which results in eliminating alternative modes or corridors from detailed study, then the planning-based analysis of alternatives:

- Should describe the rationale for determining the reasonableness of the alternative or alternatives;
- Should include an explanation of why an eliminated alternative would not meet the purpose and need or was otherwise unreasonable; and
- Should be made available for public review during the NEPA scoping process and comment period.

Under FTA's New Starts program, the alternatives considered during the NEPA process may be narrowed even further by eliminating alternatives from detailed study in those instances when the Alternatives Analysis required by 49 U.S.C. 5309(e) is conducted as a planning study prior to the NEPA review.10 In fact, FTA may narrow the alternatives considered in detail in the NEPA analysis and documentation to the No-Build (No-Action) alternative and the "Locally Preferred Alternative". The following criteria must be met if alternatives are eliminated from detailed study by a planning Alternatives Analysis conducted prior to the NEPA review:

- During the planning Alternatives Analysis, all of the reasonable alternatives under consideration must be fully evaluated in terms of their transportation impacts, capital and operating costs, social, economic, and environmental impacts, and technical considerations;
- There must be appropriate public involvement in the planning Alternatives Analysis;
- The appropriate Federal, State, and local resource agencies must be engaged in the planning Alternatives Analysis;
- The results of the planning Alternatives Analysis must be documented;
- The NEPA scoping participants must agree on the alternatives that will be considered in the NEPA review; and
- The NEPA document must incorporate by reference the evaluation of alternatives from the planning Alternatives Analysis.

If, during the NEPA process, new reasonable alternatives not considered during the planning Alternatives Analysis are identified or new information about eliminated alternatives comes to light, those alternatives must be evaluated during the NEPA process.

Affected Environment and Environmental Consequences

The EIS must present a description of the environment in the area that would be affected by the proposed action and alternatives and their environmental consequences. 40

C.F.R. 1502.15 and 1502.16. In the development of the long-range transportation plan and a corridor or subarea studies, a similar assessment of the environment in the area and environmental consequences should typically have been conducted. Such planning-level assessments might include developing and utilizing geographic information system overlays of the area; providing information on air- and water-sheds; identifying the location of environmental resources with respect to the proposed project and alternatives; conducting environmental "scans of the area of impact; and utilizing demographic trends and forecasts developed for the area. The discussion in the planning process of development growth, and consistency with local land use, growth management or development plans, as well as population and employment projections, would be particularly valuable for use in determining the affected environment and the scope of cumulative impacts assessment and possible indirect impacts of the proposed transportation improvement. Any relevant parts of such transportation planning process analysis, conducted in the planning process or by other sources and used in plan development, can be incorporated by reference and relied upon in the NEPA analysis and documentation.

The CEQ regulations require the action agency preparing an EIS to assess the environmental consequences of the proposed action and any reasonable alternatives. The CEQ regulation contains a detailed list of all of the types of environmental consequences that must be discussed, including direct, indirect and cumulative impacts and their significance, as well as means to mitigate adverse environmental impacts. These consequences must be discussed for each alternative and should be presented in a comparative form. 40 C.F.R. 1502.16. In transportation planning, the development of transportation plans and programs is guided by seven planning factors (23 U.S.C. 134(f)(1) and 23 U.S.C. 135(c)(1)), one of which is to "protect and enhance the environment, promote energy conservation, and improve the quality of life. As such, there generally is a broad consideration of the environmental effects of transportation decisions for a region.11 To the extent relevant, this analysis can be incorporated into the "environmental consequences section of an environmental assessment or impact statement performed under NEPA. However, in most cases the assessment of environmental consequences conducted during the planning process will not be detailed enough to meet NEPA standards and thus will need to be supplemented.

Nonetheless, the planning process often can be a source of information for the evaluation of cumulative and indirect impacts required under NEPA. 40 C.F.R. 1502.16, 1508.7 and 1508.8. The nature of the planning process is to look broadly at future land use, development, population increases, and other growth factors. This analysis could provide the basis for the assessment of cumulative and indirect impacts required under NEPA. Investigating these impacts at the planning level can also provide insight into landscape, watershed or regional mitigation opportunities that will provide mitigation for multiple projects.

An EIS may incorporate information regarding future land use, development, demographic changes, etc. from the transportation planning process to form a common basis for comparing the direct, indirect and cumulative impacts of all alternatives. When an analysis of the environmental consequences from the transportation planning process is incorporated into an EIS it:

- Should be presented in a way that differentiates among the consequences of the proposed action and other reasonable alternatives;
- Should be in sufficient detail to allow the decision maker and the public to ascertain the comparative merits and demerits of the alternatives; and
- Must be supplemented to the extent it does not adequately address all of the elements required by the CEQ and FHWA/FTA NEPA regulations.

V. Legal Guidance on Weight to be Given to Planning Products Incorporated into NEPA Analyses and Documents

Responsibility for NEPA analyses and documents on Federally funded or approved highway and transit projects ultimately rests with FHWA and FTA, since they are taking the federal action subject to NEPA. FHWA and FTA have an obligation to independently evaluate and review a NEPA analysis and document, even when some of the information contained in it has been prepared by the State or other local agency. 42 U.S.C. 4332(2)(D); 40 C.F.R. 1506.5 Under NEPA and other relevant environmental laws such as the Endangered Species Act, the Clean Water Act, or the Clean Air Act, other agencies also must be given an opportunity to review and comment on NEPA documents and analysis. Federal agencies that have jurisdiction by law have an independent responsibility under NEPA and, upon the request of the lead agency, shall be "cooperating agencies.12 Tribes and state and local agencies with jurisdiction by law and all agencies with special expertise may, upon the request of the lead agency, be "cooperating agencies in the NEPA process. 40 C.F.R. 1501.6 and 1508.5.

However, while imposing on Federal agencies the obligation to independently evaluate information in NEPA analyses and documents, Congress also affirmed that NEPA does not apply to the transportation planning process because it is not a Federal action:

"Since plans and programs described in this [transportation planning] section are subject to a reasonable opportunity for public comment, since individual projects included in the plans and programs are subject to review under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.), and since decisions by the Secretary concerning plans and programs described in this section have not been reviewed under such Act as of January 1, 1997, any decision by the Secretary concerning a plan or program described in this section shall not be considered to be a Federal action subject to review under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.)."

23 U.S.C 134(o) and 135(i). The transportation planning process is a local function, which, by statute, is undertaken by State and local governments. The Department of Transportation has an oversight role, but it does not conduct the process and, therefore, there is no Federal action to trigger the application of NEPA. This is different than the "big picture planning processes undertaken by other Federal agencies with respect to lands that they manage, where action by the Federal agency is involved and NEPA applies.13

The affirmation in Sections 134(o) and 135(i) that the decisions made by State and local governments during the transportation planning process are exempt from NEPA is based on a Fifth Circuit decision, *Atlanta Coalition on the Transportation Crisis, Inc. v. Atlanta Regional Commission*, 599 F.2d 1333 (5th Cir. 1979). In this case, plaintiffs sought declaratory judgment that an EIS was required for a regional transportation plan developed by the Atlanta Regional Commission in compliance with the FHWA and FTA planning regulations. The plan proposed a comprehensive transportation system for the Atlanta area. It included an analysis of projected regional transportation needs through the year 2000 and identified the general location and the mode (i.e. highway or transit) for recommended transportation corridors to meet those needs. The Fifth Circuit denied plaintiff's request for an EIS, finding that "Congress did not intend NEPA to apply to state, local or private actions; hence, the statute speaks only to ‘federal agencies' and requires impact statements only as to ‘major federal actions.' 559 F.2d at 1344. Specifically, the Court stated:

"The fact is that the [regional plan] was developed by ARC in conjunction with state and local authorities, and no federal agency had any significant hand in determining, or made any decision concerning, its substantive aspects. Under the statutes, those decisions are entrusted to the state and local agencies, not FHWA or [FTA]. Moreover, the plan, as a plan will never be submitted to a federal agency for review or approval. And while the planning process was so structured so as to preserve the eligibility for federal funding of projects included within the resulting plan, it has been consistently held that the possibility of federal funding in the future does not make the project or projects ‘major federal action' during the planning stage."

[Cites omitted] 599 F.2d at 1346. The Court further found that certification or funding of the planning process by FHWA and FTA did not amount to a "major federal action as defined in the NEPA regulations. 559 F.3d at 1344; 40 C.F.R. 1508.18. The Court concluded by again emphasizing: "We have no doubt but that the [regional plan] embodies important decisions concerning the future growth of the Atlanta area that will have a continuing and significant effect on the human environment. But at the risk of belaboring the point, we reemphasize that those decisions have been made by state and local authorities, will not be reviewed by any federal agency, and obligate no federal funds. The defendants therefore need not prepare an impact statement on the [regional plan]. 559 F.3d at 1349.

This theme is echoed in other court decisions involving local planning processes. Early in the development of NEPA law, Courts recognized that deference to local planning was appropriate in the NEPA process. In *Maryland-National Capital Park and Planning Commission v. U.S. Postal Service*, 487 F.2d 1029 (U.S. App. D.C. 1973), the Postal Service determined that the construction of a bulk mail facility would have no significant impact since, under the locality's zoning laws, the postal facility was a "permitted use at the location proposed by the Postal Service. In analyzing this issue, the Court noted: "The question of significance takes on a distinctive case in the context of land use planning. The Court went on to state: "When local zoning regulations and procedures are followed in site location decisions by the Federal Government, there is an assurance that such ‘environmental' effects as flow from the special uses of land—the safety of the structures, cohesiveness of neighborhoods, population density, crime control, and esthetics-will be no greater than demanded by the residents acting through their elected representatives. 487 F.2d at 165-66. The Court acknowledged, however, that local planning was not sufficient to effectuate NEPA, and that actions of the Federal government might have implications beyond those evaluated in the planning process: "For example, whereas the Federal Government might legitimately defer to New York City zoning in matters of, say, population density, a different issue would be posed by the location within the city of an atomic reactor. Its peculiar hazards would not be limited to the citizens of New York, nor could they control them. 487 F.2d at 166. *See also Preservation Coalition, Inc. v. Pierce*, 667 F.2d 851 (C.A. Idaho 1982) (citing *Maryland-National Capital Park* and upholding a finding of no significant impact when a Federal project conformed to existing land use patterns, zoning and local plans).

The Fifth Circuit followed a similar line of reasoning in *Isle of Hope Historical Association v. U.S. Army Corps of Engineers*, 646 F. 2d 215 (5th Cir. 1981). In this case, the Court held that, in preparing an EIS, the Corps of Engineers properly relied on information and answers from the local government regarding planning and zoning issues. The Corps had consulted with county officials to determine whether planning documents had been adopted and whether there was any inconsistency between the proposed project and the local zoning regulations. Plaintiffs challenged this part of the EIS, alleging that it had not adequately discussed the planning documents at issue nor disclosed inconsistencies between the zoning regulations and the proposed project. The Court upheld the Corps' reliance on the county officials' responses, stating that "For the Corps in this case to follow planning documents which the county had not adopted or to engage independent analysis of inconsistencies which those specifically charged with zoning enforcement did not find would make the Corps in effect a planning and zoning review board. . . The proper function of the Corps was to assess the environmental impact of the [proposed project], not to act as a zoning interpretation or appeal board. 646 F.2d at 221.14

This respect for local sovereignty in making planning decisions has been reinforced more recently in the context of transportation planning. In *North Buckhead Civic Association v. Skinner* (discussed previously in Section III of this Memorandum), the 11th Circuit emphasized that "NEPA does not confer the power or responsibility for long range local planning on Federal or state agencies. 903 F. 3d at 1541-42. See also *Sierra Club v. U.S. Department of Transportation*, 350 F.Supp.2d 1168, 1193 (D. Nevada 2004), where the Court said: "[A] federal agency does not violate NEPA by relying on prior studies and analyses performed by local and state agencies. This approach is also consistent with the statutory provision describing the Federal-State relationship for the Federal-aid highway program: "The authorization of the appropriation of Federal funds or their availability for expenditure under this chapter shall in no way infringe on the sovereign rights of the States to determine which projects shall be federally financed. 23 U.S.C.

145(a). In conducting its NEPA analysis, FHWA and FTA must take into account Congressional direction regarding its statutory authority to act. See *Citizens Against Burlington, Inc. v. Busey*, 938 F.2d 190 (C.A.D.C. 1991).15

When it enacts a provision of law, Congress is presumed to have in mind previous laws relating to the same subject matter. To the greatest extent possible, new statutes should be read in accord with prior statutes, and should be construed together in harmony. N. Singer, *Statutes and Statutory Construction*, 6th Ed., Vol. 2B, Sec. 51.02. A Federal agency's independent obligation to evaluate planning products incorporated into the NEPA process must be performed in a way that is consistent with the Congressional direction that NEPA does not apply to local transportation planning and consistent with court decisions recognizing the sovereignty of local governments in making local transportation planning decisions. Federal agencies should ensure transportation planning decisions have a rational basis and are based on accurate data, but should not use the NEPA process as a venue for substituting federal judgment for local judgment by requiring reconsideration of systems-level objectives or choices that are properly made during the local transportation planning process.16

The transportation planning process and the NEPA process work in harmony when the planning process provides the basis or foundation for the purpose and need statement in a NEPA document. To the extent regional or systems-level analyses and choices in the transportation planning process help to form the purpose and need statement for a NEPA document, such planning products should be given great weight by FHWA and FTA, consistent with Congressional and Court direction to respect local sovereignty in planning. This approach is also consistent with a letter to Secretary Mineta dated May 12, 2003, from James Connaughton, Chairman of CEQ, on purpose and need statements in NEPA documents:

"Federal courts generally have been deferential in their review of a lead agency's ‘purpose and need' statements, absent a finding that an agency acted in an arbitrary or capricious manner. They have recognized that federal agencies should respect the role of local and state authorities in the transportation planning process and appropriately reflect the results of that process in the federal agency's NEPA analysis of purpose and need [citing to *North Buckhead*]."

Further, in his letter, the Chairman states that, even though other Federal agencies must be provided an opportunity to comment, they "should afford substantial deference to the transportation agency's articulation of purpose and need when the proposal is a transportation project.17

Therefore, if transportation planning studies and conclusions have properly followed the transportation planning process, then they can be incorporated into the purpose and need statement and, further, can be used to help draw bounds around alternatives that need to be considered in detail. For example, if systems-level or other broad objectives or choices18 from the transportation plan are incorporated into the purpose and need statement used in a NEPA document, FHWA and FTA should not revisit whether these are the best objectives or choices among other options. Rather, their review would include making sure that objectives or choices derived from the transportation plan were based on transportation planning factors established by federal law; reflect a credible and articulated planning rationale; are founded on reliable data; and were developed through a transportation planning process meeting FHWA and FTA statutory and regulatory requirements. In addition, the basis for the objectives and choices must be documented and included in the NEPA document. In such cases, alternatives falling outside a purpose and need statement derived from objectives or choices identified in the planning process do not need to be considered in detail.

FHWA and FTA should independently review regional analyses or studies of transportation needs conducted during the transportation planning process at a similar level. FHWA and FTA reviewers do not need to review whether assumptions or analytical methods used in the studies are the best available, but, instead, need to assure that such assumptions or analytical methods are reasonable and scientifically acceptable. This review would include determining whether assumptions have a rational basis and are up-to-date and data, analytical methods, and modeling techniques are reliable, defensible, and reasonably current. This approach preserves the sovereignty of *state and local governments in making local planning decisions but in a way that is consistent with the principles and procedures of NEPA.*

Nonetheless, additional scrutiny may be required if the results of the planning process are more specific than needed for regional or systems-level planning. Such results might actually be part of project development, which is outside of the planning jurisdiction of local agencies. Project development often involves a Federal action and therefore would be subject to NEPA. See 23 U.S.C. 134(o) and 135(i). In addition, the information the Federal agencies rely upon in the NEPA process based on underlying transportation planning work cannot be inaccurate, false or misleading. See *Sierra Club v. U.S. Army Corps of Engineers,* 701 F. 2d 1011, 1035 (where the court required a supplementation or re-evaluation of the NEPA analyses and documentation where the Corps unquestioningly relied on inaccurate information and did not investigate, on its own, the accuracy of the fisheries data submitted to it to support a permit for a landfill in the Hudson river to accommodate the Westway highway project.)

In conducting reviews under NEPA, Federal agencies should defer to planning products incorporated into the NEPA process to the extent that they involve decisions or analysis within the jurisdiction of the local planning agency. The focus of the Federal agency's review should be whether the planning information is adequate to meet the standards of NEPA, not whether the decisions made by the planning authority are correct. This would be consistent with the specific roles assigned by Congress to local and Federal authorities and consistent with court decisions admonishing Federal agencies to respect the sovereignty of local authorities in developing local plans.

VI. Conclusion

This memorandum provides guidance on how transportation planning level information and products may be used to focus the documentation prepared to comply with NEPA when Federal approvals are needed to build a transportation project. Federal law and regulations and best practices ensure that much information that is relevant to the NEPA process is in fact developed during the planning process. Both Federal transportation law and NEPA law strongly suggest that to the extent practicable, the NEPA process should use and build on the decision made and information developed during the planning process. Of course, where the transportation planning process fails to address or document issues, the NEPA analyses and documentation may have to supplement the information developed during the planning process.

Original signed by D.J. Gribbin and Judith S. Kaleta

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1 Protection of the environment is reinforced in the FHWA and FTA regulations clarifying the factors to be considered in the transportation planning process (e.g., States and MPOs must analyze the "overall social, economic, energy and environmental effects of transportation decisions. . . 23 CFR 450.208 and 450.316.

2 As stated in the planning provisions of Title 23, "any decision by the Secretary concerning a plan or program described in this section shall not be considered to be a Federal action subject to review under NEPA. 23 U.S.C. 134(o); see also 23 U.S.C. 135(i). These provisions are discussed more fully in Section V of this memorandum.

3 Note, however, an alternative is not "speculative or "unreasonable merely because it is outside the jurisdiction of the proposing agency. 40 C.F.R. 1402.14 (c). In some cases, an agency might be required to consider an alternative outside its jurisdiction. For example, in *Muckleshoot Indian Tribe v. United States Forest Service*, 177 F.3d 800 (9th Cir. 1999), the Ninth Circuit Court of Appeals found that the lack of funds for an alternative was not sufficient to render it "speculative when the Forest Service could have at least made a request for additional funding. The facts in the *Muckleshoot* case are different than the *Utahns* case, where the local agencies had clearly declined to exercise the alternative.

4 Corridor-level "Major Investment Studies were for a time required under FTA and FHWA's planning regulations where a need for a major metropolitan transportation investment was identified and Federal funds were potentially involved. Major investment studies were intended to refine the system-wide transportation plan and lead to decisions on the design concept and scope of the project, in consultation with other interested agencies. In addition, they were intended to be used as input to EISs and EAs. 23 C.F.R. 450.318. In Section 1308 of the Transportation Equity Act for the 21st Century, the Secretary was directed to eliminate the separate requirement for major investment studies and instead to integrate it with the planning analyses required under the FTA and FHWA planning statutes "as part of the analyses required to be undertaken pursuant to the planning provisions of Title 23, United States Code and Chapter 53 of Title 49, United States Code, and the National Environmental Policy Act of 1959 (42 U.S.C. 4321 et seq.) for Federal-aid highway and transit projects.. Pub.. 105-178 (June 9, 1998). Although no longer required, "major investment studies continue to be allowed at the discretion of the State or local agency.

It is telling, however, that a good many State and local agencies continue to prepare "major investment studies (and similar corridor and sub-area analyses) on their own volition, because they have found it very valuable to vet the merits and weaknesses of various alternatives—both modal and alignment--before they even initiate the NEPA analyses and documentation. Moreover, FTA requires Metropolitan Planning Organizations and/or transit agencies contemplating major capital investment ("new starts) projects to prepare a planning-level corridor study, know as an "Alternatives Analysis, either before or during a Draft Environmental Impact Statement for the purpose of narrowing the range of alternatives for study in a subsequent NEPA analysis and document(s) by eliminating some alternatives from further detailed study. See also footnote 10.

5 Plaintiffs have appealed this decision, and the Ninth Circuit has stayed further construction on the project pending the outcome of the appeal. *Order Granting Stay*, Ninth Circuit Court of Appeals, No. CV-02-00578-PMP (July 27, 2004).

6 Documents may be incorporated by reference if they do not impede agency or public review of the action. Any document incorporated by reference must be "reasonably available for inspection by potentially interested persons within the time allowed for comment. Incorporated materials must be cited in the NEPA document and their contents briefly described. 40 C.F.R. 1502.21.

7 40 C.F.R. 1502.14 The term "alternatives is also used in many other contexts (for example, "prudent and feasible alternatives under Section 4(f) of the Department of

Transportation Act, the "Least Environmentally Damaging Practicable Alternative under the Clean Water Act, or the "Alternatives Analysis under FTA's New Starts program). This memorandum only uses the term as defined under NEPA. At the planning stage of any project, however, a determination should be made as to whether the alternatives to be considered will need to be used to satisfy multiple requirements at the planning and NEPA review stages. If so, during planning the alternatives chosen for consideration and the analysis of those alternatives should reflect the multiple statutory objectives that must be addressed.

8 In some cases, an alternative may be reasonable even if it just partially satisfies the purpose and need. See *NRDC v. Morton*, 458 F.2d 827, 836 (C.A.D.C. 1972).

9 Under the requirements for FTA's New Starts Program, however, under the appropriate circumstances, reasonable alternatives may be eliminated from detailed study during a rigorous planning-level Alternatives Analysis (including an evaluation of environmental consequences) conducted before the issuance of a NEPA Notice of Intent to prepare an Environmental Impact Statement. This is discussed later in this section.

10 FTA offers applicant sponsors the opportunity to conduct the Alternatives Analysis before NEPA begins or alternatively, to conduct the Alternatives Analysis concurrently with the NEPA DEIS.

11 Specifically, the FHWA/FTA transportation planning regulations (23 C.F.R. Part 450 and 49 C.F.R. Part 613) require inclusion of the overall social, economic, energy and environmental effects of transportation decisions (including consideration of the effects and impacts of the plan on human, natural and man-made environment such as housing, employment and community development, consultation with appropriate resource and permit agencies to ensure early and continued coordination with environmental resource protection and management plans, and appropriate emphasis on transportation-related air quality problems). 23 C.F.R. 450.316(a)(13).

12 Nonetheless, a cooperating agency may, in response to a lead agency's request for assistance in preparing an EIS, reply that other program commitments preclude any involvement or the degree of involvement requested in the action that is subject to the EIS. 40 C.F.R. 1501.6(c).

13 For example, NEPA applies to the general management plans prepared and approved by the National Park Service for each unit of the National Park System (Chapter 2, "Management Policies, at www.nps.gov/policy/mp/chapter2.htm), and applies to resource management plans prepared and approved by the Bureau of Land Management to maximize resource values of federal lands and resources (43 C.F.R. 1601.0-6).

14 Of course, the reliance on the underlying local plan does not excuse the analysis of the impacts of the project within the context of that plan. Cf. *Sierra Club Illinois Chapter v. U.S. Department of Transportation*, 962 F. 2d 1037, 1042 (N.D. Ill. 1997).

15 In this case, plaintiffs challenged the Federal Aviation Administration's EIS on an application by the Toledo Port Authority for a cargo hub in Toledo. Plaintiffs alleged that the FAA should have considered alternatives outside of Toledo. The Court disagreed,

finding that Congress had made clear that the location of cargo hubs was to be made by local authorities and not by the Federal government, stating: "Where the Federal government acts, not as a proprietor, but to approve and support a project being sponsored by a local government or private applicant, the Federal agency is necessarily more limited. In the latter instance, the Federal government's consideration of alternatives may accord substantial weight to the preferences of the applicant and/or sponsor in the sitting and design of the project. 938 F.2d at 197.

16 This would not constrain the Environmental Protection Agency's authority under Section 309 of the Clean Air Act to refer concerns to the President's Council on Environmental Quality regarding impacts on public health or welfare or environmental quality. 42 U.S.C. 7609*.*

17 See, also, *Citizens Against Burlington, Inc. v. Busey*, *id*., At 938 F.2d 190, 195-96 (C.A.D.C. 1991), stating "When an agency is asked to sanction a specific plan, see 40 C.F.R. § 1508.18(b)(4), the agency should take into account the needs and goals of the parties involved in the application. [Citations omitted]; *Louisiana Wildlife Federation, Inc. v. York*, 761 F.2d 1044 (5th Cir. 1985), stating "Under [the Corps'] Guidelines, therefore, not only is it permissible for the Corps to consider the applicant's objective; the Corps has a duty to take into account the objectives of the applicant's project. Indeed, it would be bizarre if the Corps were to ignore the purpose for which the applicant seeks a permit and to substitute a purpose it deems more suitable.

18 Examples of such planning objectives or choices that courts have accepted for use in the purpose and need statement for a NEPA document are (1) the need for a multi-lane highway connecting two other highways (*North Buckhead Civic Association v. Skinner*, 903 F.2d at 1537) and (2) the need for a particular level of service (*Carmel-by-the-Sea v. U.S. DOT,* 123 F.3d at 1156). In *Atlanta Coalition on the Transportation Crisis v. Atlanta Regional Commission*, the court discusses the distinction between "systems planning and "project planning, and describes the Atlanta "systems plan as "an analysis of projected regional transportation needs through the year 2000 [identifying] the general location and the mode (i.e., highway or mass transit) of recommended transportation corridors to meet those needs. 599 F.2d at fn.2 and at 1341

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Appendix F

Air Quality Conformity Checklist
For
Rural Isolated
Non-Attainment/Maintenance Areas

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Conformity Analysis Documentation
FHWA/EPA Checklist for Isolated Rural Nonattainment Areas
10/12/2016 update – Caltrans

This checklist can be used to ensure that all information needed for a regional conformity determination, for a regionally significant transportation project in an Isolated Rural area (nonattainment or attainment-maintenance area with no MPO(s)), is included in project documentation. This checklist would be used to structure regional conformity analysis associated with a NEPA document or other Federal action, and to assist reviewers in verifying that the necessary analysis has been done. Note that in Isolated Rural areas, since there is no MPO, there is no Regional Transportation Plan (RTP) subject to Federal conformity action; however, in California most areas have Regional Transportation Planning Agencies that prepare a RTP based on State requirements whether or not an MPO exists, and such documents along with their CEQA analyses can provide a regional planning context for project actions.

DO NOT USE THIS CHECKLIST IN "DONUT" NON-MPO AREAS. Such areas have regional conformity analysis requirements related to TIP approval, and must have a regional conformity determination approved by an adjacent MPO. Project-level conformity in those areas uses MPO-area procedures.

40 CFR	Criteria	Page	Comments
§93.102	Document the applicable pollutants and precursors for which EPA designates the area as nonattainment or maintenance. Describe the nonattainment or maintenance area and its boundaries.		
§93.104 (d)	Document whether a new conformity determination is required per this section: 1) a new project; 2) a significant change in design concept and scope; 3) three years since the most recent step to advance the project; 4) a supplemental EA/EIS was initiated for air quality purposes.		
§93.109 (a, b)	Document that the regional emissions analysis complies with any applicable conformity requirements of air quality implementation plans or court orders for the area which pertain specifically to conformity.		
§93.109 (c)	Provide a table that shows, for each pollutant and precursor, whether the interim emissions tests and/or the budget test apply for conformity. Indicate which emissions budgets have been deemed adequate and/or approved by EPA, and which budgets are currently applicable for what analysis years. Indicate what test is being used for analysis years after the attainment year (budget, interim, dispersion modeling) and if hot spot analyses are included.		
§93.110 (a,b)	Document the use of latest planning assumptions (source and year) "at the time the conformity analysis begins," including current and future population, employment, travel and congestion. Document the use of the most recent available estimates of current and future population, employment, travel, and congestion most recently developed by the MPO or other agency authorized to make such estimates. Document the date upon which the conformity analysis was begun. Document the use of planning assumptions less than five years old. If unable, include written justification for the use of older data.		
§93.110 (c,d,e,f)	Document any changes in transit operating policies and assumed ridership levels since the previous conformity determination. Document the use of the latest transit fares and road and bridge tolls. Document the use of the latest information on the effectiveness of TCMs and other SIP measures that have been implemented. Document the key assumptions and show that they were agreed to through Interagency and public consultation required by §93.105		
§93.111	Document the use of the latest emissions model approved by EPA.		

40 CFR	Criteria	Page	Comments
§93.112	Document fulfillment of the interagency and public consultation requirements outlined in a specific implementation plan according to §51.390 or, if a Consultation (Conformity) SIP revision has not been completed, according to §93.105 and 23 CFR 450. Include documentation of consultation on conformity tests and methodologies as well as responses to written comments.		
§93.113 (a,d)	Document timely implementation of all TCMs in approved SIPs. Document that the project does not interfere with the implementation of TCMs. Document timely implementation of transportation-related RACM measures that may not be formally TCMs.		
§93.116(a) [i]	Document that the project does not cause or contribute to any new localized PM or CO violations.		CO, PM10, PM2.5 areas only
§93.117 [ii]	Document that the project complies with any PM10 or PM2.5 control measures in the applicable attainment plan (approved SIP).		PM10, PM2.5 areas only
§93.118 (a, c, e)	For areas with SIP budgets: Document that emissions from the transportation network, including projects in the isolated rural nonattainment area that are in the Statewide TIP and regionally significant non-Federal projects, are consistent with any adequate or approved motor vehicle emissions budget(s) for all pollutants and precursors in applicable SIP(s).		
§93.118 (b)	Document for which years consistency with motor vehicle emissions budgets must be shown.		
§93.118 (d)	Document the use of the appropriate analysis years in the regional emissions analysis for areas with SIP budgets, and the analysis results for these years. Document any interpolation performed to meet tests for years in which specific analysis is not required.		
§93.119 [iii]	For areas without applicable SIP budgets: Document that emissions from the transportation network for each applicable pollutant and precursor, including projects in the isolated rural nonattainment area that are in the Statewide TIP and regionally significant non-Federal projects, are consistent with the requirements of the “Action/Baseline” (baseline is usually 1990 for CO and PM10, 2002 for PM2.5; EPA may also designate some other baseline) interim emissions tests as applicable.		
§93.119 (g)	Document the use of the appropriate analysis years in the regional emissions analysis for areas without applicable SIP budgets.		
§93.119 (h,i)	Document how the baseline and action scenarios are defined for each analysis year.		
§93.122 (a)(1)	Document that all regionally significant Federal and non-Federal projects in the nonattainment/maintenance area are explicitly modeled in the regional emissions analysis. For each project, identify by which analysis year it will be open to traffic. Document that VMT for non-regionally significant Federal projects is accounted for in the regional emissions analysis.		

40 CFR	Criteria	Page	Comments
§93.122 (a)(2, 3)	Document that only emission reduction credits from TCMs on schedule have been included, or that partial credit has been taken for partially implemented TCMs. Document that the regional emissions analysis only includes emissions credit for projects, programs, or activities that require regulatory action if: the regulatory action has been adopted; the project, program, activity or a written commitment is included in the SIP; EPA has approved an opt-in to the program, EPA has promulgated the program, or the Clean Air Act requires the program (indicate applicable date). Discuss the implementation status of these programs and the associated emissions credit for each analysis year.		
§93.122 (a)(4,5,6)	For nonregulatory measures that are not included in the FSTIP and are needed to demonstrate conformity, include written commitments from appropriate agencies. Document that assumptions for measures outside the transportation system (e.g. fuels measures) are the same for baseline and action scenarios. Document that factors such as ambient temperature are consistent with those used in the SIP unless modified through interagency consultation.		
§93.122 (d)	Document the continued use of modeling techniques or the use of appropriate alternative techniques to estimate vehicle miles traveled.		
§93.122 [3] (e, f)	Document, in areas where a SIP identifies construction-related PM10 or PM 2.5 as contributing, the inclusion of PM10 and/or PM 2.5 construction emissions in the regional conformity analysis.		
§93.123 [1]	Document how the required procedures were met for CO, PM10, and PM2.5 hot spot analyses. Document compliance with procedures for performing qualitative and quantitative analyses.		
§93.125 (a,d)	(a) Identify and make written commitment to implement all CO, PM10, and PM2.5 mitigation or control measures identified as conditions of NEPA approval. Identify and make written commitment to implement all project-level mitigation or control measures that are identified as conditions of the regional conformity determination and are included in the design concept and scope of the project. (d) If a mitigation or control measure was identified in a previous regional conformity analysis, may be applicable to the current regional conformity determination, and is no longer needed to demonstrate regional conformity, provide justification as described in this section.		
§93.126, §93.127, §93.128	Document all projects in the isolated rural nonattainment area that are in the Statewide TIP and exempt from conformity requirements or exempt from the regional emissions analysis. Indicate the reason for the exemption (Table 2, Table 3, signal synchronization) and that the interagency consultation process found these projects to have no potentially adverse emissions impacts.		

[*] As of January 2009, all CO areas in California are attainment-maintenance so 40 CFR 93.116(b) does not apply.
Applies for hot spot analyses in rural CO, PM10, and PM2.5 nonattainment and maintenance areas only.
Applies for project-level conformity determinations in rural PM10 and PM2.5 nonattainment areas only.
Note that some isolated rural areas are required to complete both interim emissions tests, depending on ozone classification if applicable.

Disclaimers

This checklist is intended solely as an informational guideline to be used in reviewing Transportation Plans and Transportation Improvement Programs for adequacy of their conformity documentation. It does not replace or supersede the Transportation Conformity regulations of 40 CFR Parts 51 and 93, the Statewide and Metropolitan Planning Regulations of 23 CFR Part 450 or any other EPA, FHWA or FTA guidance pertaining to transportation conformity or statewide and metropolitan planning. This checklist is not intended for use in documenting transportation conformity for individual transportation projects nonattainment or maintenance areas that include an MPO. 40 CFR Parts 51 and 93 contain additional criteria for project-level conformity determinations.

10/12/2016 Caltrans update based on 2006 FHWA checklist.

Appendix G

Glossary of Transportation Terms

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APCD Air Pollution Control District, a county agency that adopts regulations to meet State and Federal air quality standards.

AQMD Air Quality Management District, a regional agency formed by 2 or more counties, which adopts regulations to meet State and Federal air quality standards.

ATTAINMENT AREA Attainment Area, is any geographic area in which levels of a given criteria air pollutant (e.g., ozone, carbon monoxide, PM10, PM2.5, and nitrogen dioxide) meet the health-based National Ambient Air Quality Standards (NAAQS) for that pollutant. An area may be an attainment area for one pollutant and a nonattainment area for others. A "maintenance area" (see definition below) is not considered an attainment area for transportation planning purposes.

BLUEPRINT PLANNING Blueprint Planning, is a Caltrans sponsored voluntary discretionary competitive grant program designed to assist MPOs in developing a regional vision that considers transportation, land use, housing, environmental protection, economic development and equity.

CAPACITY Capacity, is a transportation facility's ability to accommodate a moving stream of people or vehicles in a given time period.

CARB California Air Resources Board, the State agency responsible for implementation of the Federal and State Clean Air Acts. Provides technical assistance to air districts preparing attainment plans; reviews local attainment plans and combines portions of them with State measures for submittal of the State Implementation Plan (SIP) to U.S. EPA.

CASP California Aviation System Plan, prepared by Caltrans Division of Aeronautics every five years as required by PUC Section 21701. The CASP integrates regional aviation system planning on a Statewide basis.

CEQA California Environmental Quality Act, State law that requires the environmental effects associated with proposed plans, programs and projects to be fully disclosed.

CMA Congestion Management Agency, the county agency responsible for developing, coordinating and monitoring the Congestion Management Program.

CMP Congestion Management Program is a countywide integrated program that addresses congestion in a coordinated and cooperative manner. The program contains 5 elements: a Level of Service element, a transit standards element, a TDM and trip reduction element, a land use analysis element, and a capitol improvement program element. To effectively address this goal, the appropriate land use, transportation and air quality agencies need to integrate their planning processes, share information and respond to congestion using a coordinated approach. In 1996 AB 2419 amended government code section 65088.3 to allow counties to opt out of this previously mandatory program.

CTC California Transportation Commission, a decision making body established by AB 402(Alquist / Ingalls) of 1977 to advise and assist the Secretary of Transportation and the legislature in formulating and evaluating State policies and plans for transportation programs.

CTP California Transportation Plan, The CTP is a long-range transportation policy plan that is submitted to the Governor. The CTP is developed in collaboration with partners, presents a vision for California's future transportation system, and defines goals, policies, and strategies to reach the vision. It is developed in consultation with the State's regional transportation planning agencies, is influenced by the regional planning process, and provides guidance for developing future RTPs. RTPs should be consistent with and implement the vision and goals of the CTP. As defined by State statute, the CTP is not project specific.

DSMP District System Management Plan, a District's long-range plan for management of the State highway transportation system in its jurisdiction.

FAA Federal Aviation Administration, the agency of the U.S. Department of Transportation charged with regulating air commerce to promote its safety and development, encouraging and developing civil aviation, air traffic control and air navigation, and promoting the development of the national airport system.

EMISSIONS BUDGET Emissions Budget, is the part of the State Implementation Plan (SIP) that identifies the allowable emissions levels, mandated by the National Ambient Air Quality Standards (NAAQS), for certain pollutants from mobile, stationary, and area sources. The emissions levels are used for meeting emission reduction milestones.

FHWA Federal Highway Administration, a component of the U.S. Department of Transportation, established to ensure development of an effective national road and highway transportation system. FHWA and FTA, in consultation with US EPA, make Federal Clean Air Act Conformity findings for

Regional Transportation Plans, Transportation Improvement Programs, and Federally funded projects.

FISCAL CONSTRAINT

Fiscal constraint, the metropolitan transportation plan, TIP, and STIP includes sufficient financial information for demonstrating that projects in the metropolitan transportation plan, TIP, and STIP can be implemented using committed, available, or reasonably available revenue sources, with reasonable assurance that the Federally supported transportation system is being adequately operated and maintained. For the TIP and the STIP, financial constraint/fiscal constraint applies to each program year. Additionally, projects in air quality nonattainment and maintenance areas can be included in the first two years of the TIP and STIP only if funds are ''available'' or ''committed.''

FTA

Federal Transit Administration, a component of the U.S. Department of Transportation, responsible for administering the Federal transit program under the Federal Transit Act, as amended, and SAFETEA-LU.

FSTIP

Federal State Transportation Improvement Program is a multi-year Statewide, financially constrained, intermodal program of projects that is consistent with the Statewide transportation plan (CTP) and regional transportation plans (RTPs). The FSTIP is developed by the California Department of Transportation and incorporates all of the MPOs *and* RTPAs FTIPs by reference. Caltrans then submits the FSTIP to FHWA.

FTIP

Federal Transportation Improvement Program is a constrained 4-year prioritized list of all transportation projects that are proposed for *Federal and local* funding. The FTIP is developed and adopted by the MPO/RTPA and is updated every 4 years. It is consistent with the RTP and it is required as a prerequisite for Federal funding.

IIP

Interregional Improvement Program is one of two component funding source programs that ultimately make up the State Transportation Improvement program. The IIP receives 25% of the funds from the State Highway account. The IIP is the source of funding for the ITIP.

ILLUSTRATIVE PROJECT

An illustrative project means an additional transportation project that may (but is not required to)be included in a financial plan for the RTP or FTIP if reasonable additional resources were to become available.

INTERMODAL

Intermodal refers to the connections between modes of transportation.

ITIP Interregional Transportation Improvement Program is a Statewide program of projects, developed by Caltrans for interregional projects that are primarily located outside of urbanized areas. The ITIP has a 4-year planning horizon and is updated every two years. It is submitted to the CTC along with the FTIP and taken together they are known as the STIP.

ITS Intelligent Transportation Systems are electronics, photonics, communications, or information processing used singly or in combination to improve the efficiency or safety of a surface transportation system.

ITSP Interregional Transportation Strategic Plan describes the framework in which the State will carry out its responsibilities for the Interregional Transportation Improvement Program (ITIP).

MIS Major Investment Study was a Federally mandated study required for major transportation improvements under ISTEA. An MIS was a planning analysis done on a corridor or sub-regional area that included social, economic and environmental considerations early in the planning process and integrated these considerations into the project development stage. Although SAFETEA-LU has deleted this requirement, Section 450.318(a) and Appendix A retains the option to link early environmental considerations in the RTP to the subsequent project specific environmental review that takes place during the project delivery process.

MODE Mode is a specific form of transportation, such as automobiles, buses, trains or planes.

MPO Metropolitan Planning Organization, a planning organization created by Federal legislation charged with conducting regional transportation planning to meet Federal mandates.

NATIONAL AMBIENT AIR QUALITY STANDARDS NAAQS are the acceptable limits that are set for various pollutants by the US EPA. Air quality standards have been established for the following six criteria pollutants: ozone, carbon monoxide, particulate matter, nitrogen dioxide, lead and sulfur dioxide.

NEPA National Environmental Policy Act is Federal legislation that created a national policy and procedures that require Federal agencies to consider the environmental effects of their actions and to inform the public that their decisions reflect this environmental consideration. NEPA applies to most transportation projects because they are jointly funded with a combination of Federal, State and sometimes local money.

NONATTAINMENT Nonattainment, any geographic region of the United States that has been designated by the EPA as a nonattainment area under section 107 of the Clean Air Act for any pollutants for which an NAAQS exists.

PERFORMANCE MEASURES Performance measures are used to model travel demand and allow the long-range forecasting of transportation network and system-level performance (e.g. Walk, bike, transit, and carpool mode share, corridor travel times by mode, percentage of population within 0.5 mile of a high frequency transit stop).

PERFORMANCE MONITORING INDICATORS/METRICS Performance monitoring indicators or metrics include field data such as vehicle miles traveled, mode share, fatalities/injuries, transit access, change in agricultural land, and CO2 emissions.

PERFORMANCE TARGETS Performance targets are numeric goals established to enable the quantifiable assessment of performance measures.

RIP Regional Improvement Program is one of two component funding source programs that ultimately make up the State Transportation Improvement program. The RIP receives 75% of the funds from the State Highway account. This 75% is then distributed to the MPOs and RTPAs by a formula. The RIP is the source of funding for the FTIP.

RTIP Regional Transportation Improvement Program, is a program proposal of projects prepared by the regions in coordination with Caltrans for inclusion in the STIP.

RTP Regional Transportation Plan, a Federal and State mandated planning document prepared by MPOs and RTPAs. The plan describes existing and projected transportation needs, conditions and financing affecting all modes within a 20-year horizon.

RTPA Regional Transportation Planning Agency, a State designated single or multi-county agency responsible for regional transportation planning. RTPAs are also known as Local Transportation Commissions or Councils of Governments and are usually located in rural or exurban areas.

SHA State Highway Account, the SHA account is the State's primary source of funding for transportation improvements. The SHA account is composed of revenues from the State's gasoline and diesel fuel tax, truck weight fees and Federal highway funds. The

SHA is primarily used for STIP, SHOPP and local assistance projects as well as non-capitol projects such as maintenance, operations, and support.

SHOPP — State Highway Operations and Protection Program is a legislatively created program to maintain the integrity of the State highway system. It is tapped for safety and rehabilitation projects. SHOPP is a multi-year program of projects approved by the Legislature and Governor. It is separate from the STIP.

SIP — State Implementation Plan, as defined in section 302(q) of the Clean Air Act (CAA), the portion (or portions) of the implementation plan, or most recent revision thereof, which has been approved under section 110 of the CAA, or promulgated under section 110(c) of the CAA, or promulgated or approved pursuant to regulations promulgated under section 301(d) of the CAA and which implements the relevant requirements of the CAA.

SMART GROWTH — Smart Growth, is a set of policies designed by local governments to protect, preserve and economically develop established communities as well as natural and cultural resources. Smart growth encompasses a holistic view of development.

SPRAWL — Sprawl is an urban form based on the movement of people from the central city to the suburbs. Concerns associated with sprawl include loss of farmland and open space due to low-density land development, increased public service costs including transportation, and environmental degradation.

STIP — State Transportation Improvement Program, a Statewide or bundled prioritized list of transportation projects covering a period of four years that is consistent with the long-range Statewide transportation plan, metropolitan transportation plans and FTIPs, and required for projects to be eligible for funding under Title 23 U.S.C. and title 49 U.S.C. Chapter 53.

TCM — Transportation Control Measures, any measure that is specifically identified and committed to in the applicable SIP that is either one of the types listed in section 108 of the Clean Air Act or any other measure for the purpose of reducing emissions or concentrations of air pollutants from transportation sources by reducing vehicle use or changing traffic flow or congestion conditions. Notwithstanding the above, vehicle technology-based, fuel-based, and maintenance-based measures that control the emissions from vehicles under fixed traffic conditions are not TCMs.

TIERING — Section 15385 of the CEQA guidelines defines tiering as the coverage of general matters in broader EIRs with subsequent narrower EIRs incorporating by reference the general discussions and concentrating solely on the issue specific to the EIR that is being subsequently prepared. Tiering allows agencies to deal with broad environmental issues in EIRs at the planning stage and then to provide a more detailed examination of specific effects in EIRs for later development projects that are consistent with or that implement the plan.

TITLE VI — Title VI of the Civil Rights Act of 1964, prohibits discrimination in any program or project receiving Federal financial assistance.

TDM — Transportation Demand Management refers to policies, programs and actions that encourage the use of transportation alternatives to driving alone and reduce vehicle miles traveled.

TSM — Transportation System Management refers to the use of relatively inexpensive transportation improvements that are used to increase the efficiency of transportation facilities. TSM can include carpool and vanpool programs, parking management, traffic flow improvements, high occupancy vehicle lanes, and park-and-ride lots.

US EPA — United States Environmental Protection Agency is the Federal agency that approves the SIP and the emissions budgets that are the basis of the RTP conformity assessments.

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Appendix H

Planning Practice Examples

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Appendix H Contents

Introduction

This appendix aggregates Metropolitan Planning Organization (MPO)-specific planning practice examples and resource information into a single location organized by topic area. While acknowledging the different statutory requirements of MPOs and RTPAs in RTP development, the examples contained in this appendix are not intended to establish baseline standards but rather serve to highlight exemplary, state of the art planning practices that Regional Transportation Planning Agencies (RTPAs) can seek to emulate in their planning processes as financial and technical resources allow.

Efforts have been made to highlight planning practices that are being undertaken by large, medium, and small MPOs in both rural and urban areas throughout the state. It is important to note that this appendix represents a snapshot of available resources and planning practices representative of the time at which these guidelines were prepared.

Coordination with Other Planning Processes

Regional Transportation Plans (RTPs) are prepared within the context of many other planning processes conducted by federal, state, and local agencies. This section provides resources associated with planning processes that are used by state, federal and local agencies such as Caltrans, the Federal Highway Administration, and local jurisdictions to further their respective goals and objectives associated with the California Transportation Plan, the federal Partnership for Sustainable Communities, and local General Plans. As the RTP is bound by fiscal constraint, the strategies, actions, and improvements described in this section are intended to inform the development of the RTP and should be considered to the maximum extent feasible.

Please see **Section 2.7** in the RTP Guidelines for additional information on these areas.

Smart Mobility Framework

The Caltrans Smart Mobility Framework (SMF) is a key strategic tool for integrating transportation with land use, to develop healthy and livable communities through multi-modal travel options, reliable travel times, and safety for all users of the transportation system. Additional Smart Mobility Framework information and resources are available at the following links:

http://www.dot.ca.gov/transplanning/ocp/sm-framework.html

http://smartmobilityca.org/

Planning for Public Health and Health Equity

Please see **Section 2.3** and **Appendix L** of the MPO RTP Guidelines for resources and planning practice information regarding the consideration of public health and health equity in the regional transportation planning process.

Complete Streets

The term “Complete Street” refers to a transportation network that is planned, designed, constructed, operated, and maintained to provide safe mobility for all users including: bicyclists, pedestrians, transit and rail riders, as well as commercial vehicles and motorists appropriate to the function and context of the facility. Complete Streets policies and practices are best implemented with a comprehensive and integrated approach of all agencies involved, taking advantage of opportunities for synergies and cost savings such as restriping when repaving.

General Complete Streets background, resources, and practice information at the state and national level:

Smart Growth America offers an interactive resources data base which offers information and case studies on a variety of mobility topics including Complete Streets: https://smartgrowthamerica.org/resources/

The National Complete Streets Coalition provides success stories, frequently asked questions, examples, and resources including sample presentations here: http://www.completestreets.org/

The National Complete Streets Coalition provides a map with states and local jurisdictions that have adopted complete streets policies: https://smartgrowthamerica.org/program/national-complete-streets-coalition/

Safe Routes to Schools National Partnership Complete Streets resources are available here: http://saferoutespartnership.org/state/bestpractices/completestreets

The guide Complete Streets: Making Roads Safe and Accessible for All Users (Safe Routes to Schools National Partnership, 2013) provides information on Complete Streets policies in underserved communities.

A Complete Intersections Guide can be downloaded from the Caltrans Pedestrian Safety Resources website: http://nacto.org/docs/usdg/complete_intersections_caltrans.pdf

Accommodating Bicycle and Pedestrian Travel: A Recommended Approach is a policy statement adopted by the United States Department of Transportation (USDOT). USDOT hopes that public agencies, professional associations, advocacy groups, and others will also adopt this approach as a way to promote the integration of bicycling and walking into the transportation main stream: http://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/design.cfm

The American Planning Association Knowledge Center offers Complete Streets applied research resources: http://planning.org/research/streets/

The AARP Complete Streets Archive provides reports, case studies, presentations and more.

State-Level Plans addressing Complete Streets:

http://www.californiatransportationplan2040.org/

http://www.cabikepedplan.org/

Regional Planning Practice Examples of Complete Streets Policies:

Large/Urban MPO Examples:

The following link contains a case study in the SCAG region of how MPOs can integrate neighborhood electric vehicles into a complete streets policy:

http://www.scag.ca.gov/sb375/pdfs/FS/cs-SouthBayStrategy.pdf

The following links contains planning practice examples of integrating Complete Streets Policies in the Metropolitan Transportation Commission (MTC) bay-area region and the San Diego Region:

http://mtc.ca.gov/our-work/plans-projects/bicycle-pedestrian-planning/complete-streets

http://www.sandag.org/index.asp?classid=12&projectid=521&fuseaction=projects.detail

Small/Medium and Rural MPO Examples:

Tahoe Metropolitan Planning Organization and the Tahoe Regional Planning Agency developed the following Complete Street Resource Guide:

http://tahoempo.org/activetransportationplan/docs/appendices/Appendix%20A_Complete%20Street%20Resource%20Guide.pdf

Local Planning Guidance for Complete Streets

Governor's Office of Planning and Research General Plan Guidelines:

https://www.opr.ca.gov/s_generalplanguidelines.php

Regional Travel Demand Modeling & Analysis

Please see **Section 3.5** for resources and planning practice information regarding travel demand modeling and analysis for the preparation of an RTP.

RTP Consultation and Coordination

Public Participation Plan

The purpose of the Public Participation Plan is to establish the process by which the public can participate in the development of regional transportation plans and programs. Please see **Section 4.1** in the RTP Guidelines for Statutory requirements associated with Public Participation Plan development and the public input process for preparing the RTP.

Exemplary planning practice examples of MPO Public Participation plans and processes include incorporating public participation strategies in the RTP that ensure members of the public are engaged throughout the development of the RTP. Given the complex nature of transportation planning, MPOs can use public participation as a way to ensure local residents and community-based organizations are active participants at each step of the process. Open-invite roundtables and/or on-going advisory committees are one way that MPOs can seek public input throughout the process.

Various MPOs have developed on-going advisory committees that included a wide range of interests including representation from historically underserved communities and rural areas. These advisory committees met regularly throughout the development of the RTP to ensure the document reflected the goals of the community. Other MPOs used on-line educational survey tools and games in addition to workshops, roundtables, and phone surveys, to allow the public to balance their priorities for the region. Additional information and specific examples are provided below:

Large/Urban MPO Examples:

Metropolitan Transportation Commission Public Participation Plan
http://www.mtc.ca.gov/get_involved/participation_plan.htm

Sacramento Area Council of Governments Public Participation Plan
http://www.sacog.org/sites/main/files/file-attachments/public_participation_plan_2013.pdf

SANDAG Public Involvement Plan:
http://www.sandag.org/uploads/projectid/projectid_428_15559.pdf

Small/Medium/Rural MPO Example:

Kern Council of Governments Online Educational Survey Game
http://www.directionsto2050.com/

To the extent that it is practicable and resources are available, the Draft RTP as well as any comments received to the draft could be posted on the MPO website in a way that is easily accessible to the public. The table below provides links to the websites of all eighteen California MPO's:

MPO Name	Website
Association of Monterey Bay Area Governments	www.ambag.org
Butte County Association of Governments	www.bcag.org
Fresno Council of Governments	www.fresnocog.org
Kings County Association of Governments	www.kingscog.org
Kern Council of Governments	www.kerncog.org
Merced County Association of Governments	www.mcagov.org
Madera County Transportation Commission	www.maderactc.org
Metropolitan Transportation Commission	www.mtc.ca.gov
Sacramento Area Council of Governments	www.sacog.org
San Diego Association of Governments	www.sandag.org
San Joaquin Council of Governments	www.sjcog.org
San Luis Obispo Council of Governments	www.slocog.org
Santa Barbara County Association of Governments	www.sbcag.org
Shasta Regional Transportation Agency	www.srta.ca.gov
Southern California Association of Governments	www.scag.ca.gov
Stanislaus Council of Governments	www.stancog.org
Tulare County Association of Governments	www.tularecog.org
Tahoe Metropolitan Planning Organization	http://www.trpa.org/transportation/

Title VI, Environmental Justice, and Social Equity Considerations in the RTP

This section includes planning practices relevant to the requirements described in Chapter 4, especially sections 4.2, 4.3 and 4.4. These requirements include conducting a social equity analysis to ensure that any planned regional transportation improvements do not have a disproportionately high and adverse impact on low income or minority populations, and to ensure that the plan will not result in the denial of, reduction in, or significant delay in the receipt of benefits by minority or low-income populations.

In order to identify and address (if further mitigation measures or alternatives are feasible that would reduce the disproportionately high and adverse effects) disproportionately high and adverse effects of programs, policies, and activities on minority and low-income populations to achieve an equitable distribution of benefits and burdens in the RTP, MPOs are called upon to (1) *identify which populations and communities are low income or minority*, and to (2) *determine what metrics they will use to measure the benefits* and burdens to those populations and communities. They are then called up to (3) *conduct an appropriate social equity analysis*, as discussed in section 4.2. Finally, (4) *a public participation* is required to ensure that the RTP planning process succeeds in "seeking out and considering the needs of low-income and minority households."

Planning practices relevant to each of these requirements are collected here:

1.) Identifying protected communities:

FTA Circular 4703.1 emphasizes the importance of understanding a community when addressing environmental justice, both in identifying low income and minority communities through the use of Census data and in engaging with potentially impacted residents and community-based organizations. In defining a unit of geographic analysis, a study area "must be appropriate to the scope of the plan, program, or project to determine disproportionate burdens on EJ versus non-EJ populations." As such, MPOs ought to "make reasonable efforts to identify the presence of distinct minority and/or low-income communities residing both within, and in close proximity to, the proposed project or activity and to identify those minority and/or low income groups who use or are dependent upon natural resources that could be potentially affected by the proposed action." This may involve analysis that summarizes impacts for areas with the highest concentration of EJ populations or potential burdens within an MPO's service area.

One particular approach, pioneered by the U.S. Department of Housing and Urban Development (HUD), for identifying especially impacted communities, is known as "Racially Concentrated Areas of Poverty." HUD's definition is "a geographic area with significant concentrations of poverty and minority populations." The concept is flexible and can be readily adapted to local conditions. For instance, in Minnesota's Twin City region, the Metropolitan Council provides a two-step definition for Areas of Concentrated Poverty. The first, contiguous census tracts where at least 40% of residents live in households with incomes below 185% of the federal poverty line. The second, a refinement of HUD's concept which further identifies, as particularly vulnerable, Areas of Concentrated Poverty where at least 50% of the residents are people of color.

2.) Defining “benefits” and “burdens” to those protected communities:

While there is some federal guidance on candidate social equity performance measures, the measures can vary according to regional goals. Examples of performance measures that have been used by California MPOs are:

- Share of population within 1/4 or 1/2 mile of transit
- Travel Time
- Active Transportation' infrastructure
- Share of transportation system usage by population type
- Physical activity (time or distance) walking/biking
- Distribution of investments
- Combined housing / transportation affordability
- Gentrification / displacement
- Access to employment
- Access to parks or open space
- Access to medical or health care facilities
- Access to primary or secondary schools
- Access to higher education
- Access to grocery stores
- Air quality - localized (near roads, ports, rail yards, etc.)
- Traffic safety - active modes
- Air quality - regional distribution
- Roadway noise

Some of these performance measures are intended to help evaluate whether a particular population will be more heavily burdened than others if the RTP is implemented, while others are intended to indicate whether some groups will glean more benefits than others if the RTP is implemented. Based on factors such as community input, availability of the necessary data, technical capabilities of the MPO, and likely accuracy of the results of the analysis, each MPO through outreach to and consultation with residents of affected communities can choose these or other measures best suited to its region.

In addition, non-governmental organizations have identified planning examples from other contexts. One example is guidance the California Air Resources Board (ARB) has provided on the implementation of SB 535 (De León).

[1] ARB’s GGRF Funding Guidelines require implementing agencies to “give priority to those [investments] that maximize benefits to disadvantaged communities” by “favor[ing the] projects which provide … the most significant benefits” to them. More specifically, the Guidelines require that every investment intended to benefit a disadvantaged community “provide[] direct, meaningful, and assured benefits to one or more disadvantaged communities.”

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[1] That statute requires that “a minimum of 25 percent” of moneys in the Greenhouse Gas Reduction Fund go “to projects that provide benefits to” disadvantaged communities and “a minimum of 10 percent … to projects located within” those communities. Health & Saf. Code § 39713.

ARB's Funding Guidelines[2] define the benefit a GGRF investment must provide under SB 535 as "a benefit that *meaningfully addresses an important community need*" in a disadvantaged community.[3] ARB's definition of "benefit" is also directly relevant to the crafting of an equity and EJ analysis of the RTP, as discussed in the next section. In addition, ARB's Funding Guidelines require that "projects be designed to *avoid substantial burdens*, such as physical or economic displacement of low-income disadvantaged community residents and businesses or increased exposure to toxics or other health risks."[4]

3.) Conducting the social equity analysis:

Many California MPOs have conducted environmental justice and social equity analyses in their respective RTP/SCS reports. Federal and state agencies have also compiled best practices in environmental justice and equity analysis in various topic areas from RTPs across the nation[5]. Efforts are underway by SANDAG[6], in partnership with other regional transportation planning agencies and Caltrans, to develop a Social Equity Analysis Method (SEAM) and a Social Equity Analysis Tool (SEAT) to assist with RTP development. This project, which is partly funded by a Caltrans Partnership Planning grant, will produce a tool that MPOs and RTPAs could use when assessing benefits and burdens on various 'social equity focus' (SEF) populations (e.g. low income and minority groups) that are expected to occur if the programs and projects in an RTP are implemented. The final version of the SEAT is expected to be complete in the first quarter of 2018 and will include up to eight performance measures – some of which will measure relative benefits and others that will measure relative burdens. The goal is to provide an analysis tool with functionality in a GIS-based application that can be used by agencies throughout the state.

MPOs also can work with environmental justice and social equity stakeholders through the RTP/SCS outreach process to develop additional measures and analyses to illustrate and identify the historical and current conditions of transportation and land use for low income and minority communities to ensure future transportation investments will not further cause disproportional impacts to those communities.

As MPOs seek to respond to the needs and concerns of low-income and minority communities, a planning practice from another (non-RTP) context that MPOs may incorporate comes from the U.S. Department of Housing and Community Development (HUD) rule on "affirmatively furthering fair housing" (or AFFH). AFFH looks at

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2 Air Resources Board, Cap-and-Trade Auction Proceeds Funding Guidelines for Agencies that Administer California Climate Investments (Dec. 2015), p. 2.A-6, available at http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/fundingguidelines.htm

3 *Id*., p. 2-6. *See id*., p. 1.A-12 (requiring reporting on "disadvantaged community benefits and … strategies the agency will use to maximize benefits" to them).

4 *Id*. p. 2-12.

5 Examples include: http://dot.ca.gov/hq/LocalPrograms/saferoutes/EnvironmentalJusticeDeskGuideJan2003.pdf, http://www.fhwa.dot.gov/environment/environmental_justice/resources/, http://www.fhwa.dot.gov/environment/environmental_justice/case_studies/

6 SANDAG Statewide Social Equity project description: http://sdforward.com/ContinuingActions/SocialEquityEnvJustice.aspx.

neighborhood-level transportation and transit access, educational and economic opportunity, and environmental health factors.[7]

The AFFH begins with assessing "the elements and factors that cause, increase, contribute to, maintain, or perpetuate segregation, racially or ethnically concentrated areas of poverty, significant disparities in access to opportunity, and disproportionate housing needs."[8] The basic methodology for HUD's AFFH rule includes the following steps:

1. Identify, with robust community engagement, current patterns and conditions of segregation, racially concentrated poverty, disparities in access to opportunity, and disproportionate housing needs, utilizing data HUD provides and other relevant regional data;
2. Identify key contributing factors of the patterns and conditions identified;
3. Prioritize the most significant contributing factors and set goals that will meaningfully address the high priority factors, with "metrics and milestones" for each goal;
4. Tailor near-term actions and investments consistent with those goals; and
5. Measure progress over the near term. (24 C.F.R. § 5.154(d) (2), (3), (4), (5) and (7).)

The HUD rule is discussed in a recent letter that the Secretary of the U.S. Department of Transportation issued with the Secretaries of HUD and the U.S. Department of Education.[9] That letter emphasized the relevance of transportation to the issues of segregation, access to opportunity, and racially-concentrated poverty, and encouraged transportation agencies (including MPOs) nationally to integrate the principles and goals of AFFH into their decision-making. In particular, the letter called on transportation agencies to "identify impediments to accessing opportunity" and to "coordinate efforts to address" issues of segregation and opportunity.[10] In considering whether to align its equity analysis with the Assessment its local jurisdictions are called up to conduct, an MPO will have the opportunity to ensure coordination regionally of local actions to identify and address current conditions of inequity.

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[7] HUD, Assessment Tool (Public Dec. 31, 2015) at 8, available online at https://www.huduser.gov/portal/sites/default/files/pdf/Assessment-of-Fair-Housing-Tool.pdf (last accessed July 12, 2016).

[8] 24 C.F.R. § 5.154 (a).

[9] The Tri-Agency letter, issued on June 3, 2016, is available at https://www2.ed.gov/documents/press-releases/06032016-dear-colleagues-letter.pdf.

[10] The letter states: "Today, our agencies are calling on local education, transportation, and housing leaders to work together on issues at the intersection of our respective missions in helping to guarantee full access of opportunity across the country. Our goals are to identify impediments to accessing opportunity; to coordinate efforts to address these issues and to provide broad-reaching benefits; and to ensure that every child and family is provided with transportation, housing, and education tools that promote economic mobility. The new process in which communities are engaging under the Affirmatively Furthering Fair Housing rule (AFFH rule) from HUD provides an opportunity for cross-agency collaboration and strong community involvement. We urge you to take full advantage of the community participation process of the AFFH rule, so that regional planning promotes economic mobility and equal access to the many benefits provided by affordable housing, great schools, and reliable transportation."

Public Engagement Practices for "Seeking Out and Considering the Needs of Low-income and Minority Households":

Building on the emphasis of public engagement outlined in FTA Circular 4703.1, it is recommended that MPOs "ensure the full and fair participation by all potentially affected communities in the transportation decision-making process….Understanding the needs and priorities of environmental justice populations will also help…to balance the benefits of the proposed project against its adverse effects." If an adverse effect is "predominantly borne by an EJ population, or will be suffered by the EJ population and is appreciably more severe or greater in magnitude than the adverse effect that will be suffered by the non-EJ population", engagement with an affected community can help to identify an appropriate strategy to mitigate, reduce, avoid, and/or offset adverse effects. Public outreach is, therefore, an essential component of an MPO's environmental justice efforts and should employ strategies to increase engagement in the transportation decision-making process from low income and minority populations. Specific strategies covering location, timing, content, format, noticing, and accessibility requirements of public outreach meetings are detailed in Chapter III of FTA Circular 4703.1.

MPOs can encourage the involvement of low-income communities and communities of color by proactively seeking the input of these households and by making public meetings as accessible as possible. Public engagement strategies to promote inclusion of these communities may include:

- Conduct education and outreach before beginning the formal input process;
- Provide all materials related to the update with adequate time for public review and input.
- Provide early and ongoing drafts for public review to ensure transparency.
- Proactively work with and/or provide financial support, as resources allow, to community-based and membership organizations across the region to help engage low-income residents and residents of color in the public process and to jointly plan public workshops or other engagement opportunities.
- Form an advisory group on Environmental Justice, Social Equity and/or Disadvantaged Communities that includes policy and community-based organizations that are focused on social equity in the region to provide feedback throughout the RTP process.
- Ensure that community residents have the opportunity to deliberate together to achieve consensus on their most pressing needs and recommendations.
- Hold meetings at accessible locations and outside of traditional working hours (e.g. evenings and weekends);
- Locate meetings in low-income communities and communities of color;
- Locate meetings at sites accessible via affordable transit;
- Translate meeting materials for non-English speakers;
- Consider the needs to low-income and individuals with limited English proficiency when translating outreach materials and ensuring that documents are easy to understand (i.e. evaluate the reading level of the materials and quality of translations);
- Technology and the Internet can reach many people, but recognize that not everyone has access to the Internet and an email address and that efforts should be made to reach individuals in other ways;
- Provide interpretation at meetings for non-English speakers;

- Create resident advisory committees or roles within existing committees with decision-making authority and identify opportunities for disadvantaged communities to serve as representatives on decision-making bodies;
- Expand the list of potential partners to include: schools, the faith community, agriculture and food hubs, local business or chambers of commerce, health providers and public health sectors, funders/philanthropy, academia, and environmental health/justice advocates, libraries, law enforcement, parks and recreation, and the technology industry;
- Create a feedback loop to provide community members information about how their input was included in any drafts and reasons for including/excluding the input;
- Make sure that there is agreement between residents and the local planning authority about what community engagement includes;
- Educate and build capacity of community members on issues such as data, evaluation, storytelling, and mentoring community members new to the process;
- Use a community health worker or promotora model to identify resident leaders;
- Use facilitators with experience in race and power inequities at community meetings;
- Work with community-based and membership organizations across the region to jointly plan public workshops on the RTP, especially the Title VI and Environmental Justice analyses. They know the communities impacted by the RTP transportation projects and can assist with recruiting residents, businesses and other affected stakeholders. Be proactive in asking for their participation instead of waiting for them to come to you; and,
- Ensure meetings are attended by MPO decision makers in addition to MPO staff.

Exemplary planning practice examples of MPO efforts to address Title VI, Environmental Justice, and Social Equity Considerations in the RTP are provided below:

Large/Urban MPO Examples:

http://planbayarea.org/the-plan/plan-details/equity-analysis.html

http://www.scag.ca.gov/programs/Pages/EnvironmentJustice.aspx

http://www.sdforward.com/pdfs/RP_final/AppendixH-SocialEquityEngagementandAnalysis.pdf

Statewide Social Equity Analysis Tool:

SANDAG, through a Caltrans Strategic Partnership Grant, is collaborating with large and small MPOs and RTPAs in the state to develop a tool that can be used for conducting Social Equity Analyses for regional plans throughout the state of California.
Currently agencies use varied approaches when conducting a social equity analyses of regional plans such as RTPs and the SCSs required by SB 375. There is not a widely accepted tool used by regional and local agencies to model the burdens and benefits of regional plans and the projects they encompass to consistently evaluate environmental justice outcomes expected to result from a plan or project. This project calls for identification of best practices being used by regional agencies to analyze proposed plans and covered projects and development of a Social Equity Analysis Methodology

(SEAM) and Social Equity Analysis Tool (SEAT) for statewide use. For more information visit: http://sdforward.com/ContinuingActions/SocialEquityEnvJustice.aspx

Small/Medium and Rural MPO Examples:

To help ensure diverse and direct input from all populations especially those with the most potential to be affected by health inequities, Fresno Council of Governments (FresnoCOG) administers a "Community-Based Mini-Grant Outreach Program[11]," which competitively awards mini-grants ($1,000 - $3,000) to community-based organizations, schools, and other groups to conduct outreach to individuals not typically involved in the regional transportation planning process. The selected organizations conduct outreach activities such as organizing and tailoring meetings, customizing presentations materials, building trust and removing barriers to participation to secure public involvement from stakeholders in their communities and the populations they currently serve, engaging them in the planning process and generating feedback on the development of the RTP and SCS.

Additional statewide examples of stakeholder engagement strategies are also compiled in the following report developed by ClimatePlan:
Leading the Way: Policies and Practices for Sustainable Communities

Private Sector Involvement

Private sector involvement refers to engaging the goods movement industry and other business or commercial interests in the development of the RTP. Trucks, freight trains, taxis, limousines, and shared mobility companies all use the transportation network and are an integral part of the regional transportation system. Other examples of private sector entities to engage in the development of the RTP include Transportation Management Associations, private transit operators, developers, and Chambers of Commerce. Private sector involvement informs the regional transportation planning process can contribute to greater efficiency of the planned transportation network.

Exemplary planning practice examples of MPO efforts to engage the private sector in RTP development are provided below:

Large/Urban MPO Examples:

http://www.sacog.org/regional-plans

The National Highway Institute offers training on engaging the Private Sector in Freight Planning:
http://www.nhi.fhwa.dot.gov/training/course_search.aspx?sf=0&course_no=139009

[11] Administered as a contractual arrangement with community based consultants for outreach services that is subject to the federal procurement process. See:
http://www.fresnocog.org/sites/default/files/publications/RTP/RTP_Mini_grant_app_Fresno_COG.pdf

Consultation with Interested Parties

The US DOT defines consultation as when: "*one or more parties confer with other identified parties in accordance with an established process and, prior to taking action(s), considers the views of the other parties and periodically informs them about action(s) taken*." Some areas of consultation could include transportation, land use, employment, economic development, housing, community development and environmental issues. Consultation requirements for the RTP are outlined in **Section 4.6**.

Large/Urban MPO Examples:

http://rtpscs.scag.ca.gov/Pages/default.aspx
Exemplary planning practice examples of MPO consultation efforts are provided below:

Small/Medium and Rural MPO Example:

http://www.sjcog.org/index.aspx?nid=181

Native American Tribal Government Consultation and Coordination

California is home to many non-federally recognized tribes as well as Native Americans living in urban areas. MPOs should involve the Native American communities in the public participation processes. Establishing and maintaining government-to-government relations with federally recognized Tribal Governments through consultation is separate from, and precedes the public participation process. Tribal Consultation requirements for the RTP are outlined in **Section 4.7**.

US DOT Order 5301.1 ensures that programs, policies and procedures administered by the US DOT are responsive to the needs and concerns of Native Americans. This Order provides a very thorough overview of the various Federal regulations and Executive Orders on this subject. This Order is available at:

http://environment.fhwa.dot.gov/guidebook/vol2/5301.1.pdf

It is recommended that federally and non-federally recognized Tribal Governments be consulted when historic, sacred sites, subsistence resources or traditional collecting properties are present in the MPOs jurisdiction.

An exemplary planning practice example of MPO Tribal Consultation efforts is provided below:

http://www.sdforward.com/pdfs/RP_final/AppendixG-TribalConsultationProcessforSanDiegoForward-CommunicationCooperationandCoordination.pdf

Consultation with Resource Agencies

Current federal regulations require MPOs to consult with resource agencies, State and local agencies responsible for land use management, environmental protection, conservation, and historic preservation concerning the development of the RTP. As part of SCS development, MPOs must gather and consider the best available scientific information on resource areas and farmlands within the region. State and federal resource agencies may be able to assist MPOs by providing data, maps, or other information. Detailed information regarding Resource Agency Consultation during RTP development is available in **Section 4.8**.

Transportation agencies and resource agencies have developed methods to better incorporate resource issues into transportation planning processes to benefit both transportation planning and project delivery as well as ecological outcomes. Two examples of processes are:

1) FHWA's *Eco-logical Approach* organizes current methods for addressing natural resource identification, avoidance, minimization and mitigation into a systematic, step-wise process that starts at the beginning of the transportation planning process and concludes with establishing programmatic approaches to recurring natural resource issues that are implemented at the project level. FHWA has developed an implementation approach called Integrated Eco-logical Framework (IEF), a nine-step, voluntary framework for partners to collaborate, share data, and prioritize areas of ecological significance. Implementing IEF at a regional scale during RTP development would allow for early coordination with resource agencies and other key stakeholders to establish a Regional Ecosystem Framework. This approach is also consistent with Regional Advance Mitigation Planning (RAMP) models developed by the RAMP Statewide Working Group.

   https://www.environment.fhwa.dot.gov/ecological/ImplementingEcoLogicalApproach/default.asp

   https://rampcalifornia.water.ca.gov/

2) AB 2087 (Levine, 2016) establishes a pilot study program for a conservation planning tool called a Regional Conservation Investment Strategy (RCIS). The purpose of the RCIS is to promote the conservation of species, habitats and other natural resources and enable advance mitigation for public infrastructure projects, including transportation. An RCIS provides a voluntary, non-regulatory assessment and analysis of conservation needs in a region including habitat connectivity and climate resilience. Transportation agencies can use an approved RCIS to secure mitigation credit for conservation investments consistent with the RCIS through a Mitigation Credit Agreement (MCA). Pursuant to AB 2087, an RCIS pilot study program is presently under development and all RCISs and MCAs must be approved prior to January 1, 2020.

Exemplary planning practice examples of Resource Agency consultation efforts and resulting planning products are provided below:

Large/Urban MPO Examples:

The San Diego Association of Governments' *TransNet* Environmental Mitigation Program (EMP), funded by local sales tax dollars, is unique in that it goes beyond traditional mitigation for transportation projects by including a funding allocation for habitat acquisition, management, and monitoring activities as needed to help implement the Multiple Species Conservation Program (MSCP) and the Multiple Habitat Conservation Program (MHCP) which are developed through extensive consultation with resource agencies. Information regarding the *TransNet* EMP is available at:

http://www.sandag.org/index.asp?projectid=263&fuseaction=projects.detail

The Southern California Association of Governments' (SCAG) recently approved SCS Appendix on Natural and Farm Lands is a prime example of successful consultation with environmental agencies and stakeholders. SCAG established an Open Space Conservation Working Group (which included resource agencies), developed a comprehensive database with resources for county transportation commissions, local governments and other planning agencies to use in their conservation and mitigation planning processes, along with a report to provide context. The SCAG SCS Appendix is available at:

www.scagrtpscs.net/Documents/2016/final/f2016RTPSCS_NaturalFarmLands.pdf

Small/Medium and Rural MPO Examples:

Butte County Association of Government's (BCAG) RTP/SCS and Regional Conservation Plan. BCAG adopted the Butte County Regional Conservation Plan (Plan), a regional Natural Community Conservation Plan/Habitat Conservation Plan (NCCP/HCP), to streamline the development and mitigation associated with public and private development in the planning area. BCAG's RTP/SCS is built around a set of general plans designed to be consistent with the Regional Conservation Plan. Preparation and adoption of the Regional Conservation Plan required extensive resource agency coordination with the planning signatories upon issuance of federal and state permits along with the Plan.

http://www.buttehcp.com/

Integrating Ecological Considerations into Transportation Planning and Project Delivery

This section discusses regionally important natural resources such as farmlands and habitat corridors that should be identified during the development and update process of RTPs, in order to more effectively implement transportation projects during the environmental review and permitting processes. This should not be considered a comprehensive list of environmental resources to consider in planning and early project development nor is this intended to include a comprehensive list for regulatory review. For a list of environmental resources to consider during environmental review, please see **Chapter 5** of these Guidelines.

Addressing Resource Areas and Farmland in the RTP

As a planning practice to comply with the requirements of CA Government Code 65080 (b)(2)(B), MPOs, based on locally and regionally significant considerations, are encouraged to develop a Regional Open Space and Conservation Area Framework that identifies and considers "resource areas" and "farmland" as defined in Government Code Section 65080.01(a) and (b). To demonstrate consideration of resource areas and farmland, the SCS could 1) identify regional priority areas for conservation and mitigation efforts, based upon existing publicly available information and developed in consultation with the appropriate resource agencies including cities and counties, 2) adopt a land use forecast structured around spatially explicit, complementary networks of priority conservation areas and priority development areas, and 3) commit discretionary funding for conservation and development incentives for such areas. For an example of this approach, see Plan Bay Area: http://planbayarea.org/the-plan/adopted-plan-bay-area-2013.html

Another way to demonstrate consideration of resource areas and farmland is to 1) incorporate layers representing all categories of "resource areas" listed in Government Code Section 65080.01(a) and (b), as well as other key resources identified in HCPs, NCCPs and input from leading conservation organizations, and 2) treat these layers as constraints to development in land use scenarios and the adopted land use forecast. This low-cost, straightforward approach was pioneered by the Santa Barbara County Association of Governments (using a "Regional Greenprint" of GIS layers representing habitat, agricultural resources and other open space areas), and the Tulare County Association of Governments (using layers from the San Joaquin Valley Greenprint).

Regional Conservation Planning Strategies to Address Potential Impacts

Landscape conservation planning takes a proactive approach, identifying priority mitigation and conservation areas in advance of impacts, with the goal of preserving larger areas of higher habitat quality and connectivity. This type of advance planning also results in a more efficient and streamlined permitting approach for development projects. Advance mitigation, Natural Community Conservation Planning, mitigation banking, and in-lieu fee programs are all examples of landscape conservation planning in California. Generally speaking, all take a long-range, regional approach to mitigation and conservation planning. By working on a regional level, rather than project-by-project, state and federal agencies can work together and in cooperation with regional and local agencies to offset the environmental impacts of several planned infrastructure projects at once. https://www.wildlife.ca.gov/Conservation/Planning

Policies and Regulations

The following is a list of national and state policies that support and enable regional conservation planning efforts in California:

National

- Department of the Interior, Order No. 3330 "Improving Mitigation Policies and Practices of the Department of the Interior (Secretary Sally Jewell, 2013);" and
- Presidential Memorandum "Mitigating Impacts on Natural Resources from Development and Encouraging Related Private Investment" (Nov 2015).
- FHWA policies to encourage integration of natural resources in the planning process: https://www.environment.fhwa.dot.gov/integ/index.asp

State

- California Endangered Species Act and Natural Community Conservation Planning Act (NCCP Act)

Tools and Frameworks

The following is a list of tools and frameworks available for regional conservation planning that can be integrated into planning processes at a regional scale:

- Regional Advance Mitigation Planning (RAMP) - Advance mitigation planning to identify areas for mitigation prior to project-by-project discussion is an exemplary planning practice. Regional Advance Mitigation Planning (RAMP) is an important example of such efforts. By coordinating early with agencies responsible for project-level permitting to evaluate the individual and cumulative impacts of one or several projects and focusing mitigation on regional priority conservation opportunities, ecosystem-scale conservation needs can be met, providing more effective conservation and mitigation. In addition, the time and cost inefficiency of project-by-project review, permitting, and mitigation can be avoided thereby making mitigation more efficient. MPOs may consider using RAMP in siting and mitigating for infrastructure projects, in order to maximize time efficiency, reduce mitigation costs, and protect regional natural resources;
- Regional Conservation Investment Strategies (RCIS) and Mitigation Credits Agreements (MCA) – Assembly Bill 2087 (Levine, 2016), established an RCIS pilot study program in California that is presently under development. An RCIS must be proposed by a public agency and would provide a voluntary process and framework to guide investments in natural resource conservation, infrastructure, and will identify priority locations for compensatory mitigation on a regional basis. Once an RCIS has been approved by the California Department of Fish and Wildlife as a pilot project, a Mitigation Credit Agreement can be established. Once established, RCISs and subsequent MCAs can provide a regional mitigation framework for RTPs and subsequent transportation projects. All RCISs and MCAs must be approved prior to January 1, 2020;
- For additional information regarding regional open space conservation please see the following EPA website - http://www.epa.gov/dced/openspace.htm.

The following is a list of regional Habitat Conservation Plan/NCCPs (HCP/NCCP) and other resources:

- CA Department of Fish and Game Natural Community Conservation Planning information - There are currently 13 approved NCCPs (includes 6 subarea plans) and 22 NCCPs in the active planning phase (includes 10 subarea plans), which together cover more than 7 million acres and will provide conservation for nearly 400 special status species and a wide diversity of natural community types throughout California - https://www.wildlife.ca.gov/Conservation/Planning/NCCP/Plans;
- USFWS Endangered Species Habitat Conservation Planning Information https://www.fws.gov/endangered/what-we-do/hcp-overview.html
- Pacific Southwest Region USFWS Offices for Ecological Information http://www.fws.gov/cno/es/
- Sacramento FWS Office list of Regional Habitat Conservation Plans - https://www.fws.gov/sacramento/es/Habitat-Conservation-Plans/es_hcp.htm

- Carlsbad FWS Office information regarding Regional Habitat Conservation Plans http://www.fws.gov/carlsbad/HCPs/CarlsbadCFWORegionalHCPs%20.html
- Ventura FWS Office information regarding Regional Habitat Conservation Plans https://www.fws.gov/ventura/endangered/habitatconservation/index.html
- Information regarding City and County Zoning Ordinances - https://www.opr.ca.gov/docs/PZD2012.pdf
- Information regarding Farmland Mapping and Williamson Act www.conservation.ca.gov/dlrp/fmmp;
- Information regarding adopted Open Space Elements is available through the Governor's Office of Planning and Research (OPR) California Planner's Book of Lists - https://www.opr.ca.gov/s_publications.php

Statewide Examples

Aggregated planning practice examples of the consideration of environmental resources in transportation planning from throughout California can be found in the Sustainable Communities Strategies and Conservation report:

http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/california/sustainable-communities-strategies-and-conservation.pdf

The following represent additional planning practice examples of how regions have conducted regional conservation planning efforts focusing on resource areas and farmland as part of their RTP process:

Large/Urban MPO Examples:

- SANDAG's Environmental Mitigation Program (EMP) - An excellent example of this approach is SANDAG's EMP, which is funded through the region's TransNet sales tax measure. The EMP directs mitigation resources to habitat identified in adopted conservation plans, leverages funding from conservation partners, and saves additional money by acquiring habitat "early, at lower prices, and in larger parcels" (http://www.keepsandiegomoving.com/EMP/EMP-intro.aspx). For more information, please see San Diego Forward: The Regional Plan http://www.sdforward.com/;
- Orange County Transportation Authority (OCTA) EMP http://www.octa.net/Projects-and-Programs/Measure-M/Measure-M2-(2011-2041)/Freeway-Mitigation/Conservation-Plan/;
- Rural-Urban Connections Strategy (RUCS) developed by SACOG: http://www.sacog.org/rucs/
- SCAG's preparation of a Conservation Framework and Assessment (Jan 2015)- http://sustain.scag.ca.gov/Sustainability%20Portal%20Document%20Library/SCAG%20Final%20Conservation%20Framework%20%20Assessment_Feb.pdf;
- SCAG's 2016 RTP/SCS preparation of Natural and Farm Lands Appendix - www.scagrtpscs.net/Documents/2016/final/f2016RTPSCS_NaturalFarmLands.pdf

Medium/Small/Rural MPO Examples:

- Butte County Association of Government's (BCAG) RTP/SCS and Regional Conservation Plan - BCAG adopted the Butte County Regional Conservation Plan (Plan), a regional Natural Community Conservation Plan/Habitat Conservation Plan (NCCP/HCP), adopted recently to streamline the development and mitigation associated with public and private development in the planning area. BCAG's RTP/SCS has identified Regional Conservation Plan development and implementation strategies during transportation projects. Preparation and adoption of the Regional Conservation Plan required extensive resource agency coordination with the planning signatories upon issuance of federal and state permits along with the Plan. For more information, see Butte County Metropolitan Transportation Plan & Sustainable Communities Strategy: http://www.bcag.org/Planning/RTP--SCS/index.html;
- AMBAG incorporated a Regional Greenprint Analysis into its 2014 MTP/SCS: http://www.ambag.org/programs-services/planning/metro-transport-plan;
- San Joaquin Valley Greenprint, sponsored by Fresno COG: www.fresnocog.org/san-joaquin-valley-greenprint-program;
- Tulare County Association of Governments (using layers from the San Joaquin Valley Greenprint) - 2014-2040 Regional Transportation Plan & Sustainable Communities Strategy for Tulare County http://www.tularecog.org/rtp2014/.
- Santa Barbara County Conservation Blueprint – A process led by the Land Trust of Santa Barbara County is underway and leading an effort of data gathering and community engagement process leading to a Conservation Blueprint that will provide a science based decision-making platform for conservation, including restoration and other land management decisions. The process is led by Land Trust for Santa Barbara County, Cachuma Resource Conversation District, and the Santa Barbara Foundation's LEAF Initiative, and is guided by a 12-member Steering Committee; http://www.aginnovations.org/project/santa-barbara-county-conservation-blueprint. For more information, see Santa Barbara's 2040 Regional Transportation Plan and Sustainable Communities Strategy: http://www.sbcag.org/rtp.html;
- The Land Trust of Santa Cruz County developed a Conservation Blueprint (http://www.landtrustsantacruz.org/blueprint/) for the county which is being integrated with Santa Cruz County's RTP and regional planning processes. Specifically, Santa Cruz County's Conservation Blueprint is the basis for developing an advance mitigation planning framework via an EMP within the 2014 RTP development process - http://sccrtc.org/funding-planning/long-range-plans/rtp/2014-plan.
- The Elkhorn Slough Early Mitigation Partnership (ESEMP) is a Caltrans-sponsored interagency effort to provide early mitigation for a series of future transportation improvement projects within the Elkhorn Slough Watershed. This project seeks to help address regional scale conservation in a manner that also can help facilitate project delivery by developing a process for identifying funding strategies and implementing conservation agreements earlier than would be possible through existing traditional channels - http://elkhornslough.ucdavis.edu/.

Aquatic and Terrestrial Habitat Connectivity

A functional network of connected wildlands is essential to the continued support of California's diverse natural communities in the face of human development and climate change. Natural and semi-natural components of the landscape must be large enough and connected enough to meet the needs of all species that use them, including species' continued need for movement, migration, and shifts in distribution. The California Essential Habitat Connectivity Project developed guidance for mitigating the fragmenting effects of roads and transportation corridors and a framework for developing regional and local connectivity plans (California Essential Habitat Connectivity Project 2010).

Policies and Regulations

The following is a list of national and state policies that support and enable habitat connectivity planning efforts in California:

National

- Federal Endangered Species Act and species recovery plans that identify habitat fragmentation and road mortality as risks to species recovery

State

- AB 498 (Levine, 2015) regarding Wildlife Conservation and Wildlife Corridors which amends California Fish and Game Code Sections 1797.5, 1930, and 1930.5;
- CEQA Guidelines and Migratory Species – "Will the project interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites;"
- California State Wildlife Action Plan and Transportation Companion Plan - https://www.wildlife.ca.gov/swap; and
- SB 857 (Kuehl, 2006) applies to State Highway System transportation projects and details requirements for assessing and remediating barriers to fish passage at stream crossings along the State Highway System. A coordinated and comprehensive fish passage improvement program is fundamental to restore unimpeded passage for aquatic organisms and for the success of habitat restoration activities.

Tools and Data

There are GIS habitat modeling tools and datasets that are available to consider and integrate into the RTP update process. These can be integrated into the RTP update itself as well as with future transportation projects identified in RTPs. The following is a list of tools and datasets available for planning decisions:

Statewide

- California Essential Connectivity Project (2010) https://www.wildlife.ca.gov/conservation/planning/connectivity/CEHC;
- California Protected Areas Database www.calands.org; and
- California Fish Passage Assessment Database (PAD) http://www.calfish.org/

Regional

- Bay Area Critical Linkages - http://www.scwildlands.org/;

- South Coast Linkages - http://www.scwildlands.org/;
- California Desert Connectivity Project - http://www.scwildlands.org/; and
- CDFW's Northern Sierra Nevada Foothill connectivity mapping project https://www.wildlife.ca.gov/Data/Analysis/Connectivity.

Examples

The following are examples of various RTPs and other long-range transportation plans that have integrated habitat connectivity resources and natural resource mapping into their planning processes:

- AMBAG's Monterey Bay Area Sensitive Resource Mapping Project with 2035 RTP/SCS Update. AMBAG received SHRP2 (C06) federal highway research funds to apply FHWA's Integrated Ecological Framework (IEF) to their Moving Forward Monterey Bay 2035 Plan and planning process. The goal was to identify sensitive resources in the AMBAG region to provide managers with a better understanding of potential conflicts and mitigation needs for transportation projects in the 2035 Plan. AMBAG created on on-line interactive GIS database with this project and developed 32 sensitive resource maps for the AMBAG region and used in the Environmental Mitigation section of the RTP/SCS 2035 Plan update;
- Caltrans District 5 Highway 17 Transportation Concept Report – http://www.dot.ca.gov/dist05/planning/sys_plan_docs/factsheets_datasheets/SR17/17_tcr.pdf;
- Caltrans District 5 Regional Wildlife and Habitat Connectivity Plan for the Central Coast Region of California – http://www.dot.ca.gov/dist05/planning/AdvWildlifeConnectivity.htm; and
- Santa Cruz County Regional Transportation Plan - Conservation planning efforts, such as the Conservation Blueprint, developed by the Land Trust of Santa Cruz County, and the Wildlife Habitat Connectivity GIS database, developed by Caltrans and partner agencies, support regional mitigation and can serve as a resource for future mitigation plans in Santa Cruz County. This data is being integrated into the RTP 2014 of Santa Cruz County and AMBAG's RTP/SCS.

RTP Financial Overview

Federal statute and regulations and California State statute requires RTPs to contain an estimate of funds available for the 20-year planning horizon. This discussion of financial information is fundamental to the development and implementation of the RTP. The financial portions of the RTP identify the current and anticipated revenue sources and financing techniques available to fund the planned transportation investments described in other portions of the RTP. The intent is to define realistic financing constraints and opportunities. All projects, except illustrative projects i.e. unconstrained projects, must be fully funded in order to be included in the RTP. With this financing information, alternatives are developed and used by the MPO, local agencies and State decision-makers in funding transportation projects. Detailed information regarding RTP financial requirements is available in **Sections 6.2 – 6.7**.

Fiscal Constraint

http://www.sandag.org/index.asp?projectid=292&fuseaction=projects.detail

http://www.scag.ca.gov/rtp2004/2004/FinalPlan.htm

Listing of Constrained and Un-constrained Projects

http://www.mtc.ca.gov/planning/2035_plan/

Revenue Identification and Forecasting

http://www.bcag.org/Planning/index.html

Estimating Future Transportation Costs

In keeping with the Federal and State efforts to streamline the project delivery and NEPA review process at the project level by providing environmental information at the earliest point in time, it is recommended that the RTP also include a preliminary cost estimate for the mitigation activities that are identified.

Asset Management

To ensure a sustainable transportation system, MPOs are encouraged to address existing infrastructure condition and performance prior to considering expansion of the system. This general approach is considered a best practice that will ensure that the agencies funding for the transportation will be adequate to sustain the system into the future.

RTP Modal Discussion

Transit

Los Angeles Metro, First and Last Mile Strategic Plan, identified strategies and potential funding sources for improving the areas surrounding transit stations to make it easier and safer for people to access them. SCAG incorporated some of these strategies into its 2016 RTP/SCS as well as short trips strategies to increase the number of trips under three miles that people take by foot or bike. The plan is available at:

http://media.metro.net/docs/sustainability_path_design_guidelines.pdf

Bicycle & Pedestrian

The use of bicycles and walking as a means of transportation has increased dramatically in California over the last 20 years. Both modes of transportation promote a healthy lifestyle and reduce environmental impacts.

Bicycle and Pedestrian planning practice information and resources are available at the following links:

"At the Intersection of Active Transportation & Equity" (Safe Routes to Schools National Partnership, 2015) http://saferoutespartnership.org/resources/report/intersection-active-transportation-equity

"Urban Bikeway Design Guide" (National Association of City Transportation Officials, 2014) http://nacto.org/publication/urban-bikeway-design-guide/

Local and Regional plans for bicycle and pedestrian trails and related facilities, including the California Coastal Trail should be supported by RTPs. Additional planning practice information regarding the California Coastal Trail is available at the following links:

Completing the California Coastal Trail Plan – California Coastal Conservancy
http://www.coastal.ca.gov/access/coastal-trail-report.pdf

Information regarding California Coastal Trail Definition and Design and Siting Standards is available at:
http://www.scc.ca.gov/webmaster/pdfs/CCT_Siting_Design.pdf

Goods Movement (Maritime/Rail/Trucking/Aviation)

MPOs are encouraged to consider developing or updating freight plans for their region, as these plans can help MPOs improve the efficiency and sustainability of goods movement in their regions.

http://www.dot.ca.gov/hq/tpp/offices/ogm/

http://rtpscs.scag.ca.gov/Pages/default.aspx

http://www.alamedactc.org/goodsmovement

http://www.ops.fhwa.dot.gov/Freight/infrastructure/nfn/index.htm

http://www.sandag.org/index.asp?classid=13&fuseaction=home.classhome

California Sustainable Freight Action Plan

In July 2015, Governor Brown issued Executive Order B-32-15 which prioritizes California's transition to a more efficient and less polluting freight transportation system. This transition of California's freight transportation system is essential to supporting the State's economic competitiveness in the coming decades while reducing greenhouse gas emissions and air quality impacts. The Executive Order directed State agencies to develop an integrated action plan by July 2016 that established clear targets to improve freight efficiency, transition to zero-emission technologies, and increase the competitiveness of California's freight system. It is suggested that regional transportation agencies consult the California Sustainable Freight Action Plan when developing the freight-related strategies in their respective RTPs. For more information see: http://www.dot.ca.gov/casustainablefreight/

California Freight Mobility Plan

The state's California Freight Mobility Plan (CFMP) is a policy and action agenda document that supports the improvement of California's goods movement infrastructure while preserving the environment. MPOs are encouraged to review the CFMP for guidance, and ensure consistency while addressing goods movement within their RTPs. The RTPs and the CFMP will ideally function in a feedback loop, as the goods movement strategies and projects identified in RTPs will be incorporated into the next update of the CFMP. For more information see:
http://www.dot.ca.gov/hq/tpp/offices/ogm/cfmp.html

Regional Aviation System

MPOs should consider including the following aviation planning topics in the development of their RTPs:

1. An overview of the role that all public use airports including both commercial, and general aviation airports, heliports, and military airfields play in the region's multimodal transportation system.
2. Describe the functional relationship between the region's airports, and heliports, and explain specific RTP policies that support and preserve the long term viability of the region's airports.
3. Identify current airport conditions such as noise, safety, and future airport improvement projects that can be found in either an airport's layout plan, or master plans.
4. Provide a list of all public-use airports, including their State functional class developed by the Division of Aeronautics for all commercial and general aviation airports, and military installations in the region, and a description of their facilities and uses, and a map of their location.
5. Provide a discussion of any future airport(s) growth and improvement needs found in each airport's master plan or airport layout plan.
6. A discussion of multimodal ground access issues and any required ground access program or plan.
7. A separate list of short (5 year) and long-range (10 year) Airport Capital Improvement Plan (ACIP) projects within the region.
8. Identify which governing body serves as each county's ALUC for the region established pursuant to PUC 21670(a), as well as the title and date of the most current ALUCPs, Airport Master Plans or Airport Layout Plans; and military Air Installation Compatible Use Zone Plans.
9. Demonstrate consistency with the State of California Office of Planning and Research's document entitled *Community and Military Compatibility Planning; Supplement to the General Plan Guidelines* (December 2009) for military installations available at:
   https://www.opr.ca.gov/docs/Military_GPG_Supplement.pdf

Additional aviation planning practice information and case studies can be found at:

http://dot.ca.gov/hq/planning/aeronaut/publication.htm http://www.faa.gov/airports/planning_capacity/ga_study

http://www.gao.gov/products/GAO-10-120

http://www.gao.gov/products/GAO-13-261

For questions and additional information regarding the state aviation program and its airport planning activities for a specific region, please visit the Caltrans Division of Aeronautics website: http://www.dot.ca.gov/aeronaut/index.html

For additional information regarding land use compatibility concerns affecting airports, please visit the Caltrans Division of Aeronautics website:
http://dot.ca.gov/hq/planning/aeronaut/documents/alucp/

Military Airfields and Installations

As a best practice, MPOs should include a discussion of military installations transportation and land use compatibility needs in their RTPs by addressing of the following:

1. A list and map of all military airfields and installations in the region.
2. An overview of the role that these military airfields and installations play in the region including a brief description of the installation's current and future mission(s).
3. Discuss multimodal ground access needs to installations for both people and freight, as well any needed ground access programs or plans that support its needs to complete its mission(s).
4. Demonstrate consistency with California's OPR document *Community and Military Compatibility Planning; Supplement to the General Plan Guidelines* (December 2009) available at:
   https://www.opr.ca.gov/docs/Military_GPG_Supplement.pdf.

Additional military installation planning practices can be found at:

http://www.napawash.org/2009/1378-strengthening-national-defense-countering-encroachment-through-military-community-collaboration.html

http://militarycouncil.ca.gov/s_economicdata.php

https://www.sdmac.org/ImpactStudy.htm

http://hrtpo.org/page/military-transportation-needs

http://www.nctcog.org/trans/aviation/jlus/JLUS_bkg.asp

http://hrtpo.org/page/military-transportation-needs

http://www.nceastmgtf.org/studies-and-analyses

For questions and additional information regarding the state aviation program and its airport planning activities for a specific region, please visit the Caltrans Division of Aeronautics website: http://www.dot.ca.gov/hq/planning/aeronaut/planners.htm

Transportation System Management and Operations

A US DOT document titled; "Management & Operations in the Metropolitan Transportation Plan: A Guidebook for Creating an Objectives-Driven, Performance-Based Approach" provides a very good overview on how to integrate transportation system management and operations into the planning process. See:

http://www.ops.fhwa.dot.gov/publications/moguidebook/index.htm

In addition, the US DOT document titled, "Traffic Signal Operations and Maintenance Staffing Guidelines," provides guidelines to estimate the staffing and resource needs required to effectively operate and maintain traffic signal systems. Specifically, Chapter 1.3.1 provides a suggestion on the level of maintenance that is necessary. See: http://ops.fhwa.dot.gov/publications/fhwahop09006/fhwahop09006.pdf

Future of Transportation and New Technology

While maintaining the current transportation network is often a priority for MPOs, MPOs need to be planning ahead for a future in which technology will transform the way that people move and live. This section provides a summary of federal and State legislation to prepare for new technologies and innovations for the future of transportation. MPOs are ideally positioned to anticipate and be responsive to the needs of future generations. In addition, RTPs can also identify how the transportation network has been designed to accommodate, and promote, new technology, alternative fuels, charging stations, zero-emission technology, and emerging technology such as automated vehicles; include a discussion about incentives and implementation of these measures; and, identify how the proposed transportation network is meeting the goals and objectives of the State's Zero Emission Vehicle Action Plan.

Connected Vehicle Program

There are several activities related to the national Connected Vehicle Program that will certainly impact regional and local transportation agencies, in addition to Caltrans. Since 90% of the roadways in California are owned and operated by local agencies, including the 58 counties and more than 500 incorporated cities, it is critically important for them to be aware of and to plan for the implementation of connected vehicles.

This document explains licensing requirements transparent and best practices accessible to any organization, public or private, seeking to deploy "Connected Vehicle" Dedicated Short Range Communications (DSRC) Roadside Units (RSU) and services that support vehicle-to-infrastructure (V2I) applications.

http://ntl.bts.gov/lib/56000/56900/56950/FHWA-JPO-16-267.pdf

This guidance is intended to assist system owner/operator staff to deploy V2I technology not only in terms Federal Aid Highway program requirements but also practices to help ensure interoperability and efficient and effective planning/procurement/operations.

http://www.its.dot.gov/meetings/pdf/V2I_DeploymentGuidanceDraftv9.pdf

SANDAG's "Off-Model GHG Reduction Methodology" provides calculations and planning practices for vehicle automation assumptions:
http://www.sdforward.com/pdfs/RP_final/AppendixA_B_C.pdf

Transportation Electrification

State law encourages MPOs to promote the development of transportation electrification and the deployment of electric vehicles in their RTPs. Section 740.12 of the Public Utilities Code describes the importance of transportation electrification for meeting greenhouse gas emission reduction targets and air quality standards.

Guidance for Zero-Emission Vehicles Readiness Planning Statewide

2016 Zero Emission Vehicle Action Plan
(Governor's Interagency Working Group on Zero-Emission Vehicles):
https://www.gov.ca.gov/docs/2016_ZEV_Action_Plan.pdf

Zero-Emission Vehicles in CA: Community Readiness Guidebook and Other Resources (Governor's Office of Planning and Research, OPR):
https://www.opr.ca.gov/docs/ZEV_Guidebook.pdf
https://www.opr.ca.gov/s_zero-emissionvehicles.php

A Toolkit for Community Plug-In Electric Vehicle Readiness and Additional Resources (California Plug-in Electric Vehicle Collaborative, PEV Collaborative):
http://www.pevcollaborative.org/sites/all/themes/pev/files/docs/toolkit_final_website.pdf
http://www.pevcollaborative.org/pev-readiness

Funding for Zero-Emission Vehicle Planning and Implementation

Zero-Emission Vehicle Regional Readiness and Planning (California Energy Commission):
http://www.energy.ca.gov/contracts/GFO-16-601/

Examples of Regional Readiness Plans (Zero-Emission Vehicles and Alternative Fuels)

Upstate Plug-In Electric Vehicle Readiness Project (Shasta, Siskiyou & Tehama Counties)
http://www.siskiyoucounty.org/pev/

AMBAG Electric Vehicle Infrastructure Plan for the Monterey Bay Area
http://www.ambag.org/programs-services/planning/electric-vehicle-planning

San Joaquin Valley Plug-In Electric Vehicle Readiness Plan
https://energycenter.org/sites/default/files/docs/nav/programs/pev-planning/san-joaquin/san_joaquin_valley_pev_readiness_plan-web.pdf

Bay Area – Experience Electric Initiative
http://mtc.ca.gov/whats-happening/news/experience-electric-initiative-brings-lastest-ev-models-people

SCAG RTP/SCS Mobility Innovations Appendix:
http://scagrtpscs.net/Documents/2016/draft/d2016RTPSCS_MobilityInnovations.pdf

SCAG Plug-In Electric Vehicle Readiness Plan
https://www.scag.ca.gov/Documents/SCAG-Southern%20CA%20PEV%20Readiness%20Plan.pdf

San Diego Regional Alternative Fuel Readiness Plan:
http://www.sandag.org/uploads/projectid/projectid_487_20274.pdf

San Diego Plug-In Electric Vehicle Readiness Plan:
http://www.sandag.org/uploads/publicationid/publicationid_1817_17061.pdf

Land Use and Transportation Strategies to Address Regional Greenhouse Gas Emissions in the RTP

MPOs are encouraged to consider and incorporate those strategies that are likely to provide the greatest level of greenhouse gas emissions reduction considering feasibility of implementation as well as the unique characteristics and needs within the region.

This section provides several, but not a complete list of many and varied resources currently available to promote reductions in greenhouse gas emissions. MPOs are encouraged to connect and consult these resources as appropriate for their region, additional information is also available in **Section 6.23**.

Pricing Strategies

(Local/State Legislation is required to implement various pricing strategies and should be researched prior to incorporating into the RTP development process)

Pricing strategies are suggested to encourage reduced driving to reduce GHG emissions, and include, but are not limited to:

1. Using alternative mode programs, congestion pricing, toll roads, and parking pricing strategies. Examples are:
   - i. Road pricing and High Occupancy Toll (HOT) lanes. To reduce VMT, MPOs should model adding pricing to existing lanes, not just as a means for additional expansion. Variable/congestion pricing should be considered.
   - ii. User fees such as fuel taxes and parking charges.
   - iii. Free or reduced fare transit fares.
   - iv. Expansion of Parking Cash-Out Programs.
   - v. Strategies to reduce the impacts of pricing strategies on low-income individuals.
   - vi. Improve the cost-efficiency of transit investments and transit operations.

2. Consider utilizing revenues from these pricing strategies for projects, such as mass transit, that improve mobility without increasing VMT or GHG emissions.

Road pricing can be found at:

"Opportunities to Improve Air Quality through Transportation Pricing Programs", U.S. Environmental Protection Agency, September 1997.
http://www.epa.gov/oms/market/pricing.pdf

"Sacramento Transportation & Air Quality Collaborative Final Report, Volume III: Supplemental Text for Agreements", December 2005.
http://www.sacta.org/pdf/STAQC/FinalReportIII.pdf

Transportation Planning and Investment Strategies

1. Consider shifting transportation investments towards improving and expanding urban and suburban core transit, programs for walkability, bicycling and other alternative modes, transit access, housing near transit, and local blueprint plans that coincide with the regional blueprint and the SCS. Although not explicitly required by law, MPOs could identify a set of indicators that will be used to assess the performance of the RTP in reaching climate and other goals, and could identify the criteria that the MPO used to select the transportation projects on the constrained and unconstrained project lists. Some examples of MPOs that have undertaken this approach include efforts by MTC and SACOG, for more information see:

MTC Plan Bay Area and Transportation Project Performance Assessment
http://planbayarea.org/the-plan/plan-details/transportation.html
http://planbayarea.org/file10305.html

SACOG 2016 Metropolitan Transportation Plan/Sustainable Communities Strategy and Planning Process:
http://www.sacog.org/general-information/2016-mtpscs
http://www.sacog.org/sites/main/files/file-attachments/chapter_2_planning_process.pdf

2. Provide funds and technical assistance to local agencies to implement blueprint strategies and the SCS.

3. Implement operational efficiencies that reduce congestion in vehicle throughput on roadways or improve transit access or other alternative access without physical expansion of the roadways.

4. Consider consulting with school districts on the regional land use plan to facilitate coordination between school siting and other land uses. This coordination could effectively reduce driving in the region. Consider school districts' facilities master plans and transportation policies in the coordination of regional planning efforts.

5. For purposes of allocating transportation investments, recognize the rural contribution towards GHG reduction for counties that have policies that support development within their cities, and protect agriculture and resource lands. Consideration should be given to

jurisdictions that contribute towards these goals for projects that reduce GHG or are GHG neutral, such as safety, rehabilitation, connectivity and for alternative modes.

6. In setting priorities, consider transportation projects that increase efficiency, connectivity and/or accessibility or provide other means to reduce GHG.

7. In setting priorities, consider transportation projects that provide public health co-benefits.

8. Employ "Fix It First" policies to ensure that preventive maintenance and repair of existing transit and roads are the highest priority for spending, to reduce overall maintenance costs, and to support development in existing centers and corridors.

Land Use Strategies that Can Help Reduce Rates of VMT and Per Person Household Greenhouse Gas (GHG) Emissions

(Strategies incorporating the "D factors" - Professor Robert Cervero research)

There have been various studies and research conducted on land use and transportation strategies regarding travel that reduces driving by walking, biking, and transit use. Some of this research is known as the "Ds factors" as the variables can be described as Density, land use; Diversity, pedestrian-scale; Design, access to regional Destinations, and Distance to transit.

Professor Robert Cervero's research efforts found that certain neighborhood characteristics significantly affect the amounts and modes of travel by residents, customers and employees.

Land use strategies that typically incorporate some or all of these "D factors" include:
urban and suburban infill, clustered development, mixed land uses, New Urbanist design, transit-oriented development, and other "smart-growth" strategies. When combined with good pedestrian and bicycle facilities and transit service, such strategies can contribute to a significant reduction in per household levels of GHG emissions (Reid Ewing, Keith Bartholomew, Steve Winkelman, Jerry Walters, and Don Chen, **Growing Cooler** – The Evidence on Urban Development and Climate Change, for the Urban Land Institute, 2008.)

The Ds are Destination (proximity), Density (or clustered development), Diversity (or mixture of land uses), Distance to transit, Design, and Development scale.

Transportation Demand Management (TDM)

The Victoria Transport Policy Institute at http://www.vtpi.org/tdm/index.php contains an Encyclopedia that is a comprehensive source of information about innovative management solutions to transportation problems. It provides detailed information on various demand management strategies, plus general information on TDM planning and evaluation techniques. It is produced by the Victoria Transport Policy Institute to increase understanding and implementation of TDM.

For example, TDM-related chapters include:

- Incentives to Use Alternative Modes and Reduce Driving
- Parking and Land Use Management
- TDM Programs and Program Support
- TDM Planning and Evaluation
- Innovative and Emerging Shared Mobility Services (i.e., bikeshare, carshare, and on-demand rideshare services)

RTP policies that support Smart Growth Land Use principles

Metropolitan Transportation Commission's Best Practice Examples related to strategies 1. and 2. listed below:

MTC's T2035 Plan called for modifying our Transportation for Livable Communities (TLC) program to support Priority Development Areas which were identified as a part of FOCUS, the Bay Area's blueprint planning process. The TLC program offers capital grants to cities, counties, and transit agencies to construct projects that support compact development near transit. See:

http://mtc.ca.gov/whats-happening/news/mtc-awards-44-million-new-grants-promote-livable-communities

MTC's Resolution 3434 TOD Policy ties regional discretionary funds for new transit extension projects (funded via Resolution 3434) to supportive land uses. This policy establishes targets for new housing units in each transit corridor and calls for station area plans and corridor working groups to help achieve the housing targets. Station area plans to meet the housing targets must be adopted by local municipalities prior to receiving MTC discretionary funding for construction of Resolution 3434 funds. See:

http://mtc.ca.gov/our-work/plans-projects/other-plans/regional-transit-expansion-program

As MPOs and RTPAs work towards achieving better linkages between land use and transportation planning within their regions, both MPOs and RTPAs are highly encouraged to include within their Policy Element the following:

1. Develop investments and programs that support local jurisdictions that make land use decisions that implement as appropriate, the SCS, regional blueprints, and other strategies that will help reduce greenhouse gas emissions and improve the quality of mobility throughout the region.
2. Emphasize transportation investments in areas where forecasted development patterns indicated may result in regional greenhouse gas emissions reduction.

Additional Planning Practice Examples

Attorney General list of mitigation measures:
http://ag.ca.gov/globalwarming/pdf/GW_mitigation_measures.pdf

CAPCOA CEQA and Climate Change paper:
http://www.capcoa.org/wp-content/uploads/2012/03/CAPCOA-White-Paper.pdf

US EPA highlighted case studies for Smart Growth illustrated through open space, mixed land use and transportation choices are available at:
http://www.epa.gov/dced/case.htm

SANDAG's Regional Parking Management Toolbox contains resources for parking and demand management. The Regional Parking Management Toolbox can be found here:

http://www.sandag.org/uploads/publicationid/publicationid_1910_18614.pdf

Adaptation of the Regional Transportation System to Climate Change

MPOs should begin to address climate change in their long range transportation plans using Caltrans guidance, Cal-Adapt.org and other state resources (see Climate Adaptation Resources table). Design and planning standards should be re-evaluated to address future conditions. Where possible, MPOs and RTPAs should consult *Safeguarding California*'s transportation chapter, local general plan safety elements, local hazard mitigation plans, and other relevant local, regional, and state resources and documents. See **Section 6.25** for additional information on Climate Change Adaptation planning.

In addition, MPOs should make use of models that predict climate impacts like sea level rise, and that estimate changes in carbon stocks from alternative project or land management activities. Recent research shows that changes in land use and management can generate GHG benefits by avoiding and reducing emissions, and by increasing carbon storage. MPOs are encouraged to refer to the Climate Action through Conservation (CATC): http://scienceforconservation.org/downloads/

The model, method and tool presented in this report is usable at the county or regional scale, and can help MPOs to provide a more comprehensive account of their progress toward meeting the state's GHG reduction goals.

Large/Urban Planning Practice Example:

Southern California Council of Government's (SCAG) has developed a section on Environmental Mitigation pursuant to 23 USC Section 134 into their RTP/SCS and planning process. SCAG has also developed a Sustainability Program focused on natural resources and climate change strategies.
http://sustain.scag.ca.gov/Pages/LinksResources.aspx
http://rtpscs.scag.ca.gov/Pages/2012-2035-RTP-SCS.aspx

MTC has been conducting climate resilience studies focused on impacts to specific communities, coastlines, and transportation assets:
http://mtc.ca.gov/our-work/plans-projects/climate-change-clean-vehicles/adapting-rising-tides

SANDAG prepared a Climate Change Mitigation and Adaptation White Paper prior to adopting the 2015 RTP/SCS:
http://www.sdforward.com/sites/sandag/files/Climate_Change_White%20Paper_fwe_07142014.pdf

SACOG, prior to preparing the 2016 MTP/SCS, partnered with CivicSpark to develop the Sacramento Region Transportation Climate Adaptation Plan (SRTCAP). This plan outlines key strategies and actions the Sacramento region can take to ensure its transportation assets are adaptable to potential climate related events:
http://www.sacog.org/sites/main/files/file-attachments/fullplanwithappendices.pdf

Performance Measures

Caltrans recommends using performance measures to measure the progress of regional projects. MPOs should take into account the benefits of using performance measures to establish a base of measurement and cross-reference the measurement with the performance measure outcome/results. These measurements can be used to justify the need for funding on specific projects. The scientific data may support regional needs and highlight the justification for funding a project that demonstrates the potential for improved performance on the Caltrans system or regional road network.

Although not explicitly required by law, MPOs could identify a set of indicators that will be used to assess the performance of the RTP. In addition, the RTP could identify the criteria that the MPO used to select the transportation projects on the constrained and unconstrained project lists. Caltrans has also developed a guidebook on how to implement performance measures in rural and small urban regions. This guidebook provides a toolbox from which to select appropriate methodologies for performance measures in rural or small urban area. The Guidebook on “Performance Measures for Rural Transportation Systems” can be accessed at:

http://www.dot.ca.gov/perf

In 2011, the San Diego Association of Governments (SANDAG) received grant funding from the Strategic Growth Council to collaborate with other California MPOs and state agencies to identify common statewide performance monitoring indicators related to SB 375 implementation. While performance measures rely mostly on modeled or forecasted data, performance monitoring indicators rely directly on observed data. MPOs use travel demand models or Geographic Information Systems analyses to forecast performance measures. Ideally monitoring indicators would be considered together and be consistent with modeling performance measures.

The following table identifies nine indicators that can be monitored using statewide and regional data sources as reflected in the *Statewide Performance Monitoring Indicators for Transportation Planning Final Report* (SANDAG, 2013), available at:

http://www.dot.ca.gov/hq/tpp/offices/ocp/ATLC/documents/august_15_2013/document_links/indicator.pdf.

Table 1: Proposed Performance Monitoring Indicators

ID	Inventory Ref. (Appendix B)	MAP-21 Category	Statewide Performance Monitoring Observed Data	Performance Measure (Model Based)	Referenced In
		Congestion Reduction			
1	A-8 / A-1	VMT a. VMT per capita*	√	√	SB 375 & MAP-21
		b. Percent of Congested Freeway/ Highway Vehicle Miles **[PeMS]**	√	√	SB 375 & MAP-21
2	A-16/A-18	Mode Share (Travel to work)*	√	√	SB 375 & MAP-21
		Infrastructure Condition			
3	-	State of Good Repair a. Highways b. Local Streets c. Highway Bridges d. Transit Assets	√		MAP-21
		System Reliability			
4	A-65	Freeway/Highway Buffer Index **[PeMS]**	√	√	MAP-21
		Safety			
5	A-39	Fatalities/Serious Injuries a. Fatalities/Serious Injuries per capita* b. Fatalities/Serious Injuries per VMT*	√	√	MAP-21
		Economic Vitality			
6	C-33	Transit Accessibility (Housing and jobs within 0.5 miles of transit stops with frequent transit service)*	√	√	SB 375
7	A-84	Travel Time to Jobs	√	√	SB 375 & MAP-21
		Environmental Sustainability			
8	B-1/B-5	Change in Agricultural Land*	√	√	SB 375
9	E-5	CO_2 Emissions Reduction per capita (modeled data)*		√	SB 375 & MAP-21
	*	Indicator relates to Public Health	[PeMS]	Indicator for MPOs that have access to PeMS data	

The following table provides a summary of potential performance metrics for rural county Regional Transportation Planning Agencies as outlined in the report, *Transportation Performance Measures for Rural Counties in California* (Rural Counties Task Force, 2015), at:
http://www.ruralcountiestaskforce.org/Assets/Resources/PerformanceMeasures/Final_Report-PerfMonIndicators_StudySept2015.pdf

These metrics were developed according to the following criteria:

- Measurement-based rather than model-based;
- Alignment with California state transportation goals and objectives;
- Capability of informing current goals and objectives of each rural and small-urban RTPA;
- Applicability across all rural and small-urban regions;
- Capability of being linked to specific decisions on transportation investments; and
- Normalized for population to provide equitable comparisons to urban regions.

Metric	Source	Website
Vehicle Miles Traveled (VMT) Per Capita By Locality By Facility Ownership Local vs. Tourist	Mobility Reporting	http://www.dot.ca.gov/hq/traffops/sysmgtpl/MPR/index.
	California DOF	http://www.dof.ca.gov/research/demographic/reports/estimates/e
	HPMS	http://www.dot.ca.gov/hq/tsip/hpms/hpmslibrary/prd/2013prd/20 13PRD-revised.pdf
Peak V/C Ratio or Thresholds	Traffic Counts: K and D Factors	http://traffic-counts.dot.ca.gov/
Journey to Work Mode	American Community Survey	http://factfinder.census.gov/faces/nav/jsf/pages/index.xht
Total Accident Cost Per VMT Per Capita	Transportation Injury Mapping	http://tims.berkeley.edu/login.php?next=/tools/bc/main1.
	SWIRS TASAS	http://iswitrs.chp.ca.gov/Reports/jsp/userLogin.jsp Caltrans Public Information Request Form
Transit Operating Cost per Revenue Mile	Local Transit Providers	
Distressed Lane Miles Total and % Total By Jurisdiction By Facility Type	Federal Highway	http://www.fhwa.dot.gov/tpm/rule/pmfactsheet.pdf
	Regional or local pavement management system	https://www.federalregister.gov/articles/2015/01/05/2014-30085/national-performance-management-measures-assessing-pavement-condition-for-the-national-highway
Pavement Condition Index (PCI) for Local Roads	Regional or local pavement management system	
Land Use Efficiency	Farmland Mapping and Monitoring Program (FMMP) DOF Annual population estimates	http://www.conservation.ca.gov/dlrp/fmmp

Additionally, the following documents contain planning practice examples for performance based planning:

- Transform report entitled "Creating Healthy Regional Transportation Plans" (2012) contains a chapter explaining what the RTP Guidelines are, how they support healthy outcomes, and best practices for public participation. http://www.transformca.org/resource/creating-healthy-regional-transportation-plans
- The Nature Conservancy report entitled "Sustainable Communities Strategies and Conservation" includes model policies and best practices for conservation policies in SCSs. http://www.southernsierrapartnership.org/scs-policy-report.html
- The ClimatePlan report entitled "Leading the Way: Policies and Practices for Sustainable Communities Strategies:" http://www.climateplan.org/wp-content/uploads/2016/10/Leading-the-Way-Full-Report.pdf
- US DOT: Management & Operations in the Metropolitan Transportation Plan: A Guidebook for Creating an Objectives-Driven, Performance-Based Approach http://www.ops.fhwa.dot.gov/publications/moguidebook/index.htm
- FHWA Model Long-Range Transportation Plans: A Guide for Incorporating Performance Based Planning (2014) http://www.fhwa.dot.gov/planning/performance_based_planning/mlrtp_guidebook/

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Travel Demand Forecasting: Parameters and Techniques

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP REPORT 716

Travel Demand Forecasting: Parameters and Techniques

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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FOREWORD

By Nanda Srinivasan
Staff Officer
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This report is an update to *NCHRP Report 365: Travel Estimation Techniques for Urban Planning* 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 straight-forward techniques, optional use of default parameters, and appropriate references to other more sophisticated techniques.

In 1978, TRB published *NCHRP Report 187: Quick-Response Urban Travel Estimation Techniques and Transferable Parameters*. This report described default parameters, factors, and manual techniques for doing simple planning analysis. The report and its default data were used widely by the transportation planning profession for almost 20 years. In 1998, drawing on several newer data sources including the 1990 Census and National Personal Household Travel Survey, an update to *NCHRP Report 187* was published as *NCHRP Report 365: Travel Estimation Techniques for Urban Planning*.

Since *NCHRP Report 365* was published, significant changes have occurred affecting the complexity, scope, and context of transportation planning. Planning concerns have grown beyond "urban" to include rural, statewide, and special-use lands. Transportation planning tools have evolved and proliferated, enabling improved and more flexible analyses to support decisions. The demands on transportation planning have expanded into special populations (e.g., tribal, immigrant, older, and young) and broader issues (e.g., safety, congestion, pricing, air quality, environment, and freight). In addition, the default data and parameters in *NCHRP Report 365* needed to be updated to reflect the planning requirements of today and the next 10 years. Thus, the objective of this research was to revise and update *NCHRP Report 365* to reflect current travel characteristics and to provide guidance on travel demand forecasting procedures and their application for solving common transportation problems.

The research was performed by Cambridge Systematics, Inc. in association with Vanasse Hangen Brustlin, Inc., Gallop Corporation, Dr. Chandra R. Bhat, Shapiro Transportation Consulting, LLC, and Martin/Alexiou/Bryson, PLLC. Information was gathered via literature review, interviews with practitioners, and a database of parameters collected from metropolitan planning organizations as well as from the 2009 National Household Travel Survey. Planners can make use of the information presented in this report in two primary ways: (1) to develop travel model components when local data suitable for model development are insufficient or unavailable and (2) to check the reasonableness of model outputs.

CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

CHAPTER 1

Introduction

1.1 Background

In 1978, the Transportation Research Board (TRB) published *NCHRP Report 187: Quick-Response Urban Travel Estimation Techniques and Transferable Parameters* (Sosslau et al., 1978). This report described default parameters, factors, and manual techniques for doing planning analysis. The report and its default data were used widely by the transportation planning profession for almost 20 years. In 1998, drawing on several newer data sources, including the 1990 Census and Nationwide Personal Transportation Survey, an update to *NCHRP Report 187* was published in the form of *NCHRP Report 365: Travel Estimation Techniques for Urban Planning* (Martin and McGuckin, 1998).

Since *NCHRP Report 365* was published, significant changes have occurred affecting the complexity, scope, and context of transportation planning. Transportation planning tools have evolved and proliferated, enabling improved and more flexible analyses to support decisions. The demands on transportation planning have expanded into special populations and broader issues (e.g., safety, congestion, pricing, air quality, environment, climate change, and freight). In addition, the default data and parameters in *NCHRP Report 365* need to be updated to reflect the planning requirements of today and the next 10 years.

The objective of this report is to revise and update *NCHRP Report 365* to reflect current travel characteristics and to provide guidance on travel demand forecasting procedures and their application for solving common transportation problems. It is written for "modeling practitioners," who are the public agency and private-sector planners with responsibility for developing, overseeing the development of, evaluating, validating, and implementing travel demand models. This updated report includes the optional use of default parameters and appropriate references to other more sophisticated techniques. The report is intended to allow practitioners to use travel demand forecasting methods to address the full range of transportation planning issues (e.g., environmental, air quality, freight, multimodal, and other critical concerns).

One of the features of this report is the provision of transferable parameters for use when locally specific data are not available for use in model estimation. The parameters presented in this report are also useful to practitioners who are modeling urban areas that have local data but wish to check the reasonableness of model parameters estimated from such data. Additionally, key travel measures, such as average travel times by trip purpose, are provided for use in checking model results. Both the transferable parameters and the travel measures come from two main sources: the 2009 National Household Travel Survey (NHTS) and a database of model documentation for 69 metropolitan planning organizations (MPOs) assembled for the development of this report. There are two primary ways in which planners can make use of this information:

1. Using transferable parameters in the development of travel model components when local data suitable for model development are insufficient or unavailable; and
2. Checking the reasonableness of model outputs.

This report is written at a time of exciting change in the field of travel demand forecasting. The four-step modeling process that has been the paradigm for decades is no longer the only approach used in urban area modeling. Tour- and activity-based models have been and are being developed in several urban areas, including a sizable percentage of the largest areas in the United States. This change has the potential to significantly improve the accuracy and analytical capability of travel demand models.

At the same time, the four-step process will continue to be used for many years, especially in the smaller- and medium-sized urban areas for which this report will remain a valuable resource. With that in mind, this report provides information on parameters and modeling techniques consistent with the four-step process and Chapter 4, which contains the key information on parameters and techniques, is organized consistent with the four-step approach. Chapter 6 of this report presents information relevant to advanced modeling practices, including activity-based models and traffic simulation.

This report is organized as follows:

- **Chapter 1**—Introduction;
- **Chapter 2**—Planning Applications Context;
- **Chapter 3**—Data Needed for Modeling;
- **Chapter 4**—Model Components:
  - Vehicle Availability,
  - Trip Generation,
  - Trip Distribution,
  - External Travel,
  - Mode Choice,
  - Automobile Occupancy,
  - Time-of-Day,
  - Freight/Truck Modeling,
  - Highway Assignment, and
  - Transit Assignment;
- **Chapter 5**—Model Validation and Reasonableness Checking;
- **Chapter 6**—Emerging Modeling Practices; and
- **Chapter 7**—Case Studies.

This report is not intended to be a comprehensive primer for persons developing a travel model. For more complete information on model development, readers may wish to consult the following sources:

- "Introduction to Urban Travel Demand Forecasting" (Federal Highway Administration, 2008);
- "Introduction to Travel Demand Forecasting Self-Instructional CD-ROM" (Federal Highway Administration, 2002);
- *NCHRP Report 365: Travel Estimation Techniques for Urban Planning* (Martin and McGuckin, 1998);
- *An Introduction to Urban Travel Demand Forecasting—A Self-Instructional Text* (Federal Highway Administration and Urban Mass Transit Administration, 1977);
- FSUTMS Comprehensive Modeling Online Training Workshop (http://www.fsutmsonline.net/online_training/index.html#w1l3e3); and
- *Modeling Transport* (Ortuzar and Willumsen, 2001).

1.2 Travel Demand Forecasting: Trends and Issues

While there are other methods used to estimate travel demand in urban areas, travel demand forecasting and modeling remain important tools in the analysis of transportation plans, projects, and policies. Modeling results are useful to those making transportation decisions (and analysts assisting in the decision-making process) in system and facility design and operations and to those developing transportation policy.

NCHRP Report 365 (Martin and McGuckin, 1998) provides a brief history of travel demand forecasting through its publication year of 1998; notably, the evolution of the use of models from the evaluation of long-range plans and major transportation investments to a variety of ongoing, everyday transportation planning analyses. Since the publication of *NCHRP Report 365*, several areas have experienced rapid advances in travel modeling:

- The four-step modeling process has seen a number of enhancements. These include the more widespread incorporation of time-of-day modeling into what had been a process for modeling entire average weekdays; common use of supplementary model steps, such as vehicle availability models; the inclusion of nonmotorized travel in models; and enhancements to procedures for the four main model components (e.g., the use of logit destination choice models for trip distribution).
- Data collection techniques have advanced, particularly in the use of new technology such as global positioning systems (GPS) as well as improvements to procedures for performing household travel and transit rider surveys and traffic counts.
- A new generation of travel demand modeling software has been developed, which not only takes advantage of modern computing environments but also includes, to various degrees, integration with geographic information systems (GIS).
- There has been an increased use of integrated land use-transportation models, in contrast to the use of static land use allocation models.
- Tour- and activity-based modeling has been introduced and implemented.
- Increasingly, travel demand models have been more directly integrated with traffic simulation models. Most travel demand modeling software vendors have developed traffic simulation packages.

At the same time, new transportation planning requirements have contributed to a number of new uses for models, including:

- The analysis of a variety of road pricing options, including toll roads, high-occupancy toll (HOT) lanes, cordon pricing, and congestion pricing that varies by time of day;
- The Federal Transit Administration's (FTA's) user benefits measure for the Section 5309 New Starts program of transit projects, which has led to an increased awareness of model properties that can inadvertently affect ridership forecasts;

- The evaluation of alternative land use patterns and their effects on travel demand; and
- The need to evaluate (1) the impacts of climate change on transportation supply and demand, (2) the effects of travel on climate and the environment, and (3) energy and air quality impacts.

These types of analyses are in addition to several traditional types of analyses for which travel models are still regularly used:

- Development of long-range transportation plans;
- Highway and transit project evaluation;
- Air quality conformity (recently including greenhouse gas emissions analysis); and
- Site impact studies for developments.

1.3 Overview of the Four-Step Travel Modeling Process

The methods presented in this report follow the conventional sequential process for estimating transportation demand that is often called the "four-step" process:

- **Step 1**—Trip Generation (discussed in Section 4.4),
- **Step 2**—Trip Distribution (discussed in Section 4.5),
- **Step 3**—Mode Choice (discussed in Section 4.7), and
- **Step 4**—Assignment (discussed in Sections 4.11 and 4.12).

There are other components commonly included in the four-step process, as shown in Figure 1.1 and described in the following paragraphs.

The serial nature of the process is not meant to imply that the decisions made by travelers are actually made sequentially rather than simultaneously, nor that the decisions are made in exactly the order implied by the four-step process. For example, the decision of the destination for the trip may follow or be made simultaneously with the choice of mode. Nor is the four-step process meant to imply that the decisions for each trip are made independently of the decisions for other trips. For example, the choice of a mode for a given trip may depend on the choice of mode in the preceding trip.

In four-step travel models, the unit of travel is the "trip," defined as a person or vehicle traveling from an origin to a destination with no intermediate stops. Since people traveling for different reasons behave differently, four-step models segment trips by **trip purpose**. The number and definition of trip purposes in a model depend on the types of information the model needs to provide for planning analyses, the characteristics of the region being modeled, and the availability of data with which to obtain model parameters and the inputs to the model. The minimum number of trip purposes in most models is three: home-based work, home-based nonwork, and nonhome based. In this report, these three trip purposes are referred to as the "classic three" purposes.

The purpose of **trip generation** is to estimate the number of trips of each type that begin or end in each location, based on the amount of activity in an analysis area. In most models, trips are aggregated to a specific unit of geography (e.g., a traffic analysis zone). The estimated number of daily trips will be in the flow unit that is used by the model, which is usually one of the following: vehicle trips; person trips in motorized modes (auto and transit); or person trips by all modes, including both motorized and nonmotorized (walking, bicycling) modes. Trip generation models require some explanatory variables that are related to trip-making behavior and some functions that estimate the number of trips based on these explanatory variables. Typical variables include the number of households classified by characteristics such as number of persons, number of workers, vehicle availability, income level, and employment by type. The output of trip generation is trip productions and attractions by traffic analysis zone and by purpose.

Trip distribution addresses the question of how many trips travel between units of geography (e.g., traffic analysis zones). In effect, it links the trip productions and attractions from the trip generation step. Trip distribution requires explanatory variables that are related to the cost (including time) of travel between zones, as well as the amount of trip-making activity in both the origin zone and the destination zone. The outputs of trip distribution are production-attraction zonal trip tables by purpose.

Models of **external travel** estimate the trips that originate or are destined outside the model's geographic region (the model area). These models include elements of trip generation and distribution, and so the outputs are trip tables representing external travel.

Mode choice is the third step in the four-step process. In this step, the trips in the tables output by the trip distribution step are split into trips by travel mode. The mode definitions vary depending on the types of transportation options offered in the model's geographic region and the types of planning analyses required, but they can be generally grouped into automobile, transit, and nonmotorized modes. Transit modes may be defined by access mode (walk, auto) and/or by service type (local bus, express bus, heavy rail, light rail, commuter rail, etc.). Nonmotorized modes, which are not yet included in some models, especially in smaller urban areas, include walking and bicycling. Auto modes are often defined by occupancy levels (drive alone, shared ride with two occupants, etc.). When auto modes are not modeled separately, **automobile occupancy** factors are used to convert the auto person trips to vehicle trips prior to assignment. The outputs of the mode choice process include person trip tables by mode and purpose and auto vehicle trip tables.

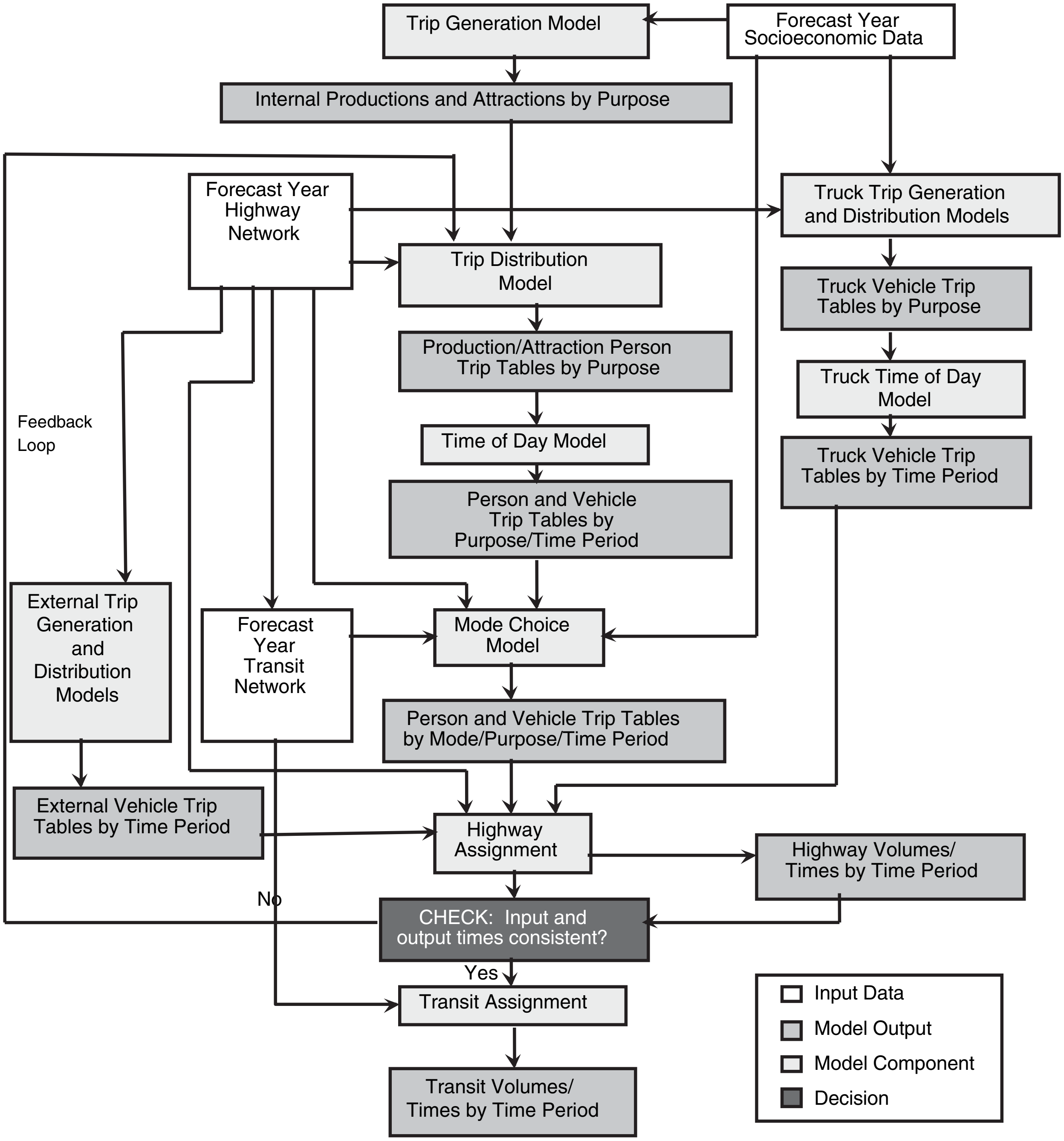

Figure 1.1. Four-step modeling process.

Time-of-day modeling is used to divide the daily trips into trips for various time periods, such as morning and afternoon peak periods, mid-day, and evening. This division may occur at any point between trip generation and trip assignment. Most four-step models that include the time-of-day step use fixed factors applied to daily trips by purpose, although more sophisticated time-of-day choice models are sometimes used.

While the four-step process focuses on personal travel, **commercial vehicle/freight travel** is a significant component of travel in most urban areas and must also be considered in the model. While simple factoring methods applied to personal travel trip tables are sometimes used, a better approach is to model such travel separately, creating truck/commercial vehicle trip tables.

The final step in the four-step process is **trip assignment**. This step consists of separate highway and transit assignment processes. The highway assignment process routes vehicle trips from the origin-destination trip tables onto paths along the highway network, resulting in traffic volumes on network links by time of day and, perhaps, vehicle type. Speed and travel time estimates, which reflect the levels of congestion indicated by link volumes, are also output. The transit assignment process routes trips from the transit trip tables onto individual transit routes and links, resulting in transit line volumes and station/stop boardings and alightings.

Because of the simplification associated with and the resultant error introduced by the sequential process, there is sometimes "feedback" introduced into the process, as indicated by the upward arrows in Figure 1.1 (Travel Model Improvement Program, 2009). Feedback of travel times is often required, particularly in congested areas (usually these are larger urban areas), where the levels of congestion, especially for forecast scenarios, may be unknown at the beginning of the process. An iterative process using output travel times is used to rerun the input steps until a convergence is reached between input and output times. Because simple iteration (using travel time outputs from one iteration directly as inputs into the next iteration) may not converge quickly (or at all), averaging of results among iterations is often employed. Alternative approaches include the method of successive averages, constant weights applied to each iteration, and the Evans algorithm (Evans, 1976).

Although there are a few different methods for implementing the iterative feedback process, they do not employ parameters that are transferable, and so feedback methods are not discussed in this report. However, analysts should be aware that many of the analysis procedures discussed in the report that use travel times as inputs (for example, trip distribution and mode choice) are affected by changes in travel times that may result from the use of feedback methods.

1.4 Summary of Techniques and Parameters

Chapter 4 presents information on (1) the analytical techniques used in the various components of conventional travel demand models and (2) parameters for these models obtained from typical models around the United States and from the 2009 NHTS. These parameters can be used by analysts for urban areas without sufficient local data to use in estimating model parameters and for areas that have already developed model parameters for reasonableness checking.

While it is preferable to use model parameters that are based on local data, this may be impossible due to data or other resource limitations. In such cases, it is common practice to transfer parameters from other applicable models or data sets. Chapter 4 presents parameters that may be used in these cases, along with information about how these parameters can be used, and their limitations.

1.5 Model Validation and Reasonableness Checking

Another important use of the information in this report will be for model validation and reasonableness checking. There are other recent sources for information on how the general process of model validation can be done. Chapter 5 provides basic guidance on model validation and reasonableness checking, with a specific focus on how to use the information in the report, particularly the information in Chapter 4. It is not intended to duplicate other reference material on validation but, rather, provide an overview on validation consistent with the other sources.

1.6 Advanced Travel Analysis Procedures

The techniques and parameters discussed in this report focus on conventional modeling procedures (the four-step process). However, there have been many recent advances in travel modeling methods, and some urban areas, especially larger areas, have started to use more advanced approaches to modeling. Chapter 6 introduces concepts of advanced modeling procedures, such as activity-based models, dynamic traffic assignment models, and traffic simulation models. It is not intended to provide comprehensive documentation of these advanced models but rather to describe how they work and how they differ from the conventional models discussed in the rest of the report.

1.7 Case Study Applications

One of the valuable features in *NCHRP Report 365* was the inclusion of a case study to illustrate the application of the parameters and techniques contained in it. In this report, two case studies are presented to illustrate the use of the information in two contexts: one for a smaller urban area and one for a larger urban area with a multimodal travel model. These case studies are presented in Chapter 7.

1.8 Glossary of Terms Used in This Report

MPO—Metropolitan Planning Organization, the federally designated entity for transportation planning in an urban area. In most areas, the MPO is responsible for maintaining and running the travel model, although in some places, other agencies, such as the state department of transportation, may have that responsibility. In this report, the term "MPO" is sometimes used to refer to the agency responsible for the model, although it is recognized that, in some areas, this agency is not officially the MPO.

Model area—The area covered by the travel demand model being referred to. Often, but not always, this is the area under the jurisdiction of the MPO. The boundary of the model area is referred to as the **cordon**. Trips that cross the cordon are called **external trips**; modeling of external trips is discussed in Section 4.6.

Person trip—A one-way trip made by a person by any mode from an origin to a destination, usually assumed to be without stops. In many models, person trips are the units used in all model steps through mode choice. Person trips are the usual units in transit assignment, but person trips are converted to vehicle trips for highway assignment.

Trip attraction—In four-step models, the trip end of a home-based trip that occurs at the nonhome location, or the destination end of a nonhome-based trip.

Trip production—In four-step models, the trip end of a home-based trip that occurs at the home, or the origin end of a nonhome-based trip.

Vehicle trip—A trip made by a motorized vehicle from an origin to a destination, usually assumed to be without stops. It may be associated with a more-than-one-person trip (for example, in a carpool). Vehicle trips are the usual units in highway assignment, sometimes categorized by the number of passengers per vehicle. In some models, vehicle trips are used as the units of travel throughout the modeling process.

Motorized and nonmotorized trips—Motorized trips are the subset of person trips that are made by auto or transit, as opposed to walking or bicycling trips, which are referred to as **nonmotorized trips**.

In-vehicle time—The total time on a person trip that is spent in a vehicle. For auto trips, this is the time spent in the auto and does not include walk access/egress time. For transit trips, this is the time spent in the transit vehicle and does not include walk access/egress time, wait time, or time spent transferring between vehicles. Usually, transit auto access/egress time is considered in-vehicle time.

Out-of-vehicle time—The total time on a person trip that is not spent in a vehicle. For auto trips, this is usually the walk access/egress time. For transit trips, this is the walk access/egress time, wait time, and time spent transferring between vehicles. In some models, components of out-of-vehicle time are considered separately, while in others, a single out-of-vehicle time variable is used.

CHAPTER 2

Planning Applications Context

The purpose of developing travel forecasting models is to provide information that can be used to make transportation planning decisions. These decisions may require different kinds of information from the model, depending on the context. The planning context, therefore, should be used to determine the appropriate model structure, parameters, and complexity. This decision, in turn, will ensure that the travel forecasting model is appropriate for each planning context. It is useful to develop a travel forecasting model that meets most (if not all) of an agency's current and future planning needs. This chapter discusses how the planning context affects the model's capabilities and provides examples of different contexts found in U.S. urban areas.

2.1 Types of Planning Analyses

The transportation planning function covers a diverse set of activities that focuses on different transportation modes and systems, timeframes, geographic scales, policy issues, and stakeholder groups. It is critical to gather input from a broad cross section of stakeholders on the types of policy considerations and modal analyses that need to be accounted for in the travel demand model prior to its development. Many planning requirements are directed by federal legislation, such as long-range transportation planning and air quality planning. Federal guidelines and regulations regarding transportation planning are summarized by agency in Appendix A. Planning practices for these requirements are generally consistent across areas of the same population. However, many other aspects of particular planning processes reflect state and local requirements, and actual planning practice varies widely. Many of these transportation planning functions require forecasts of future travel or other model outputs to aid in evaluating the benefits of different plan elements and different plans. The type of analysis being performed guides the design of models and the necessary features required to produce suitable forecasts for decision making (project prioritization, for example). Typical types of transportation planning that require travel forecasts are discussed in the following sections. The planning types are adapted from "Planning and Asset Management" (FHWA, 2009b).

2.1.1 Establishing System Performance Measures

The identification of individual performance measures depends on the complexity of the measures, as well as the size and characteristics of the transportation system. Standard metrics, such as vehicle-miles of travel, vehicle-hours of travel, link-based volume-to-capacity ratios, and travel speeds, can be produced by nearly all models, and some of these measures are used in model validation. (However, a model's ability to produce an output metric does not in itself mean that the model has been validated for that metric, and due care should be taken using the results.) More advanced metrics such as travel time reliability; intersection-based, area-based, or multimodal levels of service; hours of delay; or hours of congestion require both the input data and the model functions to calculate the measure for both a current base year and any horizon years. For example, a model that produces only daily traffic assignments will be unable to produce the data for calculating hours of delay without significant modifications. Transportation system performance measurement is a significant stand-alone topic related to the travel demand forecasting process, but too great to cover in the context of this report. *NCHRP Synthesis 311* (Shaw, 2003) and *TCRP Report 88* (Kittelson and Associates et al., 2003) provide a starting point for understanding the development and application of performance measures.

2.1.2 Long-Range Transportation Planning

Federal statutes require an MPO to prepare a long-range transportation plan (LRTP) and set forth many of the planning guidelines. Chief among these is a typical planning horizon of 20 to 30 years. This is not to say that other horizon years cannot be modeled, but the reliability of forecasts with a planning horizon of more than 30 years is highly questionable. Forecasts of less than 20 years may be appropriate for many of the types of planning activities listed below.

In general, for long-range planning, the model must be capable of analyzing, with reasonable accuracy, the impacts of projects that are included in the LRTP. The types of projects included, of course, vary depending on the characteristics of the urban area and its transportation system. In a large urban area, the plan is likely to include both highway and transit projects; therefore, the model must be capable of analyzing the impacts of projects of all travel modes. If road pricing projects are being considered, the model should be capable of considering the effects of price on travel demand. More detail on the required model features for several project types is provided in Sections 2.1.4 through 2.1.8.

If only a limited number of types of projects are included in the LRTP, which is often the case in smaller urban areas, a simpler modeling approach may be appropriate—unless the model is required to perform other analyses outside the long-range planning context that require additional modeling capabilities.

2.1.3 Policy Planning and Analysis

Tests of different policies can range from simple to complex over several dimensions. Modeling changes in population or employment growth rates require different data than do more complex scenarios, such as congestion pricing, changes in parking costs, fuel costs, assumption of realized mode split targets, or changes in high-occupancy vehicle (HOV) policies. Forecasts for all of the above types of analyses are often conducted for a series of both short- and long-term horizon years. For any of these tests, a more robust model set than one used for typical LRTP preparation is required. The constituencies of many MPOs are already demanding that many of these policies be considered as part of the LRTP development, so the model functionality required to perform these types of analyses is present in many agencies, and quickly being added by others. While it may not always be possible to anticipate all of the specific policies that the model may be used to analyze, it makes sense for model developers to consult with other planners and decision makers who may request certain types of analyses. It is important for the model to include the necessary features to support the analyses required for the policies being examined. If pricing is being analyzed, variables reflecting the pricing of various transportation options (tolls, parking, transit fares, etc.) must be included. If alternative land use patterns are analyzed, then variables reflecting land use patterns, such as density and diversity of development, should be included.

2.1.4 Regional and Corridor Planning

This type of analysis requires greater disaggregation of inputs within the study area, particularly for corridor planning. Facilities that might not be coded in a full regional travel network because they have a lower functional classification must be included for a corridor study, if observed data indicate the volume of traffic using the facilities is relevant to analyzing the corridor. Historically, subarea models have been developed for regional and corridor planning, where the level of detail of the transportation system represented by the networks is finer in the area of interest. Many current models already have a fine level of detail throughout the model area. It may be worthwhile to consider having a fine level of resolution appropriate for regional and corridor planning throughout the entire model, especially in smaller urban areas where the computation and model run time implications of a detailed model are not as likely to be severe. Small- and medium-sized agencies, in particular, must balance this consideration against their available resources to support model development and application.

2.1.5 Project Planning and Development

Forecasting the impacts of transportation projects or investments (and land development projects) is even more focused than corridor planning and requires a corresponding sharper focus and disaggregation of inputs and sometimes outputs. In many project planning studies, it is now common for a refined and study area-focused travel demand forecasting model to be one step in a larger forecasting effort that may take the output model forecasts and subsequently use them as inputs to mesoscopic or microscopic dynamic traffic assignment (DTA) or microscopic travel simulation. In these cases, the model must be able to produce compatible outputs. Even if DTA or microsimulation is not employed for project planning, it is almost inevitable that some sort of post-processing of model results must occur. It is reasonable to assume that for most projects, including studies of specific transportation improvements, either independently or as part of specific land development projects (i.e., traffic impact studies), some analysis will be conducted at the intersection level, requiring model output to be post-processed to produce reasonable intersection volumes and turning movements. This is not to say that a model is required for all such analyses; many traffic impact studies, particularly those looking at short-term forecasts, use simpler analytical methods to produce forecasts that do not require a model.

2.1.6 Transit Planning

At a minimum, forecasts for transit planning require a mode choice model and a transit network, with path building, skimming, and transit assignment capabilities. ["Skimming" sums impedances along selected paths identified as the route or path on the transit network that has the lowest cost for a traveler. Depending on the model structure, cost may be actual dollar values (fares) or monetized values of time, distance, or a combination of these and other price components.] A mode choice model, however, can have one of several different forms and specifications, ranging from a diversion table based on local survey data and a reasonable annual growth factor to a more complex nested logit structure. Regardless of the model form, the mode choice model and the entire model chain must be able to address the existing and potential new markets for transit in the study area, both regionally and for specific projects.

Transit project planning, where the project may use the FTA capital funds, has its own series of guidelines and requirements, but the FTA has been careful to avoid being prescriptive about model specifications and forms when issuing guidance, focusing instead on the properties of good modeling practices. Many of these properties focus on quality assurance and quality checks and rigorous model testing to ensure reliable results; these are characteristics of all good forecasts, not just those related to transit projects. The guidelines and requirements increase based on the potential level of federal capital investment in the project: from lowest to highest, these programs are currently known as Very Small Starts, Small Starts, and New Starts. Much of the current FTA guidance on model properties is included in Appendix A. As with certain types of short-term highway forecasts, forecasts for short-range transit service planning also use analytics that do not require a traditional model.

2.1.7 Road Pricing and Managed Lanes

Various aspects of pricing enter into the estimation of travel demand, including tolls, transit fares, parking costs, and auto/truck operating costs, which include fuel costs. This means that, to produce accurate demand forecasts, the model must be properly sensitive to the effects of price on travel demand. This type of sensitivity might require inclusion of price in all relevant travel choice components [mode, route (i.e., assignment); destination (i.e., trip distribution); time of day, etc.], as well as precise representation of time-cost tradeoffs, which requires accurate estimates of travelers' values of time. It also may require nonconstant implied values of travel time or at least market segmentation to approximate varying values of time. Some types of projects, including congestion pricing and projects where peak spreading is likely to be an issue, may require detailed time-of-day model components.

HOV lanes and carpooling incentives are analyzed in some areas using travel models. This type of analysis requires identification of roadways in the model network that require minimum occupancy levels and trip tables corresponding to each occupancy level allowed to use particular facilities. The mode choice model, therefore, must be capable of outputting these trip tables; and the highway assignment must be capable of assigning HOVs and low-occupancy vehicles to the appropriate facilities. If facilities such as HOT lanes are to be analyzed, the model must include the capabilities of both HOV and pricing analysis.

2.1.8 Nonmotorized Transportation Planning

A variety of analysis techniques is in use to forecast nonmotorized travel. Several factoring methods and sketch-planning techniques, such as aggregate demand models, have been employed to address planning needs. (At the time this report was being prepared, NCHRP Project 08-78, "Estimating Bicycling and Walking for Planning and Project Development," was under way, with a report expected by fall 2012.) The number of agencies fully integrating nonmotorized (bicycle and pedestrian) modes into travel demand forecasting is still small; however, there is continued interest in including nonmotorized treatment as part of good planning practice. Several approaches to incorporating nonmotorized travel into regional travel demand forecasting models are in use. Many major urban areas include nonmotorized travel in their trip generation models. Some agencies then immediately apply factors or models to separate motorized from nonmotorized travel. Other agencies carry nonmotorized travel through trip distribution and mode choice, employing a model that includes nonmotorized modes and delivering as outputs trip tables by mode and purpose. Most such models do not include assignment procedures for nonmotorized trips. Typically, the highway network is used as the basis for both walk and bicycle trips, excluding facilities such as freeways, where pedestrians and bicycles are prohibited. Some areas, however, have opted to develop pedestrian or bicycle networks, at least for some parts of the model region.

2.1.9 Freight Planning

At a minimum, an area planning to produce forecasts for freight will need truck modeling procedures incorporated within the model chain. Areas that observe significant truck traffic should model trucks separately, since passenger modeling procedures are not designed to accurately forecast truck movements.

At least three classes of vehicles could be considered:

1. Trucks carrying freight;
2. Trucks not carrying freight (for example, service vehicles); and
3. Other modes of freight transportation (for example, trains).

Most urban transportation planning contexts are concerned primarily with Classes 1 and 2, although certain specialized studies, such as port or freight terminal studies, may require information on Class 3. A truck model that considers Classes 1 and 2 is, therefore, the most common type of truck/freight model found in urban travel models. The truck trip tables created by the process are assigned along with autos in the highway assignment stage.

Estimates of demand for Classes 1 and 3 could be derived from a multimodal freight model, but this is difficult in urban areas since a high percentage of regional freight movements has an origin and/or destination outside the modeled area. In some states, a statewide freight model might be available to produce estimates of demand for vehicle Classes 1 and 3. However, a multimodal freight model does not consider vehicle Class 2, and so these truck trips must still be estimated.

2.1.10 Land Use Planning

The "transportation-land use" connection is a complex issue that continues to be the subject of a significant amount of research. There are several land use-transportation models that are fully integrated with travel demand models. These models consider the effects of accessibility on land use and location decisions, since travel conditions ultimately impact these choices. While there is no consensus on the best type of land use-transportation model to use, most large urban areas and many smaller ones have integrated some sort of land use modeling process. Land use models have their own data requirements and must be estimated, calibrated, and validated in a process separate from the travel demand model (Parsons Brinckerhoff Quade and Douglas, Inc., 1999).

2.1.11 Environmental Planning

While air quality planning has been established for some time by federal conformity requirements for MPOs, other areas, such as energy planning and carbon footprint forecasts, are still emerging at this time. All are interrelated with the transportation system, but the needs for forecasts are still being developed (or not well understood). Air quality planning can be performed at the regional and corridor level with the use of programs, such as MOBILE, MOVES, and EMFAC [the first two programs were developed by the U.S. Environmental Protection Agency (EPA), and the latter was developed for use in California].

These programs, however, generally require more information than typical travel models produce. Such information includes fleet estimates by vehicle size and fuel type; traffic volume and speed information by hour of the day; the operating modes of vehicles (cold start, running exhaust) at different points in the trip; and external factors such as climatic conditions. To produce the required information, many urban areas use "post-processor" programs to convert model outputs to the required format for input into the air quality analysis program. In addition to regional air quality, global climate change and related energy issues are now considered as part of environmental planning within the transportation context, and an increasing number of agencies explicitly model greenhouse gas (GHG) emissions at a project level [see ICF International (2008) and John A. Volpe National Transportation Systems Center (2009)]. It is likely that some of the guidance on these subjects may become formalized as part of the metropolitan planning process during the next federal reauthorization cycle.

Transferable parameters are more useful for some types of transportation planning than for others. If an area is calibrating a model for long-range transportation planning, land use planning, corridor planning, project site planning, or subarea planning that does not include the evaluation of transportation demand management (TDM) or more than minimal transit service, then transferable parameters are useful for calibrating models that will forecast motorized vehicle use. If planning is required to determine the impact of TDM measures or the diversion of automobile trips to other modes, then transferable parameters may be of reduced value. Other approaches, such as sketch-planning methods, may be of more use for these types of planning [see *TCRP Report 95* (Pratt et al., various years 2003 to 2011) and Cambridge Systematics, Inc. (2000)].

2.2 Urban Area Characteristics Affecting Planning and Modeling

Independent of the type of planning analysis to be performed, many urban area characteristics (e.g., population, employment, density) greatly impact both planning and modeling. Some of these characteristics are discussed in this section, and many of

> *TCRP Report 73: Characteristics of Urban Travel Demand* (Reno et al., 2002) presents a comprehensive set of tables on various aspects of urban travel demand assembled based on data from an MPO survey, the Highway Performance Monitoring System, the National Transit Database, and the 1995 National Personal Travel Survey, including demographics, vehicle ownership, trip generation by mode and trip purpose, trip generation by characteristics or origin and destination, trip making by time of day, truck trip parameters, utilization of facilities, parking, and telecommuting. Although the tables in *TCRP Report 73* contain information largely from the 1990s, it does continue to help illustrate differences among specific metropolitan areas for many of the recorded measures.

them directly inform planning and modeling requirements as set forth by federal planning regulations, which are discussed in detail in Appendix A.

2.2.1 Population and Demographics

Population size (greater than 50,000) is one of the urban area indicators that helps establish the formation of an MPO and the subsequent planning and modeling requirements. A separate threshold of 200,000, along with other guidelines, designates a transportation management area (TMA) and creates additional requirements. In general, the greater the population of an urban area, the more complex are the transportation issues, and thus the planning and modeling efforts. However, population size is not the only issue; in fact, other demographic indicators such as income, race, gender, non-native status, English as a second language, and household size all have potential impacts on aspects of travel considered in the forecasting process. Many of these characteristics are among the most common variables used in trip generation, trip distribution, and mode choice models.

The average age of the population has been increasing for many years and is expected to continue to do so for the foreseeable future. The aging of the population has significant effects on travel behavior, including the percentage of work-related travel, auto mode share, and time of day of travel. The rate of change in the age of the population differs among urban areas, and analysts should be aware of the expected trends in their regions.

2.2.2 Employment and Housing and Other Land Uses

The types, location, and concentration of housing and employment are key factors in an urban area's travel patterns. For work travel, a significant number of trips flow from home to work in the morning and the reverse in the evening. But as work hours change based on economic and travel conditions and the types of jobs in an area, and as both work and home locations become more dispersed, the travel flows become less temporally and geographically regular. This, in turn, affects nonwork travel traditionally made during off-peak periods. A travel demand model in such an area (or in a region with many such areas) would require the ability to forecast off-peak trips, and ideally would include observed off-peak and nonwork travel data for use in validation.

Urban areas vary in terms of the proportion of employment located in the central business district (CBD). The amount of centralization of employment in CBDs and other major activity centers, along with the size of the region, can impact travel behavior such as trip distance, time of day, and trip chaining.

2.2.3 Geographic Size

As with population size, increases in the geographic size of an urban area usually mean more complex planning and modeling issues. But it is also dependent on the land use and the density associated with the geography. All other features being equal, a large area of relatively uniform land uses and densities is more likely to produce uniform travel patterns (that is, little variability in trip purposes, time-of-day distribution, travel modes, trip distances, and other travel characteristics) than a smaller area with diverse land uses and densities.

2.2.4 Development Density, Diversity, Design, and Destinations

The "four Ds" of development—density, diversity, design, and destinations—can have many different effects on planning and modeling. Population (through housing) and employment density are indicators of land use intensity and, in many urban areas, are accompanied by improved pedestrian amenities, such as sidewalks, and transit options. Land use mix, or diversity, can affect motorized trip making; areas with greater mix often permit a wider variety of needs to be satisfied without needing to drive. Urban design elements, such as street pattern, block size, sidewalk coverage and continuity, and pedestrian and transit amenities, can support higher levels of walking and transit use [see *TCRP Report 95,* Chapter 15, "Land Use and Site Design" (Pratt et al., 2003), and Chapter 17, "Transit Oriented Development" (Pratt et al., 2007)]. Accessibility to a variety of destinations can affect mode shares, trip lengths, and trip chaining.

Higher densities mean more people in the same unit of area, and so the number of person trips would be expected to also be greater. However, this concentration of trip ends can be more efficient to serve with good transit service and nonmotorized transportation facilities leading to differences in the type of travel mode, as compared with less dense areas. Level of density is one of the key indicators used for developing area types in travel forecasting models, and the use of such area types is discussed in Chapter 4.

2.2.5 Natural Geography

Any natural feature that creates a travel barrier—from mountain passes to water crossings to buildable versus unbuildable land (not determined solely by regulation)—affects planning and modeling. Such barriers create good locations for screenlines to be used in model validation and must be key targets for practitioners to model accurately, since the facilities crossing them are likely to be high-profile choke points in the regional transportation system. One difference in this category is coastal versus inland urban areas. (The research team preparing this report tested a relationship between coastal and inland areas and travel characteristics using the 2001 NHTS data during initial data development for this report but found no significant relationship. Such a comparison could still be tested with local data, if available.)

2.2.6 Geographic Location within the United States

Growth and population shifts in the United States since 1945 (excluding international immigration) have generally followed a north-to-south, east-to-west flow. "Newer" urban areas, such as Phoenix and Charlotte, have different travel characteristics than older areas, such as Boston and Philadelphia. Some differences may be evident on a mega-regional level as well: travelers may behave differently in the Southwest than the Northeast, or in the Midwest compared with the East Coast and West Coast.

2.2.7 Climate and Climate Change

Prolonged periods of extreme temperatures, either hot or cold, can have an impact on planning and modeling, particularly if the climate results in degradation of or limitations to the transportation system. As noted in Section 2.1.11, global climate change and its impacts (such as rising sea levels) are now also a consideration in the planning and modeling process. However, these still-developing environmental models are considering time horizons beyond the current capabilities of travel forecasting models, so caution should be exercised when selecting analysis tools.

2.2.8 Resort/Nonresort Visitors

Resort areas that experience a significant number of visitors as a percentage of their total travelers—Las Vegas and Orlando, for example—may have different travel characteristics than areas with fewer visitors. Whether the visitors to the area tend to stay for a single day or multiple days is also an issue.

2.2.9 Presence of Alternative Transportation Modes

The presence of (or desire for) modes other than single-occupant vehicles (SOV) means an urban area should consider mode choice modeling. The complexity and specifications are dependent on the type of mode and type of analysis. The introduction of new fixed-guideway transit into an area has been a frequent application of transferable parameters for use in mode choice estimation, calibration, and validation.

2.2.10 Highway Network and Travel Conditions

Highway mileage, both overall and by functional class, and area travel conditions may lead to different requirements for planning and modeling. Areas with significant congestion will likely need to employ travel time feedback in their models to ensure that they are accurately reflecting the effects of congestion on travel behavior. Less congested areas, where more travel is on arterials rather than freeways, will have different considerations when developing volume-delay functions for their models. One indicator of congestion that can differentiate urban areas is the Annual Urban Mobility Report (mobility.tamu.edu/ums/).

2.2.11 External and Through Travel

The level of external and through travel for an urban area can affect travel conditions and may be a consideration in planning and modeling. Areas with significant through travel may be especially concerned with ways to explore diverting that through travel away from the region to help "free up" congested highways. Regions with large external travel components may need to take particular care in coordinating with neighboring jurisdictions to ensure that necessary current year data are available and that reasonable assumptions are made about future year conditions.

2.2.12 Land Use Control and Governance

The ability to regulate land uses, and at what level of geography, can have an impact on planning and the type of modeling required to test future changes. An urban area with a regional government and an urban growth boundary may have different travel characteristics than an urban area with weak counties and home-rule, with local land use control in the hands of hundreds of small municipal civil divisions, such as boroughs, townships, and other municipalities. The latter case is likely to make realization of aggressive shifts in future land use difficult to achieve even if they are modeled well, so planners should consider an appropriate level of land use sensitivity/modeling as they are building their travel forecasting model.

2.2.13 Presence of Special Generators

Small- and medium-sized urbanized areas that include a major university typically have different travel patterns than similar sized cities without a large campus. Presence of a large university indicates a relatively large number of young adults in the region, likely resulting in a larger percentage of school-related trips and part-time retail worker trips outside the peak period and potentially a larger share of bicycle, walking, and transit trips than other similar sized areas.

The presence of a state capital can also potentially impact travel patterns when compared against a similar sized city with a higher proportion of manufacturing employment. A large state worker labor force could result in additional nonhome-based travel out to lunch and running errands; whereas, factory workers typically have minimal mobility while on a time clock.

Cities with very large hub airports also have different trip characteristics reflected in a larger catchment area for their customers and a significant number of travelers spending the night at hotels in proximity to the airport property. If the airport is a freight hub, it is expected that truck traffic would potentially be higher than otherwise similar urban areas.

CHAPTER 3

Data Needed for Modeling

3.1 Introduction

Many data are required for model development, validation, and application. This chapter briefly describes the data used for these functions. Model application data primarily include socioeconomic data and transportation networks. These data form the foundation of the model for an area, and if they do not meet a basic level of accuracy, the model may never adequately forecast travel. When preparing a model, it is wise to devote as much attention as necessary to developing and assuring the quality of input data for both the base year and for the forecast years. This chapter provides an overview of primary and secondary data sources and limitations of typical data.

3.2 Socioeconomic Data and Transportation Analysis Zones

Socioeconomic data include household and employment data for the modeled area and are usually organized into geographic units called transportation analysis zones (TAZs, sometimes called traffic analysis zones or simply zones). Note that some activity-based travel forecasting models operate at a more disaggregate level than the TAZ (for example, the parcel level); however, the vast majority of models still use TAZs. The following discussion of data sources is applicable to any level of model geography.

TAZ boundaries are usually major roadways, jurisdictional borders, and geographic boundaries and are defined by homogeneous land uses to the extent possible. The number and size of TAZs can vary but should generally obey the following rules of thumb when possible:

- The number of residents per TAZ should be greater than 1,200, but less than 3,000;
- Each TAZ should yield less than 15,000 person trips per day; and
- The size of each TAZ should be from one-quarter to one square mile in area.

The TAZ structure in a subarea of particular interest may be denser than in other areas further away. It is important that TAZs are sized and bounded properly (Cambridge Systematics, Inc. and AECOM Consult, 2007). In general, there is a direct relationship between the size and number of zones and the level of detail of the analysis being performed using the model; greater detail requires a larger number of zones, where each zone covers a relatively small land area.

TAZs are typically aggregations of U.S. Census geographic units (blocks, block groups, or tracts with smaller units preferred), which allows the use of census data in model development.

To facilitate the use of U.S. Census data at the zonal level, an equivalency table showing which zones correspond with which census units should be constructed. Table 3.1 provides a brief example of such a table. Once the zone system is developed and mapped and a census equivalency table is constructed, zonal socioeconomic data can be assembled for the transportation planning process.

Estimates of socioeconomic data by TAZ are developed for a base year, usually a recent past year for which necessary model input data are available and are used in model validation. Forecasts of socioeconomic data for future years must be developed by TAZ and are estimated based on future land use forecasts prepared either using a manual process or with the aid of a land use model. As a key input to the travel demand model, the accuracy of socioeconomic forecasts greatly affects the accuracy of a travel demand forecast.

3.2.1 Sources for Socioeconomic Data

Data availability and accuracy, the ability to make periodic updates, and whether the data can be reasonably forecast into the future are the primary criteria in determining what data

Table 3.1. Example TAZ to Census geography equivalency table.

TAZ	Census Block
101	54039329104320
101	54039329104321
101	54039329104322
102	54039329104323
102	54039329104324

Source: Martin and McGuckin (1998).

will be used in a model.[1] With that consideration and the understanding that in some cases it may be an objective to gather base year data for other planning purposes, the following sources should be evaluated. In general, population and household data come from the U.S. Census Bureau and employment data from the Bureau of Labor Statistics (BLS, part of the United States Department of Labor), as well as their equivalent state and local agencies. Many of the programs are collaborations between the two federal agencies. Socioeconomic input data are also available from a number of private vendors.

Population and Households

Four major data sources for population and household information are described in this subsection: decennial U.S. Census, American Community Survey (ACS), ACS Public Use Microdata Samples (PUMS), and local area population data.

Decennial U.S. Census. The decennial census offers the best source for basic population and household data, including age, sex, race, and relationship to head of household for each individual. The census also provides data for housing units (owned or rented). These data are available at the census block level and can be aggregated to traffic zones. The decennial census survey is the only questionnaire sent to every American household with an identifiable address. The 2010 Census is the first since 1940 to exclude the "long form." Previously, approximately one in every six households received the long form, which included additional questions on individual and household demographic characteristics, employment, and journey-to-work. The absence of the long form means that modelers must obtain these data (if available) from other sources, such as the American Community Survey (see below).

American Community Survey. The ACS has replaced the decennial census long form. Information such as income, education, ethnic origin, vehicle availability, employment status, marital status, disability status, housing value, housing costs, and number of bedrooms may be obtained from the ACS. The ACS content is similar to the Census 2000 long form, and questions related to commuting are about the same as for the long form, but the design and methodology differ.

Rather than surveying about 1 in every 6 households once every 10 years, as had been done with the long form, the ACS samples about 1 in every 40 addresses every year, or 250,000 addresses every month. The ACS uses household addresses from the Census Master Address File that covers the entire country each year. The ACS thus samples about 3 million households per year, translating into a less than 2.5 percent sample per year. As a result of the smaller sample size, multiple years are required to accumulate sufficient data to permit small area tabulation by the Census Bureau in accordance with its disclosure rules. Table 3.2 highlights the ACS products, including the population and geography thresholds associated with each period of data collection. The sample size for the ACS, even after 5 years of data collection, is smaller than the old census long form. Thus, ACS's 5-year estimates have margins of error about 1.75 times as large as those associated with the 2000 Census long form estimates, and this must be kept in mind when making use of the data. AASHTO and the FHWA offer Internet resources providing additional detail on ACS data and usage considerations.

ACS Public Use Microdata Samples. The Census Bureau produces the ACS PUMS files so that data users can create custom tables that are not available through pretabulated data products (U.S. Census Bureau, 2011a). The ACS PUMS files are a set of untabulated records about individual people or housing units. PUMS files show the full range of population and housing unit responses collected on individual ACS questionnaires. For example, they show how respondents answered questions on occupation, place of work, etc. The PUMS files contain records for a subsample of ACS housing units and group quarters persons, with information on the characteristics of these housing units and group quarters persons plus the persons in the selected housing units.

The Census Bureau produces 1-year, 3-year, and 5-year ACS PUMS files. The number of housing unit records contained in a 1-year PUMS file is about 1 percent of the total in the nation, or approximately 1.3 million housing unit records and about 3 million person records. The 3-year and 5-year ACS PUMS files are multiyear combinations of the 1-year PUMS files

[1]The explanatory power of a given variable as it relates to travel behavior must also be considered; however, such consideration is subordinate to the listed criteria. A model estimated using best-fit data that cannot be forecast beyond the base year, for example, provides little long-term value in forecasting.

Table 3.2. ACS data releases.

Data Product	Population Threshold	Geographic Threshold	Years Covered by Planned Year of Release			
			2010	2011	2012	2013
1-year estimates	65,000+	PUMAs, counties, large cities	2009	2010	2011	2012
3-year estimates	20,000+	Counties, large cities	2007–2009	2008–2010	2009–2011	2010–2012
5-year estimates	All areas*	Census tracts, block groups in summary file format	2005–2009	2006–2010	2007–2011	2008–2012

*5-year estimates will be available for areas as small as census tracts and block groups.

Source: U.S. Census Bureau.

with appropriate adjustments to the weights and inflation adjustment factors. They typically cover large geographic areas with a population greater than 100,000 [Public Use Microdata Areas (PUMAs)] and, therefore, have some limits in application for building a socioeconomic database for travel forecasting, but can be helpful because of the detail included in each record. PUMS data are often used as seed matrices in population synthesis to support more disaggregate levels of modeling (such as activity-based modeling). PUMS users may also benefit from looking at Integrated PUMS (IPUMS), which makes PUMS data available for time series going back over decades with sophisticated extract tools.

Local area population data. Some local jurisdictions collect and record some type of population data. In many metropolitan areas, the information is used as base data for developing cooperative population forecasts for use by the MPO as travel model input.

Employment

Obtaining accurate employment data at the TAZ level is highly desirable but more challenging than obtaining household data for a number of reasons, including the dynamic nature of employment and retail markets; the difficulty of obtaining accurate employee data at the site level; and lack of an equivalent control data source, such as the U.S. Census, at a small geographic level. Six potential sources of data are discussed in this subsection.

Quarterly Census of Employment and Wages. Previously called ES-202 data, a designation still often used, the Quarterly Census of Employment and Wages (QCEW) provides a quarterly count of employment and wages at the establishment level (company names are withheld due to confidentiality provisions), aggregated to the county level and higher (state, metropolitan statistical area). Data are classified using the North American Industry Classification System (NAICS). The QCEW is one of the best federal sources for at-work employment information.

State employment commissions. State employment commissions generally document all employees for tax purposes. Each employer is identified by a federal identification number, number of employees, and a geocodable address usually keyed to where the payroll is prepared for the specified number of employees.

Current Population Survey. The Current Population Survey (CPS) is a national monthly survey of about 50,000 households to collect information about the labor force. It is a joint project of the Census Bureau and the BLS. The CPS may be useful as a comparison between a local area's labor force characteristics and national figures.

Market research listings. Many business research firms (e.g., Infogroup, Dun and Bradstreet, etc.) sell listings of all (or major) employers and number of employees by county and city. These listings show business locations by street addresses, as well as post office boxes.

Longitudinal Employer–Household Dynamics. Longitudinal Employer–Household Dynamics (LEHD) (U.S. Census Bureau, 2011b) is a program within the U.S. Census Bureau that uses statistical and computational techniques to combine federal and state administrative data on employers and employees with core Census Bureau censuses and surveys. LEHD excludes some employment categories, including self-employed and federal workers, and data are not generated for all states (i.e., Connecticut, Massachusetts, and New Hampshire as well as the District of Columbia, Puerto Rico, and the U.S. Virgin Islands as of September 2011). Users of LEHD should also be mindful of limitations with the methodology used to assemble the data, including the use of Minnesota data as the basis for matching workers to workplace establishments and the match (or lack of match) with Census Transportation Planning Products (discussed below). Murakami (2007) provides an examination and discussion of LEHD issues for transportation planners. The LEHD Quarterly Workforce Indicators (QWI) report is a useful source for modelers, particularly as a complement to the QCEW.

Local area employment data. Few areas record employment data other than a broad listing of major employers with the highest number of employees locally, typically reported by a local chamber of commerce or similar organization.

Special Sources

Census Transportation Planning Products. Previously called the Census Transportation Planning Package, the Census Transportation Planning Products (CTPP) Program (AASHTO, 2011) is an AASHTO-sponsored data program funded by member state transportation agencies and operated with support from the FHWA, Research and Innovative Technology Administration, FTA, U.S. Census Bureau, MPOs, state departments of transportation (DOTs), and the TRB. CTPP includes tabulations of interest to the transportation community for workers by place of residence, place of work, and for flows between place of residence and place of work. CTPP are the only ACS tabulations that include flow information. Examples of special dimensions of tabulation include travel mode, travel time, and time of departure.

CTPP are most frequently used as an observed data source for comparison during model validation, but are sometimes used as a primary input in model development, particularly in small areas where local survey data are unavailable. The previous CTPP tabulations were based on the decennial census long form. The CTPP 2006 to 2008 is based on the ACS and is available at the county or place level for geography meeting a population threshold of 20,000. The CTPP 2006 to 2010, anticipated to be available in 2013, will provide data at the census tract, CTPP TAZ, and CTPP Transportation Analysis District (TAD) levels. ACS margin of error considerations apply to the CTPP.

Aerial photography. Often aerial or satellite photographs available at several locations on the Internet can be used to update existing land use, which can then be used as a cross-check in small areas to ensure that population and employment data are taking into account changes in land use. It is crucial to know the date of the imagery (when the pictures were taken) prior to using it for land use updates. Aerial photography is also useful in network checking, as discussed later.

Other commercial directories. Some commercial directories provide comprehensive lists of household and employment data sorted by name and address. For households, such information as occupation and employer can be ascertained from these sources. For business establishments, type of business—including associations, libraries, and organizations that may not be on the tax file—can be determined. Other commercial databases provide existing and forecasted households and employment by political jurisdictions.

Other sources. Data on school types, locations, and enrollment are typically obtained directly from school districts and state departments of education (DOE). Large private schools might have to be contacted directly to obtain this information if the state DOE does not maintain records for such schools.

3.2.2 Data Source Limitations

Population

The main data source to establish a residential database is the decennial census. Other sources do not provide comparable population statistics by specific area (i.e., block level). Often, the base year for modeling does not conform to a decennial census. In that case, data from the decennial census should be used as the starting point and updated with available data from the census and other sources to reflect the difference between the decennial census year and the base year.

Employment

Each of the previously identified data sources has some deficiency in accurately specifying employment for small geographic areas:

- The census provides total labor force by TAZ; however, this represents only employment location of residents and not total employment.
- The census also shows labor force statistics by industry group but does not compile this by employer and specific geographic area (i.e., block).
- The CTPP counts employed persons, not jobs. For persons with more than one job, characteristics on only the principal job are collected.
- Considerations regarding margin of error apply to use of CTPP or ACS data (or any data for that matter).
- The employment commission data may provide accurate employment for each business but only partially list street addresses.
- Market research listings have all employers by street address. Although these listings are extensive, the accuracy is controlled internally and often cannot be considered comprehensive (because of the lack of information regarding

collection methodology), but it offers a check for other data sources.

- The land use data obtained from aerial photography provide a geographic location of businesses but do not provide numbers of employees.
- Employment commission data (as well as other data on employers) often record a single address or post office box of record; employee data from multiple physical locations may be aggregated when reported (i.e., the headquarters of a firm may be listed with the total employment combined for all establishments).
- Government employment is not included in some data sources (including market research listings) or is included incompletely. Government employment sites are often either double-counted in commercially available data sources or "lumped" (i.e., multiple sites reported at one address). For example, public school employees are not always assigned to the correct schools.

Employment data are the most difficult data component to collect. None of the data sources alone offers a complete inventory of employment by geographic location. Therefore, the methodology for developing the employment database should be based on the most efficient and accurate method by which employment can be collected and organized into the database file. All data must be related to specific physical locations by geocoding. Planning for supplementary local data collection remains the best option for addressing deficiencies in source data on employment; however, this effort must be planned several years in advance to ensure that resources can be made available for survey development, administration, and data analysis. For all sources of socioeconomic data, users must be aware of disclosure-avoidance techniques applied by the issuing agency and their potential impact on their use in model development.

3.2.3 Base and Forecast Year Control Totals for the Database

The control totals for the database should be determined before compilation of the data. The source of the control totals for population should be the decennial census. Control totals for employment at the workplace location are more difficult to establish; however, the best source is usually the QCEW or state employment commission data.

When the most recent census data are several years old, it may be desirable to have a more recent base year for the model, especially in faster growing areas. This means that some data may not be available at the desired level of detail or segmentation—for example, the number of households for a more recent year may be available, but not the segmentation by income level. Analysts often use detailed information from the most recent year for which it is available to update segmentations, such as applying percentages of households by segment from the census year to the total number of households for a more recent year. In some cases, estimates of totals (for example, employment by type) may not be available at all for the base year. Other data sources, such as building permits, may be used to produce estimates for more recent years, building upon the known information for previous years.

Census data are, of course, unavailable for forecast years. Some of the agencies discussed above—as well as state agencies, counties, and MPOs—produce population, housing, and employment forecasts. Such forecasts are often for geographic subdivisions larger than TAZs, and other types of segmentation may also be more aggregate than in data for past years. This often means that analysts must disaggregate data for use as model inputs. Data are typically disaggregated using segmentation from the base year data, often updated with information about land use plans and planned and proposed future developments.

3.3 Network Data

The estimation of travel demand requires an accurate representation of the transportation system serving the region. The most direct method is to develop networks of the system elements. All models include a highway network; models that include transit elements and mode choice must also include a transit network. Sometimes, a model includes a bicycling or a walk network. Accurate transportation model calibration and validation require that the transportation networks represent the same year as the land use data used to estimate travel demand.

3.3.1 Highway Networks

The highway network defines the road system in a manner that can be read, stored, and manipulated by travel demand forecasting software. Highway networks are developed to be consistent with the TAZ system. Therefore, network coding is finer for developed areas containing small zones and coarser for less-developed areas containing larger zones. The types of analyses, for which the model will be used, determine the level of detail required. A rule of thumb is to code in roads one level below the level of interest for the study. One highway network may be used to represent the entire day, but it may be desirable to have networks for different periods of the day that include operational changes, such as reversible lanes or peak-period HOV lanes. Multiple-period networks can be stored in a single master network file that includes period or alternative-specific configurations for activation and deactivation.

Each TAZ has a centroid, which is a point on the model network that represents all travel origins and destinations in a zone. Zone centroids should be located in the center of activity (not necessarily coincident with the geographic center) of the zone, using land use maps, aerial photographs, and local knowledge. Each centroid serves as a loading point to the highway and transit systems and, therefore, must be connected to the model network.

Sources for Network Data

Digital street files are available from the Census Bureau (TIGER/Line files), other public sources, or several commercial vendors and local GIS departments. Selecting the links for the coded highway network requires the official functional classification of the roadways within the region, the average traffic volumes, street capacities, TAZ boundaries, and a general knowledge of the area. Other sources for network development include the FHWA National Highway Planning Network, Highway Performance Monitoring System (HPMS), Freight Analysis Framework Version 3 (FAF3) Highway Network, National Transportation Atlas Database, and various state transportation networks. All of these resources may be useful as starting points for development or update of a model network. However, there are limitations with each in terms of cartographic quality; available network attributes; source year; and, especially with commercial sources, copyrights, which should be considered when selecting a data source to use.

In states where the state DOT has a database with the roadway systems already coded, the use of the DOT's coded network can speed up the network coding process. Questions can be directed to the DOT; and such a working relationship between DOT and MPO helps the modeling process because both parties understand the network data source.

Highway Network Attributes

Highway links are assigned attributes representing level of service afforded by the segment and associated intersections. Link distance based on the true shape of the roadway (including curvature and terrain), travel time, speed, link capacity, and any delays that will impact travel time must be assigned to the link. Characteristics, such as the effect of traffic signals on free-flow travel time, should be considered (see Parsons Brinckerhoff Quade & Douglas, 1992). Three basic items needed by a transportation model to determine impedance for the appropriate assignment of trips to the network are distance, speed, and capacity. Additional desirable items may include facility type and area type.

Facility Type and Area Type

The link attributes facility type and area type are used by many agencies to determine the free-flow speed and per-lane hourly capacity of each link, often via a two-dimensional look-up table.

Area type refers to a method of classifying zones by a rough measure of land use intensity, primarily based on population and employment density. A higher intensity of land use generally means more intersections, driveways, traffic signals, turning movements, and pedestrians, and, therefore, slower speeds. Sometimes, roadway link speeds and capacities are adjusted slightly based on the area type where they are located. Common area type codes include central business district (CBD), CBD fringe, outlying business district, urban, suburban, exurban, and rural. The definition of what is included in each area type is somewhat arbitrary since each study area is structured differently. In some models, area type values are assigned during the network building process on the basis of employment and population density of the TAZ centroid that is nearest to the link (Milone et al., 2008). Note that, since area type definitions are aggregate and "lumpy," their use in models may result in undesirable boundary effects. In many cases, use of continuous variables will be superior to use of aggregate groupings of zone types.

Facility type is a designation of the function of each link and is a surrogate for some of the characteristics that determine the free-flow capacity and speed of a link. Facility type may be different from functional classification, which relates more to ownership and maintenance responsibility of different roadways. Table 3.3 provides common facility types used by some modeling agencies. Features, such as HOV lanes, tolled lanes, and reversible lanes, are usually noted in network coding to permit proper handling but may not be facility types per se for the purposes of typical speed/capacity look-up tables.

Link Speeds

Link speeds are a major input to various model components. The highway assignment process relates travel times and speeds on links to their volume and capacity. This process requires what are commonly referred to as "free-flow" speeds. Free-flow speed is the mean speed of passenger cars measured during low to moderate flows (up to 1,300 passenger cars per hour per lane).

Free-flow link speeds vary because of numerous factors, including:

- Posted speed limits;
- Adjacent land use activity and its access control;
- Lane and shoulder widths;

Table 3.3. Typical facility type definitions.

Facility Type	Definition	Link Characteristics
Centroid Connectors	Links that connect zones to a network that represent local streets or groups of streets.	High capacity and low speed
Freeways	Grade-separated, high-speed, high-capacity links. Freeways have limited access with entrance and exit ramps.	Top speed and capacity
Expressways	Links representing roadways with very few stop signals serving major traffic movements (high speed, high volume) for travel between major points.	Higher speed and capacity than arterials, but lower than freeways
Major Arterials	Links representing roadways with traffic signals serving major traffic movements (high speed, high volume) for travel between major points.	Lower speed and capacity than freeways and expressways, but more than other facility types
Minor Arterials	Links representing roadways with traffic signals serving local traffic movements for travel between major arterials or nearby points.	Moderate speed and capacity
Collectors	Links representing roadways that provide direct access to neighborhoods and arterials.	Low speed and capacity
Ramps	Links representing connections to freeways and expressways from other roads.	Speeds and capacity between a freeway and a major arterial

- Number of lanes;
- Median type;
- Provision of on-street parking;
- Frequency of driveway access; and
- Type, spacing, and coordination of intersection controls.

Transportation models can use any of several approaches to simulate appropriate speeds for the links included in the network. Speeds should take into account side friction along the road, such as driveways, and the effect of delays at traffic signals.

One way to determine the free-flow speed is to conduct travel time studies along roadways included in the network during a period when traffic volumes are low and little if any delay exists. This allows the coding of the initial speeds based on observed running speeds on each facility. Speed data are also available from various commercial providers (e.g., Inrix); and in some jurisdictions, speed information on certain facilities is collected at a subsecond level. An alternative approach is to use a free-flow speed look-up table. Such a table lists default speeds by area and facility type, which are discussed later.

Although regional travel demand forecasting validation generally focuses on volume and trip length-related measures, there is often a desire to look at loaded link speeds and travel times. The analyst should be cognizant that "model time" may differ from real-world time due to the many network simplifications present in the modeled world, among other reasons. Looking at changes in time and speed can be informative (e.g., by what percentage are speeds reduced/travel times increased). When looking at such information for the validation year, a variety of sources may be available for comparative purposes, including probe vehicle travel time studies, GPS data collection, and commercial data.

Link Capacity

In its most general sense, capacity is used here as a measure of vehicles moving past a fixed point on a roadway in a defined period of time; for example, 1,800 vehicles per lane per hour. In practice, models do not uniformly define capacity. Some models consider capacity to be applied during free-flow, uncongested travel conditions, while others use mathematical formulas and look-up tables based on historical research on speed-flow relationships [e.g., Bureau of Public Roads (BPR) curves and other sources] in varying levels of congestion on different types of physical facilities. Throughout this report, the authors have tried to specify what is meant for each use of "capacity."

The definitive reference for defining highway capacity is the *Highway Capacity Manual* (Transportation Research Board, 2010), most recently updated in 2010. "Capacity" in a traffic engineering sense is not necessarily the same as the capacity variable used in travel demand model networks. In early travel models, the capacity variable used in such volume-delay functions as the BPR formula represented the volume at Level of Service (LOS) C; whereas, in traffic engineering, the term "capacity" traditionally referred to the volume at LOS E. The *Highway Capacity Manual* does contain useful information for the computation of roadway capacity, although many of the factors that affect capacity, as discussed in the manual, are not available in most model highway networks.

Link capacities are a function of the number of lanes on a link; however, lane capacities can also be specified by facility and area type combinations. Several factors are typically used to account for the variation in per-lane capacity in a highway network, including:

- Lane and shoulder widths;
- Peak-hour factors;
- Transit stops;
- Percentage of trucks[2];
- Median treatments (raised, two-way left turn, absent, etc.);
- Access control;
- Type of intersection control;
- Provision of turning lanes at intersections and the amount of turning traffic; and
- Signal timing and phasing at signalized intersections.

Some models use area type and facility type to define per lane default capacities and default speed. The number of lanes should also be checked using field verification or aerial or satellite imagery to ensure accuracy.

Some networks combine link capacity and node capacity to better define the characteristics of a link (Kurth et al., 1996). This approach allows for a more refined definition of capacity and speed by direction on each link based on the characteristics of the intersection being approached. Such a methodology allows better definition of traffic control and grade separation at an intersection.

Typical Highway Network Database Attributes

The following highway network attributes are typically included in modeling databases:

- Node identifiers, usually numeric, and their associated x-y coordinates;
- Link identifiers, either numeric, defined by "A" and "B" nodes, or both;
- Locational information (e.g., zone, cutline, or screenline location);
- Link length/distance;
- Functional classification/facility type, including the divided or undivided status of the link's cross section;
- Number of lanes;
- Uncongested (free-flow) speed;
- Capacity;
- Controlled or uncontrolled access indicator;
- One-way versus two-way status;
- Area type; and
- Traffic count volume (where available).

3.3.2 Transit Networks

Most of the transit network represents transit routes using the highways, so the highway network should be complete before coding transit. Transit network coding can be complex. Several different modes (e.g., express bus, local bus, light rail, heavy rail, commuter rail, bus rapid transit) may exist in an area; and each should have its own attribute code. Peak and off-peak transit service likely have different service characteristics, including headways, speeds, and possibly fares; therefore, separate peak and off-peak networks are usually developed. The transit networks are developed to be consistent with the appropriate highway networks and may share node and link definitions.

Table 3.4 is a compilation of transit network characteristics that may be coded into a model's transit network. Characteristics in italics, such as headway, must be included in all networks, while the remaining characteristics, such as transfer penalty, may be needed to better represent the system in some situations.

Transit networks representing weekday operations in the peak and off-peak periods are usually required for transit modeling; sometimes, separate networks may be required for the morning and afternoon peak periods, as well as the mid-day and night off-peak periods.

The development of bus and rail networks begins with the compilation of transit service data from all service providers in the modeled area. Transit networks should be coded for a typical weekday situation, usually represented by service provided in the fall or spring of the year.

Two types of data are needed to model transit service: schedule and spatial (the path each route takes). Although the data provided by transit operators will likely contain more detail than needed for coding a transit network, software can be used to calculate, for each route, the average headway and average run time during the periods for which networks are created.

Transit Line Files

Local bus line files are established "over" the highway network. Sometimes nodes and links, which are coded below the grain of the TAZ system, must be added to the highway network so that the proximity of transit service to zonal

[2]Facilities experiencing greater-than-typical truck traffic (say, greater than 5 percent for urban facilities; greater than 10 percent for nonurban facilities) have an effective reduction in capacity available for passenger cars (i.e., trucks reduce capacity available by their passenger car equivalent value, often a simplified value of 2 is used). Trucks in this context are vehicles F5 or above on the FHWA classification scheme, the standard *Highway Capacity Manual* definition.

Table 3.4. Transit network characteristics and definitions.

Transit Network Characteristic	Description
Drive access link	A link that connects TAZs to a transit network via auto access to a park-and-ride or kiss-and-ride location.
*Effective headway**	The time between successive transit vehicles on multiple routes with some or all stops in common.
Headway	The time between successive arrivals (or departures) of transit vehicles on a given route.
Local transit service	Transit service with frequent stops within a shared right-of-way with other motorized vehicles.
Mode number	Code to distinguish local bus routes from express bus, rail, etc.
Park-and-ride-to-stop link	A walk link between a park-and-ride lot and a bus stop, which is used to capture out-of-vehicle time associated with auto access trips, and also for application of penalties associated with transfers.
Premium transit service	Transit service (e.g., bus rapid transit, light rail transit, heavy rail, commuter rail) with long distances between infrequent stops that may use exclusive right-of way and travel at speeds much higher than local service.
Route description	Route name and number/letter.
Run time	The time in minutes that the transit vehicle takes to go from the start to the finish of its route and a measure of the average speed of the vehicle on that route.
Transfer link	A link used to represent the connection between stops on two transit lines that estimates the out-of-vehicle time associated with transfers, and also for application of penalties associated with transfers.
Transfer penalty	Transit riders generally would rather have a longer total trip without transfers than a shorter trip that includes transferring from one vehicle to another; therefore, a penalty is often imposed on transfers to discourage excess transfers during the path-building process.
Walk access link	A link that connects TAZs to a transit network by walking from a zone to bus, ferry, or rail service; usually no longer than one-third mile for local service and one-half mile for premium service (some modeling software distinguishes access separately from egress).
Walking link	A link used exclusively for walking from one location to another. These links are used in dense areas with small TAZs to allow trips to walk between locations rather than take short transit trips.

*Italics indicate characteristics that must be included in all networks.

activity centers can be more accurately represented. These subzonal highway links, which are used to more accurately reflect transit route alignments, should be disallowed from use during normal highway path-building and highway assignments. Local bus stops are traditionally coded at highway node locations.

Transit line files can be designated for different types of service or different operators using mode codes, which designate a specific provider (or provider group) or type of service. Premium transit line files that operate in their own right-of-way are coded with their own link and node systems rather than on top of the highway network. Some modeling software requires highway links for all transit links, thus, necessitating the coding of "transit only" links in the highway network. The modeler may not be provided with detailed characteristics for transit services that do not already exist in the modeled area and may need guidance with regard to what attribute values should be coded for these new services (FTA, 1992). Each transit line can be coded uniquely and independently so that different operating characteristics by transit line can be designated.

Transit line files contain information about transit lines, such as the headway, run time, and itinerary (i.e., the sequence of nodes taken by the transit vehicle as it travels its route). Some models compute the transit speed as a function of underlying highway speed instead of using a coded run time. Line files are time-of-day specific, so there is a set of line files for each time period for which a network is coded. One can usually designate stops as board-only or alight-only (useful for accurately coding express bus service). Similarly, one can code run times for subsections of a route, not just for the entire route; a feature useful for the accurate depiction of transit lines that undergo extensions or cutbacks, or which travel through areas with different levels of congestion. One can also store route-specific comments (such as route origin, route destination, and notes) in line files.

Access Links

It is assumed that travelers access the transit system by either walking or driving. Zone centroids are connected to the transit system via a series of walk access and auto access paths. In the past, modeling software required that walk access and auto access links be coded connecting each zone centroid to the transit stops within walking or driving distance. These separate access links are still seen, particularly in models that have been converted from older modeling software packages. Current modeling software generally allows walk or auto access paths to be built using the highway network links, including, where appropriate, auxiliary links that are not available to vehicular traffic (such as walking or bicycle paths).

Walk paths are coded to transit service that is within walking distance of a zone to allow access to and egress from transit service. The maximum walking distance may vary depending on urban area, with larger urban areas usually having longer maximum walk distances although generalizations about typical values could be misleading. The best source for determining maximum walk distances is an on-board survey of transit riders. Some models may classify "short" and "long" walk distances.

Auto access paths are used to connect zones with park-and-ride facilities or train stations. Auto access paths are coded for zones that are not within walking distance (as classified by that model) of transit service but are deemed to be used by transit riders from a zone. A rule-based approach (for example, maximum distance between the zone centroid and the stop) is often used to determine which zones will have auto access to which stops. Again, the best source for determining which zones should have auto access is an on-board survey of transit riders.

Travel Times and Fares

The time spent on transit trips—including time spent riding on transit vehicles, walking or driving to and from transit stops, transferring between transit lines, and waiting for vehicles—must be computed. This computation is done by skimming the transit networks for each required variable (for example, in-vehicle time, wait time, etc.). In-vehicle times are generally computed from the network links representing transit line segments, with speeds on links shared with highway traffic sometimes computed as a function of the underlying (congested) highway speed. Wait times are usually computed from headways with one-half of the headway representing the average wait time for frequent service and maximum wait times often used to represent infrequent service where the travelers will know the schedules and arrange their arrival times at stops accordingly. Auto access/egress times are often computed from highway networks. Walk access/egress times are sometimes computed assuming average speeds applied to distances from the highway networks.

Transit fares used in the mode choice process must be computed. The process may need to produce multiple fare matrices representing the fare for different peak and off-peak conditions. This can be done in multiple ways. If the fare system is distance based, then transit fares can be calculated by the modeling software by skimming the fare over the shortest path just as the time was skimmed. Systems that use one fare for all trips in the study area can assign a fare to every trip using transit. More complex systems with multiple fare tariffs will require unique approaches that may be a combination of the previous two or require the use of special algorithms. Some transit systems require transfer fares that are applied whenever a rider switches lines or from one type of service to another.

3.3.3 Updating Highway and Transit Networks

Transportation networks change over time and must be coded to represent not only current conditions for the base year, but also forecasting scenarios so that models can be used to forecast the impact of proposed changes to the highway network. Socioeconomic data and forecasts must also be updated, and these can affect network attributes (for example, area type definitions that depend on population and employment density).

It is good transportation planning practice to have a relatively up-to-date base year for modeling, particularly when there are major changes to the supply of transportation facilities and/or newer socioeconomic data available. Many of the same data sources, such as digitized street files, aerial photographs, and state and local road inventories, can be used to update the network to a new base year. A region's Transportation Improvement Program (TIP) and state and local capital improvement programs (CIPs) are also very useful for updating a network representing an earlier year to a more recent year. Traffic volumes and transit ridership coded in the network should also be updated for the new base year.

Most MPOs and many local governments use models to evaluate short- and long-range transportation plans to determine the effect of changes to transportation facilities in concert with changes in population and employment and urban structure on mobility and environmental conditions in an area. Updating the transportation network to a future year requires some of the same data sources, as well as additional ones. In addition to TIPs and CIPs, master plans, long-range transportation plans, comprehensive plans, and other planning documents may serve as the source of network updates.

3.3.4 Network Data Quality Assurance

Regardless of the sources, network data should be checked using field verification or an overlay of high-resolution aerials or satellite imagery.

Visual inspection cannot be used to verify certain link characteristics, such as speed and traffic volume, which may often be verified using databases and GIS files available from state DOTs or other agencies. One approach used to verify coded distances is to use the modeling software to build two zone-to-zone distance matrices: the first using airline distance calculated using the x-y coordinates for each centroid, and the second using the over-the-road distance calculated from paths derived using the coded distance on each link. If one matrix is divided by the other, the analyst can look at the results and identify situations where the airline distance is greater than the over-the-road distance, or where the airline distance is much lower. These situations should be investigated to determine if they are the result of a coding error.

Coded speeds can be checked in a similar fashion by creating skim trees (time between zone matrices) for each mode and dividing them by the distance matrix. Resulting high or low speeds should be investigated to determine if they are the result of coding errors.

There are other data sources that may be used for reasonableness checking of roadway networks. For example, the HPMS has network data that may be used to check model networks.

Quality assurance applies to transit networks, as well as highway networks. Local data sources may be available to check the networks against. For example, transit operators can often provide line-level data on run times, service hours, and service miles, which can be compared to model estimates of the same.

The *Travel Model Validation and Reasonableness Checking Manual, Second Edition* (Cambridge Systematics, Inc., 2010b) includes detailed discussions of other transit network checking methods, including comparing modeled paths to observed paths from surveys and assigning a trip table developed from an expanded transit survey to the transit network.

3.4 Validation Data

Model validation is an important component of any model development process. As documented in the *Travel Model Validation and Reasonableness Checking Manual, Second Edition* (Cambridge Systematics, Inc., 2010b), planning for validation and ensuring that good validation data are available are tasks that should be performed as an integral part of the model development process.

Model validation should cover the entire modeling process, including checks of model input data and all model components. While reproduction of observed traffic counts and transit boardings may be important validation criteria, they are not sufficient measures of model validity. Adjustments can be made to any model to reproduce base conditions. Pendyala and Bhat (2008) provide the following comments regarding travel model validation:

> There is no doubt that any model, whether an existing four-step travel demand model or a newer tour- or activity-based model, can be adjusted, refined, tweaked, and—if all else fails—hammered to replicate base year conditions. Thus, simply performing comparisons of base year outputs from four-step travel models and activity-based travel models alone (relative to base year travel patterns) is not adequate . . . the emphasis needs to be on capturing travel behavior patterns adequately from base year data, so that these behavioral patterns may be reasonably transferable in space and time.

3.4.1 Model Validation Plan

The development of a model validation plan at the outset of model development or refinement is good model development practice. The validation plan should establish model validation tests necessary to demonstrate that the model will produce credible results. Such tests depend, in part, on the intended uses of the model. Validation of models intended for support of long-range planning may have increased focus on model sensitivity to key input variables and less focus on the reproduction of traffic counts or transit boardings. Conversely, models intended for support of facility design decisions or project feasibility probably require a strong focus on the reproduction of traffic counts or transit boardings.

The validation plan should identify tests and validation data for all model components. A good approach for the development of a validation plan is to identify the types of validation tests and the standards desired (or required) prior to identifying whether the required validation data are available. Then, once the tests and required data have been identified, the available validation data can be identified and reviewed. Data deficiencies can then be pinpointed and evaluated against their importance to the overall model validation, as well as the cost, time, and effort required to collect the data.

3.4.2 Example Model Validation Tests

Ideally, model validation tests should address all model components. The list of tests shown in Table 3.5 was developed by a panel of travel modeling experts who participated in the May 2008 Travel Model Improvement Program Peer Exchange on Travel Model Validation Practices (Cambridge Systematics, Inc., 2008b). The table is intended to provide examples of tests and sources of data that may be used to validate travel models.

Table 3.5. Example primary and secondary model validation tests.

Model Component	Primary Tests	Secondary Tests	Potential Validation Data Sources
Networks/Zones	• Correct distances on links • Network topology, including balance between roadway network detail and zone detail • Appropriateness of zone size given spatial distribution of population and employment • Network attributes (managed lanes, area types, speeds, capacities) • Network connectivity • Transit run times	• Intrazonal travel distances (model design issue) • Zone structure compatibility with transit analysis needs (model design issue) • Final quality control checks based on review by end users • Transit paths by mode on selected interchanges	• GIS center line files • Transit on-board or household survey data
Socioeconomic Data/Models	• Households by income or auto ownership • Jobs by employment sector by geographic location • Locations of special generators • Qualitative logic test on growth • Population by geographic area • Types and locations of group quarters • Frequency distribution of households and jobs (or household and job densities) by TAZ	• Dwelling units by geographic location or jurisdiction • Households and population by land use type and land use density categories • Historical zonal data trends and projections to identify "large" changes (e.g., in autos/ household from 1995 to 2005)	• Census SF-3 data • QCEW • Private sources, such as Dun & Bradstreet
Trip Generation	• Reasonableness check of trip rates versus other areas • Logic check of trip rate relationships	• Checks on proportions or rates of nonmotorized trips • Reasonableness check of tour rates • Cordon lines by homogeneous land use type	• Chapter 4 of this report • Traffic counts (or intercept survey data) for cordon lines • Historic household survey data for region • NHTS (2001 or 2009)
Trip Distribution	• Trip length frequency distributions (time and distance) by market segments • Worker flows by district • District-to-district flows/desire lines • Intrazonal trips • External station volumes by vehicle class	• Area biases (psychological barrier—e.g., river) • Use of k-factors (Design Issue) • Comparison to roadside intercept origin-destination surveys • Small market movements • Special groups/markets • Balancing methods	• ACS/CTPP data • Chapter 4 of this report • Traffic counts (or intercept survey data) for screenlines • Historic household survey data for region • NHTS (2001 or 2009)

(continued on next page)

Table 3.5. (Continued).

Model Component	Primary Tests	Secondary Tests	Potential Validation Data Sources
Time of Day of Travel	• Time of day versus volume peaking • Speeds by time of day	• Cordon counts • Market segments by time of day	• Permanent traffic recorder data • NHTS (2001 or 2009) • Historic household survey data for region • Transit boarding count data
Mode Choice	• Mode shares (geographic level/market segments) • Check magnitude of constants and reasonableness of parameters • District-level flows • Sensitivity of parameters to LOS variables/elasticities	• Input variables • Mode split by screenlines • Frequency distributions of key variables • Reasonableness of structure • Market segments by transit service • Existence of “cliffs” (cutoffs on continuous variables) • Disaggregate validation comparing modeled choice to observed choice for individual observations	• Traffic counts and transit (or intercept survey data) for screenlines • CTPP data • Chapter 4 of this report • Transit on-board survey data • NHTS (2001 or 2009) • Household survey data (separate from data used for model estimation)
Transit Assignment	• Major station boardings • Bus line, transit corridor, screenline volumes • Park-and-ride lot vehicle demand • Transfer rates	• Kiss-and-ride demand • Transfer volumes at specific points • Load factors (peak points)	• Transit boarding counts • Transit on-board survey data • Special surveys (such as parking lot counts)
Traffic Assignment	• Assigned versus observed vehicles by screenline or cutline • Assigned versus observed vehicles speeds/times (or vehicle hours traveled) • Assigned versus observed vehicles (or vehicle miles traveled) by direction by time of day • Assigned versus observed vehicles (or vehicle miles traveled) by functional class • Assigned versus observed vehicles by vehicle class (e.g., passenger cars, single-unit trucks, combination trucks)	• Subhour volumes • Cordon lines volumes • Reasonable bounds on assignment parameters • Available assignment parameters versus required assignment parameters for policy analysis • Modeled versus observed route choice (based on data collected using GPS-equipped vehicles)	• Permanent traffic recorders • Traffic count files • HPMS data • Special speed surveys (possibly collected using GPS-equipped vehicles)

Source: Cambridge Systematics, Inc. (2008b).

CHAPTER 4

Model Components

4.1 Introduction

This chapter presents information on the analytical techniques used in various components of conventional travel demand models and on parameters for these models obtained from typical models around the United States and from the 2009 NHTS. These parameters can be used by analysts for urban areas with insufficient local data with which to estimate model parameters. They may also be used, in areas that have already developed model parameters, to check these parameters for reasonableness. Chapter 5 discusses the use of the parameters presented in this chapter for model validation and reasonableness checking.

4.1.1 Information Sources

There are two primary sources of information in this chapter:

1. The **NHTS** is administered by the FHWA. It provides information to assist transportation planners and policy makers who need comprehensive data on travel and transportation patterns in the United States. The 2009 NHTS updates information gathered in the 2001 NHTS and in prior Nationwide Personal Transportation Surveys (NPTS) conducted in 1969, 1977, 1983, 1990, and 1995. Data were collected from a nationwide sample of households on trips taken within a 24-hour period and include:
   - Trip purpose (work, shopping, etc.);
   - Means (mode) of transportation used (car, bus, light rail, walk, etc.);
   - How long the trip took, i.e., travel time;
   - Time of day and day of week when the trip took place; and
   - If a private vehicle trip:
     - Number of people in the vehicle, i.e., vehicle occupancy;
     - Driver characteristics (age, sex, worker status, education level, etc.); and
     - Vehicle attributes (make, model, model year, amount of miles driven in a year).

   The 2009 NHTS was used to obtain selected parameters including trip generation rates, average trip lengths, and time-of-day percentages. The information included in this report from the NHTS uses the weekday sample only. This information was estimated by urban area population range, using the urbanized area identifier in the data set. The population ranges available in the NHTS data set are as follows:
   - Over 1 million population with subway/rail;
   - Over 1 million population without subway/rail;
   - 500,000 to 1 million population;
   - 200,000 to 500,000 population;
   - 50,000 to 200,000 population; and
   - Not in an urban area.

   It was found that many of the parameters estimated from NHTS data did not vary by population range, varied only between some ranges, or had only minor fluctuations that showed no trends and appeared to be related to survey sampling. In these cases, parameters are presented for aggregated population ranges and, in cases where there was no variation among population ranges or only minor fluctuations, for all areas together.
2. **A database of information from model documentation** from 69 MPOs[4] was used to obtain information on selected model parameters. While all of the documents did not include information on every parameter of interest, information was again summarized by urban area population range where sufficient data were available.

[4]While the term "MPOs" is used here for convenience to describe the agencies maintaining travel models, it is recognized that some agencies maintaining models are not actually metropolitan planning organizations.

This database is referred to throughout the chapter as the "MPO Documentation Database." The metropolitan areas are organized by population range, as follows:

- Over 1 million population;
- 500,000 to 1 million population;
- 200,000 to 500,000 population; and
- 50,000 to 200,000 population.

The areas included in the MPO Documentation Database are shown in Table 4.1, organized by population category. Again, some parameters did not vary by population range, varied only between some ranges, or had only minor fluctuations. For some parameters, there was insufficient information for some population ranges. In these cases, parameters are presented for aggregated population ranges and for all areas together, in cases where there was no variation among population ranges, or only minor fluctuations.

A few supplementary sources were used to fill gaps where neither of the primary sources could be used. These sources are identified where they are used throughout the chapter.

4.1.2 Chapter Organization

This chapter comprises 12 sections. The first section after this introduction is a brief description of the logit model, a formulation that is used in several of the model components described later in the chapter. Each of the remaining 10 sections corresponds to a specific model component and includes the following subsections:

- **Model Function**—A brief summary of the function of the model component and how it fits into the overall modeling process.
- **Best Practices**—A brief description of the typical method(s) representing best practice. This subsection may include alternative methods that may be appropriate in different contexts. For example, trip generation might include methods to estimate total person trips, total motorized person trips, or total vehicle trips. This subsection does not include a complete discussion of the theory behind the methods and the model estimation procedures; rather, references to the already extensive existing literature documenting these items are provided.
- **Basis for Data Development**—The basis for the development of the data presented in the subsection and in typical modeling practice.
- **Model Parameters**—Model parameters classified by urban area category (including tables and figures as appropriate), with explanations of how they can be used in model estimation, validation and reasonableness checking, and parameter transfer.

Model Components

The methods presented in this chapter follow the conventional sequential process for estimating transportation demand. It is often called the "four-step" process where the principal steps are:

- Step 1—Trip Generation;
- Step 2—Trip Distribution;
- Step 3—Mode Choice; and
- Step 4—Assignment.

This chapter discusses the following components of conventional travel modeling:

- Vehicle Availability (Section 4.3)—Estimating the number of automobiles available to households;
- Trip Generation (Section 4.4)—Estimating the number of passenger trips that are made from origin zones and to destination zones, classified as trip productions and trip attractions;
- Trip Distribution (Section 4.5)—Estimating the number of passenger trips that are made between origins and destinations;
- External Travel (Section 4.6)—Estimating the travel that has at least an origin or a destination external to the area being covered by the transportation model;
- Mode Choice (Section 4.7)—Estimating the mode to be used for passenger travel between origins and destinations;
- Automobile Occupancy (Section 4.8)—Estimating the number of vehicles required to accommodate passenger trips by automobile between origins and destinations;
- Time-of-Day Characteristics (Section 4.9)—Estimating the time of the day during which passenger trips are made;
- Freight/Truck Modeling (Section 4.10)—Estimating the number of freight and other trucks that travel in addition to passenger trips between origins and destinations;
- Highway Assignment (Section 4.11)—Estimating the volume of trips on the highway segments that result from accommodating the passenger automobile and truck trips between origins and destinations; and
- Transit Assignment (Section 4.12)—Estimating the volume of trips on transit vehicles and lines that result from accommodating the passenger transit trips between origins and destinations.

One of the primary reasons for the development of this report is the presentation of transferable parameters for use in urban areas where there is insufficient local data with which to estimate models. In such cases it has been common practice to transfer parameters from other models or data sets. In preparing this report, a literature review of transferability of model parameters was undertaken (the results

Table 4.1. MPOs classified using year 2000 population.

Metropolitan Planning Organization	Region Served
MPOs with Population greater than 1,000,000 (25 MPOs)	
Atlanta Regional Commission	Atlanta, Georgia
Baltimore Regional Transportation Board	Baltimore, Maryland
Capital Area Metropolitan Planning Organization	Austin, Texas
Central Transportation Planning Staff	Boston, Massachusetts
Chicago Area Transportation Study	Chicago, Illinois
Denver Regional Council of Governments	Denver, Colorado
Durham-Chapel Hill-Carrboro MPO	Durham, North Carolina
Greater Buffalo/Niagara Falls Regional Transportation Council	Buffalo/Niagara Falls, New York
Hampton Roads MPO	Hampton Roads, Virginia
Maricopa Association of Governments	Phoenix, Arizona
Mecklenburg-Union MPO	Charlotte, North Carolina
Metropolitan Council of the Twin Cities	Minneapolis-St. Paul, Minnesota
Metropolitan Transportation Commission	San Francisco, California
Mid-America Regional Council	Kansas City, Missouri
Metropolitan Washington Council of Governments	Washington, D.C.
North Central Texas Council of Governments	Dallas-Fort Worth, Texas
Puget Sound Regional Council	Seattle, Washington
Regional Transportation Commission of Southern Nevada	Las Vegas, Nevada
Sacramento Area Council of Governments[a]	Sacramento, California
San Diego Association of Governments	San Diego, California
Shelby County MPO	Memphis, Tennessee
Southeast Michigan Council of Governments	Detroit, Michigan
Southeastern Wisconsin Regional Planning Commission	Milwaukee, Wisconsin
Southern California Association of Governments	Los Angeles, California
Wasatch Front Regional Council	Salt Lake City, Utah
MPOs with Population between 500,000 and 1,000,000 (8 MPOs)	
Akron Metropolitan Area Transportation Study	Akron, Ohio
Capital District Transportation Committee	Albany, New York
Capitol Region Council of Governments	Hartford, Connecticut
Council of Fresno County Governments	Fresno County, California
Genesee Transportation Council	Rochester, New York
Kern County Council of Governments	Bakersfield, California
Mid-Region Council of Governments	Albuquerque, New Mexico
Nashville Metropolitan Planning Organization	Nashville, Tennessee
MPOs with Population between 200,000 and 500,000 (18 MPOs)	
Brown County Planning Commission	Green Bay, Wisconsin
Chatham Urban Transportation Study	Savannah, Georgia
Chattanooga-Hamilton County Regional Planning Agency	Chattanooga, Tennessee
Des Moines MPO	Des Moines, Iowa
East Central Wisconsin Regional Planning Commission	Appleton-Oshkosh, Wisconsin
Knoxville Regional Transportation Planning Organization	Knoxville, Tennessee
Lane Council of Governments	Eugene, Oregon
Madison Area MPO	Madison, Wisconsin
Mid-Willamette Valley Council of Governments	Salem, Oregon

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Table 4.1. (Continued).

Metropolitan Planning Organization	Region Served
North Front Range Metropolitan Planning Organization	Fort Collins, Colorado
Pima Association of Governments	Tucson, Arizona
Poughkeepsie-Dutchess County Transportation Council	Poughkeepsie, New York
San Joaquin Council of Governments	Stockton, California
Spokane Regional Transportation Council	Spokane, Washington
Stanislaus Council of Governments	Modesto, California
Syracuse Metropolitan Transportation Council	Syracuse, New York
Tri-County Regional Planning Commission	Harrisburg, Pennsylvania
Tulare County Association of Governments	Visalia, California
MPOs with Population between 50,000 and 200,000 (31 MPOs)	
Adirondack-Glens Falls Transportation Council	Glens Falls, New York
Association of Monterey Bay Area Governments	Monterey, California
Bay-Lake Regional Planning Commission	Sheboygan, Wisconsin
Binghamton Metropolitan Transportation Study	Binghamton, New York
Bristol Metropolitan Planning Organization	Bristol, Tennessee
Butte County Association of Governments	Chico, California
Chittenden County Metropolitan Planning Organization	Burlington, Vermont
Clarksville-Montgomery County Regional Planning Agency	Clarksville, Tennessee
Cleveland Area MPO	Cleveland, Tennessee
Columbus-Phenix City Metropolitan Planning Organization	Muscogee, Georgia - Russell, Alabama
Elmira-Chemung Transportation Council	Elmira, New York
Fond du Lac MPO	Fond du Lac, Wisconsin
Grand Valley MPO	Grand Junction, Colorado
Herkimer-Oneida County Transportation Study	Utica, New York
Ithaca Tompkins County Transportation Council	Ithaca, New York
Jackson Municipal Regional Planning Commission	Jackson, Tennessee
Janesville MPO	Janesville, Wisconsin
Johnson City Metropolitan Planning Organization	Johnson City, Tennessee
Kings County Association of Governments	Lemoore, California
Kingsport Transportation Department	Kingsport, Tennessee
La Crosse Area Planning Committee	La Crosse, Wisconsin
Lakeway Area Metropolitan Transportation Planning Organization	Morristown, Tennessee
Madera County Transportation Commission	Madera, California
Merced County Association of Governments	Merced, California
San Luis Obispo Council of Governments	San Luis Obispo, California
Santa Barbara County Association of Governments	Santa Barbara, California
Shasta County Regional Transportation Planning Agency	Redding, California
Siouxland Interstate Metropolitan Planning Council	Sioux City, Iowa
Thurston Regional Planning Council	Olympia, Washington
Ulster County Transportation Council	Kingston, New York
West Central Wisconsin Regional Planning Commission	Eau Claire, Wisconsin

[a]The documentation reviewed for the Sacramento Area Council of Governments was for its trip-based model, not its current activity-based model.

of this review are presented in Appendix B). This review found mixed results: while transferability was valid in some studies, its validity could not be demonstrated in others. In general, transferability was demonstrated for trip generation and mode choice in some cases but not others while the literature on transferability of other parameters, including trip distribution, time of day, and freight/truck modeling, was insufficient to draw any conclusions. More research into model transferability, the conditions under which transferability is most likely to be valid, and ways in which the validity of transferred parameters could be improved, is needed.

While the literature to date has not provided conclusive guidelines for transferability across geographic areas, it appears that transferability would be improved with a transfer approach that involves transfer scaling of coefficients using limited data from the application context (the area to which parameters are to be transferred). Appendix B includes several references that describe methods for scaling that could be used if the limited data (possibly from a small household activity/travel survey or NHTS samples in the model region) were available.

However, it is recognized that many areas, especially smaller urban areas, will not have even the limited data needed, or the required resources and expertise, to perform scaling of transferred parameters. In such cases, the parameters presented in this chapter, or parameters from specific models that could provide estimation contexts, will serve as the best available parameters to use in the local models.

Regardless of the transfer approach used, validation and reasonableness testing of results based on the transferred models should be performed. Validation and reasonableness testing are described in Chapter 5 and in the *Travel Model Validation and Reasonableness Checking Manual, Second Edition* (Cambridge Systematics, Inc., 2010b). It will be particularly important to perform validations for two points in time, if possible, and to apply reasonableness tests to travel forecasts. While models based on transferred parameters may be validated to base year conditions, the transferred models may have different sensitivities to changed conditions and scenarios than might be expected in an area.

Trip Purposes

In four-step travel models, the unit of travel is the "trip," defined as a person or vehicle traveling from an origin to a destination with no intermediate stops. Because people traveling for different reasons behave differently, four-step models segment trips by **trip purpose**. The number and definition of trip purposes in a model depends on the types of information the model needs to provide for planning analyses, the characteristics of the region being modeled, and the availability of data with which to obtain model parameters and the inputs to the model.

Trip purposes are defined by the type of activity taking place at each end of the trip (home, work, school, etc.). Because most trips begin or end at home, many trip purposes are defined as "home based" (e.g., home-based work, which would include trips from home to work and from work to home). Nonhome-based trips are most often not segmented further, but some models further categorize these as work based or nonwork based ("other based").

The minimum number of trip purposes in most models is three: home-based work, home-based nonwork, and nonhome based. In this report, these three trip purposes are referred to as the "classic three" purposes. Other commonly used home-based trip purposes are school, shopping, social-recreational, escorting (pickup/dropoff), and university. Models use a "home-based other" trip purpose to represent home-based trips not to or from an activity type defined by one of the other trip purposes. While the convention varies for different model documents, in this report "home-based nonwork" is used rather than "home-based other" for models that have only one home-based trip purpose besides work.

Throughout this chapter, model parameters and other data are presented for the classic three trip purposes. In some cases, where the data are sufficient, figures for the home-based school purpose are presented separately because of the unique nature of school travel, which is mainly made by children. In these cases, a home-based other trip purpose that represents all home-based nonwork and nonschool trips is included. To clarify, "home-based other" represents all home-based trips except work and school trips, and "home-based nonwork" represents all home-based trips except work trips. Depending on whether the analyst is including a separate home-based school purpose, he or she should use the information stratified by trip purpose in one of the following ways:

- For the classic three purposes (home-based work, home-based nonwork, and nonhome based) or
- For the following four purposes: home-based work, home-based school, home-based other, and nonhome based.

Throughout Chapter 4, tables of transferable parameters are presented. The longer tables can be found in Appendix C and are referred to in the text of this chapter by table number (e.g., Table C.1).

4.2 The Logit Model

This section describes the logit model, the most commonly used discrete choice analysis method in travel forecasting. This background is provided for understanding the parameters of logit models described in this chapter, rather than to provide a detailed discussion of logit model estimation, validation, and application. The principles and the basic mathematical formulation are presented, and the ways it can be used for choice analysis in travel demand modeling are discussed. For more detailed information about logit models, the reader may wish to consult Ben-Akiva and Lerman (1985) and Koppelman and Bhat (2006).

The basic idea underlying modern approaches to travel demand modeling is that travel is the result of choices made by individuals or collective decision-making units such as households. Individuals choose which activities to do during the day and whether to travel to perform them, and, if so, at which locations to perform the activities, when to perform them, which modes to use, and which routes to take. Many of these choice situations are discrete, meaning the individual has to choose from a set of mutually exclusive and collectively exhaustive alternatives.

The presentation of discrete choice analysis uses the principle of utility maximization. Briefly, a decision maker is modeled as selecting the alternative with the highest utility among those available at the time a choice is made. An operational model consists of parameterized utility functions in terms of observable independent variables and unknown parameters.

The utility represents the individual's value for each option, and its numerical value depends on attributes of the available options and the individual. In practice, it is not unusual for apparently similar individuals (or even the same individual, under different conditions) to make different choices when faced with similar or even identical alternatives. Models in practice are therefore random utility models, which account for unexplained (from the analyst's perspective) variations in utility.

The utility function, U, can be written as the sum of the deterministic (known) utility function specified by the analyst, V, and an error term, e. That is: $U = V + e$. An analyst never knows the true utility function. In effect, the analyst always measures or estimates utility with error, and an error term of unknown size is always present in the analyst's specification of the utility function. This error term accounts for variables that are not included in the data set, or that the analyst chooses to omit from the model (e.g., because he cannot forecast them well), or that are completely unknown to the analyst.

When the true utilities of the alternatives are random variables, it is not possible to state with certainty which alternative has the greatest utility or which alternative is chosen. This inability is because utility and choice depend on the random components of the utilities of the available alternatives, and these components cannot be measured. The most an analyst can do is to predict the probability that an alternative has the maximum utility and, therefore, the probability that the alternative is chosen. Accordingly, the analyst must represent travel behavior as being probabilistic.

In logit formulations used in most travel demand models, the utility function for each alternative is a linear combination of variables affecting the choice. The utility equations have the form:

$$V_n = \beta_{n0} + \sum_k \beta_{nk} * x_k \tag{4-1}$$

where:

n = Alternative number;
V_n = (Deterministic) utility of alternative n;
β_{n0} = The statistically estimated constant associated with alternative n, essentially the effects of variables that influence the choice that cannot be included in the model due to inability to quantify or forecast, lack of data from the surveys used in model estimation, etc.;
β_{nk} = The statistically estimated coefficient indicating the relative importance of variable x_k on choice n; and
x_k = The value of decision variable k.

Variables in utility functions may be *alternative specific*, meaning that the coefficients must be different in each utility function (i.e., the values of β_{nk} cannot be equal for all values of n), or they may be *generic*, meaning that β_{nk} is the same for each alternative. In a logit model, the utility of one alternative matters only in terms of its value relative to the utilities of other alternatives.

Logit is the most widely used mathematical model for making probabilistic predictions of mode choices. The simplest function used is the multinomial logit formulation. In the multinomial logit model, the probability of each alternative is expressed as:

$$P_n = \frac{\exp(V_n)}{\sum_{Alternatives\_n'} \exp(V_{n'})} \tag{4-2}$$

where:

P_n = The probability that alternative n is chosen;
exp() = The exponential function; and
V_n = (Deterministic) utility of alternative n (from Equation 4-1).

Another logit model form that is often used for mode choice is the nested logit model. Under a nested structure, the model pools together alternatives that share similarities, and the choice is represented as a multistep decision. Consider an example with three alternatives, labeled *1A, 1B,* and *2,* where *1A* and *1B* are more similar to each other than either is to alternative *2.* In the upper level of the nested model, the probability that an individual would choose alternative 1 (one of alternative *1A* or alternative *1B*) is given by Equation 4-3.

$$P_1 = \frac{\exp(V_1)}{\exp(V_1) + \exp(V_2)} \tag{4-3}$$

The probability of choosing alternative *1A conditional* on choosing *1* is equal to:

$$P_{1A/1} = \frac{\exp(V_{1A})}{\exp(V_{1A}) + \exp(V_{1B})} \tag{4-4}$$

Thus, the probability of choosing alternative 1A is equal to:

$$P_{1A} = P_{1A/1} \times P_1 \tag{4-5}$$

In a nested model, the utility of an alternative in an upper level is a function of the utilities of its subalternatives. The utility for a nest m includes a variable that represents the expected maximum utility of all of the alternatives that compose the nest. This variable is known as the logsum and is given by the formula:

$$\text{Logsum}_{nest\ m} = \ln \sum_{All\_M\_in\_nest\_m} \exp(U_M) \qquad (4\text{-}6)$$

As an example, consider a model with a simple nest with two alternatives. If the utility of each alternative is the same, say 3.00 (indicating the choice probability of each is 50 percent), then the logsum is equal to ln [exp(3.00) + exp(3.00)] = 3.69, higher than the utility of either alternative. But if the utilities are, say, 5.00 for one alternative and 0.05 for the other (indicating a choice probability for the first alternative of over 99 percent), the logsum is equal to ln [exp(5.00) + exp(0.05)] = 5.01, only slightly higher than the utility of the superior alternative. Thus, the inclusion of a competitive alternative in a nest increases the expected maximum utility of all alternatives while the inclusion of a substantially inferior alternative has little effect on the logsum value.

Note that the logsum is equal to the natural logarithm of the denominator of the logit probability function (Equation 4-2) for the alternatives in nest *m.* A "nesting coefficient" of the logsum term is used in the utility function for nest *m.* This coefficient must be between zero and one and should be statistically significantly different from zero and one.

The primary advantage of nested logit models over (non-nested) multinomial logit models is that nested logit models enable one to reduce the intensity of the "independence of irrelevant alternatives" (IIA) assumption by nesting related choices. The IIA assumption, which is characteristic of all multinomial logit models as well as the lowest level nests in nested logit models, states that the probability of choices does not depend on alternatives that are not relevant. For example, assume in a mode choice model that there are three alternatives—car, red bus, and blue bus—with equal utilities. Most people would choose between car and any bus, not distinguishing between the bus choices simply due to their color (i.e., they would be perfect substitutes for one another). But, given equal utility for all three of these choices, in a multinomial logit model framework the choice probabilities for each of the three choices would calculate as equal (⅓), leading to a greater probability of choosing any bus than the car alternative simply because the choice is being made among three equal alternatives rather than two (i.e., respecting the IIA assumption means one must not construct such choice sets with irrelevant alternatives).

4.3 Vehicle Availability

The number of motor vehicles available to a household has a major impact on the travel behavior of the members of the household. As a result, some travel demand models have incorporated components modeling household vehicle availability or automobile ownership. Vehicle availability models estimate the number of vehicles available to households based on characteristics of the households themselves, the areas in which they are located, and the accessibilities of those areas via various transportation modes. These models are most commonly used in larger urban areas and often are not used in small or mid-size regions. While the estimation of vehicle availability is not one of the four "classic" steps of traditional travel demand models, the availability of vehicles to households can influence trip generation, trip distribution, and mode choice.

The advantage of modeling vehicle availability, rather than simply estimating it from trends or assuming that vehicle availability levels remain constant across scenarios and forecast years, is to consider the effects of changes in demographics, such as household size and income, on vehicle ownership. Furthermore, accessibility by various transportation modes and changes in land use patterns, both of which can be affected by transportation planning policies, have been shown to affect vehicle availability, and these effects can be included in vehicle availability models. To produce credible forecasts of travel demand, it is therefore desirable not only to have accurate estimates of the households and employment for traffic analysis zones, but also to have accurate estimates of the number of autos (vehicles) available to these households.

4.3.1 Model Function

The function of a vehicle availability model is to estimate the number of households with zero, one, two, etc., vehicles. In the context of a four-step travel demand model, this estimate is done through an aggregate process where the shares of households for each vehicle availability level are applied to the total households in each zone. These shares may be obtained from a disaggregately estimated model (i.e., a logit model).

The reason to have the households in each zone segmented into vehicle availability levels based on the number of vehicles is to allow later steps in the modeling process to use different parameters for market segments based on these levels. These segments may be based solely on the number of vehicles (zero, one, two, etc.) or on variables that incorporate interactions between the number of vehicles and another variable, such as the number of persons or number of workers in the household. Examples of these types of interactions include the following:

- For **trip productions**, model parameters representing the number of person trips per household (as discussed in Section 4.4) are applied for combinations of two or three input variables, such as number of persons by number of

vehicles. If one of the variables is the number of vehicles, the segmentation of households may be achieved through a vehicle availability model, assuming that the segmentation of the other variable(s) is performed through another means.
- For **trip distribution** and **mode choice**, models may be applied separately for household market segments defined simply by the number of vehicles (zero, one, two, etc.) or for segments defined by combinations of two or three input variables. Examples include households where the number of vehicles is less than, equal to, or greater than the number of workers. The use of such segmentation requires that the information needed to define the segmentation levels is available from the trip generation model. For example, segmentation comparing the number of vehicles to the number of workers could be used if the trip production model uses a cross-classification of number of vehicles by number of workers.

It is not necessary that the segmentation scheme be the same for every trip purpose. In some models, segmentation might be used only for some trip purposes such as home-based work.

Some aggregate models compute the shares for each vehicle availability level from curves fitted against observed data and do not base these shares on household, area, or accessibility characteristics. On the other hand, a logit vehicle availability model might include such variables, as discussed in Section 4.3.2.

4.3.2 Best Practices

There are two commonly used approaches in vehicle availability modeling: aggregate approaches and discrete choice models (Cambridge Systematics, Inc., 1997b). Both approaches estimate the number of households owning zero, one, two, etc., vehicles. Aggregate approaches estimate the percentage of households in each vehicle availability category while discrete choice (i.e., logit) models estimate the probabilities of having zero, one, two, etc., vehicles. These probabilities are used either as aggregate percentages applied to different segments of households or as probabilities used in simulation models. The most common number of vehicle availability categories is four (i.e., zero, one, two, or three or more vehicles), although some models have three or five categories.

Aggregate approaches estimate the percentages of households for each vehicle ownership category at the zonal level, sometimes for segments of households within zones (such as income levels). In these approaches, curves are fitted to match distributions of households by number of vehicles available. The observed distributions that the curves attempt to match usually come from U.S. Census data. These models do not necessarily use mathematical formulas; rather, points on the curves can be determined, and "smooth" curves fitting the points are derived. There are therefore no mathematical parameters to derive or transfer for these types of models.

Logit models of vehicle availability have been in use for some time. In these models, a utility function for each vehicle availability level is developed, including variables that affect vehicle availability.

Examples of the decision variables in the utility functions include the following:

- Household characteristics:
  - Persons per household;
  - Workers per household;
  - Household income; and
  - Single or multifamily dwelling.
- Geographic (zone) characteristics:
  - Urban area type;
  - Residential and/or commercial density; and
  - Pedestrian environment.
- Transportation accessibility:
  - Accessibility via highway;
  - Accessibility via transit; and
  - Accessibility via walking/bicycling.

Accessibility may be expressed as the amount of activity (for example, trip attractions) within a certain travel time by the corresponding mode or may be a more sophisticated variable that does not depend on a defined travel time cutoff. An example of the latter is provided in Figure 4.1.

A multinomial logit formulation is commonly used for vehicle availability models, although ordered response and nested models are sometimes used. Variables in vehicle availability models are alternative specific (see Section 4.2). For simplicity, therefore, the coefficient for one alternative is set to zero for each variable. It is most efficient (and easiest to interpret the results) if this is the same alternative for each variable and for the alternative-specific constant β_{n0}. So, typically, the entire utility for one alternative, most often the zero-vehicle alternative, is set to zero (i.e., all coefficients and constants for this alternative are equal to zero).

4.3.3 Basis for Data Development

When sufficient local data are available, best practice for vehicle availability models is to estimate the models from local household activity/travel survey data. Data on vehicle availability are required for model validation and usually are obtained from U.S. Census data for the urban area.

Because there are only a few alternatives (three to five) and, usually, several thousand households in the sample, typical

A_i = Auto accessibility during the peak hours for zone TSZ_i.

$$A_i = \ln(1 + \sum_j TotEmp_j \times \exp^{-2\times T_{ij} / \hat{T}_i})$$

where:

$TotEmp_j$ = Total employment in TSZ_j;

T_{ij} = Peak non-HOV auto travel time from TSZ_i to TSZ_j; and

$$\hat{T}_i = (\sum_j T_{ij}) / J$$

where J = Total number of TSZ_i to TSZ_j pairs.

TR_i = Transit accessibility during the peak hours for TSZ_j.

$$TR_i = \ln(1 + \sum_j TotEmp_j \times R_{ij} \exp^{-2\times S_{ij} / \hat{S}_i})$$

where:

$TotEmp_j$ = Total employment in TSZ_j.

R_{ij} = 1 if TSZ_i to TSZ_j has transit access, 0 otherwise.

S_{ij} = Peak non-park-and-ride transit total travel time from TSZ_i to TSZ_j.

$$\hat{S}_i = (\sum_j R_{ij} \times S_{ij}) / K$$

where K = Total number of TSZ_i to TSZ_j pairs having transit access.

Acc_i = Ratio of auto accessibility during the peak hours to transit accessibility during the peak hours.

$$Acc_i = A_i / (1 + TR_i)$$

Source: This function was recommended by a Travel Model Improvement Program Peer Review Panel and was successfully implemented for the Southern California Association of Governments.

Figure 4.1. Example accessibility variable.

urban area household surveys include sufficient data for estimation of logit vehicle availability models. It might also be possible to estimate these models using data from the NHTS, although sample sizes for urban areas that are not included in NHTS add-on areas are probably insufficient.

Usually, the main issue is whether the survey data set contains sufficient samples of zero-vehicle households, which are the smallest category in nearly all U.S. urban areas. According to data from the ACS, the percentage of zero-vehicle households in U.S. metropolitan statistical areas (MSAs) ranges from about 3 to 14 percent, with areas in Puerto Rico having 20 to 24 percent zero-vehicle households and the New York area having about 30 percent (U.S. Census Bureau, 2011a). The percentages of households with zero, one, two, and three or more vehicles from the ACS are presented in Table C.1.

Another possible source for vehicle availability model estimation data is the U.S. Census PUMS. This data source, which is now based on the ACS, can provide household-level records that include most household and person characteristics that would be used in vehicle availability models. The main limitation of PUMS data is that geographic resolution is only to the PUMA, an area of approximately 100,000 in population. These areas contain many travel analysis zones and are too large to estimate accessibility, pedestrian environment, or area-type variables.

There are relatively few U.S. urban area models for which vehicle availability model documentation is available, and most of those that have been documented are for larger urban areas. Nor have there been studies of transferability of vehicle availability model parameters. Ryan and Han

(1999) compared parameters estimated using PUMS data for the same model specification across seven large urban areas in the United States. They concluded that transferability was likely due to similarity in the estimated parameters but did not test specifically for transferability. Given the lack of information on transferability, it therefore is preferable not to transfer vehicle availability models if local data (i.e., household travel/activity survey) to estimate models are available.

However, if an area does not have the necessary local data and wishes to take advantage of the benefits of modeling vehicle availability, transferring an existing model from another location may be considered. Section 4.3.4 presents parameters from four models as examples that could be considered in urban areas where the survey data to estimate such a model is unavailable.

4.3.4 Model Parameters

Tables C.2 through C.4 in Appendix C show parameters for four U.S. urban area vehicle availability models, for the one-vehicle, two-vehicle, and three-or-more-vehicle utilities respectively. The urban areas for which these models were developed are summarized as follows:

- **Model 1**—Western metro area, 1 to 2 million population range, about 1.9 vehicles per household;
- **Model 2**—Southern metro area, over 3 million population range, about 1.8 vehicles per household;
- **Model 3**—Southern metro area, 1 to 2 million population range, about 1.7 vehicles per household; and
- **Model 4**—Eastern metro area, 1 to 2 million population range, about 1.5 vehicles per household.

In these specifications, the parameters are presented as the zero-vehicle alternative having a total utility of zero. These four models were chosen for the following reasons:

- All are multinomial logit models with four alternatives: zero, one, two, and three or more vehicles;
- All are associated with four-step models (activity-based models usually have household and person variables not usually available in four-step models);
- All were estimated since 2000 using household activity/travel survey data; and
- The variable specifications are somewhat similar.

Some important points to note regarding the variable definitions in these tables:

- The variables representing the number of persons, number of workers, and income levels are indicator variables, taking a value of one if the household has the indicated characteristic and zero otherwise. For example, when the model is applied to two-person, one-worker, high-income households, the values of the two-person, one-worker, and high-income variables would be equal to one, and the values of the other person, worker, and income indicator variables would be zero.
- The income groups are intended to represent quartiles, but the income-level definitions are different for every model. Because they were estimated in various places at different times, they are not directly comparable.
- The accessibility ratio for Model 2 is the same as the one shown in Figure 4.1.

The columns in Tables C.2 through C.4 correspond to the parameters β_{nk} in the utility functions (see Equation 4-1) of the four models (β_{n0} represents the alternative-specific constants). So, for example, in Model 2, the utility function for the one-vehicle alternative is:

$$
\begin{aligned}
U_1 = {} & 1.58 \\
& + 1.84 * \text{Low-medium income} \\
& + 2.54 * \text{High-medium income} \\
& + 0.72 * \text{High income} \\
& + 0.06 * \text{Accessibility ratio}
\end{aligned}
$$

A low-medium–income household in a zone with an accessibility ratio of 2.0 would therefore have a utility of owning one vehicle of 1.58 + 1.84 + 0.06 (2.0) = 3.54. If the household has three persons, the probabilities of the alternatives for two and three or more vehicles can be computed, using Equation 4-1, as:

$$U_2 = -1.90 + 2.78 + 3.02 + 0.089\ (2.0) = 4.08$$

$$U_3 = -12.38 + 3.04 + 4.14 + 0.12\ (2.0) = -4.96$$

The probabilities of owning zero, one, two, etc., vehicles are computed using Equation 4-2:

$$
\begin{aligned}
P_0 &= \exp(0)/\left[\exp(0) + \exp(3.54) + \exp(4.08) + \exp(-4.96)\right] \\
&= 1.06 \text{ percent}
\end{aligned}
$$

$$
\begin{aligned}
P_1 = {} & \exp(3.54)/\left[\exp(0) + \exp(3.54) + \exp(4.08)\right. \\
& \left. + \exp(-4.96)\right] = 36.43 \text{ percent}
\end{aligned}
$$

$$
\begin{aligned}
P_2 = {} & \exp(4.08)/\left[\exp(0) + \exp(3.54) + \exp(4.08)\right. \\
& \left. + \exp(-4.96)\right] = 62.51 \text{ percent}
\end{aligned}
$$

$$
\begin{aligned}
P_3 = {} & \exp(-4.96)/\left[\exp(0) + \exp(3.54) + \exp(4.08)\right. \\
& \left. + \exp(-4.96)\right] = 0.01 \text{ percent}
\end{aligned}
$$

In model application, these probabilities would be computed and applied separately to segments of households of each type as defined by the variables (number of persons, income level, etc.), and the probabilities for each segment applied to the households in each segment.

Because no two of the models presented in Tables C.2 through C.4 have identical specifications, the values for specific coefficients may differ significantly between models. The presence or absence of other variables in a model can affect the coefficients of other variables. So it is much more valid to transfer individual models rather than composites of models with different variables.

As discussed previously, there is little experience with which to guide planners in transferring vehicle availability models, or even to determine how transferable the parameters of such models are. The best guidance that can be provided if one wished to transfer one of the models shown in Tables C.2 through C.4 is to choose one of the models based on the similarity to the metro areas based on the characteristics provided above (location within the United States, population, and average vehicles per household). Because of the differences in model specification, a composite of two or more of these models cannot be created. If the chosen model proves difficult to calibrate, perhaps another model could be chosen for transfer.

4.4 Trip Generation

Trip generation is commonly considered as the first step in the four-step modeling process. It is intended to address the question of how many trips of each type begin or end in each location. It is standard practice to aggregate trips to a specific unit of geography (e.g., a traffic analysis zone).[5] The estimated numbers of trips will be in the unit of travel that is used by the model, which is usually one of the following:

- Vehicle trips;
- Person trips by motorized modes (auto and transit); or
- Person trips by all modes, including both motorized and nonmotorized (walking, bicycling) modes.

Trip generation models require explanatory variables that are related to trip-making behavior and functions that estimate the number of trips based on these explanatory variables. While these functions can be nonlinear, they are usually assumed to be linear equations, and the coefficients associated with these variables are commonly called trip rates. Whether the function is linear or nonlinear, it should always estimate zero trips when the values of the explanatory variables are all zero. Mathematically, this is equivalent to saying that the trip generation equations should include no constant terms.

4.4.1 Model Function

The purpose of trip generation is to estimate the number of average weekday trip ends by purpose for each zone. In four-step models, the trip ends of home-based trips are defined as productions, representing the home ends of trips, and attractions, representing the nonhome end, regardless of whether home is the origin or destination. In other words, for home-based trips, the production end may be the destination and the attraction end, the origin if the trip-maker is returning home. For nonhome-based trips, for convenience the production end is defined as the trip origin and the attraction end as the trip destination.

For home-based trips, the number of trip productions in a zone is, naturally, based on the number of households in the zone. Household characteristics can affect trip making; therefore, in trip production models, households are usually classified by some of these characteristics, which often include the number of persons, workers, children, or vehicles, or the household income level. The trip rates for each purpose vary depending on the household classifications, which may not be the same for all trip purposes.

Trip attractions are based on other variables besides households, because several types of activities (commercial, employment, residential, etc.) are often located at the nonhome trip end. The type of activity that affects the number of trip attractions depends on the trip purpose. For example, home-based work trip attractions are usually estimated best by using employment as the explanatory variable. Other purposes typically use different sets of variables (school enrollment or employment for home-based school trips, retail employment for home-based shopping trips, etc.). Home-based nonwork, home-based other, and nonhome-based trip attraction models usually use a linear combination of several different variables (employment by type, households, etc.).

The number of nonhome-based trips made in a region does depend on the number of households, but unlike home-based trips, they need not have one end in the zone where the household of the trip-maker is located. One way in which models deal with this issue is to use household-based nonhome-based trip production rates to estimate regional productions and to allocate this regional total to zones based on other variables. A common convention is to assume that the regional nonhome-based trips are allocated to each zone based on the number of nonhome-based trip attractions in the zone.

[5]While the geographic units of some travel models are not zones, the term "zones" is used in the remainder of the chapter for convenience.

Special Generators

While estimates of passenger trip activity based on rates applied to household or employment in a zone can address the majority of conditions, there are special conditions when these rates are insufficient to accurately estimate trip activity. These conditions might be because the trip activity is due to considerations not directly related to the number of employees or households in a zone—for example, trips to airports, hospitals, colleges, or large recreational facilities. Additional estimates of trip activity may also be necessary because the trip generation rates are for average conditions that are not applicable to specialized conditions—for example, shopping productions or attractions to "big box" retail stores that have shopping trip rates per employee that are higher than typical retail employment. These activity locations are often referred to as "special generators."

The term "special generators" is somewhat misleading in that the different travel behavior associated with them is not limited to trip generation. While it is true that the number of trips generated by these sites is not readily modeled using conventional trip attraction models, the sensitivity of trip distribution (see Section 4.5) and mode choice (see Section 4.7) to variables such as time and cost is also different than that of other trips. Ideally, such travel should be treated as a separate trip purpose so that separate models for trip generation, trip distribution, and mode choice could be applied, but unless there are detailed surveys of the special generator with a sufficient sample size for model estimation, it is unlikely that this could be done.

Trip rates are not developed for special generators. Rather, the numbers of trips attracted to these locations are exogenously estimated using separate data sources, such as surveys or counts conducted at the special generators. Hence there are no parameters for trip generation at special generators, and default parameters cannot be provided. It is important to consider how special generator travel is considered relative to the trip purposes used in the model. Generally, trips attracted to special generators are estimated separately from the attractions for the trip purposes used in the model, but the special generator attractions must be considered in examining the balance between productions and attractions. Since separate trip distribution, time-of-day, and mode choice models are not available for special generator travel, the analyst must decide how these features will be modeled for special generators (for example, using the models for home-based nonwork or nonhome-based travel).

Balancing Productions and Attractions

The regional totals of productions and attractions for each trip purpose are equal because each trip has one production end and one attraction end. However, the model results may not be equal because productions and attractions are estimated separately. While trip distribution models (see Section 4.5) can often be applied with different production and attraction totals, certain types of model formulations (such as the gravity model) produce better results if productions and attractions are equal, or close to equal.

Because trip productions are estimated for the household, which is the same as the basis of the sampling frame of the surveys from which trip generation models are estimated, trip production models are generally estimated using records representing individual households, for which the total number of trips should be reported in the household survey. Trip attractions, on the other hand, occur at locations for which a complete set of survey records comprising all trips to the attractor will not be available. It is therefore common convention to adjust trip attractions to match productions by purpose at the regional level. This "balancing" of productions and attractions must take into account trips with one end outside the region (see Section 4.6 on external travel) and trips attracted to special generators.

It is good practice to review the ratio between unbalanced attractions and productions as a large difference might indicate problems with employment estimates, trip rates, etc. Most literature on best practices recommends that the difference between unbalanced regional attractions and productions be kept to +/−10 percent for each purpose, although a review of model validation reports shows that this standard is often exceeded. Upwards of +/−50 percent difference at the regional level might be considered acceptable under certain conditions and trip purposes.

4.4.2 Best Practices

Trip Productions

While other model forms are sometimes used, the most common form of trip production model is the cross-classification model. The households in each zone are classified by two or more variables, and the number of households in each category is multiplied by the appropriate "trip rate," representing the average number of trips per household for the category. Mathematically, the number of trips generated in a zone is given by:

$$P_i^p = \sum_k P\ rate_{pk} * h_{ik} \tag{4-7}$$

where:

P_i^p = Number of trip ends produced for purpose p in zone i;
$P rate_{pk}$ = The production trip rate for purpose p per household for category k; and
h_{ik} = The number of households in category k in zone i.

The state of the practice for trip production models is to create tables of trip rates by two or more dimensions, for example by household income and by household size (number of persons). Most commonly, trip production models are two-dimensional, although three-dimensional models are sometimes used, especially in larger areas where more data are available. The households in each zone are segmented along the two dimensions, and the trip rate is estimated for each combination of the two variables. For example, a cross-classification of households by three income levels (say, low, medium, and high) and number of persons (1, 2, 3, and 4+) would have the number of households divided into 12 segments, one for each income level–number of persons combination, and would use 12 corresponding trip production rates.

Trip Attractions

Accurately estimating trip attractions can be significantly more difficult and problematic than estimating trip productions. Whether trip attraction model parameters are estimated from local data or are transferred, they are usually derived from household survey data, which collects travel information at the production end of trips. Such surveys do not provide control totals at trip attraction locations. It is common practice to estimate the parameters, such as coefficients in linear regression equations, at an aggregate level such as districts (groups of zones), implying that the results may not be as accurate at more disaggregate spatial levels (such as zones). Some regions have attempted to address this issue through the use of establishment surveys, where the data are collected at the attraction end of trips, but the wide variety of establishment types and the expense of obtaining sufficient sample sizes at each type means that accuracy issues are not completely resolved. It is therefore recommended that analysts use the information provided here (indeed, locally derived trip attraction information as well) with extreme caution and to be prepared to adjust parameters to produce more reasonable results as needed.

Trip attraction models are most often linear equations with variables representing the amount of activity in a zone—typically employment by type, student enrollment at school sites, and households or population—and coefficients reflecting the effects of these variables on trip making to the zone for the appropriate purpose. The equations follow the form:

$$A_i^p = \sum_k A\,rate_{pk} * v_{ik} \qquad (4\text{-}8)$$

where:

A_i^p = Attraction of trip ends for purpose p in zone i;
$Arate_{pk}$ = Rate of attraction trip ends for purpose p per unit of variable k; and
v_{ik} = Value of variable k in zone i.

To summarize, the model parameters for trip generation are the trip production and attraction rates, represented by $Prate_{pk}$ in Equation 4-7 and $Arate_{pk}$ in Equation 4-8.

4.4.3 Basis for Data Development

When sufficient local data are available, best practice for the development of trip generation models is to estimate the model parameters from household activity/travel survey data using statistical techniques such as linear regression. Typically, sample sizes for these surveys are sufficient for model estimation, although the required amount of data depends on factors such as:

- The number of parameters to be estimated, such as the number of cells in cross-classification models;
- The number of households occurring in each cross-classification cell in the population, and in the survey sample; and
- The resolution of the geographic units (e.g., zones) at which the models will be applied.

If local data for model estimation are not available, parameters may be transferred from another model. Transferable parameters for general use are presented in Section 4.4.4.

Trip Productions

For trip productions, cross-classification trip rates were estimated from the 2009 NHTS for the classic three trip purposes, for urban areas stratified by population. Additionally, trip rates for home-based school trips are presented, along with a home-based other trip purpose that represents all home-based nonwork and nonschool trips. These rates represent average weekday person trips, including both motorized and nonmotorized trips, and were estimated using the weighted NHTS data. Initially, separate rates were estimated for the six urban area population ranges, but, in many cases, the rates did not vary by population category, and combined rates for multiple population ranges are presented.

Note that the 2009 NHTS does not include travel for children younger than five years old. If an analyst wishes to model the travel of younger children and to use the information provided in this chapter, he/she should be prepared to slightly adjust the trip rates for all purposes except home-based work upward, with a more substantial increase in home-based school trips (if that purpose is modeled and includes pre-school/day care travel).

Trip Attractions

Documented trip attraction models from a number of MPOs were available in the MPO Documentation Database.

One conclusion from the review is that there is little commonality among MPOs regarding the variables to include in trip attraction models. The variables ranged from employment stratified by three basic groups to employment stratified by seven or eight groups. In a number of trip attraction models, school enrollment was included. The number of trip purposes and the variables used for each trip purpose also varied substantially.

Different model calibration methods also added to the variation among models. Some of the models were estimated using regression techniques that could produce somewhat surprising results. For example, regression model calibration techniques can result in negative coefficients for some of the variables. A home-based shop trip attraction model could have, say, a positive coefficient for retail employment and a negative coefficient for basic employment. Such occurrences might be explained as "second-level" relationships—each retail employee attracts a certain number of home-based shop trips during the day, but as the amount of basic employment increases around the retail location, the number of home-based shop trips decreases due to unattractiveness of, say, an industrial area.

However, some illogical regression results were also observed in the review. An example is a home-based work model using multiple employment categories as independent variables with some of the coefficients being positive and some negative. Since each employee should attract a reasonable average number of home-based work trips each day, a negative model coefficient for an employment category is not logical.

4.4.4 Model Parameters

Trip Productions

The household trip production rates classified by variables representing household characteristics were estimated from the 2009 NHTS data. These rates represent the number of person trips, including both motorized and nonmotorized trips, per household. To determine the best variables to use for the rates provided here, trip rates were summarized for the following variables:

- Number of persons,
- Number of workers,
- Income level, and
- Number of vehicles.

The number of persons categories ranged from 1 to 5+. The number of workers categories ranged from 0 to 3+. The number of vehicles categories ranged from 0 to 3+. The household income levels (in 2008 dollars) were defined as:

- $0 to $9,999;
- $10,000 to $24,999;
- $25,000 to $49,999;
- $50,000 to $100,000; and
- Over $100,000.

To determine which variables best explained trip generation behavior in the NHTS data, an analysis of variance (ANOVA) was performed to explore the explanatory power of the variables. This parametric statistical technique provides a basis to identify the most statistically significant cross-classification of explanatory variables for each trip purpose and thereby select dimensions across which the trip production rates were categorized.

The ANOVA results indicate that all of the independent variables have significant effects on home-based work trip production rates. However, among all interaction effects, the household vehicles versus household workers variable appears to be the strongest predictor of the home-based work trip production rate. For home-based nonwork and home-based other trips, household workers versus household persons appears to be the strongest predictor of the trip production rate. For the nonhome-based trip purpose, the ANOVA results suggest that household workers by household persons is again found to be the strongest predictor of the trip production rate.

The MPO Documentation Database indicated that two other cross-classifications are commonly used: number of persons by income level and number of persons by number of vehicles. Parameters for these cross-classifications, also estimated from the NHTS data set, are presented for all trip purposes.

For home-based school trips, trip rates were estimated for the cross-classification of number of persons by number of children. Since some modeling agencies do not forecast the number of children, trip rates were also estimated for number of persons by income level and number of persons by number of vehicles.

Tables C.5 through C.9 in Appendix C show the trip rates by purpose cross-classified by the preferred pairs of variables, based on 2009 NHTS data, for home-based work, home-based nonwork, nonhome-based, home-based school, and home-based other trips, respectively. The NHTS data showed nearly the same trip rates for all population ranges for most trip purposes, apparently due at least in part to the relatively low sample sizes and resulting large errors associated with some of the cells. For home-based nonwork and home-based other trips, the NHTS data indicated lower trip rates for urban areas under 500,000 in population and nonurban areas, and so separate rates are presented for such areas for these trip purposes.

Use of a cross-classification trip production model requires that the households in each zone are classified along the same dimensions as the model. For example, if the first model in

Table 4.2. Example number of households by numbers of persons and autos.

	Persons					
Autos	**1**	**2**	**3**	**4**	**5+**	**Total**
0	10	10	10	0	0	**30**
1	50	100	70	20	10	**250**
2	0	150	200	100	50	**500**
3+	0	0	40	80	100	**220**
Total	**60**	**260**	**320**	**200**	**160**	**1,000**

Table C.5 is used, the households in each zone must be cross-classified by number of workers (0, 1, 2, and 3+) and number of autos (0, 1, 2, and 3+). If the demographic estimates available to the modeler are not already classified in the required manner, there are procedures that may be used to estimate the percentages in each cell and to apply them to the total households. Common sources for these percentages include the CTPP, NHTS, and local survey data. Depending on sample sizes, however, these sources may not provide statistically significant percentages at the zone level, and it may be necessary to estimate percentages for groups of zones based on area type and location within the region.

Example Calculations

Consider a zone with 1,000 households located in an urban area of under 500,000 in population where a trip production model with the classic three trip purposes is being developed. The MPO has estimated the number of households in the zone cross-classified by number of persons and number of vehicles, as depicted in Table 4.2.

For home-based work trips, the number of households in each cell is multiplied by the trip rate from the second section of Table C.5, yielding the number of home-based work trips in each cell of the cross-classification in Table 4.3.

So this zone produces 1,839 home-based work trips. Similarly, home-based nonwork and nonhome-based trip productions can be computed using the fourth section of Table C.6 and the second section of Table C.7, performing the same type of calculations.

Reasonableness checks of the trips per household by purpose estimated from trip production model results can be performed. Information on the national sample represented by the NHTS, as represented by Tables C.5 through C.7, indicate that the average household in urban areas of greater than 500,000 in population makes 10.0 person trips: 1.4 home-based work trips, 5.6 home-based nonwork trips, and 3.0 nonhome-based trips. The average household in urban areas of less than 500,000 in population makes 9.5 person trips: 1.4 home-based work trips, 5.1 home-based nonwork trips, and 3.0 nonhome-based trips. The range of person trips per household in the MPO Documentation Database is about 1.3 to 2.0 home-based work trips, 2.6 to 5.9 home-based nonwork trips, and 1.6 to 4.5 nonhome-based trips. Total person trips per household range from 7.0 to 11.5.

Trip Attractions

Table 4.4 summarizes average daily trip attraction rates for the classic three trip purposes from the analyses of the models in the MPO Documentation Database. These rates were all estimated from local or statewide household travel surveys. While all of these models used person trips as the unit of travel, some used person trips in motorized modes while others used total person trips, including those by walking and bicycling.

While Table 4.4 shows average rates for commonly defined models, achieving commonality required substantial processing. Although trip attraction models are defined for the classic three trip purposes, development of rates for home-based nonwork and nonhome-based trips often required aggregation of more purpose-specific submodels. For example, if a region used both home-based shop and home-based other (representing nonwork and nonshopping travel) trip attraction models, the trip rates per retail employee were added in the composite home-based other trip attraction model. If

Table 4.3. Example number of home-based work trips.

	Persons					
Autos	**1**	**2**	**3**	**4**	**5+**	**Total**
0	2	7	11	0	0	20
1	30	80	84	34	15	243
2	0	195	400	200	115	910
3+	0	0	104	232	330	666
Total	**32**	**282**	**599**	**466**	**460**	**1,839**

Table 4.4. Trip attraction rates from selected MPOs (person trips per unit).

	Number of MPO Models Summarized	Households[a]	School Enrollment[b]	Employment			
				Basic[c]	Retail[d]	Service[e]	Total
All Person Trips							
Home-Based Work							
Model 1	16						1.2
Home-Based Nonwork							
Model 1	2	1.2	1.4	0.2	8.1	1.5	
Model 2	8	2.4	1.1		7.7	0.7	
Model 3	2	0.7		0.7	8.4	3.5	
Nonhome Based							
Model 1	5	0.6		0.5	4.7	1.4	
Model 2	8	1.4			6.9	0.9	
Motorized Person Trips							
Home-Based Work							
Model 1	8						1.2
Home-Based Nonwork							
Model 1	1	0.4	1.1	0.6	4.4	2.5	
Model 3	4	1.0		0.3	5.9	2.3	
Nonhome Based							
Model 1	6	0.6		0.7	2.6	1.0	

[a] The number of households in a zone.
[b] The number of elementary, high school, or college/university students in a zone.
[c] Employment primarily in two-digit North American Industry Classification System (NAICS) codes 1–42 and 48–51 [Standard Industrial Classification (SIC) codes 1–51].
[d] Employment primarily in two-digit NAICS codes 44–45 (SIC codes 52–59).
[e] Employment primarily in two-digit NAICS codes 52–92 (SIC codes 60–97).

Source: MPO Documentation Database.

a region stratified trip attraction rates by area type, averages of the trip rates were estimated. If data were available for the various strata that had to be combined, weighted averages were estimated; where data were not available for weighted averages, simple averages were used. Finally, composite trip rates were estimated for three main employment groups: basic employment, retail employment, and service employment.

Since the presence or absence of other variables in a model can affect the coefficient for a specific model variable, Table 4.4 shows sets of trip rates for trip attraction models with common independent variables. Rates are provided for all person trips and motorized person trips only. Note that there are some combinations of variables that none of the models in the database used for motorized person trip attraction models.

To use the information in Table 4.4 to obtain parameters for trip attraction models, the analyst should choose a model that is consistent with the unit of travel (motorized or nonmotorized trips) and variables that are available for use in model application. The number of attractions can then be computed for each zone. For example, for a zone with 20 households, no school enrollment, 200 basic employees, 10 retail employees, and 100 service employees, the home-based nonwork trip attractions computed from Model 3 are: $0.7 * 20 + 0.7 * 200 + 8.4 * 10 + 3.5 * 100 = 588$.

Table 4.4 shows substantial variation in the trip attraction rates for the various model forms. The variation may reflect the different sizes of urban areas, different travel characteristics, and different development densities or area types, as well as the impact of variables included or excluded from the different model forms. It should be noted that no trends in trip attraction models by urban area population were evident; although the number of models examined is small, this is consistent with previous documentation efforts such as *NCHRP Report 365* (Martin and McGuckin, 1998).

The trip attraction rates shown in Table 4.4 may provide reasonable starting points for models for areas lacking the locally collected data necessary to develop trip attraction models. The selection of the specific model forms to be used could be made based on the types of independent data available for model application. The results of such initial model specifications should be reviewed to ensure that they reflect known travel conditions and behave reasonably for a region. Three examples are provided in the following paragraphs. These examples all use the models for "all person trips" in the upper portion of Table 4.4.

Example 1. Suppose the trip attraction rates from home-based work model 1, home-based nonwork model 3, and nonhome-based model 1 are applied for a region. In a review of traffic assignment results, it is discovered that too many trips are crossing the cordon boundary around the CBD. In such a case, it might be reasonable to reduce the home-based nonwork and nonhome-based trip attraction rates for retail and service employment in the CBD and to balance those reductions in the CBD trip rates with increases of the values for the rates for non-CBD zones. However, before making such adjustments, other checks should be performed, including the accuracy of CBD socioeconomic data, mode shares to the CBD, and comparison of CBD through traffic to observed origin-destination data.

Example 2. Suppose a region has forecasts for only households, retail employment, and nonretail employment available. None of the three home-based nonwork model forms match the independent variables available for the region. In this case, it might be reasonable to test both home-based nonwork models 2 and 3, ignoring the coefficients for the missing variables. Careful attention should be paid to traffic assignment results around industrial areas and educational facilities. The "best performing" model in terms of reproducing traffic volumes would be selected. If neither model performed well, it might be appropriate to mix the rates to address the issues.

Example 3. Again, suppose a region has employment stratified only by retail and nonretail at the zone level. If regional totals for basic and service employment can be determined, nonretail attraction rates for the home-based nonwork and nonhome-based trip purposes can be estimated by applying home-based nonwork model 1 (or model 3) at the regional level and estimating a weighted average trip rate for nonretail employment. The same procedure could be applied using rates from nonhome-based model 1 to develop a weighted average nonretail employment trip rate. If the regional totals for basic and service employment are not available, the straight averages of the rates for basic and service employment could be used. For example, if using model 3 for home-based nonwork attractions for motorized trips, one could use the average of the basic and service employment coefficients (1.3) as the coefficient for nonretail employment.

It is difficult to perform reasonableness checks of trip attraction model results for most trip purposes because the models are multivariate. The coefficients of a model that has the same variables could be compared to those in one of the models in Table 4.4, but having the same or different coefficients as one other model would not provide confirmation of the reasonableness or unreasonableness of the model. For home-based work trips, the vast majority of attraction models in the MPO Documentation Database have coefficients for total employment in the range of 1.0 to 1.5, and so coefficients in this range may be considered reasonable.

4.5 Trip Distribution

Trip distribution is the second step in the four-step modeling process. It is intended to address the question of how many of the trips generated in the trip generation step travel between units of geography, e.g., traffic analysis zones. These trips are in the same units used by the trip generation step (e.g., vehicle trips, person trips in motorized modes, or person trips by all modes including both motorized and nonmotorized modes). Trip distribution requires explanatory variables that are related to the impedance[6] (generally a function of travel time and/or cost) of travel between zones, as well as the amount of trip-making activity in both the origin zone and the destination zone.

The inputs to trip distribution models include the trip generation outputs—the productions and attractions by trip purpose for each zone—and measures of travel impedance between each pair of zones, obtained from the transportation networks. Socioeconomic and area characteristics are sometimes also used as inputs. The outputs are trip tables, production zone to attraction zone, for each trip purpose. Because trips of different purposes have different levels of sensitivity to travel time and cost, trip distribution is applied separately for each trip purpose, with different model parameters.

4.5.1 Model Function

The gravity model is the most common type of trip distribution model used in four-step models. In Equation 4-9, the denominator is a summation that is needed to normalize the gravity distribution to one destination relative to all possible destinations. This is called a "doubly constrained" model because it requires that the output trip table be balanced to attractions, while the numerator already ensures that it is balanced to productions.

[6]The term "impedance" is used in this report to represent the generalized cost of travel between two zones. In most cases, the primary component of generalized cost is travel time, and so impedance is often expressed in time units such as minutes.

Gravity Model

$$T_{ij}^{p} = P_i^{p} * \frac{A_j^{p} * f\left(t_{ij}\right) * K_{ij}}{\sum_{j' \in Zones} A_{j'}^{p} * f\left(t_{ij'}\right) * K_{ij'}} \qquad (4\text{-}9)$$

where:

T_{ij}^{p} = Trips produced in zone *i* and attracted to zone *j*;
P_i^{p} = Production of trip ends for purpose *p* in zone *i*;
A_j^{p} = Attraction of trip ends for purpose *p* in zone *j*;
$f(t_{ij})$ = Friction factor, a function of the travel impedance between zone *i* and zone *j*, often a specific function of impedance variables (represented compositely as t_{ij}) obtained from the model networks; and
K_{ij} = Optional adjustment factor, or "K-factor," used to account for the effects of variables other than travel impedance on trip distribution.

Destination Choice

Trip distribution can be treated as a multinomial logit choice model (see Section 4.2) of the attraction location. In such a formulation, the alternatives are the attraction zones, and the choice probabilities are applied to the trip productions for each zone. The utility functions include variables related to travel impedance and the number of attractions (the "size variable"), but other variables might include demographic or area-type characteristics.

A logit destination choice model is singly constrained since the number of attractions is only an input variable, not a constraint or target. Sometimes such a model is artificially constrained at the attraction end using zone-specific constants or post processing of model results.

Development of Travel Impedance Inputs

Zone-to-zone (interzonal) travel impedance. One of the major inputs to trip distribution is the zone-to-zone travel impedance matrices. The first decision is on the components of the travel impedance variable. The simplest impedance variable is the highway (in-vehicle) travel time, which is often an adequate measure in areas without a significant level of monetary auto operating cost beyond typical per-mile costs—for example, relatively high parking costs or toll roads—or extensive transit service. In some areas, however, other components of travel impedance should be considered. These may include distance, parking costs, tolls, and measures of the transit level of service. These measures, and the relative weights of each component, are often computed as part of utility functions in mode choice (Section 4.7).

The individual components of travel impedance are computed as zone-to-zone matrices through "skimming" the highway and transit networks using travel modeling software. The components may be combined through a simple weighting procedure, which might be appropriate if all components are highway related, or through the use of a logsum variable, which can combine highway- and transit-related variables. In this case, the logsum represents the expected maximum utility of a set of mode choice alternatives and is computed as the denominator of the logit mode choice probability function. The logit mode choice model is discussed in Section 4.7.

Terminal times and costs. The highway assignment process (discussed in Section 4.11) does not require that times be coded on the centroid connectors since those links are hypothetical constructs representing the travel time between the trip origin/destination and the model networks, including walking time. However when the skim times from a network assignment are used in trip distribution, the travel time representing travel within zones, including the terminal time, which may include the time required to park a vehicle and walk to the final destination, must be included. If the distribution model includes consideration of impedance based on travel times, this same consideration should also be made for the centroid-based terminal considerations.

Intrazonal impedance. Network models do not assign trips that are made within a zone (i.e., intrazonal trips). For that reason, when a network is skimmed, intrazonal times are not computed and must be added separately to this skim matrix.

There are a number of techniques for estimating intrazonal times. Some of these methods use the average of the skim times to the nearest neighboring zones and define the intrazonal time as one-half of this average. Various mechanisms are used to determine which zones should be used in this calculation, including using a fixed number of closest zones or using all zones whose centroids are within a certain distance of the zone's centroid. Other methods compute intrazonal distance based on a function of the zone's area, for example, proportional to the square root of the area. Intrazonal time is computed by applying an average speed to this distance.

Friction factors. There are two basic methods for developing and calibrating friction factors for each trip purpose:

- A mathematical formula and
- Fitted curves/lookup tables.

Three common forms of mathematical formulas are shown below, where F_{ij}^{p} represents the friction factor and t_{ij} the travel impedance between zones *i* and *j*:

- **Power function**, given by the formula $F_{ij}^{p} = t_{ij}^{a}$. A common value for the exponent *a* is 2.

- **Exponential**, given by the formula $F_{ij}^p = \exp(-m * t_{ij})$. An advantage of this formula is that the parameter *m* represents the mean travel time.
- **Gamma function**, given by the formula:

$$F_{ij}^p = a * t_{ij}^b * \exp(c * t_{ij}) \quad (4\text{-}10)$$

The parameters *a*, *b*, and *c* are gamma function scaling factors. The value of *b* should always be negative. The value of *c* should also generally be negative (if a positive value of *c* is used, the function should be carefully inspected across the full expected range of input impedance values to ensure that the resulting friction factors are monotonically decreasing). The parameter *a* is a scaling factor that does not change the shape of the function. Section 4.5.4 presents some typical values for the parameters *b* and *c*. These factors may be adjusted during model calibration to better fit the observed trip length frequency distribution data (usually from household travel surveys). This adjustment is commonly done on a trial-and-error basis.

Some modeling software packages allow the input of a lookup table of friction factors for each trip purpose, with some providing the capability of fitting these factors to best fit observed trip length frequency distributions.

4.5.2 Best Practices

While best practice for trip distribution models would be considered to be a logit destination choice model, the gravity model is far more commonly used, primarily because the gravity model is far easier to estimate, with only one or two parameters in the friction factor formulas to calibrate (or none, in the case of factors fitted directly to observed trip length frequency distributions), and because of the ease of application and calibration using travel modeling software.

There is no consensus on whether it is better to always have a singly constrained or doubly constrained trip distribution model. For home-based work trips, some type of attraction end constraint or target seems desirable so that the number of work trip attractions is consistent with the number of people working in each zone. For discretionary travel, however, the number of trip attractions can vary significantly between two zones with similar amounts of activity, as measured by the trip attraction model variables. For example, two shopping centers with a similar number of retail employees could attract different numbers of trips, due to differences in accessibility, types of stores, etc. A doubly constrained model would have the same number of shopping attractions for both shopping centers, and a doubly constrained trip distribution model would attempt to match this number for both centers. So it might be reasonable to consider singly constrained models for discretionary (nonwork, nonschool) trip purposes, although implied zonal attraction totals from such distribution models should be checked for reasonableness.

Besides segmentation by trip purpose, it is considered best practice to consider further segmentation of trip distribution using household characteristics such as vehicle availability or income level, at least for home-based work trips. This additional segmentation provides a better opportunity for the model to match observed travel patterns, especially for work trips. For example, if the home-based work trip distribution model is segmented by income level, work trips made by households of a particular income level can be distributed to destinations with jobs corresponding to that income level.

However, it may be difficult to segment attractions by income or vehicle availability level since the employment variables used in trip attraction models are not usually segmented by traveler household characteristics. Often, regional percentages of trips by income level, estimated from the trip production models, are used to segment attractions for every zone, especially for nonwork travel, but this method clearly is inaccurate where there are areas of lower and higher income residents within the region.

Methods to estimate household incomes by employee at the work zone have begun to be used but are not yet in widespread practice. Kurth (2011) describes a procedure used in the Detroit metropolitan area. This procedure consists of estimating the (regional) proportions of workers by worker earnings level based on industry, calculating the shares of workers by worker earnings group for each industry by area type, and calculating the shares of workers by household income for each worker earnings group by area type. The model is applied using the workers by industry group for each zone.

Some advantages to segmentation by vehicles rather than income level include:

- Often, a better statistical fit of the cross-classification trip production models;
- Avoidance of the difficulty in accurate reporting and forecasting of income;
- Avoidance of the need to adjust income for inflation over time and the difficulty of doing so for forecasting;
- Avoidance of the need to arbitrarily define the cutoffs for income levels because income is essentially a continuous variable; and
- Likelihood that vehicle availability has a greater effect on mode choice, and possibly trip distribution as well.

That being said, there are also advantages to using income level for segmentation, which is a more common approach in U.S. travel models. Perhaps the main advantage is that the trip attractions can be more easily segmented by income level. For example, home-based work trip attractions at the zone level are usually proportional to employment, and employment is easier to segment by income level than by number of autos. Some employment data sources provide information on income levels for jobs; no such information exists for vehicle availability levels. [However, it should be noted that income for a specific work attraction (job) is not the same as household income, which includes the incomes of other workers in the household.]

No one method for developing friction factors is considered "best practice." Some analysts find the gamma function easier to calibrate, because it has two parameters to calibrate compared to a single parameter for power and exponential functions. Since the exponential function's parameter is the mean travel time, this value can be easily obtained from observed travel data (where available), but matching the mean observed travel time does not necessarily mean that the entire trip length frequency distribution is accurate.

It is important to understand that matching average observed trip lengths or even complete trip length frequency distributions is insufficient to deem a trip distribution model validated. The modeled orientation of trips must be correct, not just the trip lengths. The ability to calibrate the origin-destination patterns using friction factors is limited, and other methods, including socioeconomic segmentation and K-factors, often must be considered.

4.5.3 Basis for Data Development

The best practice for the development of trip distribution models is to calibrate the friction factors and travel patterns using data from a local household activity/travel survey. If such a survey is available, it is straightforward to determine observed average trip lengths and trip length frequency distributions for each trip purpose and market segment. Calibrating friction factors to match these values is an iterative process that is usually quick and may be automated within the modeling software.[7] Household survey data can also be used as the basis for estimating observed travel patterns for use in validation, although sample sizes are usually sufficient to do this only at a more aggregate level than travel analysis zones.

The question is what to do if there is insufficient local survey data to develop the estimates of the observed values. Data sources such as the NHTS have insufficient sample sizes for individual urban areas to develop trip length frequency estimates for each trip purpose (although if an urban area is located in an NHTS add-on area, the sample size might be sufficient). Trip length distributions can vary significantly depending on the geography of a model region and its extent, which can often depend on factors such as political boundaries, the size of the region, physical features such as bodies of water and mountain ranges, and the relative locations of nearby urban areas. Therefore, simply using friction factors from another model may result in inaccurate trip distribution patterns.

The best guidance in this situation is to start with parameters from another modeling context and to calibrate the model as well as possible using any local data that are available, including data on work travel from the ACS/CTPP, traffic counts, and any limited survey data that might be available.

Section 4.5.4 (Model Parameters) provides information from two sources. First, sample gamma function parameters for friction factors from seven MPOs, obtained from the MPO Documentation Database, are summarized. Mathematically, it does not make sense to average these parameters, nor can consensus factors be derived. The guidance is to choose a set of parameters as a starting point, perhaps by testing different sets of parameters to see which provide the best results, and adjusting them as needed. This process is described more completely Section 4.5.4.

The second data source is the 2009 NHTS, from which average trip lengths by trip purpose for each urban area size category are presented. This information could be used as a starting point for developing friction factors as well as for reasonableness checks of modeled trip lengths in areas without local survey data. They should not be used as "hard" validation targets for specific urban area models.

4.5.4 Model Parameters

Gravity Model Parameters

Gamma function parameters were available for the classic three trip purposes for seven MPOs from the MPO Documentation Database. Table 4.5 presents the *b* and *c* parameters used by these MPOs. Since friction factors can be scaled without impacting the resulting distribution, the parameters shown in Table 4.5 were scaled to be consistent with one another. The resulting friction factor curves for the home-based work, home-based nonwork, and nonhome-based trip purposes are shown in Figures 4.2 through 4.4.

The MPO size categories for Table 4.5 are:

- Large MPO—Over 1 million population;
- Medium MPO—500,000 to 1 million population;
- Medium (a) MPO—200,000 to 500,000 population; and
- Small MPO—50,000 to 200,000 population.

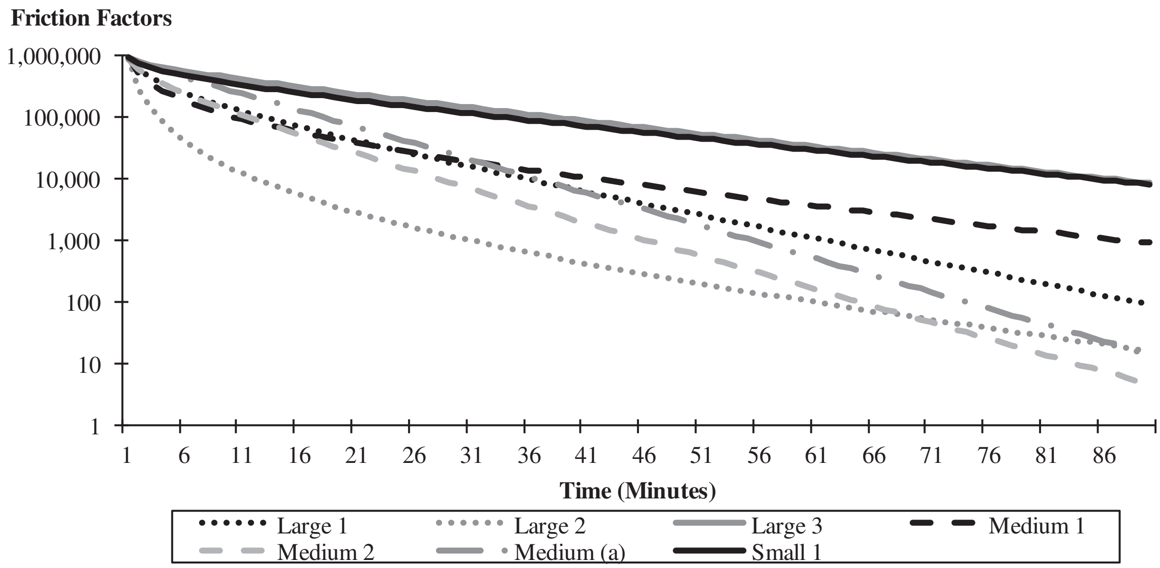
The guidance is to choose one of these seven sets of parameters (the six *b* and *c* parameters from the same model) based

[7] Frequency distributions of trip length as reported from survey respondents are "lumpy" due to rounding of times. One way of resolving this issue is to use only the respondents' reported origins and destinations and to use the travel times from the networks for the corresponding origin-destination zones to create the frequency distributions. This method also has the advantage of using a consistent basis for travel time estimation across all survey observations.

Table 4.5. Trip distribution gamma function parameters for seven MPOs.

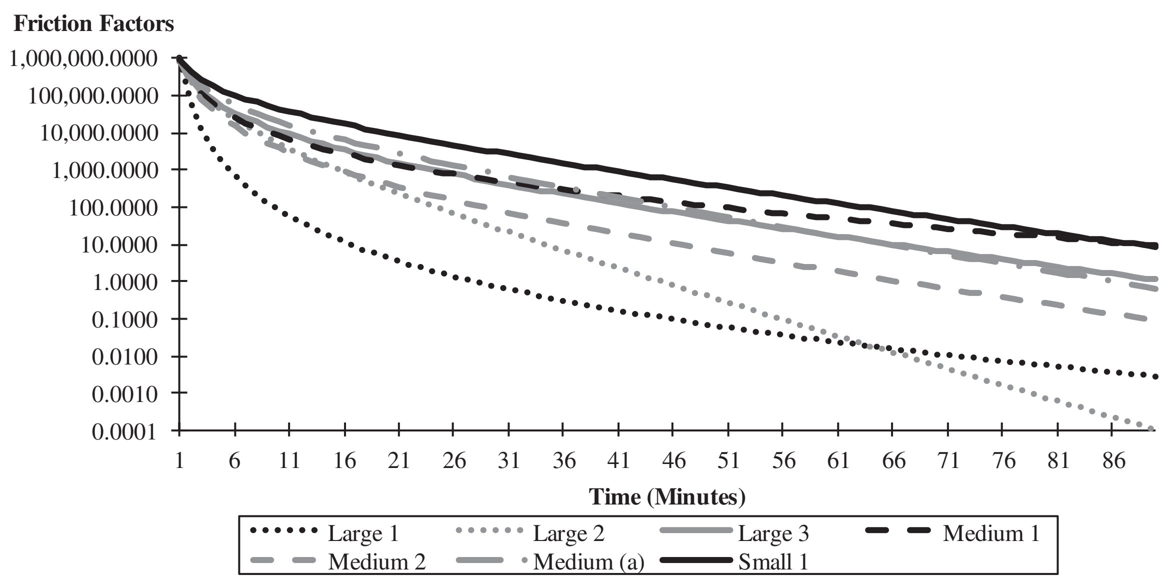
	Home-Based Work		Home-Based Nonwork		Nonhome Based	
	b	*c*	*b*	*c*	*b*	*c*
Large MPO 1	–0.503	–0.078	–3.993	–0.019	–3.345	–0.003
Large MPO 2	–1.65	–0.0398	–1.51	–0.18	–1.94	–0.116
Large MPO 3	–0.156	–0.045	–1.646	–0.07	–2.824	0.033
Medium MPO 1	–0.81203	–0.03715	–1.95417	–0.03135	–1.92283	–0.02228
Medium MPO 2	–0.388	–0.117	–2.1	–0.075	–1.8	–0.16
Medium (a) MPO 1	–0.02	–0.123	–1.285	–0.094	–1.332	–0.1
Small MPO 1	–0.265	–0.04	–1.017	–0.079	–0.791	–0.195

Source: MPO Documentation Database.



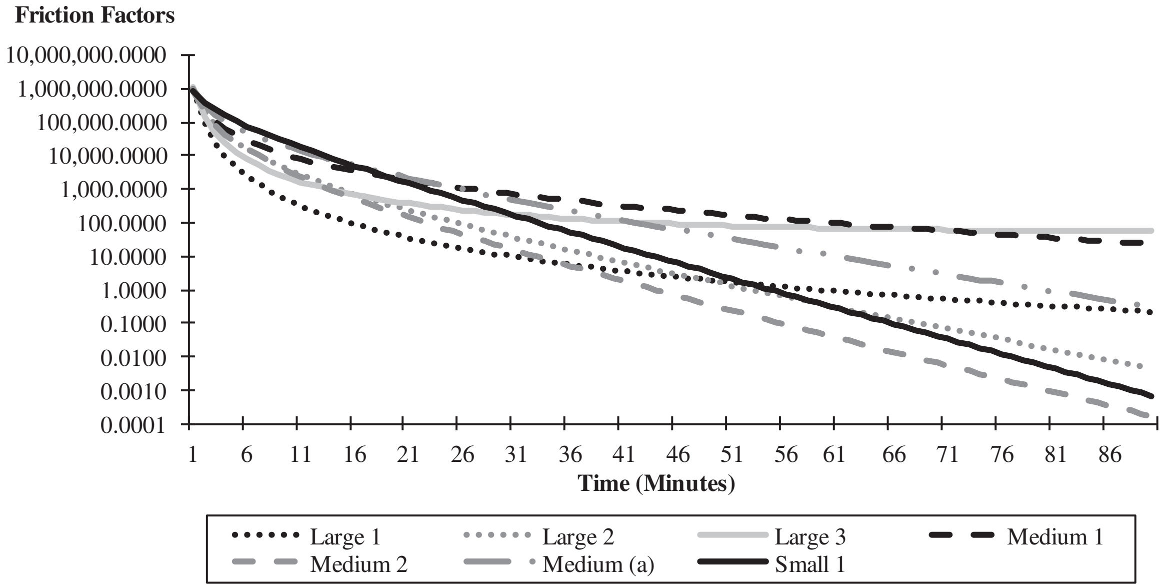
Source: MPO Documentation Database.

Figure 4.2. Home-based work trip distribution gamma functions.



Source: MPO Documentation Database.

Figure 4.3. Home-based nonwork trip distribution gamma functions.



Source: MPO Documentation Database.

Figure 4.4. Nonhome-based trip distribution gamma functions.

on the characteristics of the analyst's model region. The curves shown in Figures 4.2 through 4.4 may be useful in identifying the sensitivity to travel time and the general shape of the friction factors compared to what the analyst knows about travel in his/her region. Note that since *a* is a scaling parameter that does not change the shape of the gamma function curve, it can be set at any value that proves convenient for the modeler to interpret the friction factors.

Whichever model's parameters are chosen, they should serve as a starting point for calibrating the model to local conditions. If the analyst is unsure which set of parameters to choose, multiple sets of parameters could be tested to see which provides the best fit to observed trip length frequencies. Regardless of which set is chosen, the analyst should adjust the parameters as needed to obtain the most reasonable model for the region.

Average Trip Lengths (Times)

Table C.10 presents respondent-reported average trip lengths and standard deviations in minutes from the 2009 NHTS data set. This information can be used to help find starting points for friction factor parameters (for example, as initial values for parameters in exponential friction factor functions) and to test trip length results from trip distribution models for reasonableness. The information is presented for auto, transit, and nonmotorized modes as well as for all modes.

Initially, the trip length data were summarized for the six population ranges available in the NHTS data set. However, the trip lengths do not vary much by urban population for nonwork travel, and many of the differences appear to be small fluctuations between population ranges. The recommendations, therefore, represent mean trip lengths averaged across urban area population ranges in most cases.

It should be noted that the sample sizes for transit trips, especially for urban areas under 1 million in population, were insufficient to estimate separate meaningful average trip lengths by population range. This was true for nonmotorized trips as well in some cases.

Even though average trip lengths are fairly consistent across urban area sizes, this should not be construed to imply that trip lengths are the same among all individual urban areas, even within each population range.

Some patterns can be noted from the data shown in Table C.10:

- Average home-based work trip lengths are longer in larger urban areas, particularly for auto and nonmotorized trips;
- Transit trips are over twice as long as auto trips in terms of travel time; and
- Average trip lengths for nonmotorized trips for all purposes are about 15 minutes and are consistently in the mid-teens. This equates to about 0.75 miles for walking trips.

4.6 External Travel

Travel demand models estimate travel for a specific geographic region. While the trip generation process estimates the number of trips to and from zones within the model region based on socioeconomic data for those zones, not every trip will have both trip ends internal to the boundary of the model. In nearly all models, some trips will have one or both trip ends outside of the geography served by the model. Trips with at least one external trip end, depending on the size of the urban area and its location with respect to other areas, might represent a substantial portion of travel within the region.

By convention, zones located inside the model region are called "internal zones." External zones representing relevant activity locations outside the model region are represented in the model by points at which highway network roadways (and sometimes transit lines) enter and leave the region, often referred to as "external stations." Trips for which both ends are internal to the model region are referred to as "internal–internal" (II). Trips that are produced within the model region and attracted to locations outside the model region are called "internal–external" (IE), while trips produced outside the region and attracted to internal zones are called "external–internal" (EI). Trips that begin and end outside the region but pass through the region are labeled "external–external" (EE). (In some regions, the letter "X" is used rather than the letter "E," as in IX, XI, and XX trips.) Sometimes all trips with one end inside the model region and one end outside are referred to as IE/EI trips. Generally, the terms "external trips" and "external travel" refer to all IE, EI, and EE trips.

4.6.1 Model Function/Best Practices

Usually, external trips are treated as vehicle trips, even if the II trips are treated as person trips. This means that external transit trips are typically ignored as well as changes in vehicle occupancy for external auto trips. In many areas, there is little or no regional transit service that travels outside the model region, or HOV or managed lanes crossing the regional boundary, that might require the ability to analyze mode choice for external travel. Since urban area travel models lack sufficient information to model choices involving interurban travel, it is common practice to treat interurban trips by nonauto modes as having the external trip end at the station or airport, essentially treating these trips as II (with airports usually treated as special generators or airport access/egress treated as a separate trip purpose).

Most of the areas where some treatment of external transit trips is desirable are larger areas, often those close to other urban areas (for example New York and Philadelphia). For the vast majority of urban areas, though, treatment of external vehicle trips is sufficient. Because larger areas tend to have more survey data available, and there are insufficient examples of external transit travel models to evaluate their transferability, the remainder of Section 4.6 concentrates on the modeling of external vehicle trips.

It is important to recognize the relationship between the trip generation and distribution steps for II trips and the external travel modeling process. Two points must be considered in developing modeling procedures for external trips:

- The trip generation models described in Section 4.4 are estimated from household survey data. These surveys include both II and IE trips, and, unless the IE trips were excluded from the model estimation, the resulting trip production models include both II and IE trips. The trip rates presented in Tables C.5 through C.9 based on the NHTS data include all trips generated by the respondent households (II and IE). In most models, the II trips dominate regional travel, and the effect of IE trips is minimal. However, the amount of IE travel generated in zones near the model region boundary can be significant.
- On the other hand, trip attraction models estimated from household survey data include only those trips produced in the model region. So, estimated attraction models include only II trips. Because it is common practice to balance trip attractions to match regional productions and EI trips are modeled using other data sources, the use of only II trips in the models generally does not have the effect of "missing" the EI trips, although the quality of estimates of the split between II and EI attractions depends on the availability and quality of data on external travel, as well as the local household survey data.

Data Sources

Household activity/travel surveys include IE trips, but not EI trips as defined on a production/attraction basis. Furthermore, the information provided on the attraction end of IE trips is based on the ultimate destination and does not specify the external zone that would be the effective destination of a modeled trip. This means that the main information to be obtained on external travel from the household survey would be total numbers of IE trips for different segments of zones and perhaps some rough orientation information regarding the external destinations. Additionally, the number of IE trips reported in household surveys is often low. Thus the household survey cannot serve as the primary source for external model development.

A more complete data source would be an external station survey. In such a survey, drivers of vehicles observed on a roadway crossing the model region boundary are surveyed through vehicle intercept or mailout/mailback surveys, where the license plates are recorded to determine to whom to send the surveys. Ideally, every external station (zone) would be surveyed, although this may be impractical in areas with a large number of external zones, and it may be very inefficient to survey a large number of low-volume roadways.

Data from an external station survey could be used to develop models that estimate the number of IE/EI trips generated by internal zones, by trip purpose if the data have sufficient observations by purpose. Distribution models for IE/EI trips could also be estimated; such models would essentially match the vehicle trip ends between the external and internal zones.

External Productions and Attractions

The definitions of productions and attractions remain the same for external trips as for II trips. That is, the home end of a home-based trip is the production end and the nonhome end is the attraction end; for nonhome-based trips, the origin is the production end and the destination is the attraction end.

For simplicity, some models have treated all IE/EI trips as produced at the external zone (i.e., as if all such trips were EI). In these contexts, this simplification probably is adequate since there are relatively few significant trip attractors outside the urban area for residents of the region, and so the majority of IE/EI trips are, in fact, EI. However, in some regions, especially as areas close to the model region's boundary have become more developed, the share of IE trips has become more significant. So if data are sufficient, it may make sense to model IE and EI trips separately.

External trip generation totals for the **external zones** include EI, IE, and EE trips. The total number of vehicle trips for an external zone for the base year is equal to the observed traffic volume on the corresponding roadway at the regional boundary. For forecast years, most areas must rely on growth factors applied to the base year traffic volumes. Generally, the external zone volume serves as a control total for the sum of EI, IE, and EE trips.

External trip generation totals for the **internal zones** include EI and IE trips. The total number of these trips over all internal zones is controlled by the sum of external trips for the external zones, based on the traffic volumes as described above, and excluding the EE trips. The percentage split between EE and IE/EI trips at each external zone is typically the starting point in estimating external travel components by external zone. Ideally, the percentage split should come from a roadside cordon line survey; however, guidance is provided in the following paragraphs on tendencies that can be used to determine the percentage of EE trips.

External–External Trips

The amount of EE travel may depend on a number of factors, including:

- **Size of the region**—Generally, larger regions have fewer through trips.
- **Presence of major through routes**—Naturally, the presence of these routes, usually Interstate highways, results in higher EE travel.
- **Location of the urban area relative to others**—If other urban areas are located near the boundary of the urban area, this can have significant effects on orientation of travel within the region.
- **Location of physical features and barriers**—If there are any of these in or near the model region, they may affect the amount of through travel.

A fairly complete set of external station surveys for a region would be the best source for estimating EE travel. Such a survey could be used to develop a zone-to-zone trip table of EE trips for the base year. Forecast year tables could be developed by applying growth factors at the zone level, based on projected growth inside and outside the region for areas served by each roadway. A Fratar process is often used for this purpose. This process uses iterative proportional fitting to update a matrix when the marginal (row and column) totals are revised. In this case, the row and column totals are updated to represent the change in EE trips for each external zone between the base and forecast years.

In the absence of such survey data, the true EE trip table will be unknown, as will the error between the modeled and actual EE trips. The validity of transferring EE trip percentages from other regions is unknown; in addition, because the factors listed previously can vary significantly between regions, finding a region similar enough to the application context that has the necessary survey data can be difficult and, even if such a region is found, it is unknown how much the EE travel percentages between the regions would actually vary. Transferring EE trip tables is therefore not recommended.

A suggested method for synthesizing EE trip tables is as follows:

1. Identify which external zone pairs are most likely to be carrying EE trips. These external zone pairs should include any pairs of zones where the corresponding highways are Interstates, freeways, or principal arterials. Figure 4.5 illustrates some examples of external zone pairs that are likely or unlikely to have EE travel. External zone pairs that do not include logical paths within the model region should be excluded. For example, zone 1001 to zone 1002 in Figure 4.5 would be unlikely to include many EE trips as both zones lead to the same general location, meaning that a trip between these two zones would essentially be a "U-turn" movement. Zone pairs with short logical paths through the model region should probably be included even if one or more of the corresponding roadways is of a lower facility type (for example, zone 1002 to zone 1003 in Figure 4.5). While there are undoubtedly a few EE trips that would be made in the model region between external zone pairs that do not meet these criteria, these are probably very small in number and can be ignored without significant impacts on the model results.

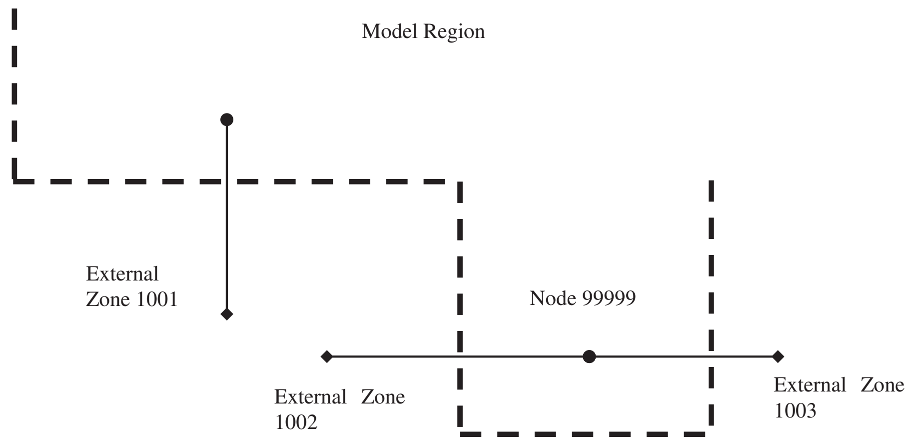


Figure 4.5. Example of external zone pairs with and without EE trips.

2. Estimate the number of EE trips for each zone pair identified in Step 1 that represent reasonable percentages of the total volumes of both highways. It makes sense to focus on the roadway with the lower volume in terms of making sure that the percentages are reasonable. There is little guidance available to estimate percentages. Martin and McGuckin (1998) cites a study by Modlin (1982) that provided a formula, intended to be used in urban areas of less than 100,000 population, that estimates the percentage of total external travel that is EE, based on facility type daily traffic volumes, truck percentages, and model region population. This formula results in EE travel percentages of about 30 percent for principal arterials and 70 percent for Interstates in urban areas of 50,000 population and of about 10 percent and 50 percent, respectively, for urban areas of 100,000 population (note that these figures represent total EE travel on a roadway to all other external zones).
3. During highway assignment, checks on volume-count ratios along "internal" segments of these roadways should help indicate whether or not the EE trips were overestimated or underestimated. For example, a persistent over-assignment along an Interstate passing through a region could indicate that the number and percentage of EE trips might have been overestimated.

While this process is very rough given the lack of data used, the amounts of EE travel are usually fairly small; therefore, the error associated with these estimates, while unknown, is likely small.

Internal–External and External–Internal Trips

The process of modeling IE/EI trips includes the following steps:

1. Identifying the trip purposes to be used for IE/EI trips;
2. Deciding whether to treat all IE/EI trips as EI;
3. Deciding on external zone roadway types to be used;
4. Estimating the number of IE/EI vehicle trips for each external zone by purpose and splitting them into IE and EI trips;
5. Estimating the number of IE/EI vehicle trips for each internal zone by purpose and splitting them into IE and EI trips; and
6. Distributing IE and EI trips between external and internal zones by purpose.

The result of this process is a set of IE and EI vehicle trip tables by trip purpose. These trip tables can be combined into a single trip table, or combined with vehicle trip tables for II trips, for highway assignment. The six steps are described in more detail in the following paragraphs.

Step 1: Identifying the trip purposes to be used for IE/EI trips. Often, the available data are insufficient to model multiple IE/EI trip purposes, and the relatively small number of these trips means that the added cost of separating IE/EI trip purposes does not usually provide a great benefit. Most models, therefore, do not distinguish among trip purposes for IE/EI trips, although some models separate trips into home-based work and all other. Another consideration is that without an external station survey, there may not be enough information to determine the percentage of IE/EI trips by purpose.

Areas that would benefit most from allocating IE/EI trips into multiple purposes are those with an adjacent urban area on the other side of the study area cordon line. In fact, it may become necessary for proper validation of such a model to allow internally generated IE/EI trips such as work to be attracted to external zones, if in fact a large percentage of residents work in the adjacent urban area. Such an adjustment is sometimes made using special generators or by modifying the trip generation program to estimate home-based work attractions to external zones.

Step 2: Deciding whether to treat all IE/EI trips as EI. As mentioned above, some models treat all IE/EI trips as produced at the external zone (i.e., as if all such trips were EI). The analyst must decide whether this distinction is warranted by the volume and orientation of external trips in the model region and the availability of data to distinguish between IE and EI trips. Generally, it is probably not worth modeling IE and EI trips separately in regions with low volumes of external travel and regions with little nonresidential activity located just outside the model area boundary. If data from an external station survey are available, they could be used to determine whether there is a high enough percentage of IE trips to make modeling them separately worthwhile.

Step 3: Deciding on external zone roadway types to be used. Travel characteristics vary significantly depending on the type of highway associated with an external zone. In general, the higher the class of highway at the cordon, the longer its trips are likely to be. For example, some roads, such as Interstate highways, carry large numbers of long-distance trips. On average, a smaller percentage of the total length of trips on these roadways would be expected to occur in the model region, implying that travelers might be willing to travel farther within the region once they cross the regional boundary. Other roads carry predominantly local traffic. Since local trips are generally short, there is a much greater likelihood that the local ends of these trips are near the boundary. The facility type of the external zone highway, therefore, becomes a strong surrogate for other determinants of the types and kind of external travel.

The following stratification scheme for external zones is often used to account for these differences:

- Expressway;
- Arterial near expressway;
- Arterial not near expressway; and
- Collector/local.

These roadway types are, in effect, the trip purposes for the external–internal trips. Other "special" roadway categories that may exist in a region, such as bridge crossings for major bodies of water at the regional boundary, toll roads and turnpikes that carry a large amount of long-distance travel, or international boundary crossings, may warrant separate categories.

Once the roadway types are chosen, each external zone is classified accordingly.

Step 4: Estimating the number of IE/EI vehicle trips for each external zone by purpose and splitting them into IE and EI trips. The control total for IE/EI trips for each external zone is the total volume for the zone minus the EE trips for the zone. If the trips are not separated by purpose or into IE and EI trips, then only total EI trips are needed, and they will be equal to the control total. Otherwise, percentages must be estimated to divide the trips. An external station survey would be the only source for actual percentages. Unfortunately, there is little information available that could be used to develop transferable parameters; even if there were, the substantial differences between urban areas and the influence of areas outside the model region would make transferability questionable in this case.

Step 5: Estimating the number of IE/EI vehicle trips for each internal zone by purpose and splitting them into IE and EI trips. The total IE/EI trips, by purpose and split into IE and EI trips, over all external zones serves as the control total of IE/EI trips for all internal zones. One example of a model used to estimate the IE/EI trips for each zone is discussed below. This example assumes that all IE/EI trips are EI trips, but the same type of model could be used separately for each trip purpose and for IE trips.

The functional form of the external trip generation model for internal zones is presented in Equation 4-11. These trips are treated as being produced at the external station and attracted to the internal zone. The attractions generated by each internal zone are computed as a function of the total trip attractions and the distance from the nearest external zone. The internal trip attraction model generates, for each internal zone, the EI trips as a percentage of the total internal trip attractions. The trip generation model has the form:

$$E_j = AT_jD_j^B \tag{4-11}$$

where:

E_j = EI trips generated in internal zone j;
T_j = Total internal trip attractions generated in internal zone j;
D_j = Distance from zone j to the nearest external station; and
A, B = Estimated parameters.

The EI trip attractions generated by this formula are subtracted from the total internal person trips generated for the zone to produce revised total II trip attractions for the zone. Note that these are person trips that must be converted to vehicle trips, using vehicle occupancy factors (see Section 4.8).

The model parameters A and B are estimated for each roadway type through linear regression based on an external station survey data set. This is done by transforming Equation 4-11 using logarithms:

$$\log(E_j) = \log(A + T_j) + B(\log(D_j)) \tag{4-12}$$

The distance variables D_j are obtained by skimming the highway network and can be expressed in any distance units, although miles are customary. The total trip attractions T_j are determined from the internal trip generation process, as described in Section 4.4. The external trips E_j are obtained directly from the external survey data set. These parameters are calibrated to produce an exact match between the modeled EI vehicle trips and the observed external zone volumes.

Step 6: Distributing IE and EI trips between external and internal zones by purpose. As is the case for the internal trips, the most common approach to distributing IE/EI trips is the gravity model (See Equation 4-9). If external station survey data are available, the friction factors can be estimated in a manner that matches the observed trip length (highway travel time) frequency distribution. K-factors are often used in model calibration to match travel patterns on an aggregate (district) basis. If survey data are unavailable, friction factors from the internal travel model could be used as a starting point for model calibration.

4.6.2 Basis for Data Development

As discussed previously, an external station survey data set is a valuable resource in estimating and calibrating external travel models. If such a survey is unavailable, Section 4.6.3 provides external trip generation parameters from an example urban area.

4.6.3 Model Parameters

Table 4.6 provides sample *A* and *B* parameters for the IE/EI trip generation equation (4-11). These were estimated using external station survey data for a large U.S. urban area.

Example

Consider an internal zone *j* with 100 total attractions, located the following distance from an external station of each facility type:

- Freeway/expressway—10 miles;
- Arterial near expressway—10 miles;
- Arterial not near expressway—5 miles; and
- Collector/local—2 miles.

The number of EI trips attracted to zone *j* for each external station facility type is given by (using the parameters shown in Table 4.6):

- Freeway/expressway: $E_j = (0.071)\ (100)\ (10^{-0.599}) = 1.8$ trips;
- Arterial near expressway: $E_j = (0.118)\ (100)\ (10^{-1.285}) = 0.6$ trips;
- Arterial not near expressway: $E_j = (0.435)\ (100)\ (5^{-1.517}) = 3.8$ trips; and
- Collector/local: $E_j = (0.153)\ (100)\ (2^{-1.482}) = 5.5$ trips.

In this example, about 12 of the 100 trip attractions in zone *j* are EI trips.

Table 4.6. Sample trip generation model parameters.

Station Type	*A*	*B*
Freeway/Expressway	0.071	−0.599
Arterial Near Expressway	0.118	−1.285
Arterial Not Near Expressway	0.435	−1.517
Collector/Local	0.153	−1.482

Source: Cambridge Systematics, Inc. (2002).

4.7 Mode Choice

Mode choice is the third step in the four-step modeling process. In models where the unit of travel is vehicle trips, only automobile travel is modeled, and therefore there is no need for a mode choice step. (Hence, these models are sometimes referred to as "three-step models.") The automobile occupancy step, discussed in Section 4.8, is not needed in these models either.

Mode choice is required in models where the unit of travel is person trips by all modes, or by all motorized modes. The mode choice model splits the trip tables developed in trip distribution into trips for each mode analyzed in the model. These tables are segmented by trip purpose and in some cases further segmented by income or number of vehicles, as discussed in Section 4.5.2. If the unit is person trips by motorized modes, these modal alternatives include auto and transit modes. If the unit is person trips by all modes including nonmotorized modes, then the modal alternatives may also include walking and bicycling, although sometimes nonmotorized trips are factored out prior to mode choice.

4.7.1 Model Function

Modal Alternatives

The first step in mode choice is determining which modal alternatives are to be modeled. Generally, alternatives can be classified as auto, transit, and nonmotorized modes. The simplest models may model just these three main modes (or two, if nonmotorized travel is not included in the model).

Auto modes are generally classified by automobile occupancy level (e.g., drive alone, two-person carpool, and three-or-more-person carpool). Sometimes autos using toll roads are modeled as separate alternatives, often also classified by auto occupancy level.

Transit modes apply to complete (linked) trips from origin to destination, including any walk or auto access or egress as well as transfers. These may be classified by access (and sometimes egress) mode and by type of service. Because such variables as walk time and parking cost are important elements in mode choice, walk access and auto access transit modes should be modeled separately, unless there is little demand for transit where people drive or are driven to the transit stop. Service types that may be modeled separately are often defined by local (e.g., local bus) versus premium (e.g., commuter rail) service. Among the modes that have been included in mode choice models in the United States are local bus, express bus, light rail, heavy rail (e.g., subway), and commuter rail. Some models include a generic "premium transit" mode.

There are advantages and disadvantages to having a large number of modal alternatives defined by service type. An advantage is that differences in level of service can be considered more readily, and many travelers view various transit types very differently (for example, some travelers who use commuter rail might not consider using local bus). A disadvantage is that having more modes makes the model more complex, and therefore harder to estimate and more time consuming to apply, and the complexity may result in complicated nesting structures that are hard to estimate and difficult to find transferable parameters for. Another issue is how to classify "mixed mode" trips, for example, a trip where a traveler uses both local bus and heavy rail. There is no ideal method to classify such trips; methods such as classifying trips as the "more premium" of the modes used would be inappropriate for trips that are primarily on a less premium mode, and most modeling software does not provide a way of identifying the percentage of each submode between an origin and destination.

Nonmotorized modes are sometimes separated into two modes, walk and bicycle, but are often treated as a single modal alternative. (Note that a walk or bicycle access segment of a transit trip is not considered a separate trip; it is considered part of the transit trip.)

Mode choice is applied by first estimating the probability of choosing each modal alternative for each traveler or segment of travelers. The probability is based on a set of explanatory variables that include characteristics of the modal level of service, traveler characteristics, and features of the areas where the travel takes place. In four-step models, the probabilities are applied as shares of the market segments to which they apply; that is, if a mode has a 75 percent probability of being chosen by a market segment (e.g., work trips for an origin-destination zone pair), 75 percent of the travelers in that segment are allocated to that mode.

Most mode choice models use the logit formulation. In a logit mode choice model, the alternatives represent the modes. The utility is a function of the explanatory variables. These variables may include the following:

- **Modal level of service—**Auto in-vehicle time, transit in-vehicle time, wait time, walk access/egress time, auto access time, transit fare, parking cost, number of transfers;
- **Traveler characteristics—**Vehicle availability (sometimes relative to other potential drivers), household income, gender, age, worker/student status; and
- **Area characteristics—**Development density, pedestrian environment.

At a minimum, mode choice models need to include level-of-service variables so that the effects of changes in level of service (e.g., run time improvements, fare increases, parking costs) can be analyzed. Transportation investment and policy alternatives usually change the level of service for one or more modes relative to the others, and so the effects on modal usage need to be estimated. The inclusion of traveler characteristics allows the model to be sensitive to changing demographics. Including area characteristics allows the model to consider the effects of land use changes, which may be part of policy alternatives the model is being used to help analyze.

The values for the modal level-of-service variables must be obtained for every origin-destination zone pair. These values are obtained through the process of skimming the networks, as discussed in Section 4.5. A separate skim matrix is needed for each modal alternative (and each time period, if time-of-day modeling, discussed in Section 4.9, is employed). This requirement implies that a network is needed for each mode. These individual modal networks are developed from the basic two networks—highway and transit—and by adjusting parameters to match the assumed use of the mode. For example, skims for a local bus mode could be obtained by allowing travel only on local bus routes in the transit network. For transit auto access modes, provision must be made for allowing auto portions of these trips to be made along the highway network. For nonmotorized modes, the usual practice is to revise the highway network by eliminating links on which only motorized vehicles are allowed (freeways, ramps, etc.) and skimming the network using minimum distance paths.

While the foregoing description of obtaining the mode-specific paths may appear to be relatively simple, great care must be used in the process to ensure that the paths and skims obtained are consistent with the mode choice model. This may be difficult when obtaining paths for "higher-level" modes. For example, while drive-alone paths could be obtained by turning off HOV links in the path-building process, it might be necessary to "encourage" the use of HOV links (or discourage the use of drive-alone links) in order to obtain reasonable HOV paths and skims for the mode choice model. At the same time, this encouragement should be performed in such a way that preserves the relationships between parameters used in the path-building process and mode choice coefficients. This is especially true for transit path-building. If the mode choice model coefficients show that out-of-vehicle time is twice as onerous as in-vehicle travel time (i.e., the ratio of the coefficients is two to one), it is improper to use a different relationship between out-of-vehicle time and in-vehicle time in the path-building process.

4.7.2 Best Practices

As is the case with trip distribution models, mode choice model accuracy can be enhanced by segmenting the model by income or vehicle availability level. When there are more than two modal alternatives, as is common in mode choice models, the multinomial logit model can introduce inaccuracies in the way it estimates how people choose among alternatives. One way of dealing with this issue is the use of a nested logit model (see Section 4.2). A major advantage of nested structures for mode choice is that similar modes, such as transit with auto access and transit with walk access, can be grouped as a subset, all branching from a common "composite mode."

As discussed in Section 4.2, the "nesting coefficient" must be between zero and one and should be statistically significantly different from zero and one. In the literature review of transferability studies (see Appendix B), no research was found into the transferability of nesting coefficients from one area to another. In models around the United States, nesting coefficients are often asserted with values ranging from about 0.2 to 0.8, nearly the entire valid range.

The IIA assumption (discussed in Section 4.2) can be problematic in mode choice models with more than two alternatives. For example, if car, bus, and rail are the alternatives and they all had equal utilities, the probability of choosing a transit mode would be greater than that of choosing the car mode. The modeler would need to decide if this were a correct formulation (i.e., although rail and bus may not be perfect substitutes, such a formulation may still be problematic). A nested logit formulation of this choice set would help address this issue by subordinating the somewhat related bus versus rail choice beneath a car versus transit choice.

4.7.3 Basis for Data Development

Logit mode choice model parameters are estimated using statistical techniques and specialized software designed to estimate this type of model. As in the estimation of a linear regression model, the data required are individual trip observations that include the trip origin and destination, the necessary traveler characteristics, and of course the chosen mode for the trip. Information on the level of service by each available mode can be added to the estimation data set from the network skims; information on area characteristics based on the origin and destination can also be added.

The only data source likely to provide a set of travel observations that include all modal alternatives is a household survey data set. Unfortunately, except in areas with high transit use (or very large survey sample sizes), the number of observations in a household survey for transit modes is likely to be too small to estimate statistically significant model parameters. Therefore, the household survey data set is often supplemented with data from a transit rider survey.

Even with typical household survey sample sizes and large transit rider survey data sets, it is often difficult to estimate mode choice model parameters that are both statistically significant and of reasonable sign and magnitude. As a result, the model development process often includes "constraining" some model parameters (utility coefficients) to specific values, often relative to one another. For example, parameters for transit out-of-vehicle time (wait time, walk time, etc.) might be constrained to be a multiple of the coefficient for in-vehicle time, say two or three, to reflect the fact that travelers find walking or waiting more onerous than riding.

Because of the difficulty in model estimation and in obtaining sufficient estimation data sets, mode choice is the model component most often characterized by parameters that are not estimated from local data, even in urban areas where parameters for other model components are estimated in that way. This practice of transferring parameters from other models has resulted, ironically, in a relative lack of recent models available for consideration as the estimation context. Many recently estimated models include at least some constrained coefficients.

The MPO Documentation Database includes mode choice model parameters for a limited number of models. These are presented in Section 4.7.4.

4.7.4 Model Parameters

Even for applications with similar circumstances, unless models have identical specifications, the values for specific coefficients may differ significantly between models. The alternative definitions, nesting structures, and presence or absence of other variables in a model can affect the coefficients of any variable. So it is much more valid to transfer individual models rather than composites of models with different variables or structures.

With that in mind, the best guidance for an MPO without sufficient local data for model estimation (the application context) is to transfer a complete model from another area (the estimation context), preferably from an area of similar demographic, geographic, and transportation system characteristics.

Model parameters can then be calibrated to ensure reasonable results in the application context, preferably retaining the relationships (i.e., ratios) between coefficients that have been estimated elsewhere. Care should be taken to note whether any of the model parameters in the estimation context were transferred themselves from elsewhere or otherwise constrained.

It is, of course, impractical to present in this report every mode choice model that might be considered in the estimation context. Analysts are encouraged to research specific models from likely estimation contexts and obtain information from sources such as direct contact of MPOs or on-line model documentation. If this is not feasible, information is presented in Tables 4.7 through 4.15 in simplified form for some of the models in the MPO Documentation Database for the classic three trip purposes.

The information from the MPO Documentation Database includes parameters for the level-of-service variables likely to be used in mode choice models in areas to which mode choice models are likely to be transferred. The MPO Documentation Database includes mode choice model parameters for about 30 MPO models. All of these models are located in urban areas with populations over 500,000 and most are in areas with populations over 1 million. For some of the models in the MPO Documentation Database, information on the mode choice models is incomplete, and some models have unusual or complex variable or modal alternative definitions that would make transferring parameters difficult. These models were excluded from the tables below, and so the number of models for which information on transferable parameters is available is less than 30.

Table 4.7 presents the characteristics of nine mode choice models for home-based work trips from the MPO Documentation Database. These models can be summarized as follows:

- Eight models from areas with populations over 1 million, and one model from the 500,000 to 1 million population range;
- Six nested logit and three multinomial logit models;
- Two models that include nonmotorized trip modes, and seven that do not; and
- Two models that have transit modes separated into local and premium submodes; one that separates transit into local, premium (e.g., express bus), and rail submodes; and six that use generic modes representing all transit. All nine models have separate modes for walk and auto access to each transit submode.

The nesting structures for the nested models in this group include separate nests for auto, transit, and nonmotorized modes.

Table 4.8 presents the coefficients of the variables in the nine models described in Table 4.7. Note that six models use a generic out-of-vehicle time variable while the others have separate components for some types of out-of-vehicle time. All of these coefficients are "generic," meaning they do not differ by modal alternative although some of the variables do not pertain to all modes (for example, wait time is not included in the utilities for auto modes). Table 4.9 presents some of the relationships between pairs of coefficients for these models.

There are some notable similarities among the parameters shown in Table 4.8 and the relationships shown in Table 4.9. The in-vehicle time coefficients range from –0.019 to –0.044, indicating similar sensitivity to travel time. It should be noted that the FTA guidance for New Starts forecasts indicates that compelling evidence is needed if the in-vehicle time coefficient does not fall between –0.020 and –0.030 (Federal Transit Administration, 2006), and most are close to this range. All of the models have out-of-vehicle time coefficients that are greater in absolute value than the in-vehicle time coefficients, with the ratios ranging from 1.5 to 4.7. FTA guidance for New Starts forecasts also indicates that compelling evidence is needed if the ratio does not fall between 2.0 and 3.0, and most are within this range.

Table 4.7. Characteristics of home-based work mode choice models from the MPO Documentation Database.

Model	Population Range	Nested Logit?	Include Nonmotorized?	Auto Submodes	Transit Submodes
A	< 1 million	Yes	No	DA/SR	Local/Premium
B	> 1 million	No	No	DA/SR	None
C	> 1 million	No	No	DA/SR	None
D	> 1 million	No	No	None	None
E	> 1 million	Yes	No	DA/SR	Local/Premium
F	> 1 million	Yes	No	DA/SR	Local/Premium/Rail
G	> 1 million	Yes	No	DA/SR	None
H	> 1 million	Yes	Yes	DA/SR	None
I	> 1 million	Yes	Yes	DA/SR	None

DA = drive alone, SR = shared ride.

Table 4.8. Coefficients from home-based work mode choice models in the MPO Documentation Database.

Model	In-Vehicle Time	Out-of-Vehicle Time	Walk Time	First Wait Time	Transfer Wait Time	Cost
A	–0.021		–0.054	–0.098[a]	–0.098	–0.0031
B	–0.030	–0.075				–0.0043
C	–0.036	–0.053				–0.0077
D	–0.019		–0.058	–0.081	–0.040	–0.0072
E	–0.025	–0.050				–0.0025
F	–0.044	–0.088				–0.0067
G	–0.028	–0.065				–0.0055
H	–0.033		–0.093	–0.038	–0.038	–0.0021
I	–0.025	–0.050				–0.0050[b]

The units of time variables are in minutes; cost variables are cents.

[a] Model A uses a first wait time stratified by the first 7 minutes and beyond. The coefficient shown is for the first 7 minutes; the coefficient for beyond 7 minutes is –0.023.

[b] Model I has a separate coefficient for auto parking cost, which is –0.0025; the coefficient shown is for all other auto operating and transit costs.

Table 4.9. Relationships between coefficients from home-based work mode choice models in the MPO Documentation Database.

Model	Out-of-Vehicle Time/ In-Vehicle Time	Walk/ In-Vehicle Time	First Wait/ In-Vehicle Time	Value of In-Vehicle Time
A		2.6	4.7	$4.06 per hour
B	2.5			$4.19 per hour
C	1.5			$2.81 per hour
D		3.1	4.3	$1.58 per hour
E	2.0			$6.00 per hour
F	2.0			$3.94 per hour
G	2.3			$3.05 per hour
H		2.8	1.2	$9.43 per hour
I	2.0			$3.00 per hour

The value of time is computed as the ratio of the in-vehicle time and cost coefficients, converted to dollars per hour. It represents the tradeoff in utility between in-vehicle time and cost; for example, in Model E an average traveler would be indifferent between a travel time increase of 6 minutes and a transit fare increase of 60 cents. There is some variability in the implied values of time, with model D on the low end.[8]

[8]Note that these values of time are implied to be constant for all persons making home-based work trips. This is, of course, a substantial simplification, as people value time differently. In some models where segmentation of travel by income level occurs, as discussed in Section 4.5.2, the cost coefficients, as shown in the last column of Table 4.8, may vary by income level. However, even this is a simplification, as varying income levels are not the only reasons why individuals value time differently. Further segmentation is difficult, however, since data for segmentation and estimation of different values of time are not readily available, and the time and resources required for model application increase with additional segmentation.

The guidance for choosing a model from Tables 4.7 through 4.9 is to look for a model with similar modal alternatives to those that the analyst wishes to model in the application context. For example, if nonmotorized modes are to be included, Models H and I can be considered. Other considerations include whether a nested logit model is desired or required (A, E, F, G, H, or I), perhaps the population of the area (although most of the models in the tables are for large urban areas), the variables the analyst wishes to include, the prevalence of existing transportation modes, and the analyst's assessment of the reasonableness of the parameters and relationships given his or her knowledge of the region.

Tables 4.10, 4.11, and 4.12 show the model characteristics, parameters, and relationships, respectively, for eight models from the MPO Documentation Database for home-based nonwork trips. Tables 4.13, 4.14, and 4.15 show the model characteristics, parameters, and relationships, respectively, for 11 models from the MPO Documentation Database for nonhome-based trips. The information in these tables is presented and used the same way as the information in Tables 4.7, 4.8, and 4.9 for home-based work trips. Note that most of the models are simpler than for work trips, with fewer submode alternatives and fewer nested logit models. Note that the parameters are a bit more variable for nonwork trips than for work trips, and the values of time are lower for nonwork travel, as expected.

The coefficients shown in Tables 4.8, 4.11, and 4.14 are used in the utility function for each mode (see Equation 4-1). For example, the utility for transit with auto access for Model B in Table 4.8 is given by:

$$V_{tw} = \beta_{tw0} - 0.030\,(\text{in-vehicle time}) - 0.075\,(\text{out-of-vehicle time}) - 0.0043\,(\text{cost})$$

The utilities are then used to compute the choice probabilities using Equation 4-2. The logit model utility and probability computations are performed the same way as in the vehicle availability logit model example presented in Section 4.3.4. Note that values for the alternative-specific constants (β_{n0} in Equation 4-1) are not provided in Tables 4.8, 4.11, and 4.14. These constants are not considered transferable, and their values are determined during mode choice model calibration or transfer scaling.

4.8 Automobile Occupancy

The highway assignment step, discussed in Section 4.11, requires tables of vehicle trips while the output of early model steps is in person trips. (As mentioned earlier, some models use auto vehicle trips as the unit of travel. Since such models

Table 4.10. Characteristics of home-based nonwork mode choice models from the MPO Documentation Database.

Model	Population Range	Nested Logit?	Include Nonmotorized?	Auto Submodes	Transit Submodes
A	< 1 million	No	No	None	None
D	> 1 million	No	No	None	None
E	> 1 million	Yes	No	DA/SR	Local/Premium
G	> 1 million	No	No	DA/SR	None
I	> 1 million	Yes	Yes	DA/SR	None
J	> 1 million	No	No	None	None
K	> 1 million	Yes	No	DA/SR	Local/Premium
L	< 1 million	No	Yes	DA/SR	None

DA = drive alone, SR = shared ride.

Table 4.11. Coefficients from home-based nonwork mode choice models in the MPO Documentation Database.

Model	In-Vehicle Time	Out-of Vehicle Time	Walk Time	First Wait Time	Transfer Wait Time	Cost	Auto Operating Cost	Parking Cost	Transit Cost (Fare)
A	−0.007	−0.017[a]				−0.005			
D	−0.011		−0.066	−0.061	−0.059	−0.033			
E	−0.020	−0.060				−0.003			
G	−0.010	−0.046				−0.029			
I	−0.008	−0.025					−0.010	−0.025	−0.010
J	−0.025		−0.075	−0.050[a]	−0.050		−0.170	−0.085	−0.250
K[b]	−0.022	−0.066				−0.009			
L	−0.007	−0.017[a]				−0.009			

The units of time variables are minutes, cost variables are cents.

[a] Models A, J, and L use a first wait time stratified by the first 7 minutes and beyond. The coefficient shown is for the first 7 minutes; the coefficient for beyond 7 minutes is – 0.007 for Model A, –0.025 for Model J, and –0.007 for Model L.

[b] Model K has an additional variable for "transfer penalty," which has a coefficient of –0.154. This coefficient is seven times the in-vehicle time coefficient, which implies that a transit transfer has the same effect on utility as an increase in travel time of 7 minutes.

Table 4.12. Relationships between coefficients from home-based nonwork mode choice models in the MPO Documentation Database.

Model	Out-of-Vehicle Time/ In-Vehicle Time	Walk/ In-Vehicle Time	First Wait/ In-Vehicle Time	Value of In-Vehicle Time
A	2.4			$0.48 per hour
D		6.0	5.6	$0.21 per hour
E	3.0			$3.69 per hour
G	4.6			$0.21 per hour
I	3.1			$0.48 per hour
J		3.0	2.0	$0.09 per hour
K	3.0			$1.40 per hour
L	2.4			$0.80 per hour

Table 4.13. Characteristics of nonhome-based mode choice models from the MPO Documentation Database.

Model	Population Range	Nested Logit?	Include Nonmotorized?	Auto Submodes	Transit Submodes
A	< 1 million	No	No	DA/SR	None
D	> 1 million	No	No	DA/SR	None
E	> 1 million	Yes	No	DA/SR	Local/Premium
F	> 1 million	Yes	No	DA/SR	Local/Premium/Rail
G	> 1 million	No	No	DA/SR	None
I	> 1 million	Yes	No	None	None
J	> 1 million	No	No	None	None
L	< 1 million	No	No	None	None
M	> 1 million	No	Yes	DA/SR	None
N	> 1 million	Yes	No	DA/SR	None
O	< 1 million	No	Yes	DA/SR	None

DA = drive alone, SR = shared ride.

Table 4.14. Coefficients from nonhome-based mode choice models in the MPO Documentation Database.

Model	In-Vehicle Time	Out-of-Vehicle Time	Walk Time	First Wait Time	Transfer Wait Time	Cost	Auto Operating Cost	Parking Cost	Transit Cost (Fare)
A	–0.026		–0.065	–0.065[a]	–0.065	–0.008			
D	–0.011		–0.066	–0.061	–0.059	–0.033			
E	–0.020	–0.060				–0.002			
F	–0.022	–0.044				–0.003			
G	–0.006	–0.068				–0.008			
I	–0.020	–0.050					–0.006	–0.016	–0.006
J	–0.025		–0.075	–0.050[a]	–0.050		–0.179	–0.090	–0.250
L	–0.026		–0.065	–0.065[a]	–0.065	–0.013			
M[b]	–0.013		–0.032	–0.032[a]	–0.050	–0.002			
N[b]	–0.030		–0.053	–0.083	–0.083	–0.182			
O	–0.035	–0.082				–0.011			

The units of time variables are minutes, cost variables are cents.

[a] Models A, J, L, and M use a first wait time stratified by the first 7 minutes and beyond. The coefficient shown is for the first 7 minutes; the coefficient for beyond 7 minutes is –0.026 for Model A, –0.025 for Model J, –0.026 for Model L, and –0.025 for Model M.

[b] Models M and N have an additional variable for "transfer penalty," which has a coefficient of –0.306 in Model M and –0.030 in Model N.

Table 4.15. Relationships between coefficients from nonhome-based mode choice models in MPO Documentation Database.

Model	Out-of-Vehicle Time/ In-Vehicle Time	Walk/ In-Vehicle Time	First Wait/ In-Vehicle Time	Value of In-Vehicle Time
A	2.5			$2.01 per hour
D		5.8	5.4	$0.21 per hour
E	3.0			$5.45 per hour
F	2.0			$4.04 per hour
G	11.3			$0.46 per hour
I	2.5			$2.00 per hour
J		3.0	2.0	$0.08 per hour
L	2.5			$1.20 per hour
M	2.5			$5.08 per hour
N		1.7	2.8	$0.10 per hour
O	2.3			$1.86 per hour

have no mode choice step, and the outputs of trip distribution will already be in vehicle trips, the auto occupancy step is not needed in these models.) A process to convert person trips made by auto to vehicle trips is therefore required. This conversion typically is based on a set of factors, called auto occupancy factors, which are applied to the various automobile passenger trip tables produced by the mode choice step described in Section 4.7. Because the auto occupancy factors vary considerably by trip purpose, it is recommended that the categorization of passenger trips by purpose used through the preceding steps be retained.

Sometimes mode choice models include multiple auto modes that are defined based on automobile occupancy levels (e.g., drive alone, two-person carpool, and three-or-more-person carpool). In such models, much of the conversion process from auto person trips to auto vehicle trips takes place in the mode choice model: There is one vehicle trip per drive-alone auto person trip and one vehicle trip per two-person carpool person trip (i.e., the conversion factors for these modes are 1.0 and 2.0, respectively). For three-or-more-person carpool trips, a conversion factor equivalent to the average vehicle occupancy for vehicles with three or more occupants is used. These factors, which may vary by trip purposes, are generally derived from local household survey data or transferred from comparable MPO models.

4.8.1 Model Function

Auto occupancy factors are scalar factors which are applied to the passenger automobile tables. In some cases the auto occupancy factor is adjusted based on Travel Demand Management policies, but the choice to ride in a shared-ride automobile mode is more properly a mode choice decision as presented in Section 4.7. It has already been stated that the automobile occupancy is expected to vary based on trip purpose; for example, the auto occupancy of a work trip is typically much lower than the automobile occupancy for a recreational trip. Other considerations that may affect automobile occupancy are metropolitan size and density, transit availability, automobile ownership, and income.

There is also support to suggest that automobile occupancy may vary by time of day. For example, work trips with lower auto occupancy may predominate during the peak hours. This possibility suggests that disaggregating passenger trips by time of day, which is discussed in Section 4.9, might be more appropriately done before applying auto occupancy factors. When the calculations are done in this order, the time-of-day effect on trip purpose and the associated auto occupancies by purpose will result in lower auto occupancies during peak hours.

The scalar formula for converting auto passenger trips into auto vehicle trips is:

$$Auto_{ij}^{p} = T_{ijauto}^{p} * AOC^{p} \quad (4\text{-}13)$$

where:

Auto_{ij}^{p} = Auto vehicle trips between zone i and zone j for purpose p;

$\text{T}_{ij\text{auto}}^{p}$ = Auto person trips between zone i and zone j for purpose p; and

AOC^p = Auto occupancy factor (persons, including driver, per auto) for purpose *p*.

Typical values for the auto occupancy factors are presented in Section 4.8.4.

4.8.2 Best Practices

If the model will be used to analyze changes in auto occupancy levels due to changes in transportation level of service, policy changes, or specific implementations designed to affect carpooling (such as HOV lanes), then it is necessary to include in the mode choice model separate modal alternatives related to auto occupancy levels (i.e., drive alone, shared ride with two occupants, etc.) with level-of-service variables that are specific to the various alternatives.

If the model is not to be used for these types of analyses, and person trips are the unit of travel, then using auto occupancy factors by trip purpose to convert auto vehicle trips to auto person trips using Equation 4-13 may be considered best practice.

4.8.3 Basis for Data Development

When sufficient local data are available, best practice for obtaining automobile occupancy rates is to estimate them by trip purpose from household activity/travel survey data. This type of data source would also be used in estimating the parameters of mode choice models related to the choice between auto modes defined by occupancy level.

To provide information for areas without local data, the 2009 NHTS data set was used to develop vehicle occupancy factors by trip purpose and urban area population shown in Table 4.16.

4.8.4 Model Parameters

Table 4.16 shows the average daily vehicle occupancy levels by trip purpose from the 2009 NHTS. These factors are presented for average weekday, morning peak period (7:00 to 9:00 a.m.), and afternoon peak period (3:00 to 6:00 p.m.) trips. Because there is no clear correlation between urban area population and vehicle occupancy, rates are not presented by urban area population range. This finding is consistent with the information presented in *NCHRP Reports 365* and *187* (Martin and McGuckin, 1998; Sosslau et al., 1978).

Table 4.16 presents occupancy rates for three groups: all auto trips, carpools with two or more persons, and carpools with three or more persons. If a mode choice model has three auto modes—drive alone, two-person carpool, and three-or-more-person carpool—then the rates for carpools with three or more persons can be applied to the three-or-more-person carpool person trips from the mode choice model to obtain vehicle trips. If a mode choice model has two auto modes—drive alone and two-person carpool—then the rates for carpools with two or more persons can be applied to the two-or-more-person carpool person trips from the mode choice model to obtain vehicle trips.

Example

Consider an urban area where the outputs of the mode choice model with the classic three trip purposes include morning peak period person trip tables for the drive-alone, two-person

Table 4.16. Average daily vehicle occupancy by trip purpose by time period.

	Trip Purpose					
Vehicle Occupancy—Time Period	**Home-Based Work**	**Home-Based Nonwork**	**Home-Based School**	**Home-Based Other (Excluding School)**	**Nonhome Based**	**All Trips**
All Auto Modes—daily	1.10	1.72	1.14	1.75	1.66	1.55
Carpool 2 Plus Only—daily	2.42	2.71	2.35	2.71	2.75	2.72
Carpool 3 Plus Only—daily	3.60	3.81	3.46	3.81	3.79	3.80
All Auto Modes—a.m. peak	1.09	1.66	[a]	[a]	1.43	1.34
Carpool 2 Plus Only—a.m. peak	2.36	2.65	[a]	[a]	2.65	2.61
Carpool 3 Plus Only—a.m. peak	3.42	3.57	[a]	[a]	3.68	3.64
All Auto Modes—p.m. peak	1.11	1.66	[a]	[a]	1.65	1.50
Carpool 2 Plus Only—p.m. peak	2.45	2.62	[a]	[a]	2.72	2.65
Carpool 3 Plus Only—p.m. peak	3.63	3.66	[a]	[a]	3.75	3.70

[a] Use daily parameters; NHTS data insufficient to estimate.

Source: 2009 NHTS.

carpool, and three-or-more-person carpool modes. Say that one origin-destination zone pair has the following values in these trip tables:

- Home-based work: Drive alone—50, two-person carpool—10, three-or-more-person carpool—2
- Home-based nonwork: Drive alone—40, two-person carpool—50, three-or-more-person carpool—20
- Nonhome based: Drive alone—30, two-person carpool—30, three-or-more-person carpool—10

The person trips for the morning peak period can be converted to vehicle trips using the values in Table 4.16:

- Home-based work: Vehicle trips = 50/(1) + 10/(2) + 2/(3.42) = 55.58.
- Home-based nonwork: Vehicle trips = 40/(1) +50/(2) + 20/(3.57) = 70.60.
- Nonhome based: Vehicle trips = 30/(1) + 30/(2) + 10/(3.68) = 47.72.

This zone pair would have a total of 55.58 + 70.60 + 47.72 = 173.90 vehicle trips.

4.9 Time of Day

It is desirable for many reasons to estimate travel by time of day, including the need for temporally varying model outputs (for example, speeds by time of day for air quality conformity analysis) and to enhance model accuracy (levels of congestion and transit service may vary significantly between peak and off-peak periods). To do this, daily travel measures are converted to measures by time of day at some point in the modeling process using a discrete number of time periods. Typically, a four-step model with time-of-day modeling uses three to five periods (for example, morning peak, mid-day, afternoon peak, night).

In urban areas that experience significant congestion, it has become standard modeling practice to perform highway assignment separately for different time periods while smaller urban areas often continue to use daily assignment procedures. The MPO Documentation Database indicates the following percentages of MPOs using time period rather than daily highway assignment:

- MPO population greater than 1 million: 88 percent;
- MPO population between 500,000 and 1 million: 64 percent;
- MPO population between 200,000 and 500,000: 45 percent; and
- MPO population between 50,000 and 200,000: 30 percent.

4.9.1 Model Function

It is typical for models to start by estimating daily travel in the trip generation step. In a four-step model, the trip generation model is typically applied to estimate average weekday trips.

It is important to consider how to determine the period in which a trip occurs, especially if it begins in one period and ends in another. Trips can be assigned to a time period based on:

- The departure time;
- The arrival time; and
- The temporal midpoint of the trip.

In an aggregately applied model such as a four-step model, the midpoint would be the most logical way to define a trip's time period, since the majority of the trip would occur during that period. Some models use the concepts of "trips in motion," essentially splitting trips into components to determine percentages of travel by time period. The specific definition usually makes little difference in aggregately applied models in the percentages of trips occurring in each period, but the definition must be known in order to estimate and validate the model.

The most common method of time-of-day modeling in four-step models is simple factoring. At some point in the modeling process, fixed factors specific to trip purpose and direction are applied to daily trips to obtain trips for each time period. (Sometimes, this factoring is done in two steps, with daily trips split into peak and off-peak trips, and later the peak trips split into morning peak and afternoon peak, and perhaps off-peak trips split into additional periods.) While this method is relatively easy to implement and to apply, it is not sensitive to varying transportation levels of service, limiting its usefulness in analyzing policy changes or congestion management activities.

The ways in which fixed time-of-day factors may be applied within the four-step process are as follows (Cambridge Systematics, Inc., 1997a):

- In **pre-distribution** applications, the daily trips are factored between the trip generation and trip distribution steps of the modeling process. The data required include factors representing the percentage of trips by purpose during each hour and for each direction, production-to-attraction or attraction-to-production as well as directional split factors. It should be noted, however, that the directional split factors cannot be applied until after both ends of trips have been determined (i.e., after trip distribution). An advantage of this method is that differences in travel characteristics by time of day can be considered in both trip distribution and mode choice. In models with feedback loops, this method can provide a "clean" way to feed back travel times from one iteration to the next; trip distribution, mode choice, and trip assignment can be run separately for each time period, since the factors are applied prior to these steps.

- In **post-distribution** applications, the factors are applied between the trip distribution and mode choice steps. The data required for this approach to splitting includes factors representing the percentage of trips by purpose during each period and for each direction, production-to-attraction or attraction-to-production. This process also provides an opportunity to consider that some trips are in the attraction-to-production direction and to use skims that reflect correct directionality. However, the modeler should decide whether the additional complexity introduced by doing so is worthwhile.
- In **post-mode choice** applications, the factors are applied to daily trips between mode choice and the assignment steps. The data required include factors representing the percentage of the trips by purpose and mode during each time period and for each direction, production-to-attraction or attraction-to-production. An issue with this approach is that transit path-building procedures may not be consistent between mode choice and transit assignment, since mode choice would be done on a daily basis while transit assignment would be done by time period.
- In **post-assignment** applications, the factors are applied to loaded trips after the assignment step is complete. The data required include factors that represent the percentage of daily traffic or transit ridership for each time period on a link and can also include directional split factors depending on how the link-level factor is represented. The main limitation of this type of procedure is that equilibrium highway assignment on a daily basis is much less meaningful than assignment for shorter, more homogeneous periods. Also, changes in land use that could affect temporal distribution of traffic are not considered when using fixed link-based factors.

4.9.2 Best Practices

While activity-based models are beginning to consider the time of day at which trips will occur based on the sequence of travel activities from a household, in four-step models the usual practice is to allocate the daily trips that are calculated from trip distribution and mode choice to time period during the day based on a fixed set of factors. These factors typically are developed from the temporal patterns of trips reported in household surveys or, for auto or transit passenger trip tables, from reported demand, such as vehicle counts for autos or ridership for transit, by time period. The typical application is:

$$T^p_{ijmTOD} = T^p_{ijm} * F^p_{mTOD} \quad (4\text{-}14)$$

where:

$T^p_{ijm\text{TOD}}$ = Trips between zone *i* and zone *j* by mode *m* for purpose *p* during the period TOD;
T^p_{ijm} = Daily trips between zone *i* and zone *j* by mode *m* for purpose *p*; and
$F^p_{m\text{TOD}}$ = Percentage of daily trips by mode *m* for purpose *p* that occur during period TOD.

While there is no consensus on the best point in the modeling process where daily trips should be converted to peak and off-peak period trips, based on the points in the previous discussion, many analysts prefer to perform the conversion prior to mode choice (in models that include a mode choice step). This could mean applying factors after trip generation (to productions and attractions) or after trip distribution (to person trip tables in production-attraction format). If peak hour trips are desired, a two-step process may be used, where factors to convert peak period to peak hour trips are applied to the peak period trips.

Nevertheless, the information in the MPO Documentation Database indicates that the majority of MPOs currently apply time-of-day factors after mode choice, due to the method's simplicity. However, using different sets of parameters for auto and transit travel may lead to inconsistencies between the transit path-building for mode choice and transit assignment. For example, say there is a corridor whose only available transit service is express bus that operates only during peak periods. The mode choice model, applied to daily trips, would estimate some transit trips for the corridor based on the presence of the express bus service. If, say, a fixed set of factors converting daily trips to trips by time period is used, the application of the factors will result in some off-peak trips in the corridor, which the transit assignment process will be unable to assign since there is no off-peak transit service. This problem would occur even if there were separate time-of-day factors for auto and transit trips.

The definition of the time periods used should depend on the analysis needs of the region, characteristics of congestion, and differences in transportation service (for example, frequency of transit service). In larger, more congested urban areas, travel conditions typically vary significantly between peak and off-peak periods, and so treating them separately would produce more accurate results. If the situations in the morning and afternoon peak periods, or between mid-day and night off-peak periods, are substantially different, then it would be preferable to separate those periods in the model.

It is important to recognize, however, the more periods, the greater the cost in terms of model estimation, validation, programming, and run time; therefore, there are good reasons to limit the number of periods used. The most common number of time periods in models that perform assignments by time of day is four, with morning peak, mid-day, afternoon peak, and night periods. Models that separate the night period into evening and overnight (with the dividing point reflecting the time when transit service ceases or is greatly reduced), and models that combine the mid-day and night periods into a single off-peak period, are also used.

The lengths of the peak periods depend on the extent of congestion in the region. Household survey data can be examined to determine the extent of the peak periods. In areas where such survey data are unavailable, traffic count data can be used.

4.9.3 Basis for Data Development

The basic data required for estimating time-of-day models of any type are household survey data, specifically the reported beginning and ending times of activities, tours, or trips. The survey data are processed for the specific type of model being estimated (fixed factor, logit, etc.) and are used separately by trip/tour purpose. These survey data (in expanded form) are also valuable for time-of-day model validation, although, as is the case anytime when the estimation data set is used for validation, the data must be used with caution.

For areas without local household survey data, factors from other sources, such as the NHTS, may be transferred. However, as discussed below, time-of-day distributions vary significantly among urban areas, and so significant model validation is required when using transferred time-of-day data.

Time-of-day distributions for truck and freight travel usually differ from those for passenger travel and can vary among urban areas. The best sources of data for these distributions are local vehicle classification counts by time of day.

4.9.4 Model Parameters

This section presents the time-of-day distributions by hour for each trip purpose, by direction for home-based trips derived from 2009 NHTS data for weekdays. Table C.11 in Appendix C shows these time-of-day distributions—for all modes[9] and individually for auto, transit, and nonmotorized modes—for use in areas where time-of-day factors are applied after mode choice. There does not seem to be a relationship between time of day and urban area population, and so the results are not stratified by population range.

The numbers shown in Table C.11 can be used to develop factors by trip purpose for any time periods defined as beginning and ending on the hour. However, while the factors are fairly consistent across urban area size categories, there can be considerable variation between different urban areas. Peaking conditions can vary greatly based on many factors. The type of economic activity that predominates in an area can affect peaking—for example, an area with large manufacturing plants might have peaks defined mainly by shift change times while an area with a large tourism industry may see later peaks. Another factor has to do with regional geography and dispersion of residential and commercial activities. Areas where commuters may travel long distances may see earlier starts and later ends to peak periods. Levels of congestion can also affect peaking, as peak spreading may cause travel to increase in "shoulder periods."

The last two rows of each section of Table C.11 show the combined factors for a typical morning peak period (7:00 to 9:00 a.m.) and a typical afternoon peak period (3:00 to 6:00 p.m.). If factors for a period defined differently are desired, then the appropriate rows from Table C.11 can be summed. For example, if factors for all modes for an afternoon peak period defined from 4:00 p.m. to 6:00 p.m. for the classic three trip purposes are desired, the factors for the rows labeled with hours ending at 5:00 and 6:00 p.m. in the all modes section of the table are added together. This would result in the following factors:

- Home-based work: From home—1.5 percent, To home—19.5 percent.
- Home-based nonwork: From home—6.9 percent, To home—9.5 percent.
- Nonhome based: 15.5 percent.

The factors are applied to daily trips by purpose, as illustrated by the following example. Say that afternoon peak period auto vehicle trips are desired for a period defined as 3:00 to 6:00 p.m. The factors from the auto modes section of Table C.11 are:

- Home-based work: From home—2.6 percent, To home—25.7 percent.
- Home-based nonwork: From home—9.5 percent, To home—15.3 percent.
- Nonhome based: 25.0 percent.

These factors are applied to the daily auto vehicle trip table. Say that the daily home-based work production-attraction

[9]Distributions by mode are presented for models where time-of-day factors are applied after mode choice. However, it should be noted that the NHTS sample sizes for transit and nonmotorized trips are much lower than those for auto trips, and so the transit and nonmotorized factors have more error associated with them, and the trips in the sample are concentrated in larger urban areas.

trip table has 100 trips from zone 1 to zone 2 and 50 trips from zone 2 to zone 1. Applying these factors results in the following origin-destination trips (recall that the home end is the production end for home-based trips):

- 2.6 home to work trips from zone 1 to zone 2.
- 25.7 work to home trips from zone 2 to zone 1.
- 1.3 home to work trips from zone 2 to zone 1.
- 12.9 work to home trips from zone 1 to zone 2.

This means that there are 15.5 home-based work trips traveling from zone 1 to zone 2 and 27.0 home-based work trips traveling from zone 2 to zone 1 in the afternoon peak period. As expected for the afternoon peak, most of these trips are returning home from work. This process would be repeated for the other two trip purposes. Since nonhome-based trips are already on an origin-destination basis, only a single factor is applied to this trip table.

As noted previously, the information provided in Table C.11 represents average national factors from the NHTS, but peaking can vary greatly from one area to another, regardless of urban area size. To illustrate this point, Table 4.17 shows the percentage of daily travel by purpose occurring during two periods—7:00 to 9:00 a.m. and 3:00 to 6:00 p.m.—for nine urban areas with populations of approximately 1 million according to the 2000 U.S. Census. While the averages presented in this table, based on data from the 2001 NHTS, have associated statistical error ranges not presented here, it is clear that the percentages for some areas differ significantly from those for other areas. For example, the reported percentage of daily home-based work travel between 3:00 and 6:00 p.m. was nearly twice as high in Providence as in Memphis. This variation indicates that when default parameters such as those in Table C.11 are used in lieu of local data, calibration may be required to obtain model results that are consistent with local conditions.

4.10 Freight/Truck Modeling

Truck models and **freight models** are different, although the terms are often used interchangeably. Freight models are multimodal and consider freight activities based, generally, on commodity flows. Truck models consider trucks regardless of whether they serve freight. Although most urban area freight is carried in trucks, it is also true that truck travel serves purposes other than just carrying freight. Trucks carrying commodities are referred to as "freight trucks"; nonfreight trucks are also referred to as service trucks. This section discusses freight and truck modeling functions, practices, and parameters and points the reader to appropriate resources for additional information.

4.10.1 Model Function

Freight and truck models enhance the overall travel demand forecasting framework and support additional decision making and alternatives evaluation. Modeling of freight/truck traffic can be important for a variety of reasons. One reason is that it typically makes a disproportionately high contribution to mobile source emission inventories in urban areas, especially for nitrogen oxide and fine particulate matter. Another reason is that in many areas and Interstate highway corridors, truck traffic is a significant component of travel demand, and the magnitude of truck traffic influences the available road capacity for passenger car movements. A third reason is that many regions have placed increased emphasis on goods

Table 4.17. Time-of-day percentages for urban areas of approximately 1 million in population.

	Home-Based Work		Home-Based Nonwork		Nonhome Based		All Trips	
Urban Area	**7–9 a.m.**	**3–6 p.m.**	**7–9 a.m.**	**3–6 p.m.**	**7–9 a.m.**	**3–6 p.m.**	**7–9 a.m.**	**3–6 p.m.**
Austin	32.3%	20.8%	12.5%	23.8%	6.9%	24.6%	13.6%	23.7%
Buffalo	23.7%	26.7%	9.3%	23.6%	5.9%	23.6%	9.7%	23.8%
Greensboro	30.3%	24.0%	12.2%	25.6%	8.1%	26.7%	12.7%	25.8%
Jacksonville	29.6%	24.7%	10.4%	24.4%	9.1%	27.1%	11.6%	25.3%
Hartford	26.0%	29.5%	9.2%	25.3%	7.2%	20.5%	10.4%	24.3%
Memphis	35.0%	18.2%	13.6%	25.6%	6.9%	27.2%	13.5%	25.4%
Nashville	32.7%	23.8%	10.1%	24.9%	7.5%	24.7%	10.4%	24.7%
Providence	28.9%	33.7%	11.8%	24.9%	7.9%	16.3%	11.8%	22.4%
Raleigh	32.4%	26.3%	12.0%	26.5%	8.0%	19.1%	12.2%	24.0%
Average	**30.1%**	**25.3%**	**11.2%**	**25.0%**	**7.5%**	**23.3%**	**11.8%**	**24.4%**

Source: 2001 NHTS.

movement and the role of the transportation system in facilitating economic activity. Having freight or truck models can help enable the evaluation of alternative strategies influencing freight or truck levels.

NCFRP Report 8: Freight-Demand Modeling to Support Public-Sector Decision Making (Cambridge Systematics, Inc. and Geostats, LLP, 2010) includes a discussion on classifying freight models and provides an overall forecasting framework, which includes nonfreight/service trucks. Adapted from this presentation, the basic freight/truck model types are as follows:

- **Trend analysis**—Trend analysis directly forecasts freight activity using, at most, historical or economic trends. It does not provide a trip table that could be used in travel demand models but can be used to calculate the background truck traffic on highway links which automobiles must consider. When used in this way, truck traffic cannot be rerouted in response to congestion.
- **Commodity forecasting**
  - **Synthetic modeling of commodity flows**—This model type develops modal commodity flow origin-destination tables using commodity generation, distribution, and mode choice models and then uses payload and temporal factors (1) to convert those commodity tables to a suitable format for assignment to modal networks and (2) to evaluate the flows on those networks.
  - **Direct acquisitions of commodity flows**—This model type directly acquires a commodity flow table instead of following the synthetic process. If the acquired table includes modal flows that are directly used, use of these mode-specific tables may replace mode choice, otherwise a mode choice model is required. After the modal commodity table is obtained, payload and temporal factors are used to convert those commodity trip tables to a suitable format for assignment to modal networks and then to evaluate the flows on those networks as is done in the synthetic model.
- **Nonfreight trucks—synthetic modeling**—Generation of information for nonfreight trucks is necessary to determine correct multiclass highway performance for freight trucks. If not, freight performance will not consider the interaction with what may be a majority of trucks on the road. The creation of nonfreight trip tables will often follow the traditional trip generation and trip distribution steps. It will not include a mode choice step because by definition only one mode, that of trucks, is being considered, and these truck trips would be generated and distributed in vehicle equivalents.
- **All trucks—synthetic modeling**—Synthetic modeling as described for nonfreight trucks can also be used to produce estimates of all trucks. If it is, the performance of freight trucks cannot be separated from the performance of all trucks. However, it is also possible to employ a hybrid approach where freight models are developed for some segments of truck travel (e.g., for trucks with an external trip end).

With the commodity forecasting methods in particular, freight demand forecasting can be thought of as a series of steps similar to those described in previous sections for passenger modeling, in which a trip table of transportation demand is created and then assigned to a modal network. Thus, freight generation is similar to the steps described in Section 4.4 for passenger trip generation; freight distribution is similar to the steps described in Section 4.5; freight mode choice is similar to the steps described in Section 4.7 for passenger mode choice; and the estimation of freight vehicles from tons and the temporal distribution is similar to the time-of-day process described in Section 4.9.

4.10.2 Best Practices

At the time of a national survey of practice conducted in 2005 (Committee for Determination of the State of the Practice in Metropolitan Area Travel Forecasting, 2007), truck trips were modeled in some fashion by about half of small and medium MPOs and almost 80 percent of large MPOs, although few MPOs reported the ability to model all freight movement. However, as freight and nonfreight truck movement volumes have increased and communities have become more concerned with infrastructure needs and investments, more interest in including freight or truck treatment in models has developed.

Two standard sources that comprehensively discuss methods for developing freight and truck models are the original Quick Response Freight Manual (QRFM 1) (Cambridge Systematics, Inc. et al., 1996) and its update, Quick Response Freight Manual II (QRFM 2) (Cambridge Systematics, 2007b), both prepared for FHWA. The interested reader can refer to these manuals to obtain more information about freight and truck modeling. The manuals discuss growth factor methods, incorporating freight into four-step travel forecasting, commodity models, hybrid approaches, and economic activity models. Several case studies are included as well.

NCHRP Synthesis of Highway Practice 384: Forecasting Metropolitan Commercial and Freight Travel (Kuzmyak, 2008) identifies methods of freight and commercial vehicle forecasting currently used in professional practice, with a primary focus on MPO forecasting, although some consideration is given to statewide freight models. The report finds that metropolitan freight and commercial vehicle forecasting is performed primarily through the use of traditional four-step models but acknowledges inherent limitations for this purpose and notes the desirability to collect data from shippers or carriers that are reluctant to divulge confidential business information. Four case studies are presented along with nine profiles of MPO freight modeling practice, covering Atlanta, Baltimore, Chicago, Detroit, Los Angeles, New York, Philadelphia, Phoenix, and Portland (Oregon).

Since the publication of the QRFM 2, the FHWA has also released the Freight Analysis Framework, Version 3 (FAF3), which includes several data products. The 2007 U.S. Commodity Flow Survey forms the core data for the FAF3, but several additional data sources were employed in developing the products. Among the data products are origin-destination-commodity-mode flow matrices and GIS link files that contain FAF3 estimates of commodity movements by truck and the volume of long-distance trucks over specific highways (Oak Ridge National Laboratory, 2010).

The GIS link files were developed through the use of models to disaggregate interregional flows from the Commodity Origin-Destination Database into flows among localities and assign the detailed flows to individual highways. These models are based on geographic distributions of economic activity rather than a detailed understanding of local conditions. The developers of the FAF3 data caution that while FAF provides reasonable estimates for national and multistate corridor analyses, FAF estimates are not a substitute for local data to support local planning and project development (Oak Ridge National Laboratory, 2011).

4.10.3 Basis for Data Development

A variety of data sources can inform freight/truck model development, including:

- Socioeconomic, demographic, and employment data from public or commercial data sources;
- Locally sourced and FHWA HPMS vehicle classification counts, separating trucks by type;
- Commercial vehicle travel surveys, bearing in mind that such surveys are generally difficult to conduct and that response rates can prove particularly challenging;
- FAF3 data products, understanding that care must be taken to understand the associated limitations and error potential; and
- Commodity flow surveys, public or commercial.

This list of potential data sources is not exhaustive, and not all sources are required for every application. (Note that the first two items refer to information that is also used for passenger travel demand modeling and is likely available to MPO modelers in some form.) The interested reader may refer to the QRFM 2 or *NCHRP Synthesis 384,* which provide more detailed discussion about freight and truck model data sources and uses.

4.10.4 Model Parameters

Freight models typically include many of the same steps as do passenger models. The difference is in the travel purposes considered and the decision variables used. Also, in freight models, cargo must be converted into modal vehicles, and these vehicles, primarily trucks, are modeled directly.

The following discussion describes steps in the freight/truck modeling process: (1) freight trip generation, (2) freight trip distribution, (3) freight mode choice, (4) application of payload and temporal factors, and (5) creation of vehicle trip tables. These steps cover the freight/truck demand modeling process prior to vehicle assignment. Steps 1 through 4 pertain to commodity-based freight modeling only, while Step 5 pertains to both freight and truck modeling. In fact, in some cases, Step 5, creation of vehicle trip tables, comprises the entire truck modeling process prior to highway assignment. All steps are summarized herein to give the reader a broad overview to potential methods.

Step 1—Freight Trip Generation: Productions and Attractions by Commodity in Tons

This step estimates cargo freight productions and attractions. To be consistent with the modeling of passenger travel, these productions and attractions are estimated for an average weekday (if a source is used that presents information for another temporal level, such as annual, a conversion is needed). The volumes of commodity flows that begin in a zone (called "productions") and end in a zone (called "attractions") must be determined for each zone. If freight mode choice is included, the freight flows must be expressed in units that are common to all modes. In the United States, tons are commonly used although other multimodal units, such as value, can be used. As described for passenger trips in Section 4.4, the productions and attractions of freight are calculated by applying trip rates to explanatory variables. Commodity cargo trips are one-way trips, not round-trips, and so the production rates and explanatory variables are different than those used for attractions. The production and attraction rates vary by commodity type, which is analogous to trip purpose in passenger models. The explanatory variables are typically measures of the activity in economic sectors, such as employment, which produce or consume (attract) freight cargo.

Public agencies generally develop equations for their own study area from a commodity flow survey of their area. For an FHWA project (not yet published as of this writing), some general linear equations have been developed to disaggregate FAF data from regions to counties. A sample of coefficients for these equations is shown in Table 4.18. In this table, the variables represent employment by type, except for farm acres (in thousands). For example, the equation for the "other agricultural products" commodity type is:

$$Tons\ produced = 0.188 * food\ manufacturing\ employment + 0.051 * farm\ acres(in\ thousands)$$

Average equations should be used with caution, since the economies of each state and region are so different that equations developed for average economic conditions cannot be expected to apply in all cases.

Step 2—Freight Trip Distribution: Trip Table Origins and Destinations

This step estimates freight trips between origins and destinations. As is the case for passenger trip distribution, described earlier in Section 4.5, the most common means to distribute freight trips between zones is through the use of a gravity model. For freight models, the impedance variable in the gravity model for the large geographies considered by freight is most often distance. In the most common freight distribution models, an exponential function is used (see the discussion of friction factors in Section 4.5.1) to compute the friction factors, where the parameter is the inverse of the mean value of the impedance.

By examining commodity flow survey data, it is possible to determine those parameters, such as the average trip length by commodity, that are used to vary the accessibility in response to changes in the impedance variable. Using locally derived

Table 4.18. Tonnage production equations for selected commodities (*2002 Kilotons*).

Commodities (SCTG[a])	NAICS	Variables	Coefficient	T-Stat	R^2
Cereal Grains (2)	311	Food Manufacturing	0.407	5.11	0.48
		Farm Acres (in thousands)	0.441	4.20	
Other Agriculture Products (3)	311	Food Manufacturing	0.188	10.43	0.65
		Farm Acres (in thousands)	0.051	2.14	
Meat/Seafood (5)	311	Food Manufacturing	0.053	25.94	0.86
Milled Grain Products (6)	311	Food Manufacturing	0.053	13.64	0.62
Logs (25)	113	Forestry and Logging	0.323	4.02	0.70
	115	Support Activities for Agriculture and Forestry	0.843	3.91	
	321	Wood Product Manufacturing	0.465	6.48	
Wood Products (26)	321	Wood Product Manufacturing	0.625	18.37	0.75
Newsprint/Paper (27)	113	Forestry and Logging	0.887	13.59	0.73
	323	Printing and Related Activities	0.086	7.38	
Paper Articles (28)	322	Paper Manufacturing	0.101	10.76	0.81
	323	Printing and Related Activities	0.038	4.82	
Base Metals (32)	331	Primary Metal Manufacturing	0.424	8.69	0.75
	333	Machinery Manufacturing	0.085	3.24	
Articles of Base Metals (33)	332	Fabricated Metal Product Manufacturing	0.115	14.51	0.65
Machinery (34)	332	Fabricated Metal Product Manufacturing	0.085	2.92	0.63
	333	Machinery Manufacturing	0.081	2.01	
Electronic and Electrical (35)	333	Machinery Manufacturing	0.02	3.00	
	334	Computer and Electronic Product Manufacturing	0.012	4.35	0.70
	335	Electrical Equipment, Appliance, and Component Manufacturing	0.029	2.44	

[a]Standard Classification of Transported Goods

Source: Federal Highway Administration (2009a).

Table 4.19. Average trip lengths by commodity group.

Commodity Group		Average Trip Length (Miles)
Code	Name	
1	Agriculture	845.30
2	Mining	593.58
3	Coal	946.86
4	Nonmetallic Minerals	141.13
5	Food	826.70
6	Consumer Manufacturing	1,071.04
7	Nondurable Manufacturing	1,020.29
8	Lumber	548.44
9	Durable Manufacturing	980.87
10	Paper	845.99
11	Chemicals	666.41
12	Petroleum	510.47
13	Clay, Concrete, Glass	359.77
14	Primary Metal	945.74
15	Secondary and Miscellaneous Mixed	586.47

Source: Alliance Transportation Group, Inc. and Cambridge Systematics, Inc. (2010).

data is encouraged, as economic conditions and geographic locations of model regions vary to such an extent that the average trip lengths for one model may not be applicable for another region. Table 4.19 presents average trip lengths from a statewide model for Texas.

Step 3—Freight Mode Choice: Trip Table Origins and Destinations by Mode

This step estimates cargo freight between origins and destinations by mode. As was discussed in Section 4.7 for passenger trips, the choice of mode used by freight is a complicated process. For freight, the choice will be based on many considerations, including characteristics of the mode, characteristics of the goods, and characteristics of the production and attraction zones. Typically, insufficient detail exists to properly model this choice, because either the format and parameters of the choice equations or the data on the characteristics are not known for the base or forecast year. Frequently, the future choice of mode is assumed to be the same as the existing choice of mode.

Table 4.20 shows tonnages and mode shares for freight in California from the FAF2. This information can be obtained from the FAF for any state.

Table 4.20. FAF freight shipments from California shipments by weight, 2002 and 2035 (millions of tons).

	2002 From State		2035 From State	
Mode	Number	Percentage	Number	Percentage
Truck	92.8	73	366.0	77
Rail	11.7	9	35.4	7
Water	1.2	1	2.2	< 1
Air and Truck	0.4	< 1	2.6	< 1
Truck and Rail	4.0	3	14.3	3
Other Intermodal	5.0	4	29.5	6
Pipeline and Unknown	12.4	10	26.7	6
Total	**127.4**	**100**	**476.9**	**100**

Source: http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/state_info/faf2/ca.htm.

Step 4—Freight Payload and Temporal Factors: Trip Table Origins and Destinations by Mode by Vehicle

This step converts the estimates of cargo freight flow by mode in tons per year into vehicle flows. For the purposes of this report, the vehicle flows of concern are freight trucks. The conversion of truck tons into truck vehicles is similar to the auto occupancy step described for passenger travel in Section 4.8. The tons in the commodity origin-destination tables are divided by the payload factor for the commodity type. The payload factors, in tons per truck, must match the behavioral commodity classification system used by the model. These payload factors should always vary by commodity. They may also vary by distance traveled. These factors may also consider the empty mileage, the class of the vehicles, etc.

A conversion is also necessary to correct the time period from annual to daily. If the average weekday in the forecasting model should be for midweek truck flows, it may be appropriate to divide annual flows by 295 days, which reflects observations of midweek truck traffic at continuous counting stations compared to annual truck counts at those same locations. To adjust the daily flows to hourly flows *NCFRP Report 8* recommends that the hourly flows for trucks should be considered to be 6 percent of daily flow for each of the hours from 11:00 a.m. to 7:00 p.m.

Table 4.21 shows payload factors used by Tennessee in freight forecasting.

Step 5—Create Vehicle Origin-Destination Tables

The transportation of freight is not the only reason for truck travel. Nonfreight trucks, which provide services, move construction materials and equipment, and are used in maintenance activities as well as the local movement of goods, are not included in the commodity flow table methodology. Freight trucks may constitute the majority of trucks on the road on rural principal highways, but in urban areas, nonfreight trucks can represent from 50 to 70 percent of the trucks on major highways, according to calculations from FAF highway assignments. In addition, the scale of the distances traveled by freight and nonfreight trucks is much different. Freight truck trips tend to average distances of hundreds of miles, much longer than the tens of miles typically traveled on individual trips by service trucks.

The differences in impact level and travel behavior of freight versus nonfreight trucks have a major bearing on the types of truck trips that are included in travel demand models. Freight may move over national distances, and the model area used in forecasting freight flows may not be the same as the model area needed to address nonfreight trucks, which have primarily a local area of operation. Thus, MPO models may primarily include nonfreight trucks and only include freight trucks as external trips. State or multistate models, which have zone systems and networks that cover larger areas, are more likely to need to include freight truck trips with two internal trip ends.

Models typically calculate trip tables for nonfreight trucks separately from freight trucks. Sometimes these are distinguished as heavy trucks and medium trucks. The forecasts of nonfreight trucks will most often be through a synthetic process of trip generation and trip distribution, similar to the steps for freight described in Steps 1 and 2 above. Although the trip generation rates and the trip distribution factors should be developed through the use of commercial vehicle surveys, the next three subsections discuss sample parameters for total truck trip generation, nonfreight truck trip generation, and truck trip distribu-

Table 4.21. Freight model truck payload after adjustment.

Commodity	Pounds per Truck	Tons per Truck
Agriculture	48,500	24
Chemicals	48,500	24
Construction and mining	50,500	25
Food and kindred products	48,500	24
Household goods and other manufactures	38,500	19
Machinery	36,500	18
Mixed miscellaneous shipments, warehouse and rail intermodal drayage, secondary traffic	36,500	18
Paper products	46,500	23
Primary metal	51,500	26
Timber and lumber	53,000	27

Source: PBS&J (2005).

tion. However, the interested reader is encouraged to consult *NCHRP Synthesis 384* for a broader array of sample parameters.

As noted in the introduction to this section, the freight commodity flow framework is but one method used by modelers to address truck trip making in models. Where the concerns are concentrated on representing truck flows within an area largely to support more accurate passenger car assignment or where truck survey data are not available, areas often use simplified approaches. Several areas use vehicle classification counts, specifically truck counts by truck type, to calibrate input origin-destination trip tables of regional truck models using an Origin-Destination Matrix Estimation (ODME) process. The ODME process iteratively updates the input origin-destination trip table of the model so that model truck volume results match with observed truck counts. A base year ODME matrix can be factored to place future-year truck demand on the network as well. The user of such methods should take care to recognize the limitations inherent in both ODME and growth factor techniques.

Total truck trip rates. Table 4.22 presents truck daily vehicle trip generation rates from two sources: a survey done by Northwest Research Group (NWRG) for southern California and the Puget Sound Regional Council (PSRC) truck model. These rates are linear equations where the dependent variables are the number of truck vehicle trip ends and the independent variables are the number of households and employment by type. They can be applied at the zone level to estimate the total number of truck trip ends per zone.

Note that the two sources have different definitions of trucks for which rates are provided. NWRG defines rates for trucks of 14,000–28,000 pounds while PSRC defines rates for single-unit trucks of two to four axles, six or more tires, and 16,000–52,000 pounds. Both of these definitions exclude smaller trucks and commercial vehicles that may not be included directly in passenger travel models.

Nonfreight truck trip rates. An example of daily trip rates for nonfreight trucks only (as opposed to all trucks, as shown in Table 4.22) is shown in Table 4.23. This table shows rates from *NCHRP Synthesis of Highway Practice 298: Truck Trip Generation Data* (Fischer and Han, 2001).

A nonfreight truck trip table may be developed by adapting an existing total truck table. If this is the case, care must be taken to avoid double counting the trucks that carry freight. It will be necessary to adjust the total truck trip rates and distributions to account for freight trucks, which are handled separately.

Truck trip distribution. As is the case with freight modeling as discussed previously, the most common procedure for distributing truck trips uses the gravity model. The calibration of friction factors should be consistent with observed truck travel. As examples, *NCHRP Synthesis 384* presents friction factor curves for the Atlanta and Baltimore truck models, adjusted to provide the best fit with the known

Table 4.22. Sample total truck trip rates by truck type and land use.

	Truck Type			
	14,000–28,000 Pounds NWRG Survey		2–4 Axles, 6+ Tire, Single Unit, 16,000–52,000 Pounds PSRC Truck Model	
Land Use	**Production**	**Attraction**	**Production**	**Attraction**
Households	0.011	0.011	0.0163	0.0283
Employment				
Agriculture/Mining/Construction	0.040	0.044		
Agriculture			0.0404	0.2081
Mining			0.0404	10.8831
Construction			0.0453	0.0644
Retail	0.032	0.035	0.0744	0.0090
Education/Government	0.037	0.038	0.0135	0.0118
Finance, Insurance, Real Estate	0.008	0.008	0.0197	0.0276
Manufacturing Products	0.050	0.050	0.0390	0.0396
Equipment			0.0390	0.0396
Transportation/Utility	0.168	0.170	0.0944	0.0733
Wholesale	0.192	0.190	0.1159	0.0258

Source: Cambridge Systematics, Inc. (2008a).

Table 4.23. Sample nonfreight truck trip rates by land use.

Land Use	Maricopa Association of Governments	Southern California Association of Governments
Households	0.069	0.0087
Employment		
Agriculture/Mining/Construction	0.106	0.0836
Retail	0.132	0.0962
Education/Government	0.006	0.0022
Financial, Insurance, Real Estate	0.021	–
Manufacturing Products	0.100	0.0575
Transportation/Utility	0.106	0.4570
Wholesale	0.106	0.0650
Other	0.106	0.0141

Note: Truck definition for Maricopa Association of Governments data is 8,000 to 28,000 pounds, while for Southern California Association of Governments it is 14,000 to 28,000 pounds.

Source: Rates are from *NCHRP Synthesis 298* (Fischer and Han, 2001) as cited in Cambridge Systematics, Inc. (2008a).

Table 4.24. Sample average truck trip lengths or travel times.

Truck Type	Atlanta (1996)	Baltimore (1996)	Detroit (1999)	Los Angeles (2000)
Heavy	22.8 min.	34.0 min.	20.1 min.	24.1 miles
Medium	19.9 min.	17.5 min.	20.5 min.	13.1 miles
Light		16.2 min.	18.3 min.	5.9 miles

Source: *NCHRP Synthesis 384* (Kuzmyak, 2008).

average trip lengths of trucks. Table 4.24 provides a summary of average trip lengths or travel times (if known), and date of origin, used by a sample of MPOs.

4.11 Highway Assignment

All of the preceding sections have dealt with the development of trip tables. Assignment is the fourth step in a four-step travel demand model. This section deals with highway assignment while Section 4.12 deals with transit assignment.

Highway assignment is the process by which vehicle trips for each origin-destination interchange included in the vehicle trip tables are allocated to the roadway network. The allocation process is based on the identification of paths through the network for each origin-destination interchange. The assignment process may be mode-specific with, for example, paths for single occupant vehicles being determined using different criteria than paths for multi-occupant vehicles or trucks.

4.11.1 Model Function

There are a number of methods by which a trip table can be assigned to a network. All of these methods are basically variations of the formula:

$$V_a = \sum_{ij} t_{ij} * P_{ija} \tag{4-15}$$

where:

t_{ij} = The number of vehicle trips from origin *i* to destination *j*;
P_{ija} = The probability of using link *a* on the path from origin *i* to destination *j*; and
V_a = The volume of vehicles on link *a*.

While the algorithms and computer code required to efficiently solve the assignment problem, as well as the requirements for storing the probability matrix, do not often lead to the assignment problem being defined in this way, describing the process in this manner does allow for the identification of features that distinguish the various assignment methods.

When the probability matrix is predetermined in some manner that cannot be changed, the method is called **a fixed path assignment**.

When the probability matrix takes on the value of one when the link is used and zero when the link is not used it is said to be an **all or nothing (AON) assignment**.

When the cells of the probability matrix are calculated from a stochastic formula that calculates the percentage of trips to be assigned to a set of links contained in reasonable paths, the method is called a **stochastic assignment**.

When the probability matrix takes on discrete values associated with the percentages of the trip table which are assigned in successive AON assignments, where between iterations the congested time is updated based on a comparison of the assigned volume on a link to its capacity, new AON paths are then calculated, and those percentages are applied to each of the successive AON probabilities (i.e., one or zero), the method is called **incremental capacity-restrained assignment**.

When the cells of the probability matrix are calculated from the percentage of the trip table assigned to successive applications of AON as in the incremental capacity-restrained assignment, but those percentages are selected through an iterative process that will result in satisfying Wardrop's first principle, which states that "the journey times in all routes actually used are equal and less than those which would be experienced by a single vehicle on any unused route" (Wardrop, 1952), the method is said to be a **user equilibrium assignment**. A variant of this method, called stochastic user equilibrium, uses stochastic assignment rather than AON assignment in successive steps to arrive at equal journeys on used paths, in which case the perceived times are said to be reasonably equal. A common method to determine the allocation of a trip table to successive iterations is the Frank-Wolfe algorithm (Frank and Wolfe, 1956).

An additional consideration in assignment is the number of trip tables that will be assigned and the manner in which the trip tables are assigned. If the trip table is assigned to the network links prior to a user equilibrium assignment, for example by assigning that trip table to fixed or AON paths that do not consider congestion, that trip table is said to be preloaded. Those trip tables (i.e., classified by vehicle and/or purpose) that are assigned jointly in a user equilibrium assignment are said to be a multimodal multiclass assignment.

The first three assignment processes previously described—fixed path, AON, and stochastic—are insensitive to congestion impacts that occur when demand for a network link approaches the capacity of the link. The last two assignment methods—capacity restrained and user equilibrium—explicitly attempt to account for congestion impacts in the traffic assignment process. The last two procedures are typically preferred for future forecasts because they inject a level of realism into the assignment process through reductions of travel speeds as traffic volumes on links increase. In addition, the last two procedures are required if air quality impacts of various alternatives or land use scenarios need to be estimated from traffic assignment results.

While the first three assignment procedures are insensitive to congestion impacts, these can provide important analysis capabilities. For example, AON assignments are useful for determining travel desires in the absence of congestion impacts and are commonly used to preload truck trips and other external through-trip movements in regional models. Such information can also be useful in targeting transportation improvements. In uncongested networks, stochastic assignment may be the only method available to represent user choices of similar alternative paths.

In all capacity-restrained and user equilibrium assignments, link travel times are adjusted between iterations using a vehicle-delay function (sometimes referred to as a "volume-delay," "link performance," or "volume-time" function). These functions are based on the principle that as volumes increase relative to capacity, speeds decrease and link travel times increase.

One of the most common of these vehicle-delay functions was developed by the BPR, the predecessor agency of the FHWA. The BPR equation is:

$$t_i = t0_i * \left(1 + \alpha * \left(\frac{v_i}{c_i}\right)^{\beta}\right) \tag{4-16}$$

where:

t_i = Congested flow travel time on link i;
$t0_i$ = Free-flow travel time on link i;
v_i = Volume of traffic on link i per unit of time (somewhat more accurately defined as flow attempting to use link i);
c_i = Capacity of link i per unit of time (see below);
α = Alpha coefficient, which was assigned a value of 0.15 in the original BPR curve; and
β = Beta coefficient, the exponent of the power function, which was assigned a value of 4 in the original BPR curve.

While t_i represents the link i travel time and is expressed in units of time (usually minutes), it may also reflect other costs associated with travel, especially tolls and auto operating costs such as fuel costs. The value t_i (and $t0_i$) may therefore be represented by something like Equation 4-17:

$$t_i = tt_i + \mathrm{K1} * d_i + \mathrm{K2} * \mathrm{toll}_i \tag{4-17}$$

where:

tt_i = Actual travel time on link i;
d_i = Length of link i in units of distance (e.g., miles);
$toll_i$ = Per vehicle toll on link i in monetary units;
K1 = Parameter reflecting marginal per-mile auto operating cost and conversion from monetary to time units; and
K2 = Parameter reflecting conversion from monetary units to time units.

Parameter K2, therefore, represents the inverse of the value of time. Note that the value of time is also an implied parameter in mode choice (see Section 4.7.4). However, the values of time implied by mode choice model parameters are often lower than those used in highway assignment, especially those used in toll road planning studies. This reflects, in part, the different market segments analyzed in each model component (travelers by all modes for mode choice, highway users in potential toll corridors in assignment), but also the artificial separation of mode and route choices in a four-step model. A 2003 memorandum (U.S. Department of Transportation, 2003) indicated a "plausible range" for the value of time in year 2000 dollars for local travel to be $7.90 to $13.40 per hour, with a recommended value of $11.20 for autos (the value for trucks was $18.10). These values are substantially higher than the values of time implied by the mode choice parameters presented in Section 4.7.4.

It is customary to express capacity in vehicles per hour. In models where daily (weekday) highway assignment is used (and therefore the volume variable is expressed in vehicles per day), the hourly capacity estimates must be converted to daily representations. This conversion is most commonly done using factors that can be applied to convert the hourly capacity to effective daily capacity (or, conversely, to convert daily trips to hourly trips, which is equivalent mathematically). These factors consider that travel is not uniformly distributed throughout the day and that overnight travel demand is low. The conversion factors are therefore often in the range of 8 to 12, as opposed to 24, which would be the theoretical maximum for an hourly-to-daily factor. [These factors are sometimes referred to as "CONFAC," the variable name in the Urban Transportation Planning System (UTPS) legacy software on which many aspects of modern modeling software are still based.]

These types of conversion factors continue to be needed in models where time periods for assignment greater than 1 hour in length are used. In such cases, the factors convert the hourly capacity to the capacity for the appropriate time period. For example, if a morning peak period is defined as 6:00 to 9:00 a.m., the conversion factor will convert hourly capacity to capacity for the 3-hour period. It is important to consider that travel is not uniformly distributed throughout the 3-hour period, although it is likely to be more evenly distributed over a shorter time period, especially a peak period that is likely to be relatively congested throughout. The theoretical maximum for the factor is the number of hours in the period (three, in this example), and in a period where there is roughly uniform congestion throughout the peak period, the factor could be close to three. Typical factors for a 3-hour peak would range from two to three. The factors for longer off-peak periods would likely be well lower than the theoretical maximum.

Depending on the application, the value of c_i (Equation 4-16) may not represent the true capacity of the link in a traffic operations sense (see Section 3.3). In the original BPR function, c_i represented the limit of the service volume for LOS C, which is often approximately 70 percent of the "ultimate" capacity (at LOS E), although the conversion between these two values is not simple. Current best practice is to use the LOS E capacity for the following reasons (Horowitz, 1991):

1. Ultimate capacity has a consistent meaning across all facility types while design capacity does not. For example, it is a relatively simple matter to relate the capacity of an intersection to the capacity of the street approaching that intersection.
2. Ultimate capacity is always easier to compute than design capacity. Finding the design capacity of a signalized intersection is especially difficult.
3. Ultimate capacity can be more easily related to traffic counts than design capacity, which would also require estimates of density, percent time delay, and reserve capacity or stopped delay.
4. Ultimate capacity is the maximum volume that should be assigned to a link by the forecasting model. Design capacity does not give such firm guidance during calibration and forecasting.

For these reasons, ultimate capacity (LOS E) is assumed to be used for capacity in the remainder of this chapter. As noted in Section 3.3.1 of this report, detailed capacity calculations as presented in the *Highway Capacity Manual* may not be possible in travel model networks as some of the variables used in the manual are not available in these networks.

4.11.2 Best Practices

While there is much ongoing research into the use of dynamic assignment and traffic simulation procedures, the state of the practice for regional travel models remains static equilibrium assignment. There has been some recent research into more efficient algorithms to achieve equilibrium than Frank-Wolfe, and some modeling software has implemented these algorithms. Since most urban areas are dependent on the major proprietary software packages for their model applications, static equilibrium procedures will continue to be used for regional modeling for the time being.

There have been some highway assignment implementations that incorporate node delay as a better way of identifying intersections that may cause congestion on multiple links, sometimes referred to as junction modeling. Some modeling software has incorporated methods to consider node delay.

For project planning and design applications to determine link volumes, the use of post-processing techniques such as those discussed in *NCHRP Report 255: Highway Traffic Data for Urbanized Area Project Planning and Design* (Pedersen and Samdahl, 1982) are recommended rather than reliance on raw

Table 4.25. BPR coefficients estimated using the 1985 *Highway Capacity Manual.*

	Freeways			Multilane Highways		
Coefficient	**70 mph**	**60 mph**	**50 mph**	**70 mph**	**60 mph**	**50 mph**
α	0.88	0.83	0.56	1.00	0.83	0.71
β	9.8	5.5	3.6	5.4	2.7	2.1

Source: Horowitz (1991). While the terms "freeways" and "multilane highways" are not defined, it can be assumed that the term "freeways" refers to modern "Interstate standard" limited access highways and "multilane highways" includes lower design roadways, including those without access control.

model output. Post-processing techniques are recommended because the assigned volumes on individual links can have substantial error, as noted when comparing highway assignment outputs to traffic counts (although count data are often sampled and also have associated error).

4.11.3 Basis for Data Development

Horowitz (1991) fit the BPR formula (among others) to the speed/volume relationships contained in the Highway Capacity Software, Version 1.5, based on the 1985 *Highway Capacity Manual* (Transportation Research Board, 1985). The results of this work are presented in Section 4.11.4. These values were also presented in *NCHRP Report 365.* There is a wealth of literature on volume-delay function form and parameters, including the 2010 *Highway Capacity Manual,* that the analyst may wish to consult.

The MPO Documentation Database provided BPR function parameters from 18 MPOs for freeways and arterials. These also are presented in Section 4.11.4.

4.11.4 Model Parameters

The BPR formula parameters estimated by Horowitz are presented in Table 4.25. The speeds shown in this table represent facility design speeds, not model free-flow speeds.

According to the information in the MPO Documentation Database, the BPR formula is the most commonly used volume-delay function. MPOs use a variety of values for the α and β parameters, and most use different parameters for freeways and arterials. Table 4.26 presents BPR function parameters used by 18 MPOs for which data were available from the database.

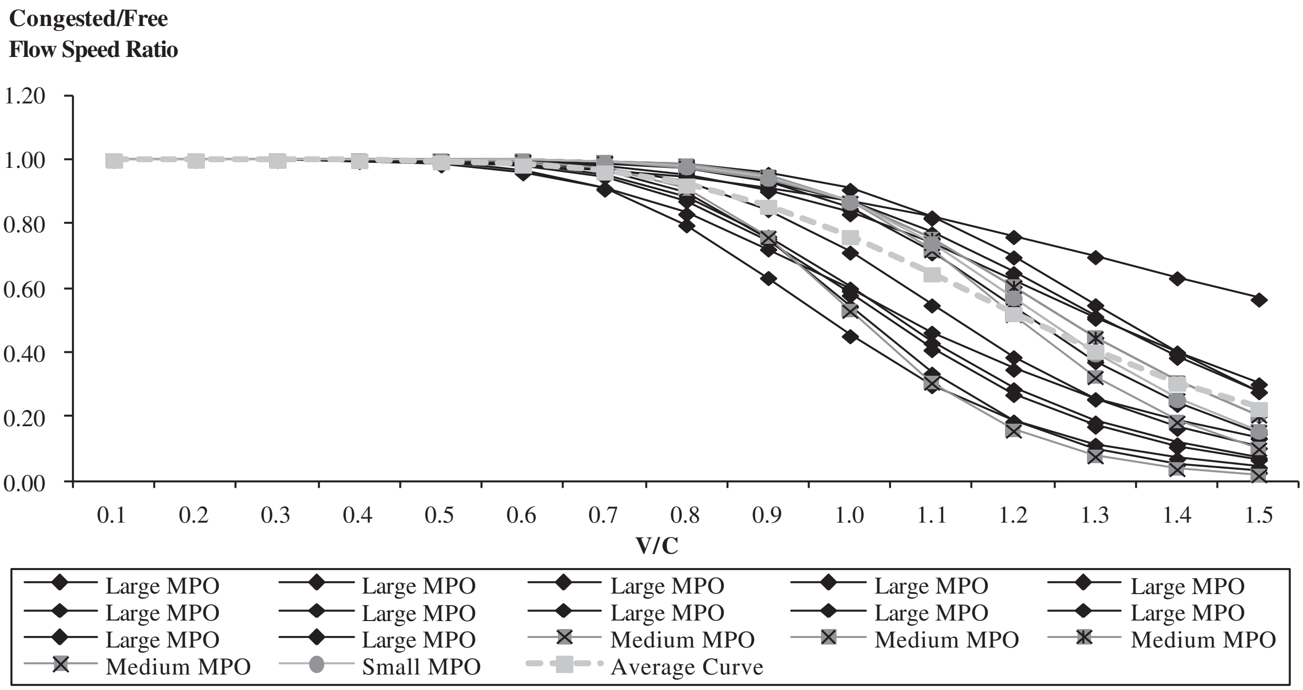
Figures 4.6 and 4.7 graph the ratios of the congested speeds to free-flow speeds on facilities at different volume/capacity

Table 4.26. BPR function parameters (morning peak period).

		Average		Minimum		Maximum		Standard Deviation	
	n	**α**	**β**	**α**	**β**	**α**	**β**	**α**	**β**
Freeways									
MPO population greater than 1,000,000	13	0.48	6.95	0.10	4.00	1.20	9.00	0.36	1.39
MPO population between 500,000 and 1,000,000	5	0.43	8.82	0.15	5.50	0.88	10.00	0.39	1.92
MPO population between 200,000 and 500,000	1	0.15	8.00	0.15	8.00	0.15	8.00	–	–
MPO population between 50,000 and 200,000	1	0.15	8.80	0.15	8.80	0.15	8.80	–	–
Arterials									
MPO population greater than 1,000,000	11	0.53	4.40	0.15	2.00	1.00	6.00	0.29	1.66
MPO population between 500,000 and 1,000,000	4	0.42	5.20	0.15	3.20	0.75	10.00	0.29	3.22
MPO population between 200,000 and 500,000	1	0.50	4.00	0.50	4.00	0.50	4.00	–	–
MPO population between 50,000 and 200,000	2	0.45	5.60	0.15	3.20	0.75	8.00	0.42	3.39

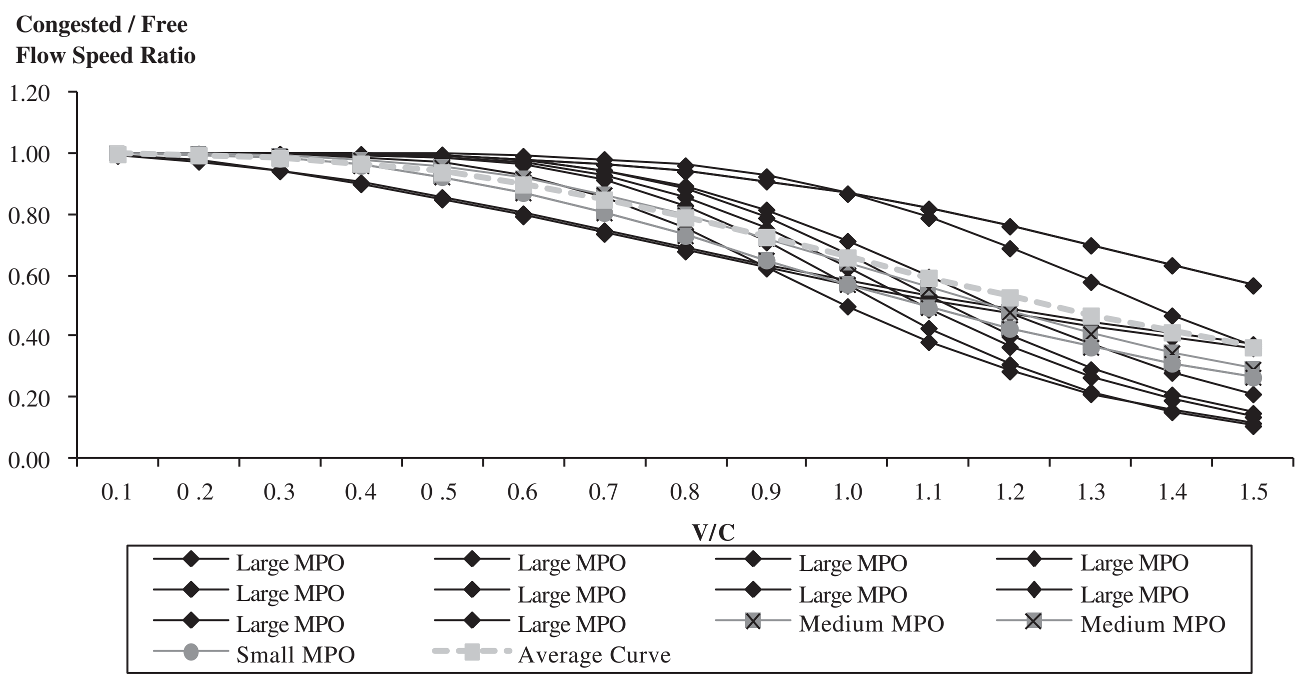
n = number of models in MPO Documentation Database

Source: MPO Documentation Database.



Source: MPO Documentation Database.

Figure 4.6. Freeway congested/free-flow speed ratios based on BPR functions.



Source: MPO Documentation Database.

Figure 4.7. Arterial congested/free-flow speed ratios based on BPR functions.

ratios using the BPR functions from the 18 MPOs. In addition, each graph includes an "average" BPR function based on the curves shown in Figures 4.6 and 4.7. The average BPR functions differ from the parameter averages shown in Table 4.26 in that the functions were derived via linear regressions to match the averages of the congested/free-flow speed ratios for the different volume/capacity ratios.[10] The resulting average BPR functions are:

- **Freeways:**
  - Alpha = 0.312.
  - Beta = 5.883.
- **Arterials:**
  - Alpha = 0.514.
  - Beta = 3.001.

4.12 Transit Assignment

While highway assignment deals with the routing of automobiles over a highway network, transit assignment deals with the routing of linked passenger trips (including walk and auto access and egress) over the available public transportation network. Differences from highway assignment include the following:

- The transit network includes not only links but also routes comprising the links, which represent the different transit services running between stops or stations;
- The flow unit in the trip table which is being assigned is passengers, not vehicles;
- The impedance functions include a larger number of level-of-service variables, including in-vehicle time, wait time, walk access and egress time, auto access and egress time, fare, and transfer activity; and
- Some paths offer more than one parallel service, sometimes with complex associated choices (e.g., express bus versus local bus service).

4.12.1 Model Function

Transit assignment is closely tied to transit path building. Typically, person trips estimated using a mode choice model are assigned to the transit paths built as input to the mode choice model. The typical transit assignment process is different from traffic assignment processes, where auto paths based on estimated congested travel times are input to a mode choice model and the output vehicle trips are assigned to the roadway network using an equilibrium or other capacity-restrained assignment method. The mode choice-traffic assignment process may require a feedback or iterative process to ensure that estimated roadway speeds used for mode choice (as well as for trip distribution) match the roadway speeds resulting from the traffic assignment process. Speeds on the transit network may also be affected by the roadway speeds, depending on the software and network coding methodologies.[11] The transit speeds used to develop the transit paths used to construct the travel time and cost skims for input to mode choice and the resulting transit assignment should match.

In the past, transit path-building and assignment were generally performed in production-attraction format with the production zone being defined as the home zone for home-based trips and the attraction zone being defined by the nonhome location. This procedure can be used to determine boardings by line, revenues, and maximum load points. It has often been performed by time of day with transit paths and assignments being performed for morning peak and mid-day periods. Such an approach accounts for time-of-day differences in transit services with the afternoon peak period being assumed to be symmetrical to the morning peak period (which is an oversimplification). In regions offering nighttime transit service, the night service may either be modeled as a separate time period or aggregated with the mid-day service for assignment purposes. Finally, some areas provide the same basic levels of transit service throughout the day and, as a result, perform nontime-specific, or daily, transit path-building and assignments.

More recently, some regions have started building transit paths in origin-destination format. This approach has been used to account for directional differences in service by time of day. Service differences may be due to different frequencies of service, different service periods, or different transit speeds due to different levels of traffic congestion. The information is particularly important for tour-based and activity-based modeling procedures, although it can also be used with trip-based modeling procedures.

4.12.2 Best Practices

Table 4.27 summarizes the time-of-day directional assignment procedures for 23 MPOs. Of the 20 MPOs reporting the use of time-of-day transit paths, 17 indicated the trip purposes assigned to each time-of-day network. Four of the 17 MPOs assigned home-based work trips to the peak period

[10]Note that volume/capacity ratios over 1.0 are shown in Figures 4.6 and 4.7. In effect, what is really being shown are the modeled demand/capacity ratios. In the real-world situations, traffic volumes cannot exceed roadway link capacities.

[11]In many models, run times are hard coded on transit lines resulting in no direct sensitivity to highway speed changes. However, good practice still dictates reviewing transit speeds for general consistency with the underlying highway speeds.

Table 4.27. MPOs using transit assignment procedures.

	Number of MPOs									
	Production-to-Attraction					Origin-to-Destination				
MPO Regional Population	A.M. Peak[a]	Mid-Day	P.M. Peak	Night	Daily	A.M. Peak	Mid-Day	P.M. Peak	Night	Daily
More than 1,000,000	12	11	3	3	0	3	3	3	1	0
200,000 to 1,000,000	3	3	1	0	3	1	1	1	0	0
50,000 to 200,000	1	1	0	0	0	0	0	0	0	0

[a] Includes MPOs assigning both morning and afternoon trips to the morning peak network in production-to-attraction format.

Source: MPO Documentation Database.

network and the remaining 13 estimated transit trips for each trip purpose by time of day and assigned the trips using time-of-day transit paths.

Transit path-builders can be characterized into two basic groups: shortest path and multipath. Shortest path methods find the shortest path through the network, based on a specified linear combination of impedance components including items such as walk or drive access time, wait time, in-vehicle time, transfer time, additional transfer penalties, walk egress time, and fare. The coefficients of the linear combination are usually based on the relative coefficients of these variables in the mode choice model.[12] Multipath procedures find multiple "efficient" paths through the transit network based on similar criteria. The multipath methods may include multiple paths for each interchange even if the alternate paths do not minimize total travel impedance. The inclusion or exclusion of alternate paths is based on a specified set of decision rules.

The use of shortest path or multipath methods should be coordinated with the type of mode choice model used. Some mode choice models incorporate path choice in the mode choice structure. For example, in regions with both bus and rail service, the mode choice model might include walk to bus only, walk to rail only, and walk to bus/rail as separate modes. If the mode choice model is structured to include path choice, the use of a shortest path procedure is reasonable although careful use of a multipath method is also appropriate.

Alternatively, some regions simply model transit use for all combined transit modes in the mode choice model. In these regions, use of a multipath method can be used to determine path choice. Of the 22 MPOs reporting their transit path-building procedures, 17 used shortest path for their peak period and off-peak period walk-to-transit paths and five used multipath procedures. For drive access to transit paths, 20 of the 22 MPOs used shortest path for their peak period and off-peak period drive-to-transit paths and two used multipath procedures.

FTA has developed a number of guidelines for transit path-building and mode choice for Section 5309 New Starts applications. The FTA guidelines have influenced path-building procedures and parameters and should be reviewed prior to model development, especially if a New Starts application is being considered for a region.

Two issues for transit path-building and the transit assignment process are:

- **Source of bus speeds**—Are bus speeds related to auto speeds in a reasonable manner, and do they reflect observed speeds?
- **Consistency with mode choice parameters**—Are transit path-building and assignment parameters consistent with the relationships used in the mode choice model?

Table 4.28 summarizes the sources of bus speeds and the consistency of the path-building parameters with mode choice parameters for the 21 MPOs reporting the information. Information is reported for only the morning peak and mid-day networks since all of the MPOs had those two networks.

4.12.3 Basis for Data Development

The basis for data development for the model parameters described below is the information obtained from 23 MPO models in the MPO Documentation Database, as discussed in the previous section.

4.12.4 Model Parameters

The main model parameters for transit path-building are the relationships between the components of transit travel impedance. Common parameters, which are usually expressed in terms of their relationship to in-vehicle time, include:

- Monetary cost/fare (value of time) including transfer costs;
- Initial wait time;

[12]As discussed in Section 4.7, there is usually a different mode choice model for each trip purpose, with different coefficients. While development of a separate set of transit paths for each trip purpose would be possible, transit trips are usually not assigned by purpose, and so a single set of paths is used. This is usually based on the home-based work mode choice model.

Table 4.28. Transit assignment consistency reported by MPOs.

	Bus Speeds Related to Auto Speeds (Yes/Total Reporting)		Path-Building Parameters Consistent with Mode Choice (Yes/Total Reporting)	
Regional Population	**Morning Peak**	**Mid-Day**	**Morning Peak**	**Mid-Day**
More than 1,000,000	14/17	13/17	13/17	12/17
200,000 to 1,000,000	2/4	2/4	2/5	2/4
50,000 to 200,000	0/0	0/0	0/0	0/0

Source: MPO Documentation Database. Numbers refer to number of agencies in the database for each item.

Table 4.29. Ratios of walk time to in-vehicle time reported by MPOs.

	Peak Period						Off-Peak Period					
	Walk Access			Drive Access			Walk Access			Drive Access		
Regional Population	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
More than 1,000,000	2.2	1.5	3.0	2.2	1.5	3.0	2.4	1.5	3.0	2.3	1.5	3.0
200,000 to 1,000,000	2.4	1.5	3.0	2.0	1.0	3.0	2.4	1.5	3.0	2.0	1.0	3.0
50,000 to 200,000	–	–	–	–	–		–	–	–	–	–	–

Source: MPO Documentation Database.

Table 4.30. Ratios of wait time to in-vehicle time reported by MPOs.

	Peak Period						Off-Peak Period					
	Walk Access			Drive Access			Walk Access			Drive Access		
Regional Population	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
More than 1,000,000	2.1	1.5	2.6	2.1	1.5	2.6	2.1	1.5	3.0	2.2	1.5	3.0
200,000 to 1,000,000	2.9	1.5	4.5	3.0	1.5	4.5	2.9	1.5	4.5	3.0	1.5	4.5
50,000 to 200,000	–	–	–	–	–		–	–	–	–	–	–

Source: MPO Documentation Database.

- Transfer wait time;
- Transfer penalty time;
- Dwell time;
- Walk time; and
- Auto time.

Typically, the auto time and dwell time parameters are set to 1.0, as both are actually in-vehicle time. While some MPOs consider fares in their transit path-building and assignment procedures, there is little variation in fares in some locations, and so fare is often excluded from the path-building impedance.

Two of the main parameter relationships that affect transit path-building and transit assignment are the ratio of walk time to in-vehicle travel time and ratio of wait time to in-vehicle travel time. Table 4.29 summarizes the ratios of walk time to in-vehicle travel time, and Table 4.30 summarizes the ratios of wait time to in-vehicle travel time, from models included in the MPO Documentation Database. As can be seen in the tables, there is little variation in the mean values of ratios, with all of the means falling in the range 2.0 to 3.0. Detailed inspection of the reported ratios shows that most of the ratios are 2.0, 2.5, or 3.0. This result is not surprising since FTA New Starts guidelines ask applicants to "provide compelling evidence" if the ratio of out-of-vehicle time to in-vehicle time in a mode choice model is outside of the range of 2.0 to 3.0 and the guidelines also encourage consistency between transit path-building and mode choice model parameter relationships.

CHAPTER 5

Model Validation and Reasonableness Checking

5.1 Introduction

Much has been written and presented recently regarding model validation and reasonableness checking, including the FHWA *Travel Model Validation and Reasonableness Checking Manual, Second Edition* (Cambridge Systematics, Inc., 2010b); the Florida Department of Transportation (FDOT) *FSUTMS-Cube Framework Phase II, Model Calibration and Validation Standards: Model Validation Guidelines and Standards* (Cambridge Systematics, Inc., 2007a); the final report for NCHRP Project 8-36B, Task 91, "Validation and Sensitivity Considerations for Statewide Models" (Cambridge Systematics, Inc., 2010a); and the FHWA's Shining a Light Inside the Black Box webinar series (Ducca et al., 2008).

This chapter demonstrates how the information from Chapters 3 and 4 of this report can support the model validation and reasonableness checking concepts and procedures presented in the aforementioned documents. **It is intended to complement, not duplicate, other reference material on validation and reasonableness checking**. The reader should review the references listed in the previous paragraph for more complete information on model validation and reasonableness checking. There are two primary uses for the data provided in this report:

- Developing travel model components when no local data suitable for model development are available; and
- Checking the reasonableness of model components developed using local data.

In the first case, local data should be collected to validate the models or model components developed based on this report. In the second case, the data in this report can be used to supplement and support the validation and reasonableness checking process.

5.2 Model Validation Overview

5.2.1 Definitions

It is important to provide clear definitions for the terms "validation" and "reasonableness checking" as used in this report. Different references may provide different definitions or emphasize different aspects of model validation. The following definitions of validation are used in the four references noted in Section 5.1:

- **Validation** is the application of the calibrated models and comparison of the results against observed data. Ideally, the observed data are data *not* used for the model estimation or calibration but, practically, this is not always feasible. Validation data may include additional data collected for the same year as the estimation or calibration of the model or data collected for an alternative year. Validation also should include sensitivity testing. (*Travel Model Validation and Reasonableness Checking Manual, Second Edition*)
- **Validation** is the procedure used to adjust models to simulate base year traffic counts and transit ridership figures. Validation also consists of reasonableness and sensitivity checks beyond matching base year travel conditions. (FDOT *FSUTMS-Cube Framework Phase II Model Calibration and Validation Standards: Model Validation Guidelines and Standards*)
- **Validation** is the process that determines whether or not a model is reasonably accurate and reliable while sensitivity assesses the ability of the model to forecast changes in travel demand based on changes in assumptions. ("Validation and Sensitivity Considerations for Statewide Models")
- **Validation** is "forecasting" current travel patterns to demonstrate sufficient ability to reproduce highway counts and transit line volumes. (Shining a Light Inside the Black Box)

A common theme in all of the above definitions is a comparison against observed data, especially against locally collected travel data, traffic counts, and transit boardings. The data summarized in this report provide independently collected observed travel data. Of course, the data summarized in this report are not specific to any single location and, thus, do not fully satisfy the intent of model validation as defined above. The best use of the data in this report is to supplement local data.

In areas with existing travel models, the data included in this report may be used for **reasonableness checking**. The observed travel data summaries and model parameters contained herein provide an independent source of data for comparing travel models estimated and calibrated using locally collected data to travel characteristics from other areas.

5.2.2 Model Validation and Reasonableness Checking Considerations

The validation documents referenced in Section 5.1 present a number of considerations that should guide model validation and reasonableness checking:

- Model validation and reasonableness checking should encompass the entire modeling process from the development of input data required for model development and application to model results.
- Matching a specified standard such as “the coefficient of determination for modeled to observed traffic volumes should be 0.89 or greater” is **not** sufficient to prove the validity or reasonability of a model.
- The intended model use affects model validation and reasonableness checking:
  - For models that will be used to assess short-term infrastructure improvements or design, validation efforts may focus on the ability of the model to reproduce existing travel.
  - For models that will be used for planning and policy analyses, validation efforts may focus on the reasonableness of model parameters and sensitivities to changes in input assumptions.
- Planning for model validation and reasonableness checking is important to ensure that this important step is not overlooked and that data required to validate the models are collected.
- Variability and error are inherent in the travel modeling process. Variability and error occur in the input data used to estimate and apply travel models, in estimated or specified model parameters, and in the data used to validate the models.

5.2.3 Uses of Data in This Report for Validation and Reasonableness Checking

If the data and parameters included in Chapter 4 of this report are used to specify or enhance travel models for an area, the specification and collection of independent validation data such as traffic counts, transit boardings, travel time studies, and special generator cordon counts (see Chapter 3) are required for model validation. Those data may be supplemented with data from other sources such as the U.S. Census, ACS, LEHD, locally collected travel surveys, or other sources. The locally collected data may be used to perform traditional model validation tests such as comparisons of modeled to observed vehicle miles of travel, screenline crossings, traffic volumes on roadways, and transit boardings.

If areas have existing travel models estimated from locally collected data, the data contained in Chapter 4 may be used for reasonableness checking of model parameters and rates for trip-based travel models. The information contained in Chapter 4 also can be used to check the reasonableness of more advanced modeling techniques such as activity-based travel models, provided the results from those models can be converted to the trips resulting from the tours and activities.

5.2.4 Layout of Chapter

The remainder of this chapter provides an overview of the use of information contained in this report for model validation and reasonableness checking. Section 5.3 focuses on validation and reasonableness checking of existing travel models. Section 5.4 provides an example of model reasonableness checking of model components and overall validation of a travel model specified using information from Chapter 4.

Section 5.5 provides cautions and caveats to using the data contained in this report for model validation and reasonableness checking. Although these data can provide useful information regarding the reasonableness of travel models, this information cannot be used to validate travel models.

5.3 Model Validation and Reasonableness Checking Procedures for Existing Models

The general approach to model validation and reasonableness checking of existing models using information provided in this report focuses on answering the following questions:

- Are the rates and parameters developed for a specific model component for the region reasonable?

- If the rates or parameters for a specific model component are different from what would be expected, are there other characteristics of the model being considered that would "explain" the differences?

As discussed in Section 1.1, this report is the third of a series of NCHRP reports that summarize typical model rates and parameters. Thus, in some cases, results summarized in this report can be compared to those summarized in *NCHRP Report 187* (Sosslau et al., 1978) and *NCHRP Report 365* (Martin and McGuckin, 1998). Such comparisons might provide an idea of the stability or trends of specific model rates and parameters over time that may help identify the reasonableness of estimated or calibrated model parameters for a region.

5.3.1 Are the Estimated Model Rates for the Region Reasonable?

Chapter 4 provides some aggregate summaries of travel data. The summaries are averages of individuals' travel behaviors summarized over different groupings of individuals, market segments, and regions. It should be possible to compare information reported in Chapter 4 to results from a travel model estimated for a region at some level of aggregation even if the underlying travel model for the region is unique.

For example, suppose a region uses an activity-based travel model. Since the information reported in Chapter 4 is trip based, no direct comparison of model parameters is possible. However, many activity-based travel models produce travel forecasts for individuals that mimic typical travel surveys. Thus, it should be possible to summarize the results of the activity-based models to produce "trip-based" summaries for statistics such as trip rates, average trip lengths, time of day of travel, mode shares, and so forth.

Example—Reasonableness of Trip Generation—A "Success" Story

Tables 5.1 through 5.3 show a typical trip generation model estimated for an example large urban area with a population between 1 and 3 million people. Table 5.4 shows the total trip rates resulting from Tables 5.1 through 5.3.

Tables 5.5 and 5.6 provide comparisons of the average trip rates by household size and by income group for the example

Table 5.1. Modeled home-based work trip production rates for example urban area.

	Household Size					
Income Group	**1**	**2**	**3**	**4**	**5+**	**Average**
Low (Less than $25,000)	0.5	1.4	1.4	1.4	2.7	*0.8*
Middle ($25,000–$99,999)	1.3	1.9	2.1	2.3	2.7	*1.9*
High ($100,000 or more)	1.0	1.9	2.6	2.5	2.1	*2.2*
Average	*1.1*	*1.9*	*2.2*	*2.4*	*2.5*	*1.8*

Table 5.2. Modeled home-based nonwork trip production rates for example urban area.

	Household Size					
Income Group	**1**	**2**	**3**	**4**	**5+**	**Average**
Low (Less than $25,000)	1.5	2.6	5.4	5.5	5.6	*2.2*
Middle ($25,000–$99,999)	1.7	3.6	5.3	8.3	11.6	*4.9*
High ($100,000 or more)	1.9	3.2	5.3	10.5	11.6	*6.2*
Average	*1.6*	*3.4*	*5.3*	*9.2*	*11.5*	*4.9*

Table 5.3. Modeled nonhome-based trip production rates for example urban area.

	Household Size					
Income Group	**1**	**2**	**3**	**4**	**5+**	**Average**
Low (Less than $25,000)	0.9	0.9	3.3	3.1	3.1	*1.1*
Middle ($25,000–$99,999)	1.5	2.8	3.3	4.0	3.8	*2.8*
High ($100,000 or more)	2.5	3.5	4.7	5.1	6.3	*4.4*
Average	*1.4*	*2.9*	*3.7*	*4.5*	*4.6*	*3.0*

Table 5.4. Total trip production rates—HBW + HBNW + NHB for example urban area.

	Household Size					
Income Group	**1**	**2**	**3**	**4**	**5+**	**Average**
Low (Less than $25,000)	2.9	4.9	10.1	10.0	11.4	*4.1*
Middle ($25,000–$99,999)	4.5	8.3	10.7	14.6	18.1	*9.6*
High ($100,000 or more)	5.4	8.6	12.6	18.1	20.0	*12.8*
Average	*4.1*	*8.2*	*11.2*	*16.1*	*18.6*	*9.7*

HBW = home-based work; HBNW = home-based nonwork; NHB = nonhome based.

Table 5.5. Comparison of example region to NHTS trip production rates by household size.

Trip Purpose and Data Source	Household Size				
	1	**2**	**3**	**4**	**5+**
Home-Based Work					
Hypothetical Region	*1.1*	*1.9*	*2.2*	*2.4*	*2.5*
NHTS	0.5	1.2	2.0	2.3	2.4
Home-Based Nonwork					
Hypothetical Region	*1.6*	*3.4*	*5.3*	*9.2*	*11.5*
NHTS	1.8	4.0	6.7	10.6	13.4
Nonhome based					
Hypothetical Region	*1.4*	*2.9*	*3.7*	*4.5*	*4.6*
NHTS	1.3	2.5	3.8	5.3	5.7
Total					
Hypothetical Region	*4.1*	*8.2*	*11.2*	*16.1*	*18.6*
NHTS	3.6	7.7	12.5	18.2	21.5

Source: 2009 NHTS.

Table 5.6. Comparison of example region to NHTS trip production rates by income group.

<table>
<tr><th></th><th colspan="5">Income Range</th></tr>
<tr><th>Trip Purpose and
Data Source</th><th>Less than
$10,000</th><th>$10,000–
$24,999</th><th>$25,000–
$49,999</th><th>$50,000–
$99,999</th><th>$100,000 or
More</th></tr>
<tr><td>Home-Based Work</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Hypothetical Region</td><td colspan="2">0.8</td><td colspan="2">1.9</td><td>2.2</td></tr>
<tr><td>NHTS</td><td>0.6</td><td>0.8</td><td>1.3</td><td>1.9</td><td>2.0</td></tr>
<tr><td>Home-Based Nonwork</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Hypothetical Region</td><td colspan="2">2.2</td><td colspan="2">4.9</td><td>6.2</td></tr>
<tr><td>NHTS</td><td>4.1</td><td>4.7</td><td>5.0</td><td>6.2</td><td>7.6</td></tr>
<tr><td>Nonhome based</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Hypothetical Region</td><td colspan="2">1.1</td><td colspan="2">2.8</td><td>4.4</td></tr>
<tr><td>NHTS</td><td>1.6</td><td>1.9</td><td>2.7</td><td>3.8</td><td>4.7</td></tr>
<tr><td>Total</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Hypothetical Region</td><td colspan="2">4.1</td><td colspan="2">9.6</td><td>12.8</td></tr>
<tr><td>NHTS</td><td>6.3</td><td>7.4</td><td>9.0</td><td>11.9</td><td>14.3</td></tr>
</table>

Source: 2009 NHTS.

urban area with the comparable rates from the NHTS as summarized in Section 4.4.4. For the example urban area, the home-based work average household trip rates are higher than the averages shown by the NHTS for all household sizes although they are close for households of three or more persons. For the home-based nonwork trip purpose, the trip rates by household size for the example urban area are all lower than the NHTS trip rates. For the nonhome-based trip purpose and for all trip purposes combined, the results were mixed with example urban area rates being higher than NHTS rates for the lowest two household sizes and lower for the top three household sizes.

The comparison of trip production rates by income group shown in Table 5.6 is not quite as straightforward as the comparison of trips by household size as shown in Table 5.5. Unlike household sizes, income groups are affected by the year for which the incomes were reported, the income group breakpoints used in the survey and, possibly, by the region of the country for which the incomes were reported. For the 2009 NHTS data, the incomes were reported in 2008 dollars. Thus, for the example urban area, Consumer Price Index information was used to convert the income group dollar ranges from 1998 dollars to 2008 dollars. After the conversion, the income group breakpoints for the example urban area were reasonably close to the $25,000 and $100,000 breakpoints in the NHTS data. After the conversion of the income group breakpoint for the example area, the lowest-income group for the example area spanned two income groups for the NHTS data, as did the middle-income group.

After the adjustments of the income groupings, the home-based work trip rates for the example urban area were higher than the comparable income groups in the NHTS data. The trip rates for the example urban area were at the low end or lower than the comparable income groups in the NHTS data for both the home-based nonwork and nonhome-based trip purposes. Results for total trip rates were mixed.

Since the NHTS provides an agglomeration of trip rates for many urban areas throughout the country, there would be no reason to expect the trip rates from the example region to precisely match those obtained from the NHTS data. Nevertheless, it would be reasonable for the estimated trip rates for the region to reflect similar patterns to those shown in the NHTS data. The marginal trip rates for the example urban area by household size and by income group shown in Tables 5.5 and 5.6 reflect the NHTS trip rate patterns. While there are differences between the marginal trip rates for the example region and the NHTS data, the rates from the two sources reflect similar trends. Thus, while the NHTS data cannot be used to validate the trip rates for the example region, the comparison demonstrates an overall reasonableness of the trip generation model for the example region.

Other sources might be considered for checking the reasonableness of home-based work trip rates. Specifically, CTPP/ACS data may provide alternative sources for determining HBW trip rates.

Example—Reasonableness of Trip Distribution—A "Nonsuccess" Story

The preceding example regarding trip generation rates provided a "success" story where the model in question was supported as being reasonable even though the trip generation rates did not precisely match the rates summarized from NHTS data. The following example describes a situation where simple comparisons to the summaries included in this report would have suggested that a regional model might not be reasonable. Additional analyses would be required to determine the reasonableness of the model.

Trip-based travel models were developed for a midsized urban area (population between 500,000 and 1 million). The observed average trip duration for home-based work trips was summarized from the household survey as 35.4 minutes for all person trips by auto. This average was based on congested auto travel times. Based on data from the 2009 NHTS, as reported in Table C.10 in Appendix C, the average home-based work trip duration for an urban area with 500,000 to 1 million people was 22 minutes. Thus, the observed average home-based work trip duration for the region appeared to be too high.

Such a conclusion led to additional analysis. The initial checks of the processing of the observed data, the modeled congested travel speeds used in conjunction with the reported trip interchanges to estimate the average trip duration, and the trip durations reported by the travelers in the household survey confirmed the 35-minute average for the home-based work trip duration. The analyses also showed that the average trip durations for home-based nonwork and nonhome-based trips were within reasonable ranges based on summaries of NHTS data.

Further investigation focused on the share of home-based work trips as a proportion of total trips. Reported home-based work, home-based nonwork, and nonhome-based trip shares were 11 percent, 54 percent, and 35 percent, respectively. For urban areas with 500,000 to 1 million people, the NHTS data showed these shares as 14 percent, 56 percent, and 30 percent. The low home-based work share coupled with the long average trip duration suggested that the region was different from other similar-sized urban areas.

Anecdotal information from local planners provided a plausible explanation for the differences. Specifically, due to the state of the public school system at the time, many residents enrolled their children in private and parochial schools. Since the private and parochial schools were often beyond walking distance, school children were driven to and from school by parents as part of the parents' work journeys. This anecdotal information was supported by the reported travel patterns in the regional travel survey. The local planners also were unconcerned regarding the 35-minute average trip duration for direct home-to-work trips due to general roadway congestion levels.

The result of the analyses led to modifications in the design of the trip-based travel models for the region. The models were designed to explicitly account for the increased serve passenger trips made by parents to serve the school trips of their children.

Example—Model Parameters (Trip Distribution)

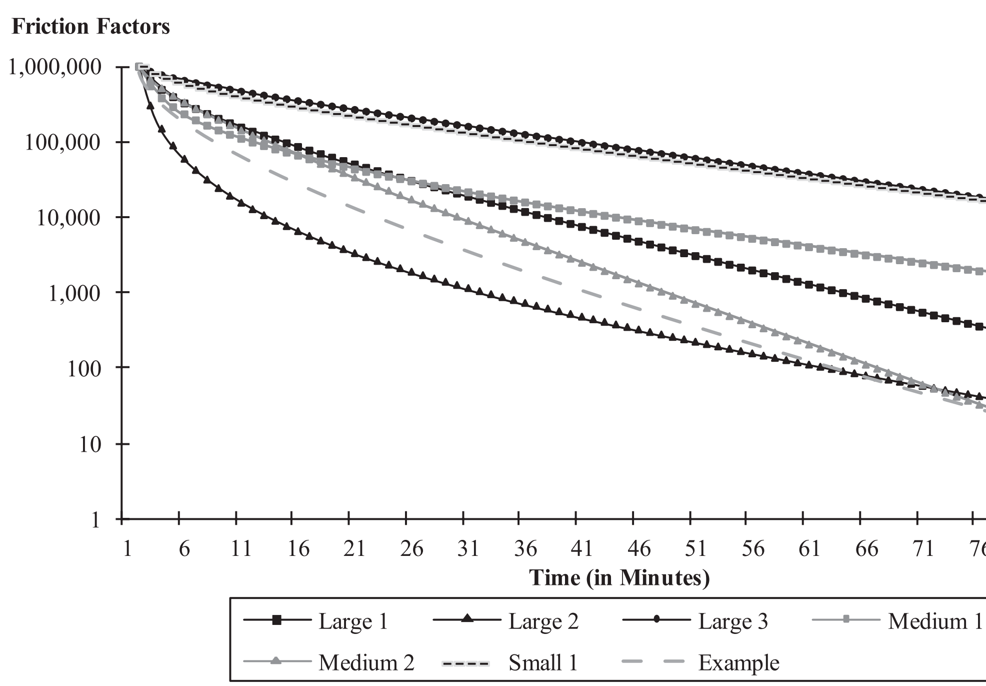
It can be useful to compare estimated model parameters to those developed in other regions as a reasonableness check. This is, quite often, a step used in the estimation of discrete choice models such as mode choice models. However, it also can be performed using more aggregate models. Suppose a region estimated the following gamma function parameters for a home-based work trip distribution model implemented using the gravity model:

$a = 5{,}280$
$b = -0.926$
$c = -0.087$

A review of Table 4.5 contained in Chapter 4 does not provide any clear indication regarding the reasonableness of the parameters. However, since the *a* parameter is simply a scale value, it can be modified to plot the various gamma functions over the same range of values. Figure 5.1 shows the resulting plot of the various functions. Again, while the data in Chapter 4 cannot validate the parameters estimated for the regional model, the information shown in Figure 5.1 suggests that the estimated function may be reasonable. However, some caution might be warranted if the example region was medium sized. The example function is generally steeper at low travel times and produces friction factors that are lower than the other medium-sized region friction factors over most of the range of travel times.

Example—Temporal Validation

Some of the summaries contained in Chapter 4 can be compared to similar summaries contained in its predecessors, *NCHRP Reports 187* and *365*. For example, Table 5.7 compares average household trip rates from those two reports and summaries of 2009 NHTS data, while Table 5.8 compares shares of total trips by trip purpose. For urban areas with populations greater than 500,000, household-based average trip rates appear to be generally increasing over time. The rates appear to be generally decreasing for areas with populations less than 500,000. For shares of trips by trip purpose, home-based work shares are decreasing over time while nonhome-based shares



Source: MPO Documentation Database.

Figure 5.1. Comparison of trip distribution gamma functions.

Table 5.7. Comparison of household trip rates.

Urban Area Population	Daily Person Trips per Household: *NCHRP Report 187*[a,c] (Published 1978)	*NCHRP Report 365*[a,c] (Published 1998)	2009 NHTS Data[b]
50,000 to 100,000	14.1	9.2	9.1
100,000 to 200,000	14.5	9.2	9.1
200,000 to 500,000	11.8	9.0	9.1
500,000 to 1,000,000	7.6	8.6	9.6
1,000,000 to 3,000,000	7.6	8.5	9.6
More than 3,000,000	7.6	8.5	9.6

[a] Trip rates are total person trips in motorized vehicles.

[b] Trip rates are total person trips by all modes.

[c] Because of differences between urban area categories in the three reports, the rates shown were chosen from the closest matching category.

Source: Sosslau et al. (1978), Martin and McGuckin (1998), 2009 NHTS.

Table 5.8. Comparison of shares of trips by trip purpose.

Urbanized Area Population	Percentage of Daily Person Trips by Trip Purpose: *NCHRP Report 187*[a] (Published 1978)			*NCHRP Report 365*[a] (Published 1998)			2009 NHTS Data[b]		
	HBW	HBNW	NHB	HBW	HBNW	NHB	HBW	HBNW	NHB
50,000 to 100,000	16	61	23[c]	20[c]	57[c]	23[c]	15	54	31
100,000 to 200,000	20	57	23[c]	20[c]	57[c]	23[c]	15	54	31
200,000 to 500,000	20	55	25[c]	21[c]	56[c]	23[c]	15	54	31
500,000 to 1,000,000	25	54	21[c]	22	56[c]	22[c]	14	56	30
1,000,000 to 3,000,000	25	54	21[c]	22[c]	56[c]	22[c]	14	56	30
More than 3,000,000	25	54	21[c]	22[c]	56[c]	22[c]	14	56	30

[a] Shares by purpose are based on person trips in motorized vehicles.

[b] Shares by purpose are based on person trips by all modes.

[c] Because of differences between urban area categories in the three reports, the rates shown were chosen from the closest matching category.

HBW = home-based work; HBNW = home-based nonwork; NHB = nonhome based.

Source: Sosslau et al. (1978), Martin and McGuckin (1998), 2009 NHTS.

are increasing. For regions that are updating or redeveloping models, comparing aggregate results to trends that can be drawn from this report and its predecessors can be useful for checking model reasonableness.

5.4 Model Validation and Reasonableness Checking Procedures for Models or Model Components Developed from Information Contained in Chapter 4

The *Travel Model Validation and Reasonableness Checking Manual, Second Edition* recommends the development of a model validation plan when a model is developed or updated. The validation plan should outline model validation and reasonableness checks that will be performed along with the validation data that will be used as the bases for comparison for the model results. This recommendation holds true for models developed from locally collected travel survey data or models specified using rates borrowed from other regions or provided in Chapter 4.

As an example, suppose an MPO for a region of 250,000 people was updating its travel model based on rates provided in Chapter 4 and Appendix C. The existing travel model had been specified using data from *NCHRP Report 365,* and no travel survey data were available. A validation plan was developed and, based on that plan, available resources were focused on the collection of traffic counts (daily and by time of day). In addition, staff from the MPO and their families were asked to record travel times on their trips to and from work.

Since the travel model being updated was based on *NCHRP Report 365* rates, the MPO had developed a procedure to esti-

Table 5.9. Initial trip production rates for example urban area.

	Household Size				
Trip Purpose	**1**	**2**	**3**	**4**	**5+**
HBW	0.5	1.2	2.0	2.3	2.4
HBNW	1.8	3.6	6.7	9.5	12.9
NHB	1.3	2.5	3.8	5.3	5.7

HBW = home-based work; HBNW = home-based nonwork; NHB = nonhome based.

Table 5.10. Initial trip production reasonableness check for example urban area.

Measure	HBW	HBNW	NHB	Total
Trip Rates				
Original Model[a]	1.8	4.8	2.0	8.6
Updated Model	1.6	5.4	3.1	10.1
MPO Averages	1.4	5.1	3.0	9.6
Distribution of Trips by Purpose				
Original Model[a]	21%	56%	23%	100%
Updated Model[b]	15%	53%	32%	100%
MPO Averages[c]	15%	53%	32%	100%

[a] Based on Martin and McGuckin (1998), Table 9.

[b] Based on model shown in Table 5.9.

[c] Tables C.5 through C.7.

HBW = home-based work; HBNW = home-based nonwork; NHB = nonhome based.

mate households by household size. Average trip production rates from Tables C.5 through C.7 were used to specify the trip rates shown in Table 5.9 for the example MPO model.

Table 5.10 shows the trips per household resulting from the applications of the original model based on *NCHRP Report 365* rates along with results from the application of the model summarized in Table 5.9 using the MPO's socioeconomic distributions of households by household size. Table 5.10 also shows the average trip rates for MPOs from Tables C.5 through C.7. The table also shows the modeled distributions of trips by trip purpose resulting from the original and updated models. Based on the information shown in Table 5.10, MPO modeling staff suspected that the model would result in more travel in the region than would be shown by the observed traffic counts.

Trips were distributed using the friction factors for "Medium (A)" MPOs shown in Table 4.5. The informal travel time survey of MPO staff did not suggest any substantial issues with the coded network speeds. Most staff reported observed travel times within ±10 percent of the modeled travel times for their trips from home to work. The modeled average trip durations are shown in Table 5.11 along with the average trip durations for urban areas of less than 500,000 population from Table C.10. The results shown in Table 5.11 also suggested that the model would show less travel in the region than would be shown by the observed traffic counts.

When the modeled vehicle trips were assigned (after applying mode split, auto occupancy, and time-of-travel model components), the resulting vehicle miles of travel were close to the vehicle miles of travel estimated from the traffic counts

Table 5.11. Initial trip distribution reasonableness check for example urban area.

	Trip Durations in Minutes			
Measure	**HBW**	**HBNW**	**NHB**	**Total**
Implied by Table C.10	20	18	18	18
Based on Model Application	18	16	18	17
Percentage Difference	–10%	–11%	0%	–4%

HBW = home-based work; HBNW = home-based nonwork; NHB = nonhome based.

collected for the model validation. Modeled screenline crossings were within 10 to 15 percent of the observed screenline crossings. Based on the information provided by the reasonableness checks for the trip production and trip distribution models and the model validation results, both the trip production and trip distribution models were deemed to produce reasonable results.

5.5 Cautions Regarding Use of This Report for Validation

The examples shown in this chapter illustrate both the risk and value of using information contained in this report for model validation and reasonableness checking. Since the data contained in Chapter 4 are highly aggregated from nationally collected data, they can be used only for general reasonableness checking. As stated previously, agreement between modeled information for a specific region and the general information in this report for any single measure is insufficient to demonstrate that a model for the region is valid. Likewise, failure to reasonably match the general summaries contained in this report does not invalidate a regional travel model. However, failure to reasonably match a general summary contained in this report should lead to further investigation of a regional travel model to explain the difference from the general travel patterns resulting from typical traveler behavior.

It also is important to verify that the data being compared are, in fact, comparable. A prime example of this issue is trip generation. Many regions summarize and forecast all person travel made in motorized vehicles, while others summarize and forecast all person travel. Efforts have been made in Chapter 4 to clearly identify whether all travel or only travel in motorized vehicles has been included in the summaries.

Finally, differences in data collection and processing techniques can introduce variation in the summarized data. There is a high level of consistency in the collection and processing of the NHTS data summaries contained in Chapter 4. However, since different MPOs have collected data for their own regions and developed their own models from those data, summaries of MPO-reported data and parameters are subject to variation from the data collection and processing procedures.

CHAPTER 6

Emerging Modeling Practices

Over the past few decades, because of escalating capital costs of new infrastructure and increasing concerns regarding traffic congestion, energy dependence, greenhouse gas emissions, and air quality, the originally supply-oriented focus of transportation planning has expanded to include the objective of addressing accessibility needs and problems by managing travel demand within the available transportation supply. Consequently, there has been an increasing interest in travel demand management strategies, such as mixed land use development, parking pricing, and congestion pricing, all of which attempt to change land use and transportation service characteristics to influence individual travel behavior and control aggregate travel demand. The evaluation of such demand management strategies using travel demand models places more emphasis on the realistic representation of behavior to accurately reflect traveler responses to management policies.

This realization has led to the consideration of the following issues, all of which have the potential to improve upon travel demand forecasts and enable more informed policy making:

- Time-space constraints and interactions in the activity-travel decisions of an individual;
- The accommodation of interindividual interactions in activity-travel decision making across individuals (such as joint participation in activities and travel, serve passenger trips, and allocation of responsibilities among individuals in a household);
- The recognition of the linkages across trips within the same "tour" (i.e., chain of trips beginning and ending at a same location) of an individual and across activities/tours of the individual over the day; and
- The explicit consideration of time as an all-encompassing continuous entity within which individuals make activity/travel participation decisions.

The result has been the increasing consideration of a fundamental behavioral paradigm referred to as an activity-based approach to travel demand modeling.

TRB Special Report 288: Metropolitan Travel Forecasting—Current Practice and Future Direction (SR 288) is the product of a TRB study, funded by FHWA, FTA, and the Office of the Secretary of Transportation, to determine the national state of practice in metropolitan area travel demand forecasting and to recommend improvements (Committee for Determination of the State of the Practice in Metropolitan Area Travel Forecasting, 2007). SR 288 recommends that the federal government "support and provide funding for the continued development, demonstration, and implementation of advanced modeling approaches, including activity-based models" and "continue support for the implementation of activity-based modeling and other advanced practices; considerably expand this support through deployment efforts in multiple urban areas." Chapter 6 of SR 288 is devoted to advancing the state of the practice.

The purpose of this chapter is to introduce the concepts of advanced modeling procedures such as activity-based models, dynamic traffic assignment models, and traffic simulation models. It is not intended to provide comprehensive documentation of these advanced models, but rather to describe how they work and how they differ from the conventional models discussed in the rest of the report.

This discussion should not be construed as a recommendation that all urban areas should be planning to switch to these types of modeling approaches in the near future, nor should it be viewed as a statement that such advanced modeling approaches address all of the problems associated with conventional modeling approaches. However, with these advanced approaches becoming more prevalent, and the likelihood that more areas will continue to switch to using them, it is desirable for the travel modeling community to become more familiar with them.

6.1 The Activity-Based Approach

The fundamental difference between the trip- and activity-based approaches is that the former approach directly focuses on "travel participation behavior" as the decision entity of interest, while the activity-based approach views travel as a demand derived from the need to pursue activities and focuses on "activity participation behavior." The underlying philosophy of the activity-based approach is to better understand the behavioral basis for individual decisions regarding participation in activities in certain places at given times, and hence the resulting travel needs. This behavioral basis includes all the factors that influence the why, how, when, and where of performed activities and resulting travel. Among these factors are the needs, preferences, prejudices, and habits of individuals (and households), the cultural/social norms of the community, and the travel service characteristics of the surrounding environment.

At a fundamental level, therefore, the activity-based approach emphasizes the point that the needs of the households are likely to be translated into a certain number of total activity stops by purpose followed by (or jointly with) decisions regarding how the stops are best organized. For example, consider a congestion pricing policy during the evening commute period along a corridor. Also, consider an individual who has the daily pattern shown in the top pattern of Figure 6.1, where the shopping stop during the evening commute is at a location that entails travel along the "to-be-priced" corridor (but assume that the person would not be traveling the "to-be-priced" corridor if she went directly home from work). In response to the pricing policy, the individual may now stop making the shopping stop during the evening commute but may generate another stop in the evening after returning home from work (see bottom pattern of Figure 6.1). If some of these post-home arrival stops are undertaken in the peak period, congestion may be simply transferred to other locations in the network. The activity-based approach explicitly acknowledges the possibility of such temporal redistributions in activity participation (and hence travel) by focusing on sequences or patterns of activity participation (using the whole day or longer periods of time as the unit of analysis), and thus is able to provide a holistic picture of policy effects.

A second defining aspect of the activity-based approach is its use of "tours" as the basic element to represent and model travel patterns. Tours are chains of trips beginning and ending at a same location, say, home or work. The tour-based representation helps maintain consistency across, and capture the interdependency (and consistency) of the modeled choice attributes among, the activity episodes (and related travel characteristics) undertaken in the same tour. This approach contrasts with the trip-based approach that considers travel as a collection of "trips," each trip being considered independent of other trips.

The activity-based approach can lead to improved evaluations of the impact of policy actions because of the explicit consideration of the interrelationship in the choice attributes (such as time of participation, location of participation, and mode of travel) of different activity episodes within a tour and, therefore, the recognition of the temporal, spatial, and modal linkages among activity episodes within a tour. Take, for example, an individual who drives alone to work and makes a shopping stop on the way back home from work (see Figure 6.2). The home-work and work-home trips in this scenario are not independent.

Now consider an improvement in transit between the home and the work place. The activity-based approach would recognize that the individual needs to make a stop on the return home from work and so may not predict a shift to transit for the work tour (including the home-work, work-shop, and shop-home trips), while a trip-based model would break the tour into three separate and independent trips—a home-based work trip, a nonhome-based nonwork trip, and a home-based nonwork trip—and would be more likely (and inaccurately so) to shift the morning home-based work trip contribution of the individual to transit.

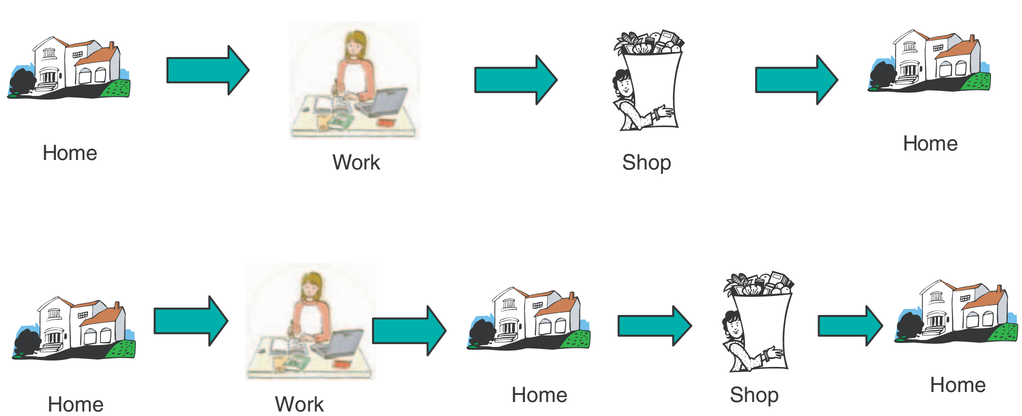


Figure 6.1. Temporal substitution of trips.

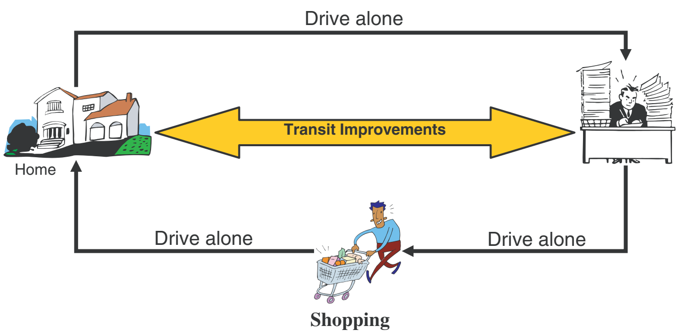


Figure 6.2. Trip sequencing and interrelationship in attributes of linked trips.

In fact, the close association between mode choice for the work commute and stop making along the way is now well established. For instance, a study of Austin area workers (Bhat, 2004) found that the drive-alone mode share was 70 percent for commuters who never stopped on the way to or from work, compared to 87 percent for commuters who sometimes made a stop. Correspondingly, the share of commuters who used transit or a nonmotorized mode was higher for individuals who did not make a commute stop.

A third defining feature of the activity-based approach relates to the way the time dimension of activities and travel is considered. In the trip-based approach, time is included as a "cost" of making a trip and a day is viewed as a combination of broadly defined peak and off-peak time periods (see, for example, the time-of-day modeling discussion in Section 4.9). On the other hand, the activity-based approach views individuals' activity-travel patterns as a result of their time use decisions within a continuous time domain. Individuals have 24 hours in a day (or multiples of 24 hours for longer periods of time) and decide how to use that time among (or allocate that time to) activities and travel (and with whom), subject to their sociodemographic, spatial, temporal, transportation system, and other contextual constraints. These decisions determine the generation and scheduling of trips. Hence, determining the impact of travel demand management policies on time use behavior is an important precursor step to assessing the impact of such policies on individual travel behavior.

Take the example of a worker who typically leaves work at 5:00 p.m. (say, the start of the afternoon peak period), drives to a grocery 15 minutes away, spends about 25 minutes shopping, and then gets back home by 6:00 p.m. (Figure 6.3). In response to an early release from work policy designed by the employer that lets the employee off from work at 4:00 p.m. instead of 5:00 p.m., a naïve model system may predict that the person would be off the road and back home by 5:00 p.m. (i.e., before the peak period begins; see the middle pattern in Figure 6.3). But the individual, now released from work earlier and having more time on his hands after work, may decide to drive a longer distance to a preferred grocery where he spends more time shopping (70 minutes rather than 25 minutes) and may eventually return home only at 6:00 p.m. (see the bottom pattern of Figure 6.3). So, in the case of this individual, not only would the policy be ineffective in keeping the person off the road during the peak period, but also the longer time spent at the grocery (in emissions analysis terms, the "soak duration," the period between successive trips when the vehicle is not operational) would have adverse air quality implications. The activity-based model is able to consider such interactions in space and time due to its emphasis on time use and thus can produce more informed evaluations of policy actions.

Another feature of the activity-based approach is the recognition of interactions among household members, which leads to the accommodation of linkages among trips of household members. As a result, policy actions could have complex

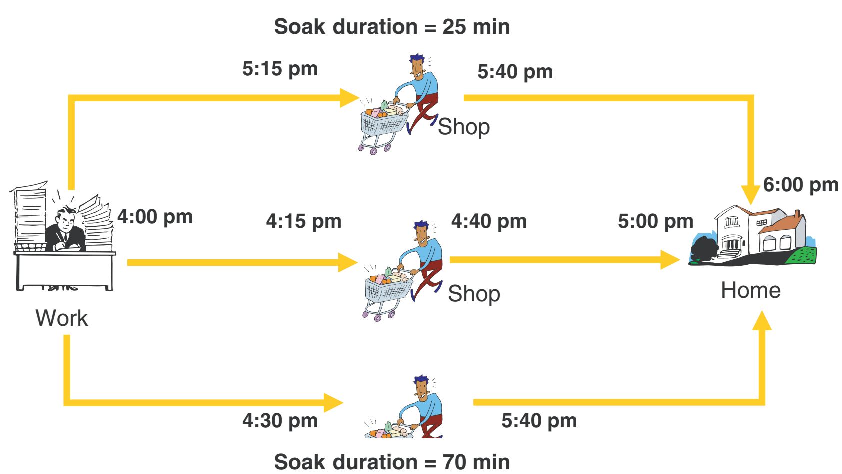


Figure 6.3. Duration and timing of activities and trips.

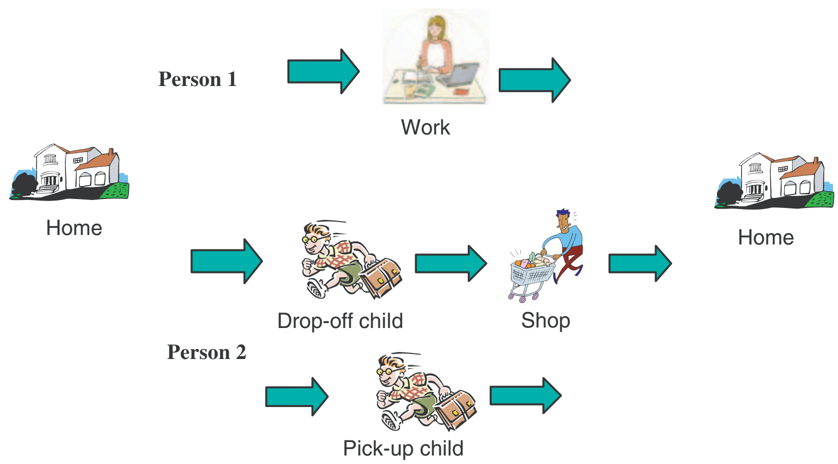


Figure 6.4. Resource sharing—linkages among trips of household members.

responses, as shown in Figure 6.4. Consider that Person 1 (the worker) was originally dropping off the child at school in the mornings and picking up the child from school in the evenings, as part of the commute. Assume a pricing strategy on a corridor that connects the school location and the worker's work location. Because of this pricing policy, the worker may not pursue the drop-off/pick-up tasks himself and has a simple home-work-home pattern (top pattern of Figure 6.4). But now Person 2 (the nonworker) generates drop-off and pick-up trips, perhaps supplemented with shopping stops during his drop-off/pick-up trips.

Such an explicit modeling of interindividual interactions and the resulting joint travel is particularly important to examine the effects of occupancy-specific tolling strategies such as HOV and HOT lanes (Davidson et al., 2007). Another way that household linkages in activities can have an effect on responses to policies is through a reluctance to change the spatial and temporal attributes of joint activity episode participations. For instance, serve passenger trips (such as dropping off/picking up children from daycare/school or other extracurricular activities) and joint social/recreational out-of-home activities of household members may not be moved around much because of schedule constraints. Acknowledging such joint interactions can, therefore, potentially lead to a more accurate evaluation of policy actions.

A final important feature of activity-based approaches relates to the level of aggregation of decision makers used in the estimation and application of the models. In the trip-based approach, several aspects of travel (number of trips produced and attracted from each zone, trip interchanges, and mode split) are usually (though not always) estimated and/or applied at a relatively aggregate level of decision makers (such as at the spatial level of travel analysis zones). The activity-based models, on the other hand, have the ability to relatively easily accommodate virtually any number of decision factors related to the sociodemographic characteristics of the individuals who actually make the activity-travel choices. Using microsimulation techniques, activity-based models predict the entire activity-travel patterns at the level of individuals (while recognizing temporal/spatial constraints across individuals of a household due to joint activity participations and serve passenger activities). Such a methodology ensures a realistic, consistent, and integral prediction of activity-travel patterns, which should lead to the better aggregate prediction of travel flows on the network in response to demographic changes or policy scenarios. Thus the activity-based models are well equipped to forecast the longer-term changes in travel demand in response to the changes in the sociodemographic composition and the activity-travel environment of urban areas, as well as in response to land use and transportation policies.

6.2 Activity-Based Travel Model Systems in Practice

6.2.1 Overall Process for Activity-Based Model Systems

The overall process used in the implementation of an activity-based model system comprises a sequence of three broad steps:

1. Population synthesis;
2. Long-term choice models; and
3. Activity-based travel models.

Activity-based model systems require as inputs the information on each (and every) individual and household of the population of the study area, because the systems simulate the activity-travel patterns of each individual in the study area. Such disaggregate-level sociodemographic inputs are generated by synthesizing (i.e., simulating) the population of the study area. This synthesis is achieved by using zonal-level (or other levels of geography such as the block level or parcel level) forecasts of sociodemographic variables (such as household size, structure, and income) as controls for sampling households using data from sources such as the ACS PUMS. At the end, the population synthesis procedure provides a synthetic sample of all households and individuals in the study area with information on household residential locations and all control variables used in the synthesis procedure.

Several other socioeconomic attributes (which are not used as control variables) required by the activity-travel models are either directly borrowed from the households drawn from the PUMS data, or generated by a separate set of disaggregate models. The use of separate disaggregate models has the advantage that it provides natural variation in the predicted socioeconomic attributes, rather than "replicating" PUMS individuals and households. Some activity-based systems generate the synthetic population based on a two-way control mechanism for both household-level attributes as well as individual-level attributes.

After the population synthesis, the longer-term decisions such as auto ownership, work locations, and school locations are determined to recognize that such decisions are longer-term decisions that are not adjusted on a daily basis. Subsequent to the determination of long-term choices, the synthetic population of households and individuals is "processed" through the activity-based travel model system, as discussed in more detail in the following sections.

6.2.2 Generic Structure of Activity-Based Systems

Activity-based model systems used in practice typically consist of a series of utility maximization-based discrete choice models (i.e., multinomial logit and nested logit models) that are used to predict several components of individuals' activity-travel decisions. In addition to such utility maximization-based model components, some model systems employ other econometric structures, including hazard-based duration structures and ordered response structures to model various activity-travel decisions. In effect, these model systems employ econometric systems of equations to capture relationships between individual-level sociodemographics and activity-travel environment attributes on the one hand and the observed activity-travel decision outcomes on the other. As of 2011, MPOs within the United States that have developed an activity-based travel model include Portland, Oregon; San Francisco, Sacramento, and Los Angeles, California; New York, New York; Columbus, Ohio; Denver, Colorado; and Atlanta, Georgia. Several other urban areas have activity-based models under development.

While there are quite substantial variations among the many activity-based modeling systems in the precise sequence and methods used to predict the entire activity-travel pattern of each individual, all of these systems essentially include a three-tier hierarchy of (1) day-level activity pattern choice models (or, simply, pattern-level choice models); (2) tour-level choice models; and (3) trip/stop-level choice models. The choice outcomes from models higher in the hierarchy (assumed to be of higher priority to the decision maker) are treated as known in the lower-level models. The pattern-level models typically provide a skeletal daily pattern for each individual, including whether the individual goes to work (or school, if the person is a student), whether the individual takes any children to/from school, any joint activities (and their purposes) among individuals in a household and the individuals involved, individual participations in activities by purpose, and number of total tours (home- and work-based) in the day.

The tour-level models typically determine the number of stops in a tour by purpose and their sequence, the travel mode for the tour, and the time of day and duration of the tour. For workers, tours are constructed based on focusing on the home-work and work-home commutes first, along with the number of stops, sequence, and travel mode during the commutes. Next, other tours during the day are constructed; those with joint activities are usually given scheduling precedence. For nonworkers, tours relating to serve passenger stops (including dropping off/picking up children from school/day care) and tours with joint activities may get scheduling precedence. Finally, the stop-level models predict the stop location, mode choice, and time of day of travel for each of the stops in each tour.

6.2.3 Data Needs for Estimation of Activity-Based Systems

The primary sources of data for the estimation of tour- and activity-based models are household activity and/or travel surveys. As the term "household activity and/or travel surveys" suggests, the surveys can be either travel surveys (that collect information on out-of-home travel undertaken by the household members) or activity-travel surveys (that collect information on out-of-home activities and associated travel). Both the surveys implicitly or explicitly collect information on (1) household-level characteristics, (2) individual-level characteristics, and (3) information on the activity/travel episodes undertaken by the individuals. Activity surveys, however, also may collect additional information on individuals' activities, specifically the participation in, timing, and duration of in-home and joint activities.

It should be noted that the development of several activity-based models to date has involved the use of household travel survey data that are not any different from those collected and used by regional MPOs for their trip-based model development and calibration. Thus, the notion that activity-based models are data hungry is not necessarily accurate, at least at the estimation stage (though, activity-based models would perhaps benefit more from larger sample sizes than would trip-based models, especially from the standpoint of estimating models of joint activity participation). The estimation of activity-based models does require more extensive efforts (relative to a trip-based approach) in preparing the data to construct the entire sequence of activities and travel, but such intense scrutiny of data also helps identify data inconsistencies that might go unchecked in the trip-based approach. For example, there might be "gaps" in an individual's travel diary because of non-reporting of several trips; these will be identified during data preparation for activity analysis but may not be identified in the trip-based approach because it highlights individual trips and not the sequence between trips and activities.

Data on regional land use and transportation system networks also are typically used in model estimation. Land use data include information on the spatial residential characteristics of households, employment locations, and school and other locations at the level of spatial resolution (for example, zones or parcels) used in the models. The typical land use information includes size and density measures, such as number of households, population, area (or size), employment by each category of employment, household density, population density, and employment density for each category of employment. In addition, one or more of the following land use data also are used by some activity modeling systems: (1) land use structure information, such as the percentage of commercial, residential, other developed, and open areas; percentage of water coverage; and the land use mix; (2) sociodemographic characteristics, such as average household size, median household income, ethnic composition, housing characteristics such as median housing value, and housing type measures (single- and multiple-family dwelling units); and (3) activity opportunity measures such as activity center intensity (i.e., the number of business establishments within a fixed network distance) and density (i.e., the number of business establishments per square mile) for each of several activity purposes.

Transportation network data needed in activity models are similar to data used in trip-based models and typically include highway network data, transit network data, and nonmotorized mode data. The transportation system performance data should be of high quality, with time-varying LOS characteristics (in-vehicle, out-of-vehicle, access, egress, and wait times) across different time periods, as well as across different location pairs.

6.2.4 Data Needs for Application of Activity-Based Systems

Once the activity-based modeling system has been estimated using the data sources discussed in the previous section, the application of these activity-based models for a study area for a base year requires as inputs the information on all individuals and households of the study area for the base year. Synthetic population generation techniques are used for this purpose, sometimes supplemented with a series of other demographic models (see Section 6.2.1). For a future-year forecasting exercise, the inputs should consist of the future-year synthetic population and land use and LOS data. Thus, activity-based model development should be supported with the development of detailed input data (i.e., the synthetic population and LOS and land use data) for future years. This can be done either by using aggregate demographic and land use projections for future years and applying a synthetic population generator (just as in the base year) or "evolving" the base-year synthetic population (see Eluru et al., 2008). More details on this are provided in Section 6.3.1.

6.2.5 Data Needs for Calibration and Validation of Activity-Based Systems

The following data sources can be used to calibrate and validate activity-based model systems:

- Validation of input data
  - The base-year synthetic population inputs can be validated against census data.
  - To validate the input work locations, the home-work trip lengths and patterns can be matched against those in observed data sources such as CTPP.
  - To validate the vehicle ownership inputs, census data and perhaps other sources such as motor vehicle department estimates of auto registrations can be used.
- Calibration and validation of activity-travel outputs
  - Each component of the activity-travel model system can be validated by comparing its predictions to the observed activity-travel patterns in the household activity-travel survey.
  - The commute mode choice model can be validated using data such as CTPP.
  - The entire model system can be validated by comparing the traffic assignment outputs with the observed traffic volumes in the study area.
  - Highway traffic assignment validation can be undertaken by using observed traffic volumes by time of day, while transit traffic assignment validation can be pursued by using transit boarding/alighting data by route and stop by time of day from an on-board transit survey/count.

Along with the above-identified base-year calibrations and validations, it is essential to understand the forecasting ability and the policy sensitivity of activity-based models for nonbase-year conditions.

To test the forecasting ability, the model performance for past years (for example, year 1990) and for existing "future" years relative to the base year for the travel modeling effort (for example, year 2010) can be compared with the observed patterns in those years. For this purpose, complete input data (including the aggregate sociodemographic variable distributions for synthetic population generation, and the land use and LOS data), observed traffic volumes, household activity-travel survey data, and the census data (if available) are required for past years and existing "future" years. In this regard, it is important that the regional planning agencies store and document the land use data and transportation network data of past and existing "future" years.

An examination of the policy sensitivity of activity-based models for nonbase-year conditions can be undertaken by assessing the impact on activity-travel patterns of changes in transportation system and land use patterns. To this end, in the recent past, several tests have been undertaken to assess the sensitivities of specific components of activity-based models to policy scenarios. Examples include (1) an analysis of the impact of LOS changes (systemwide and localized); (2) analyses of capacity expansion and centralized employment scenarios; (3) analysis of area pricing schemes; (4) assessment of the effect of shortened work days; (5) analyses of cordon pricing and increased transportation network connectivity scenarios; (6) user-benefit forecasts of light rail transit projects; (7) equity analysis of transportation investment impacts; (8) examination of the impacts of land use and urban form on area travel patterns; (9) analysis of congestion pricing policies; (10) analysis of FTA New Starts projects; and (11) analysis of transit investments. Such an examination of the response to several policy scenarios can be a useful assessment of the abilities of the activity-based model system (especially when compared with the outputs from a trip-based model system).

The scenario approach discussed above to assessing the policy sensitivity of activity-based models, however, may not completely represent the complexity of real-life projects and policies. Furthermore, sensitivity testing using test scenarios serves only as a broad qualitative reasonableness assessment of performance, rather than a quantitative performance measurement against observed data. A more robust way to quantify and assess the predicted policy sensitivity from activity-based models is to compare the model predictions with real-world data before—and after—real-life transportation infrastructure investments or policy actions. Hence, it is important to collect traffic counts and other travel pattern data before—and after—any major transportation infrastructure investments or policy actions.

6.2.6 Software for Activity-Based Modeling

At present, there are no readily available standard software packages to apply activity-based models. The model systems developed for various MPOs have been developed and implemented as customized stand-alone software, and then integrated with standard proprietary modeling software for such purposes as network skimming, matrix manipulation, and highway and transit assignment. Most activity model systems are coded using C++, C#, Python, or Java and make use of an object-oriented approach, which offers the advantages of code reuse, software extensibility, and rapid implementation of system variants.

6.2.7 Challenges of Developing and Applying Activity-Based Modeling Systems

The development of activity-based models requires careful and extensive data preparation procedures to construct entire "sequences" of activities and "tours" of travel. The data preparation process for the activity-based modeling is involved and requires skilled and experienced personnel. Furthermore, as mentioned previously, activity-based model development is associated with an initial overhead of data preparation, model estimation, calibration and validation, and the process of "putting it all together" into customized software. However, once the model system is developed, the system can be packaged as user-friendly travel demand modeling and policy analysis software. Further, the software can be sufficiently generic to allow its use in any study area, provided the model parameters for that area are available.

The implementation of activity-based models (for either the base year or for future years) requires the end user to be well aware of the details of the system. Another implementation challenge is the significant amount of run time, because activity-based models simulate the activity-travel patterns of each (and every) individual of a study area. However, it appears that the run times can be significantly reduced by one or more of the following techniques:

- Simulation of the activity-travel patterns of a sample of the population without substantially compromising the accuracy of the aggregate-level outputs;
- Efficient computing strategies such as data caching and multi-threading;
- "Clever" methods of model specification where dummy exogenous variables are used so that a substantial part of the computations in the application context can be undertaken for market segments (defined by combinations of dummy exogenous variables) rather than for each individual in the population; and
- Use of cloud (or cluster) computing approaches that use several parallel processors at the same time.

The implementation challenges associated with activity-based models appear to be higher for the forecast-year implementation rather than for the base-year implementation, primarily because of the need to generate detailed socioeconomic input data for the forecast years. Also, the development of future-year parcel-level land use data is a challenge associated with the implementation of models that use parcel-level data. And in rapidly growing areas, there may be many more synthetic persons and households to simulate than in the base year.

Finally, while the required technical background, resource requirements for development and maintenance, implementation challenges, and institutional issues associated with ownership of activity-based models are immediately evident, the need remains to assess, document, and demonstrate the potential practical benefits of these models.

6.3 Integration with Other Model Systems

The recognition of the linkages among sociodemographics, land use, and transportation is important for realistic forecasts of travel demand, which has led practitioners and researchers to develop approaches that capture sociodemographic, land use, and travel behavior processes in an integrated manner. Such behavioral approaches emphasize the interactions among population socioeconomic processes; the households' long-term choice behaviors; and the employment, housing, and transportation markets within which individuals and households act (see Waddell, 2001). From an activity-travel forecasting perspective, these integrated urban modeling systems need to consider several important issues that are outlined in this section. Some elements of this integration with activity-based models already have been introduced at several MPOs.

6.3.1 Generation of Disaggregate Sociodemographic Inputs for Forecast Years

As indicated in Section 6.2.3, activity-based travel forecasting systems require highly disaggregate sociodemographics as inputs, including data records of each and every individual and household in the study area. Hence, disaggregate population generation procedures are used to create synthetic records of each and every individual and household for activity-travel microsimulation purposes. However, to be able to forecast the individual activity-travel patterns and aggregate transportation demand at a future point in time, activity-based travel demand models require, as inputs, the disaggregate sociodemographics, and the land use and transportation system characteristics of that future point in time.

While synthetic population generator (SPG) procedures can be used for this purpose as a first step operationalization strategy, these procedures work off aggregate demographic and land use projections for future years rather than the more desirable route of evolving the base-year population. Specifically, individuals and households evolve through a sociodemographic process over time. As the sociodemographic process unfolds, individuals may move into or out of life-cycle stages such as schooling, the labor market, and different jobs. Similarly, households may decide to own a house as opposed to rent, move to another location, and acquire/dispose of a vehicle. Such sociodemographic processes need to be modeled explicitly to ensure that the distribution of population attributes (personal and household) and land use characteristics are representative at each point of time and are sufficiently detailed to support the activity-travel forecasting models.

There have been relatively limited attempts to build models of sociodemographic evolution for the purpose of travel forecasting. Examples in the transportation field include the CEMSELTS system by Bhat and colleagues (Eluru et al., 2008), the DEMOgraphic (Micro) Simulation (DEMOS) system by Sundararajan and Goulias (2003), and the Microanalytic Integrated Demographic Accounting System (MIDAS) by Goulias and Kitamura (1996). Examples from the non-transportation field include DYNACAN (Morrison, 1998), and LIFEPATHS (Gribble, 2000).

6.3.2 Connecting Long- and Short-Term Choices

Many (but not all) operational activity-based travel demand models treat the longer-term choices concerning the housing (such as residential tenure, housing type, and residential location), vehicle ownership, and employment choices (such as enter/exit labor market and employment type) as exogenous inputs. Consequently, the land use (in and around which the individuals live, work, and travel) is treated as exogenous. In such cases, the possibility that households can adjust with combinations of short- and long-term behavioral responses to land use and transportation policies is systematically ignored (see Waddell, 2001). A significant increase in transportation costs, for example, could result in a household adapting with any combination of daily activity and travel pattern changes, vehicle ownership changes, job location changes, and residential location changes.

While many travel forecasting models treat the long-term choices and hence the land use as exogenous to travel behavior, there have been recent attempts to model the longer- and shorter-term choices in an integrated manner. These include OPUS/UrbanSim (Waddell et al., 2006), CEMUS (Eluru et al., 2008), ILUTE (Salvini and Miller, 2005), and ILUMASS (Strauch et al., 2003). There also have been models studying the relationships between individual elements of land use-related choices and travel behavior choices. However, most of these models and model systems are trip based. That is, although these models attempt to study the land use and travel behavior processes in an integrated manner, the travel behavior aspect of these models is based on a trip-based approach.

6.3.3 Demand-Supply Interactions

The end use of travel forecasting models is, in general, the prediction of traffic flow conditions under alternative sociodemographic, land use, and transportation LOS scenarios. The traffic flow conditions, which are usually predicted after a traffic assignment procedure, are a result of the interactions between the individual-level demand for travel and the travel options and LOS (or the capacity) supplied by the transportation system. At the same time, the activity-travel patterns predicted by an activity-based modeling system (that are input into traffic assignment) are themselves based on specified LOS values. Thus, as in a traditional trip-based model, one needs to ensure that the LOS values obtained from the traffic assignment procedure are consistent with those used in the activity-based model for activity-travel pattern prediction. This is usually achieved through an iterative feedback process (see Section 1.3) between the traffic assignment stage that outputs link flows/LOS and the activity-based travel model that outputs activity-travel patterns. It is important to consider such demand-supply interactions for accurate predictions of activity-travel behavior, and the resulting traffic flow conditions. Further, since the travel LOS varies with the temporal variation in travel demand, and the demand for travel is, in turn, dependent on the transportation level of service, the interactions may be time-dependent and dynamic in nature. Thus, it is important to consider the dynamics of the interactions between travel demand and the supply of transportation capacity (see next section for additional details).

Similar to how transportation market processes (i.e., the interactions between individual-level travel demand and the transportation supply) influence the individual-level activity-travel patterns, the housing and labor market processes influence the residential and employment choices of individuals. In fact, individuals act within the context of, and interact with, housing, labor, and transportation markets to make their residential, employment, and activity-travel choices. While the transportation market process may occur over shorter timeframes (such as days or weeks), the employment and housing market processes are likely to occur over longer periods of time. That is, in the short term, the daily activity-travel patterns are directly influenced by the dynamics of the interaction between travel demand and supply; while in the long term, the activity-travel behavior is indirectly affected by the impact of housing and labor market processes on the residential and employment choices, and also on the land use and transportation system. If the activity-travel behavior of individuals and households is to be captured properly over a longer timeframe, the interactions with, and the evolution over time of, all these markets should be explicitly considered, along with the sociodemographic processes and the long-term housing and employment choices.

6.3.4 Traffic Simulation

The precise form of the interaction between an activity-based model and a traffic assignment model (as discussed in the previous section) depends on the nature of the assignment model used. In many places where activity-based models have been implemented in practice, it is not uncommon to convert the activity-travel patterns into trip tables by travel mode for four to five broad time periods of the day, and then load the time period-specific trip tables using a traditional static traffic assignment (STA) methodology. This static assignment methodology uses analytic link volume-delay functions, combined with an embedded shortest path algorithm, to determine link flows and link travel times (see Section 4.11). In such a static assignment approach, there is, in general, no simulation of individual vehicles and no consideration of temporal dynamics of traffic flow.

On the other hand, an important appeal of the activity-based approach is that it predicts activity-travel patterns at a fine resolution on the time scale. Thus, using an activity-based model with a static assignment process undoes, to some extent, the advantages of predicting activity-travel patterns at a fine time resolution. This limitation, and the increase in computing capacity, has allowed the field to move toward a dynamic traffic assignment (DTA) methodology. The DTA methodology offers a number of advantages relative to the STA methodology, including the ability to address traffic congestion, build-up, spillback, and oversaturated conditions through the explicit consideration of time-dependent flows and the representation of the traffic network at a high spatial resolution. As a result, DTA is able to capture and evaluate the effects of controls (such as ramp meters and traffic lights), roadway geometry, and intelligent transportation system (ITS) technology implementations.

Some literature on analytical method-based DTA models exists. However, the implementation of most DTA models relies on a microsimulation platform that combines (and iterates between) a traffic simulation model (to simulate the movement of traffic) with time-dependent routing algorithms and path assignment (to determine flows on the network). In particular, the traffic simulation model takes a network (nodes, links, and controls) as well as the spatial path assignment as input, and outputs the spatial-temporal trajectories of vehicles as well as travel times. The time-dependent shortest path routing algorithms and path assignment models take the spatiotemporal vehicle trajectories and travel times as input, and output the spatial path assignment of vehicles. The two models are iterated until convergence between network travel times and vehicle path assignments. In this process, the traffic simulation model used may be based on macroscopic traffic simulation (vehicle streams considered as the simulation entity and moved using link volume-delay functions), mesoscopic traffic simulation (groups of vehicles considered as "cells" and treated as the simulation entity), or microscopic traffic simulation (each individual vehicle considered as the simulation entity, incorporating intervehicle interactions). Macroscopic and mesoscopic traffic simulation models are less data hungry and less computationally intensive than microscopic models, but also are limited in their ability to model driver behavior in response to advanced traffic information/management systems.

Most earlier DTA efforts have focused on the modeling of private car traffic, though a few recent research efforts (see, for example, Rieser and Nagel, 2009) have integrated mode choice and departure time choice within a microsimulation-based DTA model, thus moving further upstream in integrating activity-based models with dynamic traffic assignment. Recently, there have been other efforts under way that explore the complete integration of activity generation, scheduling, traffic simulation, route assignment, and network loading within a multiagent microsimulation platform. For example, Project C10 of the second Strategic Highway Research Program (SHRP 2), "Partnership to Develop an Integrated, Advanced Travel Demand Model," is developing integrated models that include activity-based demand model and traffic simulation model components, taking advantage of the disaggregate application approach in both components (Cambridge Systematics, Inc. and National Academy of Sciences, 2009; Resource Systems Group and the National Academy of Sciences, 2010).

Activity-based modeling also can be integrated with models of transit passenger simulation. Person tours generated by the activity-based model that are fully or partially made via transit can have their transit paths simulated individually. This individual simulation requires the specification of all transit vehicle runs and stops and the assigning of passenger trips to these runs and stops, along with their walk and auto access and egress components. One of the SHRP2 C10 tasks is incorporating this capability.

The greatest impediments to regionwide traffic simulation are the expensive computational resources and time needed (though distributed and parallel implementation designs are possible), and the costs and complexity of data acquisition/management and model calibration (though GIS tools and GPS-based vehicle survey techniques are making this easier).

Note that the use of DTA does not require an activity-based model; in fact, DTA has been used in connection with conventional (i.e., four-step) models for some time. In such cases, the aggregate results of the conventional models (i.e., trip tables) are converted to disaggregate lists of trips to be simulated. Thus, disaggregate activity-based demand models have often been used with aggregate assignment techniques, and aggregate demand models have been used with disaggregate assignment techniques. The connection between disaggregate demand and assignment models is the subject of much contemporary research and development.

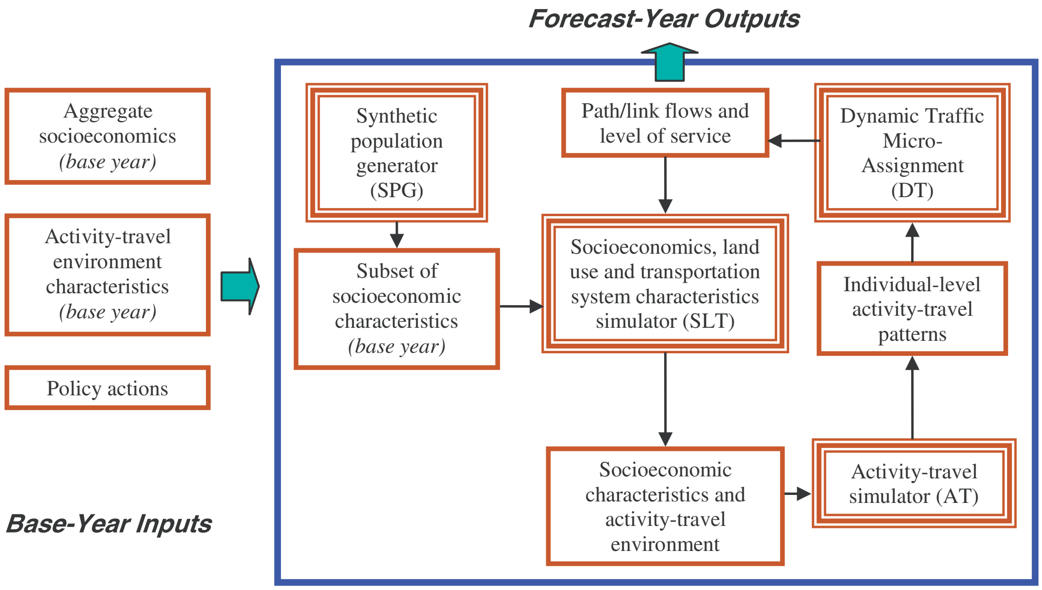
6.3.5 Example of an Integrated Urban Modeling System

In view of the preceding discussion, ideally, activity-based travel demand models should be integrated with other models that can forecast, over a multiyear timeframe, the sociodemographic processes, the housing and employment market processes, and traffic flows and transportation system conditions. The integrated model system should be able to capture the previously discussed demand-supply interactions in the housing, employment, and transportation markets. A conceptual framework of such a system is provided in Figure 6.5.

The integrated system places the focus on households and individuals, and businesses and developers that are the primary decision makers in an urban system. The system takes as inputs the aggregate socioeconomics and the land use and transportation system characteristics for the base year, as well as policy actions being considered for future years. The aggregate-level base-year socioeconomic data are first fed into an SPG module to produce a disaggregate-level synthetic data set describing a subset of the socioeconomic characteristics of all the households and individuals residing in the study area. Additional base-year socioeconomic attributes—related to mobility, schooling, and employment at the individual level and residential/vehicle ownership choices at the household level—that are difficult to synthesize (or cannot be synthesized) directly from the aggregate socioeconomic data for the base year are simulated by the socioeconomics, land use, and transportation (SLT) system simulator.

The base-year socioeconomic data, along with the land use and transportation system attributes, are then run through the daily activity-travel pattern (AT) simulator to obtain individual-level activity-travel patterns. The activity-travel patterns are subsequently passed through a dynamic traffic micro-assignment (DT) scheme to determine path flows, link flows, and transportation system level of service by time of day [see Lin et al. (2008) for a discussion of recent efforts on integrating an activity-travel simulator and a dynamic traffic microsimulator]. The resulting transportation system LOS characteristics are fed back to the SLT simulator to generate a revised set of activity-travel environment attributes, which is passed through the AT simulator along with the socioeconomic data to generate revised individual activity-travel patterns. This "within-year" iteration is continued until base-year equilibrium is achieved. This completes the simulation for the base year.

The next phase, which takes the population one step forward in time (i.e., 1 year), starts with the SLT simulator updating the population, urban form, and the land use markets



Source: Modified from Eluru et al. (2008).

Figure 6.5. An integrated model system.

(note that SPG is used only to generate the disaggregate-level synthetic population for the base year and is not used beyond the base year). An initial set of transportation system attributes is generated by SLT for this next time step based on (1) the population, urban form, and land use markets for the next time step; (2) the transportation system attributes from the previous year in the simulation; and (3) the future-year policy scenarios provided as input to the integrated system. The SLT outputs are then input into the AT system, which interfaces with the DT scheme in a series of equilibrium iterations for the next time step (just as for the base year) to obtain the "one-time step" outputs. The loop continues for several time steps forward until the socioeconomics, land use, and transportation system path/link flows and transportation system LOS are obtained for the forecast year specified by the analyst. During this iterative process, the effects of the prescribed policy actions can be evaluated based on the simulated network flows and speeds for any intermediate year between the base year and the forecast year.

6.4 Summary

Activity-based model systems are different from the conventional trip-based model systems in five major aspects. First, activity-based systems recognize that travel is derived from the need to pursue activities at different points in space and time, and thus focus on modeling activity participation. Second, activity-based model systems use a tour-based structure to represent and model travel patterns. Tours are defined as chains of trips beginning and ending at a same location, say, home or work. Such representation captures the interdependency (and consistency) of the modeled choice attributes among the activity episodes of the same tour. Third, activity-based model systems view individuals' activity-travel patterns as a result of their time use decisions within a continuous time domain, subject to their sociodemographic, spatial, temporal, transportation system, and other contextual constraints. Fourth, activity-based systems accommodate for interactions and joint activity participations among individuals in a household. Finally, activity-based systems simulate the activity-travel patterns of each (and every) individual of the study area using a microsimulation implementation that provides activity-travel outputs that look similar to survey data and can allow analysis of a wide range of policies on specific sociodemographic segments.

Activity-based travel models are increasingly being adopted by the larger MPOs in the country and offer a more comprehensive and potentially more accurate assessment of policies to enhance mobility and reduce emissions. While the principle behind the activity-based analysis approach has existed for at least three decades now, it is only in the past 5 to 10 years that the approach has started to see actual implementation. As a result, there has been no formal analysis of transferability of parameters and model structures in space and/or time in the context of activity-based models. This area will inevitably see increasing attention in the near future. Future versions of this report might include information on the potential transferability of activity-based modeling parameters and possibly some specific transferable parameters.

CHAPTER 7

Case Studies

7.1 Introduction

As discussed in Chapter 5, there are two primary uses for the data provided in this report:

- Developing travel model components when no local data suitable for model estimation are available and
- Checking the reasonableness of model components developed using local data.

In the first case, local data should be collected to validate the models or model components developed based on this report. In the second case, the data in this report can be used to supplement and support the validation and reasonableness checking process.

This chapter presents two case studies to illustrate the use of the report for these purposes. In the first case study, the MPO for a large metropolitan area, Gtown, has recently conducted a household activity/travel survey, and has recalibrated its model using the new data. The information from this report is used to verify that the model parameters and results from this recalibration are reasonable. Note that this case study does not represent the entire validation effort for such a model, which must include other checks (for example, sensitivity tests and checks of forecasts). The second case study is for a small urban area, Schultzville, that has never had a travel forecasting model and does not have any area-specific travel data. The MPO for this area has borrowed the model structure from another small area and is using that structure to develop a model for its area.

7.2 Model Reasonableness Check

Gtown is a large metropolitan area with more than 5 million residents and a diverse public transportation system that includes various rail and bus services. A household activity/travel survey was completed 3 years ago; and data from that survey, transit surveys, and traffic counts have been used by MPO staff to recalibrate the trip-based travel forecasting model for the area. The MPO staff wants to make sure that the newly calibrated model is reasonable and has decided to compare model parameters and selected model results with information contained in this report.

In this section, parameters from the recalibrated Gtown model are compared to those provided in Chapter 4 of this report. The information provided in Chapter 4 often does not use the same variables or uses them at different levels of aggregation. Therefore, throughout this section, either parameters from Chapter 4 or the Gtown data are aggregated to make them comparable. One prime example of this difference relates to trip purpose. The Gtown model has five trip purposes: home-based work (HBW), home-based shop (HBS), home-based other (HBO), nonhome-based work (NHBW), and nonhome-based other (NHBO). Parameters and data in Chapter 4 are provided for three purposes: HBW, home-based nonwork (HBNW), and nonhome based (NHB) (alternatively, for four purposes, including home-based school, but this purpose is not used in the Gtown model). Therefore, for Gtown parameters to be compared to those in this report, the Gtown data for the five trip purposes must be collapsed to the classic three trip purposes.

7.2.1 Trip Generation

Trip Production Rates

Trip production rates for Gtown for all trip purposes are applied using a three-dimensional, cross-classification model with household size, number of vehicles, and income level as variables. All person trips are modeled, including nonmotorized trips.

Table C.5 in Appendix C provides HBW trip rates derived from NHTS data, based on three different cross-classifications; two of which are household size by number of vehicles and household size by income level. However, the income definitions in the Gtown model are significantly different than those in the NHTS data summaries. It was therefore decided to compare the rates using the household size by number of vehicles classification, as shown in the middle section of Table C.5. Table 7.1 shows this comparison. Note that the Gtown model uses only four household size categories (the largest is 4 or more persons), while the NHTS data summary in Table C.5 uses five categories (the largest is 5 or more persons).

As shown in Table 7.1, the Gtown trip production rate is 1.7 HBW trips per household, compared to 1.4 trips per household from Chapter 4; a difference of about 20 percent. This difference seems to be concentrated in smaller households, which predominantly are childless households. The Gtown MPO theorized that the difference may be due to a lower than average rate of retired people living in the region. In addition, Gtown has higher than average transit usage, and there may be more direct trips between home and work than in other areas since auto trips are more likely to include stops on the way to or from work (leading to more HBNW and NHB trips in place of HBW trips). The basic question for the MPO is whether the trip rates derived from their local survey are more reliable than those from the NHTS, which has a higher sample size but is a national sample collected mostly outside Gtown. Certainly, the difference indicates that checks of the Gtown survey data are warranted.

Table C.6 provides HBNW trip rates derived from NHTS data, based on three different cross-classifications, two of which are household size by number of vehicles and household size by income level. Separate rates are presented for areas with populations more than 500,000 and less than 500,000. The appropriate rates to use for this comparison are those for the areas of less than 500,000. It was decided to compare the rates using the household size by number of vehicles classification, as shown in the third section of Table C.6. Table 7.2 shows this comparison.

As shown in Table 7.2, the Gtown trip production rate is 4.6 HBNW trips per household, compared to 5.6 trips per household from Table C.6; a difference of nearly 20 percent. For HBNW trips, the differences seem to be across all household size and vehicle availability categories. Again, the differences indicate that further checks of the Gtown survey data are warranted.

Table C.7 provides NHB trip rates derived from NHTS data, based on three different cross-classifications, two of which are household size by number of vehicles and household size by income level. It was decided to compare the rates using the household size by number of vehicles classification, as shown in the middle section of Table C.7. Table 7.3 shows this comparison.

As shown in Table 7.3, the Gtown trip production rate is 2.3 NHB trips per household, compared to 3.0 trips per household from Table C.7; a difference of nearly 25 percent. For NHB trips, the differences seem to be across most household size and vehicle availability categories, although the differences are higher in larger households. Again, the differences indicate that further checks of the Gtown survey data are warranted.

Table 7.1. Comparison of Gtown HBW trip production rates to NHTS data from Table C.5.

NHTS Data (from Table C.5)

	Persons					
Autos	**1**	**2**	**3**	**4**	**5+**	**Average**
0	0.2	0.7	1.1	1.0	0.9	**0.5**
1	0.6	0.8	1.2	1.7	1.5	**0.8**
2	0.7	1.3	2.0	2.0	2.3	**1.6**
3+	0.9	1.4	2.6	2.9	3.3	**2.3**
Average	**0.5**	**1.2**	**2.0**	**2.3**	**2.4**	**1.4**

Gtown Trip Rates

	Persons				
Autos	**1**	**2**	**3**	**4**	**Average**
0	0.9	1.3	1.4	1.5	**1.1**
1	0.9	1.4	1.8	1.8	**1.3**
2	1.0	1.6	2.0	2.1	**1.8**
3+	1.0	1.7	2.4	2.7	**2.2**
Average	**0.9**	**1.5**	**2.1**	**2.2**	**1.7**

Table 7.2. Comparison of Gtown HBNW trip production rates to NHTS data from Table C.6.

NHTS Data (from Table C.6)

	Household Size					
Vehicles	**1**	**2**	**3**	**4**	**5+**	**Average**
0	1.4	3.8	5.6	7.5	10.0	**3.2**
1	1.9	3.9	6.5	9.0	11.8	**3.7**
2	2.4	4.0	6.5	11.0	14.0	**6.8**
3+	2.5	4.0	7.3	11.0	14.5	**8.6**
Average	**1.8**	**4.0**	**6.7**	**10.6**	**13.4**	**5.6**

Gtown Trip Rates

	Persons				
Autos	**1**	**2**	**3**	**4**	**Average**
0	1.6	2.3	2.9	3.4	**1.9**
1	1.6	3.2	4.4	7.4	**2.8**
2	1.7	3.3	5.4	8.3	**5.1**
3+	1.9	3.4	5.5	9.2	**6.2**
Average	**1.6**	**3.2**	**5.1**	**8.4**	**4.6**

Table 7.3. Comparison of Gtown NHB trip production rates to NHTS data from Table C.7.

NHTS Data (from Table C.7)

	Household Size					
Vehicles	**1**	**2**	**3**	**4**	**5+**	**Average**
0	0.7	1.7	2.0	3.7	3.9	**1.3**
1	1.4	2.3	3.5	3.9	3.9	**2.0**
2	1.6	2.6	3.9	5.5	5.6	**3.5**
3+	1.6	2.7	4.5	5.8	7.1	**4.4**
Average	**1.3**	**2.5**	**3.8**	**5.3**	**5.7**	**3.0**

Gtown Trip Rates

	Persons				
Autos	**1**	**2**	**3**	**4**	**Average**
0	1.0	1.3	1.7	2.1	**1.2**
1	1.4	2.0	2.3	3.1	**1.8**
2	1.7	2.1	2.3	3.2	**2.5**
3+	2.0	2.4	2.5	3.6	**2.9**
Average	**1.5**	**2.1**	**2.3**	**3.2**	**2.3**

When total trips per household by all purposes from the Gtown model are compared to the information presented in Tables C.5 through C.7, the overall rate for Gtown is 8.6 trips per household, 14 percent lower than the total of 10.0 trips per household derived from the NHTS in Chapter 4. Based on this analysis, Gtown rates are lower than the national average. NHTS rates are averages based on urban areas with different characteristics, and the rates for individual areas can be different. Furthermore, the higher Gtown rate for HBW trips, which are generally longer, may compensate for the lower overall rate.

Trip Attraction Rates

Table 4.4 summarizes average trip attraction rates from the MPO Documentation Database for the classic three trip purposes. The Gtown trip attraction model differs from the models shown in Table 4.4 in several ways. First, the employment categories used for the Gtown HBNW and NHB attraction models are defined differently than those in Table 4.4. For comparison purposes, the categories in the Gtown model were redefined to approximate those shown in Table 4.4. Second, the Gtown model stratifies trip attraction rates by area type. Weighted averages of Gtown's area type-specific models were used to compare to the models in Table 4.4.

The resulting comparison of trip attraction models is shown in Table 7.4. The models chosen for comparison from Table 4.4 were Model 1 for HBW, Model 3 for HBNW, and Model 2 for NHB. As can be seen in Table 7.4, the Gtown trip attraction rates are lower than the rates shown in Table 4.4, especially those for HBNW trips. The Gtown trip attraction models will generate fewer attractions than the models shown in Table 4.4. Since trip attractions are typically balanced to match productions, the effects of the lower trip attraction rates might be small, but it makes sense to further check the trip attraction model estimation results, as well as the balancing of productions and attractions. If the balancing process requires factoring up attractions to match productions, perhaps the rates could be adjusted upward.

7.2.2 Trip Distribution

The reasonableness of the Gtown trip distribution model can be assessed by comparing the friction factors used in the Gtown gravity model and the resulting average trip lengths with comparable values provided in Section 4.5.

Average Trip Length

Table C.10 provides average trip length by mode (travel times in minutes) for urban areas of different sizes. The Gtown model results should be compared to the figures from Table C.10 corresponding to areas of "1 million or more with subway or rail."

The Gtown trip distribution model produces a composite travel time that reflects highway and transit travel times. Table 7.5 compares the average trip times for all modes by trip purpose from Table C.10 and compares those trip lengths to the times resulting from the Gtown model. The average trip duration for HBW trips from the Gtown model is 48 minutes, compared to an average HBW trip duration from the NHTS of 32 minutes.

While most large metropolitan areas experience high levels of congestion during peak hours, the Gtown highway network is very congested during the peak periods, which can last 4 or more hours. Since most HBW trips are made during the peak periods, it can be expected that the travel time for those trips will be longer in Gtown than in other areas with a population over 3 million. Furthermore, Gtown encompasses a very large geographic area, also contributing to longer work trips. Another consideration is that Gtown has a relatively high transit share, and transit trips are longer than auto trips, as shown in Table C.10.

Table 7.4. Comparison of Gtown trip attraction rates to those shown in Table 4.4.

		Employment			
	Households	Basic	Retail	Service	Total
Home-Based Work					
Gtown Model					0.9
Model 1 from Table 4.4					1.2
Home-Based Nonwork					
Gtown Model	0.4	0.9	3.4		
Model 3 from Table 4.4	0.7	0.7	8.4	3.5	
Nonhome Based					
Gtown Model	0.1		3.3	0.7	
Model 2 from Table 4.4	1.4		6.9	0.9	

Table 7.5. Comparison of Gtown average trip length to NHTS data from Table C.10.

	All Modes (Minutes)			Average All Trips
	HBW	HBNW	NHB	
Gtown	48	17	20	24
NHTS Averages from Table C.10	32	18	20	22
Difference	16	−1	0	2
Percentage Difference	50%	−6%	0%	9%

Nonetheless, the large discrepancy between the Gtown average trip length for HBW trips and that of other large areas does warrant some further review. The 48-minute average travel time resulting from the model was compared to the time reported in the household travel survey and the 2000 CTPP. The average travel time reported for HBW trips in the household survey was also 48 minutes; and in the 2000 CTPP, it was 45 minutes, thus, confirming the modeled time.

The average travel time for HBNW and NHB trips resulting from the Gtown model compared more favorably to those shown in Table C.10. The mean HBNW travel time for Gtown is 17 minutes, compared to 18 minutes from the NHTS data. NHB travel times also compared favorably with both the Gtown and NHTS averages at approximately 20 minutes. The total travel time for all trips is 24 minutes from the Gtown model, which is 2 minutes longer than the time reported in Table C.10.

If the Gtown trip generation rates and travel times are viewed together, they seem more reasonable. Studies have shown that people will only travel a certain amount of time for all purposes during a given day. Thus, the longer-than-usual amount of time spent making work trips can result in fewer and shorter trips for other purposes. Thus, the lower HBNW and NHB trip generation rates in the Gtown model may result from higher HBW trip rates and longer travel times.

Gamma Function and Friction Factors

The Gtown model distributes trips separately for each of four income groups and five purposes. A useful reasonableness check is to compare the Gtown estimated model parameters to those developed in other regions. The estimated friction factors calibrated for Gtown are represented by gamma functions that can be compared to those reported by areas of similar size. Table 4.5 provides trip distribution gamma function parameters for eight MPOs, three of which are large. One way to compare friction factors used in the Gtown model to those resulting from the gamma functions for large MPOs in Table 4.5 is to compare the resulting graphs of friction factors to see if they are comparable.

Figure 7.1 is a graph of the HBW friction factors for Gtown compared to those for the three large MPOs reported in Table 4.5. Friction factors for the three large MPOs and for the four HBW income groups in the Gtown model are shown in Figure 7.1. The Gtown friction factors for the two higher incomes are almost exactly the same as those for MPO 3. The friction factors for the two lower incomes are not as steep but are comparable to those for the three sample MPOs.

Figure 7.2 is a graph of the HBS and HBO friction factors for Gtown compared to the HBNW friction factors for the three large MPOs. All of the Gtown friction factors lie between the values for MPO 1 and MPO 3, and the slopes for almost all purposes and income groups are very similar to that for MPO 1.

Figure 7.3 is a graph of the NHB friction factors for Gtown compared to those for the three large MPOs reported in Table 4.5. The Gtown friction factors for NHBO trips are similar to the NHB values for MPO 2. The Gtown friction factors for NHBW trips are not as steep as those for any of the MPOs. Since neither the NHBO or the NHBW friction factors are as steep as those from any of the large MPOs, it is unlikely that friction factors for a combination of NHBO and NHBW trips would match the values for any of the MPOs. However, since the average travel times for NHB trips from the Gtown model are the same as those from the NHTS, the difference in friction factors may not be significant.

7.2.3 Mode Choice

The Gtown model uses a nested logit mode choice model with coefficients for the classic three trip purposes. Auto submodes include drive alone and shared ride; and transit submodes include local, premium, and rail submodes (as well as separate models for auto and walk access). Variables used in the Gtown model include in-vehicle time, out-of-vehicle time, and a single cost variable. The coefficients of these variables are summarized in Table 7.6.

Tables 4.8, 4.11, and 4.14 present mode choice model parameters, by purpose, that are used by MPOs included in the MPO Documentation Database. For HBW trips, Models B, C, D, F, G, and I from Table 4.8, all of which are for urban areas

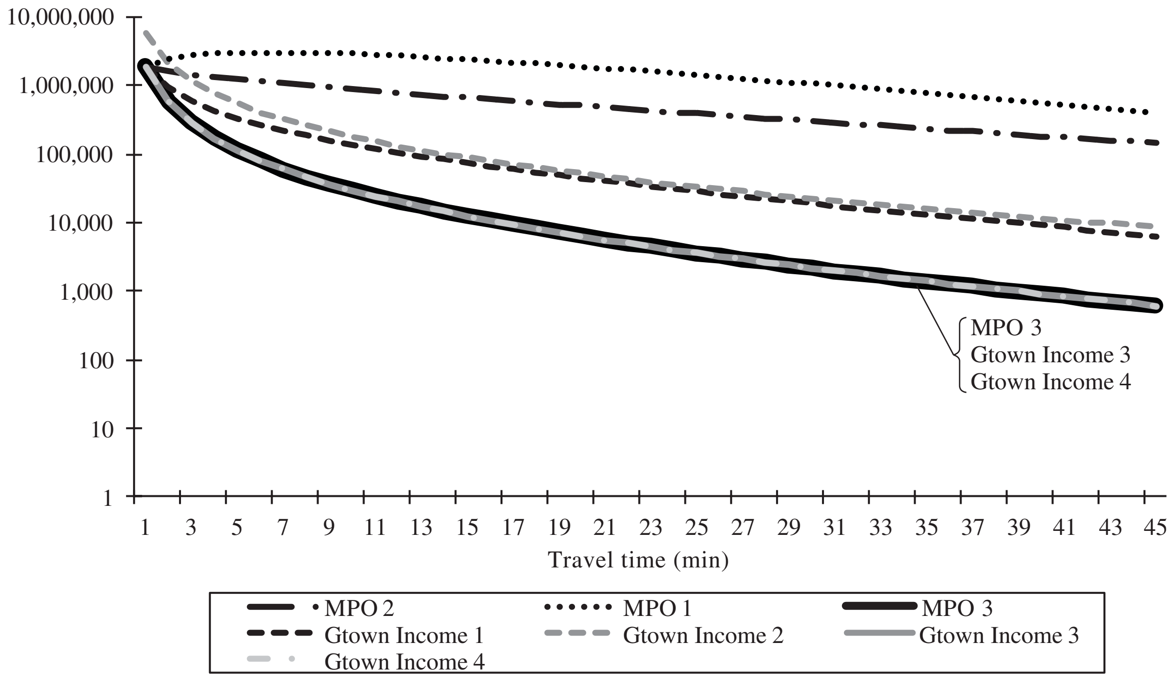


Figure 7.1. Home-based work trip distribution friction factors.

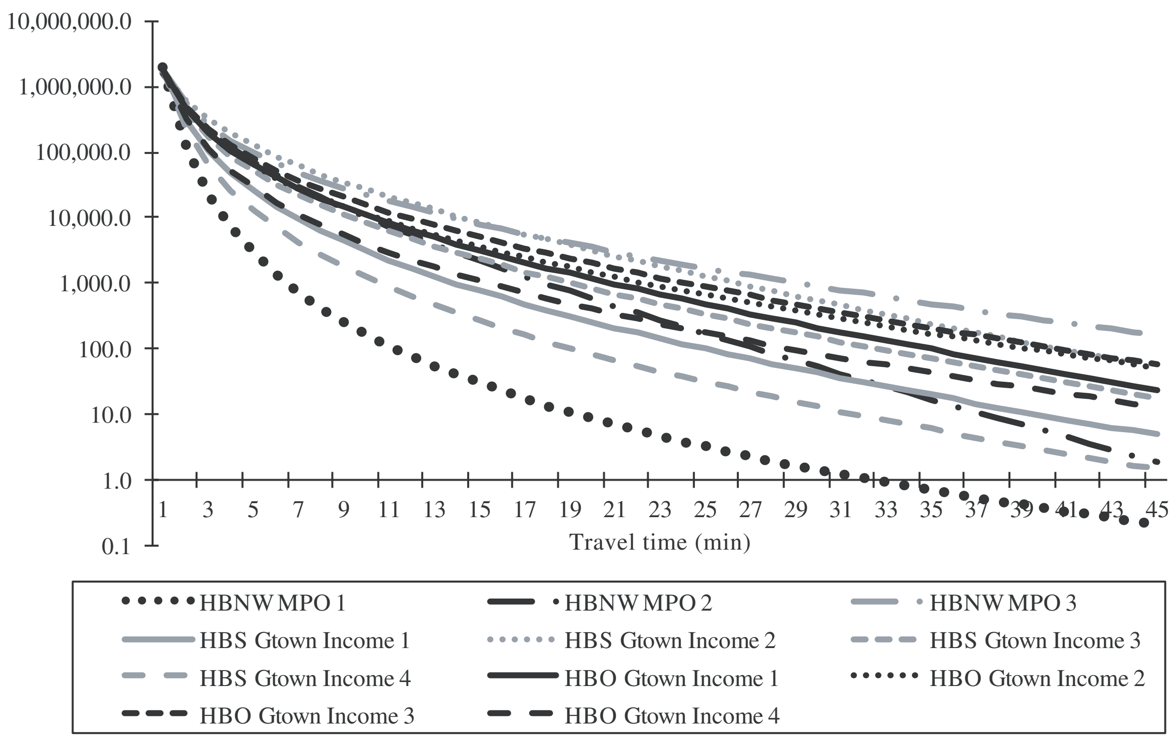


Figure 7.2. Home-based nonwork trip distribution friction factors.

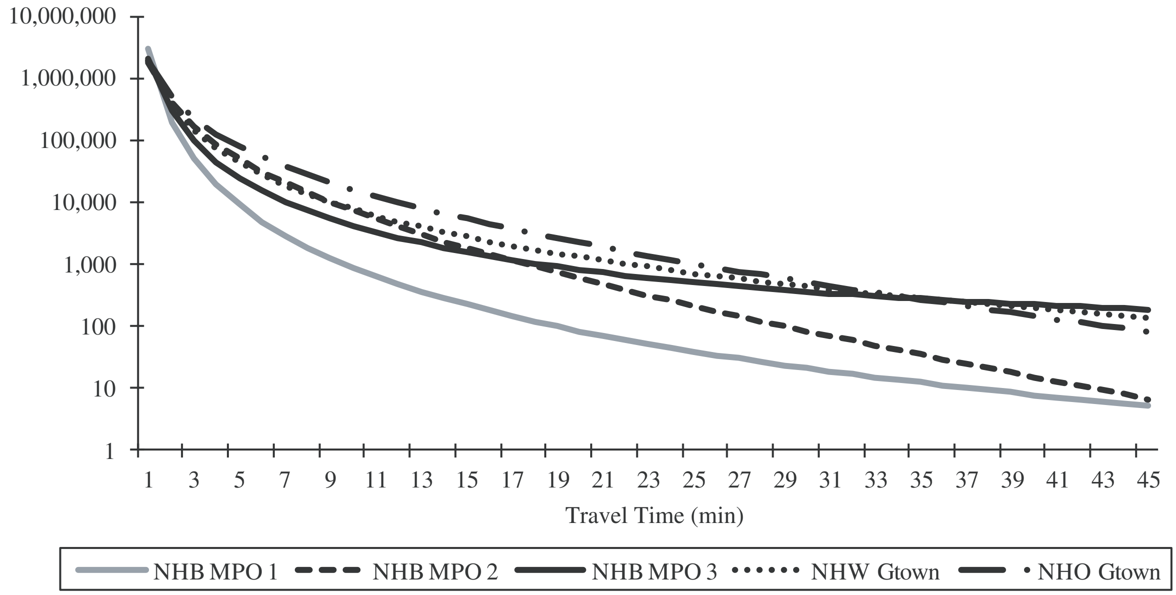


Figure 7.3. Nonhome-based trip distribution friction factors.

with populations of more than 1 million, have comparable variables to those in the Gtown model. Models F, G, and I are nested logit models. The coefficients of the Gtown HBW mode choice model are not too different from those of Models F, G, and I, although the Gtown cost coefficients are lower in absolute value.

Looking at the relationships between coefficients, Table 7.7 shows that the ratio of the out-of-vehicle time and in-vehicle time coefficients in the Gtown model is comparable to those for Models F, G, and I, as shown in Table 4.9. The value of time in the Gtown model, however, is significantly higher than in the models from other areas. This comparison holds for most of the other models shown in Tables 4.8 and 4.9.

For HBNW trips, Models E, G, I, and K from Table 4.11 are for urban areas with populations of more than 1 million and have comparable variables. The in-vehicle time coefficient of the Gtown HBNW mode choice model is higher than those in the models from Table 4.11, while the Gtown cost coefficients are lower in absolute value. Looking at the relationships between coefficients, Table 7.8 shows that the ratio of the out-of-vehicle time and in-vehicle time coefficients in the Gtown model is a bit lower than those of the other models, as shown in Table 4.12. The value of time in the Gtown model, however, is significantly higher than in the models from other areas. This comparison holds for most of the other models shown in Tables 4.11 and 4.12.

For NHB travel, models F, G, and I from Table 4.14 are most comparable to Gtown. The coefficients in the Gtown HBNW mode choice model are fairly comparable. Looking at the relationships between coefficients, Table 7.9 shows that the ratio of the out-of-vehicle time and in-vehicle

Table 7.6. Gtown mode choice model parameters.

	HBW	HBNW	NHB
Parameter			
In-Vehicle Time	−0.0212 minute	−0.022 minute	−0.029 minute
Out-of-Vehicle Time	−0.043 minute	−0.0449 minute	−0.0572 minute
Cost (low income)	−0.0014 cent	−0.0015 cent	−0.0099 cent
Cost (high income)	−0.0005 cent	−0.0006 cent	−0.0099 cent
Derived Relationships			
Out-of-Vehicle Time/ In-Vehicle Time Ratio	2.0	2.0	2.0
Value of In-Vehicle Time	\$9.08/hour (low income) \$25.44/hour (high income)	\$8.80/hour (low income) \$22.00/hour (high income)	\$1.76/hour

HBW = home-based work; HBNW = home-based nonwork; NHB = nonhome based.

Table 7.7. Relationships between coefficients from home-based work mode choice models for Gtown and from Table 4.9.

Model	Out-of-Vehicle Time/ In-Vehicle Time	Value of In-Vehicle Time
Gtown	2.0	$9.08 to $25.44/hour
Model F (Table 4.9)	2.0	$3.94/hour
Model G (Table 4.9)	2.3	$3.05/hour
Model I (Table 4.9)	2.0	$3.00/hour

Table 7.8. Relationships between coefficients from home-based nonwork mode choice models for Gtown and from Table 4.12.

Model	Out-of-Vehicle Time/ In-Vehicle Time	Value of In-Vehicle Time
Gtown	2.0	$8.80 to $22.00/hour
Model E (Table 4.12)	3.0	$3.69/hour
Model G (Table 4.12)	4.6	$0.21/hour
Model I (Table 4.12)	3.1	$0.48/hour
Model K (Table 4.12)	3.0	$1.40/hour

Table 7.9. Relationships between coefficients from nonhome-based mode choice models for Gtown and from Table 4.15.

Model	Out-of-Vehicle Time/ In-Vehicle Time	Value of In-Vehicle Time
Gtown	2.0	$1.75/hour
Model F (Table 4.15)	2.0	$4.04/hour
Model G (Table 4.15)	11.3	$0.46/hour
Model I (Table 4.15)	2.1	$2.00/hour

time coefficients and value of time in the Gtown model are (as shown in Table 4.15) fairly comparable to those in Models F and I, but Model G appears to be an outlier. The other models shown in Tables 4.14 and 4.15 have coefficient values that vary widely, but the coefficients from Gtown fit well within this range.

In summary, the value of time, indicating the willingness to pay for travel timesavings by switching modes, seems high for home-based trips in the Gtown model. The related model coefficients, mainly the cost coefficients for these trip purposes, should be reviewed.

7.2.4 Automobile Occupancy

The Gtown mode choice model forecasts auto driver and auto passenger trips by purpose separately. Table 7.10 provides a comparison of the resulting Gtown auto occupancy rates compared to the values reported from the NHTS in Table 4.16. As Table 7.10 shows, the Gtown home-based auto occupancies are within 5 percent of those from the NHTS. Gtown NHB auto occupancies are noticeably lower than those from the NHTS. The NHB mode choice model should be checked regarding how auto driver and passenger choices are made.

Table 7.10. Comparison of average daily vehicle occupancy by trip purpose.

			Nonhome Based		
	HBW	HBNW	NHBW	NHBO	All Trips
Gtown	1.05	1.64	1.10	1.48	1.39
Table 4.16	1.10	1.72	1.66		1.55

HBW = home-based work; HBNW = home-based nonwork; NHBW = nonhome-based work; NHBO = nonhome-based other.

Table 7.11. Comparison of time of day for auto trips.

Time Period	Gtown	Table C.11	Difference	Percent Difference
6:00 a.m.–9:00 a.m.	14.4%	17.1%	−2.7%	−16%
9:00 a.m.–3:00 p.m.	34.4%	35.6%	−1.2%	−3%
3:00 p.m.–7:00 p.m.	27.4%	32.1%	−4.7%	−15%
7:00 p.m.–6:00 a.m.	23.8%	15.2%	8.6%	57%
Total	**100.0%**	**100.0%**		

The household survey is another source against which auto occupancy rates by purpose can be checked.

7.2.5 Time of Day

Table 7.11 provides a comparison between the modeled times of day for auto trips in the Gtown model with those derived from NHTS data that are shown in Table C.11. As Table 7.11 shows, the percentage of travel occurring in peak periods is lower in Gtown than in the national survey, and the nighttime percentage of travel is substantially higher in Gtown. As mentioned earlier, the Gtown highway system is very congested, and the peaks are much longer than in other comparable cities. It would seem reasonable, therefore, that peak spreading would be more prevalent in Gtown. This finding could be confirmed using other data sources such as traffic counts.

7.2.6 Summary

This section provides a comparison of model parameters and results produced by the model for a hypothetical large MPO and the values in this report. Overall, the Gtown model parameters and results appear to be reasonable when compared to the values in Chapter 4 of the report, although some Gtown model parameters, such as cost coefficients in the mode choice models for home-based trip purposes, should be checked further. The congested nature of Gtown does appear to result in fewer nonwork trips, very long work trips, and extended peak periods.

7.3 Model Development Case Study for a Smaller Area without Data for Model Estimation

This case study is for a small urban area that never had a travel forecasting model and does not have any local data from which to estimate model parameters. The MPO for this hypothetical city, Schultzville, borrowed the model structure from another small area and used that structure to develop its own model. Schultzville is an urban area of about 100,000 people. It has very little in the way of public transportation, so the MPO decided to develop a daily (i.e., no time of day), three-step model with auto trips only, using the classic three trip purposes.

7.3.1 Zone and Highway Network Definition

Highway Network Definition

A highway network for the Schultzville area was developed to obtain acceptable volumes on minor arterials; therefore, collectors and local roads were included in the network. Digital street files available from the U.S. Census Bureau (TIGER/Line files) were used to create the highway network shown in Figure 7.4. Freeways, major arterials, minor arterials, collector links, and some local roads were coded into the network. The following are examples of some of the fields coded for nodes and links in the network:

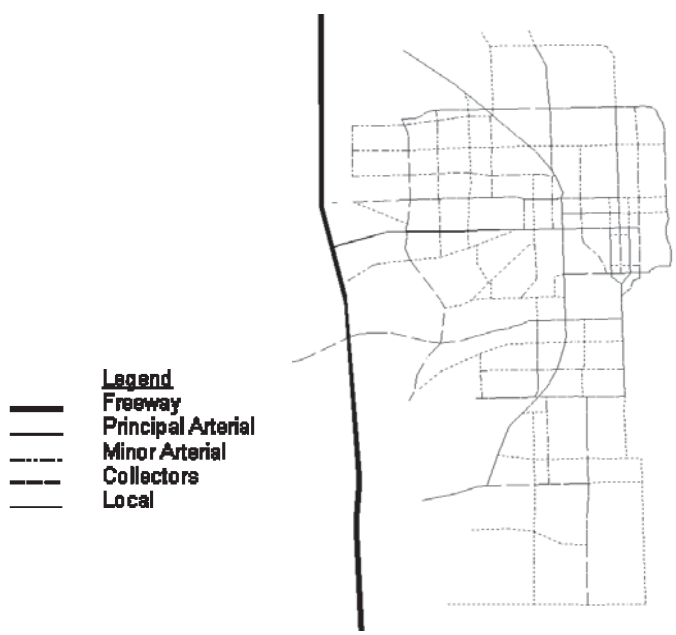


Figure 7.4. Schultzville highway network.

- **XY coordinates**—Geographic coordinates for nodes;
- **Node identifiers** (anode/bnode)—Unique numbers assigned to each end of a link;
- **Distance**—Distance in miles between anode and bnode;
- **Functional (link) classification**—Type of facility (e.g., major arterial, minor arterial, etc.);
- **Traffic count volume**—Average daily volume of traffic on link (where available);
- **Number of lanes;**
- **Facility type;**
- **Area type**—Location and development characteristics of area that link serves (e.g., urban, suburban, rural, etc.); and
- **Link capacity and free-flow speed**—Link capacities are a function of the number of lanes on a link. Area type and facility type were used to define per-lane default capacities and speed. The number of lanes was also checked using field verification or aerial imagery to ensure accuracy.

Transportation Analysis Zone Definition

A map of Schultzville transportation analysis zones is shown in Figure 7.5. Each TAZ has a centroid, which is a point that represents all travel origins and destinations in a zone.

7.3.2 Socioeconomic Data

Socioeconomic data—household and employment data for the modeled area—were organized into the TAZs. Estimates of base-year socioeconomic data by TAZ were developed for use in model development. The population and household data for Schultzville came from the decennial census. Data such as income and vehicle availability were derived from the ACS.

Basic socioeconomic data by TAZ were derived for Schultzville, including households, population, total employment, retail employment, service employment, manufacturing employment, nonmanufacturing employment, and school enrollment. More detailed data, such as number of persons per household, household income, workers per household, and vehicles owned per household, as well as cross-classifications of households by zone, were also derived from the U.S. Census and ACS.

Employment data by TAZ were derived from data provided by the state employment commission. Each employer was identified by a federal identification number, number of employees, and a geocodable address, which were allocated to TAZs. Since these data were keyed to where the payroll is prepared for employees, the MPO made adjustments to allocate employment to the proper TAZ, where necessary. School enrollment data by school were provided by the Schultzville School District and allocated to the appropriate TAZs; this information was supplemented by information the MPO collected directly from the larger private schools in the region.

Figure 7.5. Schultzville TAZs.

7.3.3 Trip Generation

Trip Productions

The MPO was able to develop estimates of households cross-classified by household size and number of vehicles, and by workers by number of vehicles for each zone. The information in Tables C.5 through C.7, which shows trip rates derived from 2009 NHTS data, was used to estimate productions by trip purpose. The HBNW trip rates for areas with less than 500,000 residents in Table C.6 were used. These trip generation rates were applied to the socioeconomic data for each zone to create total productions by purpose by zone.

An example calculation is provided for home-based work trips in Table 7.12. Trip production rates from Table C.5 were multiplied by the households cross-classified by workers and vehicles to obtain a total of 1,092 HBW trip productions occurring in the sample zone. (Note that Table C.5 provides rates for households with three or more vehicles, while data for Schultzville were only available for households with two or more vehicles; therefore, the rates for two vehicle and three vehicle households were averaged for use in Schultzville.)

Trip Attractions

The values for trip attraction rates for motorized trips, shown in Table 4.4, were used as a trip attraction model for Schultzville. Model 1 from this table was used for each trip purpose. An example calculation is provided for home-based

Table 7.12. Example trip production calculation.

Number of Autos	Workers 0	1	2	3+	Total
Home-Based Work Trip Production Rates					
0	0.0	1.1	2.0	4.0	
1	0.0	1.1	2.5	4.3	
2+	0.0	1.3	2.6	4.5	
Example TAZ Data					
0	20	30	10	0	
1	65	155	75	4	
2+	4	90	170	24	
Example Zone Trip Productions					
0	0	33	20	0	
1	0	171	188	17	
2+	0	116	442	106	
Total Productions	0	319	650	123	**1,092**

work trips in Table 7.13. Data for households, employment, and school enrollment for each Schultzville TAZ were multiplied by the trip attraction rates from Table C.7 to achieve a total of 130 HBW, 583 HBNW, and 306 NHB trip attractions occurring in the sample zone.

7.3.4 Trip Distribution

The doubly constrained gravity model, described in Equation 4-5, was used as the trip distribution model for Schultzville. The inputs to the trip distribution model include:

- The trip generation outputs—productions and attractions by trip purpose for each zone;
- Highway travel time, as the measure of travel cost between each pair of zones; and
- Friction factors, as discussed in the following section.

The outputs are trip tables, production zone to attraction zone, for each trip purpose. Because trips of different purposes have different levels of sensitivity to travel time and cost, trip distribution is applied separately for each trip purpose, with different model parameters.

Development of Travel Time Inputs

Zone-to-zone (interzonal) travel costs. This case study used the simplest cost variable, highway travel time, which is an

Table 7.13. Trip attractions calculation for sample TAZ.

Trip Purpose	Households	School Enrollment	Employment Basic	Retail	Service	Total	Trip Attractions
Home-Based Work							
Model 1						1.2	
Sample TAZ Value						108	
Trip Attractions						130	130
Home-Based Nonwork							
Model 1	0.4	1.1	0.6	4.4	2.5		
Sample TAZ Value	320	210	34	10	64		
Trip Attractions	128	231	20	44	160		583
Nonhome Based							
Model 1	0.6		0.7	2.6	1.0		
Sample TAZ Value	320		34	10	64		
Trip Attractions	192		24	26	64		306
Total Trips Attracted to Sample TAZ							**1,019**

Table 7.14. Gamma function parameters for Schultzville.

Parameter	HBW	HBNW	NHB
a	26,000	130,000	260,000
b	−0.265	−1.017	−0.791
c	−0.04	−0.079	−0.195

HBW = home-based work; HBNW = home-based nonwork; NHB = nonhome based.

adequate measure for a small area such as Schultzville. This area does not have a significant level of auto operating cost beyond typical per-mile costs—for example, relatively high parking costs or toll roads—or extensive transit service. The zone-to-zone highway travel time matrix was developed through "skimming" the highway network using travel modeling software.

The highway assignment process does not require that times be coded on the centroid connectors since those links are hypothetical constructs representing the travel time within zones. Initial skim times from the network assignment did not include time representing travel within zones, or terminal time.

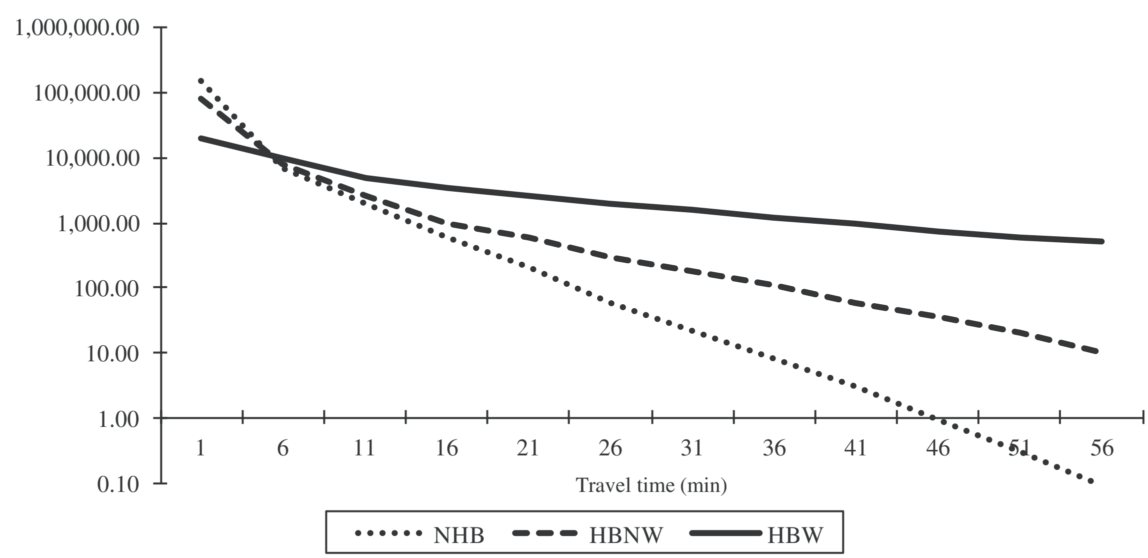
Intrazonal time. Intrazonal times were defined as one-half of the average of the skim times to the three nearest neighboring zones.

Terminal time. Terminal times, which represent the time required to park a vehicle and walk to the final destination, or vice versa, were added to the intrazonal time. Terminal times of 4 minutes were added to the time for any trip where a trip end was in the business district, and 2 minutes were added for trip ends elsewhere.

Friction factors. Friction factors were derived for each purpose (HBW, HBNW, and NHB trips) using a gamma function (described in Equation 4-6) using the *b* and *c* values shown in Table 4.5 for Small MPO 1. The gamma function parameters, including the scaling factor *a*, are shown in Table 7.14. The resulting friction factors are plotted in Figure 7.6.

The resulting average travel times by trip purpose from this first application of the gravity model were evaluated to determine if the distribution was acceptable. Friction factors were calibrated to match average travel times using an iterative process. No local data existed regarding average travel times, so the best option in this situation was to start with parameters from another modeling context. Average trip lengths by trip purpose are presented in Table C.10, and were used as a basis of comparison with trip lengths resulting from the initial trip distribution in Table 7.15.

As can be seen in Table 7.15, the average trip lengths resulting from this initial set of friction factors are lower than the average travel times reported in Table C.10. Since Schultzville is a small geographic area with little congestion, one might expect that the average trip length would be lower than the NHTS average reported for all areas with a population less than 500,000. However, the initial mean travel times were judged too low. The initial friction factors were adjusted iteratively to test variations



HBW = home-based work; HBNW = home-based nonwork; NHB = nonhome based.

Figure 7.6. Schultzville case study initial friction factors.

Table 7.15. Initial evaluation of Schultzville mean travel times.

	HBW	HBNW	NHB
Urban Area Population from Table C.10	Less than 500,000	All population ranges	Other urban area
Value from Table C.10	20 minutes	18 minutes	18 minutes
Schultzville	15 minutes	12 minutes	9 minutes
Difference	5 minutes	6 minutes	9 minutes

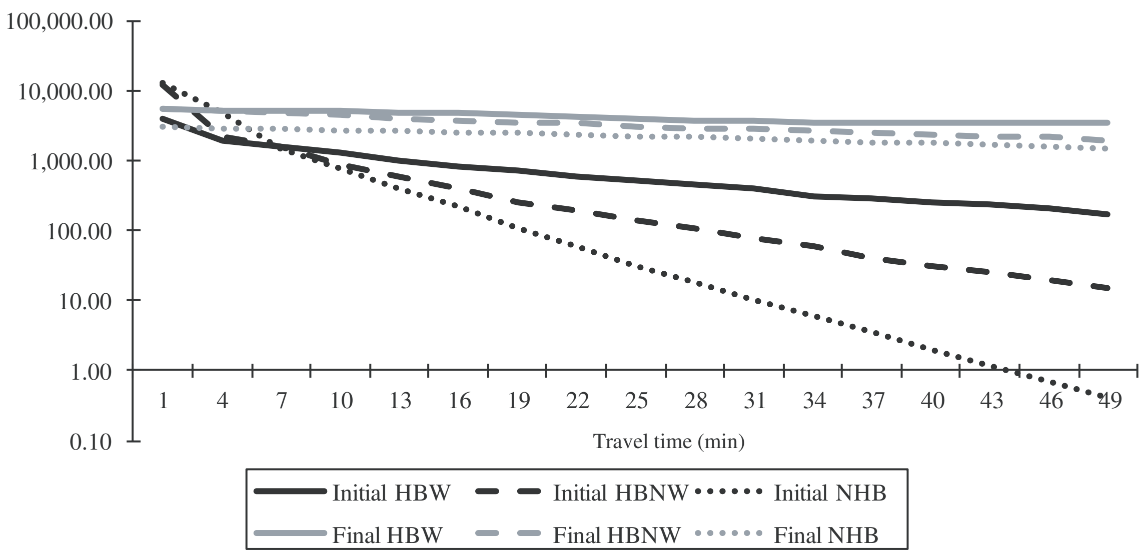
HBW = home-based work; HBNW = home-based nonwork; NHB = nonhome based.

that achieved a higher average trip length for all purposes. The friction factors resulting from this fitting process are shown in Figure 7.7. The comparison of the mean travel times resulting from the use of these revised friction factors with those from Table C.10 is shown in Table 7.16. The final friction factors are not as steep as those that were initially used and result in mean travel times closer to those shown in Table C.10.

7.3.5 External Trips

The best source of data for estimating external trips (EI and EE) is a roadside survey conducted at external stations; however, no such survey was available for Schultzville. The state in which Schultzville is located has a statewide travel model that provided information on EE trips and EI trips for the study area. The statewide model provided the origin and destination station, as well as the volume for EE trips.

For EI trips, a select link assignment from the statewide model provided the number of trips entering and leaving each external station allocated to the statewide model zones. These needed to be suballocated to the Schultzville model zones based on the relative internal attractions and productions in each TAZ compared to the total in the larger statewide model zones.



HBW = home-based work; HBNW = home-based nonwork; NHB = nonhome based.

Figure 7.7. Schultzville case study final friction factors.

Table 7.16. Evaluation of Schultzville mean travel times using adjusted friction factors.

	HBW	HBNW	NHB
Urban Area Population from Table C.10	Less than 500,000	All population ranges	Other urban area
Value from Table C.10	20 minutes	18 minutes	18 minutes
Schultzville	17 minutes	15 minutes	15 minutes
Difference	3 minutes	3 minutes	3 minutes

HBW = home-based work; HBNW = home-based nonwork; NHB = nonhome based.

7.3.6 Vehicle Occupancy

The highway assignment step, discussed in Section 7.3.7, requires tables of vehicle trips, while the output of early model steps was in person trips. Person trips made by auto from the earlier steps were converted to vehicle trips using the factors provided in the first row of Table 4.16, which represent all auto modes for daily travel. These factors—1.10 for HBW, 1.72 for HBNW, and 1.66 for NHB—were applied to the auto passenger trip tables produced by the trip distribution step, as described in Section 7.3.4.

7.3.7 Highway Assignment

Trip tables from origins to destinations (O-D format) are required for the daily highway assignment; however, the HBW and HBNW trip tables resulting from the previous steps provide trip tables from productions to attractions (P-A format). The P-A trip tables were converted to O-D trip tables by splitting the value in each cell in half to create two duplicate matrices, transposing the values in one of the matrices, and adding the two matrices together. The resulting O-D trip tables were then ready to be assigned to the highway network.

A user equilibrium assignment using the BPR formula for capacity restraint was used for assigning vehicle trips to the highway network. Values for the α and β parameters were needed for application of the BPR formula (described in Section 4.11.1). Table 4.26 presents BPR function parameters used by 18 MPOs. The most appropriate values for Schultzville are those shown for areas with a population less than 200,000:

$\alpha = 0.15$ for freeways,
0.45 for arterials; and
$\beta = 8.8$ for freeways,
5.6 for arterials.

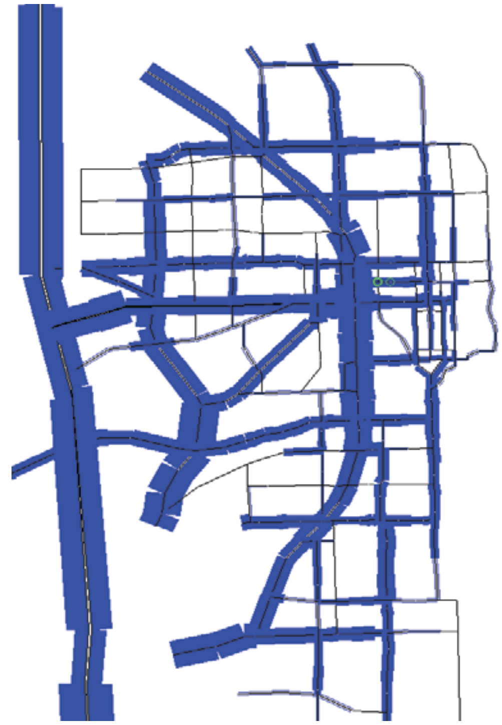


Figure 7.8. Schultzville case study final assigned volumes.

The results of the traffic assignment are shown as a bandwidth plot in Figure 7.8. In this diagram, the width of each link in the network is proportional to the volume on that link.

An assessment was made of the quality of the traffic assignment on links where traffic counts were available by comparing the root mean square error (RMSE) of assigned values to traffic counts by facility type. As can be seen in Table 7.17, the RMSE is within an acceptable range for all facility types, except local roads. Since the goal of the model was to get acceptable values for minor arterials, the results were deemed acceptable.

Table 7.17. RMSE comparison of modeled volumes with traffic counts.

Functional Class	Links	ADT	Error	Percentage Error	Acceptable Error
Freeways	18	228,340	15,021	6.6%	+/−7%
Principal Arterials	90	538,210	37,674	7.0%	+/−10%
Minor Arterials	226	730,030	80,303	11.0%	+/−15%
Collectors	218	304,110	66,904	22.0%	+/−25%
Locals	14	20,000	10,400	52.0%	+/−25%

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APPENDIX A

Federal Planning and Modeling Requirements

This appendix discusses federal agency requirements for transportation planning and travel models in urban areas. The requirements for three agencies are presented—the Environmental Protection Agency, the Federal Highway Administration, and the Federal Transit Administration—and are up to date as of the time of the writing but are subject to change based on updated legislative and rulemaking actions.

A.1 Environmental Protection Agency

The most specific federal agency requirements for travel demand forecasting are found in the Transportation Conformity Rule, promulgated by the Environmental Protection Agency (EPA) under the Clean Air Act (CAA) [42 U.S. Code (USC) 85 § 7401 et seq.].

A.1.1 Background

The EPA is the federal agency charged with implementing the requirements of the CAA, a comprehensive federal law that regulates air pollutant emissions from areawide, stationary, and mobile sources. Under the CAA, EPA established National Ambient Air Quality Standards (NAAQS), which set limits on concentrations of specific air pollutants throughout the United States. Each state is responsible for monitoring the concentrations of air pollutants within its borders and reducing emissions of those pollutants that exceed the NAAQS.

Areas within each state that currently exceed the NAAQS for specific pollutants are designated as **nonattainment areas**. Each nonattainment area is classified according to the amount by which it exceeds the NAAQS for each type of pollutant. The CAA establishes timetables (depending on the nonattainment classification) by which the area must reduce its pollutant concentrations in order to meet the NAAQS. When a nonattainment area reduces its pollutant concentrations below the NAAQS, it is redesignated as a **maintenance area.** Maintenance areas must continue to monitor their air pollutants and maintain NAAQS for a period of 20 years after their redesignation.

Each state must develop a **state implementation plan (SIP)** that explains how it will reduce air pollutant emissions in each nonattainment area to meet and maintain the NAAQS. Every SIP includes an emissions budget, which sets limits on the amount of pollutants each nonattainment area in the state can emit.

Transportation conformity is required under the CAA to ensure that federally funded and approved highway and transit activities in nonattainment and maintenance areas are consistent with (i.e., "conform to") the SIP. According to the CAA, a conforming transportation activity must not:

- Create any new air quality violations;
- Increase the frequency or severity of existing violations; or
- Delay timely attainment of NAAQS.

The Transportation Conformity Rule [40 Code of Federal Regulations (CFR) Parts 51 and 93], which establishes criteria and procedures for determining whether transportation activities conform to the SIP, was first promulgated under the authority of the 1990 CAA amendments in November 1993. Current conformity regulations reflect a comprehensive revision of the 1993 rule and were published on August 15, 1997 (Federal Register, 62, p. 43780).

The Federal Highway Administration (FHWA), Federal Transit Administration (FTA), and metropolitan planning organizations (MPOs) are responsible for making conformity determinations, based on criteria and procedures described in the conformity rule. Transportation activities that require a conformity determination include long-range transportation plans (LRTP), transportation improvement programs (TIP), and federally funded or approved transportation projects.

To demonstrate conformity, forecasts of regional emissions resulting from a LRTP or TIP must not exceed the motor vehicle emissions budgets for each specified pollutant, as defined in the SIP. Regional motor vehicle emissions must be estimated using EPA-approved emission factor models (e.g., MOBILE, MOVES, or EMFAC), per 40 CFR 93.111. These emission factor models, in turn, require estimates of vehicle speeds and travel volumes [in vehicle miles traveled], which are derived from the travel models used by transportation planning agencies to forecast travel demand under alternative transportation scenarios.

The 1997 conformity rule amendments, among other changes, mandated the use of network-based travel models to support conformity determinations in certain nonattainment areas, and included other requirements relating to model structure, input assumptions, included variables, and validation procedures. These requirements are described in the next section.

A.1.2 Travel Model Requirements in the CAA Transportation Conformity Rule

The specific requirements for travel models are described in Section 122 of the Transportation Conformity Rule [40 CFR 93.122 (b)]. However, these requirements apply only to serious, severe, and extreme ozone nonattainment areas or serious carbon monoxide nonattainment areas whose metropolitan planning area contains an urbanized area population over 200,000 (based on the most recent decennial census conducted by the U.S. Census Bureau).

In those areas meeting the above criteria, estimates of regional transportation-related emissions used to support conformity determinations must be made at a minimum using network-based travel models according to procedures and methods that are available and in practice and supported by current and available documentation. Agencies must discuss these modeling procedures and practices through the interagency consultation process, as described elsewhere in the Transportation Conformity Rule [40 CFR 93.105 (c) (1) (i)]. Network-based travel models must, at a minimum, satisfy the following requirements:

- Network-based travel models must be validated against observed counts (peak and off-peak, if possible) for a base year that is not more than 10 years prior to the date of the conformity determination. Model forecasts must be analyzed for reasonableness and compared to historical trends and other factors, and the results must be documented.
- Land use, population, employment, and other network-based travel model assumptions must be documented and based on the best available information.
- Scenarios of land development and use must be consistent with the future transportation system alternatives for which emissions are being estimated. The distribution of employment and residences for different transportation options must be reasonable.
- A capacity-sensitive assignment methodology must be used, and emissions estimates must be based on a methodology which differentiates between peak and off-peak link volumes and speeds and uses speeds based on final assigned volumes.
- Zone-to-zone travel impedances used to distribute trips between origin and destination pairs must be in reasonable agreement with the travel times that are estimated from final assigned traffic volumes. Where use of transit currently is anticipated to be a significant factor in satisfying transportation demand, these times also should be used for modeling mode splits.
- Network-based travel models must be reasonably sensitive to changes in the time(s), cost(s), and other factors affecting travel choices.

Additionally, reasonable methods in accordance with good practice must be used to estimate traffic speeds and delays in a manner that is sensitive to the estimated volume of travel on each roadway segment represented in the network-based travel model.

Highway Performance Monitoring System (HPMS) estimates of vehicle miles traveled (VMT) shall be considered the primary measure of VMT within the nonattainment or maintenance area and for the functional classes of roadways included in HPMS, for urban areas that are sampled on a separate urban area basis. For areas with network-based travel models, a factor (or factors) may be developed to reconcile and calibrate the network-based travel model estimates of VMT in the base year of its validation to the HPMS estimates for the same period. These factors may then be applied to model estimates of future VMT. In this factoring process, consideration will be given to differences between HPMS and network-based travel models, such as differences in the facility coverage of the HPMS and the modeled network description. Locally developed count-based programs and other departures from these procedures are permitted subject to the interagency consultation procedures described elsewhere in the rule.

In all areas not otherwise subject to network-based modeling requirements, regional emissions analyses must continue to use such models and procedures if the use of those procedures has been the previous practice of the MPO. Otherwise, areas may estimate regional emissions using any appropriate methods that account for VMT growth by, for example, extrapolating historical VMT or projecting future VMT by considering growth in population and historical growth trends for VMT per person. These methods also must consider future economic activity, transit alternatives, and transportation system policies.

A.2 Federal Highway Administration

The FHWA has very few explicit regulations related to the use of travel demand forecasting. The joint FHWA/FTA Statewide and Metropolitan Transportation Planning Regulations (23 CFR Parts 450 and 500) include only one specific reference to travel demand forecasts. That single reference, cited below, is included in the section of the metropolitan planning regulations dealing with the development and content of the metropolitan transportation plan:

(f) The metropolitan transportation plan shall, at a minimum, include:
(1) The projected transportation demand of persons and goods in the metropolitan planning area over the period of the transportation plan [23 CFR 450.322 (f)(1)]

Every designated MPO is required, as part of the metropolitan transportation planning process, to prepare a metropolitan LRTP that considers at least a 20-year planning horizon:

The MPO shall review and update the transportation plan at least every 4 years in air quality nonattainment and maintenance areas and at least every 5 years in attainment areas to confirm the transportation plan's validity and consistency with current and forecasted transportation and land use conditions and trends, and to extend the forecast period to at least a 20-year planning horizon [23 CFR 450.322 (b)].

The joint planning regulations provide no other specific requirements or guidance as to how future transportation demand shall be forecast, leaving the determining of such forecasts up to the discretion of each MPO.

A transportation management area (TMA) is defined as an urbanized area with a population over 200,000, as defined by the Census Bureau and designated by the Secretary of Transportation, or any additional area where TMA designation is requested by the Governor and the MPO and designated by the Secretary of Transportation. An MPO with less than 200,000 may be designated a TMA if it contains any part of an adjacent TMA. Those MPOs that do not represent a designated TMA and not in an air quality nonattainment or maintenance area may request approval from FHWA and FTA to develop a simplified transportation plan, subject to the complexity of the transportation problems in the metropolitan planning area. No further elaboration is included in the regulations on what elements of the transportation plan may be simplified, but this element of the regulations has generally been interpreted to allow smaller MPOs with no significant plans for major transportation improvements (i.e., no capital investments in new highway or transit capacity) to continue to receive federal funding for system maintenance, etc.

MPOs that are in air quality nonattainment or maintenance areas for ozone or carbon monoxide must make a conformity determination for any updated or amended transportation plan in accordance with EPA's transportation conformity regulations [23 CFR 450.322 (l)]. EPA's Transportation Conformity Regulations [40 CFR 93.122 (b) and (c)], described elsewhere in this section, do include specific requirements for travel forecasting models.

Although the FHWA has few specific regulatory requirements pertaining to travel forecasting models, the agency has a long history of supporting research and providing technical assistance to state departments of transportation (DOTs) and MPOs in travel demand estimation and forecasting. Currently, most research and technical assistance on travel demand forecasting funded by FHWA is coordinated through the Travel Model Improvement Program (TMIP), administered out of the Office of Planning. A recently established companion program focusing on freight models is administered out of the FHWA's Office of Freight Management and Operations.

FHWA and FTA oversight of the metropolitan transportation planning process is handled through a formal certification review, conducted jointly by FHWA and FTA field planners in each TMA at least every 4 years. MPOs representing urbanized areas that are not designated as TMAs are allowed to self-certify that they are meeting all federal transportation planning requirements.

Historically, the TMA certification process focused on process requirements (e.g., existence of a metropolitan transportation plan and public participation plan; composition of the MPO policy board(s); coordination agreements with key stakeholders) and rarely addressed technical issues such as the travel models used in forecasting future passenger and freight demand. In an effort to encourage its field planners to increase awareness of the importance of travel models at MPOs, the FHWA developed a "certification checklist for travel forecasting methods" (Federal Highway Administration, 2009), to be used in certification reviews. The checklist does not include questions on the specific modeling components used at the MPO but rather focuses on three, generally nontechnical, categories of questions: (1) issues or proposed projects for which forecasts will be used as indicators of model scrutiny by external organizations; (2) key indicators of the MPO's technical capabilities; and (3) availability of documentation on current conditions, planning/modeling assumptions, and forecasting methods. The certification checklist is intended to act as a rough first filter to help identify those MPOs that may require additional technical assistance in forecasting, or whose forecasting approach may not be suitable for intended applications.

A.3 Federal Transit Administration

The FTA conducts periodic workshops on travel forecasting for transit New Starts applications. The goal of these workshops is to share with project sponsors and their model consultants how FTA evaluates travel forecasts. Furthermore, the workshops serve as a forum for FTA to establish acceptable modeling procedures, inputs, and outputs essential for producing reliable forecasts that are sensitive to socioeconomic and level-of-service changes.

The material presented in this section is a synthesis of the information that the FTA provided during the September 2007 travel forecasting workshop in St. Louis, Missouri (Federal Transit Administration, 2007).

A.3.1 FTA Requirements

The FTA provides guidance on the following key aspects of travel forecasting for New Starts:

- Properties of travel models;
- Rider surveys; and
- Calibration and validation.

The subsections that follow discuss the FTA's requirements for each of these items.

Properties of Travel Models

The FTA's requirements for the properties of travel models are fairly broad. The FTA supports a localized approach to travel modeling and forecasting. The rationale for such a requirement is that there are no standard or "correct" methods that are universally applicable to all regions. Models will need to reflect the fact that each metropolitan area has unique conditions and must be responsive to local decision making.

Because models are used to forecast transit ridership, it is essential that they explain the current transit conditions and capture the tradeoffs between travel times and costs. These favorable properties are heavily dependent on the model calibration and validation procedures (discussed in the subsection after next). In addition to capturing current conditions, the models will need to fulfill their ultimate objective of yielding reasonable forecasts. Specifically, FTA requires reasonable "deltas" (changes in ridership between a base year and forecast year) for ridership that are consistent with the underlying socioeconomic growth as well as level-of-service improvements. Unreasonably high or low ridership forecasts are clear indications that the model parameters may need further examination.

The evaluation of a proposed New Starts transit project relies on the cost-effectiveness ratio of the project. The cost-effectiveness ratio relates the cost of the project to the expected benefits, usually expressed as time savings, from the project. Obviously, the estimated cost of the project is independent of the travel modeling procedures; however, the expected user benefits are inextricably linked to the modeling procedures and inputs. A major component of the FTA's guidance on model properties, therefore, relates to the user benefits implied by the model. The FTA requires that models adequately support the case for a new transit project by capturing appropriate user benefits for various market segments. Further, the models should be amenable to an analysis of the primary causes of the benefits.

The FTA recognizes that a range of modeling approaches can be used to obtain the desired model properties. These approaches could include either the traditional trip-based models or the more advanced tour and activity-based models, as long as due attention is paid to the model properties and the implied user benefits.

In summary, the FTA recognizes good models based on coherent forecasts. Careful calibration and validation coupled with rigorous quality assurance checks will help achieve the ultimate objective of developing models to gain insights into performance and benefits of the alternatives.

Rider Surveys

Rider surveys are an important source of current transit information and are crucial to calibrating models that reflect the current conditions accurately. Where possible, the FTA recommends surveys before and after project opening to get a time-varying picture of ridership patterns and also to evaluate the model predictions. In cases where only the older survey data are available, the usefulness of the data in explaining current patterns depends to a large extent on the rate of growth in the metropolitan area as well as on any major transit system changes in the area. To the extent that these changes are minimal, the FTA deems the older data acceptable for current day predictions.

The success of rider surveys in capturing the current transit travel patterns depends on the design of the surveys in terms of the sampling plan, the questionnaire, and the data items included in the questionnaire.

The FTA recommends that the sampling plan be designed with the transit markets in mind. The transit markets are determined not only by the socioeconomic attributes but also by the geographic attributes such as the area type of the origin and/or destination of the trip. Because these markets have

Traveler characteristics		
Items	Y	Comments
Driver's license	Y	Required
Age	?	
Disabilities	?	
Household drivers	Y	Required
Household workers	?	
Household adults	?	
Household persons	?	Marginally useful
Household vehicles	Y	Required
Household income	?	Necessary if used in mode choice model

Source: Session 4: Data Collection, Slide 46 (Federal Transit Administration, 2007).

Figure A.1. FTA comments on frequently included traveler characteristics.

different response rates and different travel patterns, the FTA urges sample allocation and survey methods that account for these differences and improve overall response rates.

The FTA's guidance on questionnaire design relates to the visual and interpretational aspects of the survey. Specifically, the FTA recommends that the surveys be simple in terms of layout, readability, and wording. Attention to these three aspects can help avoid round-trip reporting and can provide better data on trip origins and destinations.

Successful surveys are succinct. Recognizing this, the FTA has identified several key data items that must be included in the surveys and several others that either require the use of discretion or are simply unnecessary. Figures A.1, A.2, and A.3 show the FTA's comments on the usefulness of various commonly included traveler, trip, and other characteristics, respectively, in rider surveys.

In addition to the rider surveys, the FTA recommends the use of other ridership data, where available, to inform the modeling process. These data could include on-off counts and park-and-ride utilization counts.

Calibration and Validation

As indicated previously, the FTA emphasizes that forecasts should be based on models that are tested rigorously against current transit ridership patterns. The FTA requires that the model forecasts serve as a useful basis for quantifying and understanding user benefits from the proposed New Starts projects. The implications of a careful calibration and validation methodology are threefold: first, it necessitates better current data; second, it calls for a better focus on transit markets; and third, it requires better tests and standards.

Trip characteristics		
Items	?	Comments
O and D purposes	Y	Required
O and D locations	Y	Required
O and D access modes	Y	Required
Park-ride location	Y	Required
All routes in O-D path	Y	Required
Xfer from, Xfer to	?	Redundant; useful for path checking?
Number of Xfers	?	Redundant; useful for path checking?
O-on and D-off locations	?	Desirable, but adds complexity, length
Fare paid / method	?	Desirable, but adds length

Source: Session 4: Data Collection, Slide 45 (Federal Transit Administration, 2007).

Figure A.2. FTA comments on frequently included trip characteristics.

Other data items

Items	Y	Comments
Options if no transit	?	Best for "captivity"
Vehicle available for trip	N	Ambiguous
Path attribute weights	?	May inform pathbuilder calibration
Previous behavior	y	Useful in Before-After studies
Customer satisfaction	?	Length/responsiveness/funding
Open-ended comment	?	Responsiveness
Contact information	?	Call-backs for QC checks; responsiveness

Source: Session 4: Data Collection, Slide 47 (Federal Transit Administration, 2007).

Figure A.3. FTA comments on frequently included other characteristics.

The FTA recommends that project sponsors take advantage of the funding and guidance opportunities available from the FTA to collect good quality "before" and "after" survey data. The issue of better focus on transit markets can be achieved through an evaluation of model performance by each trip purpose, socioeconomic group, production-attraction area types, and transit access modes. The FTA deems the matching of overall target totals as an insufficient measure of model calibration. The standards for model calibration must rely as much on behavioral significance as they do on statistical significance. The FTA defines validation as a valid description of travel behavior as well as plausible forecasts of "deltas" for the future year. The FTA recommends careful documentation of key transit markets, current transit modes, and calibration forecasts to help evaluate the overall effectiveness of the model for New Starts analysis.

The FTA provides guidelines on the allocation of resources to the three important tasks of model development, calibration, and validation. Because of the critical importance of model validation, the FTA recommends that estimation be conducted only where necessary and that the testing (calibration and validation) task be fully funded. In model estimation, statistical procedures are used to develop values for model parameters that will provide a best fit with observed travel data. The FTA's guidance here indicates that it may be acceptable in many cases to transfer previously estimated parameters from another area's model and then calibrate and validate them to local data in the new area.

The FTA has provided guidance on specific properties of travel models to ensure proper calibration and validation. The FTA has found that many travel models have one or more of the following problems:

- Unusual coefficients in mode choice models;
- Bizarre alternative-specific constants;
- Path/mode choice inconsistencies;
- Inaccurate bus running times; and
- Unstable highway-assignment results.

Since naïve calibration leads to bad alternative-specific constants and has the cascading effect of producing errors in trips and benefits, the FTA suggests that modelers ask themselves if patterns across market segments are explainable.

The FTA also suggests that there be conformity between parameters used in transit path selection and mode choice utility expressions for transit choices. That is, the path-building process must weigh the various travel time and cost components in a manner that is consistent with the relative values of the mode choice coefficients. The consequences of inconsistencies include the following:

- Better paths may look worse in mode choice; and
- Build alternatives may lose some trips and benefits.

The FTA requires that level-of-service estimates for transit (and highway) must:

- Replicate current conditions reasonably well;
- Predict defensible deltas by comparing conditions today versus the future; and
- Predict defensible deltas when comparing conditions across alternatives.

The FTA recommends a careful analysis of highway and transit travel times between carefully selected origins and destinations to understand the quality of the model networks. Spurious values of travel time can distort the magnitude as well as the pattern of predicted trip making and can adversely affect the quality of project user benefits.

A.3.2 Summary of FTA Guidelines

The FTA's requirements are geared toward reasonably accounting for current patterns and predicting reasonable future ridership for the proposed New Starts projects. The FTA does not provide rigid targets for parameters in travel models. Rather, the FTA recommends methods that can be used to ensure that models reflect current travel behavior and predict reasonable future patterns.

The FTA's expectations from travel models and the New Starts process can be summarized as follows:

- Coherent narrative of the model parameters, inputs, and outputs;
- Regular and early communication regarding model parameters and forecasts to ensure that the agency/sponsor is proceeding in the proper direction;
- Reasonable model forecasts in light of the expected land use growth, service characteristics, and other project-related attributes; and
- Proper documentation and uncertainty analysis, which is directly related to the requirement of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) of 2005 that asks the FTA to provide the U.S. Congress with an assessment of contractor performance. The FTA will rate contractors based on the following measures:
  – Comparison of predicted and actual ridership;
  – Quality of documentation;
  – Uncertainty analysis, including magnitude of impact; and
  – Before and after studies for various stages, including alternatives analysis, preliminary engineering, pre-project construction, and 2 years after opening.

References

Federal Highway Administration (2009). "Certification Checklist for Travel Forecasting Methods." http://www.fhwa.dot.gov/planning/certcheck.htm (As of September 15, 2011.)

Federal Transit Administration (2007). Travel Forecasting for New Starts Workshop, St. Louis, Missouri. http://www.fta.dot.gov/documents/Sessions_01-04.pdf (As of February 8, 2012.)

APPENDIX B

Review of Literature on Transferability Studies

In preparing this report, a literature review of transferability of model parameters was undertaken. This appendix presents the results of this review, which are mixed regarding the validity of transferring model parameters in many cases. The purpose of this appendix is not to warn practitioners against transferring parameters but to provide background information on research findings regarding transferability and information that may be helpful in areas where some data may be available for model estimation but not enough to estimate a complete set of model components. It is recognized, however, that many areas do not have enough data for model estimation and must use transferred parameters such as those presented in Chapter 4.

The literature review found that while transferability was valid in some studies, its validity could not be demonstrated in others. In general, transferability was demonstrated for trip generation and mode choice in some cases but not others, while the literature on transferability of other parameters, including trip distribution, time of day, and freight/truck modeling, was insufficient to draw any conclusions. More research into model transferability, the conditions under which transferability is most likely to be valid, and ways in which the validity of transferred parameters could be improved is needed. This appendix includes several references that describe methods for scaling that could be used if limited model estimation data (possibly from a small household activity/travel survey or NHTS samples in the model region) are available.

B.1 Trip Generation

B.1.1 Spatial Transferability

Several studies in the literature have examined spatial transferability in the context of trip generation, as discussed in the following paragraph.

Caldwell and Demetsky (1980) evaluated spatial transferability of linear regression models of household-level trip generation and zonal-level trip generation, using data from three cities in Virginia: Roanoke, Harrisonburg, and Winchester. In the household-level model, they considered two explanatory variables (auto ownership and household size) and used total trip productions per household as the dependent variable. In the zonal-level model, they used a single explanatory variable (zonal-level number of cars), with total zonal trip productions classified by home-based work, home-based nonwork, and nonhome-based productions as the dependent variable. Overall, the results of the study suggest that trip generation models can be transferred between cities, at least as long as care is taken in selecting “similar” cities. “Similar” cities are implicitly defined in the study as those with similar household size, household auto ownership levels, and per capita income.

Gunn et al. (1985) examined the transfer scaling approach for spatial transferability using two adjacent urban regions of the Netherlands: one located around Rotterdam and The Hague and the other located around Utrecht. The transferability analysis was based on data collected at each of the two urban regions, though the data were collected at the two locations at different points in time, as well as at different times of year. To accommodate the intrinsic differences in background variables across the two spatial contexts due to different times of data collection and different periods within the year of data collection, the authors used a nationwide travel survey as a control data set and then examined the spatial transferability of a daily shopping trip generation model as well as a personal business trip generation model (which are parts of a linked disaggregate-level nested logit system of mode-destination and trip generation specific to each trip purpose). The overall empirical results indicate that a simple uniform scaling of the coefficients between the joint model components of the base area and the transfer area is quite adequate relative to separate locally estimated models for the two areas, both from a statistical log-likelihood ratio fit perspective as well as from a prediction perspective on a suite of predefined market segments. This is quite interesting, given that the specifications adopted in these joint models are not particularly comprehensive in trip determinant variables. Specifically, the independent variables included level-of-service variables, demographic variables (cars per licensed driver, gender, and a central business district destination dummy variable), and an intrazonal trip dummy variable.

Koppelman and Rose (1983) indicated that aggregate models are not likely to be spatially and temporally transferable, even in cases where the underlying disaggregate-level behavioral process is similar. This is because of differences in the distribution of variables within aggregate population groups in the estimation and application contexts. In their empirical analysis, the authors, among other things, examined the intra-regional transferability of household-level linear regression trip generation models between two sectors of each of three urban areas, Baltimore, Minneapolis-St. Paul, and Washington, D.C. The dependent variables in the analysis included number of stops and number of tours. The results indicate large differences in parameter estimates of the trip generation model between sectors in each urban region. However, the authors found reasonable predictive ability of the transferred models based on typical goodness-of-fit and prediction measure comparisons between the transferred models and locally estimated models. At the same time, their statistical tests reject transferability, despite the closeness of goodness-of-fit and prediction errors.

Wilmot (1995) also examined the transferability of household-based linear regression trip generation models. He used total trips per household as the dependent variable and considered household size and number of workers as the independent variables. He examined transferability within cities, between areas in a city, and between several cities in South Africa. His results suggest that model specification does influence the level of transferability, as does the difference in average income between the estimation and application contexts. Wilmot also emphasized the need to have quality data in the application context to evaluate transferability. In his study, he found a substantial improvement in transferability when the constant in the linear regression model is updated based on application context data.

Agyemang-Duah and Hall (1997) built upon the earlier research in two ways. First, they used an ordered-response model that respects the discrete and ordinal nature of number of trips and includes built-in upper limits for trip rates as the values of the explanatory variables increase. Second, they included variables related to cost of travel and accessibility in evaluating spatial transferability. The research focused on weekday home-based shopping trips made by households with one or more vehicles in the metropolitan Toronto area, based on a 1986 travel survey. The independent variables included household size, number of children less than 16 years old, number of vehicles in the household, number of full-time employed individuals working outside the home, number of part-time employed individuals working outside the home, number of individuals employed at home, number of unemployed individuals, and accessibility to shopping opportunities. Spatial transferability was examined by evaluating models estimated on a core area (estimation area) to predict trip generation in a periphery area (application context). Similarly, spatial transferability also was examined between the eastern and western parts of the metropolitan area, and among three pairs of municipalities. The transferability was assessed for a simple transfer scheme as well as a transfer updating scheme where factors (or scales) are applied to the latent index contribution of socioeconomic variables and the accessibility variable (the model coefficients used here are as obtained in the estimation context). Transferability was evaluated using a transferred pseudo R^2 measure (or the fraction of the constants-only log-likelihood ratio value in the prediction context explained by the model coefficients obtained from the estimation context), comparison of predicted versus observed aggregate shares, weighted root mean square error (the average relative error in the aggregate predicted shares weighted by the predicted shares), and two other related measures. The results indicate that the simple transfer mechanism works quite well for model transfer, though the transfer updating procedure substantially improves the predictive ability of the transferred model.

Kawamoto (2003) examined the spatial transferability of a linear regression model of total home-based trip productions at the person level between two urban areas in Brazil: Sao Paulo and Bauru. They used a standardized form of the regression model, where the dependent and independent variables are represented in standardized form and are unit free. This procedure requires the values of the mean and standard deviation of each model variable in the application area, and represents a transfer updating scheme where the scaling is done on a variable-by-variable basis. Transferability was evaluated based on a Wald test statistic of parameter equality in the regression models in the estimation and application contexts after accommodations for variance differences in the two contexts. The variables considered in the analysis included relationship with householder, educational attainment, number of cars in household, student status, employment status, and if the individual is a child younger than 11 years. The results indicate that the standardized regression models are indeed transferable between the two cities, though the unstandardized versions are not. This is interesting, especially given that the Sao Paulo data was collected in 1987, while the Bauru data was collected in 1998.

Cotrus et al. (2005) examined the spatial transferability of linear regression and Tobit models of person-level trip generation models, using data from Tel Aviv and Haifa in Israel. The data were drawn from the 1984 and 1996/1997 Israeli National Travel Habits Survey. The models included age, car availability, possession of a driver's license, employment status, education level, and whether the individual defines herself/himself as the head of the household. The results indicate that the Tobit models fit the data better, but that equality of coefficients in the two areas is rejected for both the regression and Tobit models on the basis of statistical tests. In particular, the coefficients on the license holding and age variables are statistically different, while those of other coefficients are not. However, the transferred models appear to do quite well in terms of aggregate predictions.

Greaves and Stopher (2000) employed the data transferability approach to transfer trip production models. Specifically, they used the 1995 Nationwide Personal Transportation Survey (NPTS) data and clustered households into relatively homogenous groups for each of six trip purposes: home-work, home-school, home-shop, home-other, other-work, and other-other. A classification and regression tree method, combined with the standard analysis of variance procedure, was adopted to determine the clusters. The number of clusters varied from six groups for the home-work, home-school, and work-other purposes to 16 groups for the remaining purposes. The clustering variables included household size, number of workers, number of vehicles, and number of children and adults by age group. Within each cluster for each trip purpose, a cumulative frequency distribution was developed for number of trips produced. They then applied the cluster scheme to predict the trip productions for a survey sample of households in the Baton Rouge MPO region. For this process, they applied the clustering scheme to the add-on sample as developed earlier from the main NPTS sample, and then drew a random realization from the cumulative trip production frequency distribution for each purpose and each Baton Rouge region sample household based on the cluster to which the sample household is assigned. Next, they compared the trip production predictions from their method and from a borrowed model that is based only on household size as the independent variable, using the survey-collected trip productions as "ground reality." They found that their approach does better than the borrowed model, a result that is not surprising given that the borrowed model is based only on a single household size variable, while the authors' approach effectively uses several independent variables. They also compared the model estimates obtained from estimating trip production models using their synthesized trip production data and the actual survey trip production data, and concluded that the trip production models for "home-work and home-school are well estimated, home-shop and work-other are acceptably estimated, and home-other and other-other are marginally well estimated."

Stopher et al. (2003) undertook a similar analysis as Greaves and Stopher, except that they examined the effectiveness of their approach in application areas (Dallas and Salt Lake City) where household travel surveys may not be based on the same survey collection methodology as NPTS (the Baton Rouge household travel survey used earlier was patterned after the 1995 NPTS). Specifically, the household travel surveys were collected over the fall or spring of a year, rather than the year-round data collection of NPTS, and were based on an activity survey rather than the trip-based survey of NPTS. The study also examined if the travel characteristics are a function of city characteristics in addition to demographic attributes that formed the clustering basis in the earlier work. Their results show that the simulation does not work well for the Dallas and Salt Lake City areas, though this result may simply be an artifact of the way the survey questions were worded and interpreted by respondents. They also conclude that city characteristics do matter in trip production estimates, and they recommend using contextual variables such as city population size and transit service quality. In addition, they suggest the use of a Bayesian updating of the travel characteristics for the clusters using small samples from the application context.

Reuscher et al. (2002) also pursued a data transferability analysis of vehicle trips per household, vehicle miles of travel (VMT), person trips per household, and person miles of travel (PMT) rates. They used a combination of cluster/regression analysis, judgment, and well-established relationships between VMT and area type and demographics. In particular, they first classified the census tracts in the United States into nine groups defined by area type (urban, suburban, and rural) and income (very low, very high, and other). Next, they developed household size-specific, number of vehicles-specific, and census tract (CT) cluster-specific vehicle trip, VMT, person trips, and PMT rate estimates (and standard error of estimates) using the 1995 NPTS data. Based on this initial classification, they subsequently undertook a clustering analysis procedure to determine the final clusters based on a combination of household size, number of vehicles, and the initial CT clusters. Once this clustering was established, the travel characteristics for any CT tract in the United States could be determined based on the cluster to which it belongs. The authors assessed their approach using data from Baton

Rouge and three NPTS add-on samples from New York, Massachusetts, and Oklahoma, and found their approach to be better than other approaches that cluster CT tracts based on metropolitan statistical area (MSA) size, census region, and census division.

Mohammadian and Zhang (2007) used methods similar to the earlier data transferability studies but considered a more comprehensive set of variables to cluster households on, including demographics, pedestrian-friendly environment characteristics (such as intersection density, road density, and block size), transit usage, and congestion factors (the Urban Mobility Index measure, total number of road users divided by road density, and the percentage of workers driving to work divided by road density). A combination of principal component analysis and cluster analysis was undertaken to define a total of 11 relatively homogenous groups of household types using the 2001 NHTS. This clustering scheme was then transferred to the NHTS add-on samples from New York, Wisconsin, Texas, Kentucky, and Hawaii. The transferred travel characteristics from the original NHTS survey were then compared to the actual travel characteristics directly collected in add-on samples, as a way of assessing the performance of transferability. They found reasonable transferability on such travel characteristics as person/vehicle trips and tours by purpose.

Zhang and Mohammadian (2008a) applied the data transferability approach by generating a synthetic population for the application context using well-established population generation methods. Their application context corresponded to the New York region. They classified the generated population using the approach in Mohammadian and Zhang (2007) and compared the mean values of trips per person and trip distance per person from the simulated data with the mean values from corresponding clusters from the actual observed survey data (from the New York NHTS add-on sample). The results show good fit of the simulated and observed travel characteristics.

Zhang and Mohammadian (2008b) further improved upon Zhang and Mohammadian (2008a) by fitting a gamma distribution for the trip rate per person and trip distance per person for each cluster using the main NHTS survey, and next updated the parameters of this distribution using a small sample randomly selected from the NHTS add on for New York (as suggested by Stopher et al., 2003). The authors used a Bayesian approach to updating and compared the parameters of the updated gamma distribution within each cluster with the equivalent best fit gamma distribution parameters from the corresponding cluster of households from the entire New York add-on sample. The authors note that the parameters of the updated gamma distribution are closer to those from the New York add-on sample compared to the unupdated gamma distribution parameters.

B.1.2 Temporal Transferability

There have been relatively few studies of temporal transferability in the context of trip generation. Ashford and Holloway (1971) employed data from the Pittsburgh area collected in 1958 and 1967 to examine the temporal stability of parameters from a zonal-level linear regression model as well as a household-level linear regression model (more specifically, a cross-classification model).[1] The authors found substantial differences in the estimated coefficients between the regression models for the 2 years and concluded that trip generation projections over long-term planning horizons are likely to be unreliable other than for gross level-of-magnitude estimates.

Kannel and Heathington (1972) performed a similar analysis of stability of parameters for a household-level linear regression model using data from Indianapolis in 1964 and 1971. The independent variables considered in this analysis were household size and auto ownership. The study found substantial and statistically significant differences in estimated coefficients of the linear regression models estimated in 1964 and 1971, reinforcing the finding from Ashford and Holloway (1971).

Doubleday (1976) evaluated the temporal transferability of a linear regression model of the cross-classification type using employment status and profession, presence and age of children, and household car ownership as determinant variables of individual-level trip generation by trip purpose. The data were drawn from the Reading area in England from 1962 and 1971. The results indicate, among other things, that the trip generation models provide good predictive results for employed males, but not so for retired individuals, homemakers, and employed females. The inclusion of the presence and age distribution of children appeared to provide more stable results over time.

Badoe and Steuart (1997) studied the temporal transferability of linear regression home-based trip generation models at the household level with a simple transfer method and using data from the Greater Toronto area from 1964 and 1986. Specifically, they examined model parameter stability and the predictive ability of models estimated from the 1964 data to explain household-level trip generation in 1986. The independent variables used were household size, number of vehicles owned by household, number of licensed drivers in the household, and number of employed individuals.

[1]Cross-classification is but a form of linear regression where the effects of independent variables (such as car ownership, household size, etc.) are allowed to have a general non-linear effect. An equivalent linear regression formulation would have appropriately defined dummy variables to represent the effect of each combination value of the independent variables.

The empirical results indicate generally large differences in the sensitivity to explanatory variables of total home-based trips, home-based work trips, home-based shopping trips, home-based social and recreational trips, and home-based personal business trips. Badoe and Steuart then evaluated predictive ability using a transfer R^2 measure (i.e., the R^2 measure as computed using the 1964 linear regression models on the 1986 trip generation data without any adjustments of the 1964 regression results), a transferability index (the ratio of the transfer R^2 measure and the R^2 measure from the 1986 linear regressions), the transfer root mean square error (RMSE) of the predictions using the 1964 models for the 1986 data, and a measure of relative RMSE (the ratio of the transfer RMSE and the RMSE from the 1986 linear regression models). These results indicate, as expected, that the transferred measures are not as good as the prediction measures based on the 1986 linear regression models though the differences are rather marginal. The differences in the transfer and 1986 model predictive abilities narrow further when the linear regression predictions are aggregated to obtain zonal-level trip ends. This is, of course, because of compensating errors and the loss of variation in the aggregation of trips to the zonal level. But the results do show statistically significant biases (overpredictions) in using the 1964 model to predict zonal-level trip ends in 1986. Overall, the authors find good temporal transferability of the 1964 models for total home-based trips and home-based work trips, but quite poor forecast performance for the home-based nonwork trip categories. However, they also note that the poor forecast performance for the nonwork categories can be partly attributed to the generally low ability to explain nonwork trips using the explanatory variables they used as well as ignoring trip chaining behavior.

Cotrus et al. (2005), in their study as discussed under spatial transferability, also examined temporal transferability of trip generation models in Haifa and Tel Aviv over time. Their results indicate statistically significant differences in coefficients in each urban area over time, rejecting temporal stability in the behavioral relationship characterizing trip generation. However, the authors acknowledge that their result may be an artifact of not considering several other explanatory variables in the models, including income, land use variables, spatial structure attributes, the economic conditions, and the transportation system characteristics. In addition, the results may also be affected by the different survey designs, periods of data collection, and variable definitions used in the 1984 and 1996/1997 Israeli Travel Habits Surveys.

B.1.3 Summary

The results of studies of the spatial and temporal transferability of trip generation models have been rather mixed. Unfortunately, it is difficult to synthesize the results from the various efforts to provide any conclusive guidelines for transferability because of the different variable specifications used, the different dependent variables adopted (some of which are at the person level and some at the household level), the different trip purposes considered, the different geographic and temporal periods of the studies, the different model forms employed, and the different independent variable specifications in the models. Besides, most of the trip generation studies have not controlled for land use, accessibility, and transportation system characteristics when studying spatial and temporal transferability. A study by Lin and Long (2007) highlights this issue and suggests that including these additional variables can enhance spatial transferability. However, the study by Lin and Long focuses only on household auto work trips and not on other kinds of trips that are likely to exhibit more variation in trip generation relationships across space and time.

In general, however, it appears safe to say that trip generation transferability will be improved with better variable specifications, a disaggregate-level analysis at the household or person level rather than at an aggregate zonal level, a model structure that reflects the ordinal and discrete nature of trips, and a transfer approach that involves transfer scaling of coefficients. In the context of transfer scaling, it should be pointed out that most trip generation analyses of transferability have focused on a simple transfer approach, rather than on a transfer approach that combines some limited information from the application context to update the estimation context relationships for use in the application area.

Another important issue to note in the earlier trip generation studies is that they have all been trip based and do not consider trip chaining and the more general interdependence among trips of individuals. Thus, separate models for home-based trips and nonhome-based trips are developed, without any consideration of the dependence between these categories of trips. Consequently, differences in trip chaining tendencies from one area to another, or from one time period to another, could immediately result in findings of poor trip generation transferability, even if models of the number of stops (out-of-home activity participations) have good transferability. This issue needs careful attention in the future and suggests the need for transferability analysis in the context of tour-based and activity-based frameworks for travel demand modeling.

B.2 Trip Distribution/ Destination Choice

B.2.1 Temporal Transferability

The literature on transferability of trip distribution/ destination choice is relatively limited and has been focused on temporal transferability, not spatial transferability. Volet and Hutchinson (1986) evaluated the ability of growth factor-based and gravity-based trip distribution models for commuting trips estimated in the Toronto region in 1971 to predict the spatial distribution of commuting trips in 1981. They developed models for three different spatial resolutions of the traffic zone system in the Toronto region: a 38-zone system, a 77-zone system, and a 124-zone system. The overall conclusion of this study is that the growth factor model outperforms the gravity model in predicting the 1981 spatial patterns, though both the growth factor and gravity models have difficulty in replicating commute trend shifts due to changes in the urban spatial structure of employment centers and residential locations. Duffus et al. (1987) conducted a similar temporal transferability analysis with gravity-type trip distribution models using data from Winnipeg in the years 1962, 1971, 1976, and 1981. The authors used a rather coarse spatial resolution, partitioning the Winnipeg planning area into 36 "super" zones. The results indicate that transferability in terms of zone-to-zone forecast errors deteriorates with the length of time of the temporal transferability period and with the inclusion of K-factors in the estimation phase. Elmi et al. (1999) examined the temporal transferability of entropy-type aggregate trip distribution models for commute trips based on data collected in the Toronto region in 1964, 1986, and 1996. The number of zones was 815 in 1964, and 1,404 in 1986 and 1996 (it is not clear how the authors reconciled this difference in zone systems in their empirical analysis). The authors also examined the influence of an improved model specification on transferability through the stratification of the trip data into two spatial markets (the Toronto Central area and the rest of the Greater Toronto area), and segmentation based on gender, auto ownership level, driver's license status, and worker occupation. Their results show that the coefficient on the impedance parameter (represented as the auto travel time between zones) is not temporally stable, though the transferred model forecasts are comparable to those obtained from locally (in time) estimated models. In addition, the extent of transferability deteriorates with an increase in time span between the estimation and application years, as also found by Duffus et al. Further, the authors observe that improved model specifications through the trip data stratifications enhance transferability significantly as measured by the disaggregate transfer log-likelihood value fits. However, this result did not carry over to transferability as measured by the zone-level root mean square forecast errors. Overall, the authors conclude that, from a pragmatic perspective, a simple model devoid of any stratification is adequate in forecast performance.

The above studies have used an aggregate trip distribution model, with auto travel time as the only measure of travel impedance. In contrast, Karasmaa and Pursula (1997) examined temporal transferability in the context of a disaggregate nested logit trip destination-mode choice model, which effectively considers travel time and cost characteristics by multiple modes (walk, car, and public transport) in destination choice decisions. However, like the earlier trip distribution models, Karasmaa and Pursula also confined their attention to home-based work trips in the paper. The research is based on data from the Helsinki metropolitan area, collected in 1981 (estimation context) and 1988 (transfer context). The authors examined the effects of model specification by using travel time and travel-cost variables only, and then adding the number of cars per household as an additional socioeconomic variable. Four transfer approaches were evaluated: transfer scaling, Bayesian updating, combined transfer, and joint context estimation. The influence of the size of the application context data on transferability was also examined by using five different samples. The authors found no substantial differences in disaggregate transfer predictive fit across different sample sizes and different updating methods. All sample sizes and transfer methods did well in disaggregate predictive fit compared to the locally estimated joint choice model (i.e., the model directly estimated using 1988 data). However, the implied money value of time was quite different based on estimation sample size and transfer updating procedure (the research restricted the implied money value of time to the same across modes and across the mode and destination choice dimensions). Also, the transferred model's predictions of changes in behavior due to an across-the-board 30 percent increase in public transport travel time varied substantially based on sample size and transfer updating method. The authors made some tentative conclusions about the effectiveness of the alternative transfer methods based on the model's predictions of behavioral changes, including the superiority of the transfer scaling approach for simple models and large transfer biases (i.e., large differences in the locally estimated parameter values in the estimation and application contexts), and the better performance of the combined transfer approach when the sample size in the application context is large and the transfer bias is small.

Gunn et al. (1985) also examined destination choice model transferability, as part of their joint system of mode, destination, and trip generation system.

B.2.2 Summary

There has been little previous research on studying transferability of trip distribution and destination choice models. Further, the earlier studies in this area have been confined to temporal transferability of work trips. Within this restricted context, the results from earlier studies suggest that trip distribution/destination choice models transfer reasonably well over time in terms of predictive fit and forecast errors, though the behavioral parameters do show temporal instability. However, there seems to be no clear indication of which type of updating method would be best suited for what type of transfer context. Of course, the trip-based nature of earlier studies completely ignores issues of destination linkages of stops and identifies the need for transferability analysis in the context of tour-based and activity-based frameworks for travel demand modeling.

B.3 Mode Choice

B.3.1 Spatial Transferability

Watson and Westin (1975) studied the spatial transferability of binary logit intercity mode choice models among different subareas in the Edinburgh-Glasgow area of Scotland. Specifically, they identified six travel "corridors" in the Edinburgh-Glasgow area based on whether the origin and destination ends were in the central city, the suburbs, or peripheral to the urban area. The modes considered were the automobile and train. They included level-of-service variables and a mode-specific constant, but no socioeconomic characteristics of the travelers. The models estimated in the six travel corridors were then compared for similarity in model coefficients, and each model also was transferred to the other five corridors to evaluate modal split predictions. Their findings indicate that there is a high level of model transferability between the three models estimated in the corridors with a trip-end in the central city. However, this is not the case for the models estimated in the remaining three corridors that did not have a trip-end in the central city.

Atherton and Ben-Akiva (1976) examined the spatial transferability of a home-to-work trip mode choice model estimated on data collected in Washington, D.C., in 1968 to New Bedford, Massachusetts, and Los Angeles. Data from 1963 in New Bedford and 1967 in Los Angeles were available to test the extent of transferability of the multinomial logit model estimated from Washington, D.C. The alternatives considered in the mode choice model included driving alone, sharing a ride, and public transit. The authors conclude, based on statistical tests of parameter equality and predictive ability in the transfer contexts, that the Washington, D.C. model is transferable to the other two application areas. They further examined the benefit of updating approaches that (1) update the constants only based on aggregate shares of the alternative modes in the application area, (2) update the constants as well as estimate a single factor that scales the other coefficients, and (3) use a Bayesian update method based on the inverse of the variance-covariance matrices of the coefficient estimates from the estimation context and the application context as weighting factors. The results indicate that the Bayesian update approach works best, especially when the disaggregate sample available from the application context is small in size and the original estimation context choice model is well specified. However, there is little difference in the extent of transferability between the model with no updating and that with even the Bayesian update.

Talvitie and Kirshner (1978), in their study of urban commute mode choice model transferability between Washington, Minneapolis-St. Paul, and San Francisco, used the same variable specification as that in Atherton and Ben-Akiva. The modal alternatives are drive alone, shared ride, and bus with walk access (the individuals choosing the Bay Area Rapid Transit System in the San Francisco Bay area were removed from the analysis). The authors examined transferability both within each region and between regions. The within-region transferability was examined by partitioning the sample from each region in three ways: (1) urban travel versus suburban travel (not done for the San Francisco sample), (2) central business district (CBD) travel versus non-CBD travel, and (3) a random split of the sample into two subsamples. Overall, the results of statistical tests of parameter equality between the samples within each region were mixed and inconclusive although there was more evidence of nonequality of parameters than equality of parameters. The between-region transferability in terms of model parameter equality also was statistically rejected with a high level of confidence. These results are clearly different from the results of Atherton and Ben-Akiva. The authors suggest that several factors may have played a role in their findings, including variations in network coding routines and differential trimming of outlying data points across the data sets.

Galbraith and Hensher (1982) emphasized the need to consider both level-of-service variables as well as a reasonably extensive set of socioeconomic and contextual characteristics in mode choice models before evaluating transferability. They also identified the need to use consistent data (i.e., same measurement procedures, sampling procedures, variable definitions, questionnaire wording, etc.) in the estimation and application contexts to engage in any meaningful debates about the extent of model transferability. Their empirical analysis of the spatial transferability of mode choice models involved examining the intra-urban transferability of commute binary mode choice coefficients from two suburban areas in Sydney. The alternatives included car and rail. In addition to the usual level-of-service variables, the final specification used in the paper included variables representing gross annual individual income, number of licensed drivers in the household, and number of cars in the household. Their statistical tests reject parameter equality of the logit models in the two suburban regions though they find that a specification that normalized travel cost by income transferred relatively better than a specification that used a non-normalized travel-cost variable. However, in an evaluation of predictive ability at the mode share level, the simple transferred models without any updating performed quite adequately relative to the locally estimated model. They find a Bayesian transfer update approach to perform somewhat better than the approach without any updating and the approach that updates the constants/scale.

Koppelman and Wilmot (1982) focused on the intraregional transferability of a commute mode choice model for breadwinners who work in the central business district of Washington, D.C. They caution against the sole use of model parameter equality as an indicator of whether a model is transferable or not, indicating that model parameter equality is a symmetric property between two contexts, while transferability is a directional property. In their empirical analysis, they used disaggregate measures of transferability (transfer log-likelihood ratio, transfer log-likelihood index, and the transfer rho-squared) as well as aggregate measures of transferability (root mean square error and relative root mean square error). The data sample was partitioned into three groups based on three predetermined geographic sectors in the Washington, D.C. area, and model transferability was studied between the resulting three pairs of sectors. The alternatives included drive alone, shared ride, and transit, and the variables included in the specification are level-of-service variables, income, vehicles per driver, a government worker dummy variable, and the number of workers in the household. The results reject parameter equality across the models for the three pairs of sectors. Further, the disaggregate measures of transferability reject the hypothesis of intraurban transferability, even if the modal constants are adjusted to match the application area modal shares. However, the transferred models provide close to 80 percent of the information provided by local models, indicating that the extent of transferability is not bad at all from a nonstatistical perspective. Further, the transferred models perform quite well compared on the basis of aggregate modal share predictions. This seeming inconsistency between statistical tests and transfer errors is not uncommon, and the authors recommend that "although statistical tests can be used to alert the planner or analyst to differences between models, they must be considered with reference to the magnitude of errors that are acceptable in each application context."

Koppelman and Rose (1983) studied the intraregional transferability of a multinomial work mode choice model by partitioning the Baltimore region into a North sector and a South sector. The modal alternatives were drive alone, shared ride, and transit, while the independent variables included level-of-service variables as well as socioeconomic variables such as income and cars per driver. The results reject transferability based on parameter equality, disaggregate measures of transferability, and aggregate measures of transferability, though there is substantial improvement in the aggregate measures of prediction when the estimated model constants are adjusted based on the aggregate modal shares in the applicant region. The authors conducted a similar analysis of intraregional transferability of mode choice models from the Washington, D.C. area and Minneapolis-St. Paul, and found that the transfer performance is much better in these other urban areas relative to Baltimore. However, even in these other areas, intraregional transferability is rejected based on statistical tests.

Koppelman et al. (1985) examined the effectiveness of model updating using limited data from the application context on intraregional and interregional work travel mode choice transferability. Specifically, they studied the effect of updating alternative specific constants and the scale of the model. The data used for the intraregional transferability analysis were from Washington, D.C., with the same use of three sectors as defined in Koppelman and Wilmot (1982). The data used for interregional transferability were from Washington, D.C., Minneapolis-St. Paul, and Baltimore. The independent variables used included three level-of-service variables, a car per driver variable specific to the drive-alone and shared-ride alternatives, and modal constants. The same transferability measures as developed in Koppelman and Wilmot (1982) were used in evaluating transfer effectiveness. The results indicate that transferability is improved substantially when the constants are updated, and even more so when the constant and scale are updated. However, the returns from updating the constant and scale are not as high as with updating the constant only. This holds for both interregional and intraregional transferability.

Gunn et al. (1985) conducted a similar evaluation of the effect of model updating as Koppelman et al. (1985), using a joint system of mode, destination, and trip generation system (see discussion of this paper under Section B.1.1). Their results corroborate the findings of Koppelman et al. (1985) that updating constants and the scale leads to improved model transferability.

McComb (1986) assessed spatial transferability using data from a single "high-quality" data source (the transportation supplement of the Canadian Labor Force Data) for 10 cities in Canada. He used the same uniform model specification and consistent data collection and preparation across the cities and examined socioeconomic moderating effects of sensitivities to level-of-service variables. The work trip mode choice model developed for the City of Winnipeg was used as the estimation context, while the other cities were considered as the application contexts. Four modal alternatives were considered: drive alone, shared ride (driver and passenger), transit, and walk/other. The independent variables included level-of-service-variables, sex of individual, family income, age, work trip distance, and peak versus off-peak work start time. The author found that coefficient equality cannot be rejected between cities of similar socioeconomic make-up, size, and transportation system quality (such as Edmonton and Winnipeg, and Calgary and Winnipeg, at the time). However, coefficient equality was rejected for cities that are very different in character (such as Toronto and Winnipeg and Ottawa and Winnipeg).

Koppelman and Wilmot (1986) reported an analytic and empirical investigation of omission of variables on the spatial transferability of mode choice models using the same data set and procedures in Koppelman and Wilmot (1982). Three different specifications were considered to evaluate omitted variable effects on transferability, with each subsequent specification, including the variables in the earlier specification and new variables as follows: (1) three level-of-service variables and modal constants, (2) addition of cars per driver variables specific to drive alone and shared ride, and (3) addition of a government worker dummy variable and a number of workers in the household variable, both specific to the shared-ride mode. The results indicate substantial improvement in transferability with improved specifications, and with modal constant updating based on the aggregate share in the application context. The authors also indicate that models with only level-of-service variables and constants are unlikely to achieve adequate levels of transferability for practical use.

Koppelman and Pas (1986) also examined spatial transferability of a mode choice model using the Washington, D.C. data, but added a multidimensional element to the analysis. The main focus was on whether a nested logit model of auto ownership and mode choice is more or less transferable than a simpler joint multinomial logit model of auto ownership and mode choice. The nested logit model was estimated using a two-step sequential estimation approach, which can lead to a loss of efficiency. In the empirical analysis, the nested logit model's logsum parameter is not statistically significantly different from 1 at the 0.05 level of significance. The results show that the transferred models without updating are able to capture more than 85 percent of the information obtained from locally estimated models for both the multinomial and nested logit models, indicating that both these models are transferable across three sectors in the Washington, D.C. area. The multinomial logit model has a small advantage in the extent of transferability though this improvement over the nested logit model is marginal. However, this result is likely to be specific to the empirical context in the study, because the nested logit specification essentially collapsed to the multinomial logit specification for all the three sectors in the Washington, D.C. area. Further analysis is needed to examine the effect of model structure on transferability.

Abdelwahab (1991) examined spatial transferability of intercity mode choice models between two regions in Canada encompassing travel between 23 major metropolitan areas. He used the 1984 Canadian Travel Survey (CTS) in the analysis and geographically divided the 23 metropolitan areas into two regions: an eastern region, including Thunder Bay and cities east of Thunder Bay, and a western region, including Winnipeg and cities west of Winnipeg. The intercity travel in each of these regions was categorized based on trip length (short trips less than 600 miles and long trips) and purpose (recreational and business). The author used two transfer updating methods, one being the constant-only update scheme and the second being the Bayesian update method that updates all model coefficients. The independent variables used in the analysis are not provided in the paper. The results indicate that the transferred models explain about 50 to 93 percent of the information (i.e., the difference between the log-likelihood value at convergence and the log-likelihood value at market shares) provided by the locally estimated models. Overall, the findings indicate poor transferability, as measured by disaggregate predictive fit and aggregate error, for both updating methods considered.

Karasmaa (2001) explored the spatial transferability of work trip mode choice models in the Helsinki and Turku regions of Finland. The Helsinki region was used as the estimation context, and the Turku as the transfer context. Four transfer approaches were evaluated: transfer scaling with re-estimation of alternative-specific constants and the scale, Bayesian updating, combined transfer, and joint context estimation. The influence of the size of the estimation context data on transferability also was examined by using four different sample sizes for estimation of the Helsinki mode choice model using a 1995 mobility survey. The results show that the joint context estimation is generally the best method of transfer, especially when the estimated coefficients of the locally estimated models are quite different between the estimation and application contexts. The combined transfer estimation approach is best when there is a large estimation sample and the transfer bias is small between the estimation and application contexts.

All the above transferability studies were focused on a developed country setting. In contrast, Santoso and Tsunokawa (2005) examined spatial transferability in a developing country. Travel survey data from Ho Chi Minh City in Vietnam is used as the case study. A work trip mode choice model with three modes (walking, bicycling, and motorcycles) was estimated for the urban area of the city, and its transferability to the suburban area was assessed. The independent variables included level-of-service variables, sex of the individual, and the ratio of number of vehicles to the number of workers. They considered four updating procedures: updating of only the constants, updating of the constants and scale, Bayesian updating, and the combined transfer approach. The transferability results indicate that the Bayesian updating approach does not provide any tangible improvement over the simple transfer model (with no updating at all), while the other three methods do provide improvements. This result holds up for even small sizes of disaggregate data from the transfer context and is in contrast to the finding of Atherton and Ben-Akiva (1976). Among the remaining three approaches, the approaches involving updating of the constants and scale and the combined transfer approach are particularly effective. Interestingly, while Koppelman et al. (1985) find that the gain from updating the constants and scale is not as high as with updating the constants only, the current study finds substantial gains from updating both the constants and scale, with relatively small gains (compared to the simple transfer approach) when only the constants are updated.

B.3.2 Temporal Transferability

McCarthy (1982) examined the temporal transferability of work trip mode choice models in the San Francisco Bay area using before and after data sets associated with the Bay Area Rapid Transit (BART) study. The research was confined to only those individuals who did not change residences and employment locations in the pre-BART and post-BART samples. Data collected from November 1973 to April 1974 were used to develop a pre-BART sample (with only car and bus as the modes) as well as an immediate post-BART sample (BART was a viable mode). In addition, another short-run post-BART sample was collected in the fall of 1975 after the entire BART system became operational. The explanatory variables used in the analysis are the usual generic level-of-service variables as well as alternative-specific variables for family income, number of vehicles per driver, and a San Francisco employment dummy variable. The results show that the pre-BART binary choice model coefficients are stable in the post-BART data context. Next, a model with the pre-BART coefficients for generic variables, the car-specific coefficients from the pre-BART estimation, and freely estimated alternative-specific coefficients for the BART mode was developed from the immediate post-BART sample, and the transferability of this updated model to the sample from the fall of 1975 was examined. The results indicate that the coefficients are all stable, and a statistical test of coefficient equality can be marginally rejected at the 0.05 level of significance, but not at the 0.01 level of significance. Predictive success indices confirm the good temporal transferability of the updated mode choice model to the post-BART period.

Badoe and Miller (1995a) examined the temporal transferability of a morning peak work trip logit mode choice model in Toronto over the long-transfer period from 1964 to 1986. They also assessed if transferability was related with variable specification. The alternative modes in the analysis were auto driver, transit, and walk. The independent variables included level-of-service-variables as well as spatial, personal, and household characteristics of the commuter. In addition to a single pooled model, the authors also formulated 10 models to represent 10 mutually exclusive and homogeneous (in sensitivity to level-of-service variables) segments. Overall, statistical tests reject the hypothesis of equality of coefficients between the 1964 and 1986 estimations for all the pooled and market-segmented specifications. However, from a pragmatic perspective, the transferred models provide useful information in the application context. Specifically, the pooled models that were transferred provide at least as much as 76 percent of the log-likelihood improvement (over the constants-only log-likelihood) provided by locally estimated 1986 models. Updating the constants and scale increases this percentage to 84 percent. Improved model specifications, in general, provide better transferability, though the segmented model with 10 market segments did not perform well (suggesting overfitting in the estimation context).

Badoe and Miller (1995b) used the same data and approach as in Badoe and Miller (1995a) but focused on comparing the performance of alternative transfer updating schemes for different sample sizes of disaggregate data availability in the application (transfer) context and different model specifications. The joint context estimation and the combined transfer estimation procedure provide the best transferability results. If the estimation data sample is available, the authors recommend the joint context estimation over the combined transfer approach. The simple transfer scaling approach also provides a reasonable method for model transfer. However, the authors state that "the Bayesian approach cannot be recommended as an updating procedure." Finally, model specification improvements led to a substantial improvement in transferability.

Karasmaa and Pursula (1997) also examined the temporal transferability of mode choice models, but within the context of a joint mode-destination choice model. They found the transfer scaling approach to be best for simple models and large transfer biases (i.e., large differences in the locally estimated parameter values in the estimation and application contexts), the combined transfer approach to be best when the sample size in the application context is large and the transfer bias is small, and the joint context estimation and Bayesian update approaches to be best with small sample sizes in the application context.

B.3.3 Summary

There is substantial literature on work trip mode choice model transferability although much of it is focused on spatial transferability rather than temporal transferability. There does not appear to be any published literature on transferability for non-work mode choice.

The literature on work mode choice transferability in space and time is mixed. However, some general conclusions are as follows:

- Coefficient equality between the estimation and application contexts should not be used as the sole yardstick for assessing transferability; rather disaggregate and aggregate prediction measures that provide an assessment of the amount of information provided by the transferred model also should be considered.

- Transferability improves with improved variable specification.
- Model updating leads to a substantial improvement in transferability relative to a simple model transfer, even if the updating is simply a constants-only updating to reflect the aggregate mode shares in the application context.
- There is no consensus regarding which update method is best, and it would behoove the analyst to consider all of the updating procedures that are possible in order to assess which performs best in any given context.

It is interesting to note that most of the mode choice transferability studies have been undertaken in the 1970s and 1980s, with significantly fewer studies undertaken recently. Also, while there has been substantial focus on tour-based mode choice and activity-based modeling in general in the past two decades, there does not appear to be any analysis of transferability in the context of tour-based mode choice modeling.

B.4 Conclusions

Overall, the literature provides mixed results regarding the effectiveness and validity of transferability though there also is a clear indication that transferability improves with a better variable specification and with a disaggregate-level model (at the individual or household level) in the estimation context (thus capturing more behavioral determinants that effectively get controlled for in the application context). The results also emphasize that, whenever possible, some level of model updating should be undertaken using local data collected in the application context. While the collection of a small disaggregate-level data set in the application context would allow model updating using any of the methods identified earlier in this document (and the analyst can compare alternative updating methods), the synthesis suggests that even simple updating procedures such as a constants-only updating scheme using aggregate travel data in the application context typically provide superior results than the simple (no-update) transfer approach.

However, it is recognized that even aggregate travel data may not be available in some application contexts, and there may not be resources available to collect such data prior to model transfer. In such instances, the results suggest that the simple transfer scheme should be accompanied by a careful selection of the "estimation" city, so that the "estimation" city is similar to the application city in terms of such factors as the distributions of household size, household auto ownership levels, employed individuals, household income, and population density. Further, it would be best to estimate travel models at a disaggregate level in the estimation context, and then apply the disaggregate-level model parameters using explanatory variable data from the application context to forecast travel.

If this is not possible, an alternative approach suggested by Hu et al. (2007) may be considered, which is based on using census tracts as the unit for transfer. Specifically, Hu et al. classify all census tracts in the country into one of 11 clusters based on a combination of household income, household buying power, geo-economic nature of tract (rural/suburban/urban/mega-urban/extreme-poverty), employment rates, life-cycle status, and number of household vehicles. For each cluster, a model is developed using households from the NHTS that are identified as belonging to that cluster. In application, each census tract of the application city is first classified into one of the 11 clusters. Then, for each census tract in the application city, the corresponding model estimated using the NHTS data is applied, with the exogenous variables for the tract extracted from census data. Travel statistics at the tract level (number of person trips by purpose per household, number of vehicle trips per household, PMT per household and VMT per household) are then converted to a traffic zone level using blocks as a linking mechanism. It should be noted, however, that this method does not provide spatial information on trips (origins and destinations of trips) and so may be of limited use for travel modeling. Further, these authors also emphasize the importance of local data collection in the application context.

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APPENDIX C

Transferable Parameters

Table C.1. Percentages of households by number of vehicles for U.S. metro areas.

Metro Area	Percent 0 Vehicle	Percent 1 Vehicle	Percent 2 Vehicle	Percent 3+ Vehicle
Provo-Orem, UT	2.7%	21.3%	44.2%	31.9%
Holland-Grand Haven, MI	2.9%	26.1%	45.8%	25.2%
St. George, UT	2.9%	29.4%	43.3%	24.4%
Coeur d'Alene, ID	3.0%	26.0%	40.4%	30.6%
Cheyenne, WY	3.4%	31.9%	34.1%	30.6%
Bend, OR	3.5%	25.5%	44.7%	26.3%
Lake Havasu City-Kingman, AZ	3.5%	34.7%	40.6%	21.2%
Fort Collins-Loveland, CO	3.6%	29.5%	42.0%	25.0%
Fort Walton Beach-Crestview-Destin, FL	3.6%	30.5%	43.3%	22.7%
Logan, UT-ID	3.6%	23.7%	41.5%	31.2%
Ogden-Clearfield, UT	3.9%	22.9%	43.7%	29.5%
Oxnard-Thousand Oaks-Ventura, CA	3.9%	26.7%	39.4%	30.0%
Boise City-Nampa, ID	4.0%	27.6%	42.6%	25.8%
Pocatello, ID	4.0%	27.1%	40.0%	28.9%
Rapid City, SD	4.0%	27.1%	39.6%	29.2%
Columbus, IN	4.2%	29.5%	38.7%	27.5%
Elizabethtown, KY	4.2%	30.9%	41.6%	23.4%
Mount Vernon-Anacortes, WA	4.2%	26.7%	39.1%	29.9%
Punta Gorda, FL	4.2%	42.1%	40.0%	13.7%
Fayetteville-Springdale-Rogers, AR-MO	4.3%	32.0%	43.4%	20.3%
Greeley, CO	4.3%	24.9%	40.6%	30.2%
Naples-Marco Island, FL	4.3%	42.6%	40.9%	12.2%
Palm Coast, FL	4.3%	35.2%	45.7%	14.8%
Prescott, AZ	4.3%	35.3%	38.4%	21.9%
San Luis Obispo-Paso Robles, CA	4.3%	30.1%	39.3%	26.3%
Abilene, TX	4.4%	36.3%	42.2%	17.1%
Casper, WY	4.4%	31.9%	36.7%	27.0%
Grand Junction, CO	4.4%	27.6%	40.0%	28.0%
Gulfport-Biloxi, MS	4.4%	34.0%	39.2%	22.3%
Huntsville, AL	4.4%	31.2%	39.0%	25.4%
Idaho Falls, ID	4.4%	23.9%	41.9%	29.9%
Monroe, MI	4.4%	27.9%	42.6%	25.0%
Santa Fe, NM	4.4%	31.4%	38.4%	25.7%
Appleton, WI	4.5%	28.3%	44.7%	22.5%
Jefferson City, MO	4.5%	30.0%	39.5%	26.0%
Palm Bay-Melbourne-Titusville, FL	4.5%	38.7%	40.8%	16.0%
Pascagoula, MS	4.5%	28.3%	41.7%	25.5%
Port St. Lucie, FL	4.5%	40.2%	39.6%	15.7%
Wausau, WI	4.6%	25.8%	43.9%	25.7%
Amarillo, TX	4.7%	34.3%	40.0%	21.0%
Bismarck, ND	4.7%	28.7%	36.0%	30.6%
Boulder, CO	4.7%	34.3%	40.7%	20.3%
Cleveland, TN	4.7%	29.2%	40.5%	25.6%
Killeen-Temple-Fort Hood, TX	4.7%	32.4%	43.9%	19.0%
Barnstable Town, MA	4.8%	35.3%	42.0%	17.9%
Colorado Springs, CO	4.8%	29.6%	42.5%	23.1%
Green Bay, WI	4.8%	30.2%	43.0%	21.9%
Lawrence, KS	4.8%	34.4%	38.5%	22.3%
Lewiston, ID-WA	4.8%	30.0%	36.7%	28.5%
Michigan City-La Porte, IN	4.8%	35.1%	39.4%	20.7%

Table C.1. (Continued).

Metro Area	Percent 0 Vehicle	Percent 1 Vehicle	Percent 2 Vehicle	Percent 3+ Vehicle
Morristown, TN	4.8%	28.4%	40.3%	26.5%
Ocala, FL	4.8%	43.1%	37.4%	14.7%
Raleigh-Cary, NC	4.8%	31.8%	42.7%	20.8%
Riverside-San Bernardino-Ontario, CA	4.8%	28.8%	39.0%	27.5%
Vallejo-Fairfield, CA	4.8%	29.0%	37.8%	28.5%
Dalton, GA	4.9%	37.7%	35.7%	21.6%
Janesville, WI	4.9%	32.0%	42.0%	21.1%
Orlando-Kissimmee, FL	4.9%	37.6%	41.1%	16.4%
Sherman-Denison, TX	5.0%	32.6%	41.1%	21.3%
Winchester, VA-WV	5.0%	27.7%	38.1%	29.2%
Cape Coral-Fort Myers, FL	5.1%	43.5%	38.7%	12.8%
Dallas-Fort Worth-Arlington, TX	5.1%	34.6%	42.0%	18.3%
Farmington, NM	5.1%	31.1%	38.4%	25.4%
Midland, TX	5.1%	31.5%	42.9%	20.5%
Decatur, AL	5.2%	27.7%	39.5%	27.6%
Des Moines-West Des Moines, IA	5.2%	30.6%	42.2%	22.1%
Hattiesburg, MS	5.2%	34.0%	38.6%	22.2%
Jacksonville, NC	5.2%	31.5%	41.0%	22.3%
Nashville-Davidson-Murfreesboro-Franklin, TN	5.2%	32.0%	39.5%	23.2%
Olympia, WA	5.2%	29.3%	38.5%	27.1%
Panama City-Lynn Haven, FL	5.2%	34.8%	41.8%	18.2%
St. Cloud, MN	5.2%	26.6%	42.4%	25.8%
Salt Lake City, UT	5.2%	28.6%	40.9%	25.4%
San Jose-Sunnyvale-Santa Clara, CA	5.2%	29.0%	40.9%	24.9%
Santa Rosa-Petaluma, CA	5.2%	30.0%	39.8%	25.0%
Wenatchee, WA	5.2%	27.3%	42.0%	25.5%
Anchorage, AK	5.3%	31.4%	41.0%	22.3%
Auburn-Opelika, AL	5.3%	35.3%	36.6%	22.8%
Austin-Round Rock, TX	5.3%	35.8%	42.2%	16.7%
Bloomington-Normal, IL	5.3%	33.6%	42.9%	18.2%
Indianapolis-Carmel, IN	5.3%	33.5%	41.3%	20.0%
Lincoln, NE	5.3%	33.3%	39.0%	22.4%
Oklahoma City, OK	5.3%	34.3%	40.8%	19.5%
Rochester, MN	5.3%	29.0%	43.0%	22.7%
Billings, MT	5.4%	28.2%	39.6%	26.7%
Bradenton-Sarasota-Venice, FL	5.4%	45.4%	37.3%	11.9%
Eau Claire, WI	5.4%	29.5%	40.9%	24.1%
Kennewick-Pasco-Richland, WA	5.4%	26.8%	36.8%	30.9%
Manchester-Nashua, NH	5.4%	28.9%	43.9%	21.8%
Myrtle Beach-North Myrtle Beach-Conway, SC	5.4%	36.9%	42.0%	15.7%
Bremerton-Silverdale, WA	5.5%	29.1%	38.7%	26.7%
Burlington-South Burlington, VT	5.5%	33.6%	42.0%	19.0%
Deltona-Daytona Beach-Ormond Beach, FL	5.5%	42.0%	37.5%	15.0%
Fort Wayne, IN	5.5%	32.6%	41.2%	20.7%
Gainesville, GA	5.5%	27.9%	41.1%	25.5%
Grand Forks, ND-MN	5.5%	31.7%	42.6%	20.1%
Hickory-Lenoir-Morganton, NC	5.5%	29.2%	36.8%	28.5%
Knoxville, TN	5.5%	33.6%	39.3%	21.6%
Longview, TX	5.5%	33.8%	40.0%	20.7%
Missoula, MT	5.5%	31.8%	40.4%	22.2%

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Table C.1. (Continued).

Metro Area	Percent 0 Vehicle	Percent 1 Vehicle	Percent 2 Vehicle	Percent 3+ Vehicle
Odessa, TX	5.5%	32.4%	39.4%	22.7%
Sioux Falls, SD	5.5%	28.5%	41.9%	24.1%
Topeka, KS	5.5%	31.1%	38.1%	25.3%
Florence-Muscle Shoals, AL	5.6%	29.5%	37.3%	27.6%
Lubbock, TX	5.6%	36.5%	40.3%	17.7%
Wichita, KS	5.6%	31.5%	39.1%	23.8%
Yakima, WA	5.6%	26.5%	37.0%	30.8%
Ames, IA	5.7%	30.4%	43.6%	20.4%
Charlotte-Gastonia-Concord, NC-SC	5.7%	33.4%	40.8%	20.2%
Columbia, MO	5.7%	33.1%	41.2%	19.9%
Flagstaff, AZ	5.7%	31.8%	39.6%	22.9%
Lakeland-Winter Haven, FL	5.7%	40.4%	38.7%	15.2%
Madera, CA	5.7%	28.6%	38.4%	27.2%
San Angelo, TX	5.7%	37.3%	38.9%	18.1%
Tyler, TX	5.7%	33.4%	40.6%	20.3%
Yuba City, CA	5.7%	27.4%	40.5%	26.5%
Burlington, NC	5.8%	32.1%	38.0%	24.1%
Cedar Rapids, IA	5.8%	30.8%	40.2%	23.2%
Clarksville, TN-KY	5.8%	29.3%	42.5%	22.5%
Grand Rapids-Wyoming, MI	5.8%	32.1%	41.8%	20.3%
Kansas City, MO-KS	5.8%	32.3%	40.7%	21.2%
Las Cruces, NM	5.8%	31.7%	37.4%	25.1%
Medford, OR	5.8%	32.7%	39.4%	22.2%
Wichita Falls, TX	5.8%	33.7%	41.6%	19.0%
Albuquerque, NM	5.9%	34.3%	38.8%	21.0%
Asheville, NC	5.9%	32.1%	38.9%	23.1%
Little Rock-North Little Rock-Conway, AR	5.9%	34.4%	41.4%	18.4%
Oshkosh-Neenah, WI	5.9%	32.5%	42.2%	19.4%
Santa Cruz-Watsonville, CA	5.9%	29.0%	39.0%	26.0%
Springfield, MO	5.9%	33.3%	41.1%	19.6%
Warner Robins, GA	5.9%	32.3%	36.9%	24.9%
Ann Arbor, MI	6.0%	36.0%	40.2%	17.8%
Atlanta-Sandy Springs-Marietta, GA	6.0%	33.0%	40.2%	20.9%
Gadsden, AL	6.0%	30.3%	38.7%	24.9%
Johnson City, TN	6.0%	31.9%	37.0%	25.0%
Napa, CA	6.0%	29.5%	39.0%	25.5%
Pensacola-Ferry Pass-Brent, FL	6.0%	33.6%	41.3%	19.1%
Phoenix-Mesa-Scottsdale, AZ	6.0%	37.5%	39.6%	17.0%
Racine, WI	6.0%	32.9%	41.7%	19.4%
Sebastian-Vero Beach, FL	6.0%	41.6%	40.5%	11.9%
Tulsa, OK	6.0%	33.4%	39.8%	20.8%
York-Hanover, PA	6.0%	27.7%	41.2%	25.2%
Yuma, AZ	6.0%	41.4%	35.4%	17.2%
Anniston-Oxford, AL	6.1%	31.0%	38.7%	24.2%
Dothan, AL	6.1%	35.2%	37.4%	21.3%
Fort Smith, AR-OK	6.1%	33.8%	39.5%	20.6%
Iowa City, IA	6.1%	34.8%	39.6%	19.5%
Lansing-East Lansing, MI	6.1%	35.0%	39.6%	19.3%
Norwich-New London, CT	6.1%	30.9%	40.4%	22.6%
Omaha-Council Bluffs, NE-IA	6.1%	31.3%	40.8%	21.7%

Table C.1. (Continued).

Metro Area	Percent 0 Vehicle	Percent 1 Vehicle	Percent 2 Vehicle	Percent 3+ Vehicle
Portland-South Portland-Biddeford, ME	6.1%	31.9%	42.7%	19.3%
Sacramento-Arden-Arcade-Roseville, CA	6.1%	31.6%	39.9%	22.4%
Sioux City, IA-NE-SD	6.1%	31.0%	40.0%	23.0%
Anderson, SC	6.2%	29.7%	38.6%	25.5%
Brunswick, GA	6.2%	33.1%	39.5%	21.3%
Carson City, NV	6.2%	34.5%	34.3%	25.0%
Columbia, SC	6.2%	32.3%	39.2%	22.2%
Dover, DE	6.2%	31.2%	41.2%	21.4%
Fond du Lac, WI	6.2%	29.6%	41.9%	22.3%
Greenville-Mauldin-Easley, SC	6.2%	32.8%	39.1%	21.9%
Houston-Sugar Land-Baytown, TX	6.2%	34.9%	41.3%	17.6%
Tallahassee, FL	6.2%	36.2%	38.4%	19.1%
Waterloo-Cedar Falls, IA	6.2%	30.0%	39.0%	24.8%
Davenport-Moline-Rock Island, IA-IL	6.3%	33.7%	39.7%	20.4%
Jacksonville, FL	6.3%	35.1%	41.4%	17.2%
Morgantown, WV	6.3%	38.5%	38.5%	16.8%
San Diego-Carlsbad-San Marcos, CA	6.3%	32.0%	39.4%	22.4%
Birmingham-Hoover, AL	6.4%	31.5%	38.0%	24.1%
College Station-Bryan, TX	6.4%	36.4%	38.9%	18.2%
Fairbanks, AK	6.4%	30.4%	38.0%	25.2%
Kingsport-Bristol-Bristol, TN-VA	6.4%	29.2%	39.1%	25.3%
Madison, WI	6.4%	34.0%	41.4%	18.1%
Niles-Benton Harbor, MI	6.4%	36.5%	37.7%	19.4%
Springfield, IL	6.4%	37.9%	37.6%	18.1%
Terre Haute, IN	6.4%	33.1%	38.8%	21.7%
Valdosta, GA	6.4%	33.0%	38.9%	21.7%
Athens-Clarke County, GA	6.5%	32.9%	34.9%	25.7%
Bellingham, WA	6.5%	32.0%	39.0%	22.4%
Blacksburg-Christiansburg-Radford, VA	6.5%	31.2%	36.2%	26.1%
Jackson, MS	6.5%	34.1%	37.5%	21.9%
Joplin, MO	6.5%	31.7%	40.0%	21.7%
Modesto, CA	6.5%	28.8%	39.3%	25.4%
Reno-Sparks, NV	6.5%	32.3%	38.0%	23.2%
Salinas, CA	6.5%	32.0%	36.3%	25.3%
Santa Barbara-Santa Maria-Goleta, CA	6.5%	33.3%	37.0%	23.2%
Sheboygan, WI	6.5%	31.7%	40.2%	21.6%
South Bend-Mishawaka, IN-MI	6.5%	34.7%	39.7%	19.1%
Stockton, CA	6.5%	29.5%	37.4%	26.6%
Tampa-St. Petersburg-Clearwater, FL	6.5%	42.3%	38.3%	13.0%
Virginia Beach-Norfolk-Newport News, VA-NC	6.5%	31.2%	38.7%	23.6%
Bloomington, IN	6.6%	34.4%	37.0%	22.0%
Bowling Green, KY	6.6%	33.5%	38.0%	21.9%
Denver-Aurora, CO	6.6%	33.1%	39.7%	20.6%
Jonesboro, AR	6.6%	33.5%	40.6%	19.2%
Visalia-Porterville, CA	6.6%	31.3%	39.5%	22.6%
Wilmington, NC	6.6%	32.3%	40.7%	20.4%
Charlottesville, VA	6.7%	31.3%	38.3%	23.8%
Hinesville-Fort Stewart, GA	6.7%	34.8%	37.4%	21.0%
Kalamazoo-Portage, MI	6.7%	33.8%	40.1%	19.4%
Peoria, IL	6.7%	32.3%	40.9%	20.0%

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Table C.1. (Continued).

Metro Area	Percent 0 Vehicle	Percent 1 Vehicle	Percent 2 Vehicle	Percent 3+ Vehicle
Waco, TX	6.7%	35.1%	40.9%	17.2%
Canton-Massillon, OH	6.8%	32.3%	39.1%	21.8%
Chattanooga, TN-GA	6.8%	31.3%	38.9%	23.0%
Columbus, OH	6.8%	34.2%	39.7%	19.4%
Greensboro-High Point, NC	6.8%	32.9%	36.6%	23.7%
Hagerstown-Martinsburg, MD-WV	6.8%	28.6%	39.5%	25.1%
Longview, WA	6.8%	28.5%	37.4%	27.2%
Roanoke, VA	6.8%	31.1%	36.6%	25.5%
Rockford, IL	6.8%	32.9%	39.9%	20.3%
Salem, OR	6.8%	31.8%	39.1%	22.3%
Fayetteville, NC	6.9%	33.3%	37.9%	22.0%
Hanford-Corcoran, CA	6.9%	30.7%	39.0%	23.4%
Kingston, NY	6.9%	32.5%	39.1%	21.4%
Owensboro, KY	6.9%	32.1%	38.4%	22.6%
Redding, CA	6.9%	29.2%	39.1%	24.8%
Spokane, WA	6.9%	31.0%	37.8%	24.3%
Akron, OH	7.0%	34.4%	39.3%	19.3%
Bangor, ME	7.0%	32.6%	40.9%	19.5%
Hot Springs, AR	7.0%	38.2%	38.6%	16.2%
La Crosse, WI-MN	7.0%	30.2%	42.3%	20.4%
Lafayette, IN	7.0%	34.0%	40.0%	19.0%
Lawton, OK	7.0%	33.5%	38.8%	20.8%
Lexington-Fayette, KY	7.0%	34.5%	39.9%	18.6%
Minneapolis-St. Paul-Bloomington, MN-WI	7.0%	31.1%	41.7%	20.2%
Richmond, VA	7.0%	29.8%	36.6%	26.6%
Spartanburg, SC	7.0%	32.1%	37.3%	23.5%
Winston-Salem, NC	7.0%	31.7%	37.2%	24.2%
Baton Rouge, LA	7.1%	35.8%	39.8%	17.3%
Bay City, MI	7.1%	31.5%	40.5%	20.9%
Chico, CA	7.1%	31.8%	37.7%	23.3%
Fargo, ND-MN	7.1%	31.4%	40.8%	20.7%
Gainesville, FL	7.1%	41.4%	35.1%	16.5%
Jackson, MI	7.1%	30.9%	41.4%	20.6%
Lake Charles, LA	7.1%	36.6%	39.1%	17.3%
Montgomery, AL	7.1%	34.5%	35.4%	22.9%
St. Joseph, MO-KS	7.1%	32.0%	37.8%	23.1%
Seattle-Tacoma-Bellevue, WA	7.1%	32.7%	37.7%	22.5%
Glens Falls, NY	7.2%	35.4%	39.5%	17.9%
Lebanon, PA	7.2%	31.1%	39.5%	22.2%
Mobile, AL	7.2%	34.2%	37.1%	21.5%
Texarkana, TX-Texarkana, AR	7.2%	34.5%	38.6%	19.8%
Victoria, TX	7.2%	32.6%	42.3%	17.9%
Beaumont-Port Arthur, TX	7.3%	35.0%	40.3%	17.4%
Dubuque, IA	7.3%	29.4%	43.1%	20.1%
Kokomo, IN	7.3%	29.2%	41.5%	22.0%
Springfield, OH	7.3%	33.1%	36.6%	23.1%
Youngstown-Warren-Boardman, OH-PA	7.3%	36.2%	38.1%	18.4%
Anderson, IN	7.4%	34.6%	37.8%	20.2%
Augusta-Richmond County, GA-SC	7.4%	33.7%	37.4%	21.5%
Durham, NC	7.4%	35.7%	36.0%	20.9%

Table C.1. (Continued).

Metro Area	Percent 0 Vehicle	Percent 1 Vehicle	Percent 2 Vehicle	Percent 3+ Vehicle
Evansville, IN-KY	7.4%	31.7%	38.5%	22.3%
Harrisonburg, VA	7.4%	26.4%	35.8%	30.5%
Las Vegas-Paradise, NV	7.4%	38.0%	39.0%	15.7%
St. Louis, MO-IL	7.4%	33.5%	39.2%	19.8%
Allentown-Bethlehem-Easton, PA-NJ	7.5%	30.4%	40.4%	21.7%
Bakersfield, CA	7.5%	30.6%	38.4%	23.5%
Dayton, OH	7.5%	33.6%	38.5%	20.4%
Flint, MI	7.5%	36.9%	37.7%	18.0%
Sandusky, OH	7.5%	31.5%	40.5%	20.5%
Harrisburg-Carlisle, PA	7.6%	32.8%	39.4%	20.2%
Lynchburg, VA	7.6%	29.0%	35.0%	28.4%
Muskegon-Norton Shores, MI	7.6%	34.1%	37.2%	21.1%
Pueblo, CO	7.6%	31.5%	37.2%	23.8%
Worcester, MA	7.6%	33.5%	41.1%	17.8%
Battle Creek, MI	7.7%	35.5%	39.3%	17.5%
Monroe, LA	7.7%	39.4%	37.0%	15.9%
Parkersburg-Marietta-Vienna, WV-OH	7.7%	33.6%	37.6%	21.2%
Poughkeepsie-Newburgh-Middletown, NY	7.7%	29.1%	40.4%	22.8%
Saginaw-Saginaw Township North, MI	7.7%	34.6%	39.1%	18.6%
San Antonio, TX	7.7%	34.9%	38.7%	18.8%
Savannah, GA	7.7%	34.5%	39.9%	18.0%
Charleston-North Charleston-Summerville, SC	7.8%	34.2%	39.3%	18.7%
Great Falls, MT	7.8%	27.7%	35.4%	29.0%
Alexandria, LA	7.9%	35.3%	39.2%	17.6%
Goldsboro, NC	7.9%	31.7%	36.0%	24.4%
Lima, OH	7.9%	30.6%	38.8%	22.7%
Muncie, IN	7.9%	33.1%	37.8%	21.2%
Portland-Vancouver-Beaverton, OR-WA	7.9%	32.5%	38.9%	20.7%
Detroit-Warren-Livonia, MI	8.0%	35.3%	38.4%	18.4%
Elkhart-Goshen, IN	8.0%	30.4%	40.7%	21.0%
Houma-Bayou Cane-Thibodaux, LA	8.0%	32.5%	42.3%	17.2%
Kankakee-Bradley, IL	8.0%	33.4%	39.2%	19.4%
Louisville-Jefferson County, KY-IN	8.0%	33.5%	38.3%	20.3%
Corpus Christi, TX	8.1%	36.7%	39.1%	16.2%
Jackson, TN	8.1%	31.7%	37.5%	22.8%
McAllen-Edinburg-Mission, TX	8.1%	39.7%	35.4%	16.8%
Hartford-West Hartford-East Hartford, CT	8.2%	31.8%	40.1%	19.8%
Lafayette, LA	8.2%	34.2%	41.8%	15.8%
Tucson, AZ	8.2%	39.6%	35.7%	16.5%
Bridgeport-Stamford-Norwalk, CT	8.3%	30.0%	39.5%	22.2%
Rome, GA	8.3%	31.9%	38.2%	21.6%
Toledo, OH	8.3%	35.1%	38.4%	18.1%
Cincinnati-Middletown, OH-KY-IN	8.4%	31.4%	38.5%	21.7%
Corvallis, OR	8.4%	31.8%	37.7%	22.0%
Los Angeles-Long Beach-Santa Ana, CA	8.4%	33.5%	36.7%	21.4%
New Orleans-Metairie-Kenner, LA	8.4%	36.9%	38.7%	15.9%
Duluth, MN-WI	8.5%	32.6%	36.3%	22.5%
Eugene-Springfield, OR	8.5%	32.7%	37.4%	21.4%
Memphis, TN-MS-AR	8.5%	36.7%	36.3%	18.5%
Miami-Fort Lauderdale-Pompano Beach, FL	8.5%	40.4%	37.0%	14.1%

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Table C.1. (Continued).

Metro Area	Percent 0 Vehicle	Percent 1 Vehicle	Percent 2 Vehicle	Percent 3+ Vehicle
Reading, PA	8.5%	29.9%	39.1%	22.4%
Florence, SC	8.6%	33.0%	36.3%	22.0%
Greenville, NC	8.6%	35.1%	35.5%	20.8%
Sumter, SC	8.6%	34.0%	37.1%	20.2%
Fresno, CA	8.7%	33.0%	37.9%	20.4%
Mansfield, OH	8.7%	30.2%	39.6%	21.6%
State College, PA	8.7%	34.4%	38.6%	18.3%
Tuscaloosa, AL	8.7%	31.2%	38.4%	21.7%
El Paso, TX	8.9%	34.0%	38.1%	19.1%
Ocean City, NJ	8.9%	36.7%	38.9%	15.4%
Albany-Schenectady-Troy, NY	9.0%	35.1%	40.0%	16.0%
Champaign-Urbana, IL	9.0%	37.4%	36.7%	16.8%
Decatur, IL	9.0%	35.6%	37.9%	17.5%
Merced, CA	9.0%	29.4%	38.4%	23.2%
Salisbury, MD	9.0%	32.7%	35.2%	23.2%
Altoona, PA	9.1%	33.9%	37.8%	19.1%
Elmira, NY	9.1%	35.5%	39.5%	15.9%
Providence-New Bedford-Fall River, RI-MA	9.2%	35.2%	37.5%	18.2%
Binghamton, NY	9.3%	35.4%	38.1%	17.2%
Macon, GA	9.3%	33.6%	34.4%	22.6%
Shreveport-Bossier City, LA	9.3%	37.9%	37.2%	15.6%
Weirton-Steubenville, WV-OH	9.3%	34.6%	36.9%	19.2%
Rochester, NY	9.4%	33.7%	40.1%	16.8%
Rocky Mount, NC	9.4%	31.5%	33.3%	25.8%
Williamsport, PA	9.4%	32.9%	37.3%	20.5%
Danville, IL	9.5%	34.4%	37.0%	19.0%
Pittsfield, MA	9.5%	39.0%	37.2%	14.3%
Erie, PA	9.6%	37.4%	38.1%	14.9%
Laredo, TX	9.6%	36.5%	35.6%	18.4%
Washington-Arlington-Alexandria, DC-VA-MD-WV	9.6%	33.6%	36.0%	20.9%
Lewiston-Auburn, ME	9.7%	34.6%	36.5%	19.2%
Milwaukee-Waukesha-West Allis, WI	9.7%	35.5%	38.7%	16.2%
Huntington-Ashland, WV-KY-OH	9.8%	33.1%	37.7%	19.5%
Lancaster, PA	9.8%	29.6%	40.9%	19.7%
Cumberland, MD-WV	9.9%	31.1%	36.1%	22.9%
Pine Bluff, AR	9.9%	34.4%	35.1%	20.5%
Scranton-Wilkes-Barre, PA	10.0%	35.7%	36.7%	17.6%
Brownsville-Harlingen, TX	10.1%	40.2%	35.1%	14.6%
Cleveland-Elyria-Mentor, OH	10.3%	36.2%	36.6%	16.9%
Honolulu, HI	10.3%	34.6%	35.0%	20.1%
Syracuse, NY	10.4%	35.9%	38.4%	15.2%
Albany, GA	10.5%	36.0%	32.8%	20.7%
Charleston, WV	10.5%	36.0%	37.3%	16.2%
Columbus, GA-AL	10.5%	35.5%	34.2%	19.9%
New Haven-Milford, CT	10.5%	33.7%	36.7%	19.1%
Utica-Rome, NY	10.5%	35.8%	37.9%	15.8%
Wheeling, WV-OH	10.5%	34.7%	35.7%	19.1%
Springfield, MA	10.6%	37.8%	36.5%	15.2%
Johnstown, PA	10.7%	34.5%	37.0%	17.8%
El Centro, CA	11.0%	33.1%	34.3%	21.6%

Table C.1. (Continued).

Metro Area	Percent 0 Vehicle	Percent 1 Vehicle	Percent 2 Vehicle	Percent 3+ Vehicle
Trenton-Ewing, NJ	11.0%	32.5%	39.2%	17.2%
Vineland-Millville-Bridgeton, NJ	11.1%	34.4%	35.4%	19.1%
Baltimore-Towson, MD	11.2%	32.4%	36.4%	19.9%
Pittsburgh, PA	11.2%	35.6%	37.3%	16.0%
Danville, VA	11.3%	32.1%	29.9%	26.6%
Chicago-Naperville-Joliet, IL-IN-WI	11.5%	35.1%	36.8%	16.6%
San Francisco-Oakland-Fremont, CA	11.8%	34.2%	34.2%	19.8%
Ithaca, NY	12.3%	38.4%	35.2%	14.0%
Buffalo-Niagara Falls, NY	12.6%	38.0%	36.3%	13.2%
Boston-Cambridge-Quincy, MA-NH	12.7%	35.0%	37.0%	15.3%
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	13.7%	34.4%	35.9%	16.0%
Atlantic City-Hammonton, NJ	13.9%	34.2%	36.6%	15.4%
Fajardo, PR	19.7%	45.4%	28.3%	6.6%
San Germán-Cabo Rojo, PR	19.7%	40.3%	30.2%	9.8%
Yauco, PR	20.1%	43.5%	28.2%	8.2%
Aguadilla-Isabela-San Sebastián, PR	20.3%	42.4%	27.6%	9.8%
San Juan-Caguas-Guaynabo, PR	20.5%	40.6%	29.0%	9.9%
Guayama, PR	22.1%	43.4%	26.8%	7.8%
Mayagüez, PR	23.5%	41.6%	25.0%	10.0%
Ponce, PR	24.0%	40.4%	26.4%	9.2%
New York-Northern New Jersey-Long Island, NY-NJ-PA	30.3%	32.2%	25.8%	11.7%

Note: Metro areas are ordered by percentage of zero-vehicle households, from lowest to highest.
Source: U.S. Census Bureau American Community Survey data set for 2006–2008 (http://www.census.gov/acs/).

Table C.2. Coefficients for four U.S. logit vehicle availability models.

One-Vehicle Household Utilities

	Model			
	1	2	3	4
Alternative Specific Constant	1.21	1.58	0.64	0.16
0 Workers in Household	0.95			
1 Worker in Household	1.99		0.83	0.79
2 Workers in Household	1.43			1.46
2+ Workers in Household			0.54	
3+ Workers in Household				0.65
Low Income	-1.18			-0.90
Low-Medium Income		1.84	1.16	0.53
High-Medium Income		2.54	0.87	1.93
High Income		0.72	1.78	2.30
1 Person in Household	-0.39			-0.15
2 Persons in Household	0.009			0.50
3 Persons in Household				
4+ Persons in Household				
Percent Regional Employment within 15 Min Transit			-0.03	
Percent Regional Employment within 40 Min Transit				-0.10
Employment within 30 Min Transit	-0.000012			
Accessibility Ratio		0.06		
Population Density per Acre	0.02			

Source: MPO Documentation Database.

Table C.3. Coefficients for four U.S. logit vehicle availability models.

Two-Vehicle Household Utilities

	Model			
	1	2	3	4
Alternative Specific Constant	3.23	-1.90	-0.45	4.21
0 Workers in Household	0.63			
1 Worker in Household	1.72		1.10	-1.02
2 Workers in Household	1.71			0.32
2+ Workers in Household			2.47	
3+ Workers in Household				0.52
Low Income	-2.20			-4.06
Low-Medium Income		2.78	2.18	-1.85
High-Medium Income		4.30	3.04	0.38
High Income		2.97	4.31	1.76
1 Person in Household	-2.77			-2.84
2 Persons in Household	-0.56	3.15		0.42
3 Persons in Household	-0.32	3.02		0.24
4+ Persons in Household	-0.29	3.41		
Percent Regional Employment within 15 Min Transit			-0.08	
Percent Regional Employment within 40 Min Transit				-0.17
Employment within 30 Min Transit	-0.000020			
Accessibility Ratio		0.089		
Population Density per Acre	-0.028			-0.064

Source: MPO Documentation Database.

Table C.4. Coefficients for four U.S. logit vehicle availability models.

Three-or-More-Vehicle Household Utilities

	Model			
	1	2	3	4
Alternative Specific Constant	4.29	-12.38	-2.29	5.18
0 Workers in Household	-1.00			
1 Worker in Household			1.66	-3.78
2 Workers in Household				-2.15
2+ Workers in Household			3.32	
3+ Workers in Household				-1.98
Low Income	-2.73			-4.06
Low-Medium Income		3.04	2.26	-2.45
High-Medium Income		4.88	3.64	
High Income		3.59	5.28	1.76
1 Person in Household	-3.36			-2.84
2 Persons in Household	-1.00	3.09		-0.61
3 Persons in Household		4.14		
4+ Persons in Household		4.35		
Percent Regional Employment within 15 Min Transit			-0.12	
Percent Regional Employment within 40 Min Transit				-0.17
Employment within 30 Min Transit	-0.000020			
Accessibility Ratio		0.12		
Population Density per Acre	-0.052			-0.128

Source: MPO Documentation Database.

Table C.5. Home-based work trip rates.

Number of Workers by Number of Autos

	Workers				
Autos	**0**	**1**	**2**	**3+**	**Average**
0	0.0	1.0	2.4	5.1	**0.5**
1	0.0	1.0	2.6	5.1	**0.8**
2	0.0	1.3	2.6	5.1	**1.6**
3+	0.0	1.3	2.6	5.1	**2.3**
Average	**0.0**	**1.2**	**2.6**	**5.1**	**1.4**

Number of Persons by Number of Autos

	Persons					
Autos	**1**	**2**	**3**	**4**	**5+**	**Average**
0	0.2	0.7	1.0	1.0	1.0	**0.5**
1	0.6	0.8	1.2	1.7	1.5	**0.8**
2	0.7	1.3	2.0	2.0	2.3	**1.6**
3+	0.9	1.4	2.6	2.9	3.3	**2.3**
Average	**0.5**	**1.2**	**2.0**	**2.3**	**2.4**	**1.4**

Number of Persons by Income Level

	Persons					
Household Income	**1**	**2**	**3**	**4**	**5+**	**Average**
i	0.2	0.6	0.8	1.3	1.8	**0.6**
ii	0.3	0.8	1.5	1.6	2.0	**0.8**
iii	0.7	1.0	1.8	2.3	2.6	**1.3**
iv	0.8	1.5	2.4	2.4	2.6	**1.9**
v	0.9	1.6	2.4	2.4	2.6	**2.0**
Average	**0.5**	**1.2**	**2.0**	**2.3**	**2.4**	**1.4**

Note: All averages are weighted.
Source: 2009 NHTS.

Table C.6. Home-based nonwork trip rates.

Number of Persons by Number of Workers, Urban Area Greater Than 500,000 Population

	Household Size					
Workers	**1**	**2**	**3**	**4**	**5+**	**Average**
0	1.8	4.0	5.6	9.2	10.5	**3.5**
1	1.8	4.0	6.6	9.9	12.4	**4.9**
2		4.0	7.0	11.4	14.5	**7.9**
3+			7.0	11.4	14.5	**10.8**
Average	**1.8**	**4.0**	**6.7**	**10.6**	**13.4**	**5.6**

Number of Persons by Number of Workers, Urban Area Less Than 500,000 Population (Including Non-Urban Areas)

	Household Size					
Workers	**1**	**2**	**3**	**4**	**5+**	**Average**
0	1.8	3.6	5.6	8.1	8.8	**3.4**
1	1.8	3.6	6.7	8.7	11.8	**4.6**
2		3.6	6.7	10.1	14.4	**6.8**
3+			6.7	11.2	15.3	**10.8**
Average	**1.8**	**3.6**	**6.7**	**9.5**	**12.9**	**5.1**

Number of Persons by Number of Vehicles, Urban Area Greater Than 500,000 Population

	Household Size					
Vehicles	**1**	**2**	**3**	**4**	**5+**	**Average**
0	1.4	3.8	5.6	7.5	10.0	**3.2**
1	1.9	3.9	6.5	9.0	11.8	**3.7**
2	2.4	4.0	6.5	11.0	14.0	**6.8**
3+	2.5	4.0	7.3	11.0	14.5	**8.6**
Average	**1.8**	**4.0**	**6.7**	**10.6**	**13.4**	**5.6**

Table C.6. (Continued).

Number of Persons by Number of Vehicles, Urban Area Less Than 500,000 Population (Including Non-Urban Areas)

	Household Size					
Vehicles	**1**	**2**	**3**	**4**	**5+**	**Average**
0	1.2	3.3	5.1	8.1	10.3	**2.6**
1	1.9	3.6	6.7	9.5	10.3	**3.5**
2	2.0	3.6	6.7	9.5	12.1	**5.6**
3+	2.0	3.6	6.7	9.5	14.7	**6.9**
Average	**1.8**	**3.6**	**6.7**	**9.5**	**12.9**	**5.1**

Number of Persons by Income Level, Urban Area Greater Than 500,000 Population

	Household Size					
Household Income	**1**	**2**	**3**	**4**	**5+**	**Average**
i	1.7	3.7	5.0	9.1	11.5	**4.1**
ii	1.7	4.1	6.0	9.9	11.5	**4.7**
iii	1.9	4.1	6.9	9.9	13.1	**5.0**
iv	2.0	4.1	6.9	10.4	14.7	**6.2**
v	2.3	4.1	7.1	11.8	15.4	**7.6**
Average	**1.8**	**4.0**	**6.7**	**10.6**	**13.4**	**5.6**

Number of Persons by Income Level, Urban Area Less Than 500,000 Population (Including Non-Urban Areas)

	Household Size					
Household Income	**1**	**2**	**3**	**4**	**5+**	**Average**
i	1.4	3.2	5.1	7.9	7.5	**3.3**
ii	1.9	3.4	6.8	8.9	11.9	**4.1**
iii	1.9	3.7	6.8	8.9	12.4	**4.9**
iv	1.9	3.7	6.8	10.0	14.1	**6.2**
v	2.2	3.7	7.3	10.1	14.8	**7.0**
Average	**1.8**	**3.6**	**6.7**	**9.5**	**12.9**	**5.1**

Note: All averages are weighted.
Source: 2009 NHTS.

Table C.7. Nonhome-based trip rates.

Number of Persons by Number of Workers

	Household Size					
Workers	**1**	**2**	**3**	**4**	**5+**	**Average**
0	0.9	1.8	2.7	3.1	3.1	**1.5**
1	1.6	2.4	3.3	4.7	5.0	**2.7**
2		3.2	4.5	5.9	6.1	**4.5**
3+			4.8	7.0	8.1	**6.7**
Average	**1.3**	**2.5**	**3.8**	**5.3**	**5.7**	**3.0**

Number of Persons by Number of Vehicles

	Household Size					
Vehicles	**1**	**2**	**3**	**4**	**5+**	**Average**
0	0.7	1.7	2.0	3.7	3.9	**1.3**
1	1.4	2.3	3.5	3.9	3.9	**2.0**
2	1.6	2.6	3.9	5.5	5.6	**3.5**
3+	1.6	2.7	4.5	5.8	7.1	**4.4**
Average	**1.3**	**2.5**	**3.8**	**5.3**	**5.7**	**3.0**

Number of Persons by Income Level

	Household Size					
Household Income	**1**	**2**	**3**	**4**	**5+**	**Average**
i	0.7	1.4	2.7	3.4	3.4	**1.6**
ii	1.0	1.8	2.8	3.9	3.9	**1.9**
iii	1.5	2.4	3.5	4.7	5.0	**2.7**
iv	1.8	3.0	4.4	5.5	6.8	**3.8**
v	2.0	3.2	4.6	6.5	8.3	**4.7**
Average	**1.3**	**2.5**	**3.8**	**5.3**	**5.7**	**3.0**

Note: All averages are weighted.
Source: 2009 NHTS.

Table C.8. Home-based school trip rates.

Number of Persons by Number of Children

	Household Size					
Children	**1**	**2**	**3**	**4**	**5+**	**Average**
0	0.0	0.0	0.5	1.0	1.1	**0.1**
1	0.0	1.0	1.0	1.7	1.8	**1.1**
2			1.6	1.8	2.6	**1.9**
3+				2.7	2.7	**2.7**
Average	**0.0**	**0.1**	**0.8**	**1.7**	**2.5**	**0.6**

Number of Persons by Number of Vehicles

	Household Size					
Vehicles	**1**	**2**	**3**	**4**	**5+**	**Average**
0	0.0	0.1	0.8	1.5	1.6	**0.3**
1	0.0	0.1	0.8	1.6	2.4	**0.3**
2	0.0	0.1	0.8	1.7	2.6	**0.7**
3+	0.0	0.1	0.8	1.8	2.7	**1.0**
Average	**0.0**	**0.1**	**0.8**	**1.7**	**2.5**	**0.6**

Number of Persons by Income Level

	Household Size					
Household Income	**1**	**2**	**3**	**4**	**5+**	**Average**
i	0.0	0.1	0.7	1.2	1.5	**0.4**
ii	0.0	0.1	0.8	1.6	2.6	**0.5**
iii	0.0	0.1	0.8	1.6	2.6	**0.5**
iv	0.0	0.1	0.8	1.6	2.6	**0.7**
v	0.0	0.1	0.8	1.9	2.8	**1.0**
Average	**0.0**	**0.1**	**0.8**	**1.7**	**2.5**	**0.6**

Note: All averages are weighted.
Source: 2009 NHTS.

Table C.9. Home-based other trip rates (excluding work and school).

Number of Persons by Number of Workers, Urban Area Greater Than 500,000 Population

	Household Size					
Workers	**1**	**2**	**3**	**4**	**5+**	**Average**
0	1.8	3.9	5.1	7.6	8.8	**3.3**
1	1.8	3.9	5.8	8.2	9.7	**4.4**
2		3.9	6.1	9.3	12.1	**6.8**
3+			6.2	9.5	12.1	**9.2**
Average	**1.8**	**3.9**	**5.8**	**8.7**	**10.9**	**4.9**

Number of Persons by Number of Workers, Urban Area Less Than 500,000 Population (Including Non-Urban Areas)

	Household Size					
Workers	**1**	**2**	**3**	**4**	**5+**	**Average**
0	1.8	3.5	5.2	6.7	6.7	**3.2**
1	1.8	3.5	5.9	7.3	9.5	**4.1**
2		3.5	6.1	8.2	11.5	**5.9**
3+			6.1	9.6	12.5	**9.2**
Average	**1.8**	**3.5**	**6.0**	**7.9**	**10.3**	**4.6**

Number of Persons by Number of Vehicles, Urban Area Greater Than 500,000 Population

	Household Size					
Vehicles	**1**	**2**	**3**	**4**	**5+**	**Average**
0	1.4	3.5	5.0	5.9	8.6	**2.9**
1	1.9	3.8	5.6	7.1	9.2	**3.4**
2	2.4	4.0	5.7	9.2	11.1	**6.0**
3+	2.5	4.0	6.4	9.2	12.2	**7.5**
Average	**1.8**	**3.9**	**5.8**	**8.7**	**10.9**	**4.9**

Table C.9. (Continued).

Number of Persons by Number of Vehicles, Urban Area Less Than 500,000 Population (Including Non-Urban Areas)

Vehicles	Household Size					
	1	2	3	4	5+	Average
0	1.2	3.0	4.5	6.8	8.1	**2.4**
1	1.9	3.5	6.2	8.0	8.1	**3.2**
2	2.0	3.6	6.2	8.0	9.9	**5.0**
3+	2.0	3.6	6.2	8.0	11.6	**6.0**
Average	**1.8**	**3.5**	**6.0**	**7.9**	**10.3**	**4.6**

Number of Persons by Income Level, Urban Area Greater Than 500,000 Population

Household Income	Household Size					
	1	2	3	4	5+	Average
i	1.6	3.5	4.0	7.4	9.6	**3.7**
ii	1.7	3.9	5.3	8.0	9.6	**4.1**
iii	1.9	3.9	5.9	8.0	10.4	**4.5**
iv	2.0	4.1	6.2	8,6	12.2	**5.5**
v	2.3	4.1	6.3	9.8	12.4	**6.6**
Average	**1.8**	**3.9**	**5.8**	**8.7**	**10.9**	**4.9**

Number of Persons by Income Level, Urban Area Less Than 500,000 Population (Including Non-Urban Areas)

Household Income	Household Size					
	1	2	3	4	5+	Average
i	1.4	3.0	4.6	6.9	5.7	**3.0**
ii	1.9	3.3	6.0	7.5	9.2	**3.7**
iii	1.9	3.7	6.0	7.5	10.0	**4.4**
iv	1.9	3.7	6.0	8.3	11.3	**5.4**
v	2.2	3.7	6.5	8.3	12.2	**6.1**
Average	**1.8**	**3.5**	**6.0**	**7.9**	**10.3**	**4.6**

Note: All averages are weighted.
Source: 2009 NHTS.

Table C.10. Mean trip length in minutes by mode and trip purpose by urban area population range.

Home-Based Work

	Mean			
Urban Area Population	**Auto**	**Transit**	**Nonmotorized**	**All Modes**
1 million or more with subway or rail	29	55	16	32
1 million or more without subway or rail	25	55	16	26
Between 500,000 and 1 million	22	55	16	22
Less than 500,000	20	55	16	21
Not in urban area	24	55	16	24
All trips	24	55	16	25

Home-Based Nonwork

	Mean			
Urban Area Population	**Auto**	**Transit**	**Nonmotorized**	**All Modes**
All population ranges	18	48	15	18

Nonhome Based

	Mean			
Urban Area Population	**Auto**	**Transit**	**Nonmotorized**	**All Modes**
1 million or more with subway or rail	20	42	14	20
Other urban area	18	42	14	18
Not in urban area	19	42	14	19
All trips	19	42	14	19

Table C.10. (Continued).

Home-Based School

Urban Area Population	Mean			
	Auto	Transit	Nonmotorized	All Modes
1 million or more with subway or rail	17	45	15	21
Other urban area	15	45	14	18
Not in urban area	17	45	12	23
All trips	16	45	14	20

Home-Based Other (excluding school and work)

Urban Area Population	Mean			
	Auto	Transit	Nonmotorized	All Modes
All population ranges	18	48	15	18

All Trips

Urban Area Population	Mean			
	Auto	Transit	Nonmotorized	All Modes
1 million or more with subway or rail	21	48	15	22
Other urban area	18	48	15	18
Not in urban area	20	48	14	20
All trips	19	48	15	19

Source: 2009 NHTS.

Table C.11. Time-of-day distributions by trip purpose and direction.

All Modes

	Home-Based Work		Home-Based Nonwork		Home-Based School		Home-Based Other			
Hour Ending	From Home	To Home	From Home	To Home	From Home	To Home	From Home	To Home	Nonhome-Based	All Trips
1:00 AM	0.1%	0.5%	0.0%	0.3%	0.0%	0.0%	0.0%	0.3%	0.2%	0.3%
2:00 AM	0.0%	0.2%	0.0%	0.2%	0.0%	0.0%	0.0%	0.2%	0.1%	0.1%
3:00 AM	0.0%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%
4:00 AM	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
5:00 AM	1.4%	0.0%	0.2%	0.0%	0.0%	0.0%	0.2%	0.0%	0.3%	0.4%
6:00 AM	5.2%	0.0%	0.6%	0.1%	0.2%	0.0%	0.7%	0.1%	0.5%	1.3%
7:00 AM	11.5%	0.1%	2.3%	0.3%	6.4%	0.0%	1.8%	0.3%	1.7%	3.6%
8:00 AM	14.3%	0.1%	7.0%	1.0%	28.2%	0.1%	4.2%	1.0%	4.9%	7.9%
9:00 AM	7.7%	0.1%	4.8%	1.3%	12.6%	0.2%	3.9%	1.3%	5.1%	6.1%
10:00 AM	2.8%	0.3%	3.4%	1.4%	1.7%	0.2%	3.6%	1.4%	5.1%	4.6%
11:00 AM	1.3%	0.3%	3.1%	1.9%	0.8%	0.4%	3.4%	1.9%	6.4%	4.9%
Noon	1.1%	1.0%	2.5%	2.4%	0.6%	1.1%	2.8%	2.4%	9.2%	5.8%
1:00 PM	1.6%	1.8%	2.3%	2.9%	0.7%	2.0%	2.5%	2.9%	11.1%	6.8%
2:00 PM	1.7%	1.4%	2.5%	2.7%	0.3%	2.0%	2.8%	2.7%	8.8%	6.0%
3:00 PM	1.7%	2.7%	2.7%	4.7%	0.3%	13.4%	3.0%	4.7%	8.6%	7.3%
4:00 PM	1.1%	6.2%	2.6%	5.9%	0.4%	16.5%	2.9%	5.9%	9.2%	8.6%
5:00 PM	1.0%	9.0%	3.2%	4.6%	0.6%	3.8%	3.5%	4.6%	8.2%	8.2%
6:00 PM	0.5%	10.5%	3.7%	4.9%	0.8%	2.5%	4.0%	4.9%	7.3%	8.5%
7:00 PM	0.3%	4.5%	4.1%	4.0%	0.4%	1.0%	4.6%	4.0%	5.0%	6.7%
8:00 PM	0.1%	1.9%	2.5%	3.8%	0.0%	0.8%	2.8%	3.8%	3.8%	4.9%
9:00 PM	0.1%	1.2%	1.1%	3.7%	0.0%	0.7%	1.2%	3.7%	2.1%	3.5%
10:00 PM	0.2%	1.2%	0.6%	2.5%	0.1%	0.9%	0.6%	2.5%	1.4%	2.3%
11:00 PM	0.3%	1.3%	0.3%	1.3%	0.0%	0.3%	0.3%	1.3%	0.8%	1.3%
Midnight	0.1%	1.4%	0.2%	0.7%	0.0%	0.0%	0.2%	0.7%	0.3%	0.8%
Total	**54.3%**	**45.7%**	**49.5%**	**50.6%**	**54.0%**	**46.0%**	**49.5%**	**50.6%**	**100.0%**	**100.0%**
7-9 AM	22.0%	0.2%	11.8%	2.3%	40.7%	0.3%	8.1%	2.6%	10.0%	14.0%
3-6 PM	2.6%	25.7%	9.5%	15.3%	1.7%	22.8%	10.5%	14.4%	24.7%	25.3%

Table C.11. (Continued).

Auto Modes

Hour Ending	Home-Based Work From Home	Home-Based Work To Home	Home-Based Nonwork From Home	Home-Based Nonwork To Home	Home-Based School From Home	Home-Based School To Home	Home-Based Other From Home	Home-Based Other To Home	Nonhome-Based	All Trips
1:00 AM	0.1%	0.5%	0.0%	0.3%	0.0%	0.0%	0.0%	0.4%	0.2%	0.3%
2:00 AM	0.0%	0.2%	0.0%	0.2%	0.0%	0.0%	0.0%	0.2%	0.1%	0.1%
3:00 AM	0.0%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%
4:00 AM	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
5:00 AM	1.5%	0.0%	0.2%	0.0%	0.0%	0.0%	0.2%	0.0%	0.4%	0.4%
6:00 AM	5.4%	0.0%	0.6%	0.1%	0.2%	0.0%	0.7%	0.1%	0.5%	1.4%
7:00 AM	11.7%	0.0%	1.9%	0.3%	4.0%	0.0%	1.7%	0.3%	1.6%	3.5%
8:00 AM	14.3%	0.1%	6.5%	1.0%	30.6%	0.1%	4.4%	1.1%	4.9%	7.7%
9:00 AM	7.5%	0.1%	4.6%	1.2%	12.8%	0.2%	3.9%	1.3%	5.1%	5.9%
10:00 AM	2.7%	0.3%	3.6%	1.4%	2.2%	0.4%	3.7%	1.5%	5.1%	4.7%
11:00 AM	1.3%	0.3%	3.2%	1.9%	1.2%	0.6%	3.4%	2.1%	6.5%	5.1%
Noon	1.0%	1.0%	2.7%	2.5%	1.0%	1.3%	2.8%	2.6%	9.4%	6.0%
1:00 PM	1.5%	1.8%	2.4%	3.1%	0.9%	2.5%	2.6%	3.1%	10.6%	6.8%
2:00 PM	1.7%	1.4%	2.7%	2.8%	0.5%	2.2%	2.8%	2.9%	8.7%	6.1%
3:00 PM	1.7%	2.7%	2.8%	4.0%	0.5%	8.8%	3.0%	3.5%	8.5%	6.9%
4:00 PM	1.1%	6.3%	2.6%	5.3%	0.7%	12.2%	2.8%	4.7%	9.2%	8.3%
5:00 PM	1.0%	8.9%	3.2%	4.8%	1.0%	4.5%	3.3%	4.9%	8.4%	8.4%
6:00 PM	0.5%	10.6%	3.7%	5.1%	1.3%	3.7%	3.9%	5.2%	7.4%	8.7%
7:00 PM	0.3%	4.4%	4.2%	4.1%	0.7%	1.5%	4.5%	4.3%	5.0%	6.7%
8:00 PM	0.2%	1.9%	2.3%	4.0%	0.1%	1.2%	2.5%	4.2%	3.8%	4.8%
9:00 PM	0.2%	1.2%	1.0%	4.0%	0.0%	1.1%	1.1%	4.3%	2.2%	3.5%
10:00 PM	0.2%	1.3%	0.5%	2.8%	0.2%	1.4%	0.5%	2.9%	1.4%	2.4%
11:00 PM	0.3%	1.3%	0.2%	1.4%	0.0%	0.6%	0.3%	1.5%	0.8%	1.4%
Midnight	0.2%	1.3%	0.2%	0.7%	0.0%	0.0%	0.2%	0.8%	0.3%	0.8%
Total	**54.4%**	**45.6%**	**49.0%**	**51.0%**	**57.7%**	**42.4%**	**48.2%**	**51.8%**	**100.0%**	**100.0%**
7-9 AM	21.8%	0.2%	11.1%	2.2%	43.3%	0.4%	8.3%	2.4%	9.9%	13.6%
3-6 PM	2.6%	25.7%	9.5%	15.3%	3.0%	20.4%	10.0%	14.8%	25.0%	25.4%

(continued on next page)

Table C.11. (Continued).

Transit Modes

Hour Ending	Home-Based Work		Home-Based Nonwork		Home-Based School		Home-Based Other		Nonhome-Based	All Trips
	From Home	To Home	From Home	To Home	From Home	To Home	From Home	To Home		
1:00 AM	0.0%	0.5%	0.0%	0.2%	0.0%	0.0%	0.0%	0.2%	0.1%	0.2%
2:00 AM	0.0%	0.1%	0.0%	0.2%	0.0%	0.0%	0.0%	0.3%	0.1%	0.2%
3:00 AM	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4:00 AM	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
5:00 AM	0.8%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.3%	0.3%
6:00 AM	3.0%	0.0%	1.1%	0.0%	0.8%	0.0%	1.2%	0.0%	1.0%	1.5%
7:00 AM	11.8%	0.0%	2.5%	0.0%	8.4%	0.0%	1.4%	0.0%	4.5%	5.4%
8:00 AM	17.1%	0.0%	7.6%	0.1%	27.1%	0.1%	3.9%	0.1%	6.1%	9.5%
9:00 AM	9.9%	0.2%	6.6%	0.5%	8.0%	0.2%	6.3%	0.6%	7.4%	7.9%
10:00 AM	2.7%	0.1%	6.5%	0.5%	2.0%	0.4%	7.4%	0.6%	5.1%	5.4%
11:00 AM	1.4%	0.0%	6.4%	2.7%	0.5%	0.6%	7.5%	3.1%	6.0%	6.3%
Noon	1.0%	0.5%	3.9%	2.8%	0.3%	1.3%	4.6%	3.0%	6.8%	5.5%
1:00 PM	2.6%	1.6%	1.9%	4.9%	0.7%	2.5%	2.1%	5.6%	9.4%	6.9%
2:00 PM	1.9%	1.6%	2.2%	4.0%	0.9%	2.2%	2.4%	4.0%	6.7%	5.7%
3:00 PM	1.3%	2.0%	1.8%	6.7%	0.1%	8.8%	2.2%	6.0%	7.5%	6.9%
4:00 PM	1.0%	5.5%	2.0%	6.1%	0.0%	12.2%	2.4%	4.2%	7.3%	7.5%
5:00 PM	0.4%	10.8%	1.9%	5.0%	0.8%	4.5%	2.1%	5.0%	8.0%	8.3%
6:00 PM	0.4%	8.8%	1.8%	3.7%	0.6%	3.7%	2.0%	4.1%	9.4%	7.5%
7:00 PM	0.0%	5.0%	1.5%	3.6%	0.0%	1.5%	1.8%	4.1%	6.2%	5.4%
8:00 PM	0.1%	2.0%	1.2%	2.1%	0.0%	1.2%	1.4%	2.2%	4.2%	3.3%
9:00 PM	0.2%	1.2%	0.5%	2.9%	0.0%	1.1%	0.6%	3.0%	1.6%	2.3%
10:00 PM	0.2%	0.4%	0.1%	2.4%	0.0%	1.4%	0.1%	2.0%	1.6%	1.7%
11:00 PM	0.0%	1.2%	0.1%	1.7%	0.0%	0.6%	0.1%	1.9%	0.7%	1.4%
Midnight	0.0%	2.6%	0.0%	0.4%	0.0%	0.0%	0.0%	0.5%	0.3%	0.9%
Total	**55.9%**	**44.1%**	**49.6%**	**50.4%**	**49.9%**	**50.1%**	**49.6%**	**50.4%**	**100.0%**	**100.0%**
7-9 AM	27.0%	0.2%	14.2%	0.5%	35.1%	0.0%	10.2%	0.7%	13.5%	17.4%
3-6 PM	1.8%	25.1%	5.7%	14.8%	1.5%	22.5%	6.5%	13.3%	24.7%	23.3%

Table C.11. (Continued).

Nonmotorized Modes

Hour Ending	Home-Based Work		Home-Based Nonwork		Home-Based School		Home-Based Other		Nonhome-Based	All Trips
	From Home	To Home	From Home	To Home	From Home	To Home	From Home	To Home		
1:00 AM	0.0%	0.3%	0.1%	0.2%	0.0%	0.0%	0.1%	0.2%	0.2%	0.2%
2:00 AM	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.2%	0.0%	0.2%
3:00 AM	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
4:00 AM	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5:00 AM	0.7%	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%
6:00 AM	3.0%	0.0%	0.7%	0.4%	0.0%	0.0%	0.8%	0.4%	0.2%	1.0%
7:00 AM	6.4%	0.5%	1.8%	0.9%	1.4%	0.0%	1.8%	1.0%	1.1%	2.4%
8:00 AM	12.2%	0.1%	5.4%	1.8%	26.8%	0.3%	3.3%	1.9%	2.7%	6.3%
9:00 AM	8.7%	0.1%	4.3%	2.1%	14.8%	0.2%	3.3%	2.3%	3.7%	5.8%
10:00 AM	5.2%	0.3%	2.7%	1.7%	1.9%	0.1%	2.7%	1.9%	4.9%	4.5%
11:00 AM	2.0%	0.1%	2.5%	1.8%	0.3%	0.6%	2.7%	1.9%	5.6%	4.5%
Noon	3.0%	1.4%	2.0%	2.1%	0.2%	0.9%	2.1%	2.2%	8.9%	5.3%
1:00 PM	1.7%	3.1%	2.1%	2.4%	0.6%	3.0%	2.3%	2.4%	16.5%	7.6%
2:00 PM	2.6%	1.7%	2.2%	1.9%	0.4%	2.2%	2.4%	1.9%	11.4%	5.9%
3:00 PM	1.6%	3.6%	3.1%	4.8%	0.2%	19.6%	3.3%	3.4%	9.3%	8.1%
4:00 PM	2.1%	6.2%	3.2%	4.8%	0.1%	18.2%	3.6%	3.4%	8.3%	8.1%
5:00 PM	1.4%	8.9%	4.1%	3.7%	0.1%	4.0%	4.5%	3.7%	6.7%	7.7%
6:00 PM	0.3%	10.0%	4.7%	4.7%	0.3%	2.0%	5.1%	4.9%	6.9%	8.7%
7:00 PM	0.4%	5.4%	4.8%	4.4%	0.1%	0.9%	5.2%	4.8%	5.0%	8.0%
8:00 PM	0.1%	1.1%	4.0%	4.1%	0.0%	0.3%	4.3%	4.5%	3.8%	6.7%
9:00 PM	0.0%	1.3%	2.0%	3.0%	0.1%	0.2%	2.2%	3.3%	2.0%	4.1%
10:00 PM	0.4%	0.9%	1.3%	1.9%	0.0%	0.1%	1.5%	2.1%	1.4%	2.7%
11:00 PM	0.1%	0.9%	0.5%	0.9%	0.0%	0.0%	0.5%	1.0%	1.1%	1.3%
Midnight	0.0%	2.2%	0.3%	0.5%	0.0%	0.0%	0.4%	0.5%	0.5%	0.8%
Total	**52.0%**	**48.0%**	**51.7%**	**48.3%**	**47.3%**	**52.7%**	**52.2%**	**47.8%**	**100.0%**	**100.0%**
7-9 AM	20.9%	0.2%	9.7%	3.8%	41.6%	0.6%	6.6%	4.2%	6.3%	12.1%
3-6 PM	3.9%	25.0%	12.1%	13.1%	0.5%	24.2%	13.2%	12.1%	21.8%	24.5%

Source: 2009 NHTS.

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

Homework for calibration/validation:

1. What is the average person-trip distance for trips within Fresno County?
2. What is the average vehicle-trip distance for trips within Fresno County?
3. When validating a travel model, when would average person-trip distance be relevant? When would average vehicle-trip distance be relevant?