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The primary goal in developing a regional travel demand model is to provide a means for making informed decisions regarding proposed transportation improvements.

Travel Demand Models have been used for many years to assess mobility issues for virtually all large urban areas. Substantial time and effort are invested in developing and validating a base year model to ensure its reliability. Only after a base year model has been re-calibrated to base year travel parameters & validated to base year traffic & transit ridership can the model be used to forecast travel and evaluate various transportation scenarios. Model validation is the process whereby the model’s credibility is verified based on replicating observed conditions (e.g. traffic counts, vehicle miles of travel & transit ridership). This Executive Summary reviews the 2020 Alamo Area Travel Demand Model (TDM) development process and demonstrates the validity of the resulting model.

Development of the 2020 TDM was a cooperative process between the Alamo Area Metropolitan Planning Organization (AAMPO), Texas Department of Transportation (TxDOT) – San Antonio District, VIA Transit and TxDOT Transportation Planning & Programming Division (TPP). (ref. Figure 1 on page 4). The 2020 AAMPO TDM is actually a series of models and sub-models known as the San Antonio Multi-modal Model (SAMM 5.0) regional model. This recently enhanced TDM has been developed as part of the 2020-2050 Metropolitan Transportation Plan (MTP) update and will provide the primary means for identifying existing and future transportation system deficiencies and assessing proposed regional mobility improvements. The model will also be used in conjunction with EPA’s Moves emissions software to perform regional air quality analyses & air quality conformity analyses, as required by regions designated as moderately out of compliance with AQ standards.

San Antonio Multi-modal Model (SAMM 5.0)

The AAMPO SAMM 5.0 provides an effective tool that offers regional planning agencies numerous potential uses, including the ability to:

- Provide technical analysis to support the development of the 2045 MTP.
- Evaluate proposed transportation system improvements or enhancements.
- Identify transportation system deficiencies.
- Conduct alternatives analysis.
- Conduct corridor studies.
- Interface with Moves to estimate on-road mobile source emissions for both urban airshed modeling and air quality conformity analysis.
Model Development Process

The methodology for developing and validating a regional travel demand model involves a number of distinct steps:

- Develop the 2020 base year zonal demographic database for all 1,317 internal Traffic Analysis Zones (TAZ).
- Develop the 2020 base year roadway and transit networks with facility types, speeds, capacities, headways & fares. Estimate travel times.
- Develop Trip Generation model which determines TAZ trip productions & attractions.
- Develop Trip Distribution model which estimates TAZ to TAZ person & vehicle trips.
- Develop the Mode Choice model which estimates proportion of travel by mode.
- Develop Traffic & Transit assignment models which assign trips to the appropriate routes.
- Validate the 2020 Travel Demand Model to observed data.

Executive Summary

The purpose of this Executive Summary is to provide a brief overview of the approach used in accomplishing each of these steps. This document is an overview of the model development methodology as well as supporting analytical procedures applied during model validation. For more detailed TDM documation. The full Model Validation report is available from the AAMPO website under Planning/TDM/Documation.
The demographic database is one of two essential databases (the other being the network database) required to apply travel demand models. The accuracy of model results is directly correlated to the validity of the demographic database. The demographic database has a direct impact on the number and type of trips produced by the model; it also influences regional travel patterns. Thus, the accuracy of the demographic data has extensive impact on model performance.

**Traffic Analysis Zone Definition**

The 2020 demographic database is composed of population, households, household income and employment inventories for each traffic analysis zone (TAZ) comprising the 5-county study area. TAZs are the geographic units used to inventory existing and future demographic data required for modeling purposes. Typically, a TAZ structure is developed that is consistent with the defined roadway structure. This is accomplished by allowing network roadways to be the primary definition of TAZ boundaries and attempting to minimize roadways that traverse individual TAZs. The rationale for such a structure definition is that the model will perform better by providing trips reasonable access opportunities to adjacent streets and transit lines. Aside from roadways, other typical TAZ boundaries include geographic barriers such as rivers, creeks, & flood plains; jurisdictional boundaries such as county lines, city limits, military installations & ETJs and other boundaries such as railroad tracks & public lands. The TAZ structure also features automatically generated transit walk links, representing more direct walking paths from the interior of the TAZ to nearby transit stops.

For the 2020 Travel Model update, the AAMPO study area continues to encompass all of Bexar, Comal, Guadalupe, Kendall and Wilson Counties. Total internal Traffic Analysis Zones number 1-1317. These however, include “dummy” or extra zones which can be used for splitting zones or other forecast applications. The TAZ numbering sequence by county is as follows:

1 to 963
Bexar

974 to 1074
Guadalupe

1094 to 1210
Comal

1232 to 1270
Kendall

1290 to 1317
Wilson

The numbering “gaps” between the counties represent the “dummy” zones.

Figure 2 Example TAZ Structure for Downtown San Antonio
Population

As part of the cooperative model development effort, AAMPO’s Consultant & Sub-Consultant developed the 2020 base year and forecast year’s demographic database for input to the TDM. Table 1 summarizes the 2020 5-county totals for each database element provided. Population estimates for the AAMPO study area were based upon data from the 2020 (ACS) Census. Dis-aggregations of the population and employment totals to TAZ level geography were based upon a Delphi Technique developed by AAMPO consultants.

Travel demand models weigh the relationship between people, workers (per HH) and households (HH size) and between people and employment (Pop/Empl. ratio) to determine the extent and type of travel within the urban area; thus it is critical that the population element of the demographic database be reasonably accurate representation of base year conditions.

Households/Income

Within a model, residential households produce the region’s daily person trips, which are normally attracted to employment centers. Individuals living within the 5-county region generate about 9,148,000 person trips for a typical (non-summer) weekday, including 8,701,000 vehicle trips, 102,000 transit person trips, 313,000 walk trips and 32,000 bike trips. Other daily regional travel includes 559,000 commercial vehicle trips, 408,000 visitor/commuter trips and 380,000 external-local & through trips. Median household income, which was about $57,160 for the region in 2020 is also specified for each TAZ. Income is important in estimating household travel because higher income usually means more disposable income & adequate vehicles for travel. Conversely, lower household incomes normally result in less travel and higher transit usage.

Employment Type & TAZ Density (Area Types)

Employment type is used by the model to determine the likely destination of most trips. So, for example, most home-based work trips would be destined for a TAZ that contained some type of employment, but home-based retail trips would only be destined for a TAZ containing retail employment. Also, each TAZ’s density factor, calculated as (population + (2.25* employment) / acres contributes to the destination decision. This type of Area Type model has been in use for the AAMPO models since base year 1995. A total of five Area Types are used as indicated on page 8. Figure 3 illustrates the regional TAZ densities that determine area type.
The highway and transit networks represent a second important database required to apply travel demand models. Essentially, these networks are a description of the study area’s roadway and transit systems for all significant roads and transit lines. In describing travel demand, the networks can be considered the supply side of the equation when comparing existing and future traffic to available roadway capacity. Thus, the relationship of traffic volumes and transit ridership to roadway and transit capacity (demand vs. supply) provides the basic foundation for assessing regional mobility and determining transportation system deficiencies.

**Network Development**

The AAMPO, along with TxDOT and other stakeholders performs the initial step in roadway network development. Together, they inventoried and identified which facilities should comprise the base year roadway network. Generally, all facilities functionally classified as a collector, or higher functional classification, were included in the roadway description provided by both agencies. The transit network, which operates on the roadway network was developed in cooperation with VIA. In general, the 2020 transit network consists of 4 bus modes and 68 individual or combination (aligned) routes with about 102,000 daily transit riders and 173,000 boardings.

For the **roadway network**, both physical and operational characteristics are coded for each link. These include Functional Class, Facility Type, Area Type, Lanes, Direction (1-way/2-way), Access (divided/undivided), Average Daily Speed, Loaded (congested) Speed, Tolls, Vehicle Capacity and Count data. For the **transit network**, Routes, Headways, Stops, Dwell, Access (walk or park) and Fares are coded.
Facility Types

The following Facility Type Codes are used. In addition to Facility Type, each 2020 network link was associated with one of five area types as follows:

<table>
<thead>
<tr>
<th>Functional Class Code</th>
<th>Facility Type Code</th>
<th>Facility Type Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>Centroid Connector</td>
</tr>
</tbody>
</table>

**Interstate Freeways**
- Radial IH Freeways - Mainlanes Only
- Radial IH Freeways - Toll/CO Mainlanes
- Circumferential IH Freeways (Loops) - Mainlanes Only
- Circumferential IH Freeways (Loops) - Toll/CO Mainlanes

**Other Freeways**
- Radial Other Freeways - Mainlanes Only
- Radial Other Freeways - Toll/CO Mainlanes
- Circumferential Other Freeways (Loops) - Mainlanes Only
- Circumferential Other Freeways (Loops) - Toll/CO Mainlanes

**Expressways**
- Radial Expressways
- Circumferential Expressways (Loops)

**Principal Arterials**
- Principal Arterial - Divided
- Principal Arterial - Continuous Left Turn
- Principal Arterial - Undivided

**Minor Arterials**
- Minor Arterial - Divided
- Minor Arterial - Continuous Left Turn
- Minor Arterial - Undivided

**Collectors**
- Collector - Divided
- Collector - Continuous Left Turn
- Collector - Undivided

**Frontage Roads**

<table>
<thead>
<tr>
<th>Functional Class Code</th>
<th>Facility Type Code</th>
<th>Facility Type Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>Ramps</td>
</tr>
</tbody>
</table>

**Ramps**
- Ramp (Between Frontage Road and Mainlanes)
- Ramp (Freeway-to-Freeway Interchange Ramps)
- Toll/CO Ramps (Mainlanes to Toll/CO Lanes)

**Transit**

<table>
<thead>
<tr>
<th>Functional Class Code</th>
<th>Facility Type Code</th>
<th>Facility Type Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>24</td>
<td>Transit Links</td>
</tr>
</tbody>
</table>

Area Types

In addition to facility type, each network link was associated with one of five area types as follows:

- Central Business District (CBD)
- CBD Fringe (Urban Dense)
- Urban Residential
- Suburban Residential
- Rural

Area types as defined by TAZ density are used to set roadway speeds and capacities. Changes in densities and area types over time enable the model networks to properly represent roadway and transit performance within various types of urban settings. Generally, as urban density increases, speeds decline and capacities increase.
In essence, a Travel Demand Model (TDM) is a set of mathematical formulas that emulate human travel behavior based upon observed rationale underlying daily trip making. The TDM estimates regional travel demand that would occur as part of a specific demographic scenario and a given roadway and transit structure. Recent model enhancements include the replacement of the gravity distribution model with a Destination Choice mode, the introduction of speed feedback with 4 integrated daily time period traffic assignments and a new Master Network coding process. These changes are designed to improve the model’s ability to track proposed transportation projects, better estimate travel demand and address air quality implications related to on-road mobile source emissions.

Base year TDM development relies exclusively upon observed travel behavior within the San Antonio region. The data from the following comprehensive travel surveys were used to update 2020 travel parameters used in the models:
Another important function performed by Tripcal6 is the disaggregation of the home-based trips into various levels of income, auto sufficiency & household workers. This type of household “market segmentation” of travel improves the estimation of trip destinations as well as mode of travel.

The **Trip Generation** model (Tripcal6) estimates trip productions and trip attractions by trip purpose for each TAZ (1317) in the region. The various trip purposes as used in the AAMPO model are as follows:

1. Home-based Work
2. Home-based non-work Retail
3. Home-based non-work Other
4. Home-based non-work Education (1-12)
5. Home-based non-work Educ. (College)
6. Non-work Airport
7. Non home-based
8. Non home-based (Visitor/Commuter)
9. Commercial Truck & Taxi
10. External-local Commercial Truck
11. External-local Non-commercial
12. External Through (w/separate Truck & Auto)

Another important function performed by Tripcal6 is the disaggregation of the home-based trips into various levels of income, auto sufficiency & household workers. This type of household “market segmentation” of travel improves the estimation of trip destinations as well as mode of travel.

The **Trip Distribution** model (Destination Choice) matches trip productions to trip attractions to form trip interchanges among TAZs. Trips are allocated to competing destinations based on observed trip length frequencies and the attractiveness (number of trip attractions) of each TAZ. Using the trip purpose and “market segmentation” by income, to inform the destination choice model of the relative characteristics of the traveler, the model estimates appropriate destination choices for the attraction end of the trip.

The **Mode Choice** (Nested Logit) model determines the mode of travel that is selected by the traveler. These decisions are based upon characteristics of (1) the trip maker (income & auto sufficiency), (2) the trip (purpose, length & orientation) and (3) the availability & utility of the competing transportation modes. The mode choice model produces travel for each of the daily (4) time periods for the following modes:

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**Figure 5 |AAMPO Model Process**
The Traffic Assignment model (TransCAD user equilibrium) loads the travel demand (trips) to the roadway network, calculates delay for congested links and re-assigns as necessary to achieve network equilibrium. For future year networks (containing tolled or managed lanes), additional steps are necessary to properly assign travel to the toll or HOV facilities. The TransCAD multi-class, multi-modal equilibrium assignment option is used for this application.

Currently for the AAMPO 5-county region, there’s only one tolled road... SH 130, Segments 5 & 6 (41 miles). Based upon the current toll structure, the roadway tolls are set at $.17 per mile for cars and $.25 per mile for large 5-axle commercial vehicles. For the purpose of modeling toll roads, Values of Time (VOT) are set to $16.50 per hour for cars and $40.00 per hour for commercial trucks. The traffic assignment routine calculates the total toll cost for the trip and then uses VOT to estimate whether total time savings would warrant the payment of the toll.

One very useful product of the Traffic Assignment Models is the regional traffic loads and transit demand. Analyses of vehicle flow and current or future congestion (Figure 7) are often used to examine a variety of alternatives for future transportation systems.

The Transit Assignment model (TransCAD) simply assigns the transit riders to the appropriate routes, according to access/egress (stops) and the need for possible transfers between or among modes.
Models are validated through a process that proves the model's ability to replicate existing travel conditions. This is done through comparisons of 2020 modeled traffic volumes and transit ridership to actual traffic counts and bus boardings. Modeled Vehicle Miles Traveled (VMT) vs. observed VMT are compared for each Facility Type and further stratified by Area Type. The results from the 2020 model validation for highways are shown below in Table 2a.

### Table 2a- Comparison of Assigned to Counted VMT

<table>
<thead>
<tr>
<th>Area Type</th>
<th>Observed</th>
<th>Assigned</th>
<th>Percent</th>
<th>% RMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBD</td>
<td>688,485</td>
<td>703,842</td>
<td>101.9%</td>
<td>25.9</td>
</tr>
<tr>
<td>CBD Fringe</td>
<td>26,137,665</td>
<td>25,627,458</td>
<td>98.0%</td>
<td>21.0</td>
</tr>
<tr>
<td>Urban</td>
<td>11,284,448</td>
<td>11,466,260</td>
<td>101.6%</td>
<td>24.5</td>
</tr>
<tr>
<td>Suburban</td>
<td>12,567,301</td>
<td>12,826,783</td>
<td>102.1%</td>
<td>26.2</td>
</tr>
<tr>
<td>Rural</td>
<td>9,683,809</td>
<td>9,397,467</td>
<td>107.4%</td>
<td>30.1</td>
</tr>
<tr>
<td>Total</td>
<td>60,361,707</td>
<td>61,021,450</td>
<td>101.1%</td>
<td>23.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Functional Class</th>
<th>Observed</th>
<th>Assigned</th>
<th>Percent</th>
<th>% RMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>IH Freeways</td>
<td>21,307,161</td>
<td>21,128,539</td>
<td>99.2%</td>
<td>8.8</td>
</tr>
<tr>
<td>Other Freeways</td>
<td>7,546,804</td>
<td>7,556,169</td>
<td>100.1%</td>
<td>8.2</td>
</tr>
<tr>
<td>Expressways</td>
<td>2,210,869</td>
<td>2,369,190</td>
<td>107.2%</td>
<td>17.6</td>
</tr>
<tr>
<td>Principal Art</td>
<td>9,598,896</td>
<td>9,734,533</td>
<td>101.4%</td>
<td>24.0</td>
</tr>
<tr>
<td>Minor Art</td>
<td>7,561,258</td>
<td>7,572,993</td>
<td>100.2%</td>
<td>31.6</td>
</tr>
<tr>
<td>Collectors</td>
<td>6,628,887</td>
<td>6,966,642</td>
<td>105.1%</td>
<td>46.5</td>
</tr>
<tr>
<td>Frontage Road</td>
<td>3,215,420</td>
<td>3,227,781</td>
<td>100.4%</td>
<td>34.8</td>
</tr>
<tr>
<td>Ramps</td>
<td>2,292,421</td>
<td>2,465,603</td>
<td>107.6%</td>
<td>26.3</td>
</tr>
<tr>
<td>Total</td>
<td>60,361,707</td>
<td>61,021,450</td>
<td>101.1%</td>
<td>23.5</td>
</tr>
</tbody>
</table>

Percent Root Mean Square (%RMS) is a frequently used measure of the difference between observed and estimated values. It provides a single statistic that indicates the model’s ability to accurately match link-based traffic counts. The overall %RMS for the 2020 model was 23.5% for matching VMT. This %RMS statistic generally indicates a very accurate link-based match, showing that the SAMM5 TDM does replicate 2020 travel.

The Mode Choice model, which estimates transit usage is also validated to observed bus riders for each type of bus access (walk & drive), bus mode (metro, frequent, express, skip & flex) and individual bus lines (68 routes). The 2015 & 2020 Bus ridership validations are shown on Tables 2b & 2c (page 13). Ridership was down from 2010 mostly because of low fuel prices and improving economic conditions.
In conclusion, the 2020 AAMPO SAMM5 Travel Demand Model replicates base year travel conditions. The model should be a useful tool for identifying existing and future transportation system deficiencies and assessing proposed regional mobility improvements!

The AAMPO, in cooperation with AACOG, VIA, COSA, Bexar County and TxDOT District Planning has developed the base and future year (2025, 2030, 2035, 2040, 2045 & 2050) demographic data and is in the process of finalizing the corresponding regional roadway and transit networks required for model development and forecast applications.

The 2020 based Travel Demand Model forecasts will be used to update the latest Transportation Improvement Plan (TIP), the 2050 Alamo Area Metropolitan Transportation Plan and Air Quality Conformity analysis.

### Table 2c
Validation of Transit Ridership (2020)

<table>
<thead>
<tr>
<th>Mode</th>
<th>Mode #</th>
<th>Observed</th>
<th>Modeled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metro</td>
<td>1</td>
<td>45,015</td>
<td>44,915</td>
</tr>
<tr>
<td>Frequent</td>
<td>2</td>
<td>37,459</td>
<td>37,319</td>
</tr>
<tr>
<td>Express</td>
<td>3</td>
<td>4,020</td>
<td>4,031</td>
</tr>
<tr>
<td>Skip</td>
<td>4</td>
<td>15,361</td>
<td>15,361</td>
</tr>
<tr>
<td>BRT/Primo</td>
<td>5</td>
<td>13,940</td>
<td>13,940</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>115,795</td>
<td>115,795</td>
</tr>
</tbody>
</table>

*Note: Transit being re-validated to 2020.*