This chapter describes the development and validation of the transportation model that was used for evaluating existing travel conditions and forecasting future travel demand for the City of Georgetown. The development of mathematical models capable of simulating existing traffic patterns and projecting future travel demand is one of the most important phases of the transportation planning process.

When transportation planning was in its infancy, simple trend-line analysis was performed to forecast traffic demands. However, such methods were based on the existing relationships between land uses and intensities of land uses. If land development patterns changed over time (and most do), forecasts were seldom reliable. Historical trend analysis also failed to account for the impact of construction of new transportation facilities, or even the improvement of existing facilities. To obtain reliable estimates of future travel patterns, both the travel simulation models and the projected land use data must be sensitive to the many quantitative and qualitative parameters influencing the generation and distribution of trips. These characteristics and patterns depend largely on the following factors:

1. Socioeconomic conditions affecting trip production and attraction;

2. The land-use pattern, including the location and intensity of use; and,

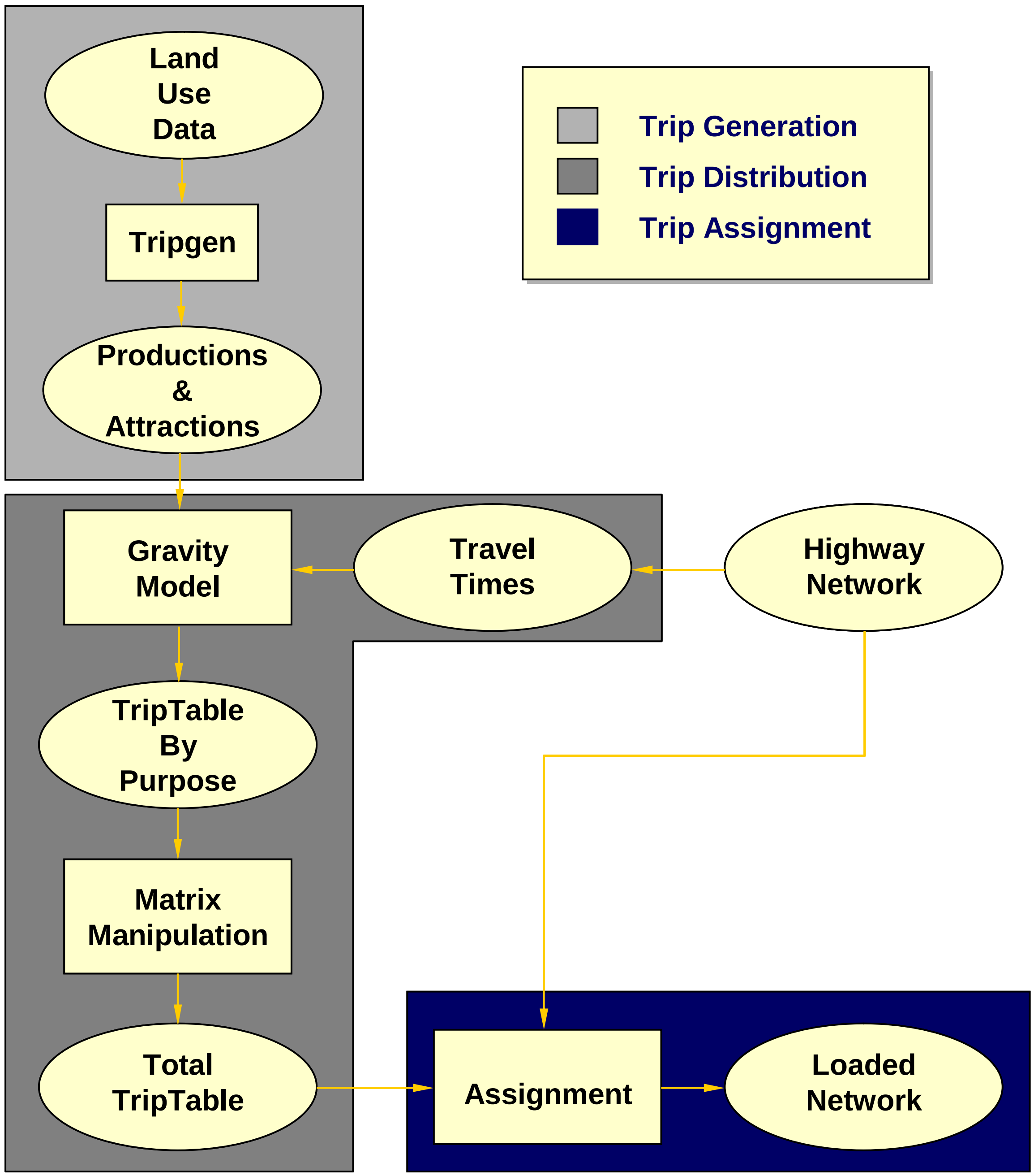
3. The type, extent, and quality of transportation facilities.

With these factors as input to travel demand models, forecasts of future travel patterns are made and used to test the adequacy of any proposed transportation system improvements to serve projected traffic demands. The evaluation of alternatives by use of the transportation model was a primary factor in developing a responsive transportation plan for the Georgetown area.

For this study, the regional transportation model, maintained by the Capital Area Metropolitan Planning Organization, was used as the basis for the Georgetown OTP model. Utilizing the CAMPO zone structure, zones were further subdivided to enable the model to be more focused on a local level. The Georgetown model works hand in hand with the data contained in the regional model, so it more accurately dealt with trips on both a localized as well as a regional level. The relationship of the models and their inputs and outputs are illustrated in **Figure 3-1**.

Demographic assumptions contained in the regional CAMPO model were further refined, and better allocated to reflect actual development as well as growth patterns within the Georgetown ETJ. City Staff worked with the Consultant Team to develop the most accurate demographic allocations for the model, which, in turn, will result in more accurate model trip predictions and roadway facility assignments.

Figure 3-1
Transportation Modeling Process
Georgetown Overall Transportation Plan
Georgetown, Texas



DATA ANALYSIS AND FORECASTING

In order to conduct the travel demand model process, regional transportation data was collected and processed as factors and inputs for the travel model analysis. The travel demand model requires such inputs as regional socioeconomic and demographic data, roadway and land use characteristics, person and vehicle trip data, and travel time and other impedance factors. A major portion of the data inputs came from the regional transportation model and network maintained by the CAMPO.

The CAMPO model and network contained population, household, and employment data for the CAMPO study area, which included the Georgetown region. First, demographic data was obtained from the City of Georgetown for the Williamson County region, while CAMPO's demographic data was maintained for the rest of the model and network. Next, the Traffic Analysis Zone (TAZ) structure was refined within Williamson County to include several new zones within the Georgetown study area; while the zones outside of Williamson County were aggregated to center the focus of the model analysis on the Georgetown study area. With the revised TAZ structure for the travel model, the population, household, and employment data was then assigned to the respective zones. A summary of the study area's demographic data is provided in **Table 3-1**.

Table 3-1
Summary of Demographics within Georgetown Study Area
Georgetown Overall Transportation Plan
Georgetown, Texas

Variable	2000	2010	2030
Population (ETJ)	36,230	68,860	227,370
HH (Dwelling Units)	13,660	26,100	97,890
Employment	6,820	20,430	70,820

The next part of the Georgetown travel model development was to refine the CAMPO transportation network to provide more focus for the Georgetown study area. The CAMPO network contains all primary freeways, arterials, and some collector roadways for the MPO study region. The network within the Georgetown study area was updated to include all freeways, major and minor arterials, collectors, and some regionally significant local roadways. Next, Wilbur Smith staff conducted a field verification of roadway lanes and posted speed limits within the Georgetown area (and also utilized aerial imagery in the verification). As a result, the Georgetown travel model provided a stronger focus for analyzing transportation conditions in their study area.

Therefore, a travel model for the Georgetown study area had been developed that contained an updated transportation network (ready for coding proposed transportation improvements) and population, household, and employment data based on CAMPO's and Georgetown's current statistics and projected for future year analyses. Wilbur Smith staff then conducted an initial travel model run, and utilized this run to verify that the model was replicating current year conditions (i.e. demographics, traffic volumes, and traffic speeds). The model did replicate current conditions within a particular confidence interval (described later in this chapter), and was validated to continue with forecasting future travel patterns.

TRAVEL DEMAND MODEL DEVELOPMENT

The development of travel demand models can be divided into three basic steps—trip generation, trip distribution, and traffic assignment. The first step, trip generation, involves estimating the number of trip ends generated in (productions) and attracted to (attractions) each traffic analysis zone. Each trip on the regional highway system has both an origin and a destination. In this fashion, each trip is defined by two trip ends, one being a production and one being an attraction.

The second step, trip distribution, involves the distribution of the trip ends between all possible zones, which is accomplished by a mathematical trip distribution (gravity) model. The gravity model is so named because its basic form follows the mathematical formula Isaac Newton developed to approximate the pull of gravity. In general terms, this model suggests that the frequency of trip interchange between zone pairs is directly related to the number of productions and attractions in each zone, and inversely related to the travel time between them.

The third step, traffic assignment, is the assignment of vehicle trips to the roadway network, which is accomplished by selecting the route with the lowest travel time. The travel demand models have two primary data elements: demographic characteristics (by TAZ) and a transportation network description.

As previously stated, the travel demand model for the Georgetown ETJ was developed using the structure of the CAMPO regional travel demand model as a starting point. Roadway capacities and speeds were derived from the CAMPO model to maintain consistency with the regional modeling efforts currently underway. From the base CAMPO model, the TAZ structure and roadway network were further refined to allow analysis of arterial and collector roadways within Georgetown.

TRAFFIC ANALYSIS ZONES

Traffic Analysis Zones define geographic areas (typically the size of Census block groups), which are used to relate travel demand to socioeconomic characteristics. For each TAZ, population, dwelling units, total employment, retail employment, and school attendance were developed for the base year of 2000. The resulting traffic zone system is shown in **Figure 3-2**. There are a total of 731 internal zones (within the study area) and 43 external zones (locations where traffic enters and exits the study area). That totals 774 zones in the analysis area.

EXISTING ROADWAY NETWORK

The determination of zone-to-zone travel times, as utilized in the gravity model, and the assignment of traffic to a network of streets and highways, requires a simulation of the transportation network by describing roadway sections and intersections in numerical or digital terms. The City of Georgetown provided a digital city street network, which was integrated into the CAMPO network and provided the basis for the Georgetown network. Each intersection, referred to as a “node”, is assigned a unique number and is connected to adjacent intersections. The section of street between nodes is referred to as a “link”. Each link in a network system contains information regarding distance, speed, number of lanes, functional classification, and capacity characteristics. For each network link, posted speed limits and number of lanes were field verified. Traffic capacity for each link was calculated based on the number of lanes and functional classification.

In addition, traffic analysis zones were represented by “centroids”, and the connection between traffic zones and the road network are represented by special links called “centroid connectors.” Total travel time between any pair of traffic zones consists of the sum of the travel times for all links traversed. **Figure 3-3** illustrates the link-node network map for central Georgetown (without node numbers).

EXISTING PLANNING DATA

Travel demand is greatly influenced by the pattern of development or land use in the study area. Changes in land use will create new travel demand or modify existing patterns. A definite relationship exists between trip-making and land use and demographic data. Existing socioeconomic data, including population, number of dwelling units, total employment, retail employment, and school attendance, were used as input variables for the transportation model to estimate the number of trips produced by and attracted to the development within each traffic zone. This existing Year 2000 level of development in each TAZ is presented at the end of this chapter.

TRIP GENERATION

Trip generation models estimate the number of trips that begin or end in a zone without identifying where the other ends of these trips are located, which is the function of the trip distribution model. Two types of trip generation models were developed: trip production models and trip attraction models. These models were stratified into three trip purposes: Homebased-Work, Homebased-Other, and Non-Homebased. For the two types of homebased trips, trip productions refer to the home end of the trip, and trip attractions refer to the non-home end of the trip. For non-homebased trips, trip productions and trip attractions refer to the origin and destination of the trip, respectively. Initial computer runs utilized multiple regression equations borrowed from travel demand models developed for other similar areas. Socioeconomic data including population, dwelling units, total employment, retail employment, and school attendance was used as independent variables to compute production and attractions. However, modifications were made to the equations during the calibration process, described in more detail in a following section of this report.

TRIP DISTRIBUTION MODELS

Once the number of trips emanating from a zone has been estimated by the trip production models, distribution models must be developed to distribute them among the trip attractions in the other zones. Many models are available for this process. The one used for this study was the gravity model. This model employs two relationships, the first of which is indirect. The shorter the travel time to the destination zone, the greater the number of trips will be distributed to it from the origin zone. The second relationship is a direct one. The more attractions there are in a destination zone, the more trips will be distributed to it from the origin zone.

Figure 3-3

Relative distribution rates express the effect that spatial separation has on trip interchanges. These factors are measures of the impedance to inter-zonal travel due to the separation between zones. In effect, they measure the probability of trip making at each one-minute increment of travel time.

TRAFFIC ASSIGNMENTS

The traffic assignment model determines which route the trips take to get from the origin zone to the destination zone. Traffic assignments were made using an equilibrium capacity restraint technique. This technique consists of an iterative series of all-or-nothing assignments where travel times are adjusted to reflect delays encountered due to congestion. As a result of these time adjustments, the loading of different iterations may be assigned to different paths. Each assignment load after the initial iteration is combined with the previous load to minimize the impedance of each trip until equilibrium is reached. In summary, equilibrium occurs when no trip can be made by an alternate path without increasing the total travel time of all trips on the network.

External travel consists of three types of trips, external-external, internal-external and external-internal. External-external trips are trips that pass through the entire study area without making a stop. External-internal and internal-external trips are those having one end of the trip inside of the study area and the other end outside of the study area. The trips that have one or more ends outside the study area are captured by traffic counts at the study area boundary. These trips are represented in the model at External Stations, which are simply locations where major highways enter or exit the study area.

In traditional travel demand models, traffic counts are collected at external stations to use in the calibration process. The traffic assignment values at the external stations in the Georgetown model used to calibrate the model are derived from the "super regional" model developed for the entire study area. A subarea analysis was conducted within TransCAD to identify which trips from the super regional travel demand model were traveling to which TAZs in the Georgetown study area. This subarea analysis was used to generate the E-E, I-E, and I-E splits in trips to and from the external stations.

Once all of the base models were developed, the models were validated using the following procedure:

1. Apply production and attraction models (including external-internal) to existing (2000) socioeconomic data to obtain zonal productions and attractions;
2. Distribute zonal productions and attractions with gravity model;
3. Add external-external trips to internal and external-internal trips resulting from gravity model distributions;
4. Assign total vehicle trips to base year (2000) network and compare model volumes to existing traffic counts;
5. Adjust trip production and attraction models if necessary;
6. Adjust external traffic models if necessary;
7. Adjust gravity model distribution rates if necessary;
8. Adjust highway network if necessary; and,
9. Repeat steps 1 through 8 until models are validated.

MODEL APPLICATION AND REFINEMENT

Following the above procedure, the models were applied with existing transportation and planning data and compared to these counts. Comparisons of the first model application to existing counts indicated that the models were over estimating traffic on a total basis by only 13 percent. However, even though comparisons were good on a total basis, there were many individual comparisons that were unacceptable.

Based on these results, it was obvious that some "fine tuning" of the models was required. These adjustments included some minor speed changes to various links on the network and trip generation modifications to account for special generators.

Comparisons of observed and assigned traffic for the final model run are shown in **Table 3-2.** Overall, the estimated trips are within two percent of observed traffic. The correlation coefficient, R2, is calculated from a linear regression analysis of assigned and observed volumes. An R2 value of 1.0 indicates a perfect correlation.

The calibration results are also illustrated graphically in **Figure 3-4**, indicating the percent deviation of assigned volumes to actual traffic counts for all locations. As can be seen, all locations fall below the curve of maximum desirable deviation as defined in the National Cooperative Highways Research Program (NCHRP) 255 report.

SUMMARY AND CONCLUSIONS

The comparison of estimated trips with observed traffic counts crossing various sections throughout the study area confirms that the model is in close agreement with actual Year 2000 conditions, and attest to the ability of the travel demand models to recreate Year 2000 travel patterns. Upon review of these results, it was concluded that the Georgetown models can be used to reliably forecast travel patterns.

Table 3-2
Comparison Of Observed Versus Assigned Traffic Volumes
Georgetown Overall Transportation Plan
Georgetown, Texas

Street Name	Link ID	AADT 2000	Assigned Flow		
Westinghouse Rd	14096	747	714		
Parmer Ln/CR 178	14068	2,435	2,004		
US 79	9106	2,941	2,441		
CR 113	7127	3,000	2,437		
Brushy Creek Rd	6443	4,012	3,646		
Loop 332/FM 1869	6528	4,229	2,421		
CR 115/Sunrise Rd	7124	4,398	3,592		
FM 2243	7008	4,531	3,690		
Old Settler's Blvd	8012	4,590	3,748		
Brushy Creek Rd	6882	4,640	7,120		
SH 95	13961	6,265	6,287		
SH 29	18373	6,500	5,334		
SH 29	17410	7,375	6,023		
Lakeline Blvd	6789	7,422	6,637		
McNeil Dr	7167	8,530	17,813		
Louis Henna Blvd	8214	9,085	7,691		
FM 973	6264	9,626	9,974		
Cypress Creek Rd	6790	10,108	10,593		
FM 2768/Anderson Mill Rd	12876	10,855	13,208		
FM 2338	17648	10,900	7,697		
FM 734/Parmer Ln	10137	11,759	9,646		
Pflugerville Rd	8197	12,156	25,684		
FM 734/Parmer Ln	10103	19,723	16,950		
US 183	7271	19,917	19,991		
FM 1431	6565	19,917	26,583		
FM 1431	6445	21,651	19,342		
IH 35	8578	24,350	24,638		
McNeil Dr	10084	33,831	34,005		
US 79	7762	35,422	29,159		
FM 1325	11986	50,734	41,266		
IH 35 N	4834	62,071	51,016		
IH 35	3712	107,890	94,081		
IH 35	3860	111,516	111,057		
Existing Traffic Volumes vs. Predicted Model Assigned Volumes		**Total AADT Counts**	**Total Assigned Volumes**	**Difference**	**Percent Difference**
		2,037,749	2,000,724	37,025	0.018169323

Figure 3-4
Model Calibration Curve
Georgetown Overall Transportation Plan
Georgetown, Texas