VICTORIA MPO

EXECUTIVE SUMMARY CONTENTS

Introduction
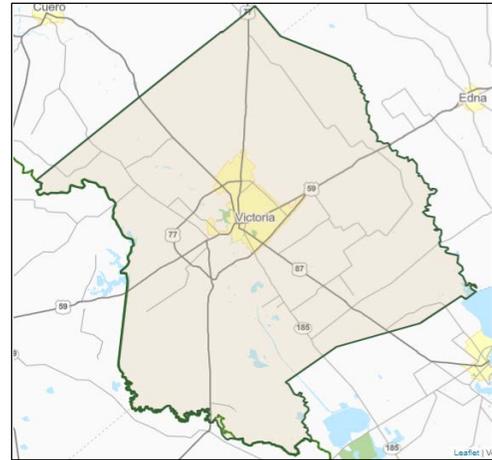
The primary goal in developing a regional travel demand model is to provide a means for making informed decisions regarding proposed transportation improvements. Therefore, the process used to develop the model, and its results need to be sound and defensible.

Consequently, substantial time and effort are invested in developing and validating a base year model to ensure its reliability.

Validation is the process confirming a model's credibility based on replicating observed conditions (e.g., traffic counts and vehicle miles of travel). This Executive Summary reviews the Victoria Travel Demand Model (VIC TDM) development process and demonstrates the validity of the resulting model.

Figure 1 –Model Development - A Cooperative Process
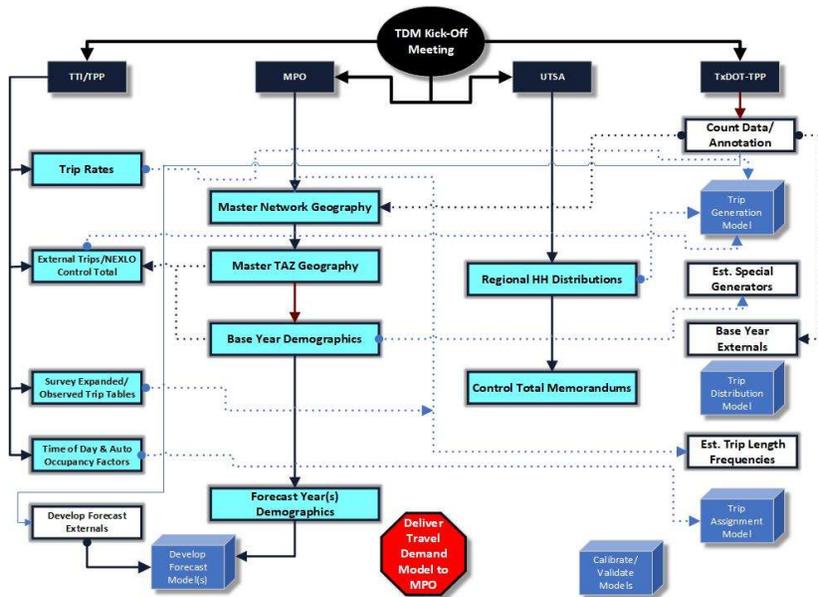
Development of the Victoria TDM was a cooperative process between the Victoria Metropolitan Planning Organization (MPO), Texas Department of Transportation (TxDOT) – Victoria, and TxDOT Transportation Planning & Programming Division Transportation Analysis Section (TPP-T) (Figure 1). The cooperative process used to develop the Victoria TDM is dependent upon the investments of each entity. The Victoria TDM is the primary means for identifying transportation system deficiencies and assessing proposed regional mobility improvements.

The Victoria TDM is also an invaluable tool that offers the Victoria MPO and the Victoria District several potential uses and benefits including the ability to:

- Provide technical analysis to support the development of local transportation plans.
- Evaluate proposed transportation system improvements or enhancements.
- Identify transportation system deficiencies.
- Conduct alternatives analysis.
- Conduct corridor studies.
- Provide technical information for public involvement meetings.
- Conduct and/or evaluate traffic impact studies.

TxDOT –TPP will also use the model as the primary basis for developing future design level traffic analysis within the Victoria study area.

This latest iteration of the Victoria model has been integrated into TxDOT's TexPACK system, version 2.5. This TransCAD add-in simplifies running the model; permits easier adjustments to each of the three model stages; and provides enhanced visualizations of model results for better analysis. For more information, please refer to the TexPACK manual, version 2.5.

Executive Summary Purpose

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

1. Develop base year (2017) demographic database.
2. Develop base year (2017) roadway network database.
3. Develop trip generation model.
4. Develop trip distribution model.
5. Develop trip assignment model.
6. Validate travel demand model.

The purpose of this summary is to provide a brief overview of the approach used in accomplishing each of these steps. This document will address model development methodology as well as supporting analytical procedures applied during model validation. Emphasis will be placed on demonstrating that the model performs within acceptable parameters and that the Victoria TDM is a credible tool to support the local transportation decision-making process.

Demographic Database

The demographic database is one of two essential databases (the other being the network database) required to apply travel demand models. It cannot be stated often enough that the accuracy of model results is directly correlated to the accuracy 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 an extensive impact on model performance.

Traffic Analysis Zone Definition

The demographic database is comprised of population, households, household income, and employment estimates for each traffic analysis zone (TAZ) comprising the 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 to be consistent with the defined roadway structure. This is accomplished by allowing network roadways to be the primary definition of TAZ boundaries and works to ensure that roadways do not traverse any TAZs. This structure definition provides trips with comparable access opportunities thus supporting increased model performance.

The Victoria planning study area is in Victoria County. The study area has been divided into 237 TAZs; this includes 225 internal TAZs and 12 external TAZs (Figure 2). The current TAZ structure is maintained and applied during all model applications.

Population

Figure 2 - Victoria TDM TAZ Structure
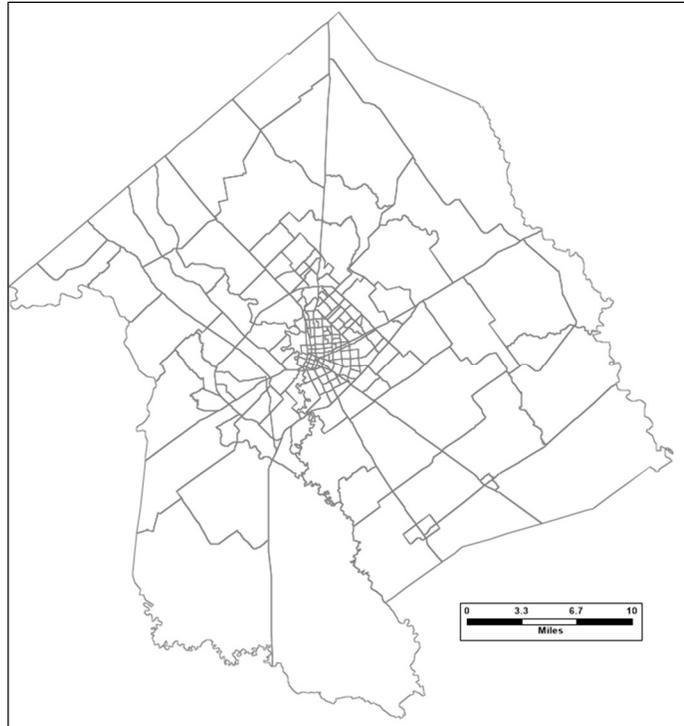
Table 1 – 2017 Demographics

Population	91,228
Households	33,625
Household Size	2.71
Median HH Income	$53,315
Basic Employment	10,199
Retail Employment	8,246
Service Employment	12,785
Education Employment	1,785
Total Employment	33,015
Pop./Emp. Ratio	2.76

As part of the cooperative model development effort, the Victoria MPO contracted with Cambridge Systematics to develop the 2017 base year and the 2050 forecast year demographic database

for input into the TDM. Table 1 summarizes the 2017 totals for each database element provided by the MPO.

Travel demand models consider people and households as the primary producer of trips. In addition, several model performance statistics are directly tied to total population. Thus, it is critical that the population element of the demographic database be an accurate summary of base year conditions.

Since the previous 2012 Victoria base year model, the study area has grown from 87,386 (2012) persons to 91,228 (2017) persons. This represents an annual increase of 4.2 percent and will result in increased travel demand throughout the study area.

Households

Within a model, households produce the majority of a region's trips and are viewed as the origin point of most trips. The number of trips produced by a household is a function of household size and income. A total of 33,625 households were reported for 2017, which yields an average household size of 2.71.

Employment

Employment is used by the model to determine the destination of trips. The total number of trips destined to a particular TAZ is determined by the number of employees within a TAZ and its density. Density is measured by a weighted combination of population and employment in relation to total TAZ acres. Figure 3 illustrates the regional TAZ acreage that determine area types. Total 2017 employment for the Victoria study area equaled 33,015 employees.

Figure 3 – TAZ Employment Densities
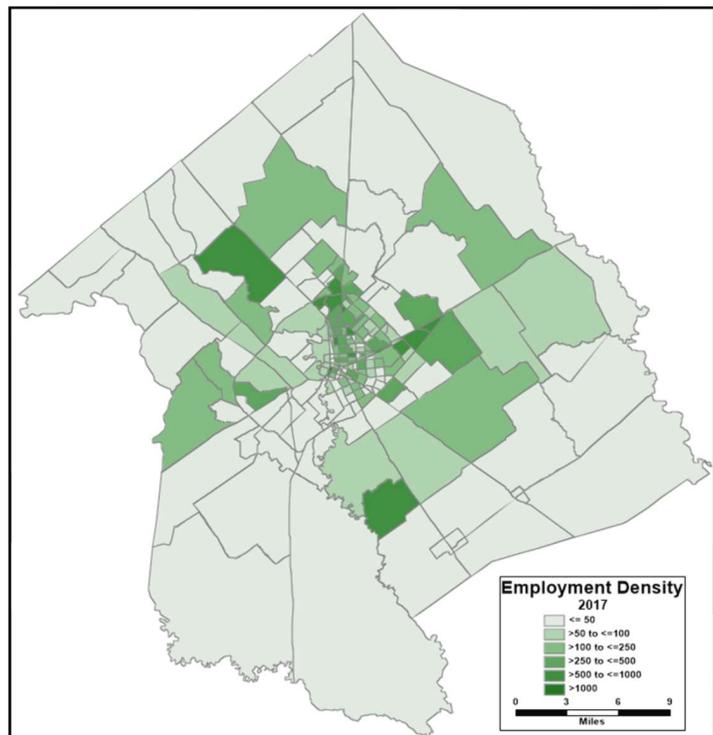
Network Database

The network database is the second crucial database required to apply travel demand models. Essentially, the network database is a description of the study area's roadway structure for all facility types, collector and higher. In discussing travel demand, the network can be considered the supply side of the equation when comparing existing and future traffic to available roadway capacity. This relationship of traffic volumes to capacity (demand vs. supply) will be the foundation of any analysis centered on assessing regional mobility and determining transportation system deficiencies.

Network Development

TxDOT's Victoria District and the Victoria MPO performed the initial step in 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. In addition, several of the primary network attributes were also inventoried and included in the network database; these attributes included facility type, number of lanes, and whether the roadway was a divided or undivided facility. The 2017 Victoria network is shown in Figure 4. Physical and operating characteristics including roadway length, number of lanes, and median access type (divided or undivided) as well as operational characteristics such as daily speed, daily capacity, average weekday traffic count and direction (one-way/two-way) are contained in the network database. Apart from link distance, physical characteristics are primarily provided by the District and MPO. Development of operational characteristics is explained below.

Facility Types

All roadways representing the 2017 network are defined by facility type as well as functional classification. Facility types are more precise classifications to properly code representative operational characteristics; for example, divided and undivided principal arterials.

Area Types

In addition to facility type, each network link was associated with one of four area types (CBD, Urban, Suburban, Rural) based on the link's physical location within the study area. Three area types - Urban, Suburban, Rural - were defined by the density values. CBD is predefined by historical land use of the Victoria downtown district. Area types designate physical boundaries where operational characteristics are assumed to change due to land use densities and the resulting impact on travel propensities.

Figure 4 - Victoria 2017 Network
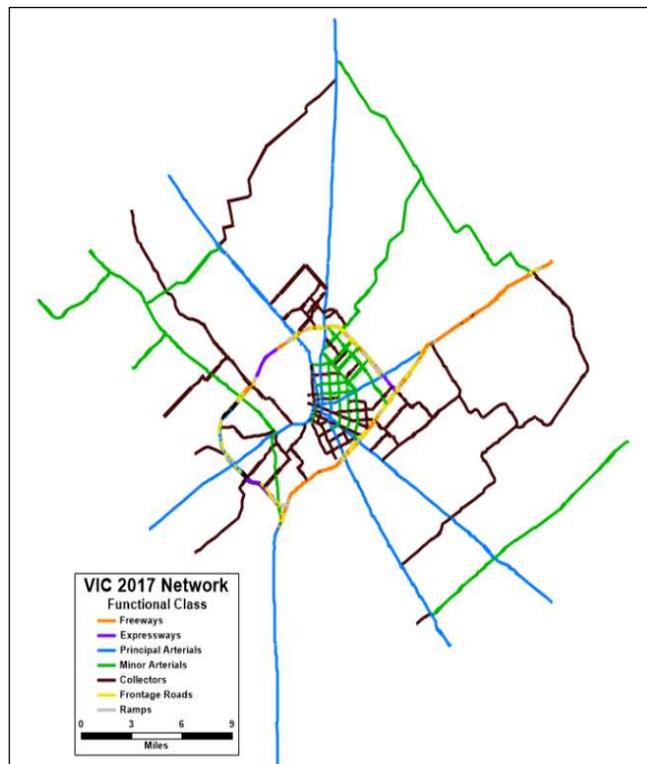
Model Development

In essence, travel demand models are a set of mathematical formulas that emulate human behavior and the rationale underlying any given trip. A TDM is comprised of several mathematical expressions each one defining the various decisions that comprise a trip, such as destination and route choice. Taken together, the TDM quantifies regional travel demand that occurs in relation to a set of demographic data and a given roadway structure.

Model development relies on the stability of general trends in travel behavior. For example, higher income households generally make more trips than lower income households; and people are generally willing to travel further to work than to the grocery store. These trends are primarily based on data from the U.S. Census, household travel surveys on daily trips, the Texas Workforce Commission database, Data Axle data, and area traffic counts.

Figure 5 Planning Area Model
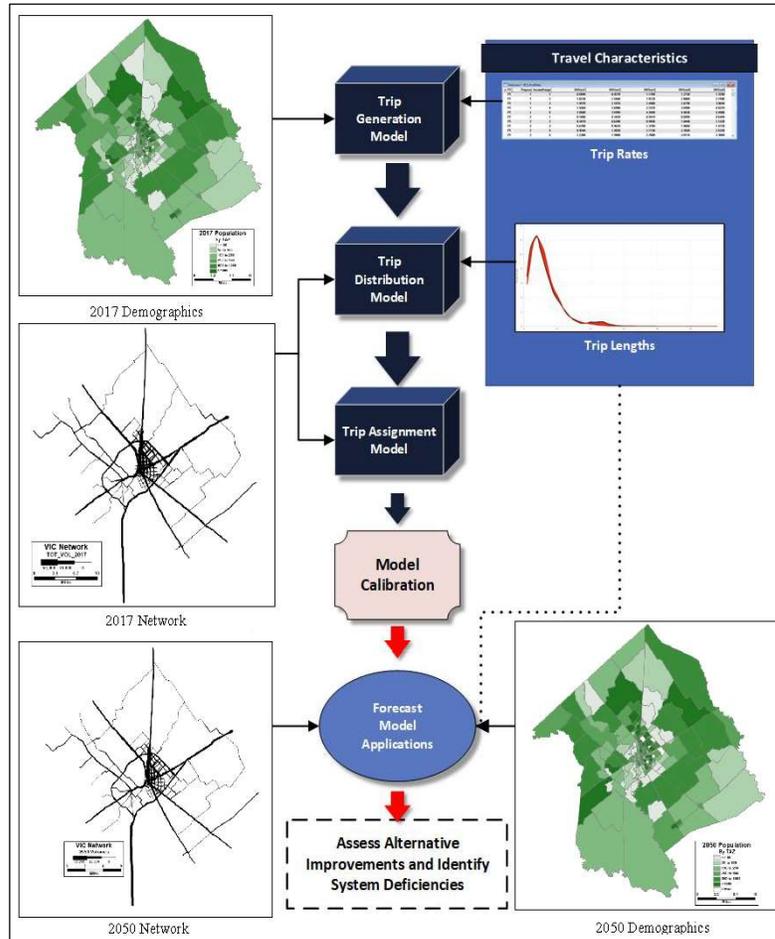
The Victoria travel demand model was developed using the TransCAD software and is comprised of three distinct steps or sub-models: trip generation, trip distribution, and trip assignment. Figure 5 shows each of these sub-models and their relation to the overall modeling process.

The trip generation model calculates trip productions and trip attractions by trip purpose for each TAZ in the region. Trip productions are a measure of how many trips a zone is expected to produce based on the number of households within the TAZ and each household's size (number of people) and income. Trip attractions are a measure of how many trips each TAZ is expected to receive.

Trip distribution uses characteristics of the transportation network and demographics to distribute the trip from the generation model to the Victoria's TAZs. The process matches trip productions to trip attractions to form trip interchanges among TAZs. Trips are allocated to competing destinations based on distance between zones and attractiveness (number of trip attractions).

Trip assignment is the process by which traffic volumes are estimated. The trip assignment step loads trips onto the network's shortest paths, calculates delay caused by congestion, and re-loads the trips onto the network based on the resultant updated shortest paths. (Congestion is measured by comparing the number of trips (vehicles) desiring to use each link to the available vehicle capacity on each link). The vehicle flow map below (Figure 6) is a representation of the model's trip assignment.

Figure 6 – Victoria TDM Results (Vehicle Flows to Capacity Ratios)
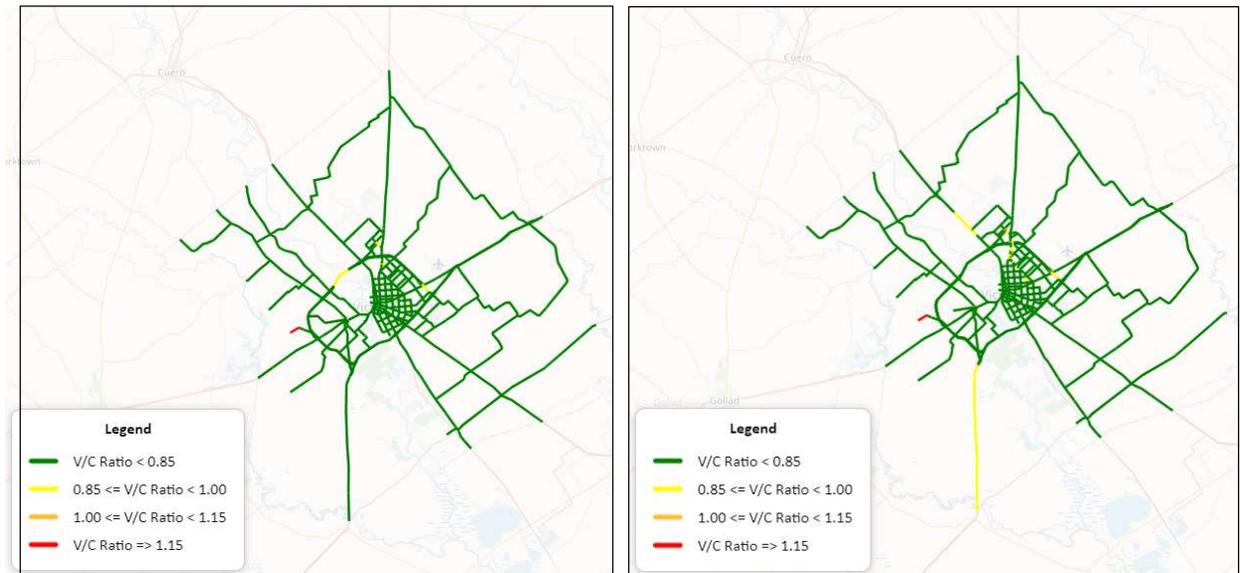
Through trip generation, distribution, then assignment the model replicates the Victoria County regional travel patterns. The model is then validated by comparing modeled traffic volumes to actual counts on each facility comprising the network. The model's ability to match observed counts is measured with various statistical tools. Because the model is based on general trends of travel behavior and the counts themselves are also considered to be typical rather than exact, there is a limit to the accuracy of the process.

The model cannot and should not be expected to replicate each count on each roadway segment. Within reasonable limits and some exceptions, a model is seen as valid if the overall area-wide modeled vehicle miles of travel (VMT) are within plus or minus 5 percent of counted VMT. Within sub-groupings of roadways, such as area types or roadway functional classification, an accepted difference between modeled and counted VMT is 10 percent.

After a model is considered validated, forecasted demographics and network improvements can be added to apply the base year model to forecasted demographic and highway scenarios and assess proposed improvements. In this way, alternative scenarios can be analyzed for traffic and air quality implications and the travel model can be used to examine a variety of alternatives for alternative future transportation systems.

Model Validation

As mentioned previously, a model's validity is determined by comparing modeled traffic volumes to actual counts on each facility comprising the network. Several performance statistics are based on comparing observed versus modeled vehicle miles traveled (VMT). VMT is defined as the number of vehicles times the length of roadway traversed; for example, 4,000 vehicles on a two-mile section yields 8,000 VMT. Overall, the Victoria TDM performed very well; regional modeled VMT versus actual VMT was 99.4 percent.

Comparing VMT percentages by area type and facility type also indicates adequate results. The standard benchmark in this instance is for the percentage of modeled to observed to be within the range of 90 percent to 110 percent (i.e., ±10 percent). By area type, the observed to actual percentages for the Victoria model ranged between 92.8 percent and 105.7 percent as indicated in Table 2. The same table also summarizes the model's performance by functional classification; it shows that by functional classification the model also performed well. The percentage ranges by functional classification were 82.5 to 107.8.

Table 2 - Comparison of Counted to Assigned VMT

Area Type	Counted	Assigned	Percent
CBD	4,528	4,739	104.7%
Urban	329,478	305,764	92.8%
Suburban	307,786	292,648	95.1%
Rural	546,552	577,772	105.7%
Total	1,188,344	1,180,923	99.4%

Functional Class	Counted	Assigned	Percent
Other Freeways	200,156	215,714	107.8%
Expressways	12,685	11,688	92.1%
Principal Arterials	633,970	649,285	102.4%
Minor Arterials	246,628	224,285	90.9%
Collectors	71,235	60,338	84.7%
Frontage Roads	20,952	17,280	82.5%
Ramps	2,718	2,333	85.8%
Totals	1,188,344	1,180,923	99.4%

In addition to assessing how well the model is performing by area type and functional classification, it is also evaluated at the corridor level. Screenlines are defined so that analysts may summarize traffic flows along parallel facilities or within a corridor. The standard benchmark in this instance is for screenlines to be within 85 percent to 115 percent (i.e., ±15 percent). Eight of the fourteen identified screenlines in Figure 7 fell within the accepted parameters.
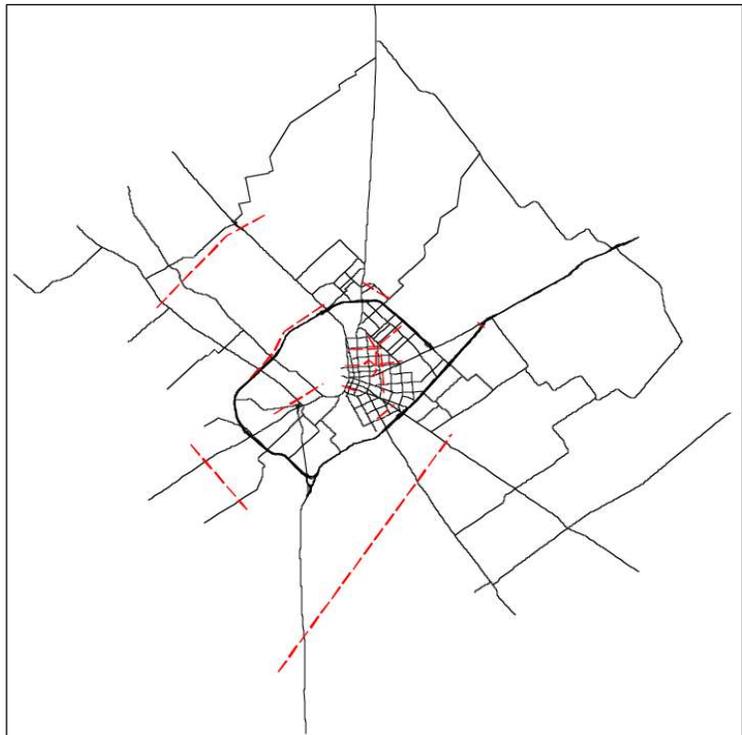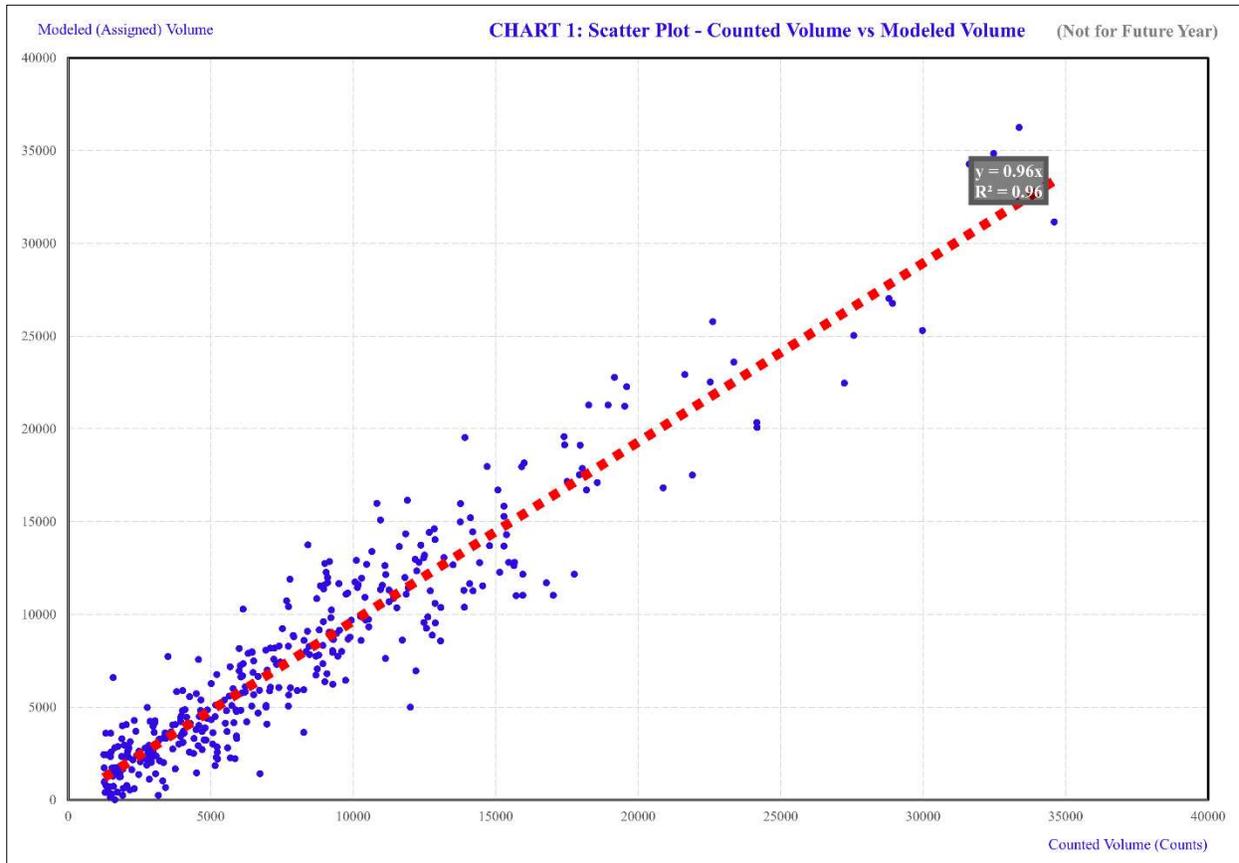
Figure 7 - Screenline Locations

Figure 8 summarizes how well all 374 counts were matched by the model. The fact that the scatter diagram follows a diagonal line within a narrow band indicates a very reasonable match between modeled volumes and actual counts.

Figure 8 - Volume Comparison

Conclusion

In conclusion, the 2017 Victoria travel demand model replicates base year travel conditions exceedingly well. The model should be a useful tool for identifying existing and future transportation system deficiencies and assessing proposed regional mobility improvements.

TxDOT-TPP offers additional assistance and training to the MPO for loading software/files, displaying networks, developing alternatives, and performing various system performance analyses. This should afford local planners the opportunity to fully utilize the regional TDM set in support of long-range planning, MTP development and assessment of proposed transportation system improvements.

TxDOT-TPP(T) Model Application Assistance

In addition to TPP modeling staff being available to assist with model application questions, TxDOT-TPP has also contracted with Texas Transportation Institute (TTI) to staff a travel demand modeling and TransCAD help desk to assist MPOs with model application issues. The TPP modeling Help Desk is available to assist with TransCAD and general modeling questions and/or concerns. The help desk can be contacted by email at TPP TRANSCAD-HELPDESK@dot.state.tx.us.

Texas Department of Transportation

Transportation Planning and Programming Division

Transportation Analysis Section