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Fargo – Moorhead MPO 2010 Regional Travel Demand Model Update

Technical Report-DRAFT

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1.0 INTRODUCTION

The Advanced Traffic Analysis Center (ATAC) at North Dakota State University has been responsible for updating and maintaining the Fargo-Moorhead Metro Council of Governments (FM Metro COG) Travel Demand Model (TDM) since the 2000 base year scenario. The model was first developed using Citilabs Cube software using TP+ scripting. TP+ scripting was updated to Cube Voyager scripting for the 2010 model update. The model is updated every five years with the prior update being 2005 which is currently being updated to a 2010 base year. The four step planning process is the modeling platform that ATAC has used for the TDM (and was used for the 2010 model update). ATAC is committed to updating the four-step process to use other models such as activity based models and dynamic traffic assignment methods as the required data become available. This document discusses the input data requirements, model output, model structure and the methods that were used for the 2010 FM Metro COG TDM update.

1.1 Report Organization

In addition to the introduction chapter, the remainder of the document is divided into the following chapters:

Chapter 2, *Model enhancements and Improvements:* provides a summary of the enhancements and improvements implemented in the 2010 base year model.

Chapter 3, Data preparation: provides information on the data that was used to build the transportation network in GIS format, assign the necessary parameters to the links and update, and prepare the socioeconomic data are discussed here.

Chapter 4, Trip Generation: socio-economic data were used to predict the number of trips produced by and attracted to each zone within the study area. The output of this process was a trip generation table.

Chapter 5, Trip Distribution: trip ends were connected between productions and attractions and trips flow from production zones to attraction zones were established. The output from this step was an origin-destination (O-D) matrix representing the productions and attractions between TAZs.

Chapter 6, Trip Assignment: discusses the process of assigning trips between O-D pairs to the traffic network and an O-D matrix was the main output for the travel demand model (TDM).

Chapter 7, Model calibration: Model calibration refers to the adjustment of model input parameters in order to replicate observed real world data for a base year or otherwise produce more reasonable results and is discussed in this chapter.

Chapter 8, Model validation: Model Validation tests whether the base year calibrated models replicate real world travel reasonably by comparing the modeled results to observed data.

Chapter 9, Model output and capabilities: Previous FM Metro COG TDM had various outputs yielded by the model. ATAC ran the model and provided results for the FM Metro COG.

Chapter 10, Model Post Processing: Post processing reflects on the over/underestimations from the base year to future forecasts. This is an important step in assessing areas that need improvements.

Chapter 11, Beyond 2010 and Future of FM Metro COG TDM: For future purposes, ATAC intends to explore into two research subjects: dynamic traffic assignments (DTA) and activity based model.

2.0 MODEL ENHANCEMENTS AND IMPROVEMENTS

This chapter describes the model enhancements and improvements that were done for the F-M 2010 TDM in comparison to the 2005 model.

2.1 Trip Production Input

A significant improvement for the 2010 model was the use of household size (person(s) per household) rather than household type (single or multi-family) to develop zonal trip productions. The number of person(s) per household is a better predictor of the number of trips that each household makes than housing size. This change significantly improved the models replication of travel demand in the region.

2.2 Trip Production Rates from the Fargo-Moorhead Area

One of the limitations of the previous 2005 model was the use of national data that were not necessarily representative of local travel demand and patterns of the area. This shortcoming was addressed in the 2010 FM METRO COG TDM by using trip generation rates from the FM Metro COG O-D Survey [3]. Local trip attraction rates are however inexistent and national rates were thus used for trip attractions. Trip rates from the O-D Survey were compared to national rates from NCHRP Report 716 [4] and were found to be about 10% lower. The trip generation rates are discussed in more detail in chapter four of this document.

2.3 University Student Trip Generation Rates

The four major educational institutes taken into account for the TDM are: North Dakota State University (NDSU), Minnesota State University Moorhead (MSUM), Concordia College, and Minnesota State Community & Technical College (MSCTC). Trip rates for these generators were revised using several different sources. The trip generation rates take into account the following factors:

- The number of on campus students and;
- The number of off campus students.

These are discussed in more detail in Chapter 4.

2.4 Junction Constrained Assignment

The F-M 2010 TDM took advantage of improvements in Citilabs software by using Cube Voyager's junction-constrained assignment process. This process improves the model's ability to correctly model intersections in the network since it uses the actual intersection traffic control data. The list of signalized intersections and the pertaining timing/phasing data were obtained from the COG as Synchro files and were converted into Cube format. For intersections where no Synchro data were available, assumptions about network link capacities were made based on the functional classification of the link, the link geometry, and the control type. This is discussed in more detail in section 4.2.

3.0 MODEL INPUT DATA

For the FM Metro COG's 2010 TDM update, the following data were required: transportation network data (network data), socioeconomic data, model input parameters, calibration data, and validation. The next two sections discuss the different data that were used for the development, calibration, and validation of FM Metro COG 2010 base year TDM.

3.1 Transportation Network Data

The transportation network data basically represents the available transportation supply. It consists mainly of the street/highway network for any given scenario within the model. The network is maintained in GIS as a geodatabase that contains four feature classes. These classes include:

- Nodes

  Nodes primarily represent intersections, centroids which are the trip origin/destination points for transportation analysis zones (TAZ), and external centroids. Figure 3-1 shows the functionally classified links that were used for the 2010 base year model.

- Links

  Links represent the functionally classified roadway segments.

- Centroids

  Centroids are the trip origin/destination points for the purpose of Transportation Analysis Zones (TAZs), and external centroids. Figure 3-1 shows the functionally classified links that were used for the 2010 base year model.

- Centroid Connectors

  Centroid connectors represent the local roads/driveways that are used by trips to load on the functionally classified links. The main purpose centroid connectors serve is appropriately loading/unloading the trips from/to the centroids and adjacent nodes/links. They should not be confused with the street network under consideration in the model.

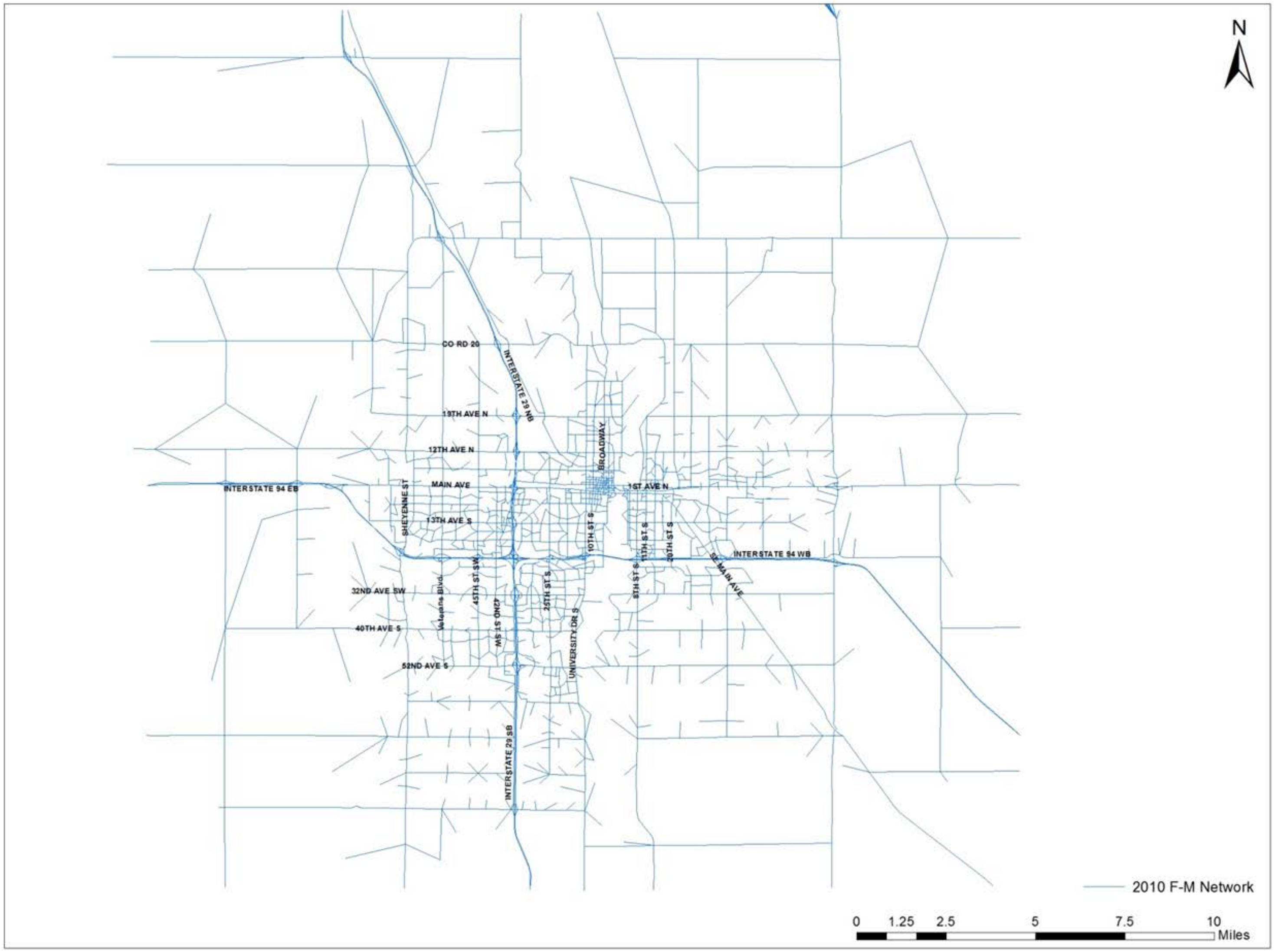

Figure 3-1 2010 F-M Network TDM

3.1.1 Node Centroid, and External Centroid Feature Classes

The node feature class has two main attributes:

- Node Number (ID)
  Node Number is unique to each node and is used not only to identify a certain intersection but also to assign other attributes to the given intersection.

- Control Type
  It describes the traffic control deployed at the node such as yield, stop (North South/East West), signal, roundabout, or free (no control/uncontrolled). The nodes are not used as model inputs but are used to develop A and B node numbers (for routing purposes) on the network and to validate and check the accuracy of locations of intersection control data that is contained in the network attribute data. The centroid and external centroid connectors have an identification field (ID) which is identical to the TAZ number field in the TAZ GIS data.

Table 3.1 Key Network Link Roadway Data for the F-M Metro COG 2010 Base Year TDM

Attribute Field Name	**Description**
A	From node number
B	To node number
SPEED	Posted network speed
ONEWAY_TWO	Describes whether link is a one or two way
NUMLANES	Number of through lanes going from A to B node / B to A node
CONTROL / R_CONTROL	Intersection Control from A to B node / B to A node based on the following code: 0-None 1-Yield 2-Stop 3-Signal 4-Roundabout
DIRECTION / R_DIRECTION	Direction of travel from A to B / B to A node according to the following code: 2-Eastbound 4-Northbound 6-Westbound 8-Southbound
RIGHT_TURN / LEFT_TURN	Number of right turn lanes and number of left turn lanes from node A to B/ Number of right turn lanes and number of left turn lanes from B to A node

DISTRICT	State in which road is found according to the following code: 1-MN 2-ND
CITY	City which contains road according to the following code: 27-Clay County 19-Dilworth 17-Fargo 12-Moorhead 9-West Fargo 16-Cass County
FUNC_CLASS	Functional classification of road according to the following code: 1-Interstate 2-Principal Arterial 3-Minor Arterial 5-Collector 6-Locals 7-TAZ centroid connector 8- Ramp
AREA_TYPE	Area type[1] in which link is located according to the following code: 1-Rural 2-Urban 3-CBD
ADT_2010	2010 Average Daily Traffic
SHAPE_LENGTH	Length of Link

3.1.2 Link Feature Class

The link feature class contains the attributes of the network that the model uses to assign trips. Table 3.1 shows the link attributes with their descriptions. These attributes affect the model in different ways and for the most part need to be accurate to improve the models ability to correctly replicate real world travel, given the available data.

For the previous 2005 model update, the process of updating the network involved making changes to the 2000 base year network supply to reflect 2005 base year transportation network characteristics. The data used to update the 2005 network was obtained from several sources including the FM Metro COG Transportation Improvement Program (TIP), aerial photos, online resources and information provided by the different jurisdictions (Cities of Dilworth, Fargo, Moorhead, and West Fargo).

[1] Area type determined by F-M Metro COG

For the 2010 model however, due to the network coding errors in the 2005 network, it was decided that instead of updating the 2005 network to 2010 conditions, a 2015 network that had been corrected would be scaled back to 2010 ground conditions. However, after reviewing the scaled back 2015 network, several errors still existed in the base 2010 network. To reduce network errors, ATAC has developed Quality Assurance/Quality Control procedures to ensure the accuracy and reliability of the 2010 base year network.

3.2 Quality Assurance/Quality Control Procedures

In addition to those described in the Master Agreement, ATAC performed the following project specific QA/QC procedures:

1. All links were checked against 2010 aerial photos. In cases where aerial photos were not clear, physical checks were performed.
2. Signalized nodes were checked against the signal timing data received from the COG.
3. Other available local data, e.g. the metropolitan profile and TIP – was used to verify attributes such as updates to functional classes.
4. Other reliable online resources were deployed to verify the accuracy of these data.
5. At least two full-time staff members were involved with verifying the accuracy of data ATAC provides to the FM Metro COG.
6. The network underwent several iterations and random checks between ATAC and Metro COG that involved using all available resources including detailed aerial photographs, FM Metro COG TIP, online databases, information from local jurisdictions, and site visits (where doubt existed) to ensure accuracy of information. ATAC is confident that the base year 2010 network is sufficiently accurate and reliable.

For the 2010 model network, several changes were made to the model network input attributes and to other network attributes that are post processed in Cube and used in the modeling process. These changes were made to ensure that the TDM network which is an abstract of the real world would represent the real world more realistically and produce a reliable calibrated model. These changes include:

1. Ramp Functional Class: Interstate ramps (ramps) were coded as a separate functional class in contrast to the past models updates where they were coded as major arterials. Coding ramps as major arterials posed issues with calculating ramp capacities. Ramps as major arterials were allocated through lanes even in cases where none existed in order that the model provided adequate ramp capacity. Ramp attributes were represented accurately and consistently. Capacity for the ramp functional classes were calculated based on Highway Capacity Manual, HCM 2010 [1]and also using the state-of-the-art in transportation planning literature.
2. Interstate Capacities: Freeway capacities were calculated as a function of the number of through lanes on each link. For previous model updates, the interstate capacities included a right turn lane even in cases where none existed. Also, auxiliary lanes were not appropriately accounted for in the previous model updates. For the 2010 network, interstate geometries were updated to correctly reflect actual conditions. Capacity calculations were also changed to correctly reflect auxiliary lanes using sources such as HCM 2010 [1] and other sources such as [2]; where capacities on auxiliary lanes are adjusted as a proportion of the capacity of full interstate lane based on the length of the auxiliary lane.
3. Node Delays: Average node control delays were assigned to signalized and stop intersections based on roadway functional classification and city in the previous model updates (2005/2000). The main shortcoming from this method was that it did not take into account the signal type, the actual signal timing, and whether or not the signal was coordinated. This resulted in modeled traffic avoiding certain corridors (unrealistic routing) due to higher node delays than traffic counts showed. For the 2010 base year model, intersection delays were based on HCM 2010 [1] procedures and built-in functions for stops, yields, and roundabouts. For signals, the actual signal timing plans were used to estimate node delays. Using actual signal timing data will reduce the aggregation node delay errors that occurred in the previous model updates.
4. Free Flow Speed Adjustments: Free Flow Speed (FFS) is the average speed that motorists would travel on a certain highway segment if there was no congestion. Free Flow Speeds play an important role in planning models since they are used as the speeds used in calculating initial free flow travel times for the initial assignment step. Congested assignments are thus based off of free flow speeds and wrong FFS will affect the models output accordingly. Free Flow Speeds from the 2000 model were carried over to the 2005

model. For the 2010 base year model, in the absence of local data, the free flow speeds were calibrated based on national averages, area types and available data for similar roadways. Local data were used as much as possible in situations where it exists. For example, ATAC performed a test of Bluetooth equipment as a data collection device for traffic volumes and travel times over several days on the interstate. Data collected in the "uncongested" periods (midnight till 5 AM) were used to develop free flow speeds for the interstate segments.

3.3 Socioeconomic/TAZ Data

ATAC received socioeconomic data that has been populated by the FM Metro COG. ATAC is confident that the FM Metro COG does an excellent job in populating these data using the best possible information available. ATAC however performs some random as well as specific checks during the calibration and validation of the model for significant trip generators such as hospitals, large malls, schools, and universities to verify that their input data is accurate.

The following TAZs have discrepancies that need to be verified by FM Metro COG. These discrepancies include TAZs that showed a significant drop in number of jobs from 2005 to 2010.

Table 3.2 TAZs with significant/unexplained drop in Jobs between 2005 and 2010

TAZ	TAZ Description	2005	2010	Difference
		Total Jobs	Total Jobs	
59	Industrial Zone north of 12th Ave N	4,613	2,945	-1,668
60	NDSU	5,137	332	-4,805
61		425	1,163	738

For the 2010 base year model, the most significant TAZ structure changes occurred in the downtown Fargo area. It was discovered during the NP & 1st Ave N Study that the TAZ structure in the downtown area was inadequate to correctly model travel. In addition, a few other TAZs were split/redrawn. The criteria used to split/redraw TAZs were intended to preserve/promote TAZ socioeconomic data homogeneity, reduce TAZ boundaries cutting across man-made/natural barriers to travel, and splitting of TAZs that were too large or otherwise heterogeneous.

3.4 Capacity Calculations

Link capacities represent transportation supply and the amount of vehicle traffic that each link can physically accommodate per unit of time. These capacities physically constrain the assignment step of the model and are critical in estimating the amount of traffic that each link will carry. The capacity determines the amount of congestion on a link, which is defined by the volume-to-capacity ratio (v/c), and the resulting delay on the link caused by congestions. The HCM 2010 [1] has standardized techniques for computing capacity calculations based on the network attributes. Link attributes such as traffic signals, signal spacing, presence of on street parking, driveways, and driver population complicate capacity calculations. The HCM technique requires a lot of data input. Locations where all these variables/data are not available, assumptions were made and used to estimate link capacities.

For the F-M 2010 model, capacities were calculated based on the links functional classification, the number of lanes for through, left, and right turn movements, and the area type. The previously stated data were provided by the F-M Metro COG.

3.4.1 Signalized Intersections

For signalized intersections, the signal timing data were used in the estimation of delays at areas that would possibly experience heavy congestions, i.e. 45th St S and 13th Ave S in Fargo. For certain intersections in the Cities of Moorhead, West Fargo, and Dilworth, signal timing was unavailable. Therefore, as stated earlier in sub-section *2.1.4*, reasonable assumptions were made based on data provided by nearby intersections based on functional class and land use.

3.4.2 Unsignalized Intersections

For unsignalized intersections, data were provided from an existing 2010 two-way and all-way stop file by the Advanced Traffic Analysis Center (ATAC). This file was then updated by utilizing Synchro files of busy corridors in the F-M area from 2009 to 2010. Roundabouts were also placed with respect to the 2010 fiscal year.

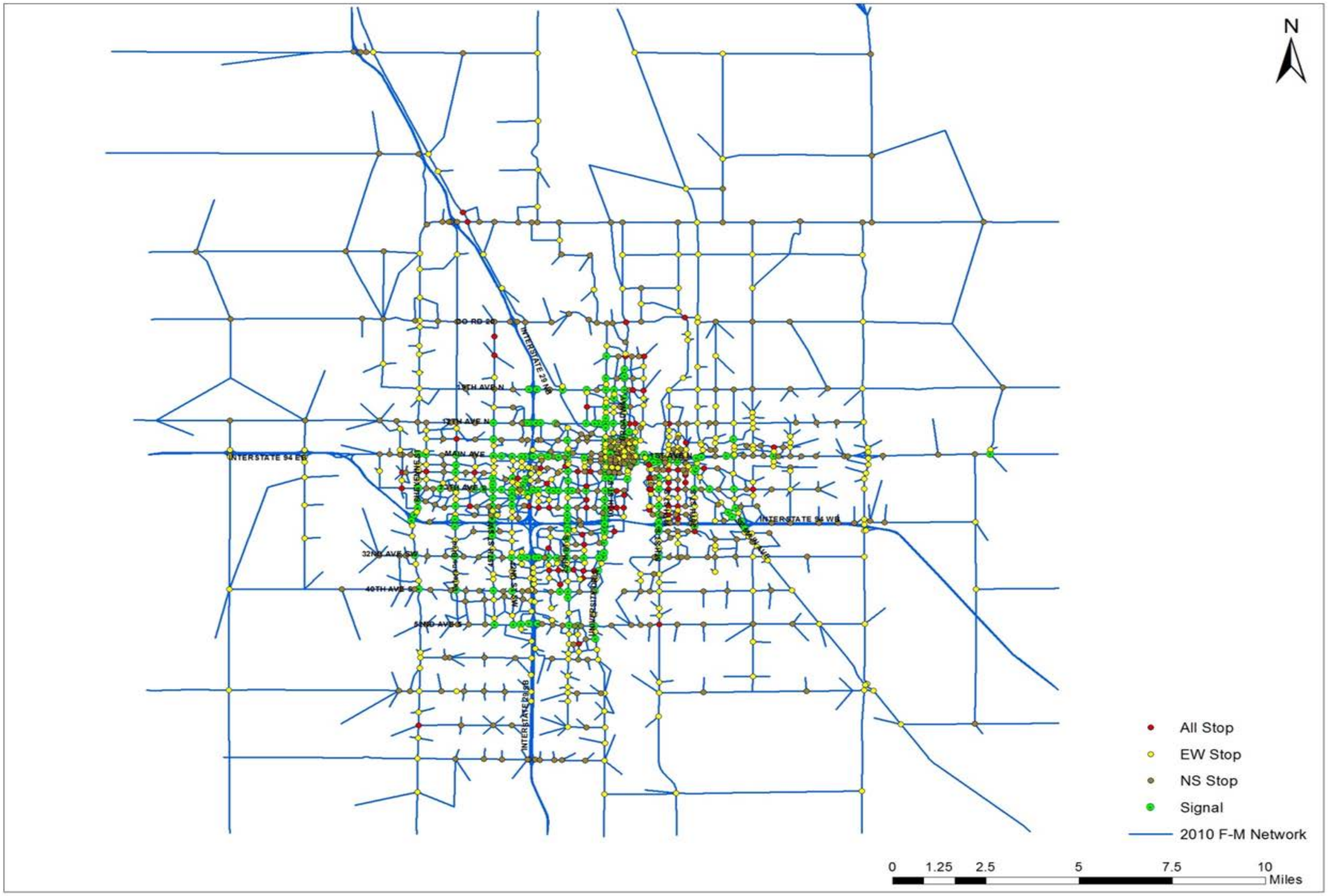

Figure 3.2 Modeled Intersections

Figure 3.2 shows the different type of intersections coded in the junction file provided by ATAC and further updated with Synchro intersection timing data. These were then ran for AM, PM, and Off Peak scenarios with data for each of the three, respectively.

3.5 TAZ Geographic Database

The F-M 2010 TDM has a total of 624 TAZs. TAZs 1-599 are internal TAZs, TAZs 600 to 624 are for the external zones. The TAZ file is GIS shapefile that also contains the socioeconomic data attributes. Figure 3-3 shows the TAZ data that was used for the model.

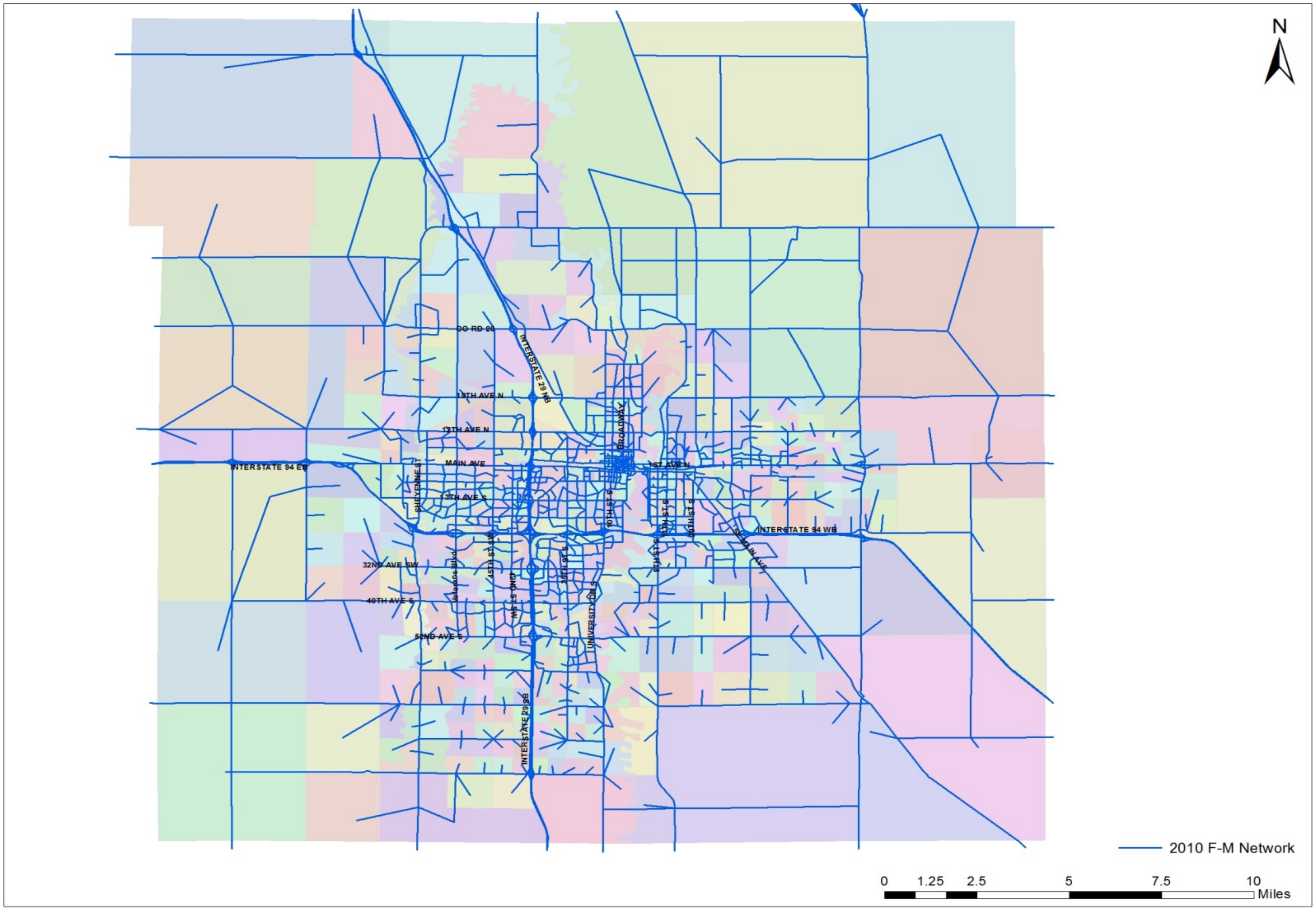

Figure 3-3 Transportation Analysis Zones F-M 2010 TDM

4.0 TRIP GENERATION

4.1 Introduction

Trip generation is the first computational step of travel demand models. It estimates the amount of trips produced by and attracted to each Transportation Analysis Zone (TAZ). These trips are a function of the socioeconomic and demographic data for each TAZ. The trip generation model has three components: trip production, trip attraction, and trip balancing for equating total trip productions and attraction.

4.1.1 Trip Purposes

Six trip purposes as described below were developed for the F-M TDM.

1. Home based work (HBW) : Trips starting at home and ending at work
2. Home based other (HBO): Trips starting at home and ending at non-work locations. For the 2010 model, HBO and HB-Shopping factors were originally provided. However, these two purposes were combined in the trip distribution step.
3. Non-home based (NHB): Trips neither starting/ending from/at home.
4. School trips K-12 (SCH): Trips starting either from or to grade schools.
5. University trips: Trips either ending or starting at North Dakota State University, Minnesota State University of Moorhead, Concordia College, or Minnesota State Community & Technical College.
6. External-External (EE), Internal-External (IE), External-Internal (EI).

4.2 Trip Productions

Trip productions relate to the number of trips that originate from each TAZ for each purpose in the study area. Trip production equations were applied to socioeconomic and demographic data to develop trip generation rates.

4.2.1 Internal Production Trips

Productions are associated with home based trips. Socioeconomic data provided by FM Metro COG was used to obtain household size for each TAZ. Trip production rates from the FM Metro COG O-D

Survey [3] were used to develop trip production rates for the HBW, HBO (HBO/HB-Shopping), NHB, and SCH trip purposes. This is a major difference from previous models where national average rates were used. Trip Production rates are show in Table 4.1.

Table 4.1 Vehicle Trip Production Rates - FM Metro COG O-D Survey [3]

	Household size			
TRIP PURPOSE	**1**	**2**	**3**	**4+**
HBW	0.914	1.422	2.327	2.180
HB-SHOPPING	0.193	0.414	0.709	0.801
HBO	0.578	1.058	1.047	2.006

4.2.2 School Trip Productions (K-12)

School trip productions (SCH) were calculated based on FM Metro COG O-D Survey [3]. Table 4.2 shows the rates that were applied to household demographic data for the FM Metro COG TDM. The rates for elementary and middle schools are the same since the survey only has one set of numbers for grade schools and one set for high schools.

Table 4.2 School Trip (K-12) Production Rates- FM Metro COG O-D Survey [3]

	Household size			
School	**1**	**2**	**3**	**4+**
Elementary	0.004	0.003	0.312	0.232
Middle	0.004	0.003	0.312	0.232
High	0.000	0.000	0.155	0.180

4.2.3 University Trips- NDSU, MSUM, Concordia College, and MSCTC

Since universities do not fall under normal trip patterns, special trip generations were given to NDSU, MSUM, Concordia College, and MSCTC for their respective students. MSCTC was not included in the university trip generations for previous models. The FM Metro COG O-D survey did not produce statistically significant trip generation rates for universities and rates that were previously developed were used for the 2010 model. Trip productions for the four colleges' and universities' students were divided into two main components: trip productions for students who live on campus and trip productions for students who live off campus.

For on campus trip generation, trip production rates were obtained from a study that was conducted by the Advanced Traffic Analysis Center in 2000 [11]. The rates are summarized in Table 4.3. NDSU occupies three TAZs for the main campus, MSUM occupies four TAZs, and Concordia College occupies five out of the 624 total TAZs. MSCTC does not have any dormitories or residences on campus.

Table 4.3 University Trip Production Rates Fargo-Moorhead [11]

Trip Purpose	Rate	Population Category
HBW Productions	0.16	On-Campus Students
HBO Productions	0.37	On-Campus Students
NHB Productions	0.17	Total Students
HBS Productions	0.12	On-Campus Students
HBW Attractions	0.30	Total Students
HBO Attractions	0.44	Total Students
NHB Attractions	0.17	Total Students
HBS Attractions	0.72	Off-Campus Students

4.2.4 External-External and External-Internal trips

Any trip that had at least one trip end outside of the F-M metropolitan planning area was considered an external trip. Internal-External (IE) trips are produced in the planning area and end in the exterior, External-Internal (EI) originate from outside of the planning area and terminate in the planning area, and External-External (EE) are trips that do not stop in the planning area. Twenty-five external stations were used for the model, external centroids 600 to 624.

EI trip generations were calculated as an equal proportion of the difference between the External-External (EE) trips and the productions and attractions of the external trips by purpose. The equal proportion is fifty percent of the average daily traffic (ADT) will start from outside the planning area and end in the planning area. The difference is then multiplied by the external-internal ratio by purpose. The ratio for HBW, HBO, and NHB for EI trips were: 0.320, 0.321, and 0.359, respectively. EE trip ratios were developed from a Bluetooth study of external stations that was performed by ATAC.

4.2.5 Trip Production Summary

After applying the various trip production rates to the demographic data, the total trip productions listed in Table 4.4 were obtained.

Table 4.4 Trip Production Summary

Trip Purpose	Production Totals	2010 % Trips
HBW	139,599	22.56%
HBO	101,997	16.49%
HB-SHOPPING	37,887	6.12%
NHB	301,632	48.76%
ELEMENTARY	15,027	2.43%
MIDDLE	3,110	0.50%
HIGH	14,104	2.28%
E-E	5,306	0.86%
Total	**618,662**	**100.00%**

4.3 Trip Attractions

Trip attractions are the number of trips attracted to each TAZ based on the type of employment and the employment intensity for that TAZ. Trip attractions were developed for internal and external trip attractions.

4.3.1 Internal Trip Attraction Rates

Trip attractions were adopted from NCHRP 716 for home-base work, home-base shopping, home-base other, and non-home based trip purposes. These rates were applied to the number of jobs for each TAZ. For home-base shopping trips, only the retail category was considered whereas home-base other trips implemented factors from the service and basic sectors.

K-12 school trip attraction rates were based on the Institute of Transportation Engineers (ITE) Trip Generation Manual 7th Edition. This was done to better reflect trip making behavior for K-12 schools. Table 4.5 is a summary of the rates by trip purposes and by variables. These rates were multiplied by the enrollment for each type of school. Furthermore, elementary and middle schools were multiplied by a ratio based upon the enrollment of either elementary or middle school to the sum of both. It was found that elementary enrollment made up roughly 70.5 percent whereas middle school enrollment made up 29.5 percent. Employment and enrollment data for the base 2010 year were provided by the F-M MPO.

Table 4.5 Trip Attraction Rates (From NCHRP 716 Table 4.4 and ITE Trip Generation Manual)

Trip Purpose	Variable	Attraction Rate
Home-Base Work Attractions	Total Employment	1.2
Home-Base Other Attractions	Households	1.2
	Retail Employment	8.1
	Service Employment	1.5
	Other Employment	0.2
Non-Home-Based Attractions	Households	0.6
	Retail Employment	4.7
	Service Employment	1.4
	Other Employment	0.5
Home-Based School Attractions	Home Based Elementary School	1.88
	Home Based Mid School	1.88
	Home Based High School	1.88

4.3.2 External Trip Attractions

Both EE and EI trip attractions were computed similar to EE ad IE production rates mentioned earlier. They were calculated as a function of the counted ADTs at each external location. Table 4.6 shows the trip proportions as a total of the external station counts each for home-base work (HBW), home-base other (HBO), and non-home-base (NHB) trips respectively. These proportions were averaged from the FM Metro COG O-D Survey [3] and from the NCHRP Report 716 [4].

Table 4.6 External-Internal Attraction Rates

	Trip Purpose		
	HBW	**HBO**	**NHB**
E-I	33.10%	27.56%	39.33%

4.3.3 University Student Trip Attractions

The number of campus residence halls/dorms and their respective capacities per TAZ were used to compute trip attractions to campus. Home based university (HBU) trips were computed based on a 2000 study done by the Advanced Traffic Analysis Center [11] rates. Trip attractions for college and university students were added to the Home-Base Other trip totals.

4.3.4 Trip Attraction Summary

Table 4.7 shows the total trips attracted after trip attraction rates are applied to the socioeconomic data by trip type.

Table 4.7 Trip Attraction Totals

Trip Purpose	Attraction Totals	2010 % Trips
HBW	147,305	18.31%
HBO	165,429	20.56%
HB-SHOPPING	170,427	21.18%
NHB	283,794	35.28%
ELEMENTARY	15,027	1.87%
MIDDLE	3,110	0.39%
HIGH	14,104	1.75%
E-E	5,306	0.66%
Total	**804,502**	**100.00%**

4.4 Special Generators

Special generators are facilities whose trip generations are not captured by trip generation parameters. These include: hospitals, airports, malls, and military bases etc. For the 2010 model, trips generated for these facilities with the potential of a special generator designation were checked against adjacent roadway traffic count. These facilities were identified prior to the trip generation step. This process was performed in order to verify if regular trip generation rates suffice for these facilities or whether they need to be designated as special generators trip rates based on the Trip Generation Manual [5]. After reviewing the model output, it was not necessary to develop special trip generation rates.

4.5 Balancing Trip productions and attractions

Applying the methodology and equations described in the previous sections to the TAZ socioeconomic data yields unbalanced production and attraction totals. In the travel demand model, each production must be matched to an attraction to form a round trip. Therefore, the total productions must equal the total attractions for each trip type.

Trip attractions for HBW and HBO were balanced to their productions while NHB and school trip productions were balanced to attractions to produce a balanced trip production as shown in Table 4.8.

Table 4.8 Balanced Trip Productions and Attraction Totals

Trip Purpose	Production Totals	Attraction Totals
HBW	139,599	139,599
HBO	101,997	101,997
HB-SHOPPING	37,887	37,887
NHB	301,632	301,632
ELEMENTARY	15,027	15,027
MIDDLE	3,110	3,110
HIGH	14,104	14,104
E-E	5,306	5,306
Total	**618,662**	**618,662**

5.0 TRIP DISTRIBUTION

The trip distribution module produced an O-D trip matrix which pairs the trips generated from each TAZ to their respective destination TAZs within the study area. The gravity model, which assumes that trips are directly proportional to the magnitude of trips generated in each TAZ and inversely proportional to the cost of travel between two TAZs, was used for the trip distribution module. Friction factors (FF) and K-factors are the two main parameters that affect the gravity model and are discussed briefly below. Equation 5.1 shows the gravity model formulation that was used for the model.

$$T_{ij} = P_i \frac{K_{ij} A_j F_{ij}}{\sum_{j=1}^{n}(K_j A_j F_j)} \qquad \text{Equation 5.1}$$

T_{ij} = Number of trips assigned between Zones i and j;

P_i = Number of Productions in Zone i;

A_j = Number of Attractions in Zone j;

F_{ij} = Friction Factor; and

K_{ij} = Scaling factor used in calibration to influence specific ij pairs

n = Number of zones in the network

5.1 Friction Factor Computation and Calibration

Friction Factor (FF) is the main independent variable in gravity models and expresses the effect travel cost (travel time) has on the number of trip exchanges between two TAZs. The gamma function was used to estimate the parameters for the FF table that was used for the 2010 model update. NCHRP Report 716 [4] and the Travel Model Validation and Reasonableness Checking Manual [6] publish ranges for gamma parameters to be used in trip distribution. For the 2010 model, gamma parameters for medium sized MPOs (populations of 200,000 to 500,000) were used as a starting point in contrast to gamma parameters for small MPO that were used for the previous model updates. Figure 5.1 summarizes the results utilized for medium-sized MPOs in the TDM. It shows longer average trip lengths for Home-Based-Work trips, as expected.

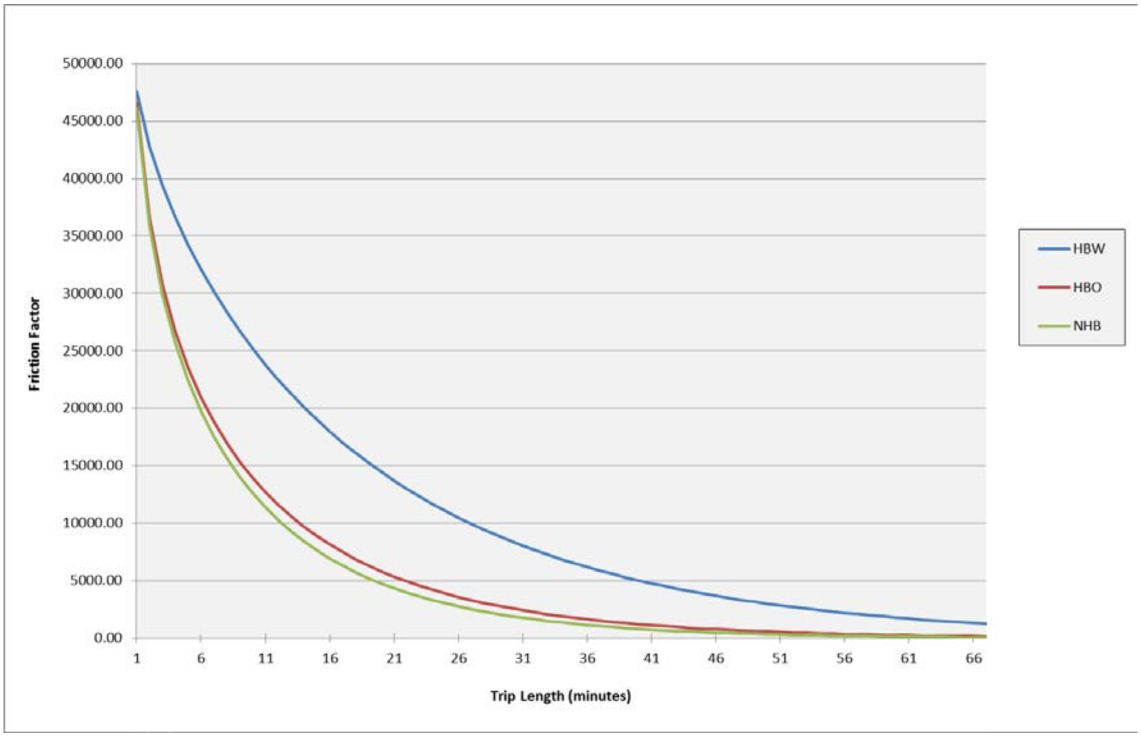

Fig 5.1 Friction Factors for HBW, HBO, and NHB Trips

5.2 K (Socioeconomic) Factor Adjustment

These are socioeconomic variables that are typically used to improve the match between modeled and observed trip distribution patterns. They are typically applied across screenlines. In the previous model updates, K-factors were adjusted in order to match screenline crossings between modeled and counted ADTs. For the 2010 model, ATAC will not only attempt to match screenline crossings but will also attempt to match O-D patterns generated from the 2010 O-D survey [3]. Screenlines were established at the following boundaries: I-94, I-29, railroads, and the Red River of the North.

5.3 Hourly Origin-Destination Calculations

While performing the Interstate Operations Study for the FM Metro COG [7], ATAC discovered that the 2005 model underestimated AM and PM peak trips. ATAC will review the hourly O-D trips and analyze hourly count data (loop count data) from various sources throughout the modeling area/national sources to develop base 2010 AM and PM peak O-Ds. These data will also be evaluated to determine if only three trip matrices should be developed (AM, PM, and Off-peak) or whether a midday trip table should be added.

For the purpose of this 2010 model update, NCHRP Report 716 [4] was used to develop peak hour factors. The respective peak hour factors were used to create three O-D trip matrices – AM, PM, and Off-peak. The peak hour factors are as follow:

1. **AM Peak**, 7:00 AM to 9:00 AM, **18.00%** of ADT.
2. **PM Peak**, 3:30 PM to 5:30 PM, **16.83%** of ADT.
3. **Off Peak**, 5.0%/hr/14*hrs. =**65.17%** of ADT.

6.0 TRIP ASSIGNMENT

The trip assignment module assigns traffic on the roadway network links. Several trip assignment methods exist in the planning literature. All these methods assign trips as a function of the following:

- O-D trip matrix,
- The probability of using a link on the path between given O-D pair,
- The volume on the link, and;
- The cost of using that link

The most commonly used formulation is the Bureau of Public Roads (BPR) formulation which assigns traffic on the roadway network based on the free flow travel time on the link, assigned volume on the link, capacity of the link, and BPR alpha and beta parameters. This formulation ensures that the cost of traveling on a link increases as the assigned volume to capacity on that link increases. The formulation when used in Cube assumes a Wardrop's User Equilibrium which states that users of the system choose the route that would minimize their travel cost without consideration to the overall system costs.

Although it is the most widely used assignment cost formulation in the planning literature, it has some drawbacks. The drawbacks are related to its sensitivity (or lack thereof) at extreme volume to capacity (v/c) ratios. At high v/c ratios, small change in volumes results in huge changes in travel cost. On the other hand, at low v/c ratios, large change in volume results in small change in travel cost, which does not impact route choice significantly. Additionally, the formulation allows for v/c values greater than 1.0 which in reality is not practical, although an acceptable practice in TDM world.

Further, ATAC tested other formulations such as the conical delay functions [8]; logit based delay functions, stochastic formulations and determined that a stochastic method best fit travel demand and pattern in the FM area.

For model reliability, it was critical to accurately reflect all the network attributes that are used in the trip assignment cost function. The most critical of these attributes are discussed below.

1. BPR parameters and other formulation parameters: BPR parameters and other parameters for the different volume delay functions affect the travel cost on each link. ATAC calibrated these parameters based on the state-of-the-art (e.g. HCM 2010 [1], NCHRP Report 716 [4]) and best practices.
2. Network capacities: Over/underestimating link capacities affects the assigned traffic volumes during the trip assignment step of the model. Capacities were calculated as a function of the roads functional class, the number of lanes (through and turn lanes) and the area type (capacities reduced by 10% in CBD) for the previous model updates. The previous models updates have used capacity at Level of Service (LOS) C. However, NCHRP 716 [4] suggests the use of capacity at LOS E as the ultimate capacity. ATAC will evaluate which LOS, C or E better represents the transportation supply for the FM metropolitan area and use that accordingly.
3. Free Flow Speeds (FFS), node delays, and junction data were discussed previously in Chapter 2. The output from the trip assignment step is assigned volumes on the network which are the main data used for calibrating and validating the model.

7.0 MODEL CALIBRATION

Model calibration refers to the adjustment of model input parameters in order to replicate observed real world data for a base year or otherwise produce more reasonable results [6]. It involves adjusting model input parameters such as trip generation rates, node delays, free flow speeds, K-factors, friction factors, etc. The goals of ATAC were to have very little influence on these factors and the fact that more local data is available will help reduce the amount of calibration that was required. Figure 7.1 shows the calibration flow chart that was used for the 2010 model update.

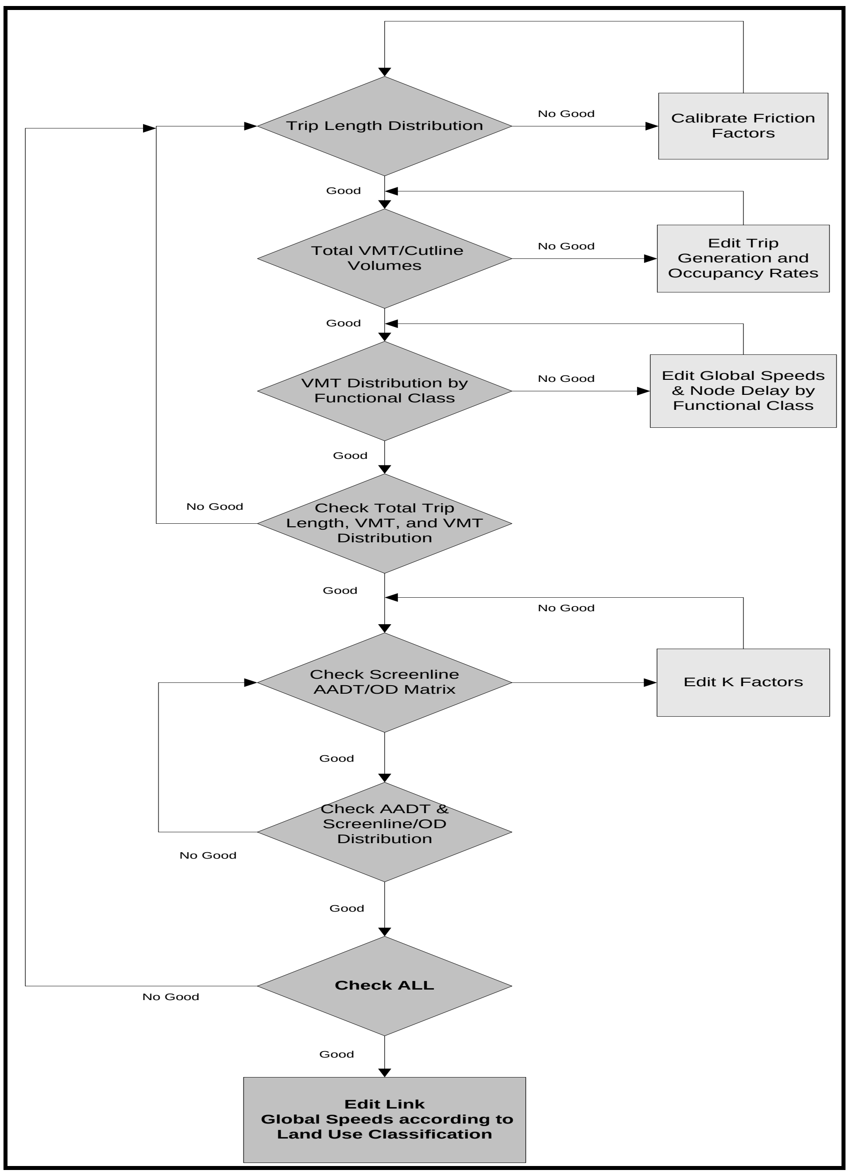

Figure 7.1 FM Metro COG 2010 TDM Calibration Flow Chart

7.1 Trip Generation Calibration

Trip generation rates were adjusted based on their physical location in the study area. During the calibration process it was found that TAZs in the Southwestern area of the model (South of I-94 and West of I-29), TAZs in Minnesota and TAZs in the downtown Fargo area were generating lower number of trips than expected. Trip productions in these areas were thus increased by 30% and 20% for the first two areas and for the downtown area respectively. These adjustments produced modeled VMTs that were within an acceptable deviation from observed VMTS.

7.2 Trip Distribution Calibration

Trip distribution calibration involved adjusting K-factors and the friction factor curve. The friction factor curve has been described previously. K-factors were adjusted across screenlines so that trips crossing those screenlines were close to observed counts. In Table 7.1, the following K-factors were used to adjust movements across the four screenlines: Red River, I-94, I-29, and Railroad. The factors were implemented by purpose and by directional boundaries. Additionally, it should be noted that I-29 is the only screenline that has variances to the K-factors based on direction, i.e. HBW I-29 east (E) has a factor of 1.5 whereas HBW I-29 west (W) has a factor of 1.0.

Table 7.1 K-factor Adjustments

Screenline	K-factor	Screenline	K-factor	Screenline	K-factor	Screenline	K-factor
Red River		**I-94**		**I-29**		**Railroad**	
HBW K RIVER WEST	0.3	HBW K 94 N	1.0	HBW K 29 E	1.5	HBW K RR NORTH	0.5
HBW K RIVER EAST	0.3	HBW K 94 N	1.0	HBW K 29 W	1.0	HBW K RR SOUTH	0.5
HBO K RIVER WEST	0.3	HBO K 94 N	1.0	HBO K 29 E	1.5	HBO K RR NORTH	0.5
HBO K RIVER EAST	0.3	HBO K 94 N	1.0	HBO K 29 W	1.0	HBO K RR SOUTH	0.5
NHB K RIVER WEST	0.3	NHB K 94 NORTH	1.25	NHB K 29 EAST	1.5	NHB K RR NORTH	0.5
NHB K RIVER EAST	0.3	NHB K 94 SOUTH	1.25	NHB K 29 WEST	1.15	NHB K RR SOUTH	0.5

8.0 MODEL VALIDATION

Model validation applies base year calibrated models by comparing the results to observed data. Ideally, model estimation and calibration data should not be used for validation but this is not always feasible. The two processes, calibration and validation, typically go hand in hand in an iterative process as shown Figure 8.1 from [6].

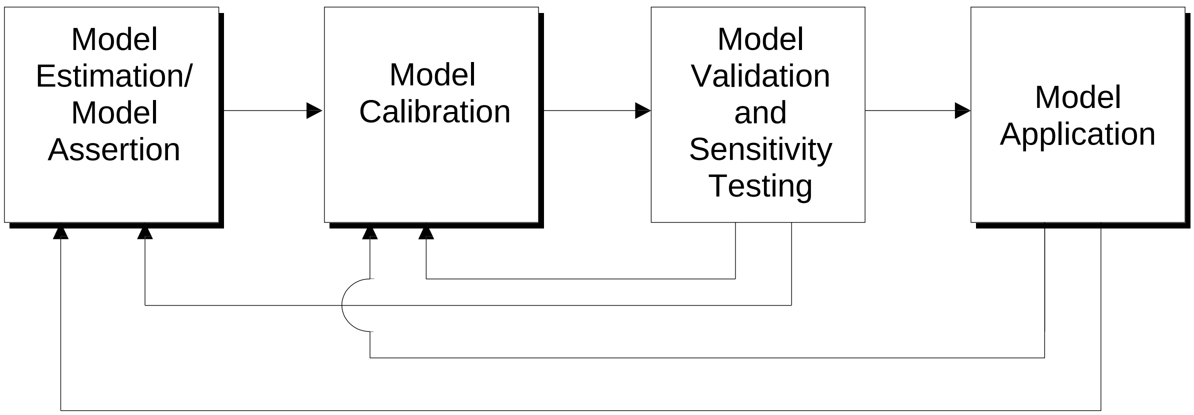

Figure 8.1 Overview of Model Development and Application Process

For the 2010 model update, three new validation procedures were added. The final validation process thus included:

- Validating the network characteristics using Cube,
- Trip generation validation for cordon lines and TAZs with homogeneous land use socioeconomic characteristics,
- Validation of trip distribution O-D trip matrix using data from the FM Metro COG O-D Survey [3], using local data from the FM Metro COG to validate trip length distribution, and;
- Sensitivity testing of model parameters and model input data.

Table 8.1 shows the different validation tests that were performed for the FM Metro COG 2010 TDM for the different model components.

Table 8.1 FM Metro COG 2010 TDM Validation Tests

Model Component	Validation Test
Network/TAZ	1. Spot check link distances in Cube 2. Network geometry: check using aerial photos, TIP, data provided by jurisdiction, and other online data sources 3. Intersection controls: use aerial photos, signal timing data/intersection control data and other online data sources 4. Functional class: use data provided by FM Metro COG, color code network to make sure it matches functional classification data provided 5. 2010 ADTs: Compare with previous ADTs and verify any huge changes 6. Network connectivity: Validate using build network feature in Cube
Socioeconomic data	1. Spot check major trip generators such as NDSU, hospitals, malls, etc. for significant discrepancies.
Trip Generation	1. Compare trip rates to similar areas 2. Check traffic counts on cordons/areas with homogeneous land use variables 3. Compare trip production and attraction totals and ensure the difference meets preset threshold values
Trip Distribution	1. Compare trip length distribution with data from FM Metro COG O-D Survey 2. Verify that intrazonal trips meet preset criteria 3. Verify External-External trips are reasonable, compare with ATAC Bluetooth study 4. Compare O-D trip matrix to FM Metro COG O-D Survey
Time of Day Models	1. Compare with loop count data
Traffic Assignment	1. Compare modeled ADTs with observed vehicle counts 2. Compare modeled screenline ADTs with observed screenline counts 3. Compare modeled VMTs to observed VMTs 4. Root mean square comparison to preset threshold values by volume range 5. Generate scatter plots, and coefficient of determination R^2 to ensure it meets preset threshold value 6. Free Flow Speeds vs. congested speeds, check with any available speed studies
Sensitivity Analysis	1. Reallocate socioeconomic data and check response of model 2. Delete major links on network and verify how model responds

8.1 Trip Length Distribution

The first step in the calibration process was to check if the modeled vehicle trips lengths were similar to observed trip lengths. In general, shorter trips tend to occur more frequently compared to longer trips and that was observed in the F-M model and can be seen in the Figure 8.2. If the model did not represent observed trip length distribution data, friction factors were adjusted until the model replicated as closely as possible to this data (Figure 8.3). Average trip lengths were 15.63 minutes, 14.32 minutes, and 13.13 minutes for HBW, HBO, and NHB trips respectively in Figure 8.2.

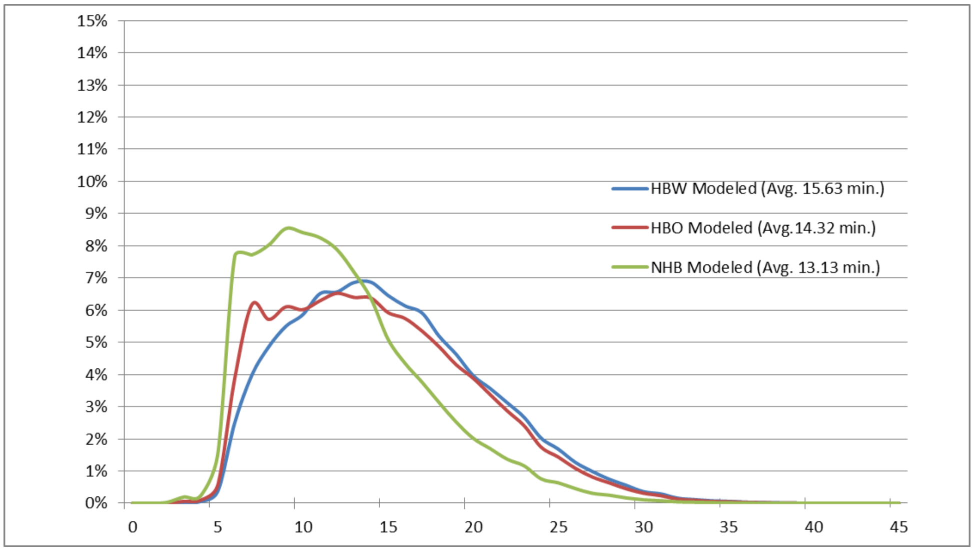

Figure 8.2 Modeled Trip Length Distributions by Trip Purpose

Figure 8.3 shows the comparison of the modeled trip lengths to the observed trip lengths for HBW trips with both having average trip lengths of 15.63 and 16.5 minutes, respectively.

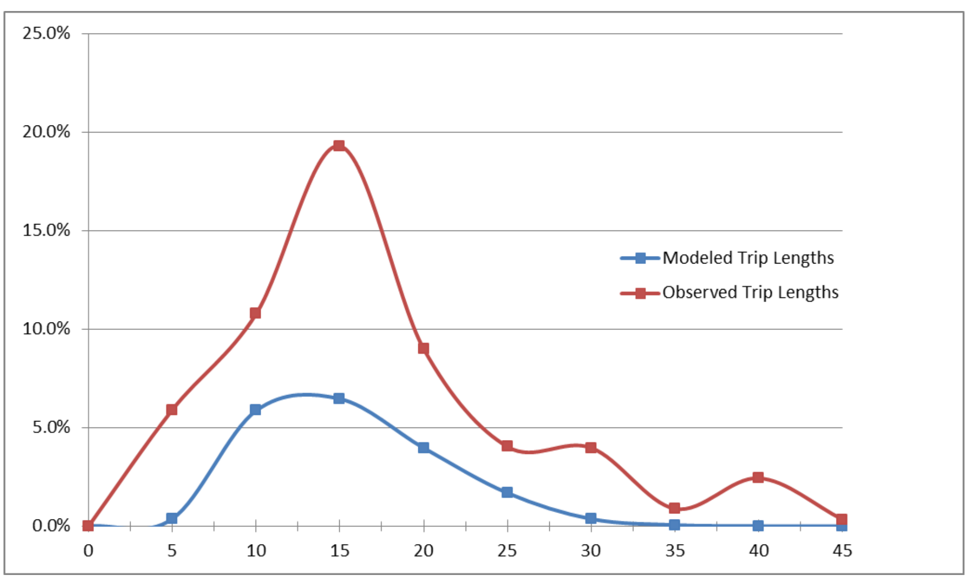

Figure 8.3 Modeled HBW Trip Length Frequency Distributions vs Observed HBW Trip Length

According to the Travel Model Validation and Reasonableness Checking Manual [6], a more rigorous check for validating trip length frequency distributions is calculating the coincidence ratio (CR). Coincidence Ratio measures the percent of the area that coincides for two curves, i.e. between the observed trip lengths and the modeled trip lengths. Equation 7.1 [6] shows the mathematical formulation for calculating the coincidence ratio. A coincidence ratio of 1.0 indicates identical distributions and is desirable while coincidence ratios less than 0.5 are weak and undesirable. The coincidence ratio for the model was 0.62 which shows a strong coincidence between the modeled and observed trip length frequency distributions.

$$CR = \frac{\sum_T [min(PM_T, PO_T)]}{\sum_T [max(PM_T, PO_T)]} \qquad \text{Equation 8.1}$$

Where:

CR = Coincidence Ratio;

PM_T = Proportion of modeled distribution in interval T;

PO_T = Proportion of observed distribution in interval T; and

T = Histogram interval for time, in 5-minute time bins.

8.2 Total Vehicle Miles Traveled (VMT)

The modeled vehicle miles traveled are a function of trips generated by the model and the length of those trips in miles. VMT summaries provide an indication of the overall reasonableness of the travel demand in the study area. To calibrate the VMT values, ATAC first calibrated the total VMT for the entire model area. If the modeled VMT values were different from the values calculated by multiplying the counted ADTs by length (observed VMTs), ATAC adjusted the trip generation and occupancy rates until the modeled and reported VMT values were similar. Adjusting the trip generation and occupancy rates changes the total number of trips that are generated within the transportation model. This in turn increases or decreases the total number of vehicle miles traveled.

Once the total VMT was reasonable, ATAC checked the VMT distribution according to the functional class. VMT summaries by functional classification provide an indication of how well the models assignment procedures perform. They will indicate if the model handles free flow speeds, capacities, or whether the trip assignment function has any issues. To calibrate the VMT by facility type, if functional class VMT distribution was off target, global speeds by facility type were adjusted.

Table 8.2 provides a summary of the final modeled and reported VMT values by functional class. Collectors and local roads had the biggest difference between observed and modeled VMTs. Overall, the difference between modeled and observed VMTs of -2.0% is low. The result is within the range of generally acceptable differences in VMTs of ±5%.

Table 8.2 VMT Validation Summary by Functional Class

Facility Type	VMT		Error		Distribution	
	Observed	Estimated	Difference	Percent	Observed	Estimated
INTERSTATE	513,464	511,025	-2,439	0.00%	29.87%	29.92%
MAJOR	395,438	415,095	19,657	5.00%	23.00%	24.30%
MINOR	568,035	557,219	-10,816	-2.00%	33.04%	32.62%
COLLECTOR	208,488	195,428	-13,060	-6.00%	12.13%	11.44%
LOCAL	33,756	29,468	-4,288	-13.00%	1.96%	1.73%
TOTAL	**1,719,181**	**1,708,236**	**-10,945**	**-1.00%**	**100.00%**	**100.00%**

8.3 Screenlines

Screenlines are barriers to travel between two areas in a travel demand model including natural barriers such as rivers, mountains, etc. and man-made barriers such as interstates and major arterials, railroads, etc. Four screenlines were used for the model: railroads, the Red River, I-94, and I-29. Table 8.3 lists the screenlines that were used in the F-M model. Railroad percent difference is especially high due to the fact that the screenline relies on links connecting to the actual crossing. This can be inaccurate since these candidates are located at an intersection and not all the traffic is crossing the screenline. Based on Travel Model Validation and Reasonableness Checking Manual, not all values fall within stated approved limits. The obvious flaw here is in the I-29 screenline.

Table 8.3 Screenline Comparisons

Screenline	Counted Volume	Modeled ADT	Difference	Percent Difference
Red River	118,525	125,880	7,355	6.2%
I-94	189,665	192,630	2,965	1.6%
I-29	165,450	179,530	14,080	8.5%
Railroad	150,020	142,160	-7,860	-5.2%

8.4 Comparison of Modeled ADTs with Counted ADTs

A comparison of modeled traffic volumes to observed traffic counts was performed to verify how well the model represented these counts. Table 8.4 shows that 75.47% of the modeled links met the FHWA criteria for model validation.

Table 8.4 Model Volumes by Traffic Volume Range

Volume Range	Above Criteria	Meets Criteria	Below Criteria	Within Criteria
ADT>25,000	2	17	0	89.47%
25,000 to 10,000	30	119	26	68.00%
10,000 to 5,000	31	102	52	55.14%
5,000 to 2,500	20	160	24	78.43%
2,500 to 1,000	13	141	0	91.56%
ADT<1000	12	107	0	89.92%
Total	**108**	**646**	**102**	**75.47% (Average)**

Table 8.5 shows the comparison of the modeled volumes and observed traffic by functional class. The deviation ranged from 69.64% for major arterials to 88.24% for the freeways.

Table 8.5 Model Volumes by Functional Class

Volume Range	Above Criteria	Meets Criteria	Below Criteria	Within Criteria
Freeway	2	30	2	88.24%
Major Arterials	19	78	15	69.64%
Minor Arterials	48	285	56	73.26%
Collector	30	198	21	79.52%
Local Roads	9	55	8	76.39%
Total	**108**	**646**	**102**	**75.47% (Average)**

8.5 Root Mean Squared Error and Percent Root Mean Squared Error

Although the comparison between modeled and counted ADTs gives a good indication of the performance of the model, they do not provide a goodness of fit test to the model. Root Mean Squared Error (RMSE) and Percent Root Mean Squared Errors (%RMSE) were used to calculate the accuracy of the model. RMSE compares the error between the modeled and observed traffic volumes for the entire network, giving a statistical measure of the accuracy of the model. RMSE and

%RMSE were found by squaring the error (difference between modeled and counted ADTs) for each link and then taking the square root of the averages as shown in Equation 8.2.

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N}[(Count_i - Model_i)^2]}{N}}$$

and Equation 8.2

$$\%RMSE = \left[\frac{RMSE}{\sum_{i=1}^{N} Count_i / N}\right] * 100$$

$Count_i$ = Observed traffic count on link *i;*

$Model_i$ = Modeled traffic volume for link *i;* and

N = The number of links in the group of links including link *i, (number of links with counts)*

Table 8.6 shows the %RMSE by volume range. The %RMSE meet typical deviation limits for the following volume ranges: 5,000 to 2,500, 2,500 to 1,000, and AADT < 1,000, indicating a good fit between the modeled and observed traffic. However, AADT > 5,000 yields RMSE percentages lower than the typical limits.

Table 8.6 Model Assignment by Modeled Traffic Volume Range

Volume Range	RMSE (%)	Typical Limits (%)
AADT>25,000	9.67%	15-20%
25,000 to 10,000	19.72%	25-30%
10,000 to 5,000	32.96%	35-45%
5,000 to 2,500	53.49%	45-100%
2,500 to 1,000	66.76%	45-100%
AADT<1000	343.60%	>100%

8.6 Scatter Plots and R-Square of Modeled Versus Observed Volumes

Scatter plots of the modeled traffic volumes against the observed traffic volumes are a good indicator of the model's fit. Figure 8.4 shows the scatter plot of modeled traffic volumes versus observed counts. The scatter plot suggests that the amount of error in the modeled volumes is proportional to the observed traffic count which is an indication of a good fit between the model and the observed traffic counts.

R-square (coefficient of determination) is the proportion of the variance in a dependent variable that is attributable to the variance of the independent variable. They typically measure the strength of the relationships between the assigned volumes and the traffic counts. It measures the amount of variation in traffic counts explained by the model. The modeled R-square of 0.8996 shows a considerably strong linear relationship between modeled and observed traffic counts.

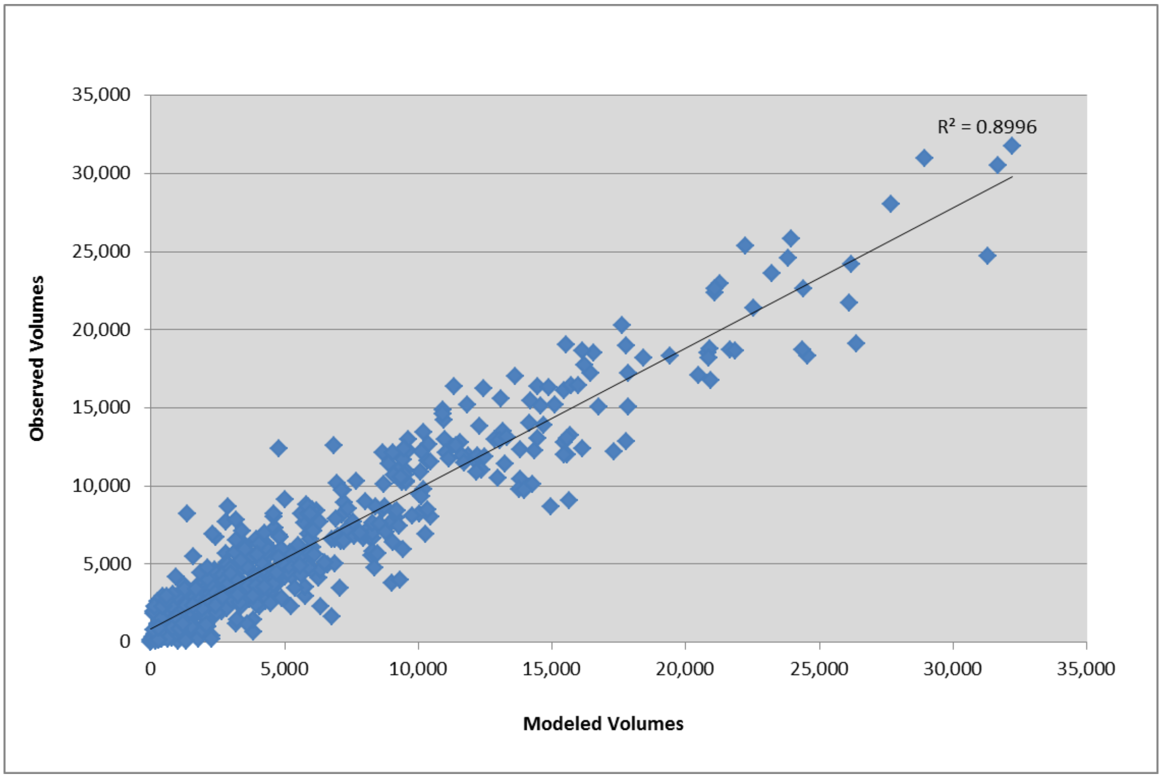

Figure 8.4 Scatterplot of Modeled Versus Observed Traffic Counts

9.0 IDENTIFIED MODELED DEFICIENCIES

A few corridors/areas were identified to have overall different modeled ADTs from the counted ADTs:

1. 42nd St S from 32nd Ave S to 17th Ave SW: its proximity to 45th St and the interstate implied the model was deficient in sending enough trips due to the attractiveness of the adjacent streets.
2. Area south of 32nd Ave S, East of I-94 and East of 18th St S and N of 40th Ave S: these TAZs generate lower trips even after their trip rates were increased by 30%.

3. Great Northern Drive has significantly higher assigned trips than counted ADTs. TAZ 98 which loads a significant proportion of trips using this corridor is generating a substantial number of trips.

10.0 MODEL OUTPUT AND CAPABILITIES

In the past, the modeling process involved the FM Metro COG requesting TDM model runs and ATAC providing the results. ATAC was not involved with how the model output was being used and what the FM Metro COG's future transportation performance objectives were. It is imperative that performance measures be communicated to ATAC so the model can be geared towards providing objectives and useable output, within the model's capability, that will provide forecasts for these measures.

Like all TDM, the FM Metro COG TDM has several key output and performance measures that can be used to evaluate proposed transportation supply changes, different planning scenarios and impacts of new development. These outputs provide technical information that should help guide and support decision-making. The following are the outputs from the model:

1. Trip generation output by trip type
2. Origin-Destination trip matrices (provided upon request)
3. Average trip length summary by trip purpose
4. Traffic assignment for each link on network
5. Turning movements summary of turning movements for each intersection (turn movements are not calibrated and should be further analyzed using actual turn movement counts)
6. Level of Service (to be determined by FM Metro COG)
7. VMT – total vehicle miles traveled comparison between modeled years and individual scenarios (VMT per capita, HH, VMT by functional class)
8. VHT – total vehicle hours traveled comparison between modeled years and individual scenarios (will be provided during scenario analysis)
9. VHD – Vehicle hours of delay
10. Screenline volumes

11. Subarea analysis – more refined by assigning traffic for a specific subarea. Subarea is recalibrated using more refined data such as peak hour counts and turning movements.
12. Select link analysis – tool that looks at a single point or points on the road network (the select link) and shows where the traffic from that link came from (origin) and where the traffic is heading (destination).
13. External trips summary – could be used to compare external growth rates and impact of external traffic
14. Possibility of developing air quality conformity analysis

10.1 Network Output Additional Attribute Fields

In addition to the network attribute fields listed in the Table 3.1, the following attributes are included in the loaded network:

Table 10.1 Loaded Output Network Field Descriptions

Attribute Field Name	**Description**
HOURCAP	Hourly Link Capacity
TOTAL_VOL	Modeled Volumes
TOTAL_CAP	Daily Link Capacity
TOTAL_VC	Daily Volume to Capacity (V/C) Ratio
DIFF	Difference between Modeled and Counted volumes
MODEL_ADT	Rounded Modeled Volumes
ADJ_VC	Adjusted V/C Ratios to account for difference between Modeled and Counted volumes
CORR_ADT	Corrected Modeled Volumes to account for differences between Modeled and Counted volumes
DISTRICT	State in which road is found according to the following code: 1-MN 2-ND

11.0 MODEL POST PROCESSING

It is a known fact that TDM assigned volumes may deviate from observed counts for several reasons. Post processing TDM model output is an important step that needs to be carried out especially for future traffic volume predictions. It is safe to assume that the deficiencies that caused the model to over/underestimate traffic in the base year for a particular link will exist in future forecasts. For the 2005 model, no post processing method was used per FM Metro COG's request. This resulted in several issues especially with forecasted traffic on several corridors. ATAC has identified a post processing technique based on NCHRP 255 [9].

The method ATAC intends to use is based on the degree of deviation between observed and modeled traffic volumes for the 2010 base year. Relative and absolute correction factors were calculated for each link with a traffic count. Relative correction factors are calculated by dividing the counted volumes by the assigned volumes. Absolute correction factors are the differences between the counted and assigned volumes. If the deviation is less than 20%, then the difference between the observed and modeled traffic volumes is simply applied to forecasted modeled traffic. If the deviation is greater than 20%, then the relative correction factor were applied to the future modeled volumes.

12.0 BEYOND 2010 AND FUTURE OF FM METRO COG TDM

ATAC, as a research entity at North Dakota State University, is committed to innovation and upgrading the FM Metro COG TDM to reflect the state-of-the-art in TDM. Lack of resources is the main obstacle since small improvements in TDM may require significant cost investment. There are two approaches in TDM that ATAC intends to explore for future model updates: Dynamic Traffic Assignment (DTA) and Activity Based Models.

DTA models bridge the gap between regional models and microscopic simulation models (which look at each driver). They are a network route assignment technique which are time-dependent and model drivers' route selection in a dynamic manner (i.e. route selection can change between or even within time periods), resulting in a more realistic model output. DTA models are implemented in areas with significant levels of congestion and typically affect peak hour traffic assignment.

Significant enhancements and data collection were required to implement a DTA model to validate the model. These are mainly related to temporal data collection such as peak hour speeds, and peak hour O-Ds etc. ATAC has in the past developed a DTA evacuation model [10] for the FM metro area. There has been a shift from a supply-oriented focus of transportation planning to include transportation management to address the issues of increasing transportation demand using available transportation supply. Four step planning models are not adequate to answer some of the questions that transportation management strategies seek to answer such as mixed land use development, congestion pricing, and parking pricing. Activity based models present a more realistic approach to travel demand that recognizes and seeks to explain the complex interactions involved in travel behavior, and hence answer some of the transportation management strategic questions.

Activity based models emphasize activity participation; focus on sequences of activity behavior usually over a full day, and better address temporal transportation supply deficiencies by examining how people modify their activity participations. These models require significantly more detail data at the spatial level and temporal network capacity data. The FM Metro COG has already conducted an O-D Survey which could be used as a starting point for an activity based model.

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