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Grand Forks/East Grand Forks Travel Model Update

Technical Report

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Prepared for:
Grand Forks/East Grand Forks
Metropolitan Council of Governments

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1.0 INTRODUCTION

This report documents the process of updating the Grand Forks-East Grand Forks regional travel demand model. The update consisted of three major components, including: 1) software upgrade, 2) base-year update, and 3) calibration. Therefore, this report is intended to serve as a technical reference which describes each of these components in great detail.

This work, which began in May of 2005, was completed by the Advanced Traffic Analysis Center (ATAC) at North Dakota State University under a contract with the Grand Forks-East Grand Forks Metropolitan Planning Organization (GF/EGF MPO). The GF/EGF MPO provided ATAC with much of the necessary data, guided the development of the model structure, and reviewed the model calibration.

1.1 Background

There were two main motivations to the GF/EGF regional travel demand model update. The first was to update network and socioeconomic data from the year 2000 (previous model base-year) to 2005 data. The second motivation was to upgrade the software system used in implementing the model (TRANPLAN) in order to take advantage of added functionality in newer modeling software.

The previous GF/EGF regional travel model was developed in 2000 and follows conventional 4-step models, i.e., trip generation, trip distribution, modal split, and traffic assignment. The GF/EGF wanted to update the base-year to reflect 2005 conditions in preparation for a new long-range transportation plan.

The previous model was implemented using Citilab's TRANPLAN software, a widely used software system in the 1980s and 1990s. Today, TRANPLAN is among the older software systems used for travel modeling and it has several limitations. These limitations include limited number of analysis zones, limited user functionality, and little or no interface to GIS. Several software upgrades have been developed by Citilabs to address these limitations. A new algorithm, TP+, that implements the 4-step process was developed as part of a comprehensive software suite, now called CUBE. TP+ offers more advanced capabilities and allows for easy integration of future model enhancements.

1.2 Report Organization

This document is intended as a technical resource that provides detailed information on the GF/EGF model update. In addition to this introduction chapter, the remaining chapters may be described as follows:

> *Chapter 2. Model Conversion to TP+*: describes the steps undertaken in converting the previous GF/EGF model from TRANPLAN to TP+. It also provides a comparison of the model output between TRANPLAN and TP+.

Chapter 3. Model Changes and Improvements: provides a summary of changes to the TRANPLAN model and a list of improvements implemented in the TP+ model.

Chapter 4. Model Calibration: identifies the methodology used for calibrating the revised model to 2005 data and shows the results of the calibration.

Chapter 5. Summary: provides concluding comments on the updated model.

2.0 MODEL CONVERSION TO TP+

This chapter describes the steps completed in order to convert the GF/EGF model from TRANPLAN to TP+ modeling software. It also discusses the results of the conversion, i.e. validating the results of the converted model to the old model. This step was necessary in order to ensure that the new model implemented in TP+ replicated the output produced by the old TRANPLAN model.

2.1 General Model Structure

One of the main differences between TP+ and TRANPLAN is how the user implements the travel model using special scripting language. TP+ provides an application manager, a powerful user interface that graphically shows the different modeling steps and how input and output from each step are linked throughout the processing. Therefore, previous TRANPLAN model scripting language had to be transferred into a compatible scripting format for the application manager in TP+. Although the scripting language in both models is fairly similar, one major difference is that TRANPLAN has more built in scripts while TP+ requires more user involvement in developing appropriate scripts.

It was ATAC's goal to replicate to the possible extent the performance of the year 2000 TRANPLAN model in TP+. This approach would allow easy comparison of the TRANPLAN and TP+ model outputs. The following section will describe the unique characteristics for each of the model 4-steps, trip generation, trip distribution, modal split, and traffic assignment.

2.2 Trip Generation

The trip generation step takes the zonal trip data as input and produces an array of production and attraction values. The values within the array are the number of trips produced within and attracted to each Traffic Analysis Zone (TAZ).

The conversion of the script from TRANPLAN to TP+ for the trip generation step was fairly straight forward. Trip generation equations for home-based work (HBW), home-based other (HBO), non-home based (NHB), elementary school, middle school, and high school trips were converted into TP+ scripting language. Results from TRANPLAN and TP+ using the 2000 socioeconomic data were identical. The trip rates for each purpose are multiplied by the associated variable to calculate the number of trips produced by or attracted to each TAZ. For example, HBW production are equal to (2.6*Single Family Household) + (1.17*Multi-Family Household) + (0.142*HBW internal/external trips). This same approach can be used to determine the productions and attractions for other trip purposes.

2.3 Trip Distribution

The trip distribution step is performed using the *Gravity Model* in order to match the productions and attractions for each zonal pair in order to define a trip. The gravity model assigns trips based on the number of productions, attractions, a friction factor, and a *k* factor. The friction factor is a value that is inversely proportional to distance, time, or cost, which measures the impedance between the zonal pairs. *k* is a scaling factor that is used during calibration to limit or increases the traffic volume that crosses a sections of the network.

Two separate distributions are conducted, one for HBW, HBO and NHB trips, and another one for school trips. There were slight differences between TRANPLAN and TP+ trip distribution results which could be attributed to differences in input parameters or internal model calculators. Distribution input parameters were examined in order to determine if they contributed to the differences. Travel time matrix and friction factors were found to be identical. Likewise the trip generation table produced in TP+ was identical to the TRANPLAN table. Finally, *k* factor matrices were also found to be identical. Since the input data to the trip distribution step were not contributing to the discrepancy, it is assumed that software calculation differences or convergence criteria between TRANPLAN and TP+ are the source for these differences.

Figures 1, 2 and 3 show trip distribution differences for non-school trips between TRANPLAN and TP+. The differences are calculated for each origin-destination (OD). About 99% of the OD pair trip distribution differences ranged between 0 and 1 vehicle trips for all three purposes. A small percentage, less than 0.5%, 0.14% and 0.21% for HBO, HBW and NHB respectively had differences greater than or equal to 5 vehicle trips. The differences were thus insignificant and are attributed to different calculations within TRANPLAN and TP+.

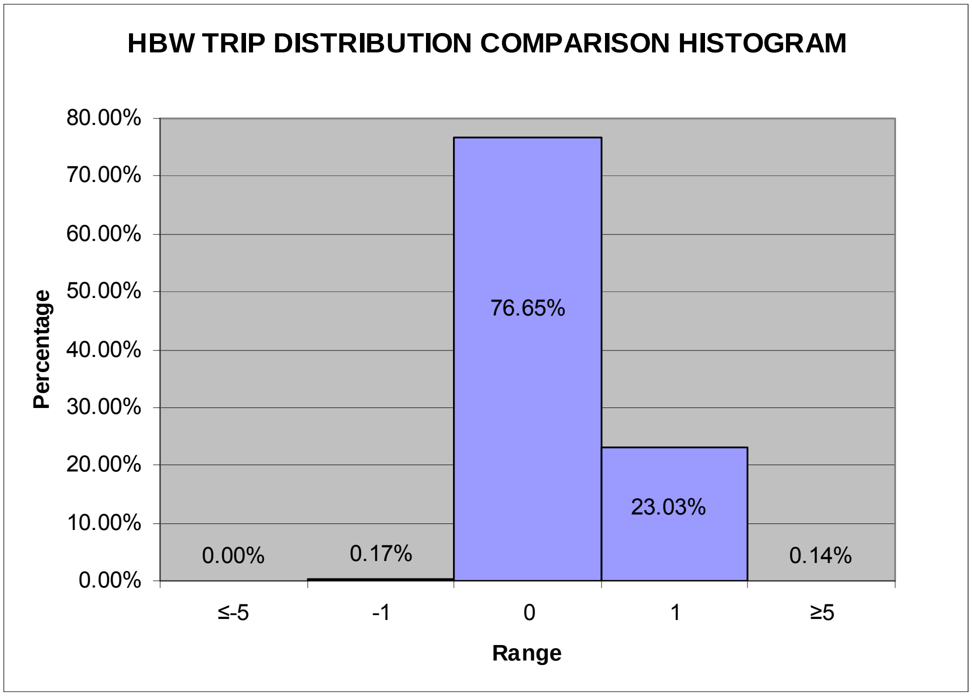

Figure 1 HBW OD Flow Differences (vehicle trips)

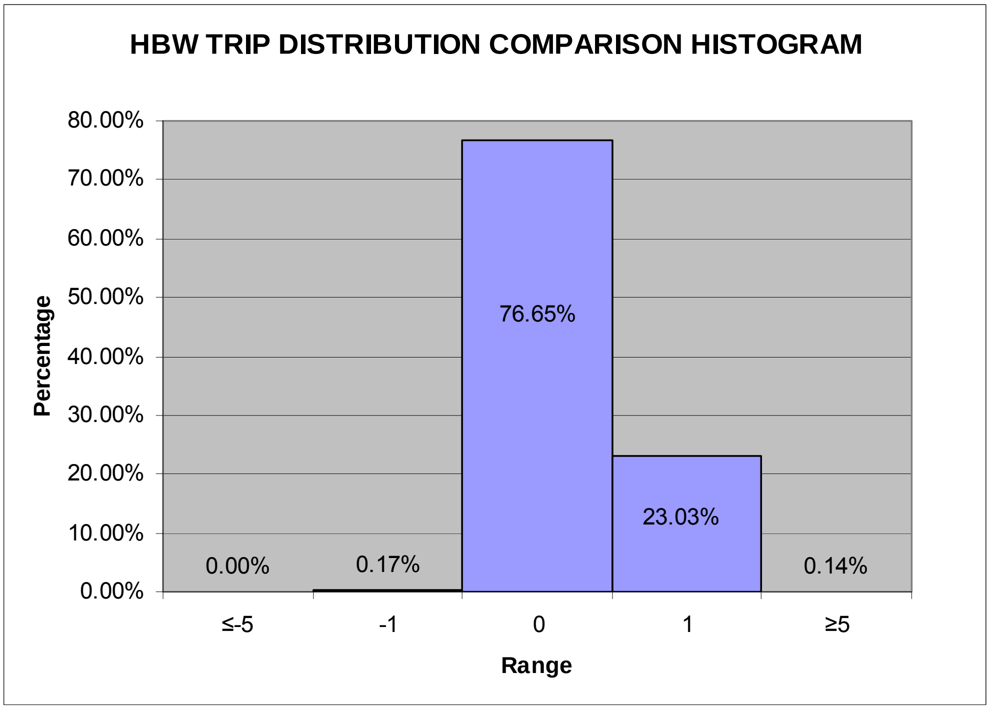

Figure 2 HBO O-D Flow Differences (vehicle trips)

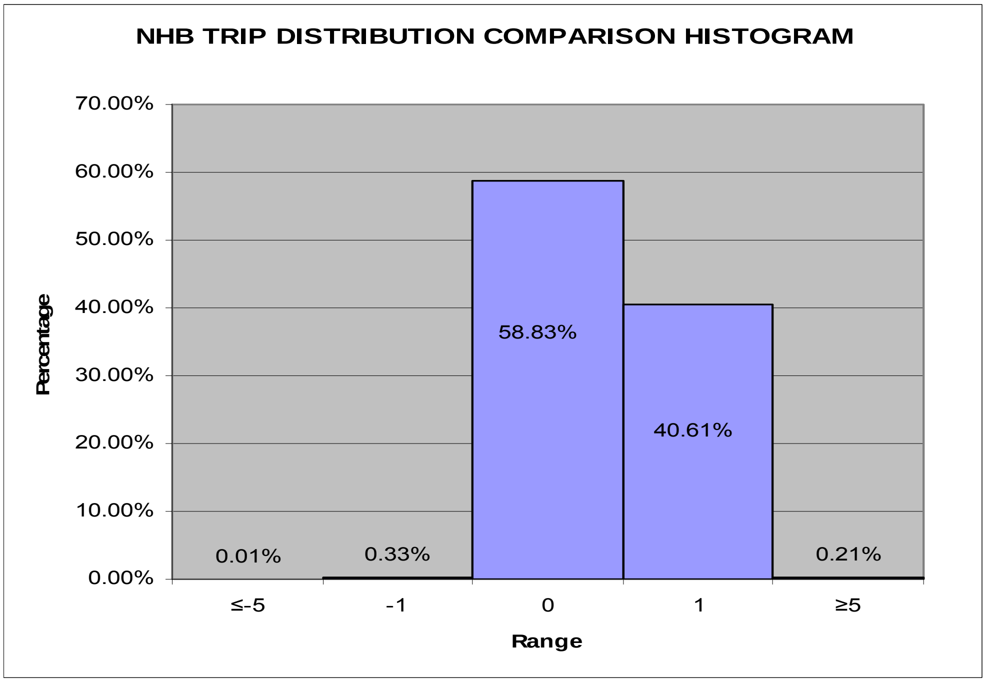

Figure 3 NHB HBW O-D Flow Difference (vehicle trips)

It is important to note that during the trip distribution step for both the TRANPLAN and TP+ model, the University of North Dakota (UND) and the Grand Forks airport were found not to be producing enough trips. The trips from UND and the airport were increased by the following percentages: UND by 26% while the airport trips were increased by 353%.

2.4 Mode Choice

Traditionally during this step, the total model trips are assigned to their respective mode of travel. However, because the area has a low transit ridership and the lack of local travel behavior data, the model assumes all trips are made by automobiles.

2.5 Traffic Assignment

After trip interchanges have been estimated, these trips are converted to traffic flows on network links. The model currently assigns trips based on the user equilibrium method, i.e., users choose routes which minimize impedance measured in travel distance, time, or cost. This is an iterative convergent process that when complete, no traveler can improve their path by changing links.

The first step is to convert vehicle trips calculated so far into hourly increments in order to match the units of measure for roadway capacity (vehicles per hour). Daily trip matrices are therefore used to estimate AM and PM peak hour tables based on the area's hourly traffic behavior. Peak hour split data were determined from an aggregation of the area's turn movement counts. Table 1 shows the AM and PM peak hour factors.

Table 1: Peak Hour Factors

	AM		PM	
Trip Purpose	P-A	A-P	P-A	A-P
HBW	8.31	0.36	1.36	11.32
HBO	3.27	0.26	3.74	5.16
NHB	0.661	0.661	5.703	5.703
HBS-Elementary	46.4	46.4	0.5	0.5
HBS-Middle	49.5	49.5	0.5	0.5
HBS-High	6.2	3.7	5.7	9.3

It is important to note that during this step, external to external trips and Cabela's external trips were added to the model (Cabela's is a regional outdoors store). External to external trips were added by applying factors to an existing daily external to external origin-destination trip table. The external to external trips were split into peak hour trips by applying peak hour percentages from Table 41 in NCHRP Report 365 (1). The temporal external trip factors are as follows,

- AM-Peak (7:00am-8:00am, 2.07%)
- PM-Peak (4:00-5:00 PM, 9.28%)
- Off-Peak (22 hours, 88.65%)

The existing peak hour external Cabela trip matrix was added to each of the respective trip tables. Cabela's trip information relates back to a study that was conducted during the planning stage of the store in Grand Forks and has never been validated.

Next, traffic assignment begins with four separate origin-destination (OD) matrices, AM peak, PM-peak, Off-peak, and daily total, which contain the volumes that are to be assigned to each OD pair. User equilibrium in TP+ uses built in functions in order to assign trips to paths from each origin zone. Travel time was set to the free flow travel time (based on posted speeds) for the first iteration and then changed with iterations depending on congestion. This iterative process continued until there was no available path on which the travel time could be improved.

2.5.1 Comparison of TRANPLAN and TP+ Output

A comparison of output from the two model runs was done to validate the results produced by the TP+ model. Minor differences are, however, expected due to the different calculators between the two programs. The following criteria were used to compare the TP+ and TRANPLAN loaded network output:

- Modeled traffic assignments by functional class to observed ground counts
- Modeled traffic assignments by volume range to observed ground counts
- Scatter plot of observed counts and model assignment
- Screenline volumes and screenline observed counts

2.5.2 Comparison of Model Assignment by Facility Type

A preset criterion by facility type was used to compare traffic assignment between the two models. Table 2 shows the model assignment by facility type for TP+ and TRANPLAN. As shown in the table, the TRANPLAN model was replicated by the TP+ model for each facility type. Overall, the criteria were met by 71% of all links in the TRANPLAN model and by 70.4% in the TP+ model. This indicates that the TRANPLAN model was being satisfactorily replicated by the TP+ model.

Table 2: 2000 Model Assignment Evaluation by Facility Type

Facility	# Above Criteria		# Withing Criteria		# Below Criteria		% Within Criteria	
Type	TP+	TRANPLAN	TP+	TRANPLAN	TP+	TRANPLAN	TP+	TRANPLAN
Freeways	0	0	6	6	0	0	100.0%	100.0%
Major Arterials	4	5	68	68	16	15	77.3%	77.3%
Minor Arterials	6	6	65	66	18	17	73.1%	74.2%
Collectors	10	10	58	60	35	33	56.3%	58.3%
Centroid Connectors	0	0	11	11	1	1	91.7%	91.7%
Ramps	5	5	7	7	0	0	58.3%	58.3%
Local	8	9	77	76	21	21	72.6%	71.4%
Rural	0	0	0	0	1	1	0.0%	0.0%
Rural Unpaved	0	0	5	5	0	0	100.0%	100.0%
Total	33	35	297	299	92	88	70.4%	71.0%

2.5.3 Comparison of Model Assignments by Volume Range

Table 3 below shows that the TP+ model output closely replicated the TRANPLAN in assignments by volume range. Both models also met the North Dakota preset volume deviation criteria for all of the different volume ranges. Overall the preset criteria were met by 70.4% and 71% of all links with counts for the TP+ and TRANPLAN models respectively. Computed values of Root Mean Square Error (RMSE), a measure of the variation between ground counts and modeled volumes, are identical for both models and also meet generally accepted levels for all the volume ranges.

TABLE 3: 2000 Model Assignment by Volume Range

Volume Range	# Above Criteria		# Withing Criteria		# Below Criteria		% Within Criteria			RMSE*	
AADT	TP+	TRANPLAN	TP+	TRANPLAN	TP+	TRANPLAN	TP+	TRANPLAN	ND Criterion	TP+	TRANPLAN
AADT > 50,000	0	0	0	0	0	0	0.0%	0.0%	± 21%	0	0
50,000 - 25,000	0	0	16	16	1	1	94.1%	94.1%	± 22%	0.15	0.61
25,000 - 10,000	3	3	49	49	9	9	80.3%	80.3%	± 25%	0.21	0.21
10,000 - 5,000	5	6	64	64	21	20	71.1%	71.1%	± 29%	0.29	0.29
5,000 - 2,500	9	8	50	53	30	28	56.2%	59.6%	± 36%	0.47	0.47
2,500- 1,000	14	16	58	57	31	30	80.6%	78.1%	± 47%	0.69	0.69
AADT < 1,000	2	2	60	60	0	0	93.8%	96.8%	± 200%	5.86	5.7
Total	33	35	297	299	92	88	70.4%	71.0%			

***RMSE = Root Mean Square Error**

2.5.4 Scatter Plot of Observed Ground Counts vs. Model Assignment.

Scatter plots are used with variable data to study possible relationships between two different variables, in this case between ground counts and model assignments. The scatter plots for the TP+ and TRANPLAN models shown in Figures 4 and 5, respectively, are similar and show that both models closely replicate ground counts. An R^2, the squared correlation coefficient, value of 0.93 for both models shows a strong positive correlation between assigned volumes and ground counts. This is another indication that the TP+ model output strongly replicated the TRANPLAN model.

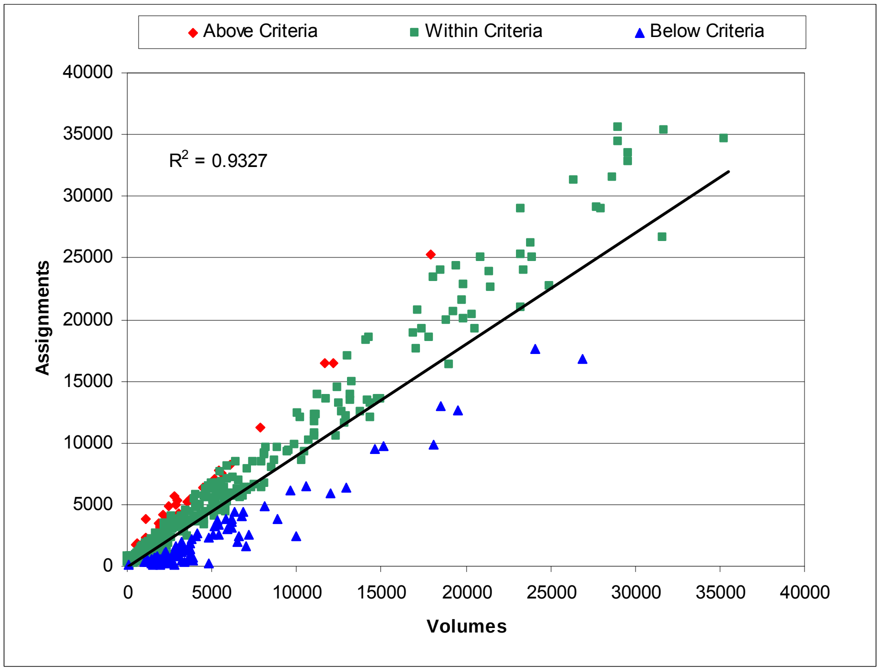

Figure 4 Ground Counts and Modeled Volumes for TP+

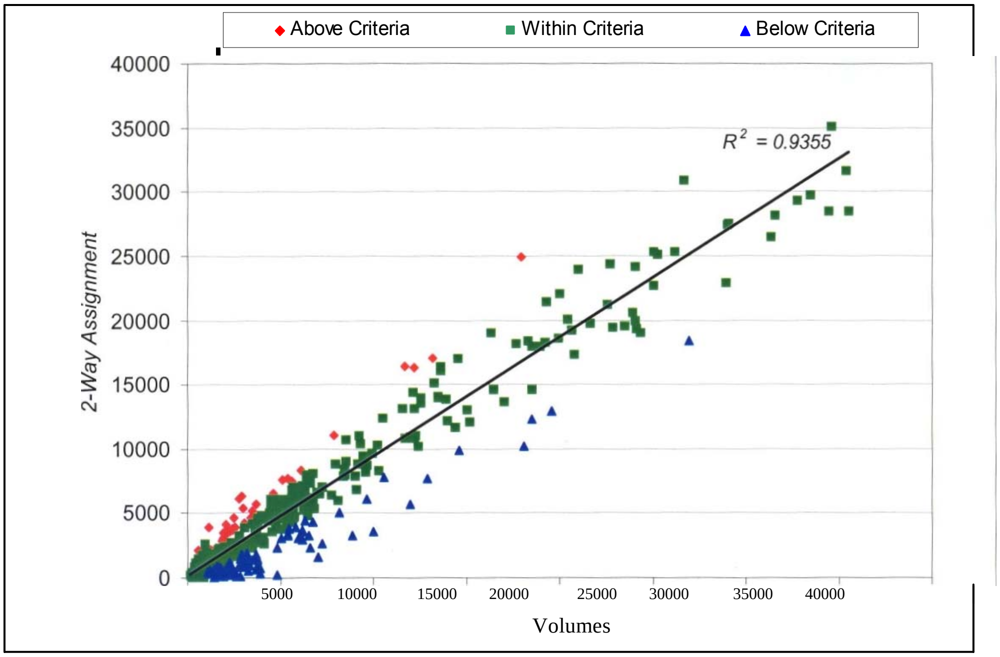

Figure 5 Ground Counts and Modeled Volumes for TRANPLAN

2.5.5 Screenline Comparison

Screenlines are imaginary lines used to assess model validation. They are often associated with physical barriers to travel such as rivers, railroads or bridges. Table 4 below, represents screenline comparisons for the TP+ and TRANPLAN model output. Overall, the TP+ had a 10% difference between assigned volumes and observed ground counts while TRANPLAN had a 9% difference. This is another indication that the TRANPLAN model was successfully replicated by the TP+ model run.

Table 4 Modeled Screenline Volumes and Ground Counts

	Assigned Volumes			% Counted Difference		% Model
SCREEN LINE DESCRIPTION	TP+	TRANPLAN	Counted	TP+	TRANPLAN	Difference*
1.RED RIVER BRIDGES	41,709	42143	39,898	5%	6%	-1%
2.E-W, North of US2	27,527	27,895	32,108	-14%	-13%	-1%
3.BNSF RAIL, GF	92,104	90,934	110,714	-17%	-18%	1%
4.E-W, South of 32nd AVE	33,205	33,071	26,440	26%	25%	0%
5.N-S, West of I-29, GF	35,110	34,917	43,724	-20%	-20%	1%
6.NS-East of Columbia Rd	108,216	113,738	120,156	-10%	-5%	-5%
7.N-S, East of Central AVE	9,297	9,410	9,736	-5%	-3%	-1%
8.E-W,South of US2	7,958	7,960	11,510	-31%	-31%	0%
9.Red Lake River	4,511	4,541	5,700	-21%	-20%	-1%
TOTAL	359,637	364,609	399,986	-10%	-9%	-1%

*** TP+ Assigned Volumes minus TRANPLAN Assigned Volumes**

3.0 MODEL CHANGES AND IMPROVEMENTS

This chapter describes some of the major changes between the TRANPLAN model and the TP+ model implemented to achieve the software conversion. It also discusses some of the improvements implemented during the model update.

3.1 Major Revisions

Due to the differences in TP+ and TRANPLAN model structures, some changes were applied to the TP+ model in order to replicate previous model results. The two most significant changes were the creation of a turn penalty file and the creation of a capacity lookup table.

3.1.1 Turn Penalty File

Turn penalties are used to prohibit certain turning movements. A separate turn penalty file was created and used in the model assignment step for the TP+ model. This is a necessary step that aids the TP+ model to closely replicate the TRANPLAN model, as well as to closely replicate the existing transportation system.

3.1.2 Capacity Lookup Table

Link capacities were incorporated as one of the attributes in the TRANPLAN network. Having capacities directly linked to the network often times creates another mechanism for human errors. To alleviate that chance for error, link capacities were incorporated into the TP+ model through a lookup table. The capacity value is extracted from this lookup table based upon the intersection control and intersection geometry, per documents provided by the GF/EGF MPO (2). This will result in a reduction in human error and will also save time for future network and model updates.

3.2 Model Improvements

In addition to converting the GF/EGF travel model to the TP+ software, several enhancements were adopted through the update process. These enhancements are discussed in the following sections.

3.2.1 Metropolitan Area and Network Data

For the new model, the TAZ structure was revisited from the previous model where some of the old TAZ’s were split and new TAZ’s were also added. The GF/EGF MPO provided ATAC with the new socio-economic data for those TAZ’s. The model now has 570 internal TAZ’s and 14 external TAZ’s, adding up to a total of 584 TAZ’s within the modeled area.

Also, the GF/EGF MPO provided ATAC with the updates and changes introduced to the traffic network for the year 2005. The number of lanes, speeds, and other attributes of the modeled network were updated based on data from the MPO. Traffic count data were also supplied in order to conduct the model calibration.

3.2.2 Trip Distribution Improvement

The TRANPLAN model distributes trips based on free-flow traffic conditions. For the updated model the distribution step takes into account the effects of traffic congestion to better capture the real traffic conditions on the modeled network.

3.2.3 External Trip Growth Rate

The current model factors external-external origin-destination data using the *fratar* model method. The *frater* model applies a growth factor to an existing origin-destination trip table to forecast external-external productions and attractions. To achieve better representation of the external-external trips, ATAC used ground counts at external station locations and applied a percentage of those counts to external-external trips. For forecasting the external trips, an appropriate growth factor can be applied to these base ground counts.

3.2.4 Wal-Mart Trips

A special generator component was incorporated into the model to account for Wal-Mart trips in order to provide a better basis for representing these trips. The values for the parameters used to predict Wal-Mart trips were obtained from ITE’s Trip Generation Manual (3).

3.2.5 Airport and UND Trips

The University of North Dakota (UND) and airport trips are increased during the trip distribution step by applying a multiplier. ATAC developed a special generator for the airport and UND during the trip generation step. For university trips, rates from a study in the Fargo-Moorhead area were used.

4.0 Model Calibration and Validation

This chapter describes in detail the process of calibrating the TP+ GF/EGF travel model to 2005 conditions. The main purpose of the calibration is to ensure that the model produces acceptable results for the base-year for which data are available. Once the calibration is acceptable, the model could be used for forecasting future traffic in the GF/EGF area to support various transportation planning and project development analysis needs.

Calibration is a tedious process that needs to be conducted in a thorough and exacting manner. Although there is no standard process for conducting the calibration, the main approach is to make adjustments to the model in order to replicate known conditions, i.e., traffic ground counts. Additionally, census data on travel time and other characteristics are used when available. Because the latest available Census Transportation Planning Package (CTPP) data are from 2000, more emphasis was placed on calibrating the model to traffic counts collected in 2005. The following flow chart describes the methodology that ATAC followed in the calibration of the GF/EGF model.

4.1 Trip Length Distribution

This step is used to check if the vehicle trips produced by the model are similar in length to the general trends in the modeled area. The 2000 CTPP Journey to Work data were used to get information regarding trip length frequencies for travel times that range from 0 to 40 minutes. Shorter trips tend to occur more frequently than longer trips, and the model needed to represent this trend.

ATAC compared the modeled HBW, HBO, and NHB trip lengths to the 2000 CTPP data. If the modeled trend did not follow the 2000 CTPP data trend, friction factor coefficients were modified until the model resembled, as closely as possible, the 2000 CTPP data. As can be seen from Figure 7, HBO and NHB trips were modeled as 76.2% and 87.4% of the HBW data, respectively. Figure 7 shows the trip purpose and the trip length distribution. The differences between 2005 modeled trip lengths and reported 200 CTPP data may be attributed to enhancements to the GF/EGF transportation network since the census data were collected.

4.2 Total Vehicles Miles Traveled (VMT):

The number of trips generated and the length of those trips plays a major role in determining the VMT. ATAC first calibrated the total VMT for the entire modeled network. If the model values were different than the values produced on the ground, ATAC adjusted the trip generation rates until the model VMT was similar. The final trip rates are shown in Table 7.

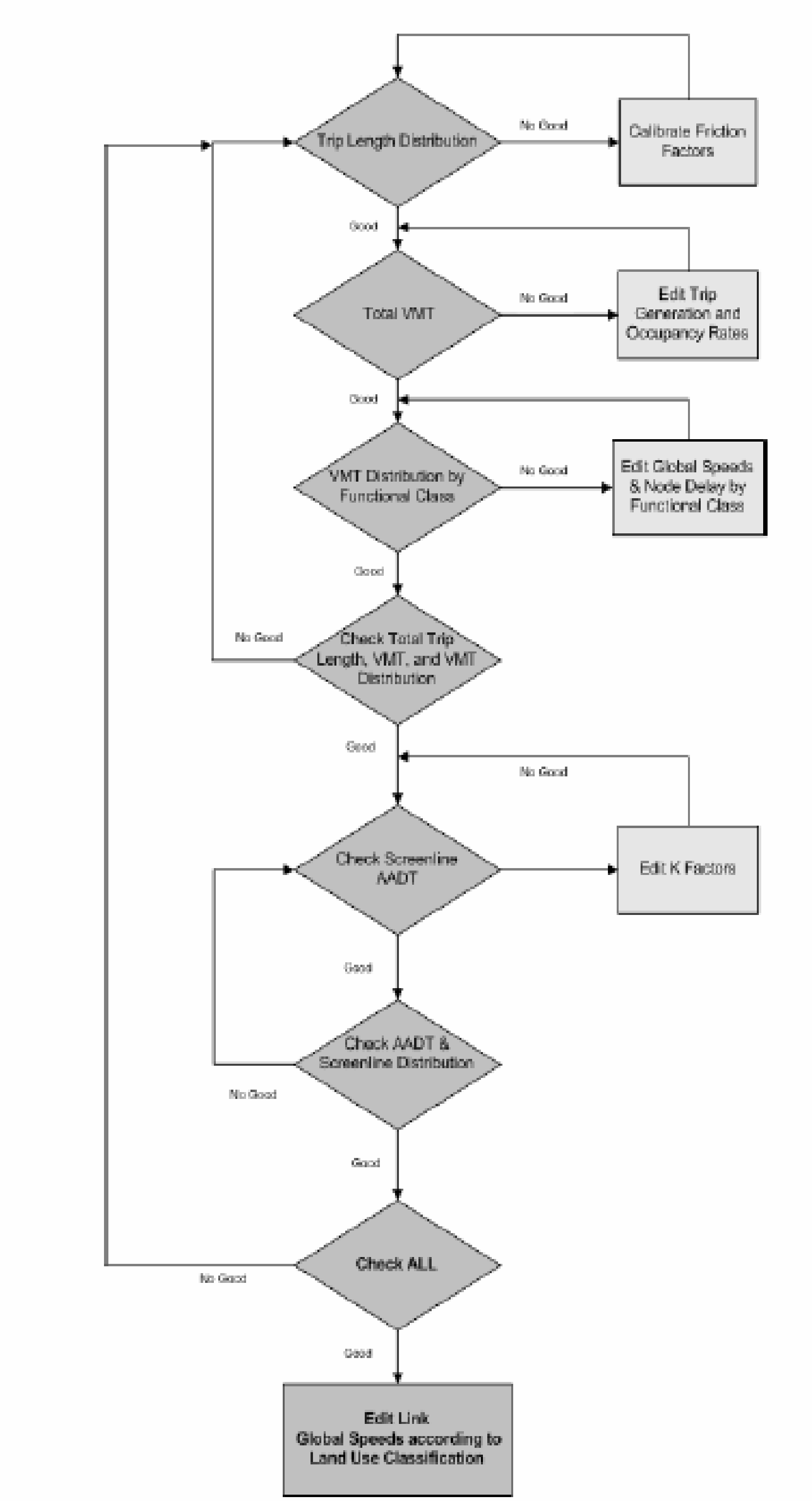

Figure 6 GF/EGF Model Calibration Process

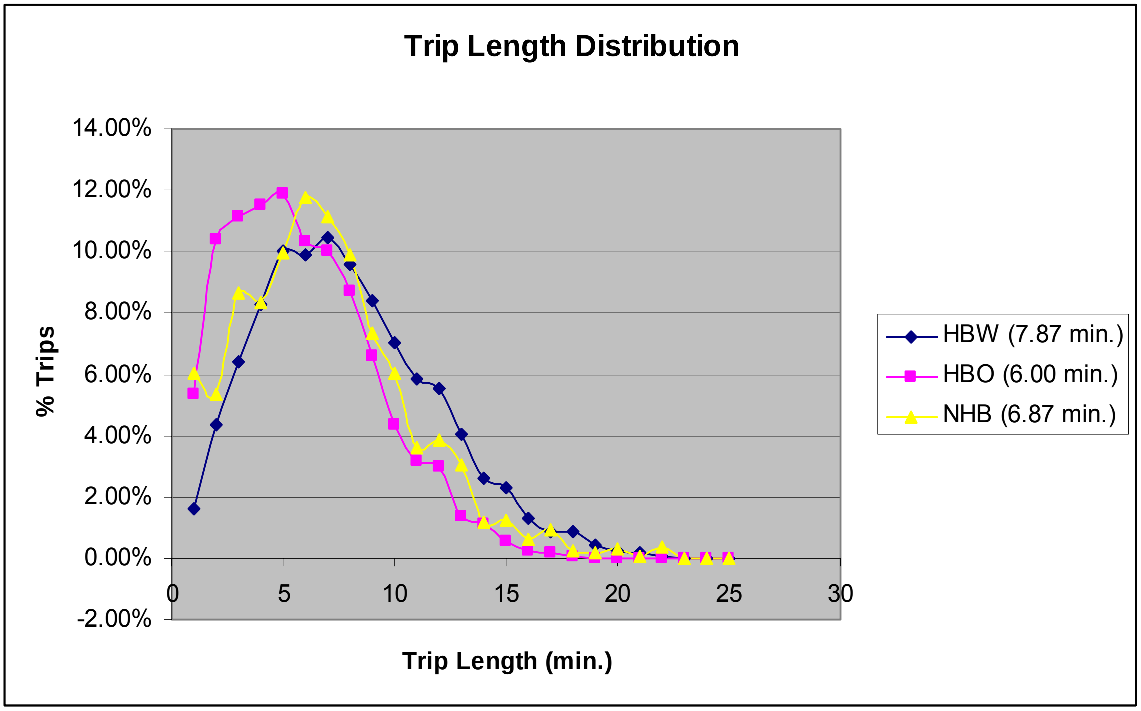

Figure 7 Trip Length Distribution Graph

Adjusting the trip generation and occupancy rates adjusts 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. The overall adjusted VMT was within 1% of the reported VMT. This is well within the standard 5% suggested by Model Validation and Reasonable Checking Manual (4). Table 5 shows the adjusted trip estimation variables, while Table 6 shows the vehicle miles traveled by jurisdiction.

4.3 VMT Distribution by Functional Class:

Once the total VMT was within the criteria, ATAC checked the VMT distribution by functional class. If the functional class distribution was off, global speeds, according to land use characteristics, and node delays were adjusted.

4.4 Screenlines:

One of the important components of calibration is traffic volumes crossing screenlines. First, ATAC checked the total AADT of the links crossing a screenline. If the total volume of vehicles crossing a screenline was above the specified criteria, a lower *k* factor was assigned to those trips. This would inhibit traffic from crossing the screenline. Similarly, if the screenline had a volume below the designated criteria, a higher *k* factor would be applied to affected zones. This would make zonal pairs that cross the screenline more attractive, Table 8 shows the modeled traffic volumes crossing the different screenlines.

Table 5 Adjusted Trip Generation Variables

HBW		HBO		NHB	
SFDU	2.5	SFDU	6.3	SFDU	0.50
MFDU	1.17	MFDU	4.2	MFDU	0.14
HBWIX	0.142	HBOIX	1.05	RETEMP	1.2
				OTHEMP	0.70
				SF_GC	0.3735
				COL	0.1735
				NHBIX	0.4

HBW: Daily Home Based Work Trips
HBO: Daily Home Based Other Trips
NHB: Daily Non-Home Based Trips
SFDU: Single Family Dwelling Units Trips
MFDU: Multi Family Dwelling Units Trips
HBWIX: Home Based Work Internal External Trips
HBOIX: Home Based Other Internal External Trips
RETEMP: Retail Employment Trips
OTHEMP: Other Employment Trips
SF_GC: South Forks Golf Course Trips
COL: Columbia Mall Trips
NHBIX: Non Home Based Internal External Trips

Table 6 Vehicle Miles Traveled by Jurisdiction

Jurisdiction	Vehicle-Miles Reported	Vehicle-Miles Modeled	Differnce in Vehicle-Miles	% Difference
Grand Forks	651,184	681,217	30,033	4.61%
East Grand Forks	115,728	79,174	-36,554	-31.59%
Total	766,912	760,391	-6,5	-0.85%

After achieving an accurate screenline distribution, the calibration process was repeated starting with checking the trip length distribution, until all the successive calibration components were completed. Table 7 shows the *k* factors used in the planning model.

Table 7 HBW Trips *k* Factors

From	To	HBW K-Factor
GF	EGF	0.41
GF	Airport	0.3045
EGF	GF	0.9
EGF	Airport	0.5
EGF	EGF DT	7.0
UND & Mall	Airport	0.07
GF DT	EGF	0.1125
GF DT	EGF DT	0.05
GF DT	Airport	0.9
EGF DT	GF	0.02
EGF DT	GF DT	0.05
EGF DT	Airport	0.5
Airport	GF	0.8
Airport	EGF	3.0
Airport	UND & Mall	0.3
Airport	GF DT	0.8
Airport	EGF DT	0.2

GF: Grand-Forks
EGF: East Grand-Forks
UND: University of North Dakota
Mall: Columbia Mall
Airport: Grand-Forks International Airport

TABLE 8 Modeled Traffic Volumes Crossing the Screenlines

Screenline		Modeled	Counted	Difference	% Difference
1	**Red River Bridges**	39,385	40,450	1,065	2.63%
2	**US 2 North**	22,406	25,520	3,114	12.20%
3	**BNSF Rail**	88,625	85,325	-3,300	-3.87%
4	**S 32nd Ave**	34,058	30,900	-3,158	-10.22%
5	**West of I-29**	42,458	44,200	1,742	3.94%
6	**E Columbia Road**	81,296	70,400	-10,896	-15.48%
7	**E Central Ave**	11,058	9,800	-1,258	-12.84%
8	**S of US2**	6,021	7,950	1,929	24.26%
9	**Red Lake River**	5,730	7,700	1,970	25.58%
Total		331,037	322,245	-8,792	-2.73%

4.5 Network Wide Adjustments

For the final phase of the calibration process, modeled link volumes were compared to links' reported AADT. If a link in a region found to have a highly differing volume, global speeds were adjusted based on land use characteristics. Using an appropriate speed adjustment helps links to fit into the specified criteria range. Table 9 shows the percentage of links that meet each criterion based on volume range.

Table 9 Model Assignment by Traffic Volume Range

Volume Range	Above Criteria	Within Criteria	Below Criteria	%Within Criteria	ND Criteria % deviation
50,000 TO 25,000	0	6	0	100%	± 22%
25,000 TO 10,000	15	56	8	71%	± 25%
10,000 TO 5,000	9	73	18	73%	± 29%
5,000 TO 2,500	29	71	27	56%	± 36%
2,500 TO 1,000	25	74	33	75%	± 47%
AADT<1000	12	78	0	87%	± 60%
Total	90	358	86	67%	

Root Mean Square Error (RMSE) is a measure for determining the overall error for each link. It is found by squaring all of the errors for each link, averaging the values, then taking the square root of the averages. The RMSE by link volume class and typical percentages are shown in the Table 10.

Table 10: RMSE Comparison

Volume Range	RMSE	ND Criteria % deviation
50,000 TO 25,000	13.66	15-20%
25,000 TO 10,000	25.88	25-30%
10,000 TO 5,000	29.29	35-45%
5,000 TO 2,500	45.74	45-100%
2,500 TO 1,000	103.62	45-100%
AADT<1000	193.38	>100%

The correlation of modeled traffic volumes to the counted AADT on the links is an important measure of how well the model is replicating existing traffic conditions. This can be quantified by the coefficient of determination, R^2. Guidance published by the Federal Highway Administration (FHWA) as part of the Travel Model Improvement Program suggests that a region-wide value of R^2 should be equal to at least 0.88. The calibrated GF/EGF model has a correlation factor of 0.89, which meets the FHWA criteria. Figures 8 and 9 show the volume correlation for the base model.

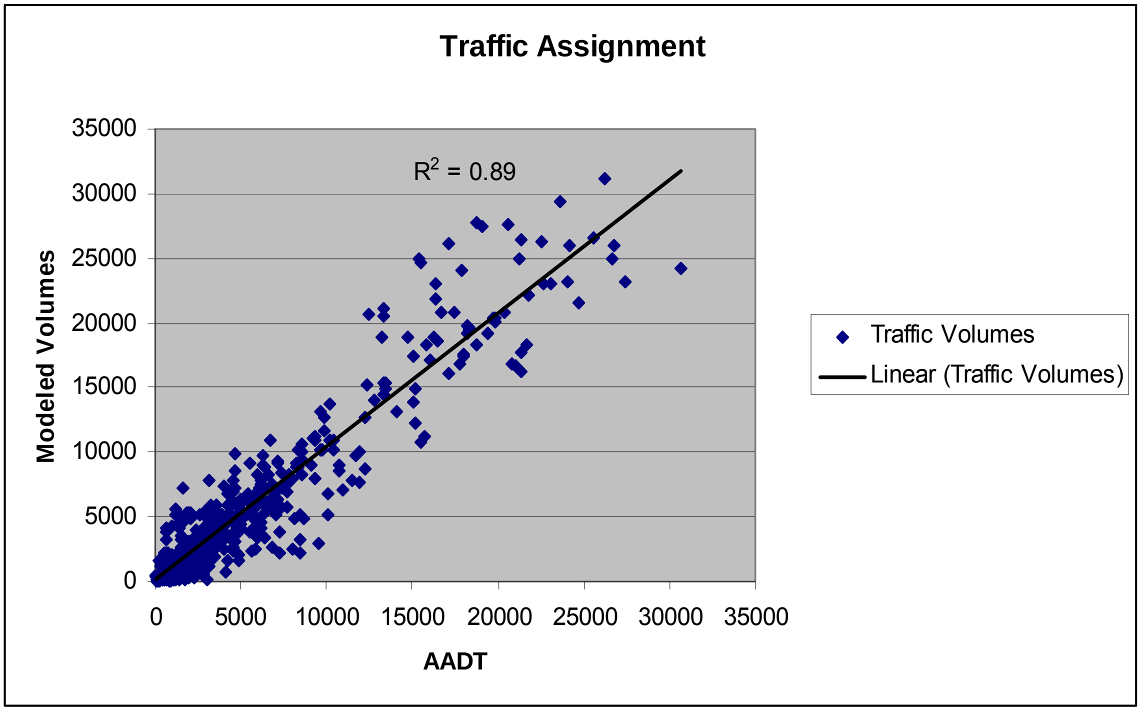

Figure 8 Modeled Volume Correlation with Ground Counts

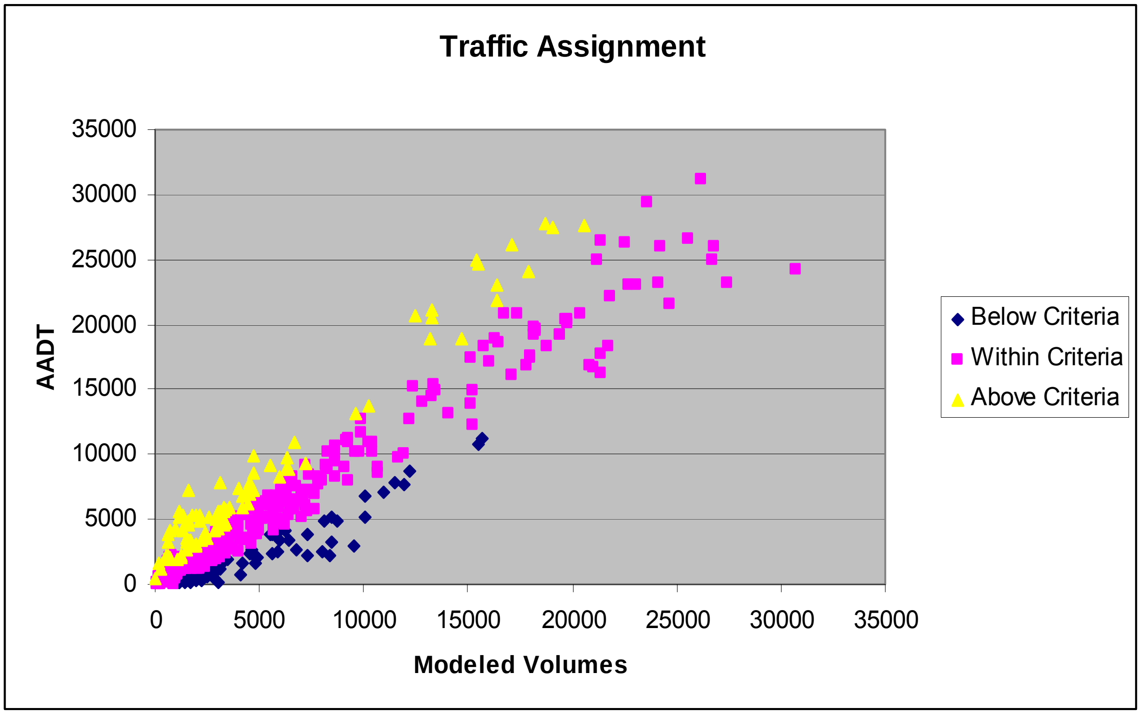

Figure 9 Modeled Volumes vs. Ground Counts

5.0 SUMMARY

This report illustrated the procedure that was followed to convert the GF/EGF regional travel demand model from TRANPLAN to TP+ software. It also provided a comparison between the outputs from both models to validate the new model. Overall the converted TP+ model produced similar results to the previous TRANPLAN model.

After results from the new TP+ model were validated, the process of calibration started. The objective of calibration is to make the model replicate the traffic conditions on the ground for a given base year, i.e. 2005. The results for each stage within the calibration process were also reported.

The performance of the model was compared to the different evaluation criteria, and it was found that the model replicates the actual traffic conditions on the ground to a satisfactory degree. This indicates that this model can be used to provide future traffic projections with a reasonable degree of accuracy.

There are some major issues that were noteworthy on the process of developing and calibrating the new model:

1. At some traffic count locations there was a considerable difference in the traffic counts provided by MNDOT and the MPO for the same location.
2. The traffic volume on the external locations dropped significantly from the year 2000.
3. The previous model was calibrated based on the 1995 model, which does not provide a reliable method to check the performance of the model against the actual traffic conditions on the ground. Most of the model parameters (such as friction and *k* factors) were carried over from the calibration of the 1995 GF/EGF model. Also the results reported were based on the 540 zone network, while the modeled network in the 2000 model had 546 zones, due to lack of data.
4. One of the common problems in areas this size is the absence of local travel data. This severely inhibits the travel model development and calibration. It is highly recommended that local travel data improvements be programmed for future model updates.

Overall, the GF/EGF model update process has resulted in model that has been satisfactorily calibrated to 2005 conditions. This model will serve the GF/EGF MPO analysis needs for supporting various transportation functions. Since the new model which was implemented in TP+ software, it also provides much more functionality than the old model. However, as more local traffic and travel data become more available, it is important to examine the model periodically for potential improvements.

6.0 REFERENCES

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