Travel Demand Model Methodology Report

(Task 3.4)

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Appendix A

Tools to Evaluate Future Growth

In order to evaluate existing travel patterns and to anticipate future travel conditions for the Grand Traverse region, the TC-TALUS travel demand model (TDM) was updated to analyze current and projected demographic data. This TDM projects future travel patterns based on projected future land use and also anticipated transportation improvements. The primary objective of this task is to refine the existing MDOT model to reflect 2007 conditions and to provide the community with an accurate tool to predict the future needs for the area.

For this study, the base year 2000 regional TDM from the Michigan Department of Transportation (MDOT) was refined and calibrated based upon new traffic count and origin-destination data. Meanwhile, the model network, person to vehicle trip conversion factors, and population and employment projections for the forecast year 2025 TDM that were developed by MDOT were obtained and adjusted based upon the refinements that have been made to the 2000 model using the methodology described below.

Travel Demand Model Background

A majority of the tasks completed as part of the model update revolved around new origin destination data collected in 2007 and the latest MI Travel Counts data. Throughout this memorandum we will step through the process used and assumptions of each step. The project team used the existing travel demand model generated for the Grand Traverse region and strived to maintain the standards employed in the development of the original model. The TDM was developed and calibrated based on MDOT standards. Furthermore, as outlined in the model documentation,

> *There are several characteristics of the Traverse City area that make it different from other areas that have a travel demand model in Michigan. There are a large number of seasonal homes and hotel visitors and the traffic varies considerably throughout the year. In order to capture the travel of non-permanent residents in the area, average occupancy rates for seasonal housing and population in overnight accommodations was included in trip generation. Traffic counts also were converted to Annual Average Daily Traffic (AADTs). Defined further, the modeled volumes represent the traffic generated on an average day in the TC-TALUS area. The model is run using MDOT's Urban Model Interface Add-in in TransCAD.*

The procedures for developing the seasonal homes, hotel occupancy, ADT values, and for running the model add-in are described specifically in the original model documentation and therefore will not be included in this memorandum.

The project team upheld the standards of MDOT while updating the TDM for continued use. Specifically, changes were made to trip length and trip rates based on local MI Counts Data. In addition, external trips and existing traffic count data were validated.

Model Inputs

Several areas of the model were refined. The following paragraphs outline the process used for the major inputs of the model.

Network Data

With the increasing population and the potential for greater amounts of traffic in the Traverse City area, there are few planned infrastructure improvements. No road projects are listed on the State Transportation Improvement Program (STIP) for the Grand Traverse area. There was a single TDM network provided as part of this project. Having only one network that ran the demographic data for both 2000 and 2025 corresponded with the lack of significant future planned capacity projects. This network was, however, calibrated and as a result of no new capacity improvements, the need for further adjustment to other factors (Alpha/Beta/Speed) would be necessary. **Figure 1** on the following page shows an image of the base network used as the base for all analyses.

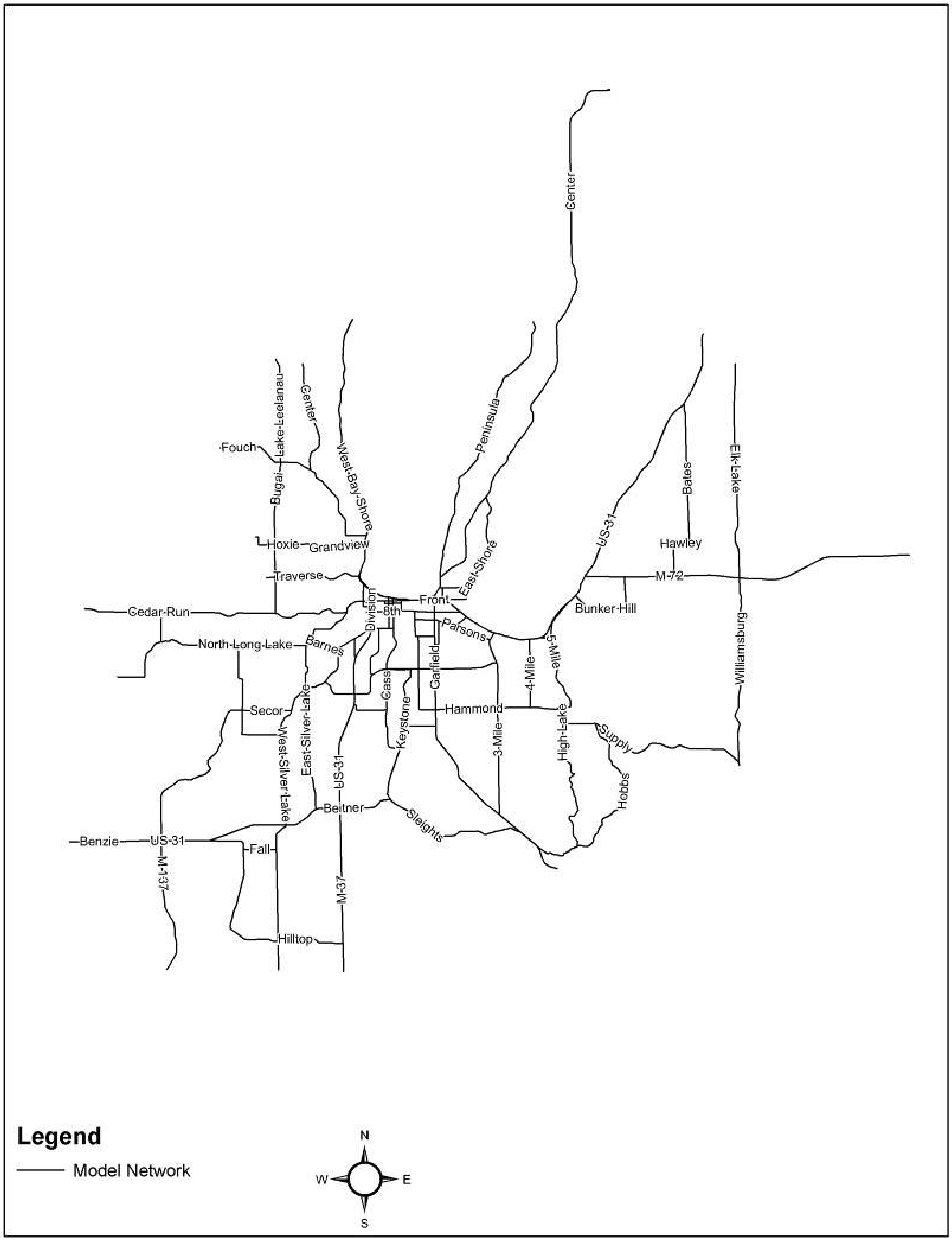


Figure 1: TDM Network

Land Use Data (Demographics)

Several sets of demographic data were created as part of the Grand Vision. The Vision document can provide more detail as to how the sets were created. For this document they will be referred to as the 2007 (base scenario) and 2035 (trend scenario). It is important to note that a total of four 2035 scenarios were developed throughout the Grand Vision study and one preferred scenario emerged as the Region's choice. (Refer to Socioeconomic Report-Task 3.2, Page 3)

As mentioned earlier in this document the TDM has a seasonal component. Specifically, 2,754 housing units are added to represent an annual average of occupied seasonal housing units. Other visitors are represented through special generators for zones containing hotels and campgrounds based on annual average occupancy rates. Those additional housing units are not added to the totals shown in **Table 1**. **Table 1** represents the raw total numbers for each input. The following four figures illustrate demographic information as it was provided through the Grand Vision process. Again these demographic sets were maintained as the base line data and used in calibration. By adding the retail, service, and other employment for 2007 and 2035, the total employment for 2007 equals 68,108 and for 2035 is 81,626.

Table 1: Demographic Summary

Demographics	2007	2035	% Change
Households	31,074	43,220	39%
Population	78,142	108,661	39%
Retail Employment	10,263	14,494	41%
Service Employment	32,905	41,154	25%
Other Employment	24,940	25,978	4%
Total Employment	68,108	81,626	18%

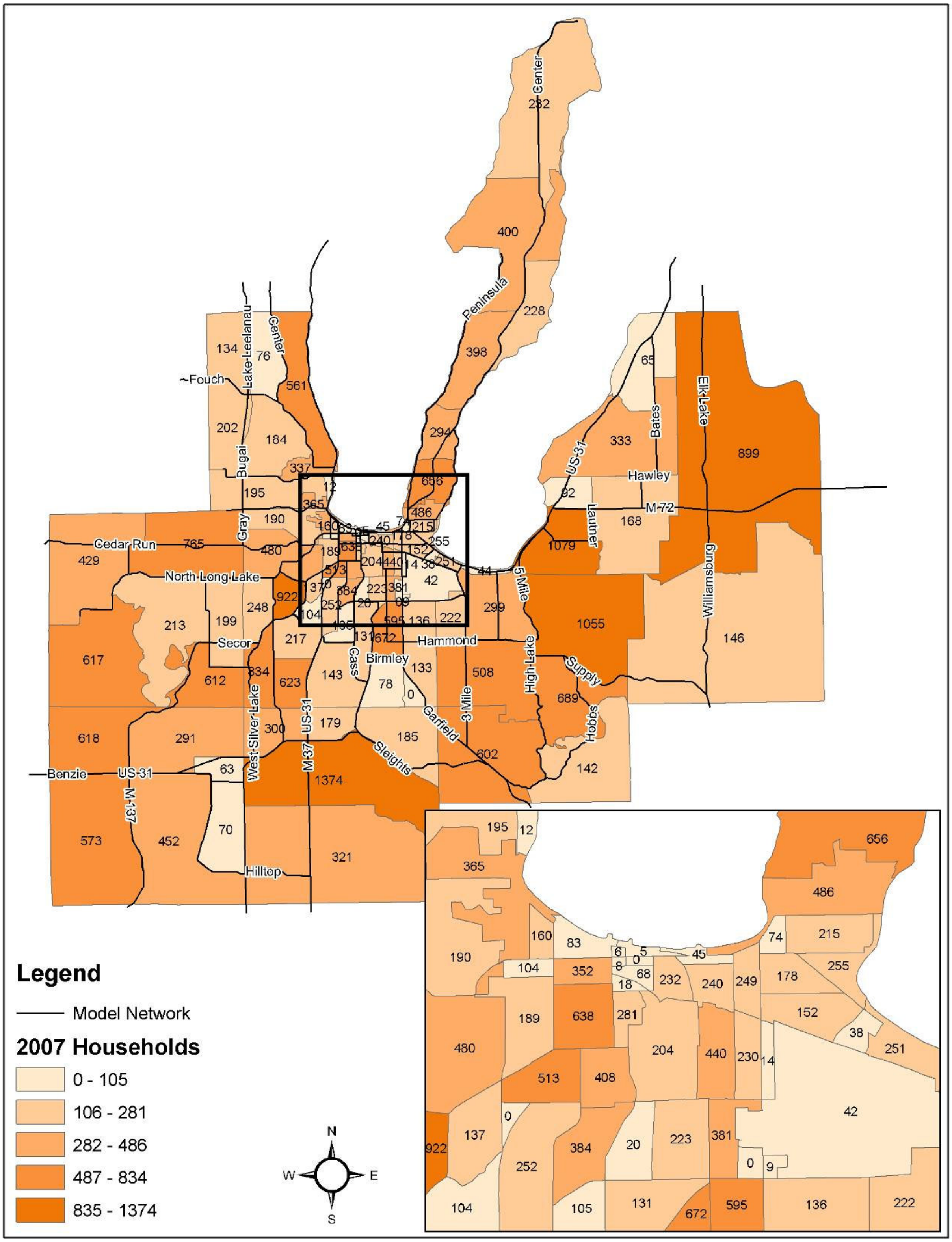


Figure 2: TDM 2007 Housing Units by Traffic Analysis Zone

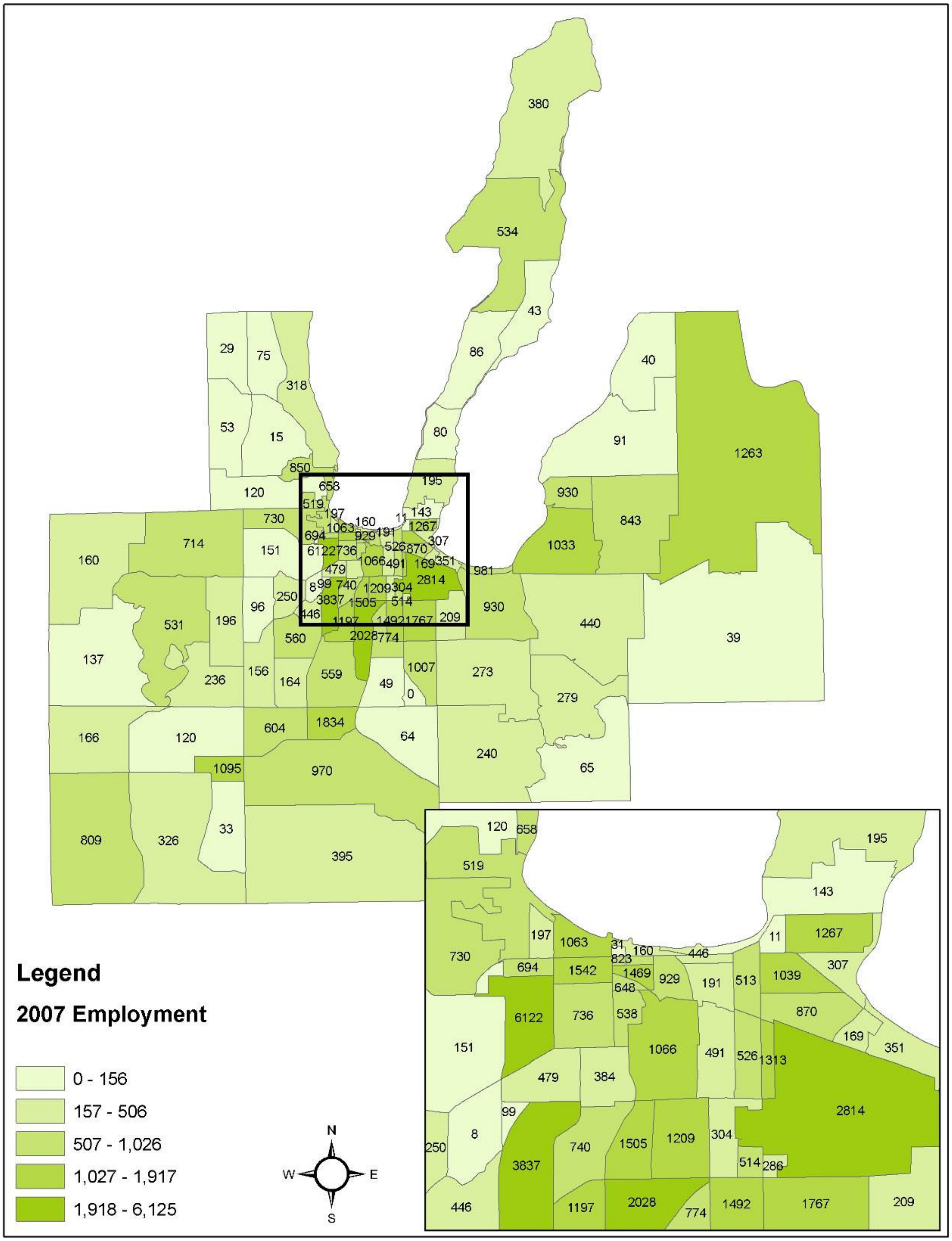


Figure 3: TDM 2007 Total Employment by Traffic Analysis Zone

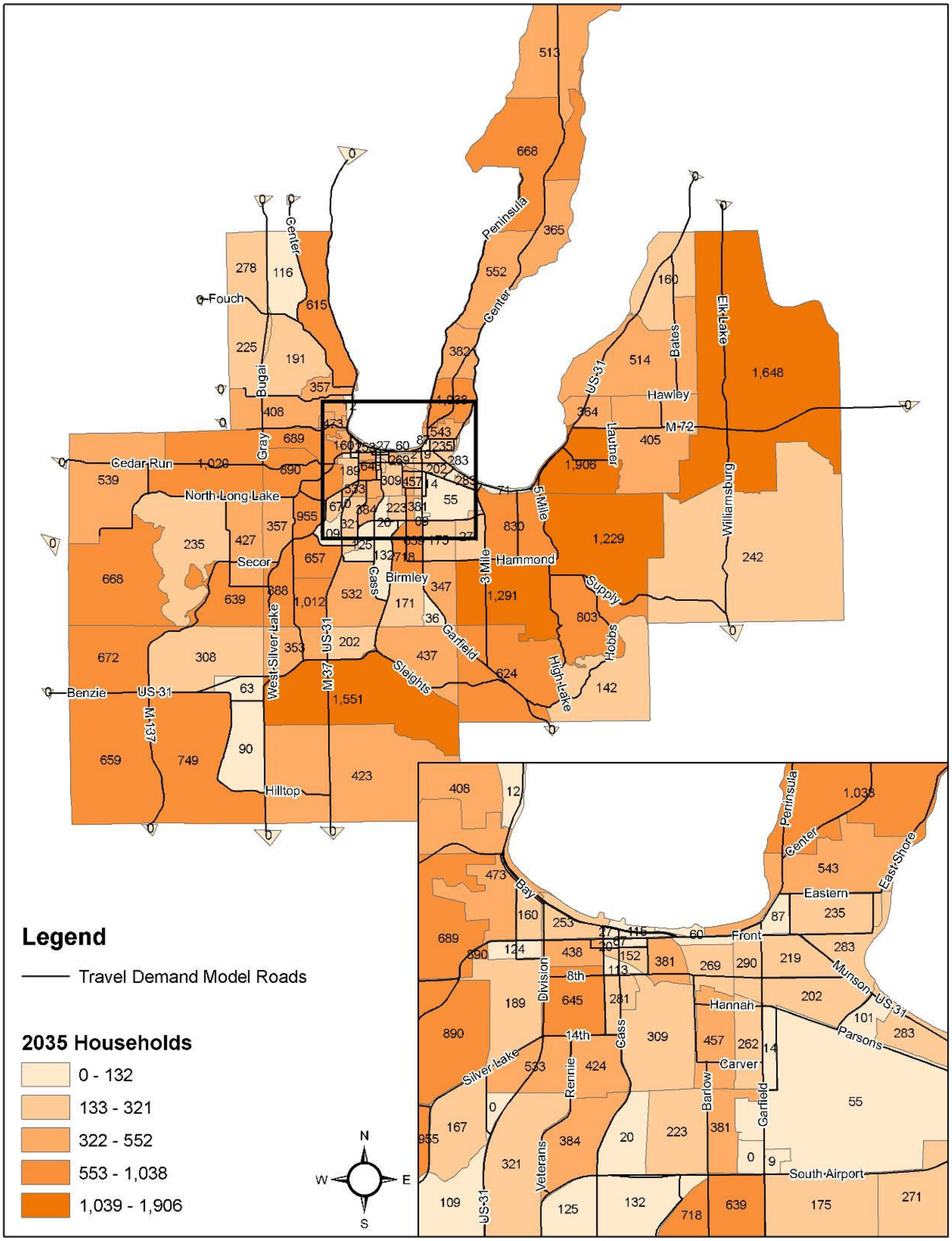


Figure 4: TDM 2035 Housing Units by Traffic Analysis Zone - Trend

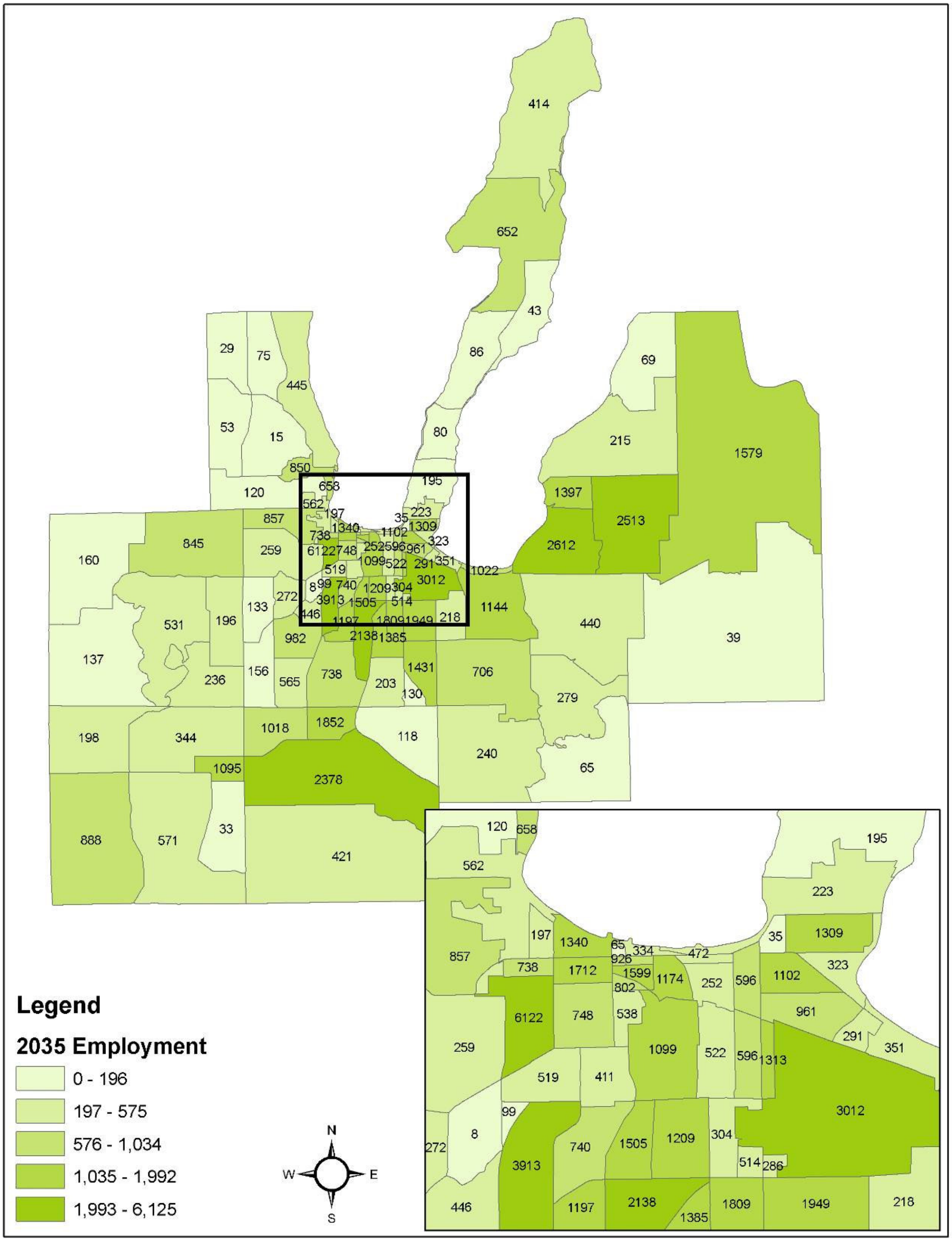


Figure 5: TDM 2035 Total Employment by Traffic Analysis Zone - Trend

Origin-Destination Data

An origin-destination study was completed on Thursday, September 13, 2007. This date was selected by the technical committee of TC-TALUS and MDOT staff, based on its optimum time for collection of a “normal” daily commuter sample. This effort was documented separately by Mead & Hunt for the modeled region in 2007. The memorandum entitled “O&D Analysis for adjacent county expansion justification” examined sixteen locations. The memorandum states that out of the 72,242 total external trips observed during the data collection period, 41,171 of these were unique vehicles. The memorandum also explains that a factor of 1.42 was created to convert the observed trips into 24 hour volumes from the TransCAD model; this would correlate to a total 24 hour volume of 103,203 trips per day entering and exiting the study area. This factor was developed based on an average conversion between the sample period traffic counts and a daily traffic count at the same location. These counts were then factored using a “seasonal factor” provided by MDOT to convert September traffic counts to an average month. The seasonal factor used is shown in **Table 2.**

The study captured three trip types: external-external, internal-external, and external-internal, as defined below.

External-external – This is the pass-through traffic. It is traffic that originates outside the study area, passes through the study area, and has a destination outside the study area.

Internal-external – This traffic starts inside the study area and has a destination outside the study area.

External-internal – This traffic starts outside the study area and has a destination within the study area.

Each of these trip types were then incorporated into the TDM. Again, sixteen locations were a part of a detailed origin-destination study and are shown in **Figure 6**. The data received from the origin destination study was directly entered into sixteen model external stations. **Table 2** shows the 2000 volumes versus the 2007 adjusted volumes.

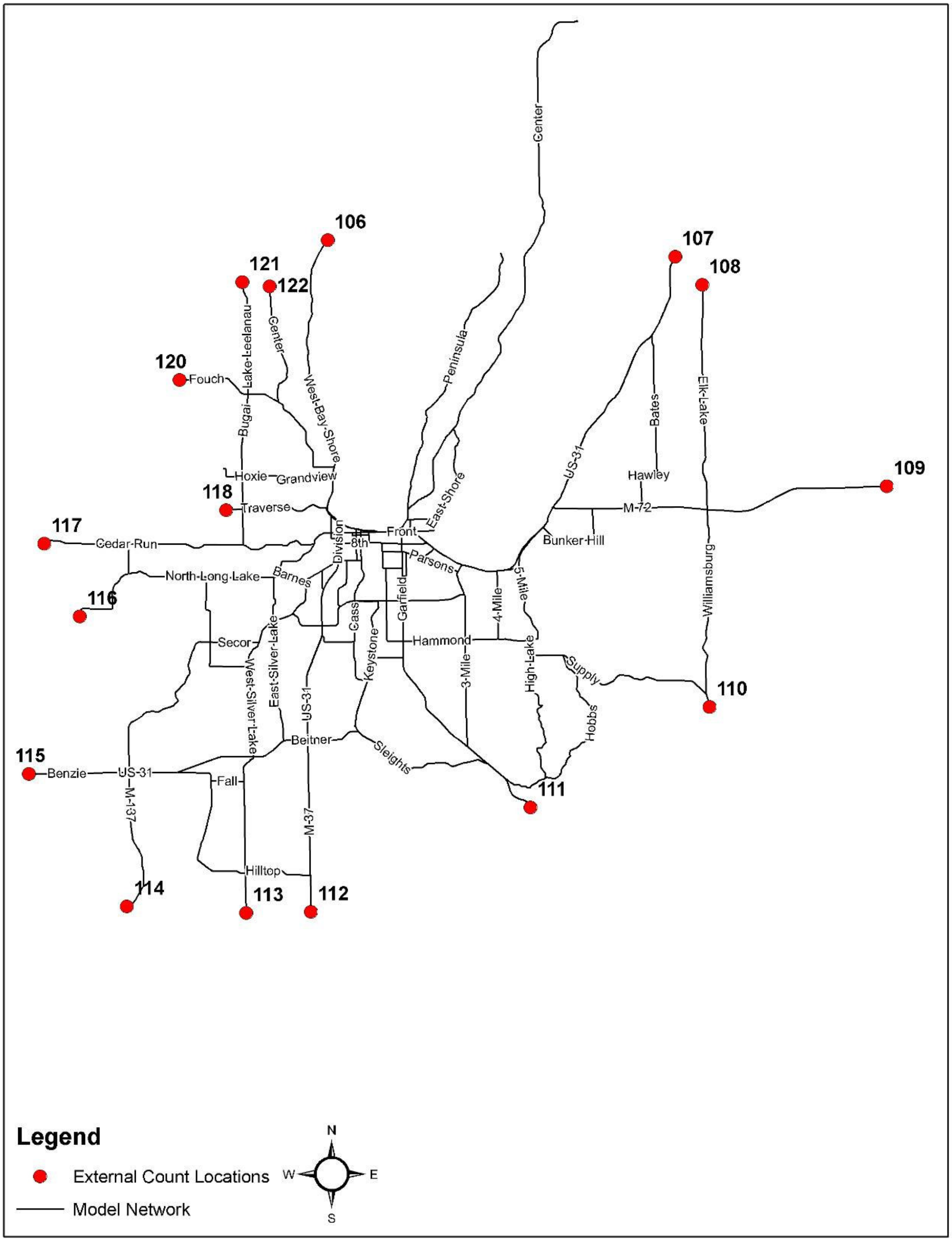


Figure 6: External Stations Studied

Table 2: Origin Destination Count Comparison

Station ID	Total Daily Trips 2000 Model Volumes	2007 Adjusted O&D Volumes	% Change	Seasonal Factor
106	9,071	8,604	-5.15%	0.87
107	7,870	9,583	21.77%	0.87
108	1,936	2,349	21.33%	0.89
109	13,762	14,372	4.43%	0.89
110	3,322	3,997	20.32%	0.89
111	6,950	8,119	16.82%	0.89
112	13,415	10,129	-24.49%	0.89
113	3,798	2,361	-37.85%	0.89
114	6,333	2,839	-55.18%	0.87
115	12,656	11,530	-8.89%	0.97
116	2,178	2,492	14.40%	0.89
117	2,005	2,340	16.71%	0.89
118	7,000	8,554	22.20%	0.87
120	1,519	976	-35.75%	0.92
121	2,336	2,649	13.40%	0.92
122	1,122	1,001	-10.81%	0.92

Note: Station 119 not included based on data availability.

This information was used to update the model in three places:

1. Incorporated as 2007 and 2035 external volumes
2. Incorporated as updated External-external trips
3. Incorporated through adjusted distribution between external points within the external to external trip matrix

To add detail to this methodology, each component will be discussed separately. As mentioned earlier, the volumes collected in the study were incorporated as the 2007 and 2035 external volumes. Within the model there is a spreadsheet that is used to determine the amount of daily traffic that is External to Internal or Internal to External versus External to External. Since the data received provided both of these elements, the volumes were directly entered into the spreadsheet. This spreadsheet uses the entered volumes to then derive future external trips based on growth factors. These growth factors, as created in the original TDM were maintained. The values generated from this spreadsheet were then incorporated into the TDM through the Traffic Analysis Zone (TAZ) geographic database file. **Table 3** illustrates the values as they have been entered into the model.

Table 3: External Station Inputs

Station ID	2007 ADT	2007 EI/IE Trips	2007 E-E Trips	2035 ADT	2035 EI/IE Trips	2035 E-E Trips
106	8,604	7,294	1,310	11,241	9,531	1,710
107	9,583	8,117	1,466	15,267	12,931	2,336
108	2,349	1,709	640	2,794	2,034	760
109	14,372	12,716	1,656	20,441	18,085	2,356
110	3,997	3,461	536	6,124	5,306	818
111	8,119	7,007	1,112	12,439	10,735	1,704
112	10,129	8,257	1,872	12,846	10,470	2,376
113	2,361	1,815	546	2,809	2,159	650
114	2,839	2,389	450	3,378	2,844	534
115	11,530	9,912	1,618	15,371	13,213	2,158
116	2,492	2,082	410	4,136	3,454	682
117	2,340	1,880	460	3,885	3,123	762
118	8,554	7,316	1,238	14,200	12,142	2,058
119	1,931	1,841	90	2,298	2,190	108
120	976	850	126	1,161	1,009	152
121	2,649	2,077	572	3,152	2,472	680
122	1,001	719	282	1,191	863	328
Total	**93,825**	**79,441**	**14,384**	**132,733**	**112,561**	**20,172**

Table 4 is a summary of the inputs. In the first column the summation of the volumes shows a decrease in traffic at the external stations between 2000 and 2007. This change is acceptable since the 2000 E-E trips were based on input from the statewide model and older origin-destination studies, while the 2007 data is based on the collected data.

Table 4: Origin-Destination Input Summary

	Total ADT	Total E-E Trips
2000 Base	97,484	21,285
New 2007	93,825	14,384
% Change	-3.8%	-32.4%

The final method used to incorporate the origin-destination data into the TDM was to adjust the trip distribution matrix of External to External trips. The observed trip distribution from the origin-destination study was incorporated into the 2007 and 2035 external trip distribution matrix. Specifically, using the totals observed in the study the matrix files were balanced and modified. **Tables 5 and 6** show the resulting matrices as they were used in the TDM.

Table 5: 2007 External to External Vehicle Trip Matrix

TAZ	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	Total
106	0	69	3	85	9	33	108	6	5	39	3	7	113	5	6	114	50	655
107	69	0	121	215	11	35	71	4	9	105	4	3	69	4	1	11	1	733
108	3	121	0	130	52	4	3	0	1	1	0	1	4	0	0	0	0	320
109	85	215	130	0	85	56	59	3	11	66	6	6	79	13	3	7	4	828
110	9	11	52	85	0	36	37	4	2	15	1	4	6	0	1	2	3	268
111	33	35	4	56	36	0	258	29	6	47	3	4	32	6	0	5	2	556
112	108	71	3	59	37	258	0	127	47	132	8	5	41	15	3	17	5	936
113	6	4	0	3	4	29	127	0	30	49	3	1	9	0	3	4	1	273
114	5	9	1	11	2	6	47	30	0	89	6	6	9	0	1	3	0	225
115	39	105	1	66	15	47	132	49	89	0	106	74	79	0	2	4	1	809
116	3	4	0	6	1	3	8	3	6	106	0	38	26	0	0	1	0	205
117	7	3	1	6	4	4	5	1	6	74	38	0	78	0	0	1	2	230
118	113	69	4	79	6	32	41	9	9	79	26	78	0	0	13	46	1	619
119	5	4	0	13	0	6	15	0	0	0	0	0	0	0	0	0	52	45
120	6	1	0	3	1	0	3	3	1	2	0	0	13	0	0	23	7	63
121	114	11	0	7	2	5	17	4	3	4	1	1	46	0	23	0	4	286
122	50	1	0	4	3	2	5	1	0	1	0	2	15	2	7	48	80	141
Total	655	733	320	828	268	556	936	273	225	809	205	230	619	45	63	286	141	7192

Table 6: 2035 External to External Vehicle Trip Matrix

TAZ	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	Total
106	0	94	3	116	12	45	148	8	7	53	4	10	154	7	8	109	77	855
107	94	0	196	347	18	56	116	7	15	170	6	5	111	7	1	18	1	1168
108	3	196	0	120	48	4	2	0	1	1	0	1	4	0	0	0	0	380
109	116	347	120	0	128	85	89	5	16	99	9	9	119	14	5	11	6	1178
110	12	18	48	128	0	66	68	8	5	27	1	7	11	0	1	4	5	409
111	45	56	4	85	66	0	393	43	9	72	4	6	48	10	0	8	3	852
112	148	116	2	89	68	393	0	118	44	123	7	4	38	14	3	16	5	1188
113	8	7	0	5	8	43	118	0	41	67	4	2	12	0	3	5	2	325
114	7	15	1	16	5	9	44	41	0	101	7	6	10	0	1	4	0	267
115	53	170	1	99	27	72	123	67	101	0	146	102	109	0	2	6	1	1079
116	4	6	0	9	1	4	7	4	7	146	0	89	61	0	0	2	1	341
117	10	5	1	9	7	6	4	2	6	102	89	0	135	0	0	2	3	381
118	154	111	4	119	11	48	38	12	10	109	61	135	0	0	37	135	45	1029
119	7	7	0	14	0	10	14	0	0	0	0	0	0	0	0	0	2	54
120	8	1	0	5	1	0	3	3	1	2	0	0	37	0	0	11	4	76
121	109	18	0	11	4	8	16	5	4	6	2	2	135	0	11	0	9	340
122	77	1	0	6	5	3	5	2	0	1	1	3	45	2	4	9	0	164
Total	855	1168	380	1178	409	852	1188	325	267	1079	341	381	1029	54	76	340	164	10086

Trip Generation

As the first step in the modeling process, trip generation remains a critical element in travel demand modeling. In order to assure the highest degree of accuracy tailored to the local Grand Traverse region, MI Travel Counts data was used to establish new trip production rates. The trip production rates for all TAZs were updated using trip production rates from the small urban sample area from MI Travel Counts.

Table 7: Person Trip Production Rates

Autos per Household	Persons per Household	Home Based Work Trip Production Rate	Home Based Other Trip Production Rate	Non Home Based Trip Production Rate
0.999	1.999	0.110	0.665	0.220
0.999	2.999	0.328	1.281	0.688
0.999	3.999	0.318	1.682	0.682
0.999	99.999	0.688	4.438	1.625
1.999	1.999	0.730	1.768	1.282
1.999	2.999	0.772	3.180	1.807
1.999	3.999	1.242	5.633	2.658
1.999	99.999	1.259	6.705	3.125
2.999	1.999	0.730	1.768	1.282
2.999	2.999	1.686	1.768	2.252
2.999	3.999	2.014	5.266	3.065
2.999	99.999	1.868	9.116	3.971
99.999	1.999	0.730	4.782	1.282
99.999	2.999	1.686	3.484	2.252
99.999	3.999	2.545	4.782	3.209
99.999	99.999	2.918	8.212	4.209

Friction Factors

Friction factors are used to calibrate the average trip lengths in a TDM. Specifically, friction factors limit the average trip length and are used to help calibrate average trip lengths. For the Grand Traverse region, average trip lengths were established using the MI Travel Counts data for each of the three trip purposes in the TDM. Once the average trip length was established for the Grand Traverse region, an interactive process of fine tuning the friction factors was used until each of the three trip purposes, Home Based Work (HBW), Home Based Other (HBO), and Non Home Based (NHB) were considered calibrated.

```
MI Travel Counts
Average trip lengths:
HBW = 19.76 min
HBO = 18.86 min
NHB = 18.32 min
```

The following tables and figures represent the results for each of the three trip purposes using the modified friction factors:

Table 8: HBW Friction Factor Calibration

TIME RANGE	TRIPS	HBW PERCENT DISTRIBUTION	CUMULATIVE	CUMULATIVE PERCENT
0-5.37	66.47	0.16	66.47	0.16
5.39-9.23	630.48	1.56	696.95	1.72
9.23-13.08	3799.85	9.39	4496.79	11.12
13.08-16.94	7889.64	19.50	12386.44	30.62
16.94-20.79	11543.51	28.54	23929.95	59.16
20.79-24.65	9756.95	24.12	33686.90	83.28
24.65-28.50	5141.96	12.71	38828.86	95.99
28.50-32.35	1280.66	3.17	40109.52	99.16
32.35-36.21	276.64	0.68	40386.16	99.84
36.21>	64.28	0.16	40450.44	100.00

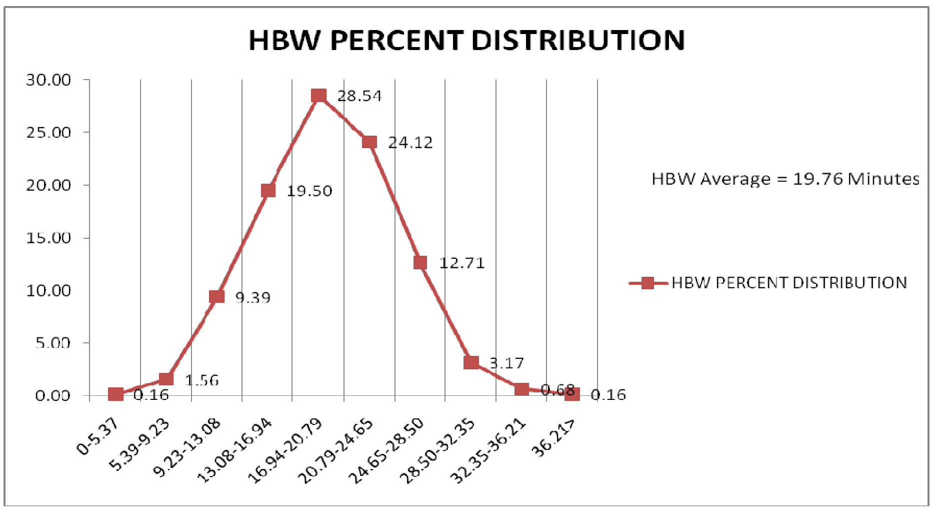


Figure 7: HBW Friction Factor Calibration Chart

Table 9: HBO Friction Factor Calibration

TIME RANGE	TRIPS	HBO PERCENT DISTRIBUTION	CUMULATIVE	CUMULATIVE PERCENT
0 - 5.37	211.37	0.17	211.37	0.17
5.37-9.23	2406.77	1.93	2618.14	2.10
9.23-13.08	15808.13	12.69	18426.27	14.79
13.08-16.94	23864.42	19.16	42290.69	33.95
16.94-20.79	33991.98	27.29	76282.67	61.24
20.79-24.65	26822.13	21.53	103104.80	82.77
24.65-28.50	16331.70	13.11	119436.49	95.89
28.50-35.32	4228.34	3.39	123664.84	99.28
35.32-36.31	711.78	0.57	124376.61	99.85
36.31>	185.61	0.15	124562.22	100.00

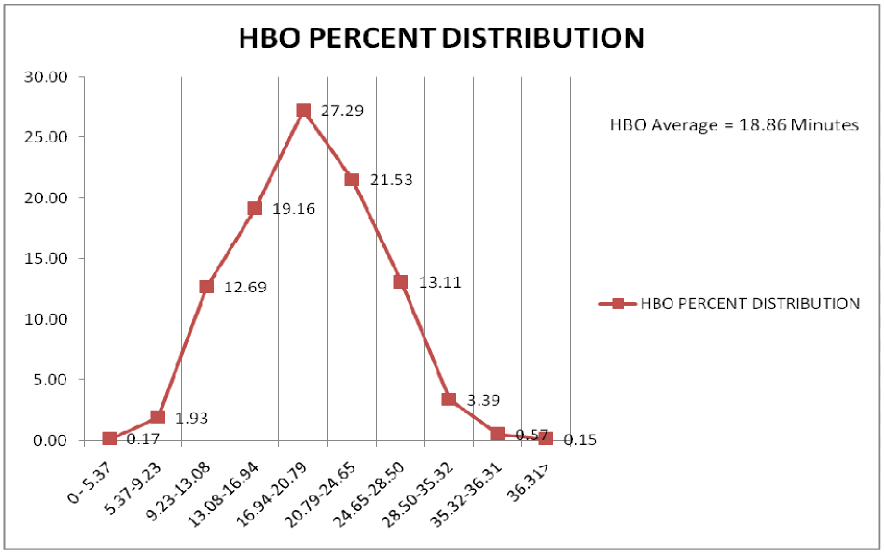


Figure 8: HBO Friction Factor Calibration Chart

Table 10: NHB Friction Factor Calibration

TIME RANGE	TRIPS	HBO PERCENT DISTRIBUTION	CUMULATIVE	CUMULATIVE PERCENT
0 - 5.37	18.84	0.01	18.84	0.01
5.37-9.23	9940.75	6.69	9959.59	6.70
9.23-13.08	31653.04	21.29	41612.63	27.99
13.08-16.94	20315.88	13.67	61928.50	41.66
16.94-20.79	62738.92	42.21	124667.43	83.87
20.79-24.65	19840.57	13.35	144508.00	97.22
24.65-28.50	4112.06	2.77	148620.06	99.98
28.50-35.32	26.88	0.02	148646.94	100.00
35.32-36.31	0.16	0.00	148647.10	100.00
36.31>	0.02	0.00	148647.12	100.00

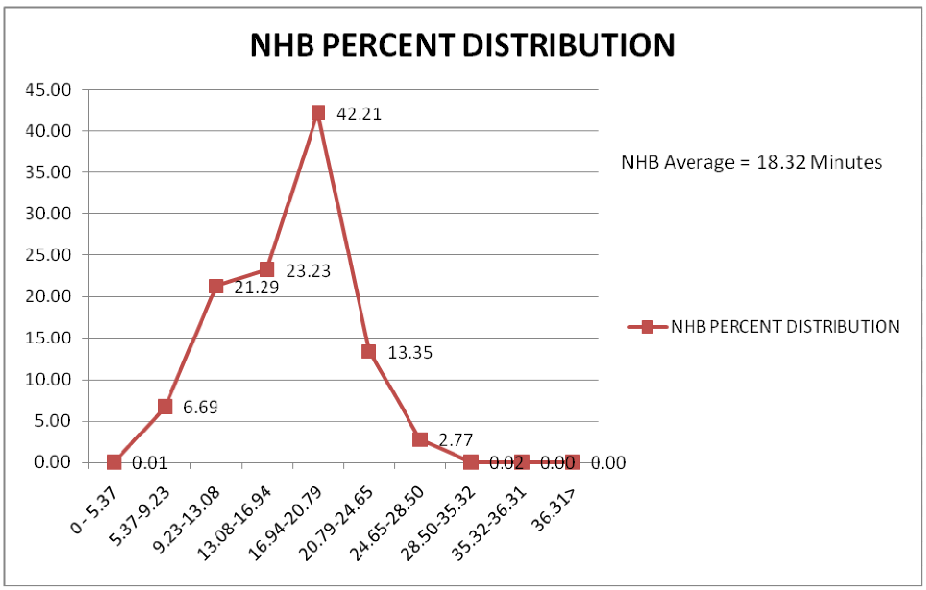


Figure 9: NHB Friction Factor Calibration Chart

Auto Occupancy Rates

The MI Travel Counts data was also used to estimate auto occupancy rates within the Grand Traverse region. These rates were used as input into the travel demand modeling process.

HBW: 1.05
HBO: 1.54
NHB: 1.46

Model Validation Process

After the refinement of the above inputs it was necessary to recalibrate the TDM to a 2007 base year. The validation/calibration process involves comparing model generated link volumes with traffic counts at a specific location. This process was selected based on the recently updated origin-destination data and also to remain consistent with the previous calibration process completed by MDOT. In order to complete this analysis the team used MDOT standards of validating daily traffic volumes based on the total volume of the link. The percent error represents the percent change from the total assigned model traffic volumes to the total counted traffic volumes (ground counts) for all links that have counted volumes. Percent error is more widely used than absolute numerical values because it better reflects the volume of the roadway. This test provided insight into whether the assignment model was loading trips onto the roadway system in a reasonable manner. **Table 11** shows the MDOT Validation Criteria as documented for the existing model. Again these standards were maintained.

Table 11 : Daily Link Volume Validation Criteria

ADT	Percent Error
<1,000	200
1,000-2,500	100
2,500-5,000	50
5,000-10,000	25
10,000-25,000	20
25,000-50,000	15
>50,000	10

*Note that external station links are to have 0% error.

Two hundred forty (240) specific links were analyzed within the model to validate the updated data sets. The 16 origin/destination links are also considered valid locations. Based on the calibration year of 2007 count data was collected. In some instances data collected in previous years were factored based on year-to-year comparisons for use in calibration. These factors were based on statewide MDOT average traffic growth or decline by region. This was done to allow for a larger sample size for calibration. Using 2007 traffic count data the MDOT validation standards **(Table 11)** were maintained. **Table 13** shows the two hundred forty locations and compares the 2007 traffic count to the model volume, while **Figure 12** graphically shows the location of each comparison. The result of the calibration is shown below (**Table 12**) but in general, of the 168 miles of links with counts, only 15% were either over or under the allowable calibration tolerances, resulting in only 22 miles considered not calibrated. Overall, this model is well within local, regional and national tolerances for acceptability.

Table 12: Validation Results

Number of miles Calibrated	**146.11**
Number of miles over	**18.02**
Number of miles under	**4.33**
Percent miles not Calibrated	**15%**

Table 13: Link Validation Results

Model ID	Street Name	Link Length	2007 Average Daily Traffic	Modeled Daily Traffic	Volume Difference	Percent Difference	Over (Calibration Standards)	Under (Calibration Standards)	
1503250	Lautner	0.98	928	250	-678	-73%			Volumes < 1,000
1499456	Bunker Hill	1.02	2387	250	-2137	-90%			
1841470	High Lake	2.09	2034	411	-1623	-80%			
1434714	Hastings	0.23	7993	509	-7484	-94%			
1481897	East Bay	0.19	1320	587	-733	-56%			
1841438	East Bay	0.18	1320	587	-733	-56%			
1481850	Front	0.24	1415	587	-828	-59%			
1841435	East Shore	0.33	1176	595	-581	-49%			
1841509	East Shore	1.21	1176	600	-576	-49%			
1488505	High Lake	1.55	2034	690	-1344	-66%			
1490133	Hobbs	1.16	895	736	-159	-18%			
1799405	Bates	0.87	877	841	-36	-4%			
1506235	Fouch	1.09	1746	962	-784	-45%			
1508817	Center	1.61	1290	971	-319	-25%			

Model ID	Street Name	Link Length	2007 Average Daily Traffic	Modeled Daily Traffic	Volume Difference	Percent Difference	Over (Calibration Standards)	Under (Calibration Standards)	
1436351	Elmwood	0.17	2784	1141	-1643	-59%			Volumes between 1,000 and 2,500
1841456	Carver	0.30	5968	1398	-4570	-77%			
1440391	Bay	0.32	2358	1403	-955	-41%			
1439085	6th	0.17	4591	1404	-3187	-69%			
1441739	Union	0.12	6883	1410	-5473	-80%			
1508475	Center	2.15	877	1487	610	70%			
1479530	Milliken	0.22	4160	1878	-2282	-55%			
1405638	Hoxie	0.63	2542	1912	-630	-25%			
1436968	Elmwood	0.45	1836	2199	363	20%			
1419747	Rennie	0.85	10657	2272	-8385	-79%			
1802218	Elk Lake	3.16	2233	2272	39	2%			
1841090	Elk Lake	3.49	2226	2275	49	2%			
1310943	Cedar Run	1.63	2313	2294	-19	-1%			
1373065	County Road 633	0.95	4367	2307	-2060	-47%			
1308263	North Long Lake	0.33	2504	2457	-47	-2%			
1321405	Cedar Run	1.64	6380	2490	-3890	-61%			

Model ID	Street Name	Link Length	2007 Average Daily Traffic	Modeled Daily Traffic	Volume Difference	Percent Difference	Over Calibration Standards	Under Calibration Standards	
1461791	Hobbs	0.74	1174	2545	1371	117%	X		**Volumes between 2,500 and 5,000**
1507220	Lake Leelanau	1.49	2686	2582	-104	-4%			
1393991	East Long Lake	0.96	3821	2784	-1037	-27%			
1295554	M 137	0.25	7282	2809	-4473	-61%		X	
1396828	East Silver Lake	1.77	1935	3308	1373	71%	X		
1841460	West Silver Lake	0.99	5874	3314	-2560	-44%			
1478693	4 Mile	0.97	3895	3358	-537	-14%			
1483297	Peninsula	1.22	5069	3415	-1654	-33%			
1411013	Fouch	0.49	2956	3466	510	17%			
1841481	Fouch	0.50	2956	3466	510	17%			
1437018	Bay	0.28	4811	3677	-1134	-24%			
1477065	3 Mile	1.01	5823	3697	-2126	-37%			
1480876	Eastern	0.28	5430	3716	-1714	-32%			
1787620	Supply	0.25	3820	3939	119	3%			
1392236	River	0.73	3402	4029	627	18%			
1841485	East Silver Lake	0.41	1935	4139	2204	114%	X		
1405614	Gray	1.12	5071	4402	-669	-13%			
1445619	Eastern	0.09	4535	4510	-25	-1%			
1405665	Green	0.97	4059	4581	522	13%			
1438649	Cherry Bend	0.66	6162	4661	-1501	-24%			
1411402	Cherry Bend	0.51	3426	4666	1240	36%			
1375144	County Road 633	0.25	5348	4880	-468	-9%			
1445463	Garfield	0.12	10386	4917	-5469	-53%		X	

Model ID	Street Name	Link Length	2007 Average Daily Traffic	Modeled Daily Traffic	Volume Difference	Percent Difference	Over	Under	
							Calibration Standards		
1396024	Cedar Run	1.90	5238	5240	2	0%			Volumes between 5,000 and 10,000
1397500	West Silver Lake	0.87	6489	5249	-1240	-19%			
1422585	Keystone	0.51	4701	5281	580	12%			
1414291	Cass	0.51	6720	5989	-731	-11%			
1394289	West Silver Lake	0.78	5874	6094	220	4%			
1550605	Center	2.47	4761	6502	1741	37%			
1403779	Barnes	0.55	7495	6941	-554	-7%			
1453809	Garfield	1.25	7538	7188	-350	-5%			
1486568	Center	1.14	6403	7603	1200	19%			
1487257	Center	0.47	6403	7613	1210	19%			
1544778	Center	3.13	6403	7640	1237	19%			
1432424	Hannah	0.26	5303	7692	2389	45%	X		
1424125	Garfield	0.90	5559	7712	2153	39%	X		
1443638	Cass	0.08	4880	7895	3015	62%	X		
1476185	Parsons	0.37	7286	7897	611	8%			
1841408	Garfield	1.06	7992	7983	-9	0%			
1841409	Garfield	0.18	7992	7983	-9	0%			
1477102	3 Mile	0.93	8077	8012	-65	-1%			
1444146	Boardman	0.08	5796	8057	2261	39%	X		
1434050	Hannah	0.12	5155	8386	3231	63%	X		
1841399	Traverse	0.50	7593	8386	793	10%			
1515361	West Bay Shore	4.75	10431	8455	-1976	-19%			
1837956	US 31	0.77	9050	8595	-455	-5%			
1408184	Traverse	0.95	8043	8855	812	10%			
1841100	Traverse	0.97	10385	8857	-1528	-15%			
1841432	Traverse	0.05	10385	8857	-1528	-15%			
1841379	Traverse	0.71	8043	8857	814	10%			
1841514	Union	0.18	8577	8951	374	4%			
1424860	Hammond	0.50	11805	8971	-2834	-24%			
1439843	Division	0.01	22339	9012	-13327	-60%		X	
1395102	North Long Lake	0.13	8783	9019	236	3%			
1837893	US 31	2.70	9050	9052	2	0%			
1421987	Union	0.14	10994	9180	-1814	-17%			
1492802	Holiday	0.26	6750	9324	2574	38%			
1839589	US 31	2.40	9050	9425	375	4%			
1299941	South Long Lake	0.55	5200	9449	4249	82%	X		
1437042	M 72	0.01	10385	9453	-932	-9%			
1490108	Supply	1.02	6817	9459	2642	39%			
1841407	La Franier	1.25	8269	9655	1386	17%			
1415328	North Long Lake	0.05	7341	9697	2356	32%			
1841501	North Long Lake	1.03	7341	9697	2356	32%			
1403822	North Long Lake	0.48	10746	9700	-1046	-10%			
1443801	Boardman	0.16	6388	9701	3313	52%			
1443607	Cass	0.06	10176	9784	-392	-4%			
1443764	State	0.12	14892	9829	-5063	-34%			

Model ID	Street Name	Link Length	2007 Average Daily Traffic	Modeled Daily Traffic	Volume Difference	Percent Difference	Over	Under
							Calibration Standards	
1444164	Boardman	0.08	5667	10003	4336	77%	X	
1441175	Front	0.11	7212	10193	2981	41%	X	
1841424	Cass	0.12	10176	10371	195	2%		
1421874	Union	0.18	8577	10377	1800	21%	X	
1431091	Garfield	0.56	11850	10439	-1411	-12%		
1401040	Zimmerman	0.53	7530	10457	2927	39%	X	
1445456	Peninsula	0.31	13311	10470	-2841	-21%		
1428986	Woodmere	0.24	8394	10627	2233	27%	X	
1841427	Cass	0.05	10176	10682	506	5%		
1374466	M 37	1.16	15427	10759	-4668	-30%		X
1427555	Cass	0.77	12778	10899	-1879	-15%		
1504141	US 31	2.12	9050	10914	1864	21%		
1427614	14th	0.14	13909	10926	-2983	-21%		
1301197	US 31	0.81	18563	10940	-7623	-41%		X
1443657	State	0.14	11581	11138	-443	-4%		
1435831	Front	0.53	9749	11217	1468	15%		
1443664	Front	0.14	8444	11271	2827	33%	X	
1284281	Benzie	1.70	14554	11319	-3235	-22%		
1445435	Garfield	0.29	16106	11368	-4738	-29%	X	
1401269	North Long Lake	0.37	14409	11417	-2992	-21%		
1439674	Front	0.09	14519	11430	-3089	-21%		
1431714	Carver	0.37	15435	11469	-3966	-26%		
1438697	Front	0.08	14519	11571	-2948	-20%		
1373875	M 37	0.84	15427	11764	-3663	-24%		
1431708	Barlow	0.51	8671	11768	3097	36%	X	
1443613	Front	0.06	9592	11773	2181	23%	X	
1437061	Grandview	0.05	12143	12091	-52	0%		
1437055	West Bay Shore	0.06	12143	12091	-52	0%		
1301222	US 31	0.44	18563	12120	-6443	-35%		X
1413401	South Airport	0.52	15205	12421	-2784	-18%		
1434174	8th	0.16	14019	12453	-1566	-11%		
1841413	Front	0.07	9592	12460	2868	30%		
1841520	Cass	0.21	12635	12480	-155	-1%		
1414128	Hartman	0.65	3679	12616	8937	243%	X	
1375902	US 31	1.39	18563	12773	-5790	-31%		
1381720	M 37	2.31	15427	12805	-2622	-17%		
1427741	Cass	0.17	12635	12970	335	3%		
1474176	8th	0.32	2248	12973	10725	477%	X	
1400022	South Airport	0.58	12009	13015	1006	8%		
1436344	Front	0.17	14008	13056	-952	-7%		
1401289	North Long Lake	0.27	13650	13163	-487	-4%		
1443576	West Bay Shore	2.40	13060	13344	284	2%		
1473544	Parsons	0.28	14192	13511	-681	-5%		
1301259	US 31	0.22	18563	13559	-5004	-27%		X
1445637	Peninsula	0.15	15528	13647	-1881	-12%		
1841434	Peninsula	0.17	15528	13647	-1881	-12%		
1439824	Grandview	0.58	13960	13872	-88	-1%		
1402312	Silver Lake	0.17	9666	13971	4305	45%	X	
1440466	Grandview	0.58	13960	14066	106	1%		
1441049	Grandview	0.30	14534	14127	-407	-3%		
1826543	M 72	3.78	15826	14159	-1667	-11%		
1444359	Grandview	0.39	13687	14362	675	5%		
1841443	8th	0.26	14019	14580	561	4%		
1443670	Grandview	0.13	13687	14609	922	7%		
1443683	Grandview	0.06	13687	14804	1117	8%		
1444365	Grandview	0.39	13687	14831	1144	8%		

Volumes between 10,000 and 25,000

Model ID	Street Name	Link Length	2007 Average Daily Traffic	Modeled Daily Traffic	Volume Difference	Percent Difference	Over	Under	
							Calibration Standards		
1841505	Grandview	0.13	13687	14832	1145	8%			Volumes between 10,000 and 25,000
1841411	Grandview	0.09	13687	14837	1150	8%			
1420875	14th	0.26	19106	14882	-4224	-22%			
1441080	Grandview	0.11	14534	15152	618	4%			
1472810	Parsons	0.28	12012	15186	3174	26%	X		
1841448	Parsons	0.30	12012	15186	3174	26%	X		
1445565	Peninsula	0.22	15528	15199	-329	-2%			
1474997	South Airport	0.64	12890	15338	2448	19%	X		
1445491	Peninsula	0.08	15528	15387	-141	-1%			
1376947	US 31	1.04	21737	15512	-6225	-29%		X	
1444352	Front	0.15	7868	15606	7738	98%	X		
1441068	Grandview	0.30	14534	16169	1635	11%			
1841503	Grandview	0.15	13687	16178	2491	18%	X		
1472295	South Airport	0.53	12724	16234	3510	28%	X		
1415785	Silver Lake	0.60	15380	16311	931	6%			
1439837	Division	0.02	22339	16384	-5955	-27%		X	
1297923	US 31	1.07	14554	16428	1874	13%			
1434168	Garfield	0.19	18674	16473	-2201	-12%			
1440532	Front	0.26	15630	16576	946	6%			
1441099	Grandview	0.11	14534	17108	2574	18%			
1441894	West Bay Shore	0.27	18673	17219	-1454	-8%			
1439812	Division	0.12	23230	17401	-5829	-25%			
1841429	Division	0.15	23230	17405	-5825	-25%			
1383589	M 37	0.69	15427	17575	2148	14%			
1439830	Division	0.05	22339	17782	-4557	-20%			
1399370	Silver Lake	0.14	9573	19051	9478	99%	X		
1426276	South Airport	0.23	23499	19133	-4366	-19%			
1488660	Hammond	1.00	10387	19538	9151	88%	X		
1799323	M 72	0.60	19201	19700	499	3%			
1841149	US 31	0.58	21737	20194	-1543	-7%			
1801376	M 72	2.01	19201	20524	1323	7%			
1841462	US 31	0.14	27509	20846	-6663	-24%			
1424866	Garfield	0.50	16129	21214	5085	32%	X		
1423964	Birmley	0.71	10631	21216	10585	100%	X		
1476339	3 Mile	0.25	20552	21385	833	4%			
1413426	South Airport	0.26	32420	21419	-11001	-34%		X	
1805769	M 72	1.57	15826	21558	5732	36%	X		
1384127	US 31	0.55	25172	21850	-3322	-13%			
1477127	Hammond	0.75	15009	22590	7581	51%	X		
1441873	West Bay Shore	0.39	24287	22643	-1644	-7%			
1502794	M 72	0.55	19201	22736	3535	18%			
1503256	M 72	0.68	19201	22804	3603	19%			
1471565	Hammond	0.52	18266	22947	4681	26%	X		
1799317	M 72	0.93	19201	23055	3854	20%			
1439680	Division	0.16	24181	23096	-1085	-4%			
1431661	Garfield	0.59	20011	23301	3290	16%	X		
1433547	Garfield	0.25	21283	23301	2018	9%			
1382565	US 31	0.38	21737	23405	1668	8%			
1382578	US 31	0.12	21737	23405	1668	8%			
1433585	Garfield	0.25	23978	23600	-378	-2%			
1478020	3 Mile	0.73	18910	23649	4739	25%	X		
1434080	Garfield	0.25	26886	23965	-2921	-11%			
1441805	West Bay Shore	0.58	24287	24183	-104	0%			
1383640	Beitner	0.75	21737	24386	2649	12%			

Model ID	Street Name	Link Length	2007 Average Daily Traffic	Modeled Daily Traffic	Volume Difference	Percent Difference	Over (Calibration Standards)	Under (Calibration Standards)	
1384139	US 31	0.12	25172	25688	516	2%			Volumes between 25,000 and 40,000
1398487	US 31	1.10	25172	25688	516	2%			
1413439	US 31	0.33	27509	26608	-901	-3%			
1414445	US 31	0.20	27509	26608	-901	-3%			
1419644	Division	0.08	24181	26808	2627	11%			
1479597	Munson	0.20	29735	27071	-2664	-9%			
1418891	US 31	0.45	27409	27256	-153	-1%			
1841493	US 31	0.24	27509	27774	265	1%			
1474170	Munson	0.23	29735	27848	-1887	-6%			
1841498	8th	0.12	23269	27888	4619	20%	X		
1415902	US 31	0.30	27509	27893	384	1%			
1413286	US 31	0.41	25172	28099	2927	12%			
1479465	Munson	0.17	29735	28142	-1593	-5%			
1414973	US 31	0.47	27509	28151	642	2%			
1398502	US 31	0.14	25172	28241	3069	12%			
1841441	Front	0.12	29735	28471	-1264	-4%			
1445507	Front	0.14	29735	28485	-1250	-4%			
1412685	US 31	0.96	25172	28636	3464	14%			
1428380	8th	0.13	23269	28693	5424	23%	X		
1479449	Front	0.10	29735	30347	612	2%			
1441745	Grandview	0.16	30200	32260	2060	7%			
1444942	Front	0.16	35957	32671	-3286	-9%			
1444901	Front	0.12	35957	32990	-2967	-8%			
1413414	US 31	0.33	27509	33676	6167	22%	X		
1476345	US 31	0.43	31849	36406	4557	14%			
1494952	US 31	1.35	32596	36999	4403	14%			
1841511	South Airport	0.12	35955	37223	1268	4%			
1474320	Munson	0.12	29735	37643	7908	27%	X		
1841446	Munson	0.11	29735	37802	8067	27%	X		
1429708	South Airport	0.28	35955	37917	1962	5%			
1444851	Front	0.33	35957	43460	7503	21%	X		
1444790	Front	0.13	35957	44800	8843	25%	X		

Number of miles Calibrated	**146.11**
Number of miles over	**18.02**
Number of miles under	**4.33**
Percent miles not Calibrated	**15%**

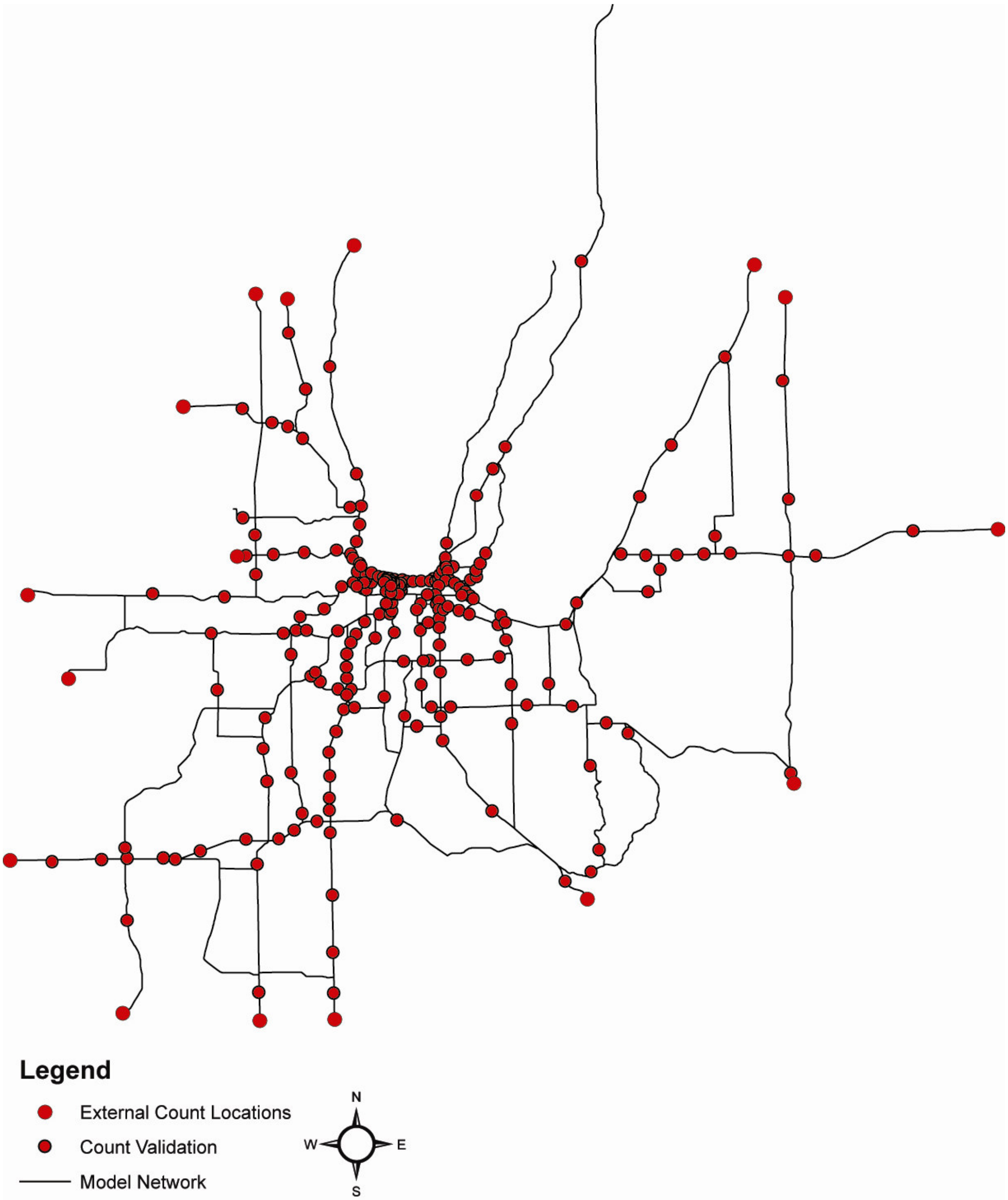


Figure 10: Link Validation Locations

The preceding paragraphs outline the methodology used in the development of the models and modeling of the Grand Traverse region thoroughfares and adjacent roadway network. As outlined in the introduction, the primary objective of this task was to refine the existing model to reflect 2007 conditions and to provide the area with an accurate tool to predict future needs. Throughout this section the team summarized the process or steps taken to validate external trips and traffic counts within the Grand Traverse Regional TDM. These processes included some specific updates to external count data. More importantly the processes were validated through a detailed origin-destination study and current 2007 daily traffic counts to ensure a model that would predict traffic volumes within the standard error acceptable to MDOT criteria. The resulting model provided by the project team has produced a more current and up to date tool for Grand Traverse region that will certainly assist in the enhancement of their future.

Modeling Scenarios

Within the Grand Vision two scenarios types were generated, Land Use scenarios and a Transportation scenario to accompany. Both were generated by the public and both generated a preferred scenario. Specific evaluations and results of the scenario process will be given in the following paragraphs; however we would like to provide an overview of how the evaluations were completed.

Testing Demographic and Transportation Scenarios

Within the context of the Grand Vision, various demographic scenarios were run through the TDM to estimate future traffic demands. These scenarios contained population, households, and employment which were input directly into the TAZs. The specific numbers used will be documented in the Scenario section. TAZs are geographic areas that contain houses and jobs. The model then converts houses and jobs into trips and then places the trips onto the transportation system connecting them together. Many indicators were developed to evaluate each scenario (which is described in the following section).

Transit Capability and Mode Choice

One of the areas of the model that was expanded on was passenger transit. It is important to note that this process was used as a scenario planning tool. For use in the model, formulas were applied for a simple nested logit model. These formulas helped to predict the percentage of auto, transit trips, walk and internal trips within the study area. This process is known as the 4D process. The four D's, Density Diversity, Design, and Distance/Destinations, are based on over 50 national case studies completed by Metropolitan Planning Organizations, Council of Governments, and Federal agencies looking at the effect the 4D's have on transit ridership. Specifically, a majority of these case studies are being aggregated in the NCHRP Report 08-61 "Travel Demand Forecasting: Parameters and Techniques." In the 4D mode choice each factor affects ridership based on elasticity factors. These factors are then used to determine travel times and used to estimate ridership. The process was developed as an additional layer to the person to vehicle trip conversion factor that exists within the TDM. Vehicle occupancy rates were maintained. To determine transit potential, the 4D process relied on the following major factors:

Distance/Destinations

After each scenario was run through the model, predicted travel times were obtained and used to generate trip tables of constrained travel times (often called skims). These skims were used as input into a mode choice routine and compared with transit travel times. These travel times were used to evaluate the likelihood that individuals will select transit over a personal vehicle based on the total travel time of the trip. The image below shows how the mode choice model script incorporates the elements of the TDM into the process. Notice that the model includes the TDM Network, TAZ information, transit stop locations, and person trip table inputs.

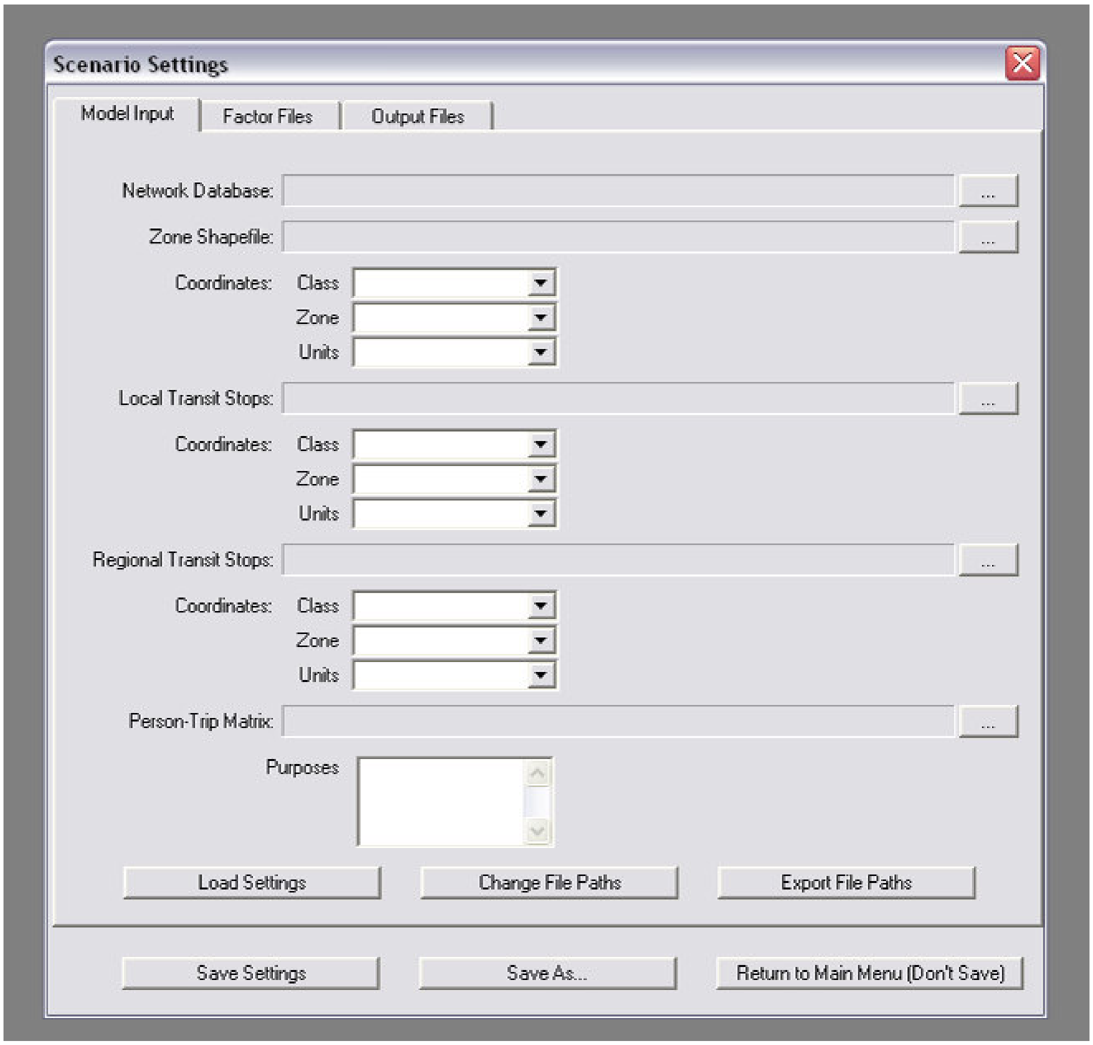


Figure 11: Mode Choice Macro

To develop transit travel times, several transit routes were developed throughout the public process and again with the project team. The defined transit routes, provided the framework for detailed model input. Speeds, headways (distance between transit vehicles) , and costs were input into each route. Travel time tables were again developed for the transit system and used as input to compete against auto travel times.

Density

Each demographic scenario contains household and employment density which plays a major role in the time it takes to get to a transit station. Less dense developments often have fewer streets and larger lot sizes which translate into less accessible transit stations.

Diversity

The diversity factor looks at the balance of housing and jobs within the vicinity of the traveler. It also looks at demographic inputs such as number of available vehicles per household, to determine if the travelers are more likely to be dependent on transit.

Design

Developments that have a mix of uses within walking or biking distance from each other have the ability to reduce overall auto travel demand and often result in transit trips. On average, a single household generates ten auto trips per day. Of those ten trips only two to four are home to work trips. In walkable, mixed use developments, a percentage of the remaining trips are satisfied by walking or biking. These percentages vary anywhere between 12 to 40 percent. Within the mode choice development, intensity/density and walkable/mixed use developments affect the outputs via set factors based on national and localized data. The following image is a screen shot of the TDM macro that incorporates these factors.

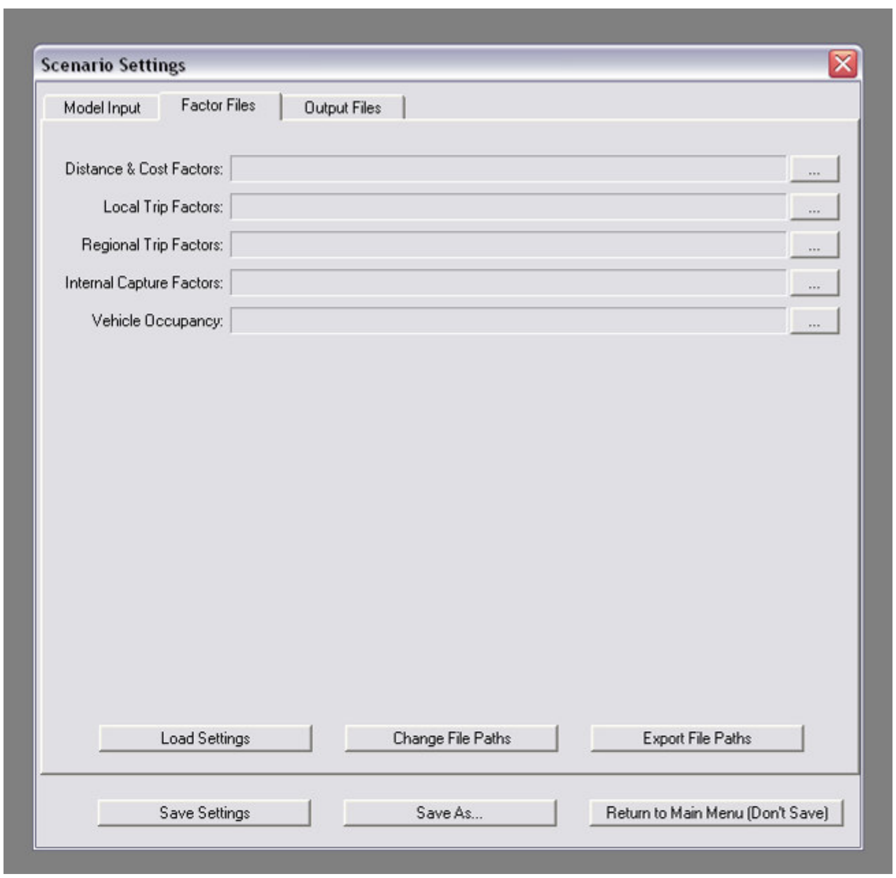


Figure 12: Mode Choice Factor Inputs

In each situation, the team relied on ranges developed through national research that compares results observed in regions of similar size to the Grand Traverse region. Based on regions of similar size, density, and transit ridership each component of the mode choice was refined to meet expected criteria. The following four pages show a flow chart of exactly how the additional factors are incorporated into the model process. The first page shows the overview of how the process is incorporated into the four step modeling process. The remaining three pages reflect how each specific element of the mode choice model works. Again it is important to note that this is a scenario planning tool and that final road projects were evaluated both with and without this mode choice tool.

The 4D mode choice model was chosen as the most effective tool to develop and evaluate a mode specific model for each scenario within the study area for several reasons. First, the process has been used successfully in many areas throughout the country including Southern Louisiana, Dallas, Phoenix, and Tulsa. A similar process called Aggregate Rail Ridership Program (ARRP) is used in the State of Florida as a means to back check traditional mode choice models. In many cases, the ARRP process derives more realistic ridership numbers which are presented to the Federal Transit Authority (FTA) for agreement. Second, the pairing of a mixed use, walkable villages land use pattern with a complementary transportation system is a key element in increasing the number of non-auto trips. The use of a traditional mode choice model within a visioning and scenario planning process would be limiting because the current FTA process does not allow for land use to be considered for New Starts transit facilities. It also would not allow for the consideration of transit options which are part of the future scenarios but do not currently exist. For these reasons, the 4D modeling process was used because it was a better tool than a traditional mode choice model and the most effective tool for the Grand Vision project.

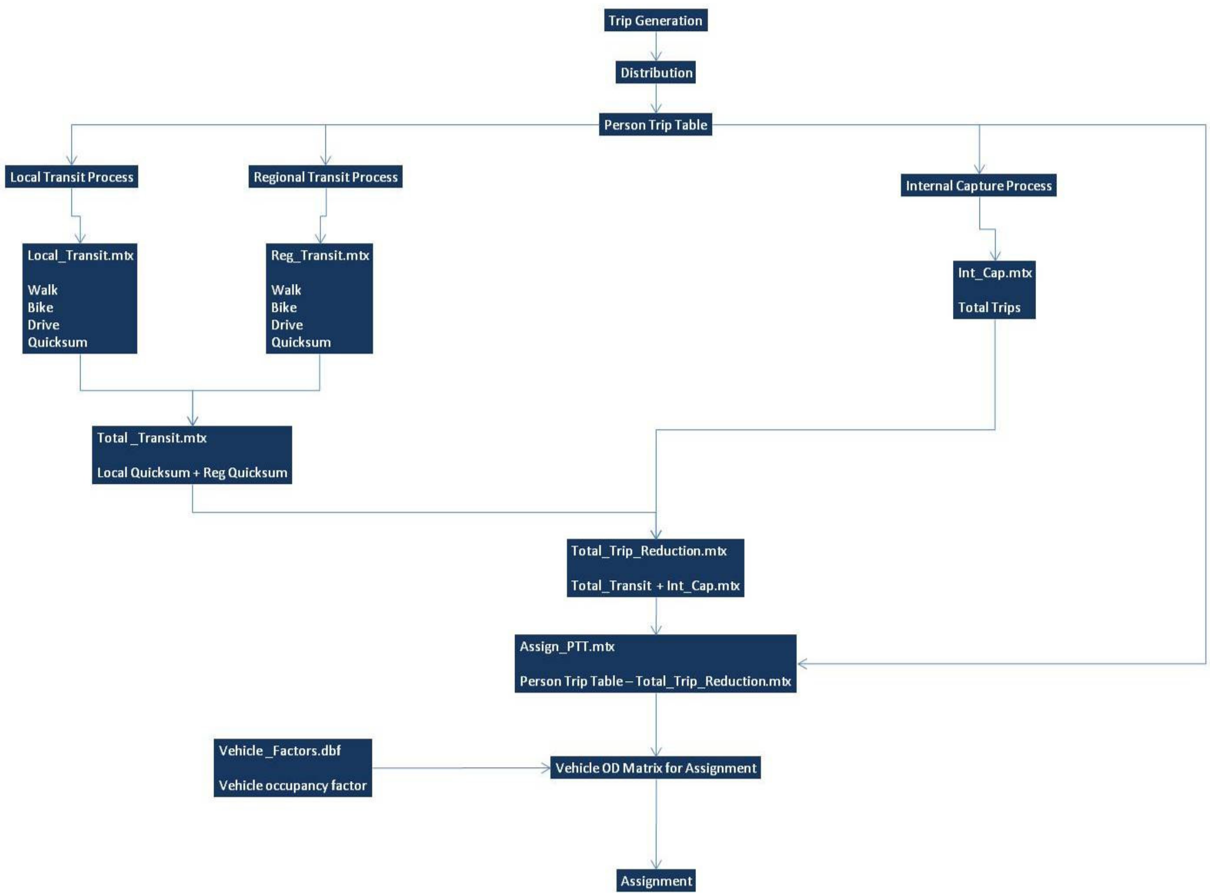


Figure 13: Mode Choice Overview Flow Chart

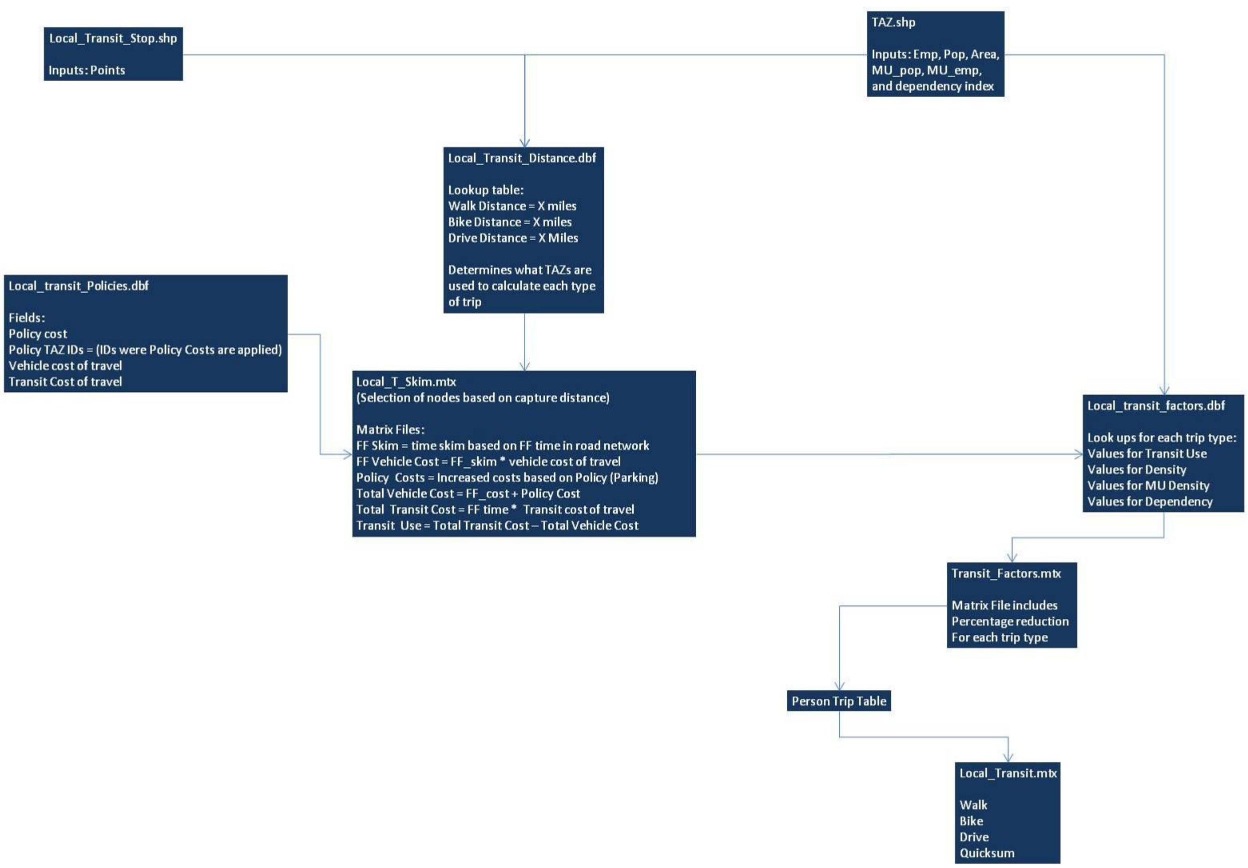


Figure 14: Mode Choice Local Transit Process Flow

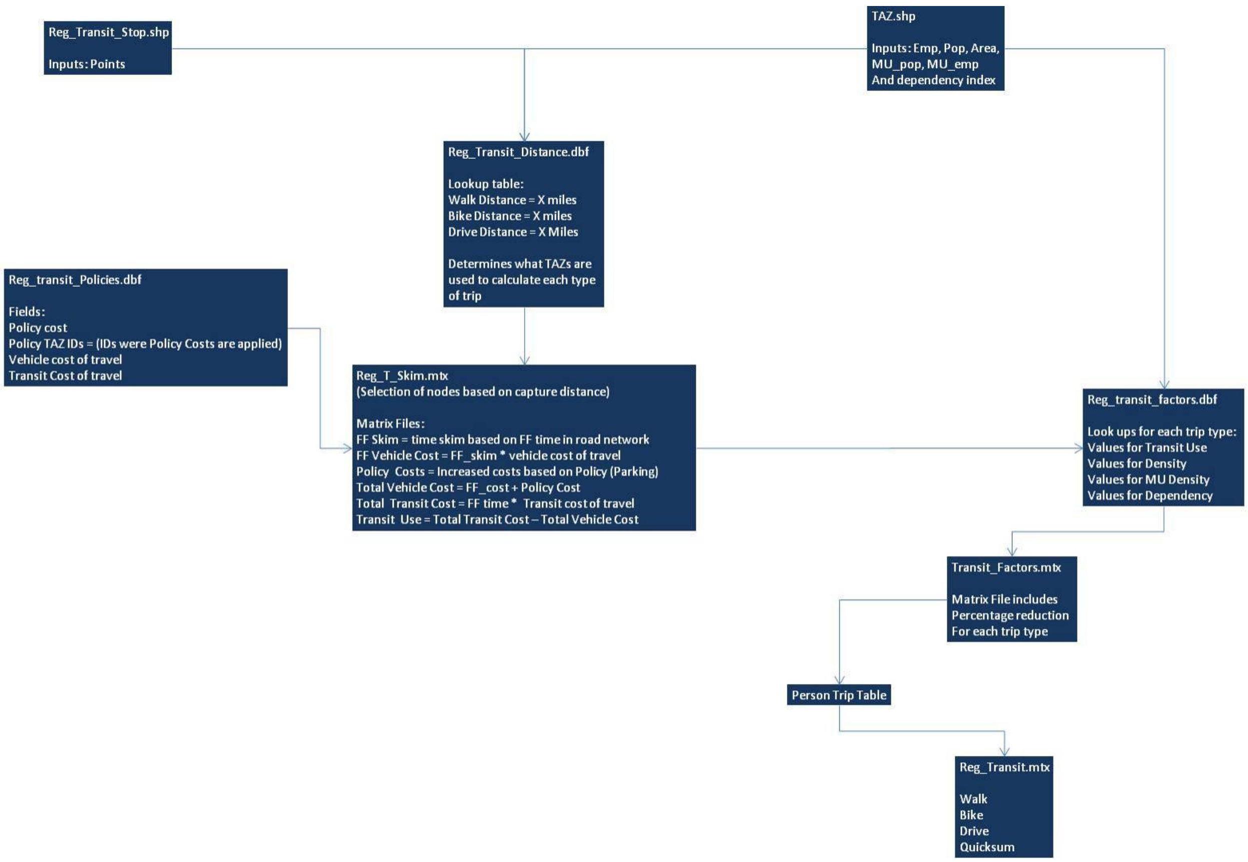


Figure 15: Mode Choice Regional Transit Process Flow

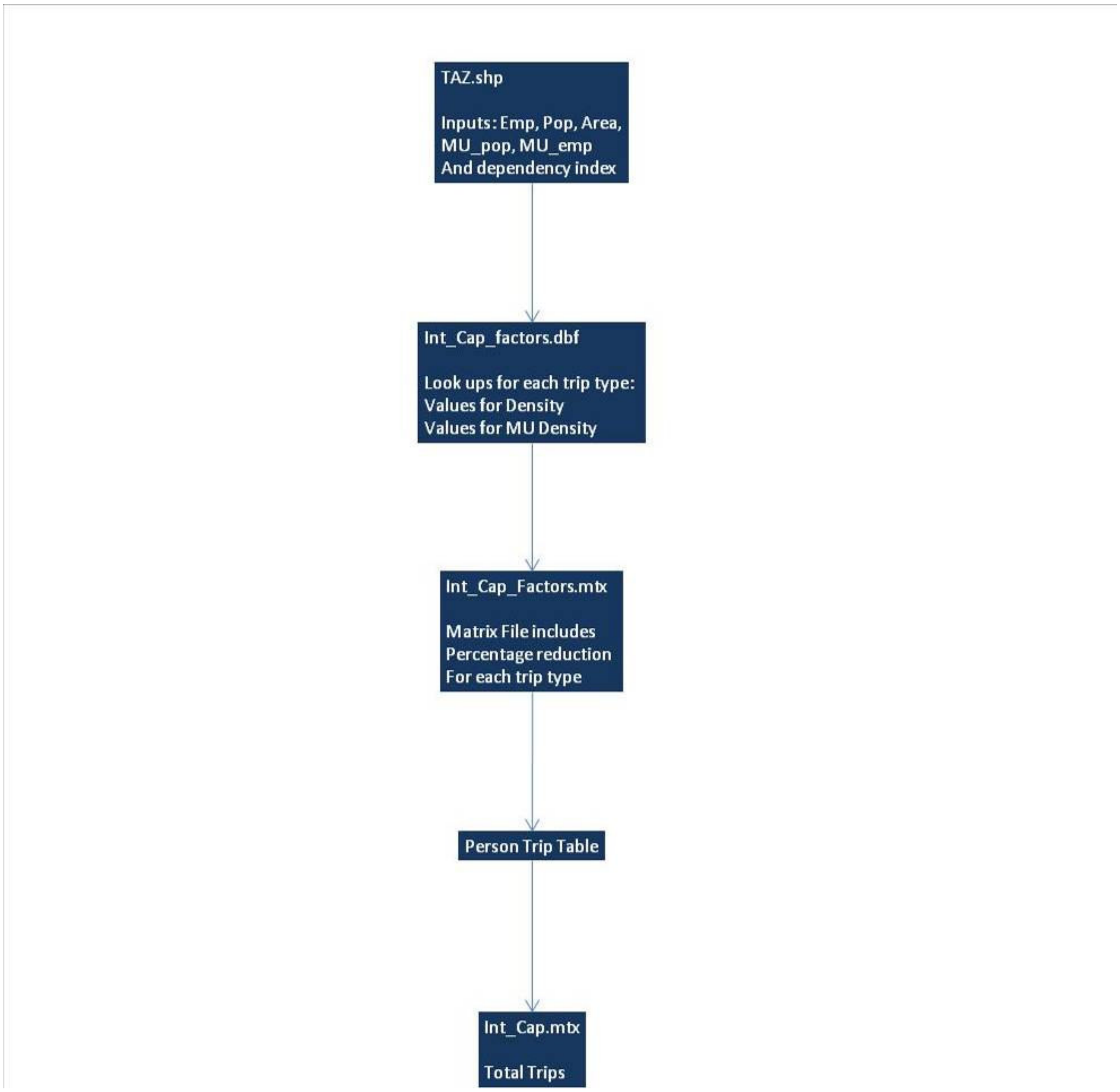
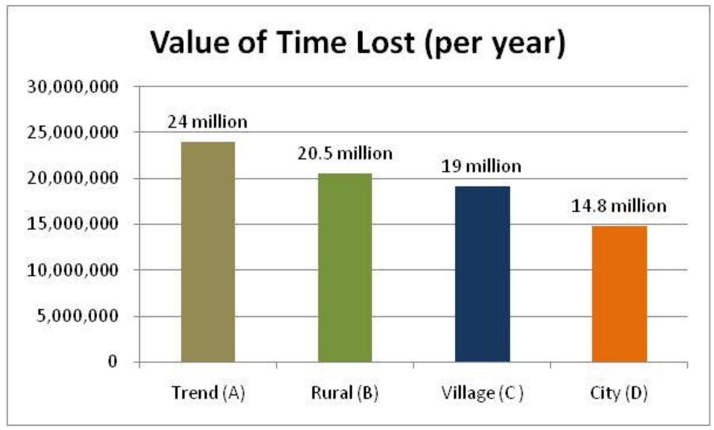


Figure 16: Mode Choice Internal Capture Process Flow

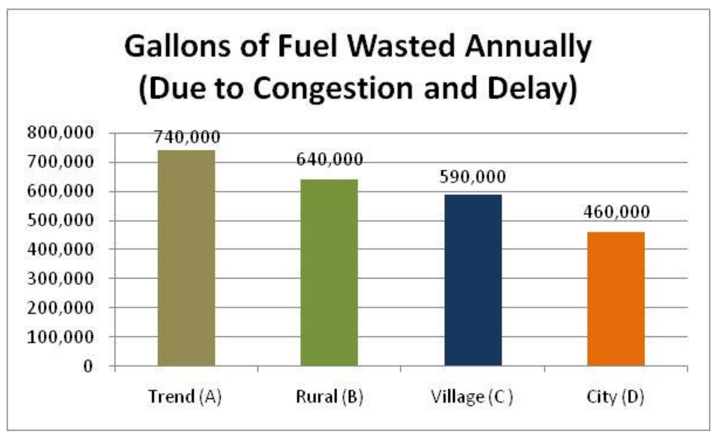
Scenario Modeling

Through the public participation process four different 2035 land use scenarios were developed to explore growing population concerns in the region. In response to changing land use patterns, the transportation element was developed to marry land use patterns with associated transportation scenarios. As employment and households move and change over time, transportation effects are inevitable. For example, if a new employment center is established on the southeast portion of the city on Hammond Road, how is that going to affect transportation in the area and across the region?

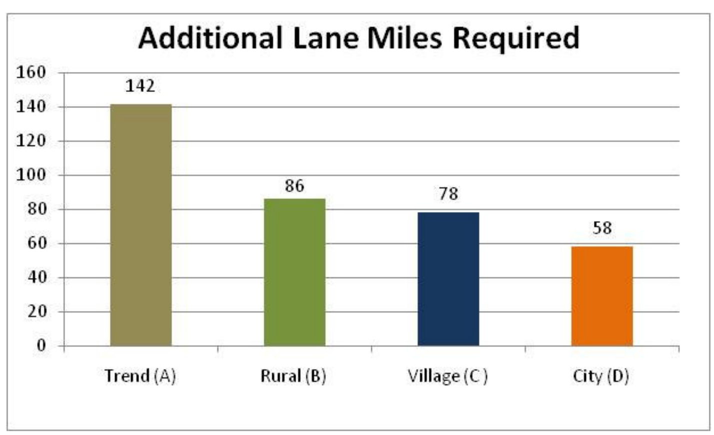
The TDM takes the existing conditions and uses future demographic data to predict future scenarios based on the differing trends in land use. By using the TC-TALUS TDM, transportation professionals can test the consequences of each growth scenario. The four scenarios are: trend, rural, Village and City. It must be noted that the modeling results from all these scenarios were built upon an initial 2007 year TDM and not the updated 2007 TDM that is described in the preceding pages of this document.



By using indicators such as vehicle miles traveled (VMT), vehicle hours traveled (VHT), and delay, one can predict future outcomes that may occur in each scenario. Other indicators that are of particular importance for transportation planning purposes are Value of Time Lost and Gallons of Fuel Wasted Annually. The graphs on the right show the changes between the different scenarios. Notice how as the scenarios move from A to D the Time Lost, Fuel Wasted and Additional Lane Miles Required decreases. This identifies that our land use and development patterns have a clear effect on the transportation systems, both their function and cost. These examples do not necessarily determine that scenario D is the best option for the Grand Traverse region, but they are merely indicators of different development choices and the resulting cost associated.



As a result of the expected growth between 2007 and 2035, the roadway facilities in each of the scenarios will witness varying travel patterns. Therefore each scenario required a different emphasis on improvements, including multi-modal changes such as transit. The following sections describe the different roadway and transit scenarios as a result of the changes in the travel demand model.



Scenario Population and Employment

The TC-TALUS modeled region is expected to grow by more than ten thousand housing units between 2007 and 2035. The table below illustrates forecasted households for each scenario in the area covered by the TC-TALUS travel demand model.

Table 14: 2035 Total Households within each Scenario

Trend Households	City Households	Rural Households	Village Households
43,220	46,682	42,604	40,528

Employment within the region is also expected to grow. **Tables 15-18** below show the employment figures for retail, non retail, service, and total employment for each scenario. The difference in housing units and employment figures can be explained by understanding the distribution of the total population and employment figures in the five county region that is outside of the bounds of this TDM. Maps displaying the total housing and employment are illustrated on the following pages.

Table 15: 2035 Trend Case Employment Summary

Trend Retail	Trend Non Retail	Trend Service	Trend Total Employment
14,494	25,978	41,154	81,626

Table 16: 2035 City Employment Summary

City Retail	City Non Retail	City Service	City Total Employment
14,855	26,505	39,475	80,835

Table 17: 2035 Rural Employment Summary

Rural Retail	Rural Non Retail	Rural Service	Rural Total Employment
13,233	26,204	38,228	77,665

Table 18: 2035 Village Employment Summary

Village Retail	Village Non Retail	Village Service	Village Total Employment
12,771	25,773	36,668	75,212

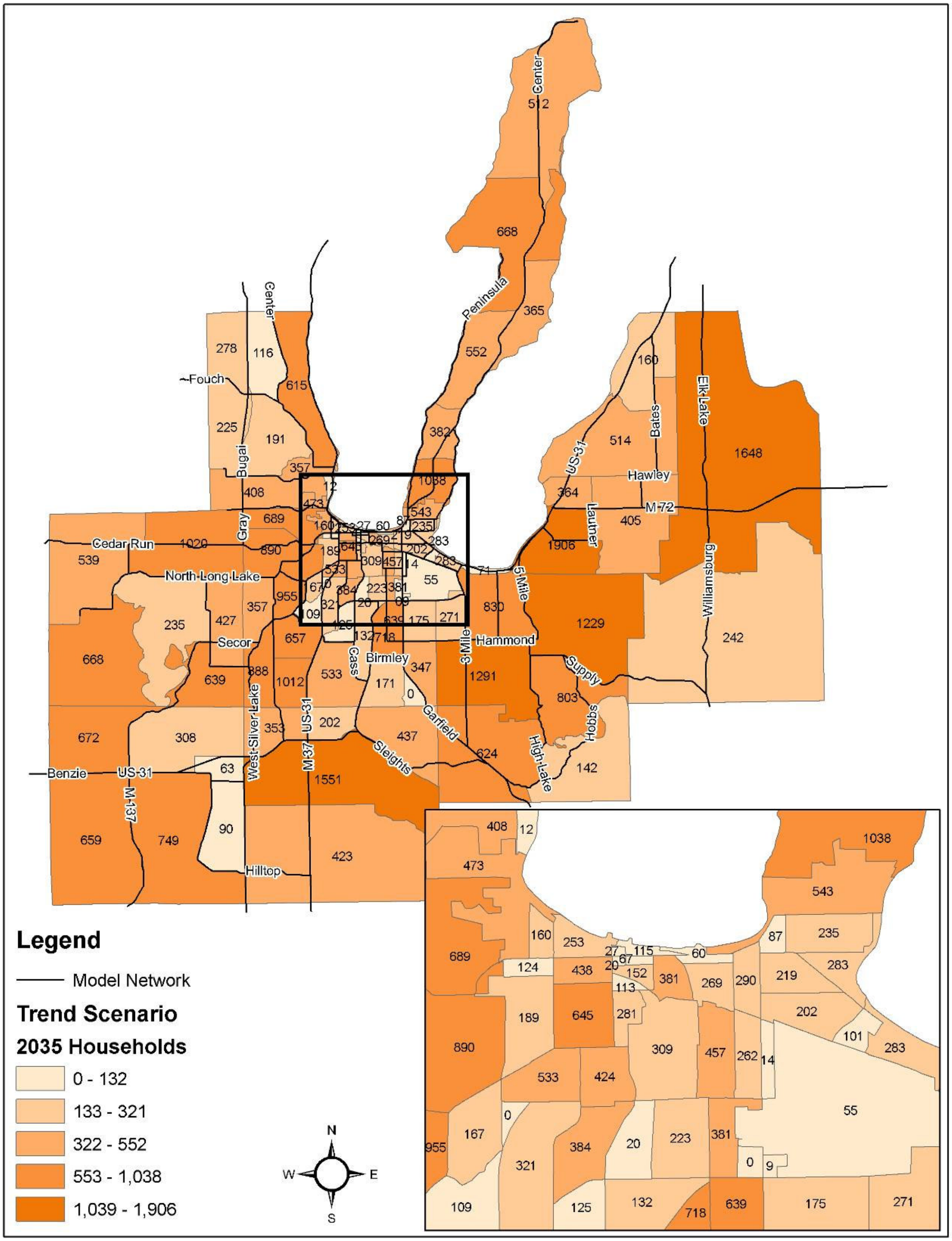


Figure 17: 2035 Trend Case Households by TAZ

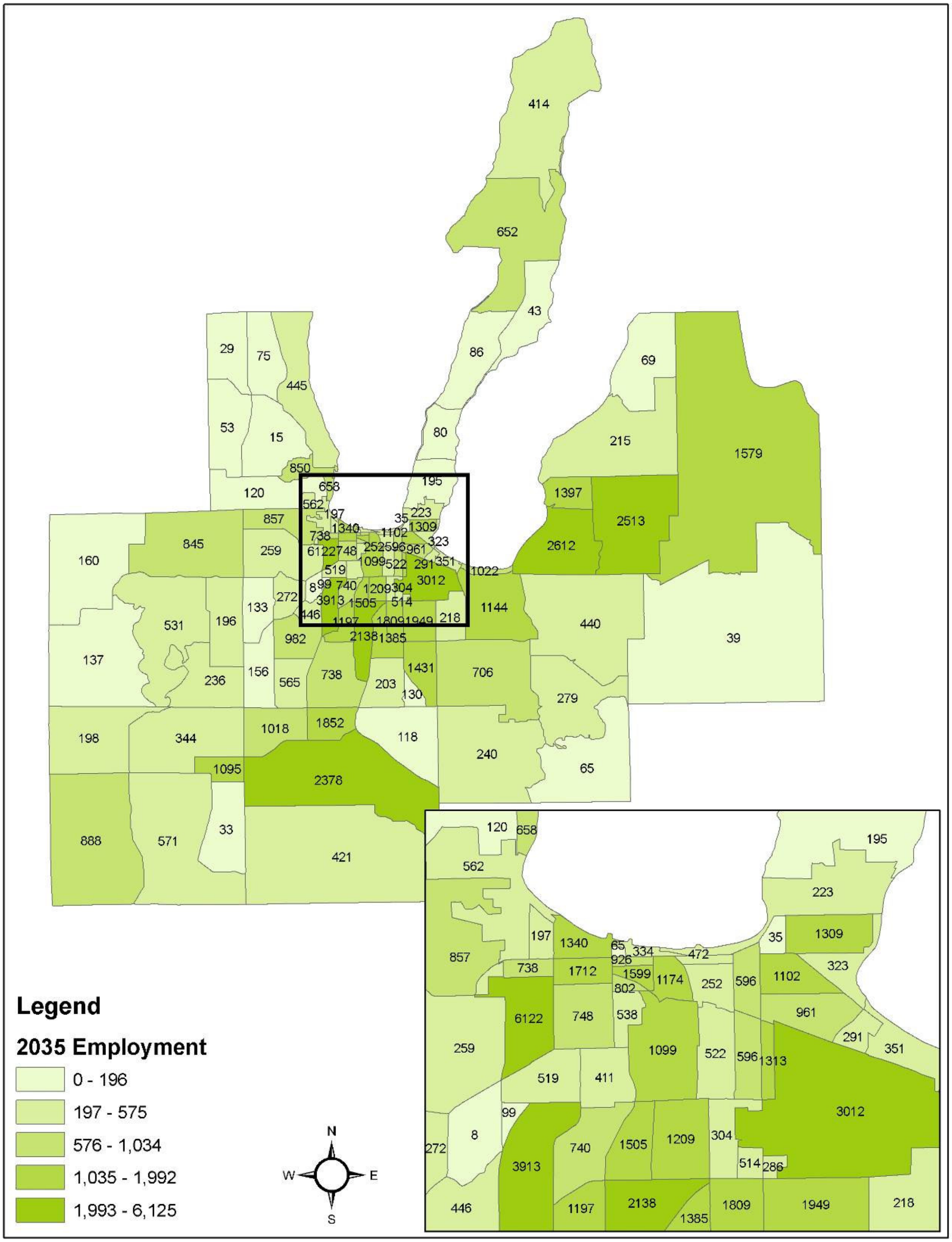


Figure 18: 2035 Trend Case Employment by TAZ

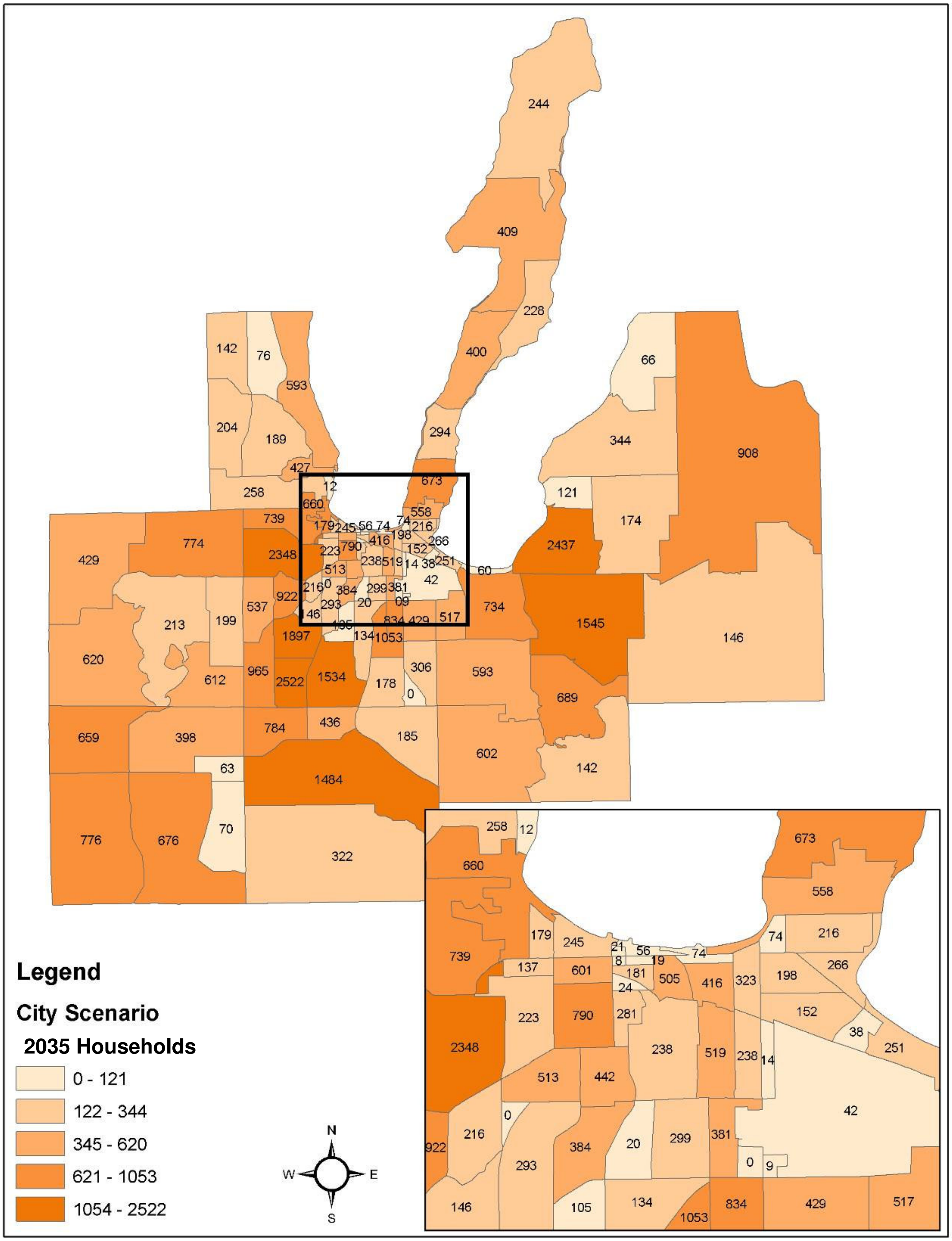


Figure 19: 2035 City Households by TAZ

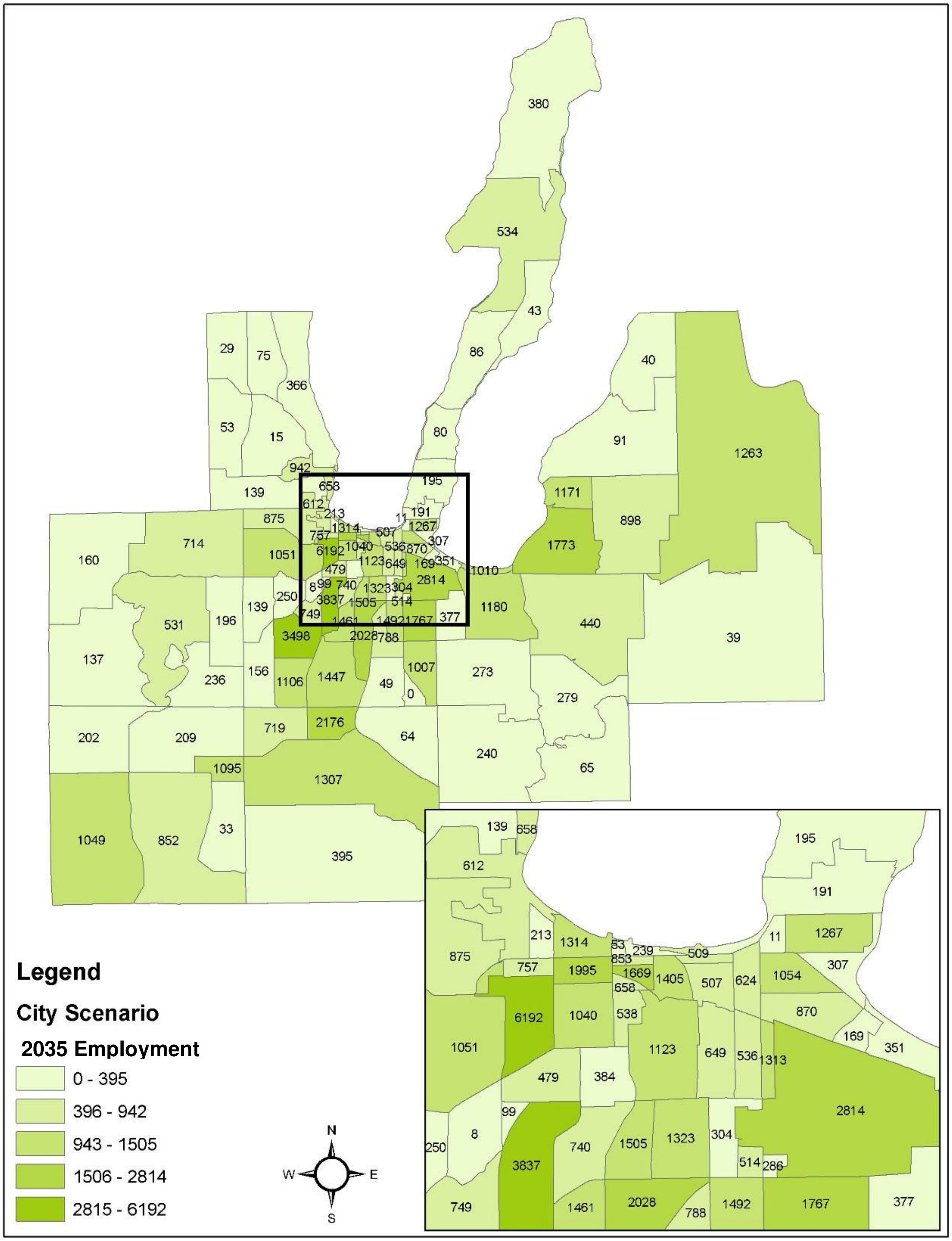


Figure 20: 2035 City Employment by TAZ

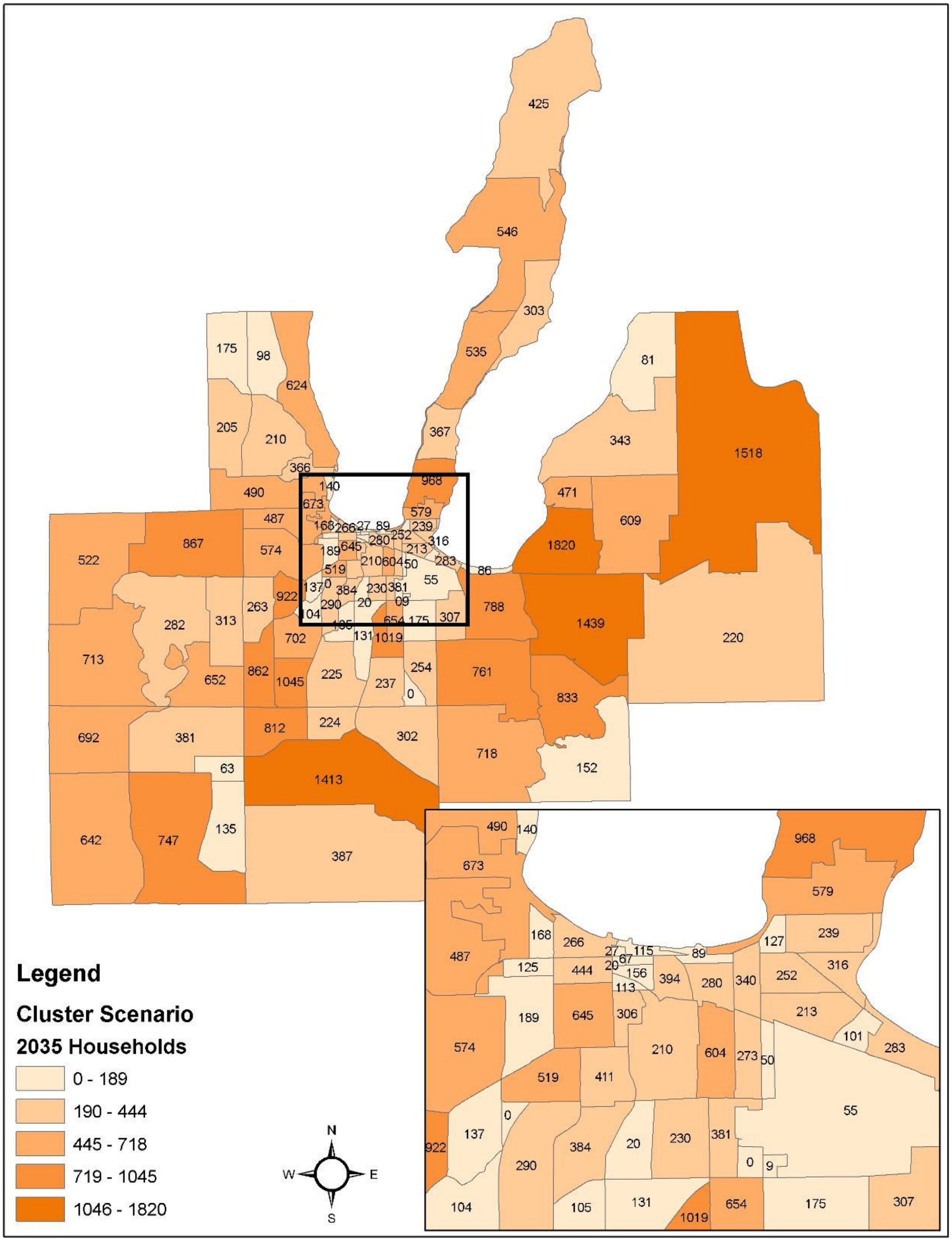


Figure 21: 2035 Rural Households by TAZ

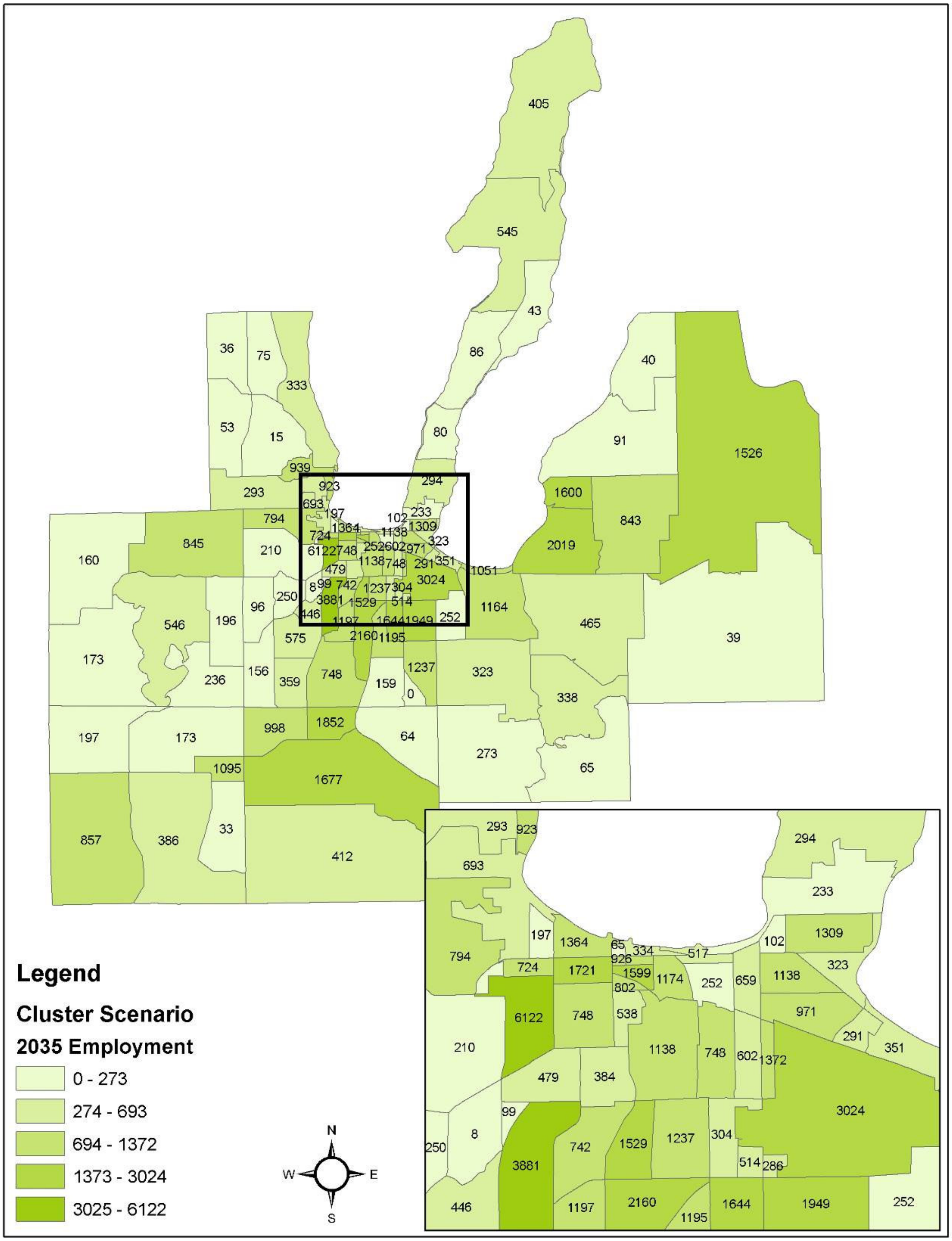


Figure 22: 2035 Rural Cluster Employment by TAZ

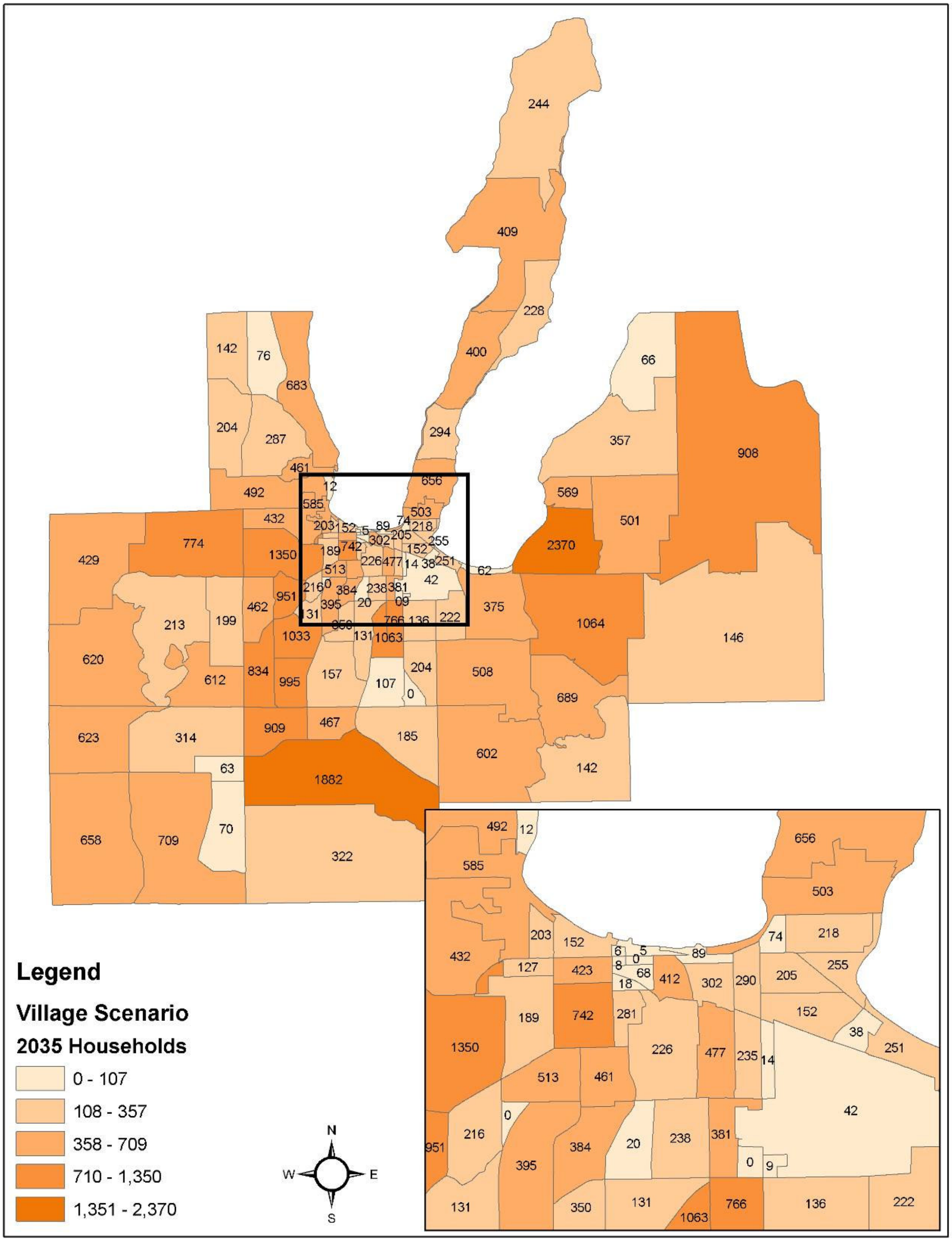


Figure 23: 2035 Village Households by TAZ

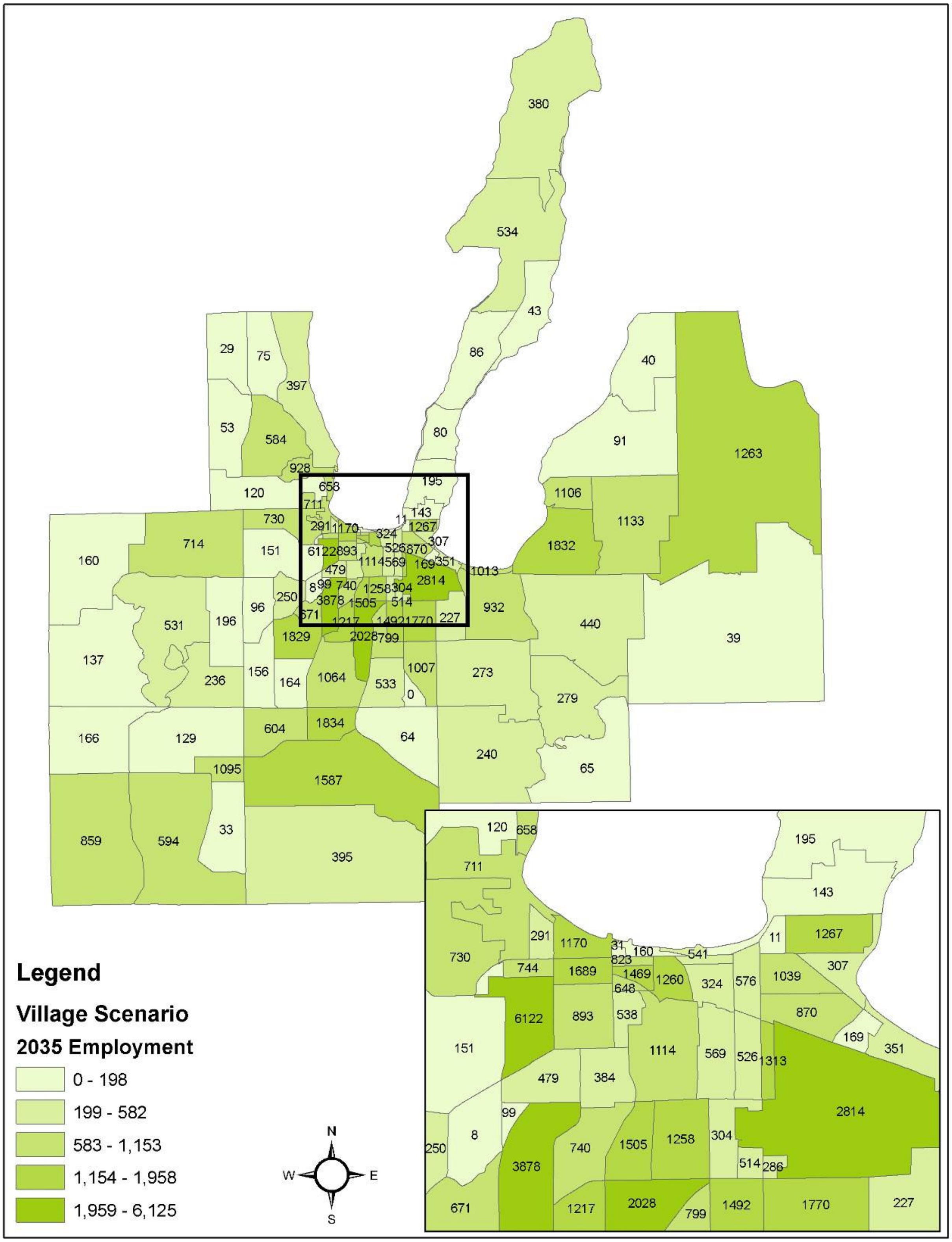


Figure 24: 2035 Village Employment by TAZ

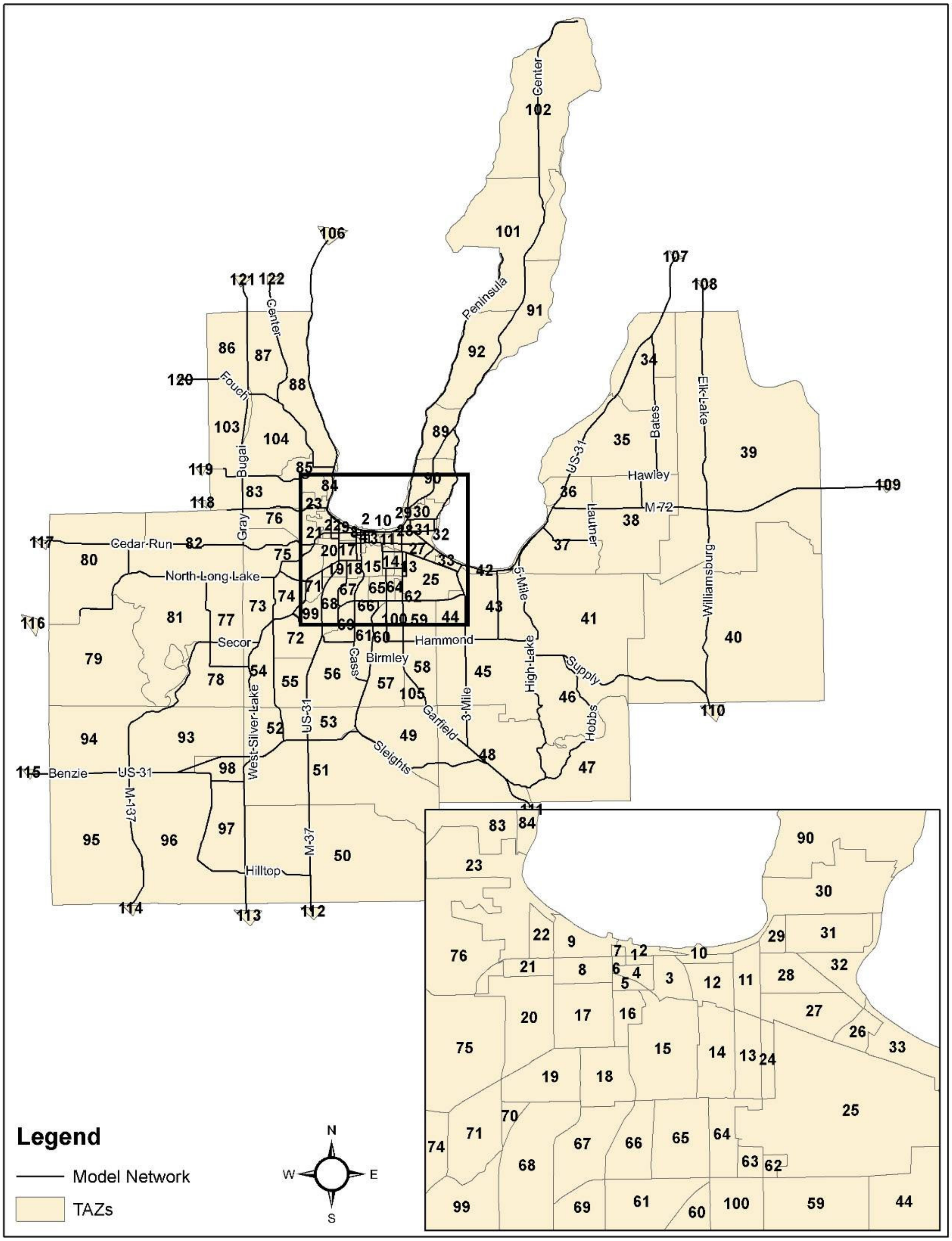


Figure 25: TAZ ID Reference

Table 19: 2035 Households/Employment by TAZ

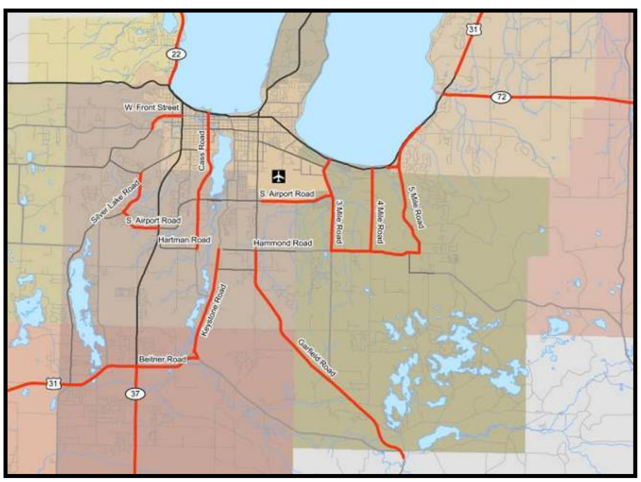
TAZ	Trend					City					Rural					Village				
	Housing Units	Retail	Other	Service	Total Employment	Housing Units	Retail	Other	Service	Total Employment	Housing Units	Retail	Other	Service	Total Employment	Housing Units	Retail	Other	Service	Total Employment
1	67	183	399	345	926	19	165	399	289	853	67	183	399	345	926	0	158	399	266	823
2	115	87	24	223	334	56	59	24	156	239	115	87	24	223	334	5	40	24	96	160
3	381	155	426	593	1174	505	249	426	730	1405	394	155	426	593	1174	412	214	426	621	1260
4	152	39	763	796	1599	181	85	763	821	1669	156	39	763	796	1599	68	8	763	698	1469
5	113	75	470	258	802	24	30	470	158	658	113	75	470	258	802	18	28	470	150	648
6	20	178	225	474	877	8	165	225	462	852	20	178	225	474	877	8	165	225	462	852
7	27	27	6	32	65	21	22	6	25	53	27	27	6	32	65	6	16	6	8	31
8	438	225	722	765	1712	601	324	722	949	1995	444	227	722	772	1721	423	223	722	744	1689
9	253	173	261	906	1340	245	152	261	901	1314	266	184	261	918	1364	152	118	261	792	1170
10	60	13	30	428	472	74	40	30	439	509	89	34	30	452	517	89	58	30	453	541
11	290	135	119	342	596	323	142	119	362	624	340	147	119	393	659	290	126	119	331	576
12	269	107	29	116	252	416	198	29	280	507	280	107	29	116	252	302	147	29	148	324
13	262	109	128	360	596	238	75	128	333	536	273	106	133	363	602	235	69	128	328	526
14	457	47	220	255	522	519	120	220	309	649	604	137	220	390	748	477	76	220	273	569
15	309	65	850	184	1099	238	81	850	191	1123	210	57	897	184	1138	226	76	850	187	1114
16	281	147	16	375	538	281	147	16	375	538	306	147	16	375	538	281	147	16	375	538
17	645	57	195	496	748	790	220	195	625	1040	645	57	195	496	748	742	139	195	560	893
18	424	34	32	345	411	442	21	32	330	384	411	21	32	330	384	461	21	32	330	384
19	533	182	87	249	519	513	162	87	230	479	519	162	87	230	479	513	162	87	230	479
20	189	12	419	5691	6122	223	51	419	5722	6192	189	12	419	5691	6122	189	12	419	5691	6122
21	124	160	103	476	738	137	170	103	484	757	125	152	103	470	724	127	162	103	478	744
22	160	8	30	159	197	179	17	30	166	213	168	8	30	159	197	203	60	30	201	291
23	473	89	176	297	562	660	119	176	317	612	673	130	176	386	693	585	158	199	354	711
24	14	145	619	549	1313	14	145	619	549	1313	50	178	619	575	1372	14	145	619	549	1313
25	55	534	1708	770	3012	42	456	1653	705	2814	55	534	1718	772	3024	42	456	1653	705	2814
26	101	99	34	158	291	38	40	34	95	169	101	99	34	158	291	38	40	34	95	169
27	202	110	203	649	961	152	59	203	608	870	213	105	203	663	971	152	59	203	608	870
28	219	183	298	621	1102	198	157	298	600	1054	252	192	298	648	1138	205	148	298	593	1039
29	87	15	2	18	35	74	4	2	5	11	127	51	2	49	102	74	4	2	5	11
30	543	47	41	135	223	558	38	41	112	191	579	53	41	139	233	503	11	41	91	143
31	235	32	8	1270	1309	216	8	8	1251	1267	239	32	8	1270	1309	218	8	8	1251	1267
32	283	14	146	163	323	266	5	146	156	307	316	14	146	163	323	255	5	146	156	307
33	283	6	147	198	351	251	6	147	198	351	283	6	147	198	351	251	6	147	198	351
34	160	25	3	41	69	66	9	3	28	40	81	9	3	28	40	66	9	3	28	40
35	514	115	10	90	215	344	44	10	37	91	343	44	10	37	91	357	44	10	37	91
36	364	300	67	1030	1397	121	362	97	712	1171	471	438	78	1084	1600	569	327	65	715	1106
37	1906	542	306	1765	2612	2437	420	370	983	1773	1820	296	373	1349	2019	2370	383	438	1012	1832

TAZ	Trend					City					Rural					Village				
	Housing Units	Retail	Other	Service	Total Employment	Housing Units	Retail	Other	Service	Total Employment	Housing Units	Retail	Other	Service	Total Employment	Housing Units	Retail	Other	Service	Total Employment
38	405	578	433	1503	2513	174	79	271	548	898	609	78	271	495	843	501	227	272	634	1133
39	1648	148	541	889	1579	908	61	518	683	1263	1518	110	541	875	1526	908	61	518	683	1263
40	242	0	12	27	39	146	0	12	27	39	220	0	12	27	39	146	0	12	27	39
41	1229	20	151	268	440	1545	20	151	268	440	1439	35	151	280	465	1064	20	151	268	440
42	71	74	113	836	1022	60	66	113	830	1010	86	87	113	851	1051	62	68	113	831	1013
43	830	47	472	626	1144	734	178	413	589	1180	788	88	486	591	1164	375	38	413	481	932
44	271	2	118	98	218	517	86	125	167	377	307	21	121	110	252	222	3	125	99	227
45	1291	238	61	406	706	593	65	59	149	273	761	91	61	171	323	508	65	59	149	273
46	803	10	159	110	279	689	10	159	110	279	833	43	159	136	338	689	10	159	110	279
47	142	0	53	12	65	142	0	53	12	65	152	0	53	12	65	142	0	53	12	65
48	624	83	75	83	240	602	83	75	83	240	718	99	75	99	273	602	83	75	83	240
49	437	32	48	37	118	185	0	48	16	64	302	0	48	16	64	185	0	48	16	64
50	423	60	283	78	421	322	46	283	66	395	387	55	283	74	412	322	46	283	66	395
51	1551	320	663	1395	2378	1484	202	624	482	1307	1413	202	822	654	1677	1882	356	622	609	1587
52	353	314	265	439	1018	784	122	335	262	719	812	341	247	410	998	909	117	247	240	604
53	202	564	686	602	1852	436	753	672	751	2176	224	564	686	602	1852	467	563	672	599	1834
54	888	5	53	98	156	965	5	53	98	156	862	5	53	98	156	834	5	53	98	156
55	1012	209	67	289	565	2522	487	137	482	1106	1045	136	96	127	359	995	72	32	59	164
56	533	88	340	310	738	1534	541	294	611	1447	225	118	354	276	748	157	312	393	359	1064
57	171	7	125	72	203	178	1	6	42	49	237	5	91	63	159	107	32	168	333	533
58	347	164	1010	257	1431	306	44	854	109	1007	254	52	1001	184	1237	204	44	854	109	1007
59	175	209	1144	597	1949	429	163	1061	543	1767	175	209	1144	597	1949	136	165	1061	544	1770
60	718	168	595	622	1385	1053	77	539	172	788	1019	144	566	484	1195	1063	84	539	177	799
61	132	255	1059	824	2138	134	252	1055	721	2028	131	256	1076	828	2160	131	252	1055	721	2028
62	9	147	36	103	286	9	147	36	103	286	9	147	36	103	286	9	147	36	103	286
63	0	426	35	53	514	0	426	35	53	514	0	426	35	53	514	0	426	35	53	514
64	381	29	183	93	304	381	29	183	93	304	381	29	183	93	304	381	29	183	93	304
65	223	164	686	359	1209	299	223	686	414	1323	230	173	695	368	1237	238	191	686	381	1258
66	20	34	1147	324	1505	20	34	1147	324	1505	20	35	1165	329	1529	20	34	1147	324	1505
67	384	60	345	335	740	384	60	345	335	740	384	60	347	335	742	384	60	345	335	740
68	321	2430	454	1029	3913	293	2388	454	996	3837	290	2412	454	1015	3881	395	2407	454	1017	3878
69	125	650	243	304	1197	105	657	243	560	1461	105	650	244	304	1197	350	659	243	315	1217
70	0	27	46	27	99	0	27	46	27	99	0	27	46	27	99	0	27	46	27	99
71	167	0	6	2	8	216	0	6	2	8	137	0	6	2	8	216	0	6	2	8
72	657	432	121	429	982	1897	784	1060	1654	3498	702	283	122	170	575	1033	483	371	975	1829
73	357	31	19	82	133	537	38	19	82	139	263	11	19	65	96	462	11	19	65	96
74	955	15	46	211	272	922	3	46	201	250	922	3	46	201	250	951	3	46	201	250
75	890	73	68	118	259	2348	316	302	433	1051	574	43	68	99	210	1350	9	68	73	151

TAZ	Trend					City					Rural					Village				
	Housing Units	Retail	Other	Service	Total Employment	Housing Units	Retail	Other	Service	Total Employment	Housing Units	Retail	Other	Service	Total Employment	Housing Units	Retail	Other	Service	Total Employment
76	689	96	259	502	857	739	101	259	515	875	487	59	259	476	794	432	26	259	446	730
77	427	4	22	170	196	199	4	22	170	196	313	4	22	170	196	199	4	22	170	196
78	639	8	80	148	236	612	8	80	148	236	652	8	80	148	236	612	8	80	148	236
79	668	13	53	70	137	620	13	53	70	137	713	34	53	87	173	620	13	53	70	137
80	539	8	99	53	160	429	8	99	53	160	522	8	99	53	160	429	8	99	53	160
81	235	3	40	488	531	213	3	40	488	531	282	12	40	495	546	213	3	40	488	531
82	1020	137	410	298	845	774	59	410	245	714	867	137	410	298	845	774	59	410	245	714
83	408	12	73	35	120	258	24	73	42	139	490	25	131	137	293	492	12	73	35	120
84	12	48	326	284	658	12	48	326	284	658	140	189	326	408	923	12	48	326	284	658
85	357	20	506	323	850	427	63	506	373	942	366	52	530	357	939	461	64	506	358	928
86	278	0	16	13	29	142	0	16	13	29	175	4	16	16	36	142	0	16	13	29
87	116	0	71	4	75	76	0	71	4	75	98	0	71	4	75	76	0	71	4	75
88	615	211	76	157	445	593	158	74	134	366	624	143	74	116	333	683	179	74	143	397
89	382	15	47	17	80	294	15	47	17	80	367	15	47	17	80	294	15	47	17	80
90	1038	7	54	134	195	673	7	54	134	195	968	62	54	178	294	656	7	54	134	195
91	365	13	18	11	43	228	13	18	11	43	303	13	18	11	43	228	13	18	11	43
92	552	6	47	33	86	400	6	47	33	86	535	6	47	33	86	400	6	47	33	86
93	308	133	73	138	344	398	26	73	111	209	381	40	73	60	173	314	13	73	42	129
94	672	46	76	76	198	659	45	76	80	202	692	46	76	75	197	623	29	76	61	166
95	659	125	128	635	888	776	198	128	722	1049	642	104	128	625	857	658	103	128	628	859
96	749	147	111	313	571	676	179	111	562	852	747	49	111	226	386	709	145	111	338	594
97	90	0	24	9	33	70	0	24	9	33	135	0	24	9	33	70	0	24	9	33
98	63	157	834	104	1095	63	157	834	104	1095	63	157	834	104	1095	63	157	834	104	1095
99	109	267	102	77	446	146	431	102	216	749	104	267	102	77	446	131	347	167	157	671
100	639	164	830	815	1809	834	131	764	598	1492	654	144	821	679	1644	766	131	764	598	1492
101	668	105	127	420	652	409	50	127	357	534	546	55	127	363	545	409	50	127	357	534
102	512	81	149	184	414	244	65	149	165	380	425	77	149	179	405	244	65	149	165	380
103	225	0	30	23	53	204	0	30	23	53	205	0	30	23	53	204	0	30	23	53
104	191	0	12	3	15	189	0	12	3	15	210	0	12	3	15	287	127	12	445	584
105	0	79	0	51	130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**43,220**	**14,494**	**25,978**	**41,154**	**81,625**	**46,682**	**14,855**	**26,505**	**39,475**	**80,835**	**42,604**	**13,233**	**26,204**	**38,228**	**77,665**	**40,528**	**12,771**	**25,773**	**36,668**	**75,211**

Congested Areas

The changes in traffic patterns as a result of scenario planning can vary due to differences in land uses. However, overall there is a lot of overlap between the different scenarios and the streets that will need future focus. As mentioned earlier the 2035 scenario demographics are used in the TDM to determine congestion on the streets in the region. A street with congestion is considered one that has a larger traffic volume than the capacity of street can handle. For example, if a roadway can handle 10,000 vehicles per day and the volume of the road is 12,000 vehicles per day, it is operating above the capacity. The following maps show the priority roadways for each respective planning TDM scenario. While these maps are general in nature, data for each roadway within each model is available. These areas should only be used as a starting point to the development of a long range transportation plan. Once the region agrees upon an approved demographic forecast, a more detailed traffic analysis should be conducted. This analysis was completed to compare growth scenarios using the initial 2007 version of the TDM. The addition of lane miles was determined through demand and level of service (LOS). Roadways that consistently showed poor levels of service (volume to capacity ratio greater than 1) were widened in the future scenarios. Within each scenario, roadways were widened based on a combination of LOS across the link and surrounding land uses. For instance, most roadways that observed poor LOS and were near commercial retail centers are eligible for widening.

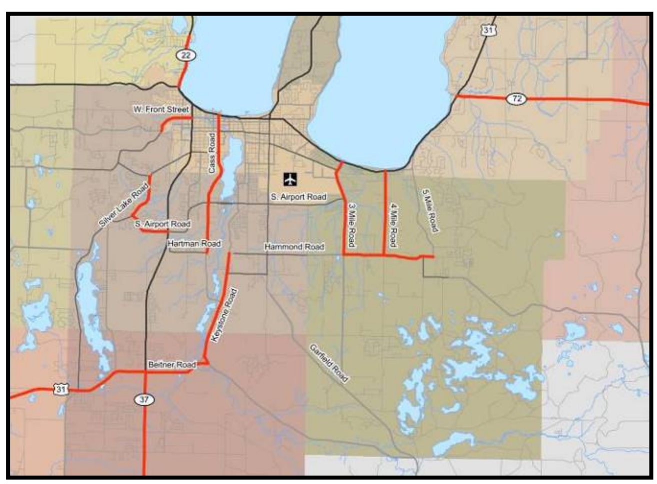


Trend Scenario

The Trend Scenario follows the current progression of development in the area. This scenario has the most corridors of concern with the need to add another 142 lane miles. This development pattern encourages increased driving because the built environment is much less dense, thus increasing VMT, VHT, and Delay.

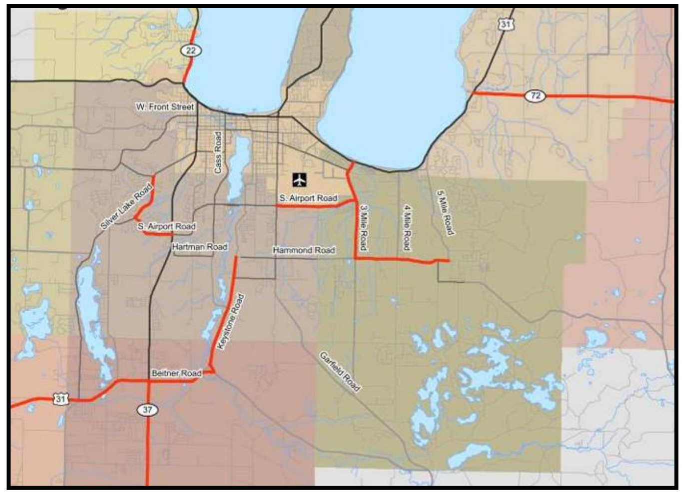
Rural Scenario

This scenario focuses on the development in rural areas as clusters which consolidates growth into focus nodes. This growth pattern reduces vehicle travel within the region; however, it is still a dispersed type of development. The amount of lane miles needed to accommodate the growth in this scenario is 86 additional miles.



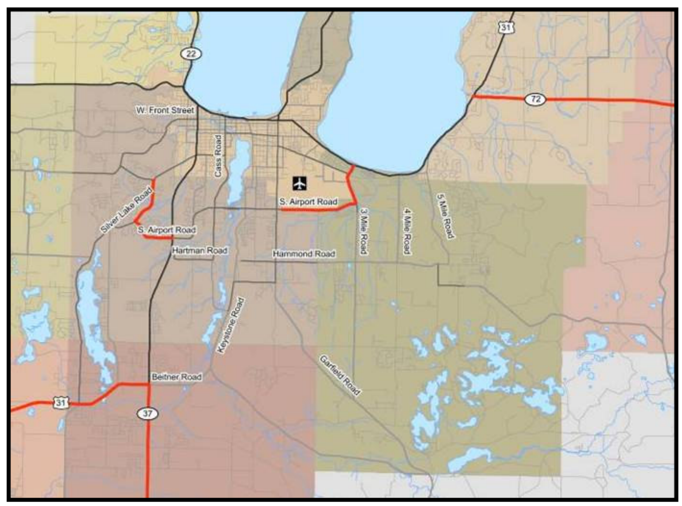
Village Scenario

As a result of even more focused development in key areas of the region, this scenario limits the need for new roadway infrastructure with only 78 lane miles needed.



City Scenario

This scenario allows for growth to occur mainly in already populated areas the region. This scenario has the highest population density and employment of any scenario and therefore people will not need to drive as far as they would in a more spread out pattern. Only 58 additional lane miles are needed under this type of growth pattern, making it the least expensive transportation alternative in terms of roadway construction.



The **Table 20** demonstrates the overall mobility indicators for each scenario. While the TDM has volumes and delay for every link, their numbers are better reflected in a summary format as shown below. It is also important to note that the model only contains arterials and collectors. Subsequently, as the network becomes dense in the urban areas, an operations model is needed to truly evaluate the congestion levels. For instance, in downtown Traverse City the gridded network can handle much more traffic than this model reflects. It is recommended that a specific downtown circulation plan be developed before any projects are recommended. TDMs are an excellent tool to compare scenarios and determine overall mobility indicators.

Table 20: Mobility Indicators by Scenario

Scenario		Trend (A)	Rural (B)	Village (C)	City (D)
Model with 4D Processing	Vehicle Miles Traveled	2,500,000	2,400,000	2,300,000	2,100,000
	Vehicle Hours Traveled	51,000	47,600	46,800	42,500
	Delay	3,400	2,900	2,700	2,100
	Additional Lane Miles	142	86	78	58
	Urban Lane Miles	40	26	18	10
	Rural Lane Miles	102	60	60	48
	Total Transit Ridership	13,000	11,500	12,000	22,000
	Walked to Transit	9,750	8,625	9,000	16,500
	Bike to Transit	2,600	2,300	2,400	4,400
	Drive to Transit	650	575	600	1,100
	Total Walk Trips	21,700	32,800	37,800	48,600
	Total Vehicle Trips	326,000	302,000	300,000	288,000
	Value of Time Lost (per year)	$24,000,000	$20,500,000	$19,100,000	$14,800,000
	Gallons of Fuel Wasted Annually	740,000	640,000	590,000	460,000
	Air Quality (per day)				
	NoX(g)	4,000	3,800	3,800	3,500
	CO2(g)	14,700	13,900	13,700	12,600
	VOC(g)	391	365	355	327

* Table represents modeling results from an initial 2007 year TDM and not the updated 2007 TDM.

Transit

With changes in land use patterns in the region, transit has the potential to function either more or less efficiently depending on the choices made. If households and locations of employment become dense, these nodes create a preferred environment for transit ridership. Areas in the city that have dense populations are more likely to have high ridership on transit routes than more suburban locations. It is suggested that the following minimum densities be used to evaluate the ability to run a transit service in an area:

Table 21: Minimum Densities for Supporting Transit[1]

	Local Bus, Intermediate Service	Local Bus, Frequent Service	Light Rail	Heavy Transit
Dwelling units per acre	7	15	9	12
Residents per acre	18	38	23	30
Employees per acre	20	75	125+	N.A.

For the Grand Traverse area, increased bus service can be more efficient in areas that have dwelling unit densities greater than seven units per acre. The increased potential for transit usage can help alleviate other aspects of the transportation system by taking personal trips out of the private automobile and into public transit. This in turn can remove traffic from the roads and increase their potential person capacity.

Different transit scenarios were developed to coincide with the different land use scenarios developed through the public participation process as shown in the following figures.

[1] Robert Dunphy, Deborah Myerson, & Michael Pawlukiewicz. (2003) *Ten Principles for Successful Development Around Transit,* Urban Land Institute

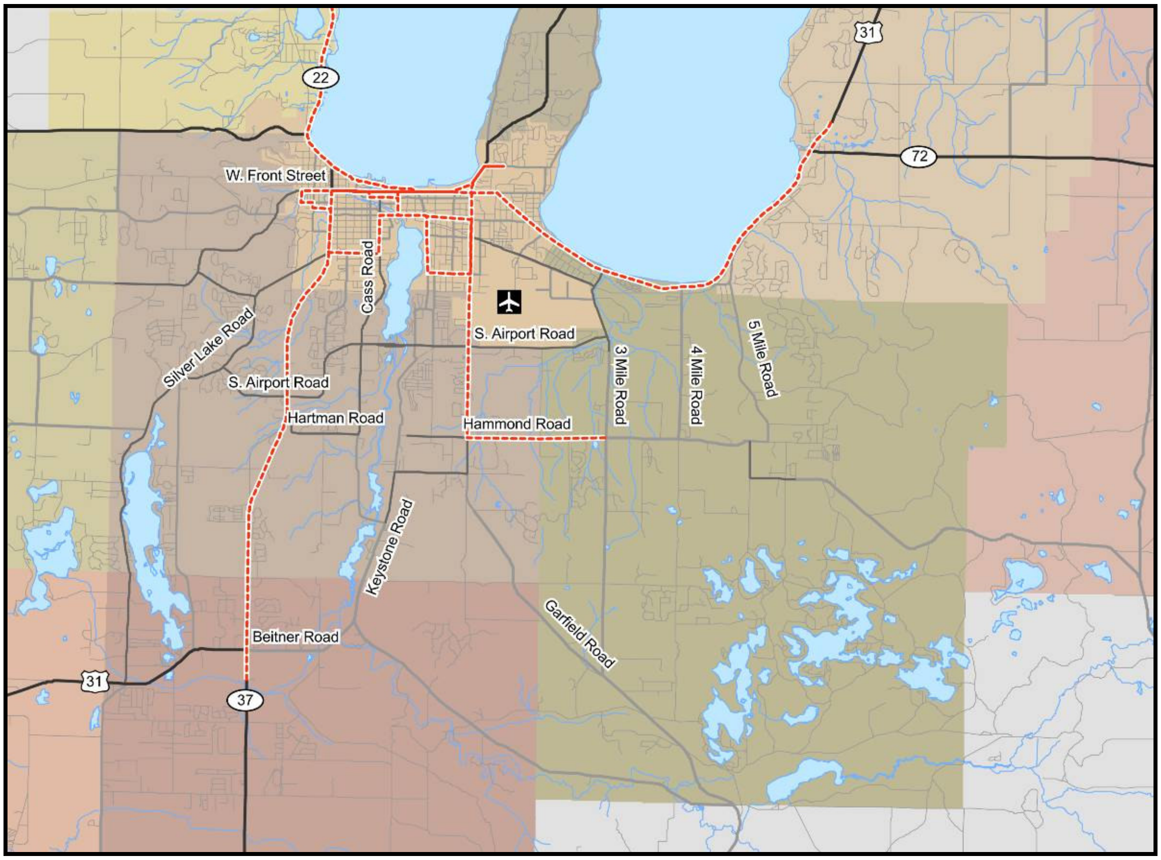


Figure 26: Trend Scenario Transit Lines

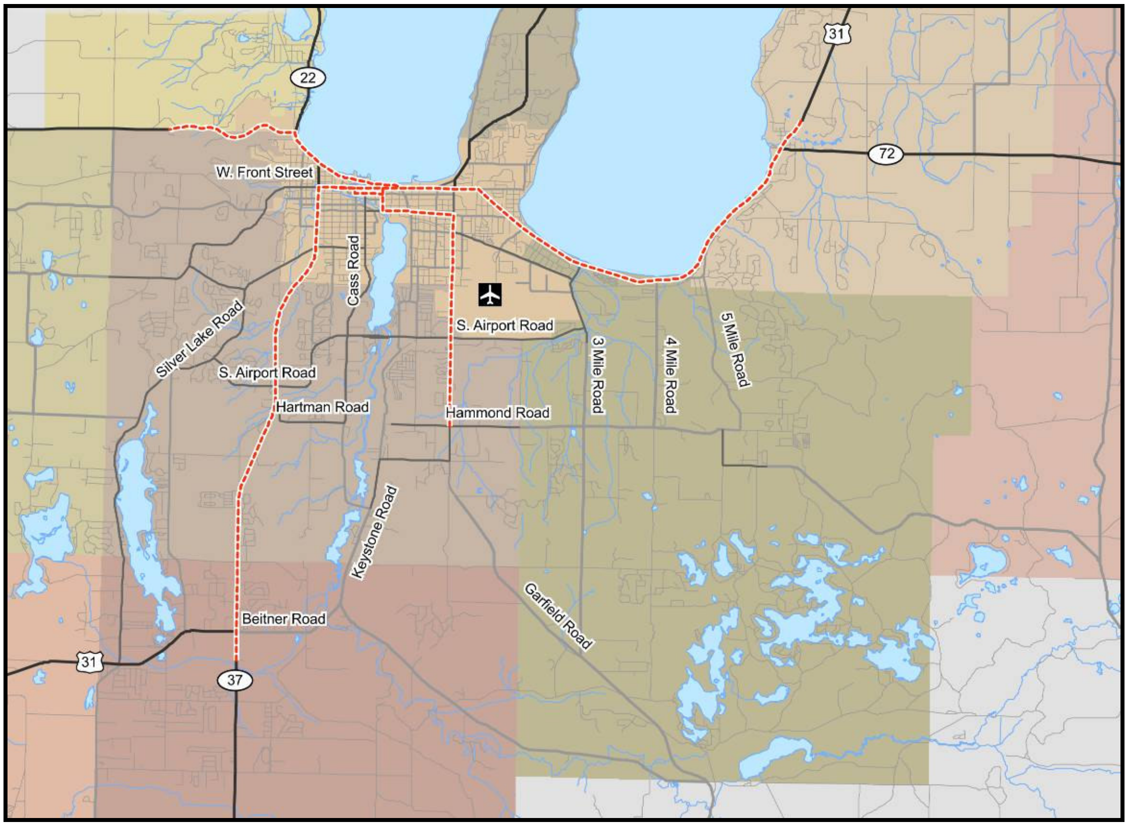


Figure 27: Rural Scenario Transit Lines

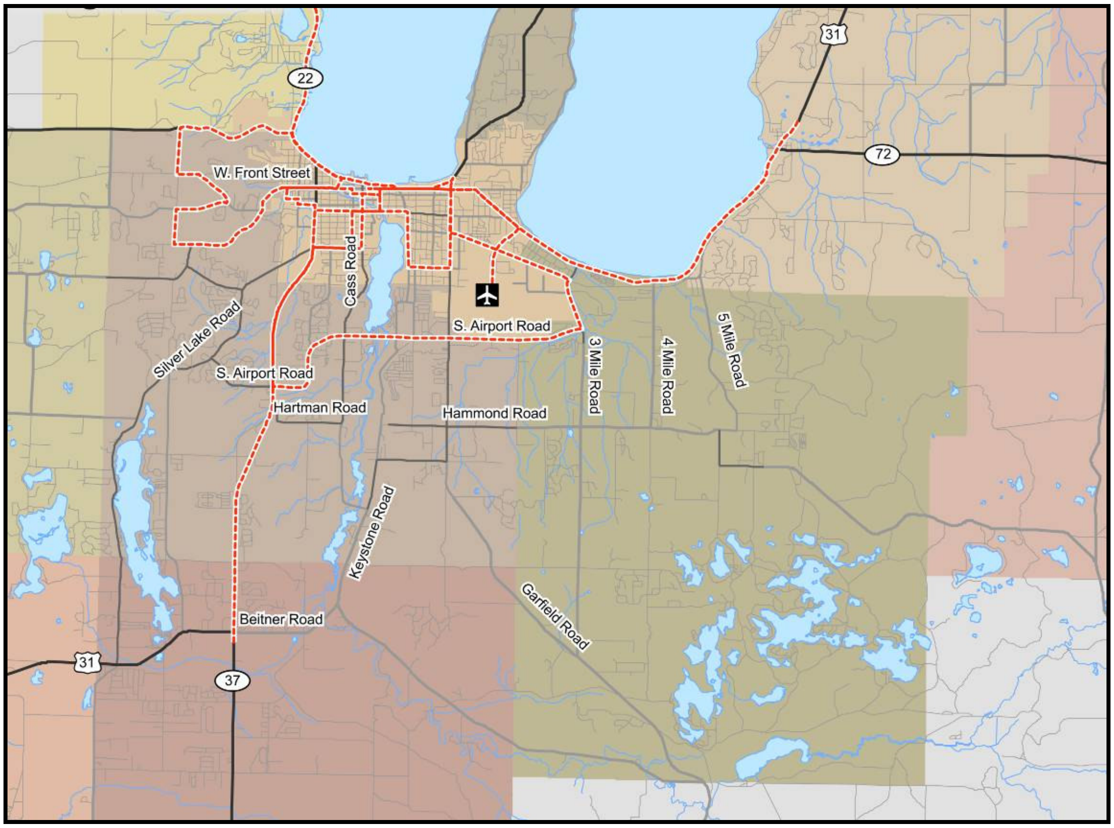


Figure 28: Village Scenario Transit Lines

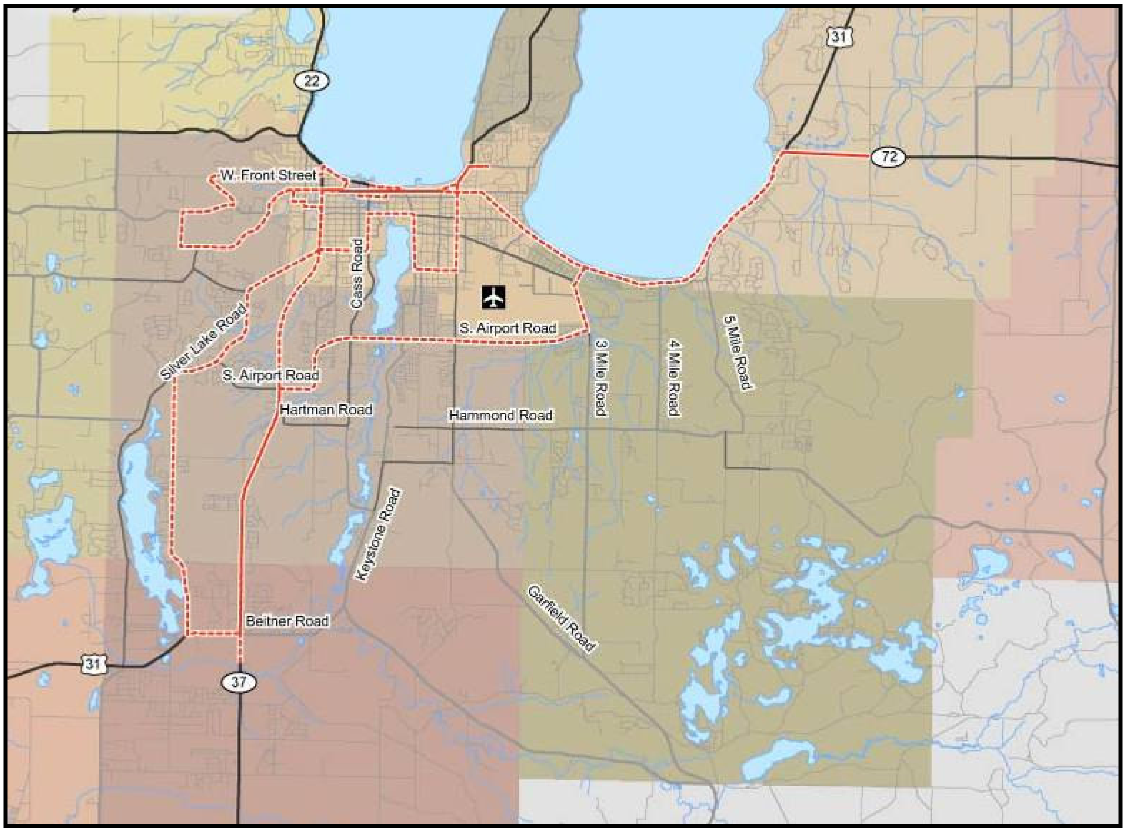


Figure 29: City Scenario Transit Lines

Moving Forward…

As documented in the Socio Economic Report Task 3.2 a preferred land use scenario was created within the Grand Vision, there will need to be a transportation equivalent. Based on information gathered through the transportation workshop, stakeholder groups, and technical committee, corridors have begun to emerge as priorities. These elements are presented now in draft format and should continue through an evaluation process as the Vision is refined through public input. Prioritization may adjust; solutions may change; but the key is to generate a clear vision for the future.

Seven elements were defined as evaluation criteria to determine the priority corridors. Each set of criteria used one of three data types for evaluation, numeric base information, public input, or modeled future. Those that ranked high in multiple areas received priority on the list in **Table 22**. The criteria analyzed include:

Public influence – based on the land use, transportation, and stakeholder workshops, this element was discussed and documented on a majority of the maps or comment sheets. For a project to receive this distinction more than ¾ of the maps had to include the project. Other projects on the list may have received public support, however if it did not meet the "¾"criteria the distinction was not made on the recommendation chart.

Improves regional mobility – these corridors were noted as regional corridors based on traffic volume, existing thoroughfare designation, and preferred scenario land use. When combined, these elements show corridors of regional significance, such as US 31, Airport Road, and M-72. This criterion focused on input from current conditions as well as the TDMs future condition.

Improves local mobility (neighborhoods) – this criterion focus on the improvement of circulation for local residents. These corridors in some cases may improve regional mobility, and at the same time improve access to businesses and resident's at the local level. These corridors should consider context sensitive solutions to allow for local activity. One characteristic of a local mobility corridor is that it primarily serves to improve the "home to work" or "home to retail" trip.

Promoter of alternative travel modes – Based on public comment, it was determined that a desire of the region was to become more multimodal. This criterion was used to select projects that would allow for regional or local multimodal improvement. In many cases this criterion focuses on transit; however, this criterion was also used to consider context sensitive solutions that may address pedestrian and biking activity.

Regional benefit cost – As in any region, major infrastructure projects tend to be costly. The criterion was developed to address the "most bang for the buck" question. Based on TDM indicators (VMT, VHT, and Delay) and an estimated project cost, corridors were identified as projects that would give more for less. In many cases the projects are still costly. However they provide more benefit than alternative projects.

Safety – This criterion always influences the decision making process. The improvement of safety within any corridor is always a priority. This criterion specifically targeted projects that could improve safety, such as median construction, signal improvement, or pedestrian access improvement.

Increased capacity to meet future demand – This criterion is based on the technical analysis for future LOS. Based on the preferred (Village) scenario and using the TDM, corridors were examined to see if the future LOS would be reduced below a D. Vehicle speeds are somewhat reduced, and drivers observe shortened spacing between vehicles.

Recommendations

Transit

It is recommended that a further study be completed analyzing the potential for increased transit in the region by looking at population and employment densities, and determining what potential transit technologies can be implemented in the area, i.e. Bus, Bus Rapid Transit, or Rail technologies. Although preferred routes have been generated for each scenario, an implementation strategy that details cost, ridership, and infrastructure will need to be created.

Priority corridors

As a result of the scenario process, 14 different corridors were identified through public involvement and the scenario results as needing special attention. Corridors prioritization was based on technical information such as the TDM and public preference (number of times a project was highlighted during the workshop). The following table shows a random list of different corridors that should be analyzed in detail and why they were selected. Again, the continued refinement through open public discussions with the involvement of all stakeholders is recommended.

Following the completion of the scenario analysis, the list of corridors was amended by the TC-TALUS technical committee and approved as amended by the TC-TALUS board of directors. The amended list of corridors carried forward for analysis is presented in the Task 3.5 document entitled “Land Use Scenario Environmental Report”.

Table 22: Corridor Evaluation Process

Corridors	Regional Significance	Evaluation criteria: Public influence	Improve regional mobility	Improve local mobility (neighborhoods)	Promoter of alternative travel modes	Regional benefit to cost	Safety	Increases capacity to meet future demand
Regional Transit & non-motorized Analysis*	Designating transit routes and coordinating multi-modal centers will be key to the success of the regional network within the Traverse Region.	X	X		X		X	X
M-72/M-22/US-31 (Grandview Parkway to M72)	Corridor serves as major east-west Route for Traverse City. The corridor will continue to be dominated by retail and commercial activity		X	X		X	X	X
Airport Road (US-31 to 3 Mile)	Airport is another significant east-west Route that serves as the primary route for local traffic.	X	X	X		X	X	X
Division Street/M-37/US-31 (Beitner to Grandview Parkway)	Division Street is a dense section of US 31. It is the primary north-south route for the western edge of Traverse City.	X	X	X		X		X
W US-31 (West of M-37)	This roadway is more significant as an entryway and a future growth corridor. As development continues, and this area, specifically the intersection of US31 and M37 will become the entryway to Traverse City.	X	X			X		X
M-37 (South of US-31)	This roadway is more significant as an entryway and a future growth corridor. As development continues this area, specifically the intersection of US-31 and M-37 will become the entryway to Traverse City.		X			X		X
Garfield Road (South of Airport)	Garfield currently serves as a more localized north-south route. However as growth continues this corridor will evolve into the spine for the community.	X	X		X			X
3 Mile Road (South of US-31)	Due to its connections to US-31, Airport, and Hammond; 3 Mile becomes the primary route for north-south traffic on the eastern side. Furthermore a large portion of this corridor is undeveloped.		X			X		X
Hammond Road (Garfield to 4 Mile)	The area surrounding Hammond Road is largely undeveloped and is noted in the scenarios for future dense development. Proper planning in this area will only serve to benefit the final design.		X	X		X	X	X
M-72 (East of US-31)	M-72 at US-31 serves as an entry feature to the Traverse region. When mixed with current development projects within the areas, this corridor should be evaluated to preserve the existing character.	X	X			X		X
M-22 (North of Grandview Parkway)	This route, although not largely effected by regional impacts, serves as the primary route heading north to Leelanau County.		X				X	X
Silverlake Road (West of Division)	As residential areas west of town continue to become more dense, larger amount of traffic will continue to use Silverlake due to geographic contraints.			X				X
Airport Road (West of Division)	Airport although recently improved should be evaluated for context. The corridor should adjust and change to meet the needs of the adjacent land uses.	X	X	X	X	X	X	X
Beitner Road (US-31 to Keystone Road) and Keystone Road (North of Beitner)	Once Hammond is extended to Keystone, this road will provide an alternative to Division. Improvement should be considered to allow for the influx of traffic as well as to maintain the character of the existing corridor.	X		X		X		X

NOTE: Each corridor should be studied with the surrounding land use in mind. The study area is not limited to the corridor, but includes developments, local roads, and parallel routes. Each corridor plan should consider the regional network and how the local study area will create change within the region.

* A detailed corridor evaluation should be completed prior to the creation of a final list of recommended projects.

* The full regional transit analysis is a very significant undertaking and is not covered by the current scope of services. A preliminary analysis and recommendations on the scope for a future full regional transit analysis can be completed as part of the ten corridors of significance.

Appendix A – MDOT Approval

MDOT Statewide Urban Travel Analysis staff approved the TC-TALUS Travel Demand Model (TDM) for use for the Grand Vision corridor analysis on April 6, 2010. MDOT approval was based on the provision that the following items be taken into consideration when conducting the analysis:

1. Several key corridors were over-assigned in the base year and with the additional traffic generated in 2035 these same corridors are showing very high V/C ratios. Raw model volumes should not be used to identify problem areas and solutions. 2035 model volumes should be adjusted based on the 2007 model-to-count ratio or the 2007 to 2035 actual traffic growth produced by the model.
   UPDATE 6/24/10: This comment will be carried forward and action will be taken to address this issue in future deliverables for Task 3.6, 4.1, 4.2, 4.3, and 5.1.

2. The extension of Hammond to Keystone should be included in the network prior to beginning any corridor analysis.
   UDPATE 6/24/10: This link has been added to the model and will be utilized going forward with Task 3.6, 4.1, 4.2, 4.3, and 5.1.

3. Due to the equilibrium traffic assignment process, some path shifting occurred between the 2007 and 2035 assignments. Thus, decreases in traffic are shown on Garfield between South Airport and Hammond, Hartman between Cass and US31, and Keystone north of Brimley. As a result of those decreases, there are large increases in traffic on Cass between Keystone and South Airport, Brimley between Keystone and Garfield, LaFranier between Hammond and South Airport, and Garfield between Brimley and Hammond. V/C ratios alone should not be used to identify deficient segments. Much care should be taken in identifying problems and solutions in this area.
   UPDATE 6/24/10: This comment will be carried forward and action will be taken to address this issue in future deliverables for Task 3.6, 4.1, 4.2, 4.3, and 5.1.