Chicago Metropolitan Agency for Planning

233 South Wacker Drive
Suite 800
Chicago, Illinois 60606

312 454 0400
www.cmap.illinois.gov

CMAP Travel Demand Model Validation Report

Prepared by Craig Heither

February 23, 2011

Contents

List of Tables

List of Figures

1. Introduction

During 2007-2008 data from more than 10,500 households were collected for a comprehensive travel and activity survey (Travel Tracker[1]) for the Chicago Metropolitan Agency for Planning (CMAP). Following data collection, a number of parameters in CMAP's regional travel demand models were re-estimated and re-calibrated to take advantage of the new data source. This report documents the final step in updating CMAP's travel demand models: validating the 2010 scenario year model results to show that they are reasonable.

Ideally model validation analyses should be conducted using data that are independent of those used to estimate and calibrate the model. Often times it is not possible to satisfy this ideal, either because these independent datasets do not exist or the cost (in terms of time and/or budget) of collecting new data or processing existing data into a useful format for validation is prohibitive. Whenever it was feasible, the model validation analyses documented in this report were conducted using data that were independent of those used to calibrate the travel demand models.

Model Updates

In addition to updating model coefficients, the latest versions of CMAP's travel demand models implement a number of procedural changes from the previous version. The significant changes are as follows and are summarized in Table 1:

- **Trip Generation**: The updated Trip Generation model creates two sets of production and attraction files for Home-Based Work (HBW) trips: a high income set and a low income set. Productions and attractions for Home-Based Other (HBO) trips and Non-Home Based (NHB) trips are not divided by income class. Thus the new Trip Generation model effectively has four trip purposes.
- **Trip Distribution**: The productions and attractions for the four trip purposes are distributed independently yielding four person trip matrices.
- **Mode Choice**: The previous CMAP Mode Choice model created six modal person trip tables (auto and transit trips for each of the three trip types). The updated Mode Choice model takes the high and low income HBW person trip tables and separates each into four modes: single occupant vehicles (SOV), 2-person high occupancy vehicles (HOV2), 3-or-more person HOV (HOV3+) and transit. The updated Mode Choice model thus creates twelve modal person trip tables.

[1] In coordination with CMAP the same data were also collected for the Northwestern Indiana Regional Planning Commission (NIRPC) for three counties in northwest Indiana. The CMAP Travel Tracker data are available at Travel Tracker Survey -- Chicago Metropolitan Agency for Planning. The NIRPC Travel Tracker data are available at Travel Tracker Survey.

- **Traffic Assignment**: The previous version of Traffic Assignment maintained results for five vehicle classes: all autos and four separate truck classes. In the new Traffic Assignment results are maintained for six vehicle classes because autos are separated into HBW HOV2+ and all other autos. While the model setup routines provide for flexibility in assigning vehicle classes (for instance the HOV class could be assigned as HOV3+ only), Table 1 illustrates the standard CMAP setup. Further, while it is possible to assign the HBW trips as separate classes based on the high income/low income dichotomy, CMAP currently combines them for purposes of assignment.

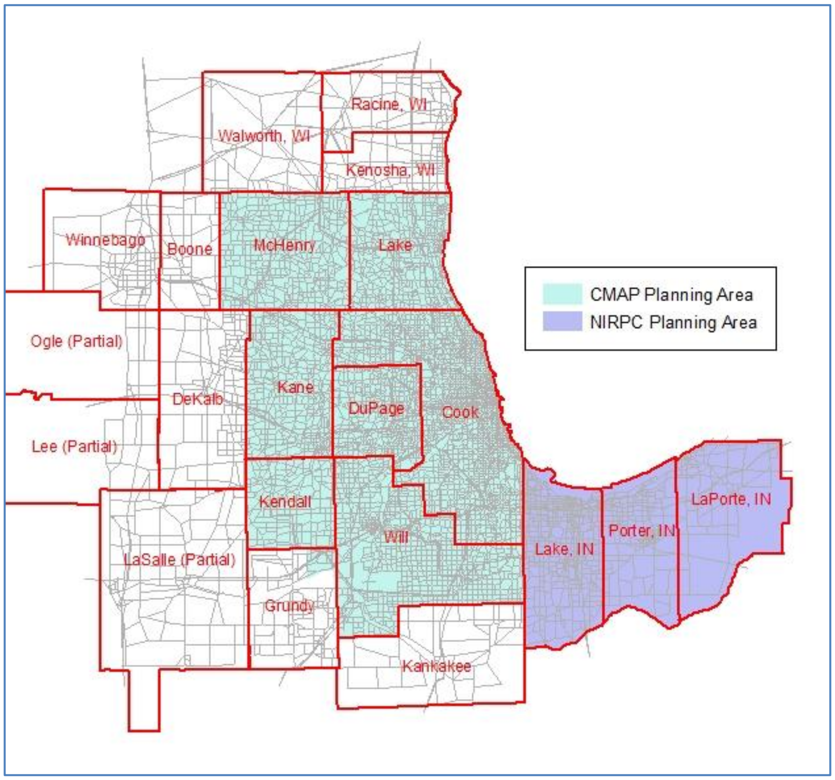
Table 1. CMAP Model Output Changes

	Previous Model	Updated Model
Trip Generation	*Productions & Attractions* HBW HBO NHB	*Productions & Attractions* HBW high income HBW low income HBO NHB
Trip Distribution	*Person Trips* HBW HBO NHB	*Person Trips* HBW high income HBW low income HBO NHB
Mode Choice	*Person Trips* HBW auto HBW transit HBO auto HBO transit NHB auto NHB transit	*Person Trips* HBW SOV high income HBW HOV2 high income HBW HOV3+ high income HBW transit high income HBW SOV low income HBW HOV2 low income HBW HOV3+ low income HBW transit low income HBO auto HBO transit NHB auto NHB transit
Traffic Assignment	*Vehicle Classes* auto 4 truck classes	*Vehicle Classes* SOV HBW HOV2+ 4 truck classes

Modeling Area

CMAP's model highway network covers an area of more than 10,000 square miles and is displayed in Figure 1. It covers 18 full counties and three partial counties in Illinois, three full counties in Indiana and three full counties in Wisconsin. The Indiana counties comprise the metropolitan planning area for the Northwestern Indiana Regional Planning Commission (NIRPC), and the two Metropolitan Planning Organizations (MPOs) are moving toward fully integrating NIRPC into CMAP's travel demand modeling framework.

Figure 1. CMAP Modeling Network



2. Trip Generation

Trip Generation is the first step in a traditional trip-based four step travel demand model and answers the questions: how many trips do people make and what is the purpose of each trip? Inputs to the Trip Generation model include socio-economic data that provide the spatial distribution of employment and households throughout the region. Households are cross-classified by various categories such as number of adults, number of children, number of workers, number of vehicles available and household income. The output data of Trip Generation are zonal trip ends (productions and attractions) for each trip purpose. These indicate the number of trips originating from or destined to each zone for each trip purpose.

Households

Table 2 compares the regional share of households classified by the number of adults and number of children from the CMAP Trip Generation model to data from version 2.1 of the 2009

National Household Travel Survey (NHTS)[2]. The NHTS is an inventory of daily travel for the nation and includes information on trip purpose, mode of transportation, driver and household characteristics, and vehicle characteristics. Survey data for the 2009 NHTS were collected between March 2008 and May 2009, and were weighted based upon the 2008 American Community Survey (ACS). As data from three years' worth of American Community Surveys (2005-2007) were used to estimate and calibrate CMAP's Trip Generation model, the NHTS data are used as an alternative for model validation.

Table 2. Share of Households Classified by Number of Adults and Children

	0 children		1 child		2+ children	
	Observed	*Model*	*Observed*	*Model*	*Observed*	*Model*
Illinois						
1 adult	25.5%	25.2%	0.9%	2.0%	0.7%	2.8%
2 adults	23.9%	23.0%	8.1%	6.4%	14.7%	15.8%
3+ adults	10.9%	8.4%	4.4%	3.7%	3.7%	5.5%
Indiana						
1 adult	1.9%	1.7%	0.1%	0.2%	0.2%	0.3%
2 adults	2.6%	2.1%	0.3%	0.5%	0.7%	1.1%
3+ adults	1.1%	0.6%	0.2%	0.3%	0.2%	0.3%
Region						
1 adult	27.4%	26.9%	0.9%	2.2%	0.8%	3.1%
2 adults	26.5%	25.0%	8.4%	7.0%	15.4%	16.9%
3+ adults	12.0%	9.0%	4.5%	4.0%	3.9%	5.8%

Notes: For analysis, children are defined as age 15 and younger, and adults as age 16 and older. Data represent the Illinois and Indiana portions of the Chicago-Gary-Kenosha CMSA.

The data summarized in Table 2 represent the Illinois and Indiana portions of the Chicago-Gary-Kenosha Consolidated Metropolitan Statistical Area (CMSA)[3]. Unfortunately the NHTS does not allow for analysis at a finer level of geography such as county-level or below. For consistency the model results have been aggregated based on the same counties included in the NHTS analysis, even though the geographies differ somewhat from the CMAP and NIRPC planning areas.

[2] NHTS data are available for download and on-line analysis at http://nhts.ornl.gov/.

[3] The Chicago-Gary-Kenosha CMSA includes the following counties:
- Illinois – Cook, DeKalb, DuPage, Grundy, Kane, Kankakee, Kendall, Lake, McHenry and Will.
- Indiana – Lake and Porter.
- Wisconsin – Kenosha.

The CMAP Trip Generation model defines a child as someone 15 years of age or younger, and an adult as an individual 16 years of age or older. The NHTS definition of an adult is someone 18 years of age or older. The following procedures were used to make the NHTS data more directly comparable to the CMAP Trip Generation model data:

- *For survey households with 100% of the members completing the survey interview (80% of the households analyzed):* The household "adult-child" category was developed by aggregating data from the Person file. Each household member was labeled either as an adult (age 16 and older) or a child (under 16) based on their age, then both values were summed for every household.
- *For the remaining households:* The household "adult-child" category was developed using the summary characteristics contained in the Household file. The number of children was initially calculated as the difference between the total number of household members and the number of adults in the household (defined as at least 18 years if age). An adjustment was then made based on the number of drivers[4] in a given household. When the number of drivers exceeded the number of adults, the difference was added to the number of adults and subtracted from the number of children in the household.

Each cell in Table 2 represents that category's share of regional households. For instance, the "1 adult-0 children" households in the Illinois portion of the CMSA are 25.5% of the regional households in the survey data and 25.2% of the regional households in the model data. The Illinois and Indiana values for each column are summed to create the Regional shares. As can be seen, the model data closely match the NHTS data in terms of regional shares. In fact, the difference between the model and observed data for most of the "adult-child" categories does not exceed ±1.0 percentage points. In general the model is somewhat underestimating "0 child" households and somewhat overestimating "2+ child" households for the region compared to the NHTS data.

Table 3 provides another comparison of observed and modeled households, this time classified by the number of workers and number of vehicles available. Both the survey and modeled data consider workers to be at least 16 years of age. Note that the Indiana households with at least one worker have been combined into a "1+ Workers" category to eliminate cells with a very small number of observations. Compared to the NHTS, the CMAP Trip Generation model slightly overestimates the number of households with two vehicles and at least one worker, and slightly underestimates the number of households with at least one worker and a minimum of three vehicles. Again the data in Table 3 show that the modeled household shares match the survey shares reasonably well.

[4] Drivers were assumed to be at least 16 years of age.

Table 3. Share of Households Classified by Number of Workers and Vehicles Available

	0 vehicles		1 vehicle		2 vehicles		3+ vehicles	
	Observed	*Model*	*Observed*	*Model*	*Observed*	*Model*	*Observed*	*Model*
Illinois								
0 workers	7.7%	6.4%	10.6%	10.2%	4.4%	3.3%	0.9%	0.6%
1 workers	4.4%	4.7%	17.8%	17.4%	11.9%	11.7%	5.7%	2.4%
2+ workers	0.5%	1.1%	3.2%	5.0%	15.8%	19.3%	9.8%	10.6%
Indiana								
0 workers	0.3%	0.3%	1.3%	0.9%	0.6%	0.5%	0.2%	0.1%
1+ workers	0.1%	0.2%	1.3%	1.4%	2.2%	2.6%	1.3%	1.2%
Region								
0 workers	8.0%	6.6%	11.9%	11.2%	5.0%	3.8%	1.1%	0.7%
1+ workers	5.0%	5.9%	22.4%	23.8%	29.9%	33.6%	16.8%	14.3%

Notes: For analysis, workers are are defined as age 16 and older.
Data represent the Illinois and Indiana portions of the Chicago-Gary-Kenosha CMSA.

Trip Generation Rates

Table 4 shows the daily household trip generation rates by trip purpose from CMAP's model. The model data are reported at the county level and are aggregated to the Illinois and Indiana portions of the Chicago-Gary-Kenosha CMSA for direct comparison with the NHTS data. Another set of household trip generation rates by purpose are also reported for comparison: a range of rates compiled from several other MPOs from around the country (Baltimore, Detroit, Miami, Seattle and Washington, D.C.), as reported in their travel demand model documentation[5].

The following procedures were used to adjust the NHTS data to make it more directly comparable to the CMAP Trip Generation model definitions:

- *Serve passenger trips were linked*. Survey trips with the singular purpose of dropping off/picking up a passenger were linked with the subsequent trip (unless the linkage resulted in a "home – serve passenger – home" chain[6]) and the trip purpose was

[5] Table 4 citations:
(Baltimore Metropolitan Council, 2007, pp. 42-43)
(Miami-Dade Metropolitan Planning Organization, 2009, p. 14)
(National Capital Region Transportation Planning Board, Draft 2008, pp. 4-4,4-6,4-7)
(Puget Sound Regional Council, 2007, p. 70)
(Southeast Michigan Council of Governments, 2002, p. 4-6)
[6] The lack of origin/destination location data in the NHTS prevented a more rigorous analysis of the origin and ultimate destination in the linked trips to ensure they were not the same location.

reclassified accordingly. Thus a trip leaving home to drop off a student at school (classified as HBO in the survey) was linked with the subsequent trip continuing on to work (classified as NHB in the survey), and the new linked trip was reclassified as HBW.

- *Change mode trips were linked*. In the Trip Generation model trips with the sole purpose of changing to another travel mode are linked with the subsequent trip. These types of trips cannot be directly identified in the NHTS so a proxy was used: trips by transit and non-motorized modes were linked with succeeding trips if: a) the intermediate dwell time was 15 minutes or less, b) the dwell time was less than 30% of the total travel time of the linked trip and c) the trip was classified with a non-specific purpose ("Other reason"). This should be a conservative estimate of change mode trips from the survey. The trip purpose category for the new linked trip was reclassified accordingly.
- *Intermediate trips during a commute were linked*. Trips were linked if they included an intermediate purpose during a home-work commute and the dwell time at the intermediate stop was 30 minutes or less[7]. Trips were not linked if the intermediate purpose included: attending class, civic/religious activities, health care activities or eating meals outside of home[8]. The trip purpose was reclassified for the linked trips.
- *Adult home-school trips were reclassified*. Consistent with the CMAP Trip Generation model, all home-school trips for adults (age 16 and older) were classified as HBW.
- *Weekend trips were removed*. The CMAP Trip Generation model estimates weekday travel so only weekday trips from the NHTS were analyzed.
- *Trips for children younger than 12 were removed*. The Trip Generation model does not estimate trips for children eleven and younger.
- *Non-motorized trips were removed*. Only motorized trips are carried forward from Trip Generation through the remainder of the CMAP travel demand model.

The NHTS household trip generation rates by purpose are shown in Table 4 for the Illinois and Indiana portions of the Chicago CMSA, and a combined Illinois-Indiana region. For each trip purpose, the rates derived from the NHTS are approximately half a trip lower than the corresponding CMAP rate[9]. The standard deviations of the NHTS trip generation rates for the region (by trip purpose) are included in Table 4 and show the data are fairly dispersed from the

[7] The CMAP Trip Generation model includes an additional criterion for linking these trips: the origin-intermediate stop airline distance must be less than the origin-destination airline distance. Again, the lack of location data in the NHTS impedes conducting this type of analysis.

[8] The CMAP Trip Generation model also does not link these trips if the intermediate purpose is major purchase shopping, but there is no reliable way to distinguish this from other types of shopping in the NHTS.

[9] The NHTS rates seem a bit low and the 2009 NHTS User's Guide cites several factors external to the survey that may have impacted both the travel behavior recorded and the survey response rates (Federal Highway Administration, 2011, pp. 3-8, 3-9).

mean. The standard deviations of the NHTS rates range from nearly 2 trips for HBW trips to nearly 4 trips for HBO trips. Each of these standard deviations is much larger than the half trip differential between the NHTS rates and the corresponding CMAP rates. Note that the cross-classification of households in CMAP's Trip Generation model is calibrated to 3 years' worth of ACS data summarized at the 5% sample Public Use Microdata Areas (PUMAs) level.

With respect to the trip generation rates from other MPOs, the regional rates from CMAP's model all fall within the range of rates reported from other metropolitan areas. Additionally, nearly all of the county-level trip generation rates from the CMAP model fall within the reported ranges. Note that the regional trip generation rates for each purpose derived from the NHTS are all below the values reported by other MPOs. Overall CMAP's household trip generation rates for each of the three trip purposes appear reasonable.

Appendix A contains additional data tables related to the Trip Generation validation analyses.

Table 4. Daily Household Trip Generation Rates by Purpose (Motorized Trips)

Home-Based Work	CMAP Model	2009 NHTS	Other MPOs
Cook	1.50		
DeKalb	1.72		
DuPage	1.89		
Grundy	1.74		
Kane	1.88		
Kankakee	1.59		
Kendall	1.97		
Lake	1.87		Range:
McHenry	1.95		1.35 - 1.93
Will	1.91		
IL Region	1.65	1.18	
Lake	1.53		
Porter	1.73		
IN Region	1.58	1.12	
REGION	1.64	1.18	
		std. dev.:	
		1.96	

Non-Home Based	CMAP Model	2009 NHTS	Other MPOs
Cook	1.32		
DeKalb	1.52		
DuPage	2.35		
Grundy	2.30		
Kane	1.62		
Kankakee	1.24		
Kendall	1.02		
Lake	2.47		Range:
McHenry	1.60		1.22 - 2.80
Will	1.38		
IL Region	1.55	1.20	
Lake	2.34		
Porter	2.15		
IN Region	2.29	1.24	
REGION	1.60	1.20	
		std. dev.:	
		2.30	

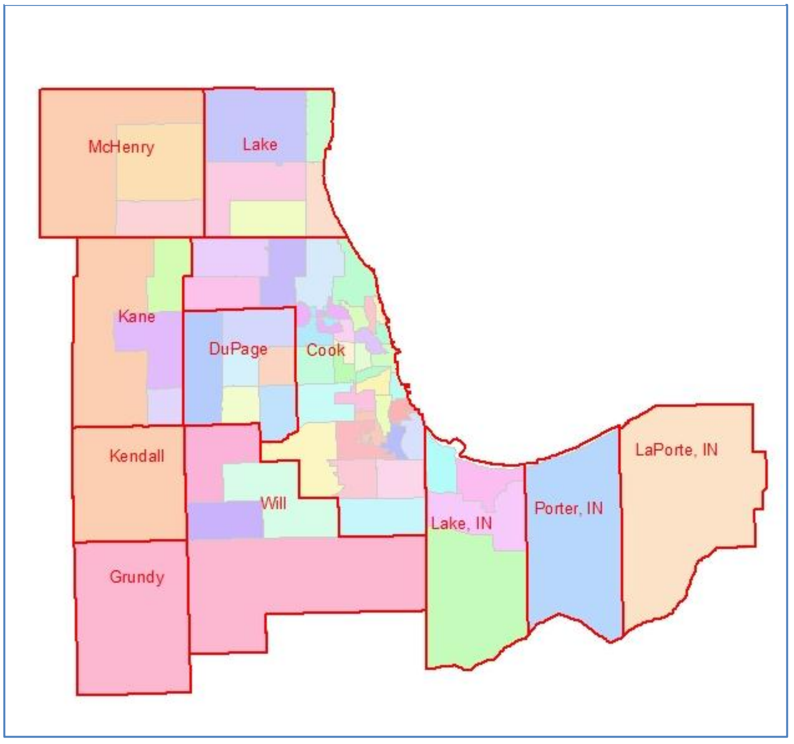
Home-Based Other	CMAP Model	2009 NHTS	Other MPOs
Cook	2.72		
DeKalb	3.32		
DuPage	3.10		
Grundy	3.30		
Kane	3.30		
Kankakee	3.18		
Kendall	3.31		
Lake	3.35		Range:
McHenry	3.26		2.55 - 4.60
Will	3.34		
IL Region	2.93	2.38	
Lake	3.23		
Porter	3.27		
IN Region	3.24	2.50	
REGION	2.95	2.39	
		std. dev.:	
		3.96	

3. Trip Distribution

Trip Distribution is the next step in travel demand modeling, which connects the zonal productions with the zonal attractions from Trip Generation to create person trips. As implemented in CMAP's model, trip distribution is carried out using a doubly constrained intervening opportunity model (a type of gravity model). L-values are calibration constants (specific to each trip purpose) used in the model that measure how selective travelers are in accepting opportunities (i.e., destinations). In general, lower L-values lead to longer trips in the model (because the traveler is more selective), and higher L-values lead to shorter trips.

L-values are calculated in the Trip Distribution model based on the generalized cost of the transportation system and the available opportunities within a specific cost cutoff. Thus the L-values are responsive to both land use and transportation system changes. The Trip Distribution model coefficients were re-estimated and calibrated by fitting L-values to match average trip distances from the observed data at the PUMA-level geography, shown in Figure 2. The Public Use Microdata Areas (PUMAs) from the 2000 Census contain records for a 5% sample of the people and housing units. Each PUMA contains at least 100,000 people.

Figure 2. Census 2000 PUMAs



It is worth noting that the sixty PUMAs shown in Figure 2 vary greatly in terms of size and scope. The smallest PUMA has an area of just over 5.5 square miles while the largest covers nearly 1,000 square miles. Additionally, some counties contain numerous PUMAs while other PUMAs cross county boundaries.

Trip Lengths

Calibration of the Trip Distribution models was conducted at the PUMA level so validation results are reported at the same geographic scope. Home-Based Work trips were calibrated to trip lengths from the 2000 Census Transportation Planning Package (CTPP), while the other trip purposes were calibrated using weighted trips from the Travel Tracker survey (collected in 2007-08). The average trip distances for modeled trips were calculated using the highway network skim data and the purpose-specific person trip table resulting from the Trip Distribution. Trip distances for the observed data were calculated using the highway network skim data and trip matrices created from the weighted observed trips.

Table 5 summarizes the average trip distances by purpose for trips originating in the PUMAs shown in Figure 2. For the region, the average modeled trip distance for each purpose compares favorably to the observed data: the regional average for HBW work trips is within 0.5 miles of the observed data and the regional average trip lengths for the other two purposes are within 0.3 miles of the observed data. While the difference between the modeled and observed average trip lengths is somewhat high in certain PUMAs, the overall comparison is quite good. Among each trip purpose, more than half of the PUMAs have a modeled mean trip distance that is within ±1.1 miles of the observed trip distance. Table A-1 in the Appendix includes the average trip lengths for a secondary measure: work trips from each PUMA to the Chicago Central Area.

Table 5. Average Trip Distances in Miles by Origin PUMA

		Home-Based Work		Home-Based Other		Non Home-Based	
StatePUMA	General Location	Observed	Modeled	Observed	Modeled	Observed	Modeled
1703001	McHenry - NE	18.7	19.1	7.3	6.8	7.2	7.1
1703002	McHenry - SE	19.9	16.4	6.4	6.9	5.8	7.2
1703003	Kane - NE	15.3	14.9	7.4	6.5	6.8	6.9
1703004	Kane - E Central	16.0	15.8	8.1	5.6	6.3	6.6
1703005	Kane - SE	12.6	16.4	5.5	6.4	10.8	6.8
1703006	W. Kane/Kendall/W. McHenry	20.5	18.2	10.8	9.0	8.4	9.2
1703101	S. Will/Grundy	22.9	19.8	12.2	10.3	11.4	10.8
1703102	Will - W Central	14.7	18.4	5.9	6.4	6.6	7.5
1703103	Will - NE	19.5	17.8	8.9	6.4	8.5	6.7
1703104	Will - NW	19.5	15.2	8.3	6.5	7.2	7.3
1703201	DuPage - W	16.2	14.7	7.7	5.7	6.6	6.4
1703202	DuPage - Central	12.8	13.2	5.9	4.9	5.2	6.5
1703203	DuPage - S Central	14.7	14.4	6.1	4.9	7.2	6.2
1703204	DuPage - SE	14.2	13.7	6.0	4.7	7.9	6.3
1703205	DuPage - E Central	11.6	11.7	5.9	4.1	6.8	6.2
1703206	DuPage - NE	12.4	11.3	6.4	4.6	7.4	6.1
1703301	Lake - SE	14.4	11.5	6.0	5.6	6.7	5.7
1703302	Lake - NE	13.8	15.4	5.5	7.6	5.2	7.4
1703303	Lake - NW	19.2	16.0	7.2	7.9	6.6	7.6
1703304	Lake - W Central	16.2	12.5	8.4	7.1	8.3	7.0
1703305	Lake - SW	16.4	10.4	6.2	5.5	7.6	4.3
1703401	Cook - NW (Palatine)	14.4	11.8	6.3	5.3	7.2	6.4
1703402	Cook - NW (Schaumburg)	14.9	12.2	6.7	5.4	7.0	6.2
1703403	Cook - NW (Arl. Hgts.)	12.6	10.2	5.4	4.8	6.2	6.0
1703404	Cook - N (Glenview)	12.1	9.8	5.7	5.1	6.1	5.8
1703405	Cook - N (Skokie)	12.1	10.8	4.8	6.9	4.9	6.2
1703406	Cook - N (Rosemont)	10.9	10.7	5.5	5.5	7.3	6.8
1703407	Cook - WC (Hillside)	11.7	11.3	4.5	5.7	4.8	7.2
1703408	Cook - WC (Cicero)	11.5	11.0	5.1	6.4	5.1	7.6
1703409	Cook - WC (La Grange)	13.1	12.7	6.0	5.4	6.5	6.5
1703410	Cook - SW (Tinley Park)	18.1	15.8	6.7	4.5	6.4	5.3
1703411	Cook - S (Oak Lawn)	14.3	14.3	5.7	5.1	5.1	6.4
1703412	Cook - S (Midlothian)	16.8	17.4	5.7	5.2	6.3	6.4
1703413	Cook - S (Harvey)	18.0	16.8	6.4	5.6	7.2	6.3
1703414	Cook - S (Matteson)	19.5	18.6	6.2	5.8	7.2	6.1
1703501	Chicago - NE (Edgewater)	11.3	11.2	6.0	7.9	4.6	7.9
1703502	Chicago - NE (Lincoln Park)	9.4	9.3	4.9	5.8	5.7	7.7
1703503	Chicago - NE (Lincoln Square)	10.5	10.2	5.8	6.2	4.2	6.7
1703504	Chicago - NC (North Park)	11.1	10.4	5.0	5.4	5.3	6.5
1703505	Chicago - NW (O'Hare)	11.4	10.4	5.7	5.7	8.0	7.3
1703506	Chicago - NW (Portage Park)	11.5	10.4	5.9	5.3	4.8	6.8
1703507	Chicago - WC (Austin)	11.2	10.4	5.9	6.2	6.5	7.4
1703508	Chicago - WC (Humboldt Park)	11.0	10.1	5.8	6.0	6.4	7.4
1703509	Chicago - C (Logan Square)	9.7	9.6	4.7	5.4	5.7	6.8
1703510	Chicago - EC (Loop)	9.6	8.6	6.9	5.7	10.1	8.6
1703511	Chicago - C (Lower West Side)	11.9	10.6	6.1	6.0	7.4	8.1
1703512	Chicago - C (Bridgeport)	11.7	11.7	5.9	6.6	9.3	9.0
1703513	Chicago - WC (Gage Park)	12.7	12.7	5.6	6.3	6.4	8.2
1703514	Chicago - EC (Hyde Park)	10.9	12.5	5.5	7.6	6.6	11.1
1703515	Chicago - SE (South Shore)	14.1	14.9	6.0	8.9	5.8	11.3
1703516	Chicago - SC (Englewood)	13.7	14.3	6.1	7.6	6.2	9.9
1703517	Chicago - SW (Beverly)	14.3	14.6	5.8	6.3	6.0	9.0
1703518	Chicago - SC (Pullman)	16.8	17.0	9.2	9.5	7.1	11.1
1703519	Chicago - SW (Hegewisch)	15.7	15.2	7.9	9.7	7.4	10.0
1800100	Lake,IN - NE	13.0	17.0	8.2	8.5	8.4	9.3
1800201	Lake,IN - NW	12.7	14.4	5.6	6.5	7.8	7.4
1800202	Lake,IN - Central	15.0	16.6	7.2	8.8	6.7	8.9
1800203	Lake,IN - South	20.4	17.2	9.1	10.0	8.9	9.7
1800300	Porter,IN	17.7	19.1	9.2	10.0	7.5	10.6
1800400	LaPorte, IN	14.2	19.7	9.2	9.0	7.8	9.8
REGION		14.3	13.8	6.4	6.5	6.8	7.1

Notes: For reporting purposes, high and low income Home-Work person trips have been combined.

Figure 3. Observed vs. Modeled Average Trip Distances

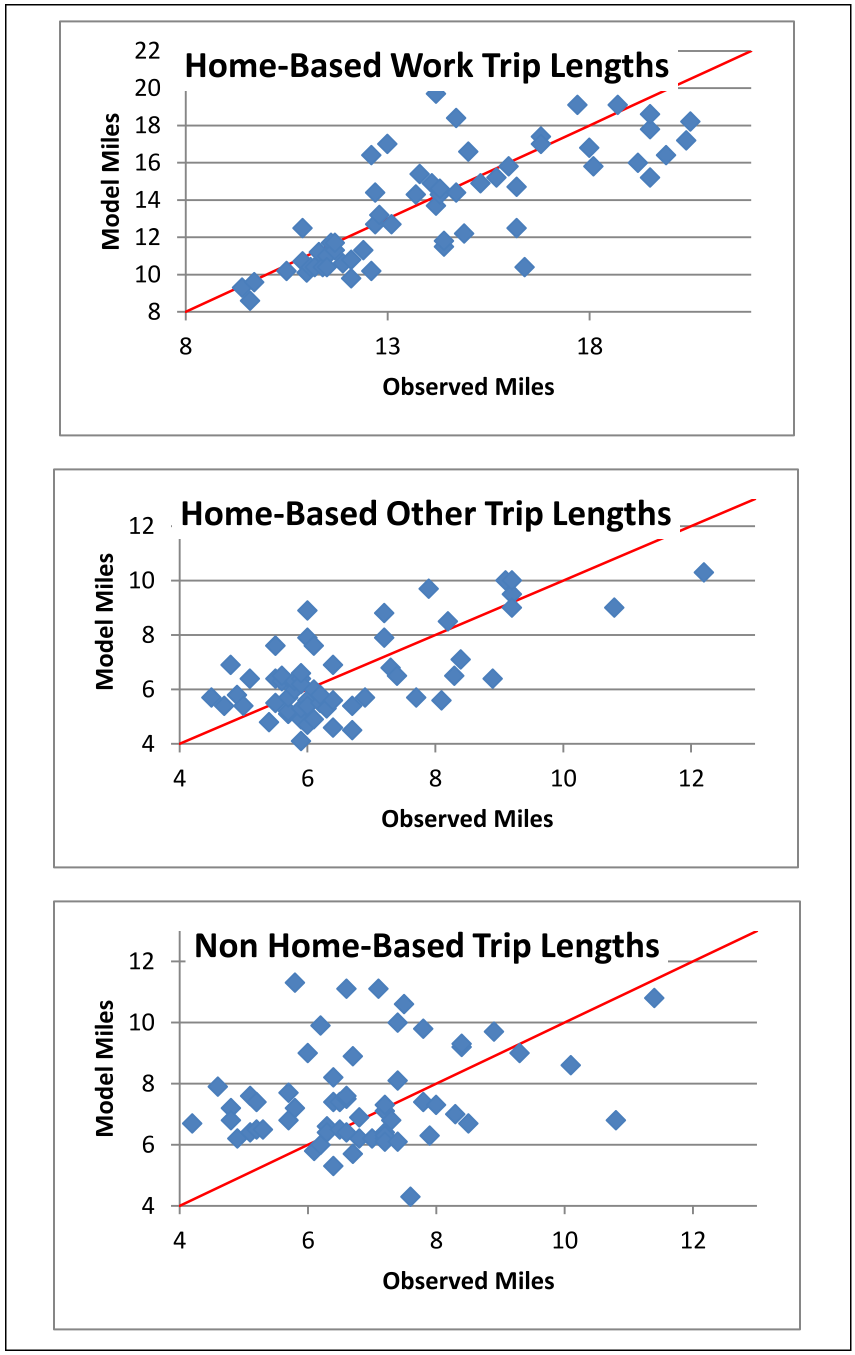


Figure 3 shows separate scatterplots comparing the modeled versus observed average trip distances from each of the PUMAs for each trip purpose. The red diagonal line in each plot represents the ideal values: perfect correspondence between the modeled and observed data. As can be seen, the HBW and HBO values cluster around the equality line fairly well. The data points for the NHB trips are a bit more dispersed, showing more deviation among the values, but still reflect a reasonably good representation of the average trip lengths around the region.

While Figure 3 illustrates the relationship between the modeled and observed trip lengths, it does not offer any insight into how the differences in mean trip lengths are distributed spatially or take into consideration the relative importance of some PUMAs over others. Figure 4 attempts to address both of these issues. The left column displays the difference in modeled and observed average trip distances by PUMA for each of the trip purposes. In each of the charts, the largest deviations in modeled and observed mean trip lengths are represented by yellow (modeled trips too short) and dark brown (modeled trips too long). The remaining light brown and orange shades indicate a much closer correspondence between the average modeled and observed trip lengths. Note that the scales of the categories differ slightly between the trip purposes

The right column displays the same information as cartograms, map transformations where PUMA size is recalculated based on some variable other than area. In this case, each PUMA is weighted by the number of modeled trips for the specific purpose originating within its boundary. To provide an additional point of reference to interpret then data, the non-transformed county boundaries are included with the cartograms.

Reviewing the HBW trips, the largest discrepancies show up in Lake County, Illinois and across the southern end of the modeling area: stretching from Grundy County to Indiana. Note that the PUMA comprising Grundy County/southern Will County is one large PUMA covering over 950 square miles. The cartogram reveals the relative importance of the PUMAs and shows most of the southern PUMAs with the largest discrepancies have a minimal impact. While the Lake County, Illinois PUMAs do expand to show their importance, the largest ballooning up occurs with the PUMAs in Cook and DuPage counties, which show a good correspondence between the modeled and observed values.

The data for HBO trips show what appears at first glance to be a geographic bias in the Trip distribution model: the modeled trips originating in the western and southern sections are noticeably shorter than the observed trips. This is mitigated by the fact that this nearly 2,000 square mile area is comprised of only two PUMAs. The cartogram further illustrates that these areas have a relatively low importance and that the PUMAs with a close model-observed trip length correspondence are dominant. The data for the NHB trips show a somewhat different pattern: more of the PUMAs with the largest discrepancies are in the center of the modeled area as opposed to the periphery. Thus, these PUMAs tend to carry more weight than their high discrepancy counterparts from the other two trip purposes. This is not unexpected based on the scatterplot of NHB trips in Figure 3.

Figure 4. Distribution of Differences between Observed and Modeled Average Trip Distances

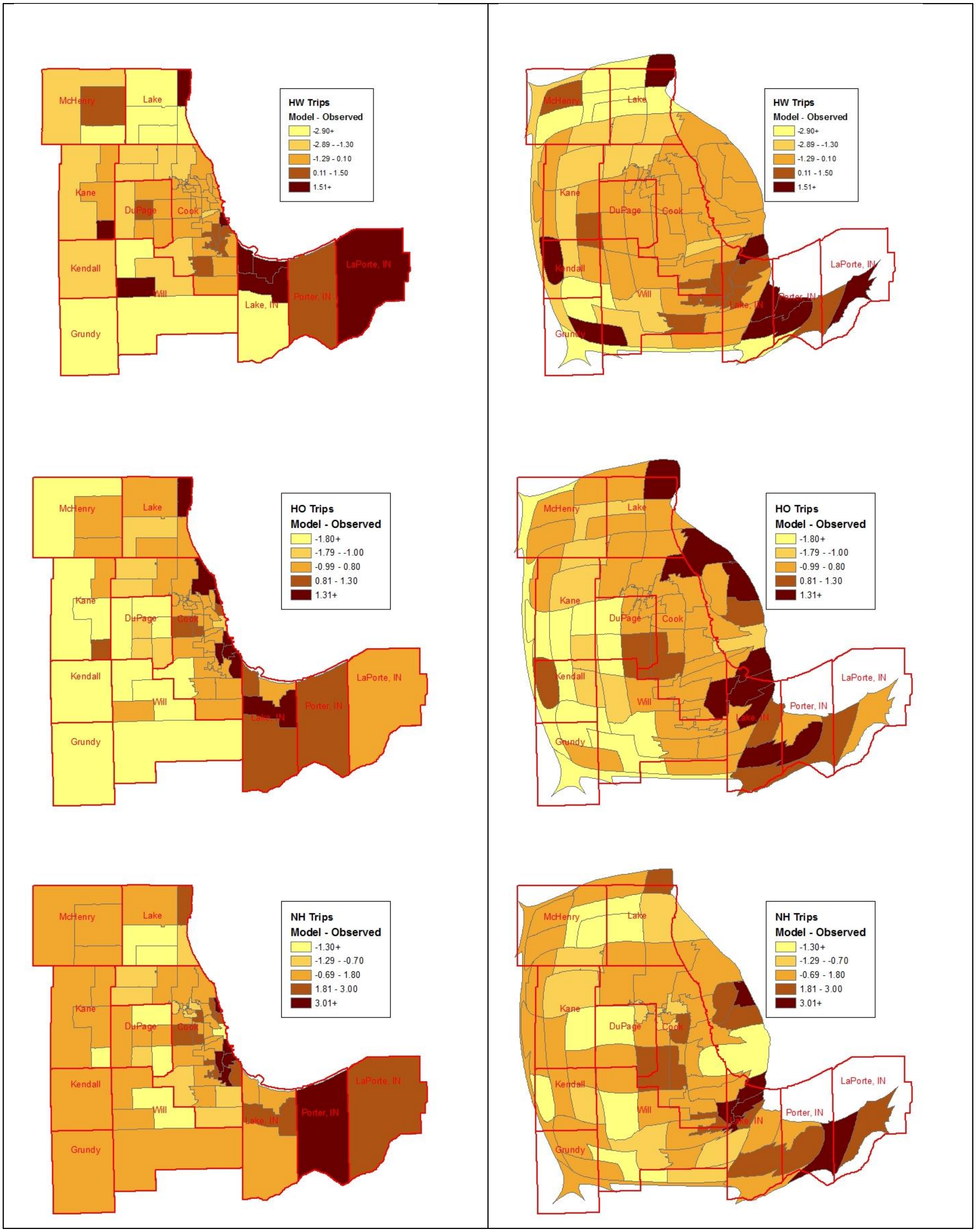
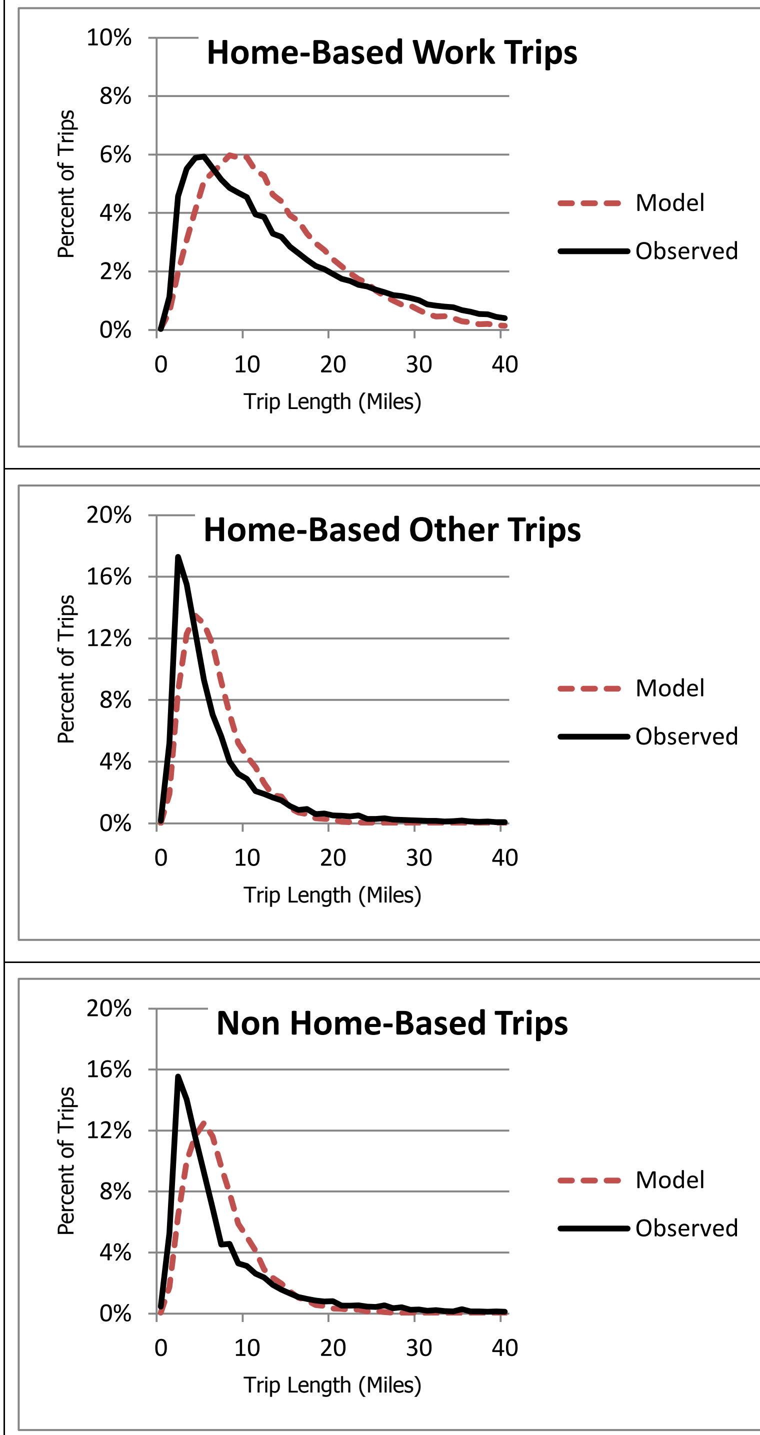


Figure 5 provides a final comparison of modeled and observed trips lengths. Trip distance frequency distribution plots are provided for each of the trip types. Note that intra-zonal trips (which do not cover any distance in the model) are excluded from these plots. The plots show that the Trip Distribution models do a reasonably good job of replicating observed trip lengths. In general, the model underestimates very short trips and very long trips, and overestimates trips in the 8-12 mile range (or 8-20 mile range in the case of HBW trips).

Figure 5. Average Trip Distance Frequency Distributions



Note: Intra-zonal trips are excluded from plots.

Work Trip Flows

Table 6 below provides a comparison of modeled versus observed work trip flows between residence and work place counties. The modeled work flows represent the HBW person trips output by the Trip Distribution model in Production-Attraction (P-A) format, meaning that the Home end of each trip is set as the Production regardless of the direction of the trip (home-to-work or work-to-home). The observed flows represent 2008 data on all primary jobs from the Longitudinal Employer-Household Dynamics dataset (available at http://lehd.did.census.gov/led/). Home locations for the LEHD data are assigned by the Census Bureau while the work locations are derived from payroll tax information collected by individual states.

In order to make the two datasets more directly comparable, the total number of modeled work trips moving between the county interchanges was divided by the total number of LEHD trips to develop a scaling factor. The number of LEHD trips in each cell was then multiplied by the factor to develop a value normalized by the modeled trips. The modeled trips value in each cell was then divided by the corresponding normalized LEHD trips to calculate the final ratio. A ratio value of 1.0 reflects perfect unity between the modeled and observed values, while a value higher than 1.0 indicates the Trip Distribution model is allocating a higher proportion of the trips between the county interchange than what is reflected in the observed data.

Table 6. Work Trip Flow Ratios

	Work Place											
Residence	Cook	DuPage	Grundy	Kane	Kendall	Lake	McHenry	Will	Lake IN	LaPorte IN	Porter IN	TOTAL
Cook	1.01	0.72		0.36		0.75	0.35	0.61	**3.10**			0.96
DuPage	0.96	1.17		1.05	1.08			0.92				1.03
Grundy			0.91					1.39				0.69
Kane	0.82	**1.62**		1.01	**1.53**	0.39	**1.82**	0.94				1.09
Kendall		0.92		**1.92**	1.22			**2.63**				1.09
Lake	0.64					1.37	**1.72**					1.01
McHenry	0.61			**1.56**		**1.75**	1.05					0.96
Will	0.85	1.35	**1.78**	0.99	**2.99**			1.29	**3.84**			1.11
Lake IN	1.49							1.03	0.92	**1.71**	**1.55**	1.07
LaPorte IN									**1.53**	1.04	**2.11**	1.20
Porter IN	0.94								1.04	**3.32**	0.85	1.08
TOTAL	0.97	1.00	1.09	0.94	1.30	1.09	1.03	1.08	1.13	1.37	1.13	1.00

Note: Interchanges with fewer than 2000 trips are excluded.

X.XX	90% of total work trips in observed data.
X.XX	1% of total work trips in observed data.
X.XX	3% of total work trips in observed data.

The data in Table 6 are color-coded to improve readability and to highlight the significant trip interchanges. The orange shaded cells represent interchanges with a high volume of work flows (at least 30,000) in the original observed data. Values in bold red indicate interchanges where the model is overestimating work flows by at least 50%. Ninety percent of the LEHD work trip flows are in major interchanges where the model is not overestimating trips by 50% or more. There is only one major interchange (Kane-DuPage) where the model is overestimating trips by at least 50%, and it accounts for only 1% of the LEHD work flows. The remaining interchanges where the model is overestimating trips by 50% or more account for only 3% of the LEHD work flows. Overall the Trip Distribution model does a good job of distributing trips.

Arguably the four most important cells in Table 6 are the ones representing all combinations of Cook-DuPage trip interchanges: these four cells account for just over 60% of all of the LEHD trips summarized in the table. The ratios in three of these cells are close to 1.0, while the model is somewhat under-representing work trips from Cook to DuPage. The total of the modeled HBW trips between these two counties is just under 60% of all modeled flows represented in the table, nearly identical to the observed data.

Trip Duration

Table 7 compares the duration of the average trip for the observed and modeled data. The observed data are from the 2009 National Household Travel Survey (accessed using the Online Analysis Tool available at http://nhts.ornl.gov/) and include all trip purposes for the Chicago-Gary-Kenosha CMSA. The modeled average trip duration was calculated using the highway skim times weighted by the person trip tables output by Trip Distribution and limited to the counties comprising the Chicago-Gary-Kenosha CMSA. As can be seen, the modeled average trip duration is 0.5 minutes shorter than the observed data, a discrepancy of only 2%.

Table 7. Average Trip Duration (Minutes), All Trip Purposes

Observed	Model
23.0	22.5

Additional data tables related to the Trip Distribution validation analyses are included in Appendix B.

4. Mode Choice

Mode Choice is the third step in CMAP's sequential four step travel demand model. The Mode Choice model takes the purpose-specific person trips created by Trip Distribution and allocates them between four separate motorized modes[10]: transit, SOV auto, HOV2 auto (HBW only) and HOV3+ auto (HBW only). The "auto or transit" decision is made by the Mode Choice model by comparing the transportation costs (in-vehicle time, auto operating costs, transit fare, parking costs, wait time, etc.) of each type of trip between zone pairs.

Transit Mode Share

Table 8 shows the overall transit mode share by trip purpose for the CMAP and NIRPC planning areas. The observed data for HBW trips are from the 2000 CTPP for CMAP and NIRPC, while data for the other purposes are weighted trips from the Travel Tracker survey. The results indicate the Mode Choice model does a good job of replicating the observed transit mode shares: the modeled transit mode shares are within ±1.0 percentage point for each of the trip purposes. The Mode Choice model slightly overestimates the HBW transit trips and slightly underestimates transit trips for the other two purposes. Note that the values represent the percentage of motorized trips (not all trips), as non-motorized trips are not modeled by CMAP's Mode Choice model.

Table 8. Transit Mode Share by Purpose

	Observed	Model	*Percentage Point Difference*
Home-Based Work	11.9%	12.2%	0.3
Home-Based Other	5.5%	4.9%	-0.6
Non-Home Based	4.1%	3.1%	-1.0
OVERALL	6.8%	6.4%	-0.4

Note: Values represent percentage of motorized trips.

The overall transit mode share shown in Table 8 is within 0.4 percentage points of the observed value. As the Travel Tracker survey includes all HBO and NHB trips while the CTPP data only includes work flows (not all HBW trips), the observed trip data were on somewhat different scales. The following process was used to calculate the overall transit mode share percentage for the observed data:

- The total number of trips by purpose from the CMAP Mode Choice model was used as a control total.
- Within each trip purpose, the number of trips from the model was divided by the number of observed trips to create a scaling factor. The observed trips (auto and transit) were then multiplied by the scaling factor to create normalized values.

[10] Note that only motorized trips are carried from Trip Generation on through the remaining steps in the travel demand models.

- The normalized values were summed to obtain the overall transit mode share for observed trips. Note that this process does not affect the share of transit trips within each purpose, only the overall transit mode share.

Table 9 provides a more detailed breakdown of the transit mode share data shown in Table 8. It compares the transit mode share for each of the three trip purposes, summarized by the county of origin. Statistics for the City of Chicago are reported separately from those applying to the remaining area in Cook County. The model underestimates the transit trips originating in Chicago for each of the three purposes and overestimates the transit trips originating in the Cook County balance. The overall pattern shows the Mode Choice model does a good job of replicating the observed transit trips.

At least part of the explanation for the model's underestimate of transit trips in the most transit-rich part of the region may be the way in which the four-step models handle trips. An individual's non-incidental travel is segmented into separate purpose-specific trips, which are then distributed and allocated to a transportation mode independent of one another. This represents a disconnect from reality. Often times an individual's choice of transport mode for a specific trip is at least influenced by (and possibly predetermined by) the mode taken in the preceding segment of a trip chain.

Table 9. Transit Mode Share by Origin

	Home-Based Work		Home-Based Other		Non Home-Based	
Origin	Observed	Model	Observed	Model	Observed	Model
Chicago	28.1%	26.1%	17.6%	13.2%	14.2%	8.5%
Cook balance	8.6%	12.2%	2.2%	4.2%	1.6%	3.4%
DuPage	7.1%	6.8%	0.5%	2.6%	0.3%	1.9%
Grundy	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%
Kane	2.8%	2.9%	1.8%	1.0%	1.6%	0.6%
Kendall	2.1%	0.7%	1.6%	0.2%	0.0%	0.0%
Lake	4.9%	3.8%	1.0%	1.2%	0.0%	2.0%
McHenry	3.3%	2.3%	0.5%	1.4%	0.0%	1.3%
Will	4.2%	3.3%	0.2%	0.6%	0.3%	0.2%
Lake IN	3.1%	5.2%	1.2%	0.3%	0.3%	0.1%
LaPorte IN	1.0%	0.6%	0.3%	0.4%	0.4%	0.1%
Porter IN	1.4%	1.7%	0.3%	0.0%	0.4%	0.0%

Note: Values represent percentage of motorized trips.

Home-Work Trip Modes

Table 10 shows a detailed mode share breakdown for HBW trips, which separates auto trips into SOV and HOV components. Note that the Auto Shared Ride category includes both HOV

2 and HOV3+ trips. The comparison in Table 10 is done at two levels: HBW trips for the entire CMAP+NIRPC planning area and HBW work trips destined to the Chicago Central Business District (CBD)[11], which is displayed in Figure 6. At the regional level, the modeled results are within ±1.5 percentage points of the observed values for each of the motorized modes. The results indicate that while the transit mode share matches almost perfectly to the observed data, the Mode Choice model is slightly over-allocating HBW trips to the HOV mode at the expense of the SOV mode. The results for HBW trips destined to the CBD are even better: the values for all modes are within ±1.0 percentage points of the observed data.

Table 10. Detailed HBW Mode Share

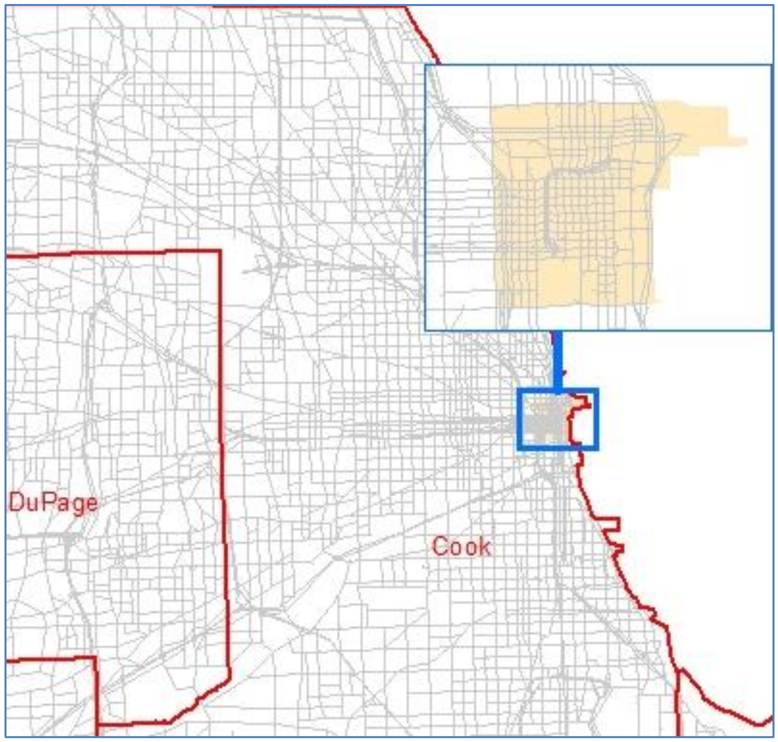
	Observed	Model	*Percentage Point Difference*
Entire Region			
Auto - Drive Alone	76.4%	75.0%	-1.4
Auto - Shared Ride	11.7%	12.8%	1.1
Transit	11.9%	12.2%	0.3
Trips Destined to CBD			
Auto - Drive Alone	31.6%	30.8%	-0.8
Auto - Shared Ride	8.9%	9.9%	1.0
Transit	59.5%	59.4%	-0.1

Figure 7 shows the zonal share of HBW trips destined to the CBD that are made using transit. The top graphic shows the observed data (based on the 2000 CTPP) while the bottom graphic shows the results from the Mode Choice model. To improve readability of the maps: a) only zones with a minimum of 100 transit trips destined to the CBD in the observed data are included, b) the CBD zones themselves are excluded as origins, and c) the model network commuter rail lines are included.

Not surprisingly the observed data show that the commuter rail line corridors tend to have a higher share of transit HBW trips destined to the CBD. This is especially true in DuPage County and in northwest Cook County into McHenry County. Overall the Mode Choice model does a reasonably good job of replicating the HBW transit trips destined to the CBD. As one would expect, the model tends to smooth out the peaks and valleys present in the observed data, and cluster data into the middle categories.

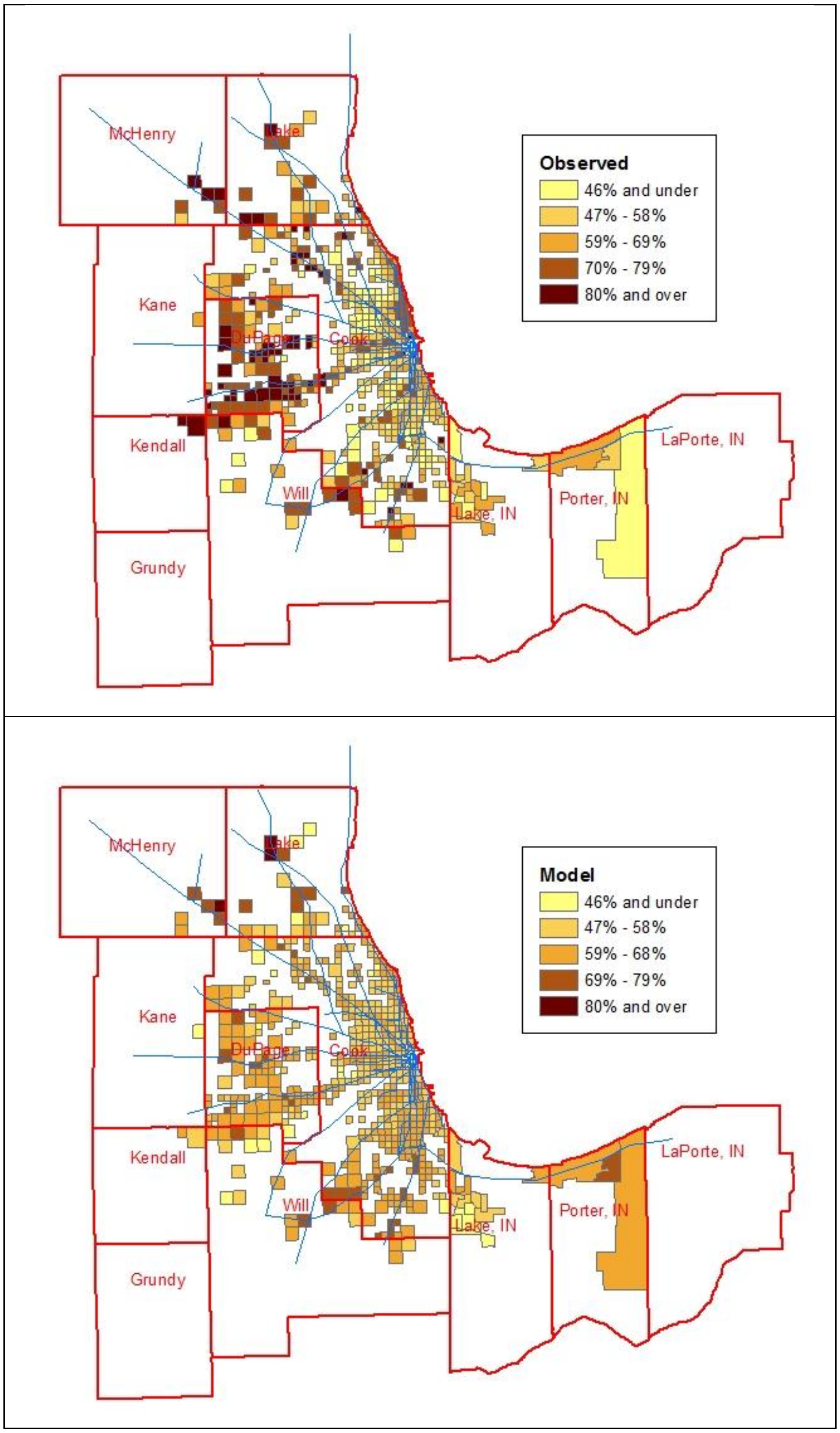
[11] The Chicago CBD is bounded by Chicago Avenue to the north, Halsted Street to the west, Roosevelt Road to the south and Lake Michigan to the east.

Figure 6. Chicago Central Business District



Additional data tables related to the Mode Choice validation analyses are included in Appendix C.

Figure 7. Transit Share of HBW Trips to CBD



Note: Analysis limited to zones with a minimum of 100 transit trips destined to the CBD in the observed data. CBD zones are excluded as origins.

5. Traffic Assignment

The fourth step in the sequential travel demand models is Traffic Assignment, when trips are actually routed along the model network to determine the path they follow from origin to destination. The assignment may be on the highway network or the transit network. When a capacity-constrained equilibrium is reached in the highway assignment, vehicle class volumes for each link are retained to determine the demand on each link. These vehicle class volumes are then used to calculate standard measures such as vehicle miles of travel (VMT). The results of a transit assignment are used to determine the number of boardings on the system.

Highway Assignment

The first validation analysis for highway assignment looks at area wide VMT, where VMT is summed for all links in the model network within a geographic area. Table 11 compares the regional shares of observed and modeled average daily VMT for the six counties in northeastern Illinois that comprise the Illinois Department of Transportation's (IDOT's) District 1. The model results compare quite favorably to the observed data, with the main difference being that the model slightly underestimates the traffic in Cook County and slightly overestimates traffic in the outer edge of counties. However the overall geographic distribution of traffic is quite good.

Table 11. Comparison of District 1 Daily VMT

	Observed	Model
Cook	56%	52%
DuPage	14%	14%
Kane	6%	7%
Lake	10%	12%
McHenry	4%	5%
Will	10%	10%
TOTAL	100%	100%

Source: (Illinois Department of Transportation, 2008, pp. 21-24)

Table 12 presents an expanded version of the data in Table 11, summarized by facility type[12] within the District 1 counties. The observed data shares were developed using IDOT values for annual VMT, while the model results are based on daily VMT. One can see that the model is

[12] Data from five facility type categories reported by IDOT were combined into the groupings shown in Table 12. The following lists the correspondence between CMAP's model network facility types and IDOT's functional classification for Table 12:

- Interstate: 2 (freeway), 3 (freeway-arterial ramp), 4 (expressway), 5 (freeway-freeway ramp), 7 (toll collection facility) and 8 (metered freeway ramp).
- Arterial/Collector: 1 (arterial).
- Local: 6 (zone centroid connector).

slightly overestimating VMT on the Interstates and slightly underestimating VMT on the arterials. Both of these instances are most noticeable in Cook County. Overall the modeled VMT does a good job of matching the observed VMT shares across counties and functional classes.

Table 12. District 1 Share of VMT by Functional Class

		Observed	Model
Cook	Interstate	19%	22%
	Arterial/Collector	31%	25%
	Local	6%	5%
DuPage	Interstate	5%	5%
	Arterial/Collector	8%	8%
	Local	2%	2%
Kane	Interstate	1%	2%
	Arterial/Collector	4%	4%
	Local	1%	1%
Lake	Interstate	2%	2%
	Arterial/Collector	7%	8%
	Local	1%	2%
McHenry	Interstate	0%	0%
	Arterial/Collector	3%	4%
	Local	1%	1%
Will	Interstate	4%	4%
	Arterial/Collector	4%	5%
	Local	1%	1%
District	Interstate	31%	35%
	Arterial/Collector	58%	53%
	Local	12%	12%
TOTAL		100%	100%

Notes: Observed data represent 2008 Annual VMT (source: Illinois Department of Transportation, 2008, p. 19). Model data represent daily VMT.

The next set of analyses compare link-based modeled volumes to recorded traffic counts. Only model network links with corresponding traffic counts are included. There are two sources of data for the traffic count information:

1. Freeways/expressways – CMAP staff annually prepares Annual Average Daily Traffic (AADT) numbers for IDOT for the Interstate and tollway systems and their ramps located in District 1. Volumes for the tollway system are provided by the Illinois State

Toll Highway Authority and are based on sample counts and toll plaza transaction data, while volumes for the non-toll system are derived from data recorded by IDOT's network of induction loop detectors.

2. Arterials – IDOT provided CMAP staff with a database of arterial AADT counts for District 1. The AADT values are based on 24-hour traffic counts taken as part of IDOT's Illinois Traffic Monitoring Program[13]. Geoprocessing of the database was used to attach the arterial AADT counts to the appropriate model network links.

Figure 8 displays the model network links used in the traffic count analyses. It includes traffic count data on more than 11,000 directional links in the model highway network, out of more than 44,000 total directional links. Table 13 summarizes the breakdown of links with traffic count data by facility type. Note that more than 90% of the expressway links and nearly half of their ramps are included in this analysis. Table 14 shows the distribution of traffic count data collection years: 40% of the data was collected in 2008 and 2009.

Table 13. Model Network Links with Traffic Counts

	CMAP Type Code	Links with Traffic Counts	Total Network Links	% of Links
Freeway/Expressway	2,4	1,453	1,573	92%
Arterial	1	8,957	36,711	24%
Ramp	3,5,8	860	2,012	43%
Toll Collection	7	41	146	28%
All Facilities		11,311	40,442	28%

Note: excludes zone centroid connectors.

Table 14. Traffic Count Data Collection Years

Traffic Count Year	Number of Links	Percent
2002-5	3,751	33%
2006-7	3,056	27%
2008	1,653	15%
2009	2,851	25%

13 Information on the Illinois Traffic Monitoring Program is available at http://www.dot.il.gov/itmp.pdf.

Figure 8. Vehicle Count Locations

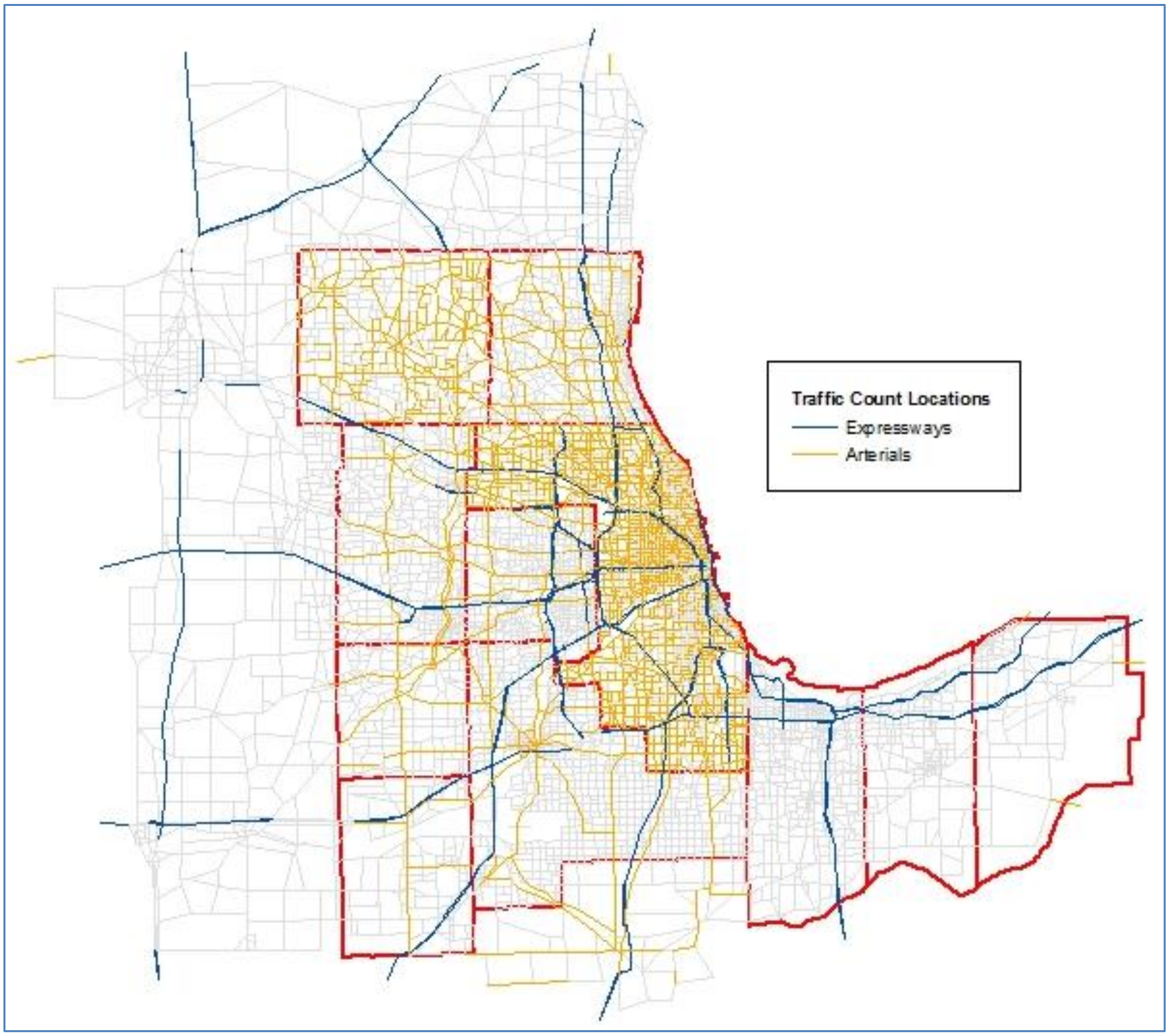


Table 15 displays a comparison of modeled versus observed daily VMT for both arterials and expressways. Within each facility type, the links are separated into volume bins based on their observed volumes. For instance the 10,000-vehicle bin includes links with AADT values ranging from 5,000 to 14,999. The general trend of the data in Table 15 shows that CMAP's model is overestimating traffic on low-volume links and underestimating volumes on high-volume links.

The Federal Highway Administration and the state transportation departments of Florida, Ohio and Michigan have all developed guidelines for use in validating travel demand model results[14]. While there is no universally accepted standard that must be met, these benchmarks are commonly cited in model validation reports. For freeway/expressway VMT, the range of acceptable values from the above agencies is ±6% to ±7%. As shown in Table 15 the total modeled VMT for the expressways is 7.6% higher than the observed VMT: just slightly above the general guidelines.

Table 15. Daily VMT Comparison by Volume Range

	Volume Range	Directional Links	Observed VMT	Model VMT	% Difference
Expressway					
	0	205	143,327	283,769	98.0%
	10000	743	7,722,345	12,311,141	59.4%
	20000	382	6,536,355	9,955,357	52.3%
	30000	166	6,251,096	6,605,853	5.7%
	40000	153	6,165,521	7,260,213	17.8%
	50000	96	5,804,211	5,743,526	-1.0%
	60000	152	8,609,601	8,340,013	-3.1%
	70000	154	9,751,385	8,892,932	-8.8%
	80000	97	9,457,415	8,072,707	-14.6%
	90000	59	4,017,824	3,490,937	-13.1%
	100000	52	3,314,663	2,795,218	-15.7%
	110000	36	2,008,751	1,660,593	-17.3%
	120000+	59	2,422,841	2,252,421	-7.0%
	Subtotal	2,354	72,205,335	77,664,680	7.6%
Arterial					
	0	2,435	5,698,113	6,973,729	22.4%
	10000	4,786	27,419,941	25,447,758	-7.2%
	20000	1,554	14,989,629	12,689,301	-15.3%
	30000+	182	2,778,501	1,925,658	-30.7%
	Subtotal	8,957	50,886,184	47,036,446	-7.6%
TOTAL		11,311	123,091,519	124,701,126	1.3%

Note: The Expressway category includes all non-arterial facilities with traffic count data: freeways, expressways, ramps and toll collection facilities.

The general VMT guideline ranges for arterials[15] vary by functional classification and are:

- Principal Arterials: ±7% to ±15%.
- Minor Arterials: ±10% to ±15%.

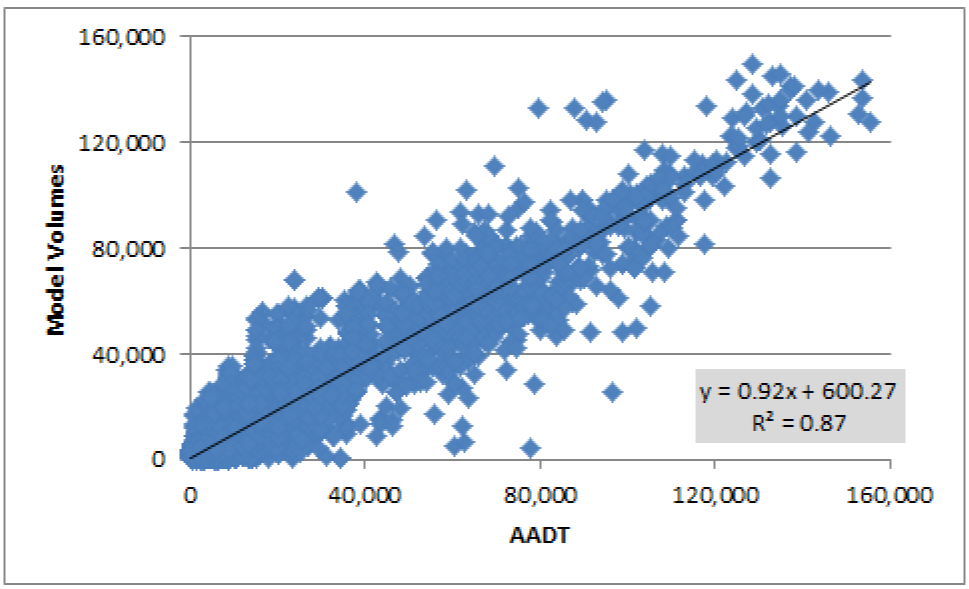
[14] (Federal Highway Administration, 2010, p. 9-19)
[15] Ibid.

- Collectors: ±15% to ±25%.

CMAP's arterial facility type includes a combination of principal and minor arterials, as well as some collectors. Table 15 shows that the overall modeled arterial VMT are 7.6% less that the observed VMT, which is well within the generally accepted range. Total modeled VMT for all facilities are very close to the observed value: only 1.3% higher.

Figure 9 shows a scatterplot of the daily link volumes, with observed values (AADT) plotted on the horizontal axis and modeled volumes plotted on the vertical axis. The linear regression line and equation are also included. The graph shows a strong positive relationship between the data sets, which is verified by the R^2 value of 0.87. This indicates there is a reasonable correlation between the modeled and observed link volumes.

Figure 9. Scatterplot of Daily Link Volumes



Another analysis comparing the modeled and observed link volumes is shown in Table 16. Links were again stratified into volume bins based on AADT and linear regression analyses (weighted by link length) were run for each stratum. The root mean squared error (RMSE) measures the average difference between the estimated volume and the volume predicted by the linear regression. The percent RMSE standardizes the RMSE by dividing it by the mean of the AADT (observed value). The results show a very favorable comparison, with the percent RMSE declining as the volume categories increase.

Table 16. Root Mean Squared Error Analysis

Volume Range	Links	Weight (Miles)	AADT	Model Volumes	Root Mean Squared Error	% Root Mean Squared Error
0	2,640	2,845	2,670	3,317	2,003	75.0%
10000	5,529	6,715	9,233	9,920	4,435	48.0%
20000	1,936	1,366	18,641	19,610	7,182	38.5%
30000	348	715	29,887	28,238	10,355	34.6%
40000	153	298	38,731	45,607	11,981	30.9%
50000	96	285	49,942	49,419	14,762	29.6%
60000	152	249	60,397	58,506	13,463	22.3%
70000	154	248	69,208	63,115	13,853	20.0%
80000	97	222	79,534	67,889	15,121	19.0%
90000	59	49	89,127	77,439	13,204	14.8%
100000	52	35	99,839	84,193	12,106	12.1%
110000	36	15	108,230	89,472	10,237	9.5%
120000+	59	10	128,396	119,365	7,007	5.5%

A final analysis comparing the modeled and observed link volumes is shown in Table 17. This uses a subset (about 52%) of the data from the previous tables to compare modeled and observed VMT within the time-of-day (TOD) periods CMAP models[16] to represent an entire day. Data in this analysis were limited to those that had observed volumes by time-of-day and were calculated as follows:

- Arterials – A subset of the count locations provided by IDOT included hourly traffic volumes. These counts were aggregated into CMAP's TOD modeling periods and divided by the daily total to calculate daily shares for each period. The shares were then multiplied by the AADT values to determine each link's TOD VMT.
- Expressways – One year's worth (November 2009 – October 2010) of archived 5-minute summary data collected from the freeway/tollway detectors were analyzed to create the expressway TOD shares. Average five-minute detector volumes were calculated for each detector for each of the 288 5-minute periods in a day, and then a composite daily volume for each detector was determined by summing the 5-minute volumes. The TOD

[16] CMAP model time-of-day periods:

- Off Peak: 8:00 PM - 6:00 AM
- Pre AM Peak: 6:00 AM - 7:00 AM
- AM Peak: 7:00 AM - 9:00 AM
- Post AM Peak: 9:00 AM - 10:00 AM
- Midday: 10:00 AM - 2:00 PM
- Pre PM Peak: 2:00 PM - 4:00 PM
- PM Peak: 4:00 PM - 6:00 PM
- Post PM Peak: 6:00 PM - 8:00 PM

shares were calculated and multiplied by the AADT to yield link VMT for each time period.

The data in Table 17 have been collapsed from CMAP's eight TOD periods into four (the peak periods have been combined with their shoulders) so that each represents a more equivalent portion of the day. Table 17 shows that the model tends to considerably underestimate VMT during the overnight period (8:00 PM to 6:00 AM). VMT is overestimated by the model during the morning and midday hours, but closely matches the observed volumes during the evening peak period and its shoulders. The overall modeled daily VMT for these links is very close to the observed value: only 2.4% less.

Table 17. VMT by Time-of-Day Period

Time Period	Directional Links	Observed VMT	Model VMT	% Difference
Off Peak: 8:00 PM - 6:00 AM	5,846	10,659,621	5,639,727	-47.1%
AM Peak & Shoulders: 6:00 AM - 10:00 AM	5,847	12,414,714	15,159,101	22.1%
Midday: 10:00 AM - 2:00 PM	5,846	11,992,712	13,622,467	13.6%
PM Peak & Shoulders: 2:00 PM - 8:00 PM	5,846	21,377,587	20,642,409	-3.4%
DAILY		56,444,634	55,063,704	-2.4%

This is the first time CMAP staff has analyzed the daily distribution of VMT in this way. In CMAP's current modeling procedures, purpose-specific daily person trip tables are parsed into TOD demand tables based solely on weighted trip departure times from the Travel Tracker survey. The results in Table 17 indicate there may be room for improvement in the allocation of TOD demand. This is an area of model improvement that CMAP staff will have to investigate further.

Transit Assignment

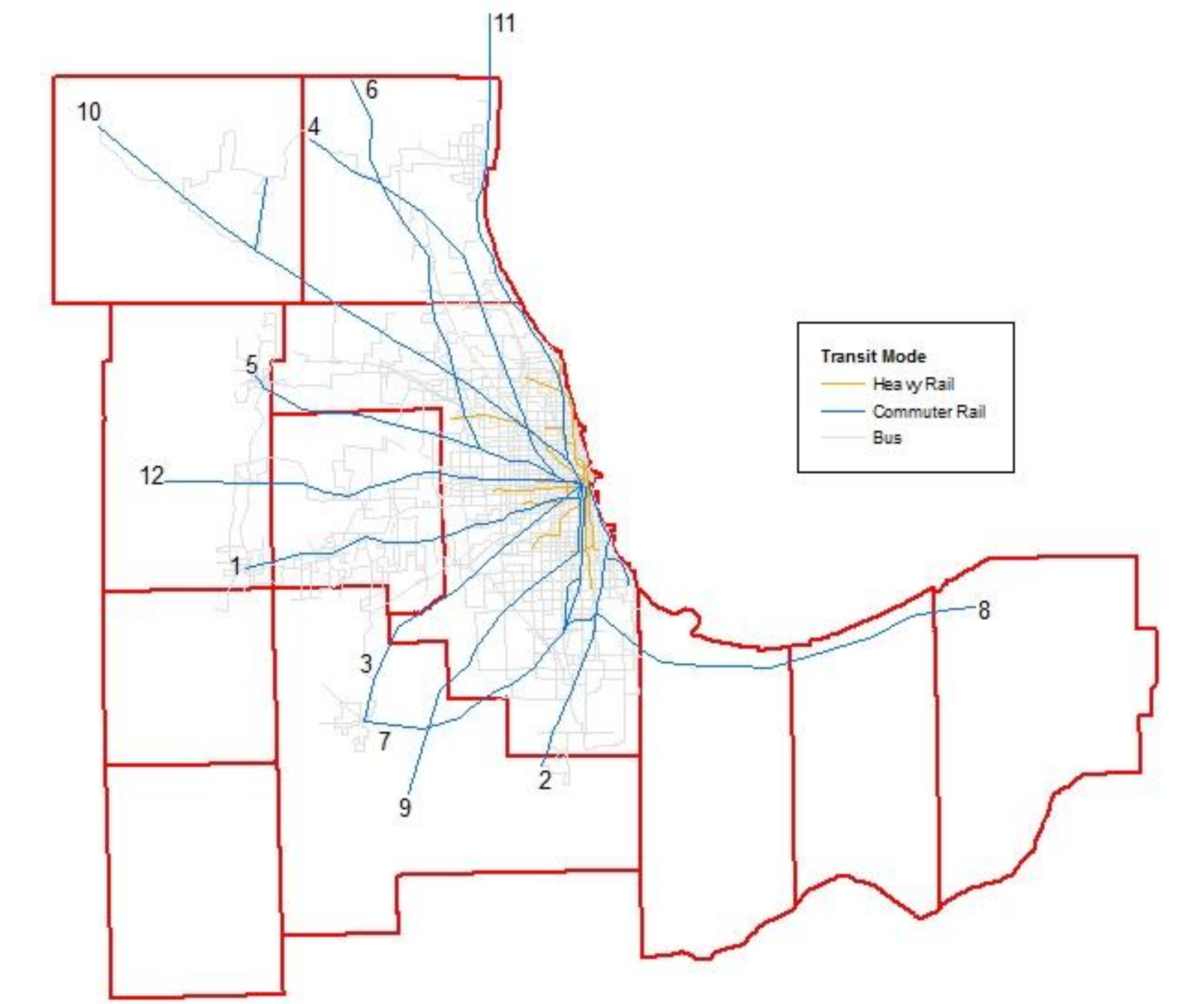
The CMAP model transit network is shown in Figure 10 and includes the following modes:

- Heavy Rail – operated by the Chicago Transit Authority (CTA) in Chicago and some surrounding communities.
- Commuter Rail – operated by Metra[17] throughout the CMAP region.
- Bus – operated by CTA (in Chicago and some surrounding communities) and by Pace Suburban Bus (in northeastern Illinois, mostly outside of Chicago).

[17] The South Shore Railroad is operated by the Northern Indiana Commuter Transportation District (NICTD) between Chicago and South Bend, IN.

There are twelve separate commuter rail lines operated in the region. Figure 11 shows the heavy rail system against the City of Chicago boundary. The CTA operates eight separate heavy rail lines, identified by color names.

Figure 10. CMAP Region Commuter Rail Lines



Commuter Rail Lines:

1. Burlington Northern Santa Fe (BNSF)
2. Metra Electric (ELEC)
3. Heritage Corridor (HC)
4. Milwaukee District North (MDN)
5. Milwaukee District West (MDW)
6. North Central Service
7. Rock Island District (RI)
8. South Shore Railroad (SoShore) – *NICTD*
9. SouthWest Service (SWS)
10. Union Pacific Northwest (UPNW)
11. Union Pacific North (UPN)
12. Union Pacific West (UPW)

Figure 11. CMAP Region Heavy Rail Lines

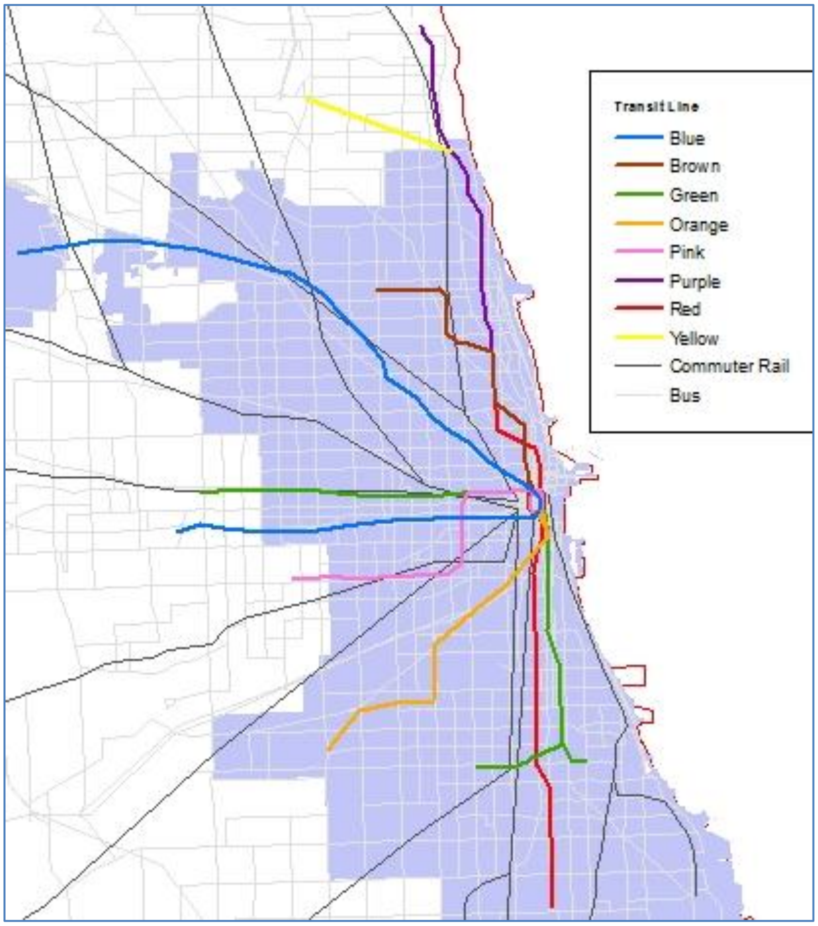


Table 18 displays the number of observed daily transit boardings for 2010[18] compared to the model results. The modeled number of boardings is just over 1% higher than the observed value. Table 19 separates the daily boardings into three modes: commuter rail, heavy rail and bus. The modeled boardings are within 1.3% of the observed for each of the three modes. Looking at the share of daily boardings by mode, the model just slightly under-assigns trips to heavy rail and just slightly over-assigns trips to the bus mode.

[18] Table 18 citations:
(Chicago Transit Authority, 2010, p. 1)
(Pace, 2010)
(Metra, 2010, p. 52)
(Federal Transit Administration, 2010)

Table 18. Total Daily Transit Boardings

Observed	Model	*Difference*
2,056,777	2,079,172	1.1%

Table 19. Daily Transit Boarding Summary by Mode

				Share of Boardings	
	Observed	Model	*Difference*	Observed	Modeled
Commuter Rail	320,091	323,631	1.1%	15.6%	15.6%
Heavy Rail	666,515	671,809	0.8%	32.4%	32.3%
Bus	1,070,172	1,083,734	1.3%	52.0%	52.1%
TOTAL	2,056,777	2,079,173	1.1%	100.0%	100.0%

The daily share of transit boardings is shown at a finer level of detail in Table 20: the commuter and heavy rail boardings are reported by individual lines. As can be seen, the modeled share of transit boardings is within ±0.6% of the observed share for each of the heavy rail lines. The modeled shares of boardings for the commuter rail lines are even closer to the observed data: within ±0.4%.

Additional data tables related to the Traffic Assignment validation analyses are included in Appendix D.

Table 20. Share of Daily Transit Boardings

		Observed	Model
Heavy Rail			
	Blue	7.1%	6.7%
	Brown	4.6%	4.2%
	Green	3.0%	2.8%
	Orange	2.5%	3.1%
	Pink	1.3%	0.9%
	Purple	1.9%	2.1%
	Red	11.7%	12.3%
	Yellow	0.3%	0.1%
Commuter Rail			
	BNSF	3.1%	2.9%
	ELEC	1.8%	1.9%
	HC	0.1%	0.1%
	MDN	1.2%	0.7%
	MDW	1.1%	0.9%
	NCS	0.3%	0.4%
	RI	1.5%	1.8%
	SoShore	0.6%	0.9%
	SWS	0.5%	0.9%
	UPNW	2.0%	2.0%
	UPN	1.9%	1.7%
	UPW	1.5%	1.4%
Bus		52.0%	52.1%
TOTAL		100.0%	100.0%

Works Cited

Baltimore Metropolitan Council. *Baltimore Region Travel Demand Model Version 3.3: 2000 Validation: Task Report 07-8.* (January 2007). Available at Baltimore Metropolitan Council.

Chicago Transit Authority, Planning and Development - Planning Analytics. *Monthly Ridership Report*. (January 2010 - August 2010 reports). Available at Regional Transportation Asset Management System (accessed November 3, 2010).

Federal Highway Administration. *2009 National Household Travel Survey User's Guide (Version 1)*. (February 2011). Available at National Household Travel Survey Publications.

Federal Highway Administration, Travel Model Improvement Program. *Travel Model Validation and Reasonability Checking Manual Second Edition*. (September 24, 2010). Prepared by Cambridge Systematics, Inc. for Federal Highway Administration. Available at Travel Model Improvement Program.

Federal Transit Administration. 2009 National Transit Database: Annual Transit Profiles (for Northern Indiana Commuter Transportation District. (2010). Available at National Transit Database - Annual Profiles (accessed November 3, 2010).

Ilinois Department of Transportation, Office of Planning and Programming. *Illinois Travel Statistics 2008*. (2008). Available at Illinois Department of Transportation - Travel Statistics.

Metra. *2011 Program and Budget Book: Proposed*. (2010). Available at Metra - Budget Book.

Miami-Dade Metropolitan Planning Organization. *Miami-Dade 2035 Long Range Transportation Plan: Model Review, Validation, and Update Report*. (October 29, 2009). Prepared by Gannett-Fleming, Advanced Transportation Engineering Consultants, AECOM Consult, Charesse Chester Associates, Citilabs, Metropolitan Center at Florida International University and Strategy Solutions for Miami-Dade Metropolitan Planning Organization. Available at Miami-Dade MPO.

National Capital Region Transportation Planning Board. *TPB Travel Forecasting Model, Version 2.3: Specification, Validation, and User's Guide*. (Draft June 30, 2008). Available at Metropolitan Council of Governments.

Pace. *Average Weekday Bus Ridership by Route*. (January 2010 - August 2010 reports). Available at Regional Transportation Asset Management System (accessed November 3, 2010).

Puget Sound Regional Council. *PSRC Travel Model Documentation (for Version 1.0): Final Report - Updated for Congestion Relief Analysis*. (Revised September 2007 by Puget Sound Regional Council). Prepared by Cambridge Systematics, Inc., Mirai Associates, RST International and Mark Bradley Research for Puget Sound Regional Council. Available at Puget Sound Regional Council.

Southeast Michigan Council of Governments. *SEMCOG Travel Model Documentation*. (November 2002). Prepared by Cambridge Systematics, Inc. for Southeast Michigan Council of Governements. Available at Southeast Michigan Council of Governments.

Appendix A: Trip Generation Data

Table A-1 lists the actual number of households tabulated in each of the "adult-children" categories from the CMAP Trip Generation model and the 2009 NHTS. Table A-2 lists the household count for the "worker-vehicles" categories.

Table A- 1. Number of Households by Adults and Children

		0 children		1 child		2+ children	
		Observed	*Model*	*Observed*	*Model*	*Observed*	*Model*
Illinois							
	1 adult	856,763	879,088	29,108	70,944	22,259	97,441
	2 adults	803,843	800,353	273,247	224,282	493,761	552,040
	3+ adults	364,781	292,244	147,721	129,627	125,200	191,805
Indiana							
	1 adult	64,962	58,010	2,713	6,911	6,213	9,754
	2 adults	86,449	72,106	9,354	18,093	25,052	38,257
	3+ adults	38,187	21,726	5,150	10,770	6,613	9,695
Region							
	1 adult	921,725	937,098	31,821	77,855	28,472	107,195
	2 adults	890,292	872,459	282,601	242,375	518,813	590,298
	3+ adults	402,968	313,970	152,871	140,397	131,813	201,500

Notes: For analysis, children are defined as age 15 and younger, and adults as age 16 and older.
Data represent the Illinois and Indiana portions of the Chicago-Gary-Kenosha CMSA.
Data sources: CMAP Trip Generation model and 2009 NHTS.

Table A- 2. Number of Households by Workers and Vehicles Available

	0 vehicles		1 vehicle		2 vehicles		3+ vehicles	
	Observed	*Model*	*Observed*	*Model*	*Observed*	*Model*	*Observed*	*Model*
Illinois								
0 workers	257,919	222,069	354,885	356,430	148,017	116,294	30,389	21,805
1 workers	147,793	163,489	599,172	607,743	401,356	409,141	192,543	84,926
2+ workers	17,288	37,187	108,326	174,818	530,292	673,680	328,701	370,243
Indiana								
0 workers	9,652	8,751	43,923	32,357	20,317	16,049	6,113	3,604
1+ workers	3,470	5,418	44,932	48,073	73,396	89,165	42,892	41,904
Region								
0 workers	267,571	230,820	398,808	388,787	168,334	132,342	36,502	25,410
1+ workers	168,551	206,094	752,430	830,635	1,005,044	1,171,986	564,136	497,073

Notes: For analysis, workers are are defined as age 16 and older.

Data represent the Illinois and Indiana portions of the Chicago-Gary-Kenosha CMSA.

Data sources: CMAP Trip Generation model and 2009 NHTS.

Appendix B: Trip Distribution Data

Figure B-1 displays the Chicago Central Area, which is bounded by North Avenue to the north, Ashland Avenue to the west, Cermak Road to the south and Lake Michigan to the east. Table B-1 shows the average trip distances for HBW trips originating in each of the PUMAs and destined to the Chicago Central Area.

Figure B- 1. Chicago Central Area

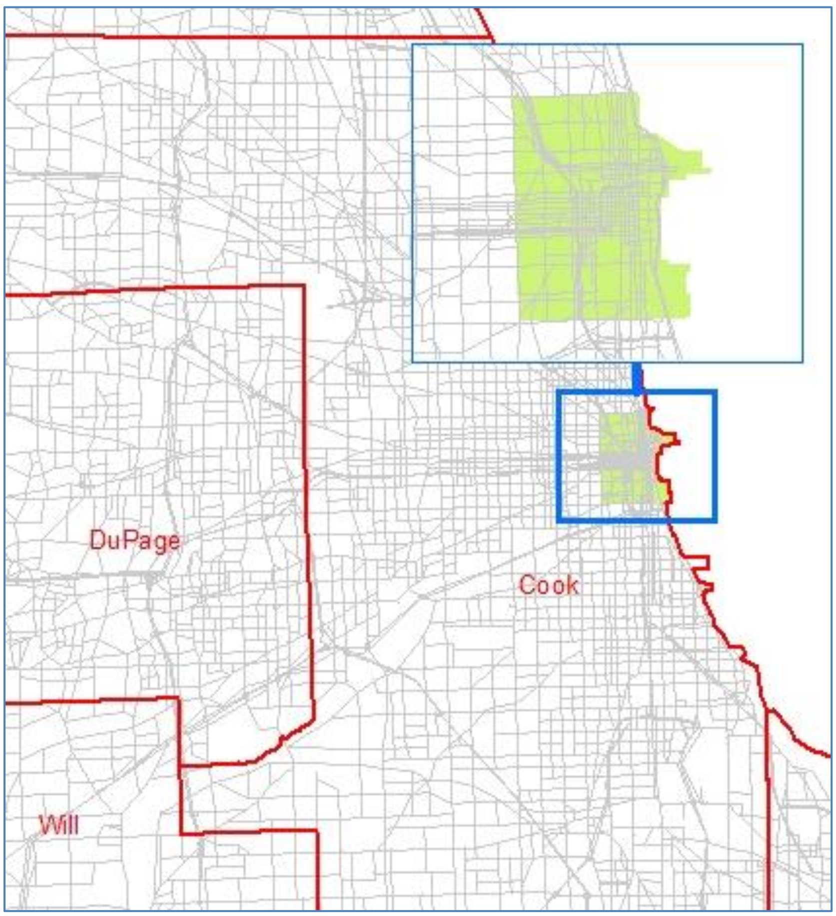


Table B- 1. Average Trip Distances - Home-Work Trips Destined to the Central Area

StatePUMA	General Location	HW to Central Area Observed	HW to Central Area Modeled
1703001	McHenry - NE	58.7	60.2
1703002	McHenry - SE	50.8	49.9
1703003	Kane - NE	44.0	43.2
1703004	Kane - E Central	45.6	44.8
1703005	Kane - SE	42.7	42.2
1703006	W. Kane/Kendall/W. McHenry	54.0	48.2
1703101	S. Will/Grundy	42.4	39.6
1703102	Will - W Central	45.5	45.2
1703103	Will - NE	37.2	37.5
1703104	Will - NW	37.0	36.7
1703201	DuPage - W	36.4	35.7
1703202	DuPage - Central	28.3	28.3
1703203	DuPage - S Central	31.4	30.6
1703204	DuPage - SE	24.6	24.3
1703205	DuPage - E Central	20.7	20.6
1703206	DuPage - NE	27.3	25.0
1703301	Lake - SE	28.6	29.6
1703302	Lake - NE	43.4	44.0
1703303	Lake - NW	51.8	52.6
1703304	Lake - W Central	42.7	41.1
1703305	Lake - SW	36.1	34.0
1703401	Cook - NW (Palatine)	33.7	32.8
1703402	Cook - NW (Schaumburg)	33.8	33.5
1703403	Cook - NW (Arl. Hgts.)	27.0	26.1
1703404	Cook - N (Glenview)	20.3	19.2
1703405	Cook - N (Skokie)	16.5	15.4
1703406	Cook - N (Rosemont)	14.5	14.9
1703407	Cook - WC (Hillside)	13.6	13.6
1703408	Cook - WC (Cicero)	9.8	9.7
1703409	Cook - WC (La Grange)	17.1	16.3
1703410	Cook - SW (Tinley Park)	28.8	29.3
1703411	Cook - S (Oak Lawn)	18.7	18.5
1703412	Cook - S (Midlothian)	26.2	25.4
1703413	Cook - S (Harvey)	23.8	23.4
1703414	Cook - S (Matteson)	31.6	31.6
1703501	Chicago - NE (Edgewater)	9.0	9.0
1703502	Chicago - NE (Lincoln Park)	5.0	4.9
1703503	Chicago - NE (Lincoln Square)	8.8	9.3
1703504	Chicago - NC (North Park)	9.5	9.6
1703505	Chicago - NW (O'Hare)	12.9	13.0
1703506	Chicago - NW (Portage Park)	10.2	10.2
1703507	Chicago - WC (Austin)	8.6	8.4
1703508	Chicago - WC (Humboldt Park)	6.1	6.1
1703509	Chicago - C (Logan Square)	5.1	5.7
1703510	Chicago - EC (Loop)	2.4	2.4
1703511	Chicago - C (Lower West Side)	5.5	6.4
1703512	Chicago - C (Bridgeport)	6.6	7.3
1703513	Chicago - WC (Gage Park)	11.3	11.5
1703514	Chicago - EC (Hyde Park)	7.4	7.4
1703515	Chicago - SE (South Shore)	11.4	11.6
1703516	Chicago - SC (Englewood)	11.5	11.6
1703517	Chicago - SW (Beverly)	15.8	15.9
1703518	Chicago - SC (Pullman)	16.0	16.0
1703519	Chicago - SW (Hegewisch)	14.5	14.4
1800100	Lake,IN - NE	33.1	32.3
1800201	Lake,IN - NW	24.0	23.6
1800202	Lake,IN - Central	35.2	34.6
1800203	Lake,IN - South	43.9	38.7
1800300	Porter,IN	49.2	43.5
1800400	LaPorte, IN	64.5	59.5
REGION		15.9	15.1

Note: For reporting purposes, high and low income Home-Work person trips have been combined.

Tables B-2 shows the work flows among county interchanges from the CMAP Trip Distribution model. Table B-3 lists the corresponding work flows from the LEHD data and Table B-4 shows the LEHD flows after there are normalized by the Trip Distribution model data.

Table B- 2. CMAP Trip Distribution Model Flows

	Work Place											
Residence	Cook	DuPage	Grundy	Kane	Kendall	Lake	McHenry	Will	Lake IN	LaPorte IN	Porter IN	TOTAL
Cook	2,545,010	199,450	143	18,110	187	91,142	4,707	37,801	54,094	1,127	2,099	2,953,870
DuPage	239,784	346,443	36	32,884	2,266	1,668	264	17,277	122	18	18	640,781
Grundy	29	25	9,212	97	636	0	0	11,682	0	0	0	21,681
Kane	71,691	101,984	166	121,658	5,955	4,418	18,395	7,195	0	0	0	331,462
Kendall	1,231	17,586	1,828	27,339	12,152	0	0	15,156	0	0	0	75,292
Lake	98,970	1,291	0	1,410	0	310,123	17,765	1	1	0	0	429,561
McHenry	40,063	953	0	27,105	1	48,113	83,684	0	0	0	0	199,918
Will	137,913	113,313	8,383	13,021	7,794	3	0	172,532	8,551	1	31	461,542
Lake IN	86,838	172	0	0	0	0	0	4,607	167,012	5,400	22,848	286,879
LaPorte IN	838	0	0	0	0	0	0	3	8,342	38,573	14,466	62,223
Porter IN	6,421	0	0	0	0	0	0	161	37,471	19,166	37,004	100,223
TOTAL	3,228,788	781,217	19,768	241,624	28,991	455,467	124,815	266,416	275,593	64,286	76,466	5,563,432

Notes: Data are in Production-Attraction format.

Source: CMAP Trip Generation model.

Table B- 3. LEHD Work Trip Flows

	Work Place											
Residence	Cook	DuPage	Grundy	Kane	Kendall	Lake	McHenry	Will	Lake IN	LaPorte IN	Porter IN	TOTAL
Cook	1,779,346	194,488	1,089	35,597	1,819	85,897	9,518	43,858	12,277	393	1,029	2,165,311
DuPage	176,471	208,785	335	22,055	1,475	11,856	2,628	13,289	424	36	123	437,477
Grundy	5,272	2,212	7,143	656	275	302	111	5,937	220	6	27	22,161
Kane	61,394	44,345	224	84,556	2,749	8,048	7,104	5,383	101	13	42	213,959
Kendall	11,910	13,496	401	10,026	7,002	1,275	609	4,055	15	1	6	48,796
Lake	109,471	15,761	89	5,212	289	159,400	7,283	2,662	108	17	56	300,348
McHenry	46,226	10,342	87	12,210	239	19,406	56,359	1,951	43	9	33	146,905
Will	114,877	59,173	3,324	9,269	1,838	5,797	1,696	93,841	1,568	57	184	291,624
Lake IN	40,908	3,250	70	726	71	859	159	3,154	127,586	2,222	10,390	189,395
LaPorte IN	1,154	192	7	70	4	47	11	83	3,839	26,133	4,837	36,377
Porter IN	4,834	235	4	90	2	72	11	212	25,306	4,065	30,754	65,585
TOTAL	2,351,863	552,279	12,773	180,467	15,763	292,959	85,489	174,425	171,487	32,952	47,481	3,917,938

Source: LEHD work trips (2008 data: all primary jobs).

Table B- 4. LEHD Work Trip Flows Normalized by Model Flows

	Work Place											
Residence	Cook	DuPage	Grundy	Kane	Kendall	Lake	McHenry	Will	Lake IN	LaPorte IN	Porter IN	TOTAL
Cook	2,526,653	276,171	1,546	50,547	2,583	121,973	13,515	62,278	17,433	558	1,461	3,074,720
DuPage	250,587	296,473	476	31,318	2,094	16,835	3,732	18,870	602	51	175	621,213
Grundy	7,486	3,141	10,143	932	390	429	158	8,430	312	9	38	31,468
Kane	87,179	62,969	318	120,069	3,904	11,428	10,088	7,644	143	18	60	303,820
Kendall	16,912	19,164	569	14,237	9,943	1,810	865	5,758	21	1	9	69,290
Lake	155,448	22,380	126	7,401	410	226,346	10,342	3,780	153	24	80	426,491
McHenry	65,640	14,686	124	17,338	339	27,556	80,029	2,770	61	13	47	208,604
Will	163,124	84,025	4,720	13,162	2,610	8,232	2,408	133,253	2,227	81	261	414,103
Lake IN	58,089	4,615	99	1,031	101	1,220	226	4,479	181,171	3,155	14,754	268,939
LaPorte IN	1,639	273	10	99	6	67	16	118	5,451	37,109	6,868	51,655
Porter IN	6,864	334	6	128	3	102	16	301	35,934	5,772	43,670	93,130
TOTAL	3,339,621	784,231	18,138	256,261	22,383	415,999	121,394	247,682	243,510	46,792	67,423	5,563,432

Notes: LEHD work trips normalized by CMAP Trip Distribution flows.

Appendix C: Mode Choice Data

Table C-1 lists the number of motorized work trips by travel mode. Table C-2 contains the number of transit trips summarized by origin and trip purpose.

Table C- 1. Work Trips by Mode

	Observed	Model
HBW Trips Entire Region		
Auto drive alone	2,915,218	4,174,098
Auto shared ride	446,690	710,641
Transit	452,156	677,972
HBW Trips Destined to CBD		
Auto drive alone	149,207	262,924
Auto shared ride	42,251	84,312
Transit	281,320	507,268

Notes: Modeled trips in Production-Attraction format.

Data sources: CMAP Mode Choice model and 2000 CTPP.

Table C- 2. Transit Trips by Origin and Purpose

		Observed Trips		Model Trips	
		Total	Transit	Total	Transit
HBW					
	Chicago	1,049,843	295,211	1,497,851	391,010
	Cook balance	993,049	85,241	1,461,836	177,719
	DuPage	415,254	29,560	641,065	43,849
	Grundy	17,065	118	24,431	0
	Kane	172,859	4,805	338,484	9,876
	Kendall	24,930	520	78,536	564
	Lake	277,383	13,574	467,879	17,702
	McHenry	124,492	4,112	223,463	5,233
	Will	219,423	9,266	468,155	15,544
	Lake IN	187,898	5,797	287,292	14,810
	LaPorte IN	41,049	398	62,223	378
	Porter IN	65,436	910	100,242	1,657
HBO					
	Chicago	2,572,238	453,902	2,476,145	325,698
	Cook balance	3,089,301	68,424	2,529,779	106,211
	DuPage	901,985	4,501	1,039,615	26,965
	Grundy	56,727	0	45,225	0
	Kane	387,805	6,851	604,448	5,997
	Kendall	59,085	943	127,947	226
	Lake	852,377	8,524	995,366	12,380
	McHenry	340,725	1,539	402,701	5,821
	Will	590,547	1,142	763,287	4,781
	Lake IN	542,610	6,379	673,413	1,963
	LaPorte IN	98,355	289	175,124	755
	Porter IN	177,410	542	245,168	20
NHB					
	Chicago	1,361,511	193,336	1,004,346	84,943
	Cook balance	1,768,917	27,894	1,602,383	53,873
	DuPage	605,884	2,094	798,724	15,439
	Grundy	30,954	0	32,251	0
	Kane	230,161	3,613	290,476	1,821
	Kendall	24,948	0	40,727	4
	Lake	520,589	0	617,610	12,214
	McHenry	182,227	0	183,501	2,394
	Will	247,639	787	339,114	786
	Lake IN	298,518	748	438,198	551
	LaPorte IN	58,820	253	98,897	92
	Porter IN	89,476	313	124,763	17

Data sources: CMAP Mode Choice model, 2000 CTPP (observed HBW trips) and weighted Travel Tracker survey data (other observed trips).

Appendix D: Traffic Assignment Data

Table D-1 lists the VMT by county for the six counties that comprise IDOT District 1. Table D-2 shows the VMT by facility type for each of the counties in District 1.

Table D- 1. VMT by County

	Observed VMT	Model VMT
Cook	89,725,121	85,968,654
DuPage	23,128,616	23,449,796
Kane	9,936,634	11,403,522
Lake	15,444,172	19,755,369
McHenry	5,939,653	7,993,995
Will	15,650,342	15,907,861
TOTAL	159,824,538	164,479,197

Note: Observed data represent 2008 (source: IDOT).

Table D- 2. VMT by County and Facility

		Observed VMT (ANNUAL)	Model VMT (DAILY)
Cook	Interstate	10,957,783,000	36,804,097
	Arterial/Collector	18,216,405,000	40,686,255
	Local	3,575,481,000	8,478,302
DuPage	Interstate	2,719,128,000	7,988,836
	Arterial/Collector	4,756,766,000	12,530,442
	Local	966,051,000	2,930,518
Kane	Interstate	689,459,000	2,732,589
	Arterial/Collector	2,418,914,000	7,175,821
	Local	518,499,000	1,495,112
Lake	Interstate	967,276,000	3,916,598
	Arterial/Collector	3,989,461,000	13,011,169
	Local	680,386,000	2,827,602
McHenry	Interstate	155,168,000	692,341
	Arterial/Collector	1,618,940,000	5,992,981
	Local	393,865,000	1,308,672
Will	Interstate	2,326,260,000	5,851,451
	Arterial/Collector	2,568,242,000	7,665,743
	Local	817,874,000	2,390,667
District	Interstate	17,815,074,000	57,985,912
	Arterial/Collector	33,568,728,000	87,062,411
	Local	6,952,156,000	19,430,873
TOTAL		58,335,958,000	164,479,196

Notes: Observed data represent 2008 Annual VMT (source: IDOT).
Model data represent daily VMT.

Table D-3 lists the average weekday boardings for the bus and heavy rail systems in northeastern Illinois. Table D-4 shows the average weekday boardings for the each individual heavy rail line. Table D-5 displays the average weekday passenger loads for each commuter rail line.

Table D- 3. Average Weekday Boardings - Bus and Heavy Rail

	CTA bus	Pace bus	Heavy rail
Jan. 2010	989,134	92,965	618,011
Feb. 2010	993,829	96,667	644,029
Mar. 2010	992,627	98,728	652,327
Apr. 2010	992,547	100,147	682,284
May 2010	993,150	100,505	676,356
Jun. 2010	958,472	95,526	694,711
Jul. 2010	930,052	94,168	686,033
Aug. 2010	934,951	97,904	678,365
Average	973,095	97,076	666,515

Data sources: (Chicago Transit Authority, 2010, p. 1) (Pace, 2010).

Table D- 4. Average Weekday Boardings by Heavy Rail Line

	Observed	Model	*Difference*	*% Difference*
Blue	145,030	138,978	-6,051	-4.2%
Brown	95,216	87,520	-7,697	-8.1%
Green	62,143	58,940	-3,203	-5.2%
Orange	51,641	65,223	13,582	26.3%
Pink	27,366	19,144	-8,222	-30.0%
Purple	38,515	43,978	5,463	14.2%
Red	241,462	255,581	14,119	5.8%
Yellow	5,142	2,445	-2,697	-52.4%
TOTAL	666,515	671,809	5,294	0.8%

Data source: (Chicago Transit Authority, 2010)

Table D- 5. Average Weekday Passenger Loads by Commuter Rail Line

	Observed	Model	*Difference*	*% Difference*
BNSF	64,100	59,442	-4,658	-7.3%
ELEC	37,200	40,324	3,124	8.4%
HC	2,600	1,895	-705	-27.1%
MDN	23,900	15,513	-8,387	-35.1%
MDW	22,000	18,566	-3,434	-15.6%
NCS	5,400	8,192	2,792	51.7%
RI	31,200	38,455	7,255	23.3%
SoShore	12,991	18,935	5,944	45.8%
SWS	9,400	18,193	8,793	93.5%
UPNW	42,100	40,635	-1,465	-3.5%
UPN	39,200	34,888	-4,312	-11.0%
UPW	30,000	28,595	-1,405	-4.7%
TOTAL	320,091	323,631	3,540	1.1%

Data sources: (Metra, 2010, p. 52)

(Federal Transit Administration, 2010) - South Shore only.