Technical Memorandum

I-290

Preliminary Engineering
and Environmental (Phase I) Study

West of Mannheim Road to East of Cicero Avenue

I-290 Travel Model Assumptions Methodology & Validation

July 2010

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1.1 Purpose of the Technical Memorandum

The purpose of this memorandum is to summarize the I-290 travel model update process and methodology, to present the assumptions used in the effort, and to provide a validation of the base year scenario. This document will be organized as follows:

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1.2 Background of the I-290 Model Update Process

The current I-290 model adaptation is part of a larger preliminary engineering and environmental effort that includes field surveys, environmental, noise, and air quality inventory and analysis, geometric studies, traffic and safety studies, bridge inspections, hydraulic studies, public involvement and other related activities.

An initial feasibility study of a high occupancy vehicle (HOV) lane between Mannheim Road and Cicero within the Eisenhower Expressway was completed in 1998[i]. The feasibility study contained 1990 and 2010 future traffic estimates for an HOV lane and the general purpose lanes. These traffic forecasts were then initially updated for the I-290 Eisenhower Expressway Phase 1 Preliminary Engineering Study during 2001-2003. The Phase 1 traffic forecasts took into account:

- Traffic growth between the 2010 forecast year for the feasibility study and the 2020 forecast year for the Phase 1 traffic estimates.
- Integration of a revised regional 2020 forecast of population, households, and employment completed after the feasibility study was finished.
- Updates to the Regional Transportation Plan (RTP) for northeastern Illinois[ii].
- The rebuilding of the "Hillside Interchange" section of the Eisenhower Expressway.

1.3 Opportunity & Need for an I-290 Model Enhancement

Since the initial Phase 1 traffic analysis, additional considerations have come to light that affect the model application and planning assumptions. Regional socioeconomic forecasts of population, households, and employment have been updated during this period, and the forecasts' horizon year is now 2030. The region's long-range transportation plan has similarly gone through several revisions and project traffic forecasts must take into account facilities and policies in the current 2030 Regional Transportation Plan[iii].

Travel demand models applied in the initial Phase 1 study were based on 1990 survey data. The Chicago Area Transportation Study (CATS, the Chicago Metropolitan Agency for Planning [CMAP] predecessor transportation planning agency) 1990 household travel survey[iv] was one of the basic sources of trip rates and distributions. The 1990 Census journey to work data was also used[v]. More current travel and socioeconomic data are now available. CMAP has recently completed a comprehensive household travel and activity survey for northeastern Illinois[vi] that updates the 1990 effort. Data collection for the CMAP Travel Tracker survey took place between January 2007 and February 2008 with more than 10,500 households participating in the survey.

Additionally, the 2000 decennial census provided more recent journey to work and other base data for the region. The long-form household sample portion of the decennial census, which collected journey to work and other detailed household and population characteristics, is no longer part of the 2010 and future decennial censuses. Long-form data are now continuously collected by the Census Bureau through the American Community Survey[vii] (ACS), which annually samples approximately 3,000,000 households. Although the annual sample of households for the ACS is far smaller than the number of households that previously received the long-form in the decennial census, roughly comparable quality data can be obtained by combining multiple years of the ACS.

The travel demand models used for the traffic forecasts in both the initial feasibility and Phase 1 studies made use of regional coded highway networks and region-wide traffic analysis zones maintained by CMAP. These regional coded highway networks exclude most local streets. A further abstraction is the CMAP schematic coding of intersections and interchanges to reduce labor intensive data entry. Traffic is modeled between zones, and most regional zones are one-mile in area or larger. Evaluation of the traffic estimates from these studies indicated that a more detailed analysis of corridor traffic was desirable both to improve the model's sensitivity to corridor improvements and to understand the effects of congested operating conditions.

The needs of the current I-290 Phase 1 study, the availability of CMAP's model sets and expertise, and new sources of household and trip making data combined to provide the framework for the I-290 model adaptation and update. In keeping with the congruence with CMAP planning and modeling activities, the base year for the I-290 study is 2010. This memo reports on the establishment and validation of the 2010 base year. In general, model validation serves two key purposes:

- Establishes a model scenario in the current year (2010) that matches observed traffic conditions. The major observed elements are IDOT Average Annual Daily Traffic (AADT), peak period traffic and peak speeds. While the focus is the study corridor, the base year validation also shows that the travel model is replicating current traffic levels throughout the region. For example, in a validated I-290 model, interstate facilities throughout the region will have modeled traffic close to the observed values.

- Prepares a solid foundation for a future base year. Once a validated current year travel model is in place, it is understood that the socioeconomic inputs, model steps and parameters are working correctly and that future base and alternative scenarios will have an accurate starting point.

The 2010 validation has been completed. This validation indicates that a 2030 base can now be prepared and applied for use in the I-290 study area. The 2030 base year will next be prepared and compared to the 2010. At that point 2030 alternatives in the study area will be developed and tested. It is important to note that the alternatives evaluation will focus on relative differences, rather than absolute numbers as the 2030 alternatives are compared to the 2030 base.

2.0 Model Preparation

2.1 Introduction

The I-290 travel model preparation involved two major areas. The first was the preparation of the input files, both geographic (zones and network) and data related (socioeconomic data). The second key area was composed of changes to the four-step model structure. This section will address the preparation of the input files to the model. All preparation steps and four-step model changes were done to enhance the capability of the model to analyze I-290 scenarios.

The philosophy of the I-290 model can be summarized by the following points:

- **Fidelity** to the CMAP models – The goal of the current I-290 model update process is to adapt and utilize the accepted CMAP socioeconomic forecasts and travel demand model for the purpose of studying the traffic on the I-290 corridor between west of Mannheim Road to east of Cicero Avenue.

- **Detailed I-290 Subarea** – Given that the I-290 study area encompasses the I-290 facility, but also the parallel roadways such as Roosevelt Road and Madison/Washington Streets, it was necessary to build a detailed zone system and a correspondingly detailed network within the study area. The CMAP representational highway network was enhanced considerably by preparing a ground-truthed articulated network of I-290. This task involved a process called "conflation" in which the CMAP model highway segments and attribute information were transferred to a highly accurate Geographic Information System (GIS) data layer. As an example, the complex ramping configurations on the I-290 interchanges were added to the starting point CMAP network so that the true distance and intersection geometry could be captured. This detailed network editing included I-290 highway centerline conflation, ramp placement and directionality, and the confirmation of the number of mainline and slip lanes on the facility. The placement of centroid connector links was also revisited as part of the network editing.

- **Income and Auto Occupancy** – Where it is conceptually required, major new modules were added to the CMAP models. The most important one was the stratification of low and high income workers within the Home-Based Work (HBW) trip distribution and mode split models. The low/high income categories are retained through the trip table estimation and produce Single Occupancy Vehicle (SOV), High Occupancy Vehicle (HOV2 and HOV3+) home to work tables, each containing some low and some high income workers.

- **Focus on Efficiency and Comparability** – The regional model with all updates and revisions will be run for the 2010 base, 2030 no-build and 2030 "generalized" build cases in the full model iteration mode to establish model outputs that are very highly converged.

- **Sensitivity Testing** – The overall reason for building the model is to test alternatives in the I-290 transportation corridor. Sensitivity tests were conducted including:
  - Identification of Regional Users – Select link analysis of representative link segments on I-290 and the parallel arterials by direction by time of day for truck and passenger vehicle were conducted.
  - Estimation of Transit Use – The 2030 RTP (conformity/fiscally constrained) transit network was used for the 2030 no-build case and will be the starting point for any transit use analysis. The transit network is, and will remain, in the CMAP regional analysis zone structure – matrix aggregate/disaggregate procedures were used to convert skim and/or person trip tables between the CMAP and I-290 zone structures as needed. Transit measures will include mode split trip reporting of the regional impacts of potential major transit alternatives in the corridor.
  - Investigation of travel model Level of Service Assumptions – Investigation into the Volume Delay Functions (vdfs) for use in the model to represent each of the eight time of day periods in the model by facility will be conducted.

2.2 Traffic Analysis Zones

2.2.1 Background on Zone Disaggregation

After reviewing the traffic forecasts from the Phase 1 study, it was apparent that the regional zones were problematic for eastern portions of the corridor. Many traffic movements originating or destined to this part of the corridor have a choice between the Eisenhower and competitive alternative routes. For example, traffic traveling between the eastern end of the Eisenhower and the area west of O'Hare airport could reasonably be routed by either I-290 or I-90 (Kennedy Expressway). Smaller zones improve the ability of the model to distinguish between competitive alternative routes by both increasing the number of inter-zonal movements to be assigned to routes and locating origins and destinations more accurately.

For the purposes of the I-290 study, the regional one mile square zones in the corridor were subdivided into subzones, which are generally speaking, quarter-sections, one-half mile on a side. The resulting corridor zone system is shown in **Figure 2-1**. Three hundred eighty-four subzones are located within the outlined borders of the corridor, which runs from just west of the Chicago central area to a mile inside DuPage County. Additional tiers of smaller zones are added toward the eastern part of the corridor. This should allow the models to better distinguish between traffic routed through the focused study area portion of the Eisenhower Expressway and alternative routes involving the I-90 Kennedy and I-55 Stevenson Expressways.

Figure 2-2 is an overlay of the parent CMAP zone system and the zone system used as a base to the I-290 study. **Figure 2-3** shows the entire regional zone system surrounding the corridor. There are a total of 2,233 zones covering the region – including the corridor zones - plus seventeen external points of entry located on major roadways at the border of the study area where traffic can enter and leave the region.

Figure 2-1: Traffic Analysis Zones in the I-290 Corridor

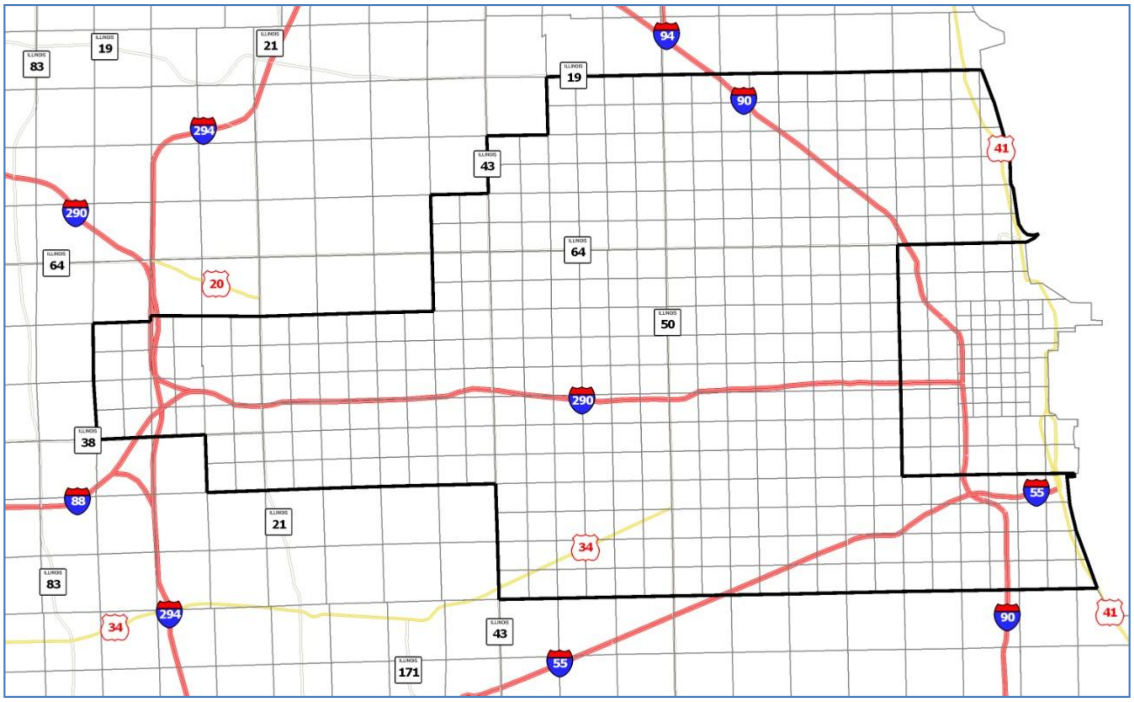


Figure 2-2: CMAP and I-290 Traffic Analysis Zone System (Close up)

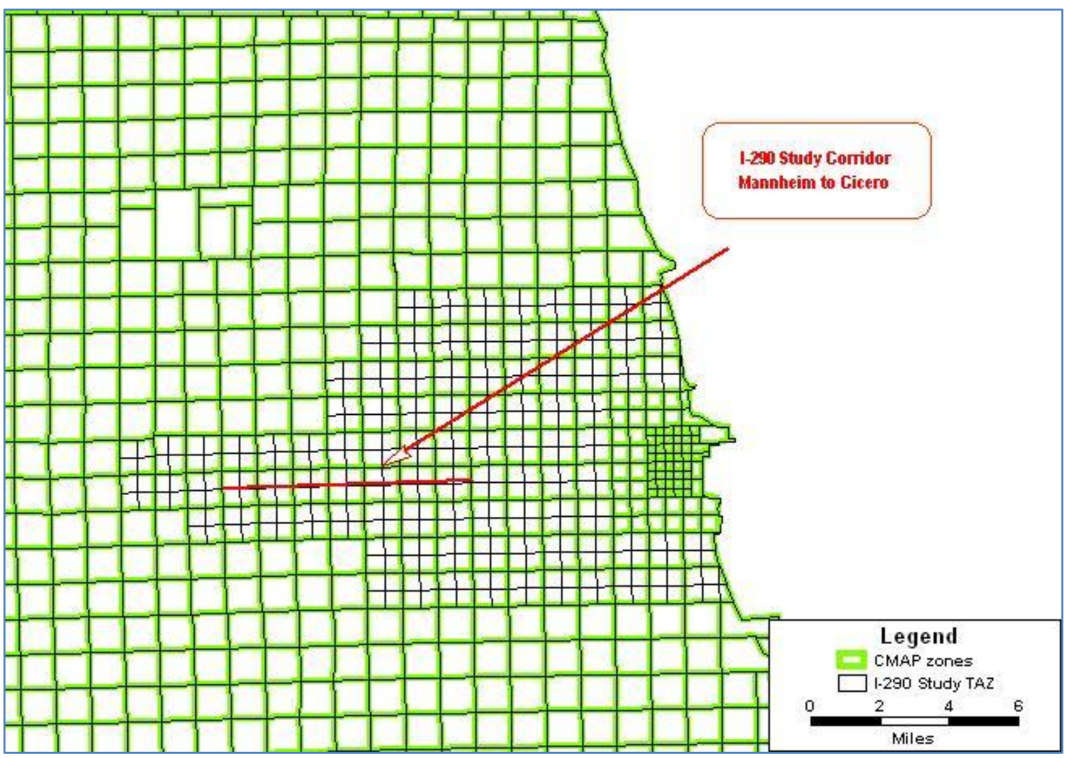
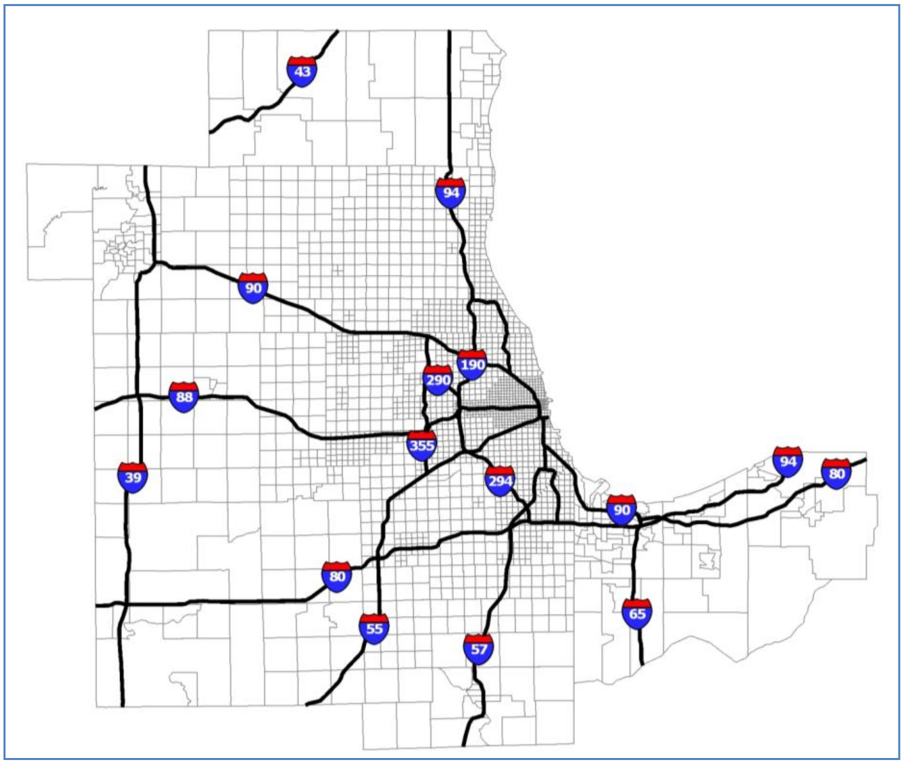


Figure 2-3: Regional I-290 Traffic Analysis Zones



2.2.2 Decision Rules for Zone Disaggregation

The guidance for I-290 zonal definition is as follows:

- Build the zonal structure to provide adequate detail to capture movement on both I-290 and the parallel roadways. Centroid connector review and addition was done manually at each of the new study zones with reference to the expanded network.
- Provide adequate detail to capture movement from zones to the west and east of the I-290 study corridor.
- Maintain consistency with the basic building block of CMAP zonal forecasting: the subzone.
- Nest the zone correspondence within the existing CMAP zone system to enable matrix interchange between the two models. One example of this interchange is the processing and provision of transit skims from the CMAP model to the I-290 model.

Table 2-1 shows that 289 traffic analysis zones were added to the CMAP model to better represent the I-290 study corridor. The building block of zonal construction is the CMAP subzone input file. Most zones were added in Cook County with a small number in DuPage County. The other counties maintained exactly the same number of zones as the parent CMAP model. The zonal disaggregation extends well to the east of Cicero Avenue to allow testing of highway facilities that may operate in and out of the Chicago west side, near-west and the Chicago central business district (CBD).

Table 2-1: Number of Internal Zones by County - CMAP and I-290 Zone System

County Name	County ID	Number of Zones		
		CMAP zone07	**I-290 Study**	**Difference**
Cook	17031	854	1137	283
DuPage	17043	224	230	6
Will	17197	188	188	0
Lake	17097	175	175	0
Kane	17089	145	145	0
McHenry	17111	104	104	0
Six County Subtotal		1690	1979	289
All Other Counties		254	254	0
Grand Total		**1944**	**2233**	**289**

2.3 I-290 Coded Highway Network

2.3.1 Background on Highway Coding

The travel model required highway network refinements in the expanded study area so that sufficient detail could be captured in the model traffic assignment result. These refinements added a local street network to the existing network so that it is possible to better evaluate traffic on the frontage roads and parallel local streets in the study area.

Links in the network are typically only coded between nodes that correspond to intersections and ramp junctions. While most intersections are accurately placed, ramp junction nodes are often located for ease of representation. Shape point nodes are rarely used to improve coded roadway alignments. As a result, maps of the coded network are not geographically accurate, which increases the effort required to interpret model results and prepare meaningful exhibits.

The future modeling of alternatives, such as special purpose lanes within the Eisenhower corridor increases the complexity of the network coding since these lanes must be restricted to certain classes of vehicles. They may also function differently depending on the time of day, with different peak and off-peak vehicle prohibitions or lane configurations, for example. These facilities also may serve a more limited set of traffic movements than the general purpose lanes. The coded representation of special and general purpose lanes, as well as their points of access, must closely resemble the actual facility in order to ensure that the modeled version functions as designed.

As a first step, two tiers of corridor zones – one on either side of the expressway – were identified as areas warranting more detailed network coding. North and south boundaries for these two tiers of corridor zones are two arterial streets paralleling the expressway, Madison Street to the north and Roosevelt Road to the south. The east-west limits of the detailed coding extended from the Chicago central area to just west of Tri-State Tollway (I-294). Locations of local streets and frontage roads for the detailed network coding were obtained from the street network portion of the 2006 Census Topologically Integrated Geographic Encoding and Referencing system (TIGER) line files[viii]. Node numbers greater than the highest node numbers in the regional network were assigned to intersections in the TIGER network files. Network link files are customarily in a "from node" to "to node" format, unlike the TIGER network links. To create a network-like link file from the TIGER street segments, intersection node coordinates were matched against street segment endpoints and "from nodes" and "to nodes' transferred to the street segment file. The resulting network link file contained a link's defining node numbers and the distance along the link.

Nodes and links in the CMAP regional network within the detailed network area were deleted. TIGER source nodes and links were then combined with the remaining regional links and nodes to form I-290 project network files. Remaining cleanup of the network files required manual coding using transportation modeling software.

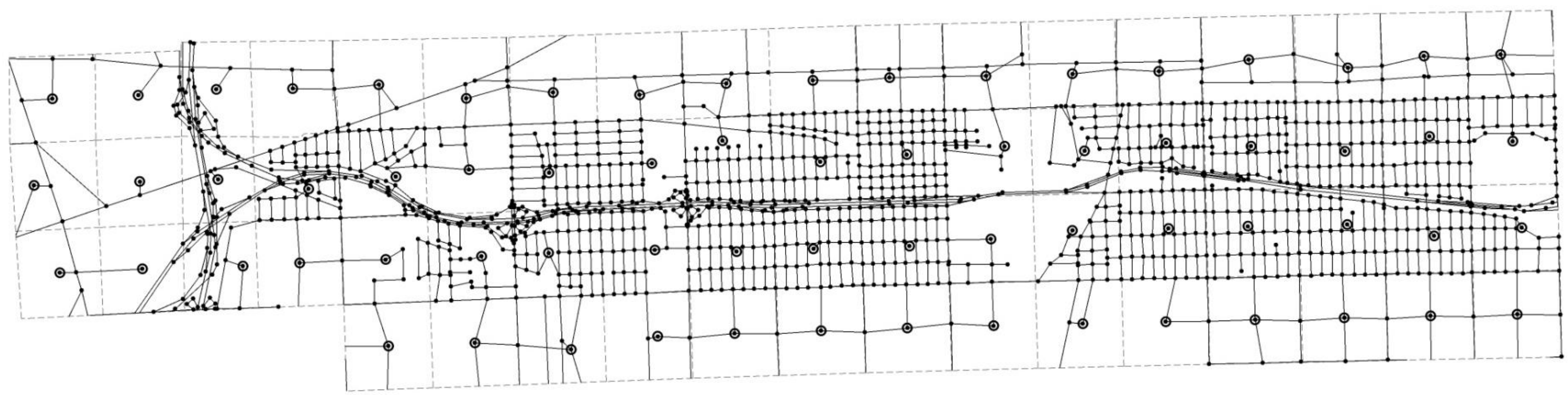
- The detailed TIGER network was stitched into the regional network at the boundaries of the detailed coding.
- Zone centroid nodes plus access links to connect centroids with the highway network were added for the new zones in the I-290 corridor.
- Eisenhower links and expressway-local street ramps were manually adjusted to more faithfully represent the actual facilities' alignments.
- Link data items from the regional network – not including distance - were copied to corresponding links in the detailed network.
- Additional data sources – the Illinois Roadway Information System[ix] and air photos – were consulted to code data items for additional links.

Figure 2-4 shows the detailed network within the zones on either side of the Eisenhower Expressway. The figure also shows zone boundaries and the locations of zone centroid nodes. It is apparent from the figure that even with the smaller zones, the number of points where traffic may enter and leave the network is still limited compared to the detail obtained from the TIGER files.

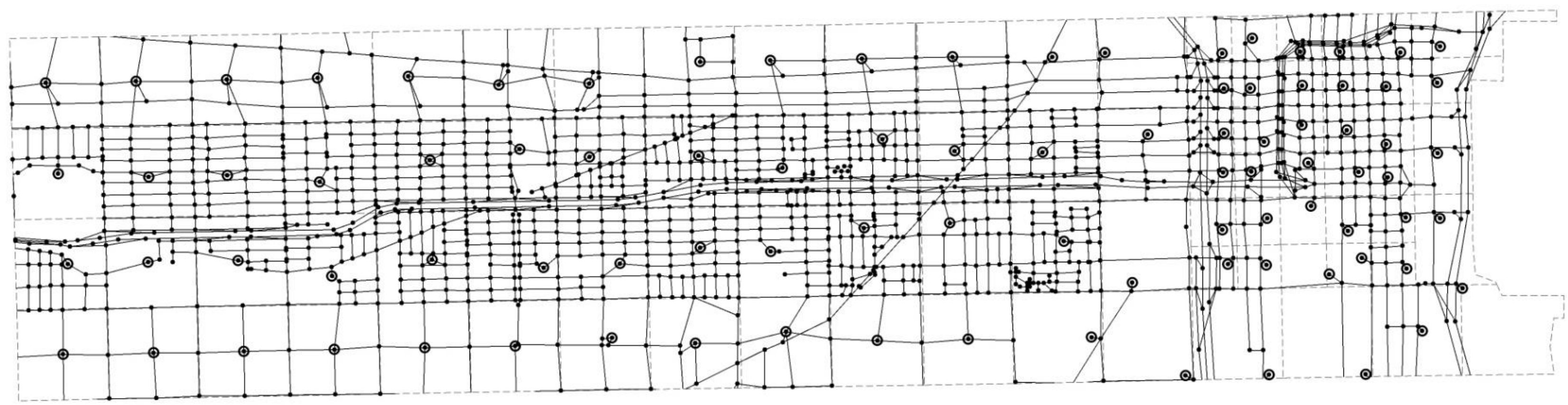
Table 2-2 summarizes the coding of the different variable fields in the network node and link records. Variable names that are preceded by the symbol @ are variables that must be coded in addition to the standard variables anticipated by the EMME/3[x] travel demand modeling software. Assignment of vehicle trips to the coded highway network is covered in a later section. The EMME/3 macros were changed to allow highway segments to serve High Occupancy Vehicles (HOVs) alone in preparation for the alternative testing in the 2030 models. This model capability, in the form of a switch that can be turned on and off in the model trip table macros, was not activated in the 2010 validation. The link volume delay functions were revisited as part of the I-290 conversion although they did not differ from the original CMAP coding protocol. And finally, the CMAP Travel Tracker 2008 survey allowed for the reestimation of the factors that allocate daily vehicle trips to time periods within a day. The issue of the volume delay function to be used for the High Occupancy Vehicle (HOV) facilities will be addressed prior to the alternatives testing when travel times in the study area will be an important focus.

Figure 2-4: Detailed Network Coding in the I-290 Corridor

Eastern Portion from Austin Avenue (6000 West) to Lakefront



Western Portion from Eastern DuPage County to Central Avenue (5600 West)



Zone Border

Table 2-2: Coded Variables in I-290 Network

(I-290 Project Specific Coding in Boldface)

Node Variables	Description
@zone	**I-290 zone where node is located**
@atypej	Area type of I-290 zone
	1 = inside Chicago CBD (zones 1-47)
	2 = inside Chicago Central Area (zones 48-77)
	3 = inside remainder of Chicago
	4 = inside inner suburbs where the Chicago major and minor arterial street grid is continued
	5 = inside remainder of Chicago urbanized area
	6 = inside Indiana urbanized area
	7 = inside remaining Illinois suburban urbanized areas (Joliet, McHenry, etc.)
	8 = inside remaining Indiana suburban urbanized areas
	9 = inside remaining northeastern Illinois urban area
	10 = rural
	11=external area covered by Kenosha, Walworth, Racine, Boone, Winnebago, DeKalb, Ogle, Lee, LaSalle, Grundy, Kankakee, Porter, and LaPorte counties.
	12 = area of detailed network within I-290 corridor
	99 = points of entry into region
Link Variables	
mod	Modes permitted on link
	A = Generalized auto
	S = Single occupant auto
	H = High occupancy vehicle
	T = General truck
	b = B plate truck
	l = Light truck
	m = Medium truck
	h = heavy truck
lan	Number of driving lanes
vdf	1 = arterial street
	2 = freeway
	3 = freeway/expressway ramp from/to arterial street
	4 = expressway
	5 = freeway/expressway to freeway/expressway ramp
	6 = auto access to network
	7 = link where toll is paid
	8 = metered expressway entrance ramp
	9 = collector-distributor and local street links in I-290 corridor detailed network
typ	1 = default
	10 = POE connector
	88 = collector-distributor links in I-290 corridor detailed network
	99 = local street links in I-290 corridor detailed network
@speed	link free speed or speed limit from CATS/CMAP network
@parkl	number of parking lanes on link from CATS/CMAP network
@width	average lane width in feet

2.3.2 Decision Rules for Highway Coding

The network coding prepared for the I-290 Study followed these guidelines:

- Provide adequate highway detail to capture movement on both I-290 and the parallel roadways. Include the capability to reflect interstate-to-interstate movements that are rational path choices for I-290 travelers.
- Provide network detail at one level below the desired analysis level of detail. As discussed above, previous studies in the corridor have shown that network detail within a wide band of influence in the I-290 study corridor will be helpful in alternatives analysis.
- Build a highly detailed I-290 study network with all interchanges, merges and lane configurations matching the actual physical facility.
- Within the focused zone area, plus a one mile buffer, identify the locations for and code multiple centroid connectors.
- Prepare for a 2030 Baseline network. The I-290 study required that a custom 2030 Baseline network be constructed. This network will not include any capacity enhancements on I-290, although it does include 2030 Regional Transportation Plan highway and transit elements outside of the study area. The 2030 Baseline network will be discussed in a future report.

2.4 Socioeconomic Data

The socioeconomic data used for the I-290 study was obtained directly from the CMAP forecasts. **Table 2-3** shows the totals for households and employment for 2010 which was the scenario year base for model conversion from the CMAP to the I-290 study.

Table 2-3: CMAP Socioeconomic Forecast Totals for 2010

County or District Name	Population		Employment	
	# of Households	% of Regional	# of Total Workers	% of Regional
Cook	2,059,288	65%	2,964,616	63%
DuPage	337,937	11%	710,030	15%
Will	228,658	7%	247,024	5%
Lake	241,551	8%	389,557	8%
Kane	170,513	5%	254,812	5%
McHenry	112,197	4%	126,259	3%
Six County Subtotal	3,150,144	100%	4,692,298	100%
All Other Counties*	794,324		916,441	
Grand Total	3,944,468		5,608,739	

* *In Illinois, Wisconsin & Indiana; Source: CMAP c09q1 forecast series, 2009*

The CMAP forecast values for 2010 were prepared and transmitted by CMAP in 2009 for direct use in the I-290 study.

Table 2-3 shows over 3.1 million households and an employment total of over 4.6 million for 2010 in the six county area. More than 60% of the households and employment in the six county area lie in Cook County. DuPage County contains 11% of the regional households and 15% of the employment in the same area. The outer counties included in the I-290 models (see **Figure 2-3**) contribute about 800,000 households and 900,000 jobs.

3.0 Travel Model Enhancements

3.1 Need for the Model Enhancements

The zonal and network disaggregation discussed in **Section 2** were conducted in parallel to the travel model enhancement work. The travel model enhancement was done at each level of the CMAP four-step model: (1) trip generation, (2) trip distribution, (3) mode choice, and (4) traffic assignment.

3.2 Household Person Trip Generation Model

The CMAP household person trip generation model was updated in 2008-2009. Only minor changes to this version of the model were completed as part of the I-290 project. The most significant enhancement was the option to create a file of estimated household vehicle ownership levels by the subzones that are used by the trip generation model.

For background, the 2008-2009 updated CMAP household person trip generation model has the following features:

- Trip generation rates for persons residing in households are estimated with trip data from the 2007-2008 CMAP household travel survey.
- Model inputs can readily be updated with ongoing ACS data.
- A synthetic four dimension (adults-workers-children-income quartile) distribution of households into 224 categories is estimated for every trip generation sub-zone.
- Trip end estimates in detailed trip categories can be output including home-work trips by low and high income workers.
- Attraction allocation, household vehicle ownership, and non-motorized sub-models are revised and re-estimated with 2007-2008 household travel survey data.

The sequence of travel demand models for the I-290 project includes a mode choice model that allocates person trips into person trips by drive alone private vehicle, two persons ride-sharing, and three or more persons carpooling. The sub-mode choice model for private vehicles includes independent variables for the proportions of households within a zone at different levels of vehicle ownership. Since the household vehicle ownership sub-model in the CMAP trip generation model estimates these proportions, the same values of household vehicle ownership should be used in both trip generation and mode choice for internal consistency.

An option was incorporated into the trip generation code to retain the household vehicle ownership estimates for later use in mode choice. The fixed format for this file is listed in **Table 3-1**. Low income workers are defined as workers with below median regional earnings and high income workers have above median earnings.

Table 3-1: Household Vehicle Ownership File

Variable	Location
I-290 Zone	1-5
Households with One or More Low Income Workers	
Fraction of Households without Vehicles	6-17 (12.4)
Fraction of Households with One Vehicle	18-29 (12.4)
Fraction of Households with Two or More Vehicles	30-41 (12.4)
Households with One or More High Income Workers	
Fraction of Households without Vehicles	42-53 (12.4)
Fraction of Households with One Vehicle	54-65 (12.4)
Fraction of Households with Two or More Vehicles	66-77 (12.4)

A keyword was added to the program control file to optionally create the household vehicle ownership file. The **&PARAM** and **&END** statements identify the beginning and end of the **NAMELIST** input file that now includes the following keyword variables.

1. **TITLE**: An 80 character name identifying the model run enclosed in single quotes.
2. **SUBZONES:** Trip generation sub-zones in the study area.
3. **PUMA5:** Five percent sample Public Use Microdata Areas in the modeled study area.
4. **PUMA1:** One percent sample Public Use Microdata Areas in the modeled study area.
5. **ZONES:** Zones used in the remaining CMAP models for trip distribution (linking of trip ends into trips between zones), mode choice (allocation of trips to travel modes), and assignment (allocation of trips to highway and transit routes).
6. **COUNTIES:** Counties in the study area.
7. **PUMA_TG:** A true/false variable that defaults to false. When true the model's logic includes an optional subroutine that prepares an updated (future) four-way cross-tabulation of households within sub-zones. This new table is based upon (future) large area average household characteristics and the initial (base year) cross-tabulated household table.
8. **SAVE_FILE:** A true/false variable that defaults to false and causes all intermediate program files to be retained after the model run is completed.

9. **EXP_TTYPE:** A true/false variable that defaults to false. When true, all files and reports include forty-nine trip types based upon trip purposes in the CMAP household travel survey. When false, files and reports have the eleven trip types in the current CMAP trip generation.

10. **MODE_CHOICE:** A true/false variable that defaults to false. The optional household vehicle ownership file (Table 2) is created when keyword is true.

11. **IN_EMPFACT:** Employment in Indiana is multiplied by this factor, which defaults to 1.00. This variable and the following one for Wisconsin are included to offset possible systematic differences in employment definitions and estimation methods between CMAP and neighboring MPOs.

12. **WI_EMPFACT:** Employment in Wisconsin is factored by this value that defaults to 1.00.

3.3 Trip Distribution

3.3.1 Pre-Distribution Transit Access Parameters

Transit access parameters stored in two legacy trip distribution input files (M01.dat and DISTR.dat) were reviewed and updated for both 2010 and 2030. These file inputs were prepared using spatial analysis with a Geographic Information System (GIS) tool.

3.3.2 Pre-Distribution Travel Cost Model

The next model in the sequence of CMAP regional travel models estimates the highway and transit costs for trips between zones for use by the agency's trip distribution model. Costs are here calculated as in the CMAP mode choice model and the pre-distribution code is largely the same as the mode choice model code.

The overriding objective for revisiting this model in the I-290 project was to make all cost calculations in the model consistent with current, or near current, regional conditions. To this end, cost parameters that are model control variables and input files containing data used in the model's cost calculations were reviewed and updated.

The pre-distribution model reads data directly from an EMME/3 databank, a large data file that contains all network and zone data processed by the EMME/3 travel modeling software. A few minor changes in the code were required to reflect the naming of the databank as EMMEBANK by the most recent version of the EMME/3 software.

Home-Work Control Variables

Table 3-2 lists the control variables for trips between home productions and work attractions. These variables are read into the pre-distribution model through five namelist variable lists, lists of control variables contained between an &NAME identifier before the list (&PARAM, &OPTION, &PROCESS, &SYSTEM, and &TABNUM) and an &END at the end of the list. The table includes the variable values in the current CMAP model setup for regional planning and the values used in the I-290 project plus a brief rationale for any adjustment of the CMAP values.

The coefficients in the mode choice model date from the original model estimation based on 1970 travel data. In particular, the coefficients for travel costs reflect 1970 dollar values. Since costs in the I-290 project are in current dollars, these coefficients needed to be adjusted. The Historical Consumer Price Index for all Urban Consumers[xi] indicates that a 1970 dollar would be worth $5.55 in current dollars and the cost coefficients were reduced accordingly.

Table 3-2: Control Variables In & PARAM Namelist for Home-Work Trips

Variable	Description	CMAP Regional Planning	Project	Reason for Change
ZONES	Highest zone number, must be less than or equal to EMMEBANK	1944	2233	Internal zones for I-290 project
CBDZON	CBD zone numbers (maximum of 200 zones)	1-77	1-77	I-290 project zones defined as Chicago central area
RNSEED	Random number seed (an integer value between 0 and 9999 with 0 implying a random value)	1934	1934	Arbitrary integer value set to allow comparison between model runs
COEFF1	Six coefficients in mode choice model to weight cost components for trips with destinations not in CBD	1. 0.0186 (Auto or transit line-haul in-vehicle time in minutes)	1. 0.0186	1. CMAP historical value
		2. 0.0072 (Auto line-haul costs or transit line-haul and access/egress costs in cents)	2. 0.00130	2. CMAP value factored by 0.18 (2008 to 1970 Urban Consumers' Price Index)
		3. 0.0584 (Auto walk time to/from parking or transit access/egress in-vehicle time in minutes)	3. 0.0584	3. CMAP historical value
		4. -2.000 (Transit bias)	4. 0.0	4. Transit bias not included in costs
		5. 0.0399 (Transit line-haul and access/egress out-of-vehicle time in minutes)	5. 0.0399	5. CMAP historical value
		6. 0.0811 (Half headway of first transit line-haul service boarded in minutes)	6. 0.0811	6. CMAP historical value
COEFF2	Six coefficients in mode choice model to weight cost components for trips with destinations in CBD	1. 0.0159 (Auto or transit line-haul in-vehicle time in minutes)	1. 0.0159	1. CMAP historical value
		2. 0.0085 (Auto line-haul costs or transit line-haul and access/egress costs in cents)	2. 0.00153	2. CMAP value factored by 0.18 (2008 to 1970 Urban Consumers' Price Index)
		3. 0.0486 (Auto walk time to/from parking or transit access/egress in-vehicle time in minutes)	3. 0.0486	3. CMAP historical value
		4. 0.0 (Transit bias)	4. 0.0	4. Transit bias not included in costs
		5. 0.0290 (Transit line-haul and access/egress out-of-vehicle time in minutes)	5. 0.0290	5. CMAP historical value
		6. 0.0173 (Half headway of first transit line-haul service boarded in minutes)	6. 0.0173	6. CMAP historical value

Table 3-2 continued. Control Variables in &PARAM Namelist for Home-Work Trips

Control Variable	Description	CMAP Regional Planning	I-290 Project	Reason for Change
APC	Four daily parking costs for work locations in the region in cents	1. 400 (Chicago central area)	1. 800	1. The balance of the central area outside the zones covered by the CBD parking sub-model. Set to approximately half the on-street rate to reflect free employee parking.
		2. 100 (Balance of Chicago)	2. 100	2. Reflects mostly free employee parking outside the central area
		3. 100 (Dense suburban)	3. 200	3. Approximately half the on-street rate in business districts in dense suburban area
		4. 0 (Low density suburban)	4. 0	4. Generally free employee parking
WFA	Four average walking times from parked auto to workplace in minutes	1. 5 (Chicago central area)	1. 5	1. Default value for the balance of the central area outside the zones covered by the CBD parking sub-model.
		2. 3 (Balance of Chicago)	2. 3	
		3. 3 (Dense suburban)	3. 3	
		4. 3 (Low density suburban)	4. 3	
PRKZON	Zone numbers covered by CBD parking sub-model (maximum of 200 zones)	15-18,	2-7,	Determined by the availability of off-street parking rate data
		20-30,	9-30,	
		32-36,	32-36,	
		39, 40	39-41,	
			45, 47,	
			55-57	
ITER	Number of trips simulated between zone pairs to produce average cost values	10	100	Faster processing speeds allow far more trips to be simulated in acceptable times

Table 3-3: Control Variables in &Option Namelist for Home-Work Trips

Control Variable	Description	CMAP Regional Planning	I-290 Project	Reason for Change
HW	Indicates home productions and work attractions are simulated	TRUE	TRUE	
HNW	Indicates home productions and non-work attractions are simulated	FALSE	FALSE	
OTH	Indicates origins and destinations without a home or work trip end are simulated	FALSE	FALSE	
ASM_AREA	Indicates parameters that control the simulation of distance from trip end to line-haul transit service are input by area type (Chicago central area, balance of Chicago, dense suburban sparse suburban)	FALSE	FALSE	
ASM_ZONES	Indicates parameters that control the simulation of distance from trip end to line-haul transit service are input by zone (DISTR input file)	FALSE (Note: regional defaults are used when both ASM_AREA and ASM_ZONES are false, see discussion of DISTR input file)	TRUE	New zone distance parameters estimated for I-290 zone system, current rail transit and commuter rail stations, existing CTA bus service, and PACE regional and feeder bus.
INCOST	Indicates that unit modal travel costs are input by area type and not set to program defaults	TRUE (Note: see discussion of M023 input file for values)	TRUE	Modal travel costs revised to approximate current values in M023 input file
TRACE	Indicates that extensive intermediate output is desired for program debugging	FALSE	FALSE	Used to check program calculations

Table 3-4: Control Variables in &PROCESS Namelist for Home-Work Trips

Control Variable	Description	CMAP Regional Planning	I-290 Project	Reason for Change
PZOI	Production/origin zones to be processed	1-1944	1-2233	More I-290 zones due to detailed zones in corridor
QZOI	Attraction/destination zones to be processed	1-1944	1-2233	

Table 3-5: Control Variable in &SYSTEM Namelist for Home-Work Trips

Control Variable	Description	CMAP Regional Planning	I-290 Project	Reason for Change
SPDWLK	Average walking speed in tenths of a mile per hour	30	30	
SPEEDS	Four average auto speeds in miles per hour followed by four average bus speeds for use in the access/egress	1. 7 (Auto in Chicago central area) 2. 15 (Auto in balance of Chicago) 3. 20 (Auto in dense suburban) 4. 30 (Auto in low density suburban) 5. 5 (Bus in Chicago central area) 6. 10 (Bus in balance of Chicago) 7. 12 (Bus in dense suburban) 8. 17 (Bus in low density suburban)	1. 7 2. 15 3. 20 4. 30 5. 5 6. 10 7. 12 8. 17	
DRVOT	Value of time for auto drivers in cents	60	20	I-290 project value is one-half the 2008
AFC1	Auto fixed costs for driver in cents per trip	0	0	Auto fixed costs not used in cost estimation
AFC2	Auto fixed costs for auto passenger in cents per trip	0	0	Auto fixed costs not used in cost estimation
W2PNR	Walk time to station platform from park and ride lot in minutes	3	3	
DISCNT	Discount factor to bring costs to 1970 dollars,	0.3	1	Costs are expressed in current dollars

Table 3-6: Control Variables in &TABNUM Namelist for Home-Work Trips

Control Variable	Description	I-290 Project
TABLE_FMD	EMMEBANK input table number for first transit mode boarded	Table numbers depend upon data preparation in EMME software
TABLE_LMD	EMMEBANK input table number for last transit mode boarded	
TABLE_IVT	EMMEBANK input table number for transit in-vehicle time	
TABLE_OVT	EMMEBANK input table number for transit out-of-vehicle time	
TABLE_HWAY	EMMEBANK input table number for headway of first transit line boarded	
TABLE_PMD	EMMEBANK input table number for priority mode	
TABLE_FARE	EMMEBANK input table number for transit fares paid	
TABLE_HTIME	EMMEBANK input table number for highway travel time	
TABLE_HDIST	EMMEBANK input table number for highway distance traveled time	
TABLE_AUTIL	EMMEBANK output table number for auto general cost	
TABLE_TUTIL	EMMEBANK output table number for transit general cost	

3.4 Mode Choice

3.4.1 Project Approach

The CMAP mode choice model was partly recalibrated for the I-290 study to reflect current travel costs and mode shares in the region. The calibration process started with the model coefficients that were estimated some years before by CATS, CMAP's predecessor agency, and currently used for agency planning projects. The cost coefficients were next adjusted so that costs could be expressed in current dollars, rather than 1970 dollars, the date of the survey used for the original model estimation. The Consumer Price Index for all Urban Consumers indicated that one 1970 dollar equaled approximately $5.50 in 2008-2009 dollars.

Final calibration consisted of adjusting bias constants so that resulting mode shares estimated by the model matched observed mode shares. Home-work coefficients were calibrated to observed data in the 2000 Census Transportation Planning Package, while home-other and non-home model coefficients were calibrated to data from the CMAP-Northwestern Indiana Regional Planning Commission 2007-2008 household travel survey. This work fitted the model to reflect that there are very long work trips to the Chicago central area.

3.4.2 Descriptions of Model Coefficients

1. **COEFF1:** Six model coefficients that control binary auto-transit mode shares for trips (home-work, home-non-work, and non-home) to non-CBD destinations.
    a. **COEFF1 (1):** Zone to zone in-vehicle time on line-haul modes in minutes.
    b. **COEFF1(2):** Zone to zone auto operating costs or zone to zone line-haul transit fares plus costs to access/egress transit service in cents.
    c. **COEFF1 (3):** In-vehicle time to access/egress transit in minutes.
    d. **COEFF1 (4):** Transit bias constant. Although a negative number due to the negative sign associated with the variable in the transit cost (negative utility) calculation, it can be interpreted as the added inherent cost of selecting transit.
    e. **COEFF1(5):** Zone to zone out-of-vehicle time accrued from the initial transit boarding to final alighting plus the out-of-vehicle time to access/egress transit except for the time spent waiting for the initial boarding due to service frequency (one-half headway) in minutes.
    f. **COEFF1 (6):** One-half headway of first transit line boarded in minutes.

2. **COEFF2:** Six model coefficients as described above that control binary auto-transit mode shares for trips to non-CBD destinations.

3. **HOV_BIAS:** Two bias constants used in the submodel to allocate home-work person trips by auto into drive alone, two person shared ride, and three or more person carpool auto submodes for trips to non-CBD destinations.
    a. **HOV_BIAS (1):** Three or more persons carpool bias. The inherent added cost of selecting the three or more person carpool mode versus the two person shared ride mode. .
    b. **HOV_BIAS (2):** Shared ride (two or more persons) bias versus. The inherent added cost of shared ride modes as opposed to driving alone.

4. **HOV_CBDBIAS:** Two bias constants as described above for trips to CBD destinations.

3.4.3 Mode Choice Coefficients for Different Model Applications

The model can be run in six different modes depending on the trip purpose, use of the HOV submodel to allocate auto trips into occupancy level submodes, and segmentation home-work trips by earnings level.

1. Home-work trips for all workers
    a. Auto-transit binary choice
    b. Auto-transit binary choice with HOV submodel allocation

2. Home-work trips segmented by workers' earnings
    a. Auto-transit binary choice with HOV submodel allocation for low earnings (below regional median earnings) workers
    b. Auto-transit binary choice with HOV submodel allocation for high earnings (above regional median earnings) workers

3. Auto-transit binary choice for home-non-work trips

4. Auto-transit binary choice for non-home trips

The following coefficients were calibrated during the preparatory work for modeling an HOV lane treatment as part of the reconstruction of the Eisenhower (I-290) Expressway.

Table 3-7: 2009 I-290 Project Mode Choice Coefficients for Home-Work Trips

	Auto-Transit Binary Choice	Auto-Transit Binary Choice with HOV Submodel	Low Earnings Auto-Transit Binary Choice with HOV Submodel	High Earnings Auto-Transit Binary Choice with HOV Submodel
COEFF1(1)	0.0186	0.0186	0.0186	0.0186
COEFF1(2)	0.0013	0.0013	0.0013	0.0013
COEFF1(3)	0.0584	0.0584	0.0584	0.0584
COEFF1(4)	-0.7357	-0.7357	-0.9814	-1.5484
COEFF1(5)	0.0399	0.0399	0.0399	0.0399
COEFF1(6)	0.0811	0.0811	0.0811	0.0811
COEFF2(1)	0.0159	0.0159	0.0159	0.0159
COEFF2(2)	0.00153	0.00153	0.00153	0.00153
COEFF2(3)	0.0486	0.0486	0.0486	0.0486
COEFF2(4)	-0.8812	-0.8812	-0.4121	-0.6959
COEFF2(5)	0.029	0.029	0.029	0.029
COEFF2(6)	0.0173	0.0173	0.0173	0.0173
HOV_BIAS(1)	NA	2.09	2.09	2.09
HOV_BIAS(2)	NA	1.15	0.263	0.45
HOV_CBDBIAS(1)	NA	2.51	2.51	2.51
HOV_CBDBIAS(2)	NA	1.59	0.583	-0.06

Table 3-8: 2009 I-290 Project Mode Choice Coefficients for Home-NW and NH Trips

	Home-Non-Work	Non-Home
COEFF1(1)	0.0114	0.0114
COEFF1(2)	0.00592	0.00592
COEFF1(3)	0.0663	0.0663
COEFF1(4)	-0.4482	-1.1403
COEFF1(5)	0.0589	0.0589
COEFF1(6)	0.061	0.061
COEFF2(1)	0.0159	0.0159
COEFF2(2)	0.00153	0.00153
COEFF2(3)	0.0486	0.0486
COEFF2(4)	-0.5507	-1.6275
COEFF2(5)	0.029	0.029
COEFF2(6)	0.0173	0.0173

3.5 Traffic Assignment

The CMAP and I-290 models use the EMME/3 standard traffic assignment which is a user-optimal equilibrium assignment with linear approximation (Frank and Wolfe). It is based on the assumption that each traveler chooses the path (or route) perceived as being the best; if there is a shorter path than the one being used, the traveler will choose it. At the equilibrium, no one can improve their travel time by changing paths. With the standard traffic assignment, up to 12 classes can be assigned simultaneously. For each class there are multiple choices for saving and storing the assignment results. For the I-290 effort the class specific volumes on links are saved in link segment extra attributes keyed to the vehicle class**.** **Table 3-9** lists the six vehicle classes for the study.

Table 3-9: Vehicle Classes for Traffic Assignment

Number	Link Mode	Description	Extra Attribute Name from Assignment
1	H	High Occupancy Vehicle	@hov
2	S	Single Occupancy Vehicle	@vauto
3	b	"B" Plate truck	@vbplt
4	l	Light Truck	@vlght
5	m	Medium Truck	@vmed
6	h	Heavy Truck	@vhevy

It is anticipated that INRO's EMME/3 path-based assignment will be tested and implemented in the scenario testing phase of the study.

3.6 Model "Batch" Processing

The recalibration and validation steps implemented in the I-290 model conversion required that the structure of the EMME/3 batch file be revisited and revised. The batch program is designed so that a scenario is prepared after which eight time periods summing to a 24-hour day are assigned in turn. A two databank structure was established for the I-290 work:

1. **Simulation Bank** – the EMME/3 databank that is alternative specific and which holds the base network, eight time of day networks, reports from the model runs, and the zonal data.
2. **Archive Bank** - An archive or "hold" databank, also alternative specific, that captures the current times and trips by purpose and mode in matrix form from each of the five full model iterations

Parallel (Multi-threaded) Standard Traffic Assignment

Revision of the EMME/3 macro approach also allowed a software innovation to be introduced. INRO's EMME/3 assignment called Parallel Standard Traffic Assignment is a multi-threaded implementation of the Standard Traffic Assignment with Fixed Demand that makes use of multiprocessor systems when available. It remains an implementation of the linear approximation algorithm (Frank and Wolfe) equilibrium assignment, hence the same convergence properties as the Standard Traffic Assignment, with the distinction that computing times can be reduced significantly when run on systems with multiple processors. The user is able to select how many threads will be used in the assignment, with each thread corresponding to dedicated use of one processor. This allows users to choose how many processors to dedicate to the parallel traffic assignment and provides the opportunity to leave processors for other concurrent computing needs if desired[xii]. The I-290 model application integrates calls to the multi-threaded EMME/3 module thus enhancing run time and efficiency.

Model Set-up Steps

The steps in making a model run to obtain a daily traffic estimate for a scenario year within the EMME/3 environment are as follows:

1. Prepare the network for the appropriate study year and scenario. Include reference to the time periods and directionality of link segment availability (Example, the Kennedy reversibles).
2. Prepare the input household productions and attractions for the I-290 expanded zone system.
3. Build the time of day scenarios to be alternative specific.
4. Prepare the transit network skims in the I-290 expanded zone system.
5. Clear and load the alternative specific folder with the macros, input files and executables required for a full model run. Establish and clear the archive folder.
6. Clear and prepare the path and location for the output and reporting files.
7. Edit the batch file to be alternative specific.
8. Conduct the run.
9. Run the post-processing macros to tabulate the model results. Convert trucks to vehicle equivalents for summary statistics.

Output

A library of EMME/3 macro scripts was prepared to serve the model runs with a reporting stream allowing error investigation ("trouble-shooting") and monitoring of model runs to take place. The batch processing approach was written so that both base and future years could be run with a minimum of file setup changes. Post processing and reporting of the eight time of day periods and the six vehicle types includes:

- Calculation of an average daily vehicle link value from the weighted sum of single occupancy vehicles, high occupancy vehicles, B-plate, light, medium and heavy trucks over the eight periods.
- Calculation of the daily Vehicle Hours Traveled (VHT).
- Calculation of the Vehicle Miles Traveled (VMT) totals by time of day.
- Mode split report that facilitates the summary of trips by purpose by auto mode (SOV, HOV2 and HOV3+) and transit.

4.0 2010 Validation of the I-290 Model

4.1 Introduction

A preliminary review of how the I-290 model performs with the full set of 2010 inputs as well as the model enhancements was conducted. The intent of this review was to determine the basic validity of the I-290 model for its use in 2030 alternatives analysis. Additional analysis and detailed review, including a comparison of the 2010 and 2030 scenarios, will be conducted in a follow-on technical memorandum. The travel model outputs reviewed are:

1. Daily Traffic Estimates and Vehicle Miles Traveled (VMT)
2. Select Link Flows
3. Peak Periods
4. Volume/Capacity Ratios
5. I-290 Corridor Traffic

4.2 Regional Model Validation

The eight time periods established in the CMAP models are summed to a daily vehicle load (attribute @vadt) on each highway segment of the model. This estimated daily traffic can then be compared to observed traffic data (Average Annual Daily Traffic or AADT).

4.2.1 Observed Data

Observed data for the I-290 effort was obtained from CMAP with the ultimate source being the Illinois Department of Transportation[xiii] (IDOT). CMAP staff tabulates, geocodes, and updates the observed traffic data in EMME/3-ready format allowing the analyst to compare the counted links to the model output. Over 4,100 link segments are counted in the CMAP model network as shown in **Table 4-1**. Of the arterial segments, 13% are counted. Of the freeway and expressway segments, over 80% are counted. **Figure 4-1** shows the locations of the CMAP observed data for the three main classes. For the I-290 project the count locations within the CMAP conformity area (six county plus parts of Kendall and Grundy) are used. **Figure 4-2** shows a close-up of the I-290 corridor with count locations.

Table 4-1: Number of Count Locations by Class (Using VDF Function Group)

Link Type	Volume Delay Function	*Count Profile*		
		Counted Links	Total Links	% Counted
Arterial Street	1	2,711	20,316	13%
Freeway	2	1,200	1,489	81%
Freeway/expressway ramp from/to arterials street	3	80	1,363	6%
Expressway	4	146	177	82%
Freeway/expressway to freeway/expressway ramp	5	10	215	5%
Link where toll is paid	7	47	144	33%
Total		**4,194**	**23,704**	**18%**

Figure 4-1: Location of CMAP Observed Traffic Data

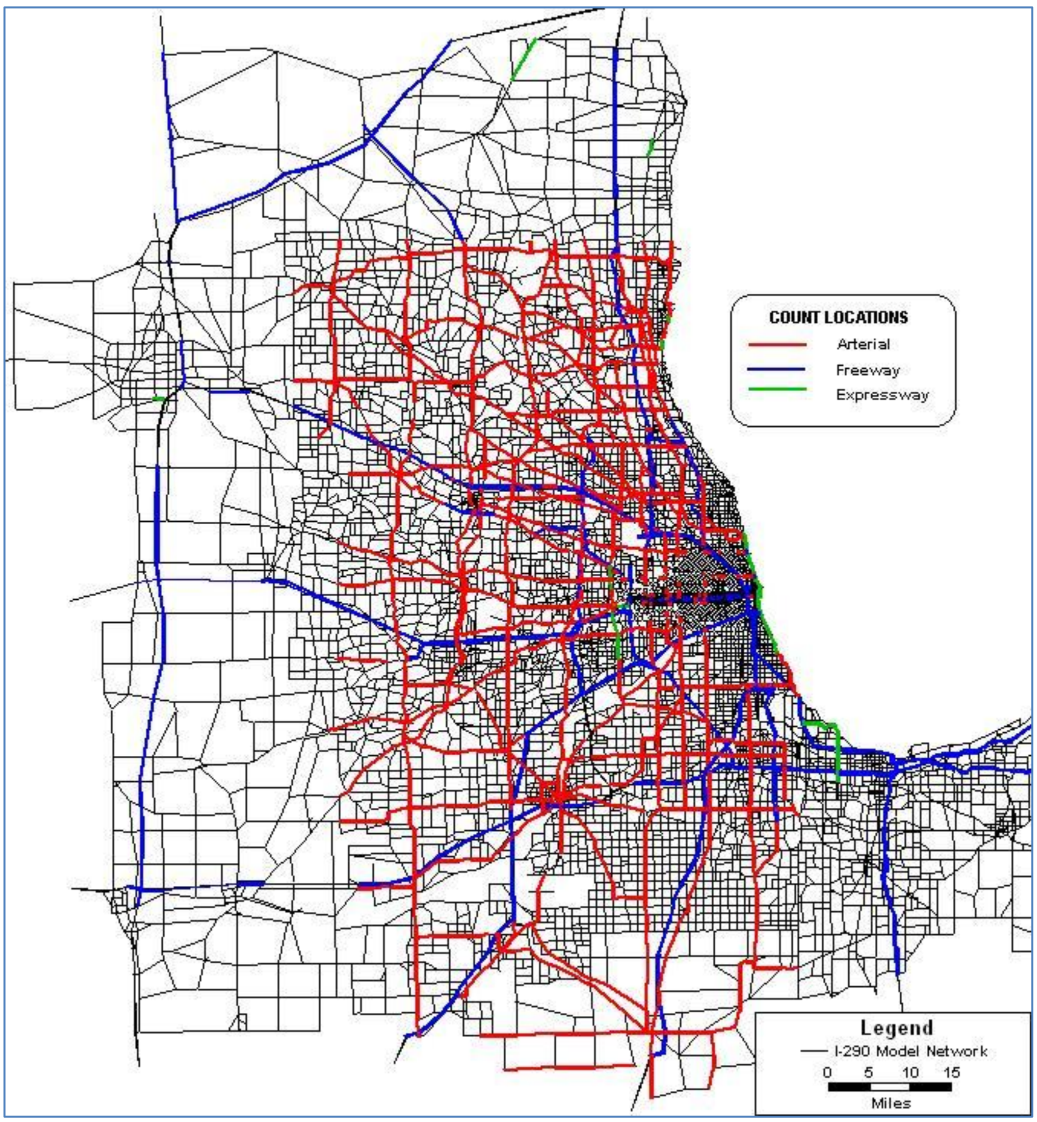
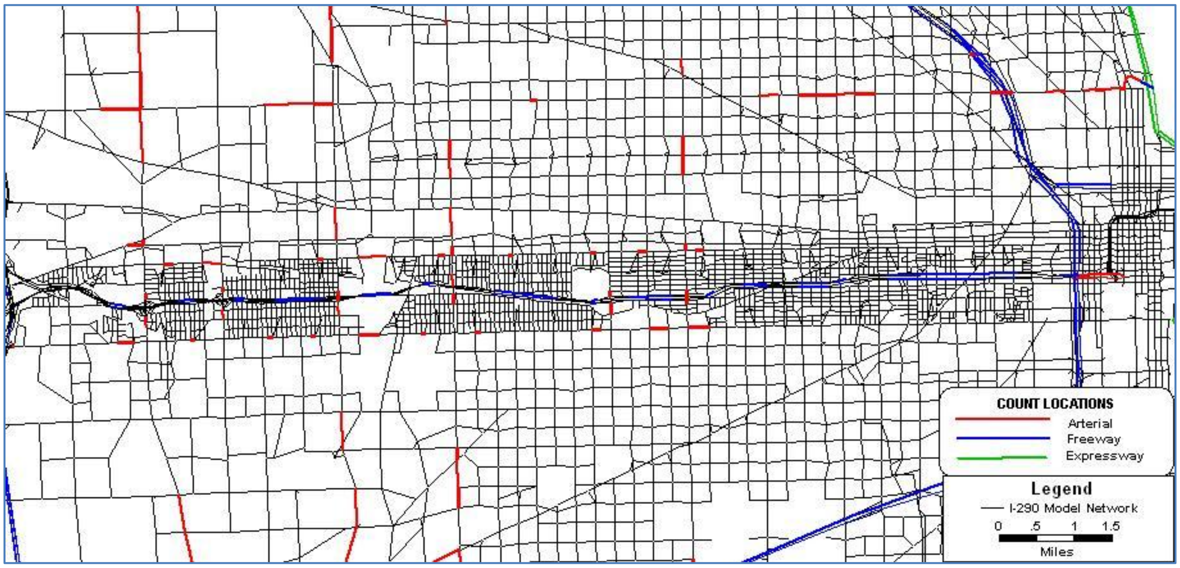


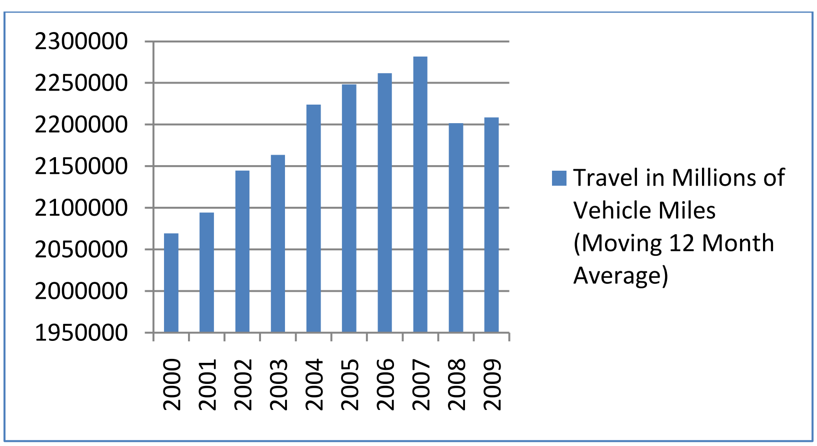
Figure 4-2: Location of CMAP Observed Traffic Data (Close-up)



The majority of the CMAP traffic data (70%) was collected in 2004-2005. Updates are conducted by CMAP on a rolling schedule so that approximately 16% of the locations were updated after 2005.

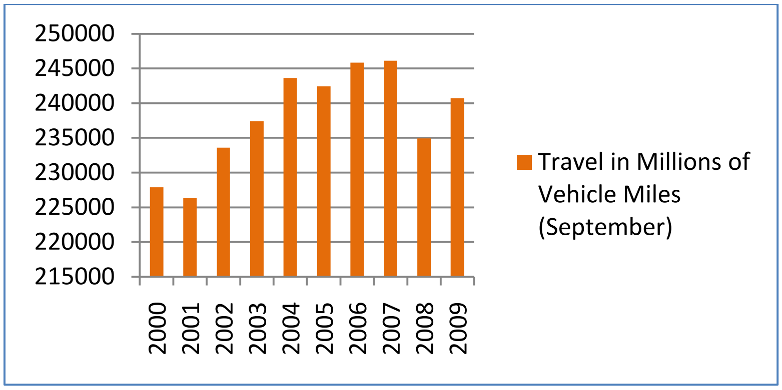
A review was conducted of national and state trends of annual traffic to determine the most efficient approach to establishing a target year for traffic counts for the I-290 study. The U.S DOT Federal Highway Administration publishes traffic trends[xiv] based on preliminary reports from state highway agencies on all roads and streets in the nation. These trends are based on hourly traffic count data collected at approximately 4,000 continuous traffic counting locations nationwide. These data clearly show the effect of the 2008-2009 economic down turn and the recent uptick of traffic.

Figure 4-3: National Traffic Trends (All Classifications) 2000-2009



Source: "Traffic Volume Trends", US DOT FHA, Office of Highway Policy Information, September, 2009.

Figure 4-4: National Traffic Trends (All Classifications) 2000-2009



Source: "Traffic Volume Trends", US DOT FHA, Office of Highway Policy Information, September, 2009.

Figure 4-3 and **Figure 4-4** show that the approximately 1% average increase in traffic per year between 2000 and 2007 came to a halt in 2008 when traffic levels fell nationwide. In 2009 the traffic levels had a small increase. This observed traffic profile needs to be addressed to know what a reasonable target is for the 2010 validation. Because the traffic for 2009 is not at the "trough" levels of 2008 and because we have no knowledge of the traffic that will occur in 2010, it is reasonable to use 2009 traffic levels as a target for the model validation. The use of the CMAP traffic counts of which 70% are collected from the 2004-2005 time period sets an observed traffic target that is higher than the existing observed traffic of 2009.

4.2.2 Regional Scale Validation Tests

As mentioned above, validation of the travel model traffic to observed conditions is an important part of establishing a base for alternatives testing. Validation has two levels:

- **Regional Validation** which shows that the model is working at reasonable levels throughout the entire metropolitan area and thus forms a stable platform for a smaller study area such as the I-290;

- **Corridor Validation** which shows that the model is working at very close tolerances to the observed data in a study area and can replicate conditions for the daily as well as the peak periods in that selected study area.

Although absolute criteria for assessing the validity of all model systems cannot be precisely defined, a number of target values have been developed. Guidance on validation targets is provided by the Federal Highway Administration (FHWA)[xv] as well as by state DOTs such as Michigan. Observed volumes should be checked by facility type both for the percent traffic difference and for the Root Mean Square Error (RMSE). Freeway and interstate segments should be within +/- 7% of the observed traffic. Less heavily traveled roadways have less stringent requirements on their fit to observed traffic. With a reasonable regional validation result, the study corridor can then become the focus of the validation effort.

The following validation tests were performed on the I-290 Travel Model to test the daily traffic assignment:

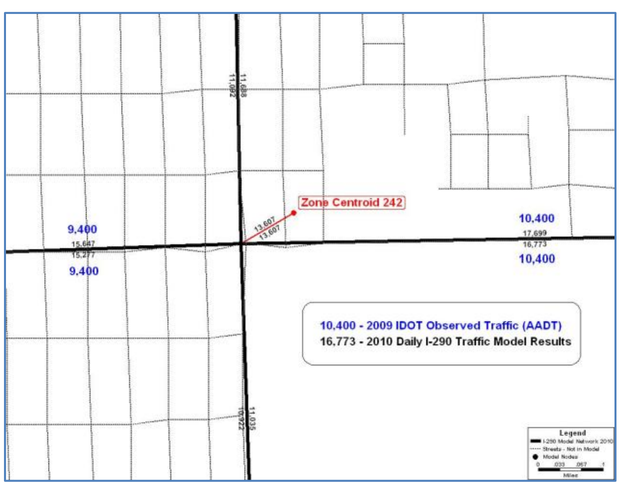
- **All Links** Observed and Modeled Traffic Volume Comparison – This test, which compares the observed and the modeled traffic using observed and counted traffic presented by functional classification, and volume class.
- **All Links** Percent Root Mean Square Error – This test, which measures the difference between model volumes and observed traffic counts, is where the variability of the traffic counts is most evident. If the model fit were perfect, the percent root mean square error would be equal to zero.

Table 4-2: Traffic Validation by Functional Classification

Link Type	# of Records	Total Counted Traffic	Total Model Traffic	*Difference*		*Root Mean Square Error*	
				Traffic	**%**	**RMSE**	**% RMSE**
Arterial Street	2,711	31,156,866	55,835,869	24,679,003	79%	6,559	113.16
Freeway	869	52,343,034	56,129,543	3,786,509	7%	17,739	29.45
Expressway	146	5,791,420	5,561,718	(229,702)	-4%	11,815	30.60

On the arterial street class, the overall daily model volume at the count locations was 79% higher than observed on the arterial class. While this ratio appears high, the major contributing factor is the way the model networks are constructed. **Figure 4-5** shows an example of the arterial/local model network detail. The model traffic is labeled in black while observed traffic is shown in blue. The smallest functional classification that the model network uses is arterials with the finer roadway network (the street grid) not represented at all in the model. Thus the arterials must carry all the local traffic within the model. This bias in roadway use is understood and accepted in travel modeling.

Figure 4-5: Detail of Intersection Coding Protocol



The freeway and expressway systems observed-to-modeled ratios range from +7% freeway to -4% expressway with low percent root mean square errors which shows a minimum of variability and is consistent with the FHWA standards cited above.

Table 4-3: Traffic Validation by Volume Class

Volume Group (Observed AADT)	Counted Links	Total Counted Traffic	Total Model Traffic	*Difference*		*Root Mean Square Error*	
				Traffic	**%**	**RMSE**	**% RMSE**
Less than or Equal to 10,000	2,569	24,636,522	47,207,492	22,570,970	92%	6,417	129.21
Between 10,000 and 30,000	754	16,058,980	24,213,852	8,154,872	51%	12,207	79.58
Between 30,000 and 50,000	283	11,137,830	13,640,766	2,502,936	22%	16,135	41.14
Between 50,000 and 80,000	360	23,731,260	23,914,069	182,809	1%	17,811	27.09
Between 80,000 and 100,000	127	11,217,100	10,491,956	(725,145)	-6%	22,052	24.97
Greater than 100,000	101	11,835,149	12,074,451	239,302	2%	22,191	18.94

Table 4-3 presents the same data stratified by volume class instead. This table shows that the smaller volume facilities operate within the travel model at higher traffic levels than the observed data, which is consistent with the previous table. As mentioned above, this difference is attributed to the fact that the arterials carry the traffic for many lower classification facilities which are not included in the model network. Note that the volume class with the poorest performance is composed of facilities carrying less than 10,000 ADT and that the ratio improves as the facilities grow in observed traffic levels. This differential is common in demand model results and can be accommodated as long as the higher level roadways perform close to the observed levels. This table shows that higher volume facilities do generally operate within the travel model at very close to observed levels. This range of observed to estimated is -6% to +2% on facilities over 50,000 ADT. The Percent Root Mean Square Error shows that the variability of the model results is very small. PRMSE values of 30% or less are considered within the normal limits of MPO validation.

In summary, regional model validation is a first step to determining if the travel model is a reasonable tool to use within a focused study area. Table 4-2 and Table 4-3 are consistent in the overestimation of traffic at the lower volume classes which is expected. The regional numbers show very good results (RMSE of 30 or lower) in the over 50,000 ADT facilities. This result is acceptable at a regional level, particularly if it can be shown that the model will operate at very close tolerances in the study area, both for daily and for peak periods. Sections 4-4 through 4-8 show that the travel model replicates existing traffic in the I-290 study area and thus the regional results can be accepted.

4.2.3 Vehicle Miles Traveled

A review of regional Vehicle Miles Traveled (VMT) was conducted to determine if the application for I-290 model is consistent with the existing CMAP model output. During the I-290 update described above, model inputs and modules changed considerably with major change occurring in trip rates by purpose, percentage of work trips of all trip purposes, trip distribution structure, average trip lengths by purpose, and the values of the time of day percentages by purpose. Some changes, such as trip rate values for H-W, have decreased the number of trips. Other elements, such as the trip length profile for Home-Work trips, has led to higher VMT due to the longer average work trip lengths that emerged from the higher income category of the dual income structure. The percentage of trips by purposes assigned to each of the eight time periods was also updated using the new CMAP survey information, shifting the percentages assumed to travel in the peaks. The change in VMT reflects the **net** result of these multiple changes. **Table 4-4** provides a comparison of the Vehicle Miles Traveled (VMT) between the approved CMAP 2010 scenario (2009 Q3 database) and the I-290 application.

Table 4-4: 2010 VMT Comparison

Daily Vehicle Miles Traveled (2010)	CMAP (Conformity Analysis 2009q3)	I-290 Application
All Links	280,704,000	260,136,000

4.3 Select Link Analysis

4.3.1 Select Link Approach

Select link analysis shows where the traffic originates and is destined on a specific link segment in the network. Select link analysis does not present total volumes on other roadways that are feeding or being fed by the selected link. A select link will often show similar patterns of daily traffic whether it is west-to-east or east-to-west.

The steps in running select link within the EMME/3 environment for I-290 are as follows:

1. Identify the locations where select link is to be conducted. The locations for preliminary analysis are three points on the I-290 facility (west, central and east) as shown in **Figure 4-6**.
2. Identify the time periods in which select link analyses are to be run. CMAP has eight time periods that make up the daily traffic. These are shown in **Table 4-5**.
3. Identify the vehicle types that are to be saved as part of the select link process. Since the traffic assignment must be rerun to obtain select link results, each vehicle thread must be treated exactly as it was in the CMAP model assignment procedure. There are six vehicle types prepared for the I-290 study: Single Occupancy Vehicles (SOV), High Occupancy Vehicles

(HOV), B Plate trucks, light, medium and heavy trucks. All these vehicle classifications are consistent with the CMAP definitions.

4. Prepare extra attributes to save the select link traffic by vehicle type.
5. Rewrite the EMME/3 assignment routines to incorporate the eight time of day assignments saving the select link traffic.
6. The 2010 scenario year network was used for the analysis.

Table 4-5: Time Periods CMAP Models

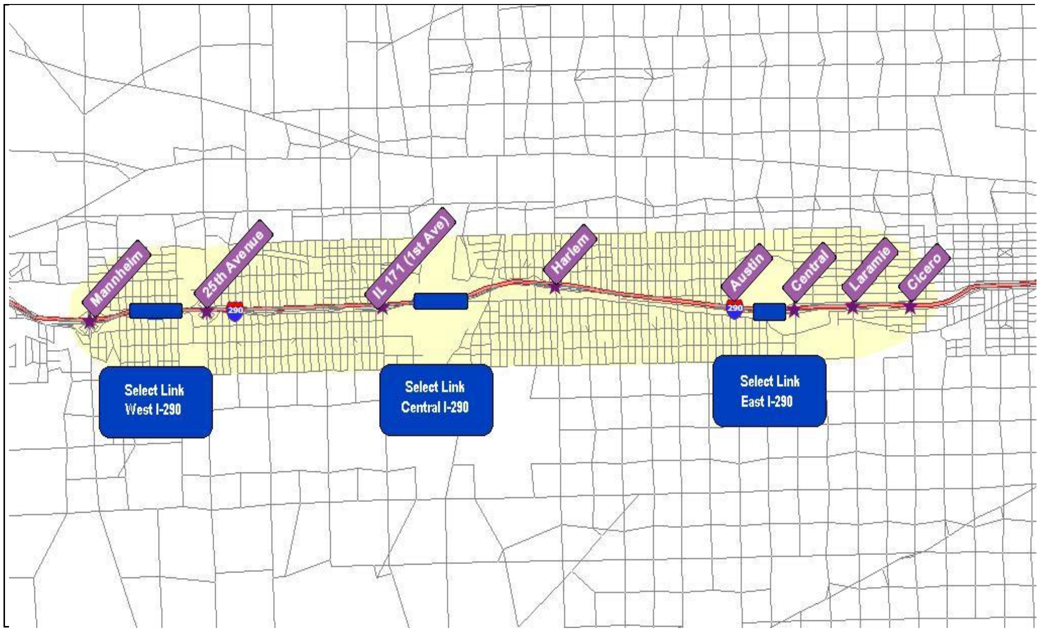
Name	Time Range	Description	Capacity Multiplier
Period 1	8 pm-6 am	Overnight	5
Period 2	6 am-7 am	pre AM peak	1
Period 3	7 am-9 am	AM peak	2
Period 4	9 am-10 am	post AM peak	1
Period 5	10 am-2 pm	Midday	4
Period 6	2 pm-4 pm	pre-PM Peak	2
Period 7	4 pm-6 pm	PM peak	2
Period 8	6 pm-8 pm	post - PM peak	2

The locations selected for preliminary review using select link are:

1. **I-290 Study Area (West)** – Location #1 - Both directions of the facility between Mannheim Road and 25th Avenue.
2. **I-290 Study Area (Central)** – Location #2 – Both directions of the facility just east of IL 171 (1st Avenue).
3. **I-290 Study Area (East)** – Location #3 – Both directions of the facility between Austin and Central.

The Central I-290 will be presented in this preliminary overview.

Figure 4-6: Location of I-290 Select Links



4.3.2 Preliminary Select Link Findings

In this preliminary analysis, the select link plot shows a distinct and stable travel pattern for passenger vehicles in the I-290 study corridor. The following patterns can be seen:

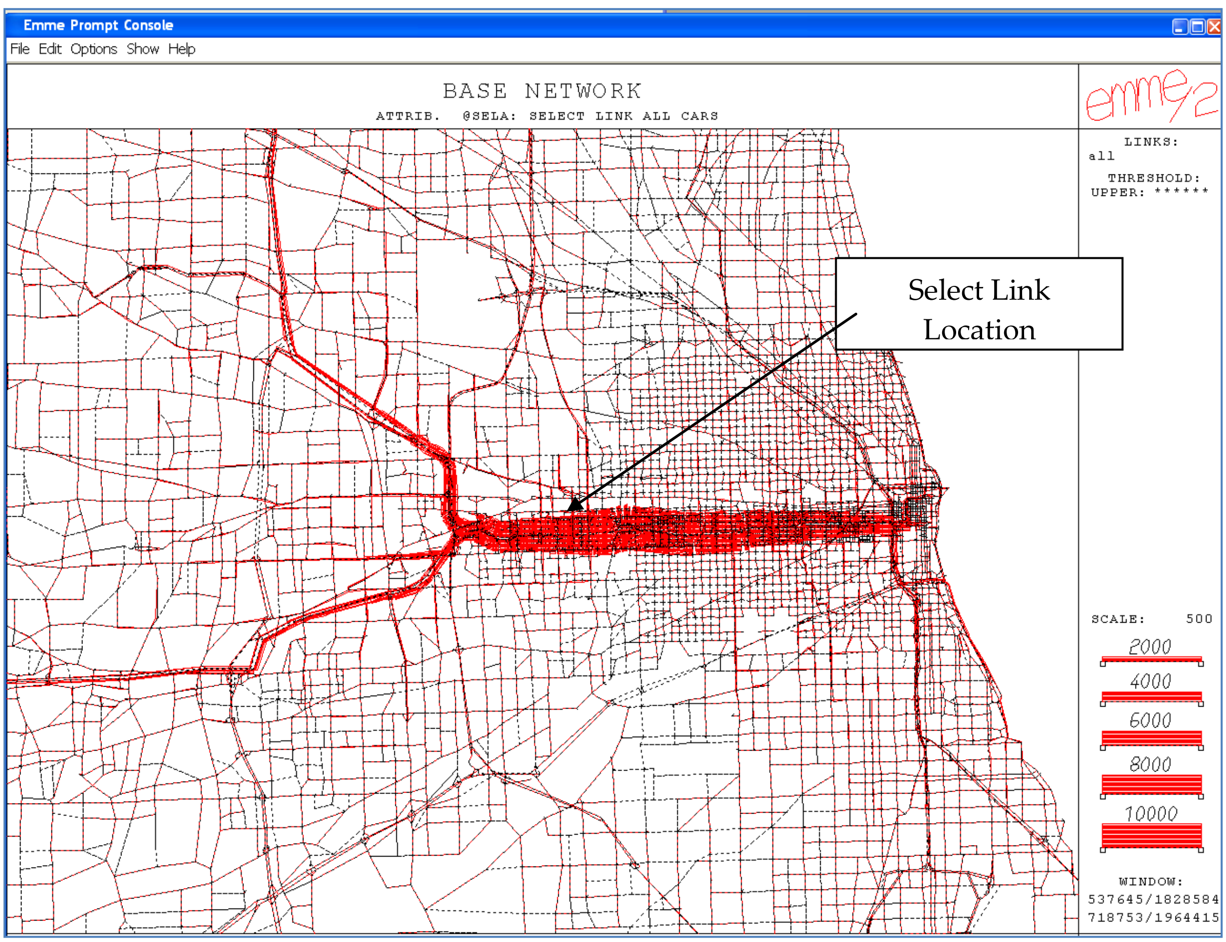
- **East / West Directional Fidelity** – The I-290 auto select link pattern shows a stable directionality with similar auto volumes flowing east and west. See **Figure 4.7**
- **Regional East-West Throughput** – The select link shows that passenger vehicles that use I-290 in the study corridor are also strong users of the interstate facilities of I-88 and of the I-290 segment linking I-294 and I-355. Smaller but strong volumes are found on the Kennedy Expressway (I-90 north of downtown) and the Dan Ryan (I-90 south of downtown).
- **Time of Day** – The eight time of days were run and reviewed although only AM Peak is shown. They show highly similar patterns consistent with the AM Peak although with varying volumes.
- **Table 4-6** shows a point in the Central I-290 corridor with the eight time of day model traffic totals before they are summed to the estimated daily traffic. The model traffic is measured in vehicles and includes the four CMAP classes of trucks.

Table 4-6: 2010 Model Time of Day Traffic just East of IL 171 (First Avenue)

Time Period			Eastbound		Westbound	
ID	**Time Range**	**Description**	**Model Traffic***	**% of Daily**	**Model Traffic***	**% of Daily**
Period 1	8 pm-6 am	Overnight	14,334	16%	14,300	16%
Period 2	6 am-7 am	pre AM peak	5,375	6%	5,362	6%
Period 3	7 am-9 am	AM peak	11,646	13%	12,512	14%
Period 4	9 am-10 am	post AM peak	5,375	6%	5,362	6%
Period 5	10 am-2 pm	Midday	21,501	24%	21,450	24%
Period 6	2 pm-4 pm	pre-PM Peak	11,646	13%	11,619	13%
Period 7	4 pm-6 pm	PM peak	11,646	13%	11,619	13%
Period 8	6 pm-8 pm	post - PM peak	7,167	8%	7,150	8%
Total			**89,586**	**100%**	**89,374**	**100%**

*model traffic is measured in vehicle equivalents.

Figure 4-7: Select Link Traffic at the Central I-290 Location in the AM Peak



4.4 Peak Periods Traffic and Percentage of Daily

Since the peak periods are an important part of the traffic model for I-290 work, it was determined that comparing the AM and PM observed traffic to the model results is an important validation step. **Table 4-7** shows the 2009 observed mainline traffic at six locations during the peak periods in the I-290 study corridor. Observed IDOT peak period definitions are as follows:

- Eastbound Traffic - one hour from 7 to 8 am and 4 to 5 pm
- Westbound traffic – one hour from 8 to 9 am and 4 to 5 pm

Table 4-7: AM and PM Peak Observed Traffic in the I-290 Corridor

ID	I-290 Facility		Eastbound		Westbound	
	From	To	AM Peak	PM Peak	AM Peak	PM Peak
2	Mannheim	25th Avenue	5,340	5,240	7,130	6,790
3	25th Avenue	17th Avenue	5,430	5,330	6,980	6,700
4	9th Avenue	IL 171 (1st Avenue)	5,840	5,850	6,570	6,560
6	Des Plaines	Harlem	6,100	6,240	5,800	5,890
8	Austin	Central	7,670	7,110	5,740	6,410
9	Laramie	Cicero	8,430	7,670	6,100	6,650

Source: IDOT, 2009

The I-290 traffic model peak hours were extracted and compared to the observed IDOT data. Note that the peak hour for the CMAP models is defined as the two hour period between 7 am and 9 am and that the PM peak is defined as a two hour period between 4 pm and 6 pm for both directions on the facility.

Table 4-8: AM and PM Model and Observed Traffic on I-290 (Eastbound)

ID	I-290 Facility		Observed 1 Hour		Modeled (2 hour)	
	From	To	AM	PM	AM	PM
2	Mannheim	25th Avenue	5,340	5,240	13,190	13,333
3	25th Avenue	17th Avenue	5,430	5,330	12,847	13,452
4	9th Avenue	IL 171 (1st Avenue)	5,840	5,850	13,234	13,454
5	IL 171	Des Plaines Avenue	6,240	6,510	12,461	13,058
6	Des Plaines	Harlem	6,100	6,240	11,989	12,288
8	Austin	Central	7,670	7,110	14,380	13,548
9	Laramie	Cicero	8,430	7,670	17,282	14,979

*Source: IDOT 2009 Traffic Counts, I-290 Model Alt. 408 for 2010

Table 4-9: AM and PM Model and Observed Traffic on I-290 (Westbound)

ID	I-290 Facility		Observed 1 Hour		Modeled (2 hour)	
	From	To	AM	PM	AM	PM
2	Mannheim	25th Avenue	7,130	6,790	13,423	12,466
3	25th Avenue	17th Avenue	6,980	6,700	13,808	12,715
4	9th Avenue	IL 171 (1st Avenue)	6,570	6,560	13,597	12,746
5	IL 171	Des Plaines Avenue	6,500	6,480	13,387	12,341
6	Des Plaines	Harlem	5,800	5,890	12,511	11,878
8	Austin	Central	5,740	6,410	14,690	14,998
9	Laramie	Cicero	6,100	6,650	15,604	17,446

*Source: IDOT 2009 Traffic Counts, I-290 Model Alt. 408 for 2010

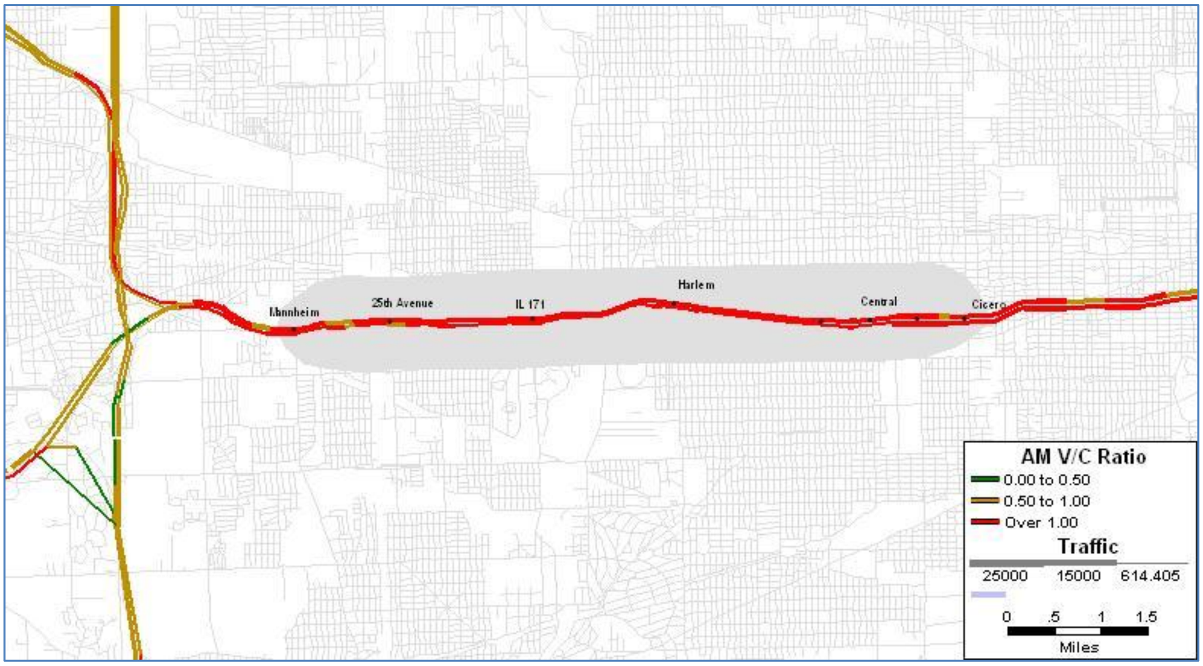
Table 4-8 and **Table 4-9** show the following:

- The volume of traffic produced by the I-290 model is commensurate to observed traffic levels on the I-290 facility for both the AM and PM peaks when the one hour vs. two hour intervals are considered.

4.5 Peak Period Volume/Capacity Ratio

The volume to capacity ratio (V/C ratio) is defined as the ratio of traffic demand flow rate to capacity. In the CMAP models it may be calculated for each of the eight time periods and is calculated on each link segment of a traffic model. V/C is a planning tool used in this analysis to provide conceptual level views of congestion for the time periods provided in the model. Each time period for the 2010 base was reviewed to demonstrate that the I-290 model was able to capture basic directionality and congestion via the V/C ratio. **Figure 4-8** shows the V/C ratio in the AM peak for 2010. Note that I-55 and Lake Shore Drive show directionality with inbound directions more congested than outbound. I-290 shows consistent over capacity conditions in both directions as does the Kennedy Expressway.

Figure 4-8: Volume/Capacity Ratio for the AM Peak 2010



The volume delay functions, intersection delay values and network detail will be reviewed during the 2010 to 2030 comparison and the initial testing of the added capacity alternatives to I-290.

4.7 I-290 Corridor

The last topic of validation is the performance of the I-290 model in the study corridor. The previous section addressed the AM and PM peaks. The performance of the model on a daily basis adds understanding of the overall validity of the model. **Figure 4-9** is a snapshot of the daily model traffic for the I-290 2010 scenario. The summary attribute is total vehicles in vehicle equivalents (@vadt). Note that the interstate facilities are heavily traveled, the daily facility directionality is balanced, and the traffic volumes, measured in vehicle equivalents, are in the range of 90,000 to 100,000 in each direction at most points in the I-290 study corridor.

Figure 4-9: 2010 I-290 Daily Traffic Estimate

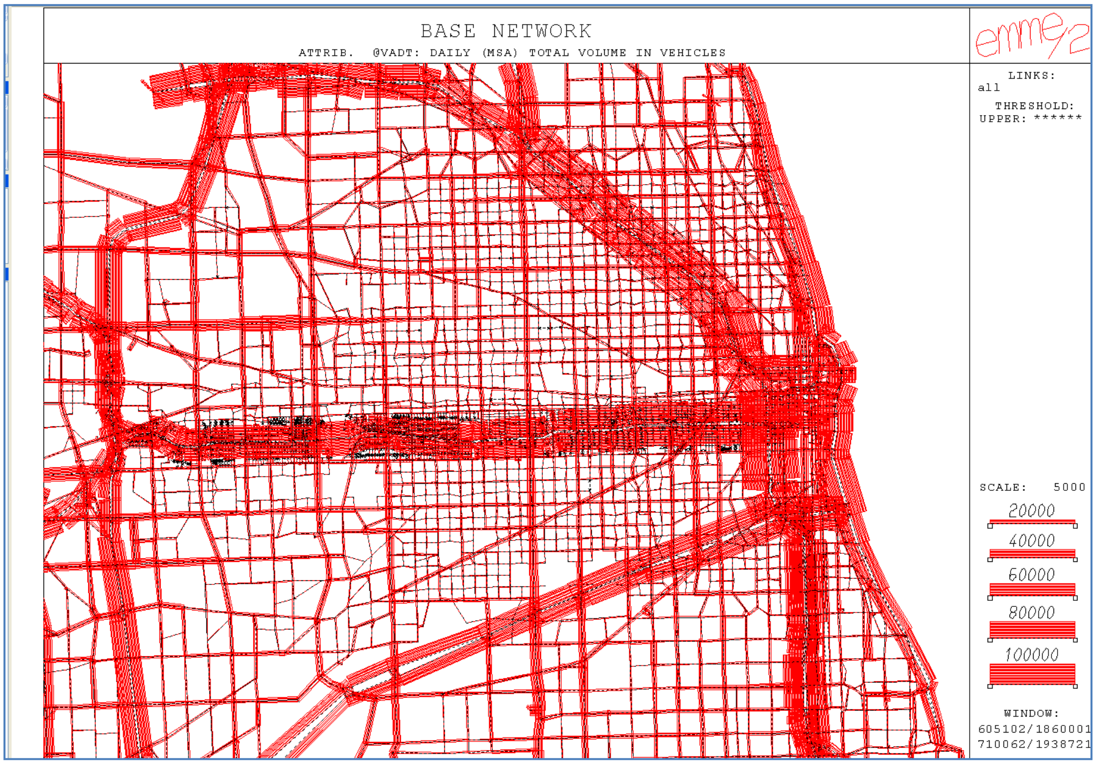


Table 4-10: I-290 Mainline Traffic Comparison (Observed vs. Modeled)

ID	I-290 Facility		AADT 2006-2007 (IDOT)	Model ADT two-way	Difference (Traffic)	
	From	To			#	%
1	W of Mannheim		207,100	197,621	(9,479)	-5%
2	Mannheim	25th Ave	191,100	179,901	(11,200)	-6%
3	E of 25th Avenue		187,400	183,306	(4,094)	-2%
4	9th Avenue	IL 171	189,500	183,991	(5,509)	-3%
5	IL171	Des Plaines	194,500	178,960	(15,540)	-8%
6	Des Plaines	Harlem	179,400	170,068	(9,332)	-5%
7	Harlem	Austin	184,200	180,919	(3,281)	-2%
8	Austin	Central	202,000	199,103	(2,897)	-1%
9	Laramie	Cicero	216,200	226,995	10,795	5%
10	E of Cicero		188,200	197,648	9,448	5%
	Total		**1,939,600**	**1,898,512**	**(41,088)**	**-2%**

Source of AADT: IDOT Traffic Data, 2009

Table 4-10 shows an overall -2% of daily model traffic compared to observed counts and is consistent with regional performance on interstate facilities of this traffic level (see **Table 4-3**).

4.8 Findings

It has been the intent of **Section 4** to present a first cut overview of selected workings of the I-290 Travel Model demonstrating that the model provides a stable base that replicates the CMAP efforts while providing a reasonable starting point for the I-290 work.

A set of tests and reviews were conducted on this base 2010 model run:

- Based on a set of CMAP counts obtained from the Illinois DOT, the I-290 travel model is performing at a reasonable level to regional capture traffic flows. The ratio of observed to modeled traffic on regional interstates and freeways and the Percent Root Mean Square error are within normal limits for MPO validation.
- The I-290 model enhancements steps which included major changes in trip rates by purpose, percentage of work trips of all trip purposes, trip distribution structure, average trip lengths, auto occupancy changes, and time of day percentages resulted in a net change in Vehicle Miles Traveled (VMT) of 7% less than the approved CMAP totals for year 2010.
- The peak periods in the model produce traffic levels commensurate with the IDOT 2009 observed data when the one hour vs. two hour intervals are considered.
- Select link analysis showed that typical segments in the I-290 corridor have a stable directionality with similar volumes flowing east and west and vehicles that use I-290 in the study corridor are also strong users of the interstate facilities of I-88 and of the I-290 segment linking I-294 and I-355.
- I-290 mainline traffic for 2010 averages about 2% lower in the model than in the observed 2009 IDOT counts.

In summary, a detailed travel model customized for I-290 was developed, including constructing a detailed zone system and network. The use of newly collected household survey and other data to re-estimate selected parts of the CMAP models, resulted in an updated model that can be applied to the 2030 study year. The I-290 travel model is a tool for modeling transportation improvement alternatives in the I-290 corridor. Additional model output analysis and sensitivity test results will be provided in a companion technical memorandum, which will focus on a comparison of 2010 and 2030 baseline results.

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