Chicago Metropolitan Agency for Planning

Travel Model Documentation

FINAL REPORT: OCTOBER 2010

Contents

1 INTRODUCTION

The northeastern Illinois region is a moderate nonattainment area for the 8-hour ozone standard under the Clean Air Act Amendments of 1990, and a nonattainment area for fine particulate matter (PM2.5). Provisions of this act require regional transportation plans and programs to conform to the State Implementation Plan (SIP) for air quality, which sets out how the region will meet emission reduction targets specified by the act. In advance of an approved SIP or emissions budgets, interim tests are required. This is the case with the PM2.5 standard; the tests required to demonstrate conformity in this case are described in further detail in the main body of the document.

The travel demand models, and emission calculations that depend on the models' travel forecasts, are the technical core of the conformity evaluations of the region's Transportation Improvement Program (TIP) and Regional Transportation Plan (RTP). The purpose of this report is to document the travel demand modeling process used in the conformity analysis.

1.1 Surveys

The Chicago Metropolitan Agency for Planning, formerly Chicago Area Transportation Study (CATS), is the primary agency responsible for the development and maintenance of travel forecasting methods for the Chicago region. CMAP has been developing and improving these travel forecasting procedures constantly since 1956. The present set of models was originally developed using a 1970 home interview survey. This survey obtained the daily travel patterns for over 21,000 households in the region. The original CATS home interview survey was taken in 1956 and consisted of almost 40,000 household interviews.

In 1979 a much smaller home interview was conducted. This survey combined with the 1980 Census Journey to Work data was used to review and modify the procedures. Between 1988 and 1991 another large-scale home interview survey (over 19,000 households) was conducted. The information from this survey and the 1990 and 2000 Censuses have been used to update and modify the travel demand procedures. Most recently, starting in January 2007 and lasting 1 year, CMAP completed a comprehensive travel and activity survey for northeastern Illinois called the "Travel Tracker Survey." A total of 10,552 households participated in either a 1-day or 2-day survey, providing a detailed travel inventory for each member of their household on the assigned travel day(s). As a test of available technology, four-hundred and sixty Travel Tracker participants also volunteered to wear global positioning devices (GPS) or to use auto-based devices to track their travel.

In addition to the home interview surveys, there have been several other data collection efforts, including a *1986 Commercial Vehicle Survey*, a *1963 Pedestrian Survey*, a *1987 Survey of Parkers* in the Chicago Central Business District, and a *1991 Survey of Parking Spaces* in the Chicago Central Business District, all of which have been used to enhance the region's travel demand procedures.

1.2 Northeastern Illinois Modeling History

Since the early 1990's, CMAP has been working to enhance the travel demand modeling process used in the air quality conformity analysis of transportation improvement programs and regional transportation plans.

Travel demand modeling was first employed to assist in the development of regional transportation plans. The four-step process (trip generation, distribution, mode split and assignment) was fundamental from the beginning. Early enhancements focused on making the process run more quickly on the computers available at the time and on the calibration of individual model components. In the seventies, in response to concerns about improving public transit, CMAP concentrated enhancement activities on the mode split model and transit assignment techniques.

In the late seventies and eighties, efforts were focused on adapting the modeling process to sub-area and project specific studies. For example, CMAP developed a block by block zone system for the downtown area. Trips were generated based on zonal floor space from a building-by-building file of the area. Networks were coded with detailed pedestrian links. These techniques were employed to evaluate transit alternatives for the CBD area. Similarly, zone sizes were reduced and more detailed highway networks coded in suburban areas to evaluate freeway proposals.

When federal regulations were changed to require emissions estimates for conformity analysis, the regional models were initially employed as they then existed. It was in 1994 that the first significant model changes, explicitly motivated by conformity issues, were implemented. Since then, CMAP has committed substantial resources to develop models that are responsive to needs imposed by air quality requirements.

CMAP continuously strives to improve its travel forecasting techniques in response to policy priorities. Since 2003, CMAP has contributed to the development of a Chicago Regional New Starts Forecasting tool and has embarked on a regional activity-based modeling and microsimulation development program.

1.3 Overview of the Regional Model Structure and Process

The CMAP travel demand models represent a classical "four-step" process of trip generation, distribution, mode choice, and assignment, with considerable modifications used to enhance the distribution and mode choice procedures. The present CMAP region, for analysis purposes, includes the counties of Cook, DuPage, Kane, Lake, McHenry, Will, Kendall, in Illinois and parts of other Illinois, Indiana and Wisconsin counties buffering the region.

Figure 1.1 contains a flow diagram showing the general steps used in the travel demand modeling process. The ovals on the chart are data files. The rectangles are models or processes.

The first step in the procedure is to use the socioeconomic/land use data to estimate the trip ends for each trip type. For home based trips, trip ends located at the travelers' homes are defined as productions, and trip ends located at the non-home end are defined as attractions.

The CMAP procedure to estimate productions consists of several sub-models. One of these models estimates the number of households stratified by adults, workers and children in the household. Another model adds vehicle ownership to the stratification. Vehicle ownership rates are dependent on the composition and income of the household as well as the transportation characteristics of the area in which the household is located. Area characteristics include a measure of the pedestrian friendliness and the availability of transit. Transit availability is based on a modeled mode split estimate for the zone. Consequently trip generation is network dependent. In general, higher transit mode shares decrease vehicle ownership rates, which in turn decrease trip rates. The attraction model uses employment, categorized as retail and total, and the number of total households to estimate the attractions, by purpose, for each analysis zone. The model has a trip rate associated with each type of employment and household, used with the total number of employees and households.

Figure 1.1

Modeling Process for Conformity Analysis

FULL MODEL ITERATION

Socioeconomic/Land Use Data → Trip Generation Model

Initial AM and Midday Highway Times (iteration 0)

Transit Network

Non Motorized Productions and Attractions

Motorized Productions and Attractions → Generalized Cost Calculation ← Transit Times and Fares ← Transit Network Skimmer

Trip Distribution Model ← Generalized Cost Tables

AM Peak and Midday Congested Highway Times (iteration 1-4)

AM Peak Congested Highway Times for Bus (iteration 1)

Person Trip Tables

Auto Share → Mode Split Model

Through, Visitor, Air Passenger & Commercial Vehicle Trips → Highway Trip Table

Factor Auto Person Trips and Commercial Vehicles to Time Periods

Highway Networks for Each Time Period

Time Period Vehicle Trip Tables → Capacity Constrained Equilibrium Time of Day Highway Assignment → Link Volumes and Speeds by Time Period → MSA Link Volume Balance and Speed Recalculation by Period

NO ← 4 Full Model Iterations Complete?

YES

POLLUTANT POSTPROCESSING

Link Volumes and Speeds by Time Period → Convert to IEPA Type & Class Definitions & Collapse → Vehicle Miles of Travel by Speed & Type & Class

Climate, Technology & Emission Control Programs → MOBILE Model → Emission Rates by Speed & Type Class → Pollutant Burden Calculation → Emission Totals -END-

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The trip generation model estimates total trips, including both motorized trips such as those made by auto and public transit, and non-motorized trips such as those made by pedestrian and bicycle modes. A calculation of the proportion of non-motorized trips in an area is made based on the pedestrian friendliness parameter for the area. Non-motorized trips are subtracted out from the total number of trips generated from an area, and only the motorized trips are carried through the remaining model steps. The regional motorized trip total is therefore sensitive to the allocation of development between areas that differ in their measure of pedestrian and bicycle friendliness.

The next model in the four step process is the distribution model, which "distributes" the trip ends to produce person trips being made between traffic analysis zone origins and destinations. The CMAP procedure uses an intervening opportunity distribution model, which uses the trip ends from the trip generation model as a measure of the number of satisfying opportunities, and a measure of the "difficulty" to travel between analysis areas (a trip impedance measure).

The distribution model incorporates recent distribution model advances. A key modification to the distribution model was to redefine the impedance measure as the combined time and cost for both the highway and transit systems. This combined impedance (or generalized cost) measure is called the *LogSum* variable. The use of generalized cost allows the distribution model to be sensitive not only to highway and transit service levels but also to highway and transit costs.

The second modification to the distribution model is in the development of the L-values, a trip distribution parameter. The L-value can be thought of as a measure of how "selective" trip makers are towards "accepting" an opportunity to fill a trip need. The lower the L-value is, the more selective the person is in accepting an opportunity and, therefore, the longer the trip length is for a set of given opportunities. Typically the L-values are low in the center city, where there are many opportunities (attractions) and a person can be more selective, and high in low density suburban areas, where the opportunities are more limited. Years ago, L-values were developed based upon the geographic location of the traveler. These locations were primarily identified as the counties in the region and the city of Chicago. The current procedure relates the L-values to the number of opportunities that can be reached within a given generalized cost boundary. Thus the L-value is now related to the transportation service level (the generalized cost) and the land use form (the number of destination opportunities) which are explicit measures of transportation system service rather than travelers' location which was, at best, a proxy for this service level. This change in the method of estimating L-values allows the distribution model to respond to changes in residential and employment density (as density increases the L-value decreases) and changes in both transit and highway travel times and costs (as times or costs decrease the L-value decreases).

Mode choice is the third model in the process. This model, used after distribution, divides the total person trips resulting from the distribution model into transit person trips or automobile person trips. This allocation is based upon the times and costs for the available modes and the socioeconomic status of the traveler. The CMAP mode choice model is a multinomial logit model and is unique in that it uses simulation techniques to estimate many of the time and cost variables. The Monte Carlo simulation is an attempt to decrease the errors inherent in using average values by allowing the model to use knowledge of the distribution of attributes. The simulation techniques are used to estimate parking costs, the traveler's income, and the access and egress times from the primary transit routes. The mode choice model is applied once for each person trip resulting from the distribution model. The model estimates the probability of this person trip using either mode and then the Monte Carlo simulation technique is used to allocate this person's trip to a specific mode, i.e. transit or auto user.

The fourth step of the travel demand procedure is the assignment model. The assignment model uses the auto person trips from the mode choice model and a description of the transportation system to estimate the volume of trips on each segment of the road network. For the air quality analysis, the highway assignment procedure is essential for estimating the vehicle miles of travel (VMT) on each highway segment, and also to estimate the speed of each highway segment. The highway assignment step has two significant features that are important for both transportation and air quality analysis. First, because it is a capacity constrained equilibrium assignment, the level of service (in terms of travel time) worsens as additional volumes are assigned to each link. Second, the equilibrium procedure solution ensures that simulated travelers are not able to improve their level of service (i.e. travel time) by any alternate routing. For each individual simulated traveler, travel times are optimal to the supply and demand of transportation because the traveler cannot find a shorter route.

As shown in the diagram, the steps of trip generation, distribution, mode split and time of day assignment are iterated through at least five times (iterations zero through 4). A current improvement to the model set eliminates the "daily" travel time assignment for roadway generalized cost calculations and uses instead information resulting from the time of day assignment procedure. AM peak congested times and distances are used for the work trip purposes and midday times and distances are used for the nonwork purposes. To create these, the link volumes from each full model iteration time of day assignment are combined (the step termed volume balancing and speed recalculation) with the link volumes from the same period in the previous iterations using the Method of Successive Averages (MSA). For example, the link volumes resulting from the first and second iterations of the time of day highway assignment period 3 are combined using the MSA procedure, then skimmed to produce the highway travel information input to the generalized cost calculation for the third iteration of the process.

The time of day procedure more realistically matches travel demand to network supply and structure as these vary over the course of 24 hours. The time of day procedure also

incorporates features such as multiclass assignment and additional options assignment. These features enable the conformity emissions analysis to reflect link volumes by specific vehicle type (rather than using regional or statewide averages) and separately identify travel in the cold start operating mode. The highway time of day assignment splits into eight time periods the final highway trip table from the iterated process. Separate assignments estimate highway vehicle-miles and travel speeds for eight time periods during the day: (1) the ten hour late evening-early morning off-peak period; (2) the shoulder hour preceding the AM peak hour; (3) the AM peak two hours; (4) the shoulder hour following the AM peak hour; (5) a four hour midday period; (6) the two hour shoulder period preceding the PM peak hour; (7) the PM peak two hours, and; (8) the two hour shoulder period following the PM peak hour. Results of the separate period assignments are accumulated into daily volumes, and also tabulated into the vehicle-mile by vehicle type by speed range tables needed for the vehicle emission calculations. The principal new element in this analysis is the adaptation of model outputs for emissions calculation by Mobile6.

All analyses use CMAP trip generation *Subzone09* (largely quartersections) and traffic analysis zones *Zone09* (largely aggregations of quartersections) geography. All model related databases are accessible through ARC/INFO or EMME® software. This ensures that the many ancillary databases required by the regional travel models are consistent with the scenarios to which they apply. Automated GIS data handling procedures eliminate almost all manual data coding, which reduces error and speeds processing of different scenarios.

2 MASTER HIGHWAY NETWORK DATABASE

The Master Highway Network (MHN) design has been developed and improved over the last several years to meet the complicated and data intensive requirements of regional transportation analysis, particularly as it relates to making an air quality conformity determination. Specifically, the MHN design and processing accomplishes the following:

- Analysis **into** multiple future years – Assignable networks are produced that maintain consistent project coding into future years (e.g. a project that is built in an earlier year will be included in all subsequent networks).

- Analysis **across** multiple scenarios – Assignable networks are produced that maintain consistent project coding between analysis scenarios (e.g. a project that is included in one land use scenario will be identically coded in any other appropriate scenario).

- Maintains information about the region's bus system (discussed in Chapter 3 Transit Network).

These features of the MHN occur automatically by defining the scenario/year topology at the beginning of the MHN processing sequence.

- <u>Reconciliation with the TIP database project information</u> – The TIP database is the official and only correct repository of all project information. While only some of the projects included in the TIP database are analyzed within the travel demand models, relying solely on the TIP database for project information provides a single direct link for reconciling network coding with the actual project information.

2.1 NETWORK DATABASE HANDLING

The availability of GIS software that can hold a large number of network attributes and export the information in useful formats has transformed the process of creating analysis networks. What once was a process susceptible to coding errors is now largely standardized and reliably consistent.

2.2 DIGITIZING ROUTE SYSTEMS IN ARC/INFO®

In the past, CMAP node references were hard coded into the TIP database. This was cumbersome and problematic because the TIP database has no geographic interface. Furthermore, the information structure required to code a project for travel demand analysis is not consistent with the information structure required to monitor the project's life in the TIP. ARC/INFO® offers a facility within its dynamic segmentation capabilities called *route systems*. A group of network links is selected to define a single route (highway project), the individual arcs of which are referenced in that route's *section table*. The section table contains link attributes that will be updated when highway projects are completed, and an action code that determines how the attributes for each link are processed. Different routes can be ascribed to a single arc and, by extension, the section table can contain multiple attributes for a single highway link depending on which route is being selected. This capability allows projects to be coded across scenarios and into multiple forecast networks.

The general relationship between the database files is:

ROUTE ATTRIBUTE TABLE

TIP project ID

SECTION TABLE

TIP Project ID	MHN ID	Project Attributes

MASTER ARC ATTRIBUTE TABLE

MHN ID	Base Network Attributes
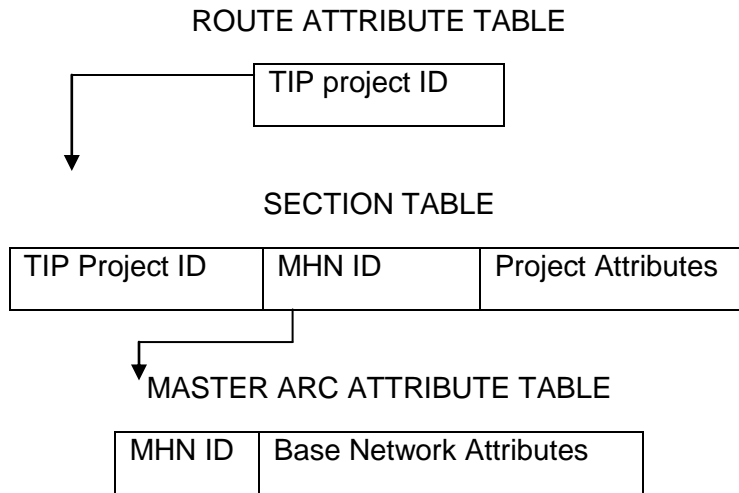
The variable definitions for each of these tables appear at the end of this section.

2.3 REBUILDING TOPOLOGY AND UPDATING VARIABLES

Editing a coverage corrupts its ARC topology (i.e. spatial interrelationships) necessitating use of the ARC "build" command. A macro recalculates a number of variables to ensure that any changes resulting from the editing process are carried through to the database's established relationships:

- updates all x, y coordinates,
- identifies CMAP traffic analysis zone number and capacity zone reference for each node,
- assigns *anode* and *bnode* values to link attribute file based on the MASTER-ID variable of the node attribute file, and
- rebuilds the coverage.

2.4 PREPARATION OF ANALYSIS NETWORKS

Significant changes have been made in the way analysis networks are prepared. These changes are primarily intended to take advantage of enhancements to CMAP's GIS and travel demand modeling procedures.

- Resolving analysis year information is accomplished using ARC/INFO® now that network, project link coding and scheduling information can be assimilated within the MHN coverage.

- Preparing individual analysis networks using SAS® is significantly streamlined as it is now necessary to output only EMME® formatted network files specific to CMAP's Time Period and Vehicle Class Assignment procedure.

2.5 RESOLVING ANALYSIS YEAR INFORMATION USING ARC/INFO®

In an effort to ensure consistency, project and base network information reconciliation is handled comprehensively, with all of the analysis networks for a particular application, at one step, existing in a single dataset. Introducing a geographic context to project coding within ARC® makes it more practical to reconcile projects with the base network at a smaller and more efficient scale.

As noted at the outset, the MHN data base is designed to permit reconciling projects with the base network **into** multiple analysis years and **across** multiple scenarios. This topology was in direct response to the types of comparative evaluations that were necessary under the air quality conformity baseline/action rules. With approval of a SIP budget, conformity analysis no longer entails a baseline/action test so a simpler hierarchy is utilized. Nonetheless, this ability is useful within any forecasting exercise where multiple time frames and scenarios are compared (e.g. land use/transportation interactions).

A list of modeled project TIP identification numbers and the year in which they are to be constructed is imported and joined to the route table. Because complete project coding information exists in the section and route tables, a simple mathematical expression is able to select only those records needed to prepare the current analysis network. The desired information is exported to a set of text files.

2.6 PREPARING INDIVIDUAL ANALYSIS NETWORKS USING SAS®

Individual highway scenario networks are prepared from the text files exported from the Master Highway Network process. The files are processed by a SAS® program that creates the node, link, node extra attribute and link extra attribute files required by EMME® for importing and building highway scenarios.

The following describes the method used to correctly interpret the attributes of links that are split (ACTION=2) in order to accommodate a new node(s). The skeleton link that awaits the

attributes of the split link is called the "*replacer*" link. The original base link that gets split is called the "*replaced*" link. Replace link coding is straightforward. The section table's only attributes for *replacer* links is REPLACE_ANODE and REPLACE_BNODE referring to the *replaced* link. The SAS® procedure that interprets the attribute and section tables simply updates the *replacer* attributes with the attributes found on the *replaced* link. The *replaced* link is subsequently deleted. *Replacer* links receive ACTION=2 instructions on the section table and *replaced links* ultimately receive ACTION=3.

Network Coding Example: New Interchange at I-294 and I-57

| Step 1. All existing roadway facilities (gray) and future planned facilities (blue) are coded into the Master Highway Network (MHN) coverage. | |
| Step 2. All links (existing and future) impacted by the project are associated with the project ID through a route system (red). The link coding contained in the route system serves as a set of instructions on how to process each link. To build an EMME® network, an ARC program selects all existing links and nodes in the MHN, and the links and nodes associated with all future projects that will be completed by a specified year. This information is stored in temporary datasets. A SAS program then uses the instructions provided in the project coding to process the network links in the temporary dataset (update attributes, delete links, etc.). EMME® batchin files are the final output. | |

| Step 3. EMME® network before the interchange is built. | |
| Step 4. EMME® network after the interchange is built. | |
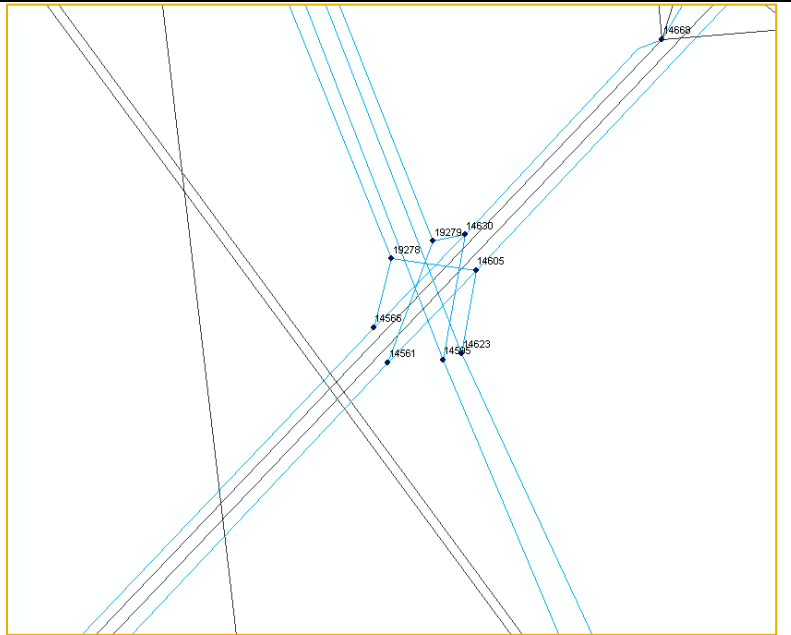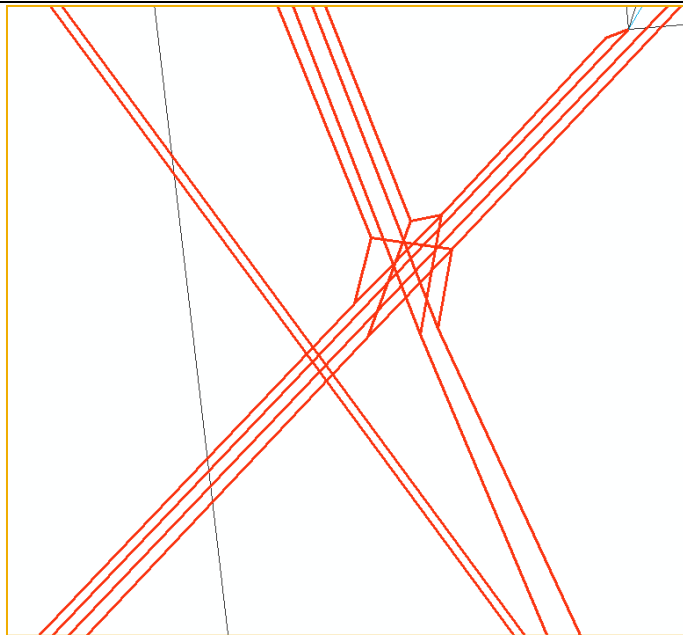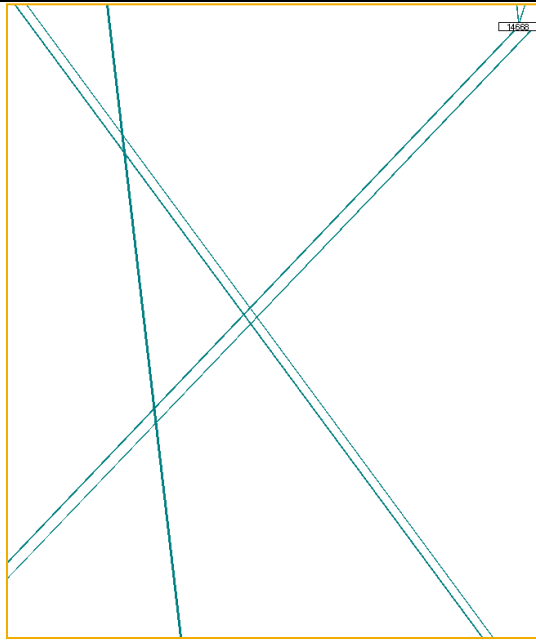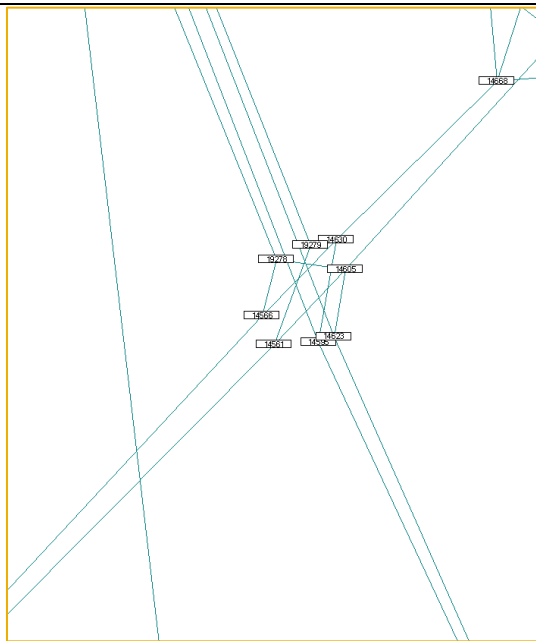
Occasionally, a project will *modify* (ACTION=1) a link that is being *replaced* in another project. If the *modify* precedes a link being *replaced*, then the modified attributes will be successfully copied to the *replacer* link. If, however, the link is *replaced* prior to the original link being *modified* then the section table reference for the *modify* is incorrect as it is instructed to process a link that has been previously deleted. This problem is solved with specialized data handling that maintains the desired order of operations.

2.7 VARIABLE DEFINITIONS

2.7.1 Master Highway Network ARC attribute table

__MASTER.NAT__	__Description__
MASTER-ID	ARC user/auto assigned unique identification variable.
X-COORD	ARC provided state plane x coordinate
Y-COORD	ARC provide state plane y coordinate
ZONE09	Overlay identity with Z09 polygon coverage
AREATYPE	Area Type = Capacity Zones developed for calculating link capacities based on geographic location.

Note: suffixes 1,2 indicate directionality

MASTER.AAT	**Description**
MASTER#	ARC id automatically assigned unique identification variable. Relates to ARCLINK# on master.secttipproj.
ANODE	Analysis network "From" node
BNODE	Analysis network "To" node
MILES	Link length in miles

TYPE1
TYPE2
	Facility Type:
	  1=Arterial
	  2=Freeway
	  3=Ramp Freeway/Arterial
	  4=Expressway
	  5=Ramp Freeway/Freeway
	  6=Centroid Connector
	  7=Toll Collection link
	  8=Metered Ramp

TOLLDOLLARS	Toll charged in dollars (I-PASS rate for autos)
AMPM1 AMPM2	Time period restrictions: 1=open all time periods, 2=open a.m. periods only , 3=open p.m. periods only 4=open off-peak periods only
SIGIC	Indicates whether link is part of coordinated signal interconnect
POSTED_SPEED1 POSTED_SPEED2	Posted speed
THRULANES1 THRULANES2	Number of driving lanes

MASTER.AAT	Description
PARKLANES1 PARKLANES2	Number of parking lanes
MASTER.AAT	**Description**
CLTL	1=Continuous left turn lane present.
THRULANEFEET1 THRULANEFEET2	Width of one driving lane (average)

BASELINK	Link description flag:
	
	  0=future project link ("skeleton" link); attributes added with project coding
	
	  1=existing network link ("base" link); all attributes present

DIRECTIONS	Identifies the number of directions and implicit values of link attributes for each direction. 1=one way link, 2=two way street with the opposing direction implied to have identical attributes as those coded in the first direction, 3=two way link with the opposing direction's attributes explicitly coded.
MODES	Modes permitted: 1=all vehicles 2=autos only 3=trucks only 4=transit only

2.7.2 Route Attribute Table

This is a relational dataset that is permanently linked to the master.aat. *__Caution__*: Common variable names do not imply common relatable values. Look for explicit relationships.

MASTER. RATTIPPROJ	Description
TIPPROJ#	Internal ARC variable
TIPPROJ-ID	Sequential Route ID assigned by ARC
TIPID	CMAP TIP Database ID number. Unique to the TIP project. Relates to TIPID on master.sectipproj.
COMPLETION_YEAR	Project completion year from TIP.

2.7.3 Section Attribute Table

This is a relational dataset that is permanently linked to the master.aat. *__Caution__*: Common variable names do not imply common relatable values. Look for explicit relationships.

MASTER. SECTIPPROJ	Description
ROUTELINK#	Internal ARC id. Establishes relationship with MASTER.RATTIPPROJ variable.
ARCLINK#	Internal ARC id. Automatically assigned when route is digitized. Establishes relationship with MASTER.AAT variable
TIPID	CMAP TIP Database ID number. Unique to the TIP project. Establishes relationship with MASTER.RATTIPPROJ

ACTION	Transaction code used to prepare analysis networks.
	
	    1=modify
	    2=replace
	    3=delete
	    4=add

NEW_TYPE1 NEW_TYPE2	New facility type
NEW_SIGIC	Add a signal interconnect flag to the link attributes
NEWTHRULANEFEET1 NEW THRULANEFEET2	Modify the corresponding aat fields.
NEW_THRULANES1 NEW_THRULANES2	Modify the corresponding aat fields.
NEW_POSTEDSPEED1 NEW_POSTEDSPEED2	Modify the corresponding aat fields.
ADD_PARKLANES1 ADD_PARKLANES2	Add this value to the corresponding aat fields.
REPLACE_ANODE REPLACE_BNODE	when action=2 copy the attributes of this link to the corresponding skeleton.
NEW_TOLLDOLLARS	Modify the corresponding aat fields.
ADD_CLTL	Add this value to the corresponding aat field.
NEW_DIRECTIONS	modify the corresponding aat field
NEW_AMPM1 NEW_AMPM2	modify the corresponding aat field
NEW_MODES	modify the corresponding aat field
TOD	Time-of-day code indicating specific time periods when link changes are applied.

2.8 ANALYSIS NETWORK PREPARATION

Two EMME® macros prepare the network quantities needed for the time period assignments. The first macro, named Ftime.Capacity99, determines a link's uncongested speed and its hourly capacity per driving lane from network variables. A second macro, Arterial.Delay, estimates signal cycle lengths for the j-node of a link, and green time to cycle length ratios for the approach link. These link quantities are used in the revised volume-delay functions.

The macro Ftime.Capacity99, systematically calculates link lane capacities and uncongested speeds based on link characteristics such as functional class, lane width and posted speed limit. The network database also includes variables to flag those links that change characteristics depending on the time period, such as links that have peak period parking restrictions. These are also considered for calculation of capacity.

Calculations in the macro are generally consistent with the capacity procedures found in the 1985 Highway Capacity Manual and the 1994 update to the manual. More important, the capacities of arterial street links reflect the type of signalized intersection located at the link's j-node. The macro reviews the links entering a node, and then estimates capacity for each approach link based on generalized signalized intersection characteristics. Capacities for ramps between freeways and arterial streets ending at signalized intersections are determined in the same manner as arterial streets.

The concept behind this process is that link capacities and uncongested travel times must always be recalculated before an assignment is run, rather than maintained as part of a network database. The capacities and uncongested travel time for links ending at a signalized intersection depend on the characteristics of all approach links into the intersection, not just the link of interest. As a result, link capacities and uncongested travel times depend on network topology. Adding, removing or modifying a link affects the capacities and uncongested travel times of all links intersecting the changed link at a signalized intersection, not just the changed link. Calculating these network quantities as part of the assignment procedure ensures that they are current when the assignment is carried out.

The second macro, Arterial.Delay, repeats many of the same calculations as the previous macro. It again evaluates approach links at signalized intersections and estimates signal cycle lengths at j-nodes of arterial street links, and the proportion of the cycle length allocated to traffic on the link. These two quantities are retained in extra link and node attributes for later use in volume-delay functions that estimate intersection delays.

This approach simplifies the introduction of certain types of improvements into the modeled network. The effects of parking restrictions, traffic control device improvements, signal progression and intersection improvements can be modeled in the macro, eliminating lengthy manual adjustment of capacities and times on a link by link basis.

The macros also reflect the fact that network editing normally takes place in a network database outside of EMME®, and that EMME® network import files will be created from this database. Importable text files containing extra node and link attributes used by the macros are generated from the Master Highway Network database.

Table 2.1 lists the node variables that must be coded in all scenarios for input into the macros. Node attributes are the standard EMME® node variables with coordinates in Illinois

State Plane feet (NAD27, IL East). Node extra attributes are additional quantities associated with the node, including the zone number and area type at the node location. Area type definitions are listed in Table 2.1.

Table 2.1

Node Variables	Definition
I	Node number
Xi	x-coordinate
yi	y-coordinate
@zone	Zone number
@atype	1=inside Chicago CBD (2009 subzones 1-47)
	2=inside remainder of Chicago central area (2009 subzones 48-80)
	3=inside remainder of Chicago (2009 subzones 81-976)
	4=inside inner suburbs where Chicago street grid is generally maintained
	5=remainder of Illinois portion of the Chicago Urbanized Area
	6=Indiana portion of the Chicago Urbanized Area
	7=other Urbanized Areas and Urban Clusters within the CMAP Metropolitan Planning area plus other Urbanized Areas in northeastern Illinois
	8=other Urbanized Areas and Urban Clusters in northwestern Indiana
	9=remainder of CMAO Metropolitan Planning Area
	10=remainder of Lake County Indiana (rural)
	11=external area
	99=points of entry

Table 2.2 shows the network link attributes and link extra attributes that must be coded. Modes on links are defined to enable a multiple vehicle class assignment that matches the vehicle types used for emission calculations. Mode A is the primary auto mode and all other modes are secondary auto modes. No transit modes are included because the transit network exists as a separate entity. This also means that no transit only links are included in the network (rail links, dedicated busways), only links that allow trucks or automobiles.

Secondary auto modes S and H allow high occupancy vehicle facilities to be coded in the network. For example, mode S would not be coded on HOV links. All links in the network allowing high occupancy vehicles - usually every network link, with the possible exceptions of truck only roads - would have mode H coded.

Secondary auto mode T is a general truck mode coded on all network links that allow trucks. By excluding truck modes, trucks can be prohibited from Lake Shore Drive and the Kennedy and Dan Ryan express lanes. The additional truck modes b, l, m and h permit more specialized coding of truck prohibitions or truck only facilities based on weight classes. At present, all links permitting trucks are coded with all truck modes, T, b, l, m and h.

A link's volume-delay function is based upon the five link categories in CMAP's link capacity calculations: arterial, freeway, arterial-freeway ramp, expressway, and freeway to freeway ramps. Three additional volume-delay functions are included for links connecting zone centroids to the network, links where tolls are collected and metered freeway entrance ramps.

Other attributes used in the macros include the link's speed limit, or an estimate of the uncongested speed on the link without intersection delay, as well as the number of parking lanes and lane width of driving lanes on the link.

Two link extra attributes are coded only on links where tolls are collected. These are the toll on the link in dollars and an estimate of the maximum volume through the link if it is untolled. Maximum toll link volumes were determined from an all-or-nothing assignment without tolls. Both variables are used in the toll link volume-delay function. Note that since the introduction of regionwide open-road tolling, delay associated with tolling has been eliminated. However, the variables associated with tolling are still included in the database for future refinement of the toll volume delay function.

Table 2.2 Link Attributes

Link Variables	Definition
I J Len	From node To node Length in miles
Mod (modes on link)	A=primary auto S=single occupant auto (SOV) H=high occupancy auto (HOV) T=general truck b= B plate truck l=light truck m=medium truck h=heavy truck
Lanes	Driving lanes
Vdf (volume delay function code)	1=arterial street 2=freeway 3=freeway-arterial ramp 4=expressway 5=freeway-freeway ramp 6=zone centroids connector 7=link where toll is collected 8=metered entrance ramp
Extra Attributes @speed @parkl @sigic @width @toll @tollv	 Speed limit or CMAP free speed Parking along roadway is allowed Link with interconnected signals Driving lane width Toll on link in dollars Maximum volume on toll link without tolls

Several node and link extra attributes are calculated inside the macros. These are listed in Table 2.3. Node extra attributes are the number of approach links entering a node and the signal cycle length at a node. The extra attribute containing the number of approach links is retained only for checking, but cycle length appears in the volume-delay functions.

Extra link attributes output by the macros are described as follows. Link uncongested travel time (@ftime) is included in the volume-delay functions. It should be noted that this travel time does not contain any intersection delay, which is calculated separately by the volume-delay functions. Capacities (@emcap) calculated by the macros are hourly lane capacities at level-of-service E. Link capacity for the time period, which is in the volume-delay functions, is later obtained by multiplying this quantity times the number of driving lanes on the link and the length of the assignment time period.

An ad hoc functional (@artfc) class is also assigned to arterial street links based on the location of the link, its speed limit and number of driving lanes. This functional class is only used to allocate green time at signalized intersections. which depends on the cycle length and the number and types of conflicting approach links. The final link extra attribute in the table is the ratio of green time to cycle length (@gc) at the downstream node of a link. It later appears in the volume-delay functions.

Table 2.3 Calculated Extra Network Attributes

Node Attributes	
@napp	Number of approach links
@cycle	Signal cycle length in minutes
Link Attributes	
@ftime	Uncongested Link Travel Time in minutes
@emcap	Lane Capacity on Link (Level of Service E)
@artfc	Arterial Link Functional Class *1 = Principal Arterial Street* *2 = Major Arterial Street* *3 = Minor Arterial Street* *4 = Collector Street*
@gc	Green time to cycle length ratio

3 TRANSIT NETWORK

The northeastern Illinois region has one of the most extensive public transportation systems in North America. Service is provided by three public operating agencies: the Chicago Transit Authority (CTA), Metra commuter rail and Pace suburban bus. Each of the three agencies has its own autonomous board, management and operating personnel. An umbrella Regional Transportation Authority, while not an operating agency, has oversight responsibility for budget and financial performance of the three operators. The RTA also collects a regional sales tax and distributes it back to the service operators as an operations subsidy.

The CTA, Pace and Metra service areas overlap to varying degrees and many riders' trips involve transfers between services provided by different operators. The CTA operates heavy rail transit and bus within the city of Chicago and several adjacent older suburbs. Metra's radial commuter rail services generally carry commuters from suburban areas to the central area. There are, however, a number of Metra stations within the city of Chicago, and some Metra lines parallel CTA rail lines. Pace suburban bus operates nearly exclusively in the suburban trips, feeder buses focused on suburban Metra commuter rail and CTA rail stations, all regional ADA paratransit, a vanpool program and some long distance express buses.

The coded transit network reflects transit service in the morning peak period (7am -9am). The EMME® coded morning peak period transit network has nearly 11,000 bus and rail mode links totaling over 5,600 miles in length. The base itineraries include all currently inventoried publicly operated fixed route bus and rail lines. It does not include paratransit, vanpool or subscription services. The nodes and links include all facilities which carry transit vehicles (rail and bus). It does not include nodes and links which do not carry transit vehicles.

In the conformity analyses, the primary role of transit networks is to generate transit level of service variables which are needed as input to the generalized cost procedure. For each conformity scenario, impedance matrices are created for zone to zone in-vehicle times, fares, first wait time and remaining out-of-vehicle time. In the logic of the CMAP models, the zone to zone quantities are all measured from the point where transit service is first boarded, rather than the actual trip origin. As stated earlier, access modes and quantities are generated using Monte Carlo Simulation techniques.

3.1 PATH BUILDING

The transit network databases are prepared in two distinct steps. All bus itineraries are maintained on the Master Highway Network (MHN) database as ARC/INFO® route systems. This permits them to carry highway attributes, most particularly, congested highway times into the transit skimming procedures. For details on the preparation of the bus transit network database, see CMAP Working Paper (01-09). All rail itineraries are maintained in a separate ARC/INFO coverage, stored in a similar fashion to the bus itineraries. Rail transit coding was migrated to a GIS environment from EMME® to ensure consistency between transit network scenarios and to simplify itinerary editing procedures. For details on the preparation of the rail transit network database, refer to Working Paper (06-05). These two "service" databases are combined and auxiliary links are generated automatically in the ARC/INFO environment based primarily on the proximity of access, egress and transfer eligible nodes.

Zone to zone minimum impedance paths are built using the time and cost (fare) components of the transit network. Time components are weighted to reflect the relative disutility to the traveler. For instance walking time is weighted at three times the rate of time spent within a transit vehicle. Similarly fares are weighted so that they can be combined with times to create an overall measure of the impedance of a particular path. The transit paths are input to the trip distribution and mode split models. The costs are discounted to 1970 dollars when used in the mode split model for consistency with the calibrated mode split equation.

A multi-path transit assignment is run to provide transit impedances for zones that have walk access to a transit station. The current transit network scenario is used to generate zone groups based on a hierarchy of services present in the zone. This is analogous to CMAP's historic use of first, last and priority mode categorization. The mode matrices are then constructed based upon the transit services likely to be utilized when moving between these zone groups. For zones with no walk access to a transit station, highway impedances from a complimentary highway assignment are used to index the highway centroid to a station zone that minimizes highway and transit impedance to the destination. In this application, a generalized parking cost is calculated to reflect on and off street parking availability and cost. Station zones are identified by flagging the walk access centroids within an origin matrix. All cost components are then indexed from the station zone to the highway centroid. The resulting impedances are applied only to zones with no walk access.

This process has been improved by including the effects of roadway congestion on bus travel times. In the past, the skimmed bus times resulted only from the coded schedule times. Now, the scheduled times are skimmed and fed into the 4 step modeling process. When the entire 4-iteration run of the model is complete, the am peak hour congested times are added back as an extra attribute to the transit scenario. The network is skimmed for the impedance variables again, but this time the bus travel times are calculated using the longer time, either scheduled or

congested roadway time, for each link traversed. The new times are then fed back into the 4 step modeling process, and an entire new 4 iteration process is completed. An additional feature allows the schedule time to be retained by coding travel time function as 2 where congested times should not be considered. This is helpful for scenarios that include bus rapid transit or other similar services that will not be impacted by traffic.

3.2 ANCILLARY TRANSIT DATABASES

M01 (mode choice zonal attributes)

The M01 database is comprised of several arrays of variables that provide the mode choice model with parameters regarding a specific zone. Some of the variables are indices of the region's transit geography and reside in a manually coded base file (e.g. zone type). Other variables are derived from external sources such as the census (e.g. auto occupancy). The remaining variables are derived directly from the current transit network or trip generation database.

INFO Variable Name	Width	Description
		Table 3.1 M01: Geographic Variables Drawn from Base INFO® File
Z95	4	CMAP zone number
DISTRICT	2	(Ring*10)+Sector id.: Rings are numbered 1-9 concentrically from cbd. Sectors are numbered 1-7 from N to S.
COUNTY	1	1=Cook, 2=DuPage, 3=Kane, 4=Lake, 5=McHenry, 6=Will, 7=Kendall, 8=Grundy, 9=Lake, IN
ZTYPE1	1	ZoneType:1=Chicago CBD, 2=Chicago balance, 3=Suburban CBD, 4=Suburban balance
ZTYPE2	1	Zone Type 2: Rail Sectors numbered 0-8 from N to S
ZSIZE	1	Zone size: generally in integer square miles. Calculate from GIS. (Historically, these appear to be treated as indices. See 95-01 if this value becomes problematic)
ZAREA	6	Zone area: acres*10. Calculate from GIS
AUTOCCO	3	Work trip auto occupancy at the origin zone*100. This value was originally derived from the 1990 CTPP. In mode choice and vehicle trip preparation, it is a policy variable not responsive to *a priori* conditions.
AUTOCCD	3	Work trip auto occupancy at destination as above.

Table 3.2 M01: Transit Variables Drawn from the Current Network		
INFO Variable Name	Width	Description
PR12	4	Park and Ride cost per 12 hours in cents. Derive from current transit networks. Use also to calculate hourly cost = pr12/5.
PRAVAIL	1	Park and Ride Available. Derive from current transit network. Input file produced with transit tabulation procedure under transit emmebank
BUSMILES	4	Bus Route Miles. Derived from current transit network. Input file produced with transit tabulation procedure under transit emmebank.
WRKBUSWAIT	2	First wait for bus. Derived from transit network. There are historically four bus wait fields in this file (work and non-work for regular and feeder busses) but they have contained duplicate values for quite some time. Wait time for all modes is used.

Table 3.3 M01: Socioeconomic Variables Drawn from the Current Trip Generation		
INFO Variable Name	Width	Description
MEDINC	4	Average annual median income * 100. Derive from current trip generation inputs.
PCTDEV	4	Percent developed area*10. Base data derived from NIPC land use coverage, but forecasts should be correlated to socioeconomic scenarios.
CONCFACT	1	Concentration Factor: Only three values are used. Derive from current trip generation inputs (PEF). e.g. if PEF>20 then Concfact=1, if 10 < PEF < 20 then Concfact=2, if PEF < 10 then Concfact =4.

A final step employs ARC Macro Language (AML) to join the three M01 constituents, saving them as a scenario file and exporting them for column formatting in SAS.

DISTR (mode choice access parameters)

The composite cost and mode choice model simulates access to transit based on zonal parameters. The parameters are estimated based on the geographical distribution of rail stations and bus stops. This file has historically been the product of a number of FORTRAN programs, specially prepared input data sets and very general assumptions regarding urban form. With the advent of commercial GIS software, generating these data can be greatly simplified with fewer assumptions. In this exercise, Arc/Info® and SAS® are used prepare the access distance to transit distributions. These have been incorporated into the transit network summary procedure.

The data required are derived from EMME® node coordinates. Four node files are necessary: 1) modeling zone centroids locations, 2) commuter rail station nodes locations, 3) rapid transit station nodes and 4) bus stop locations.

After the node files are built into coverages, the Arc command *Pointdistance* is used to produce three data tables of distances between each centroid and each transit node. Because the ARC coverages use state plane coordinates, the distance measure is reported in linear feet. To keep the tables from becoming too large, the user may limit the range of distance within which transit nodes are reported. The limits are currently set at 10 miles for bus and rapid transit and 20 miles for commuter rail.

The mode choice access parameters file includes the estimated minimum, maximum, mean, standard deviation and variance of distance to the five closest stations in each service (i.e. commuter rail, rapid transit and bus) from each centroid, estimated by a SAS® program. Distance is expressed in hundredths of city blocks (where blocks = (feet/5280)*8)*100. Zones outside the ranges used in the ARC/INFO® step are set to the maximum range. Bus stop parameters are also classified by a concentration factor variable similar to that found in M01, giving the ratio between the number of trip ends in the 8 blocks nearest the bus stop and the 8 blocks farthest away from the bus line. At present the DISTR file is prepared with some specific fields maintained at historic values. Variance of distance to rail stations is always set to 10100 and bus stop concentration receives one of four discrete values. 0 = no transit service, 385 = less dense suburban, 588 = more dense suburban, and 830 = urban. Local and feeder bus parameters are identical.

Table 3.4 includes a description of the fields along with sample data.

Table 3.4 Mode Choice Parameters File

```
Z95                             1- 4
Mean blocks to commuter rail    5-10
Std blocks to commuter rail    11-16
Var blocks to commuter rail    17-22
Mean blocks to rapid transit23-28
Std blocks to rapid transit    29-34
Var blocks to rapid transit    35-40
Min blocks to local bus        41-46
Max blocks to local bus        47-52
Factor local bus               53-58
Min blocks to feeder bus       59-64
Max blocks to feeder bus       65-70
Factor feeder bus              71-76

1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
   1    557    330 10100   2732    249 10100     38    385    830     38    385    830
   2    588    307 10100   2936    111 10100    162    540    830    162    540    830
   3    771    319 10100   3553    100 10100    397    665    588    397    665    588
   4    930    606 10100   3281    392 10100     33    172    830     33    172    830
   5   1197    593 10100   3933    301 10100    248    623    588    248    623    588
```

Mode choice system attributes (M023) and CBD Parking

A database of selected central area parking facilities is used to provide parking cost distribution information to the composite cost and mode choice models. The specification of the variables and fields is described in CATS Working Paper 95-01 and substantially elaborated in an undated memo by Gordon Schultz on the subject "1990 Central Business District Parking Costs." The procedure by which the downtown parking access distribution is calculated has been automated using SAS® with inputs produced from a CBD parking database stored in ARC/INFO®. These values typically do not change unless a scenario is testing the effect of downtown parking costs on regional mode choice.

4 TRIP GENERATION

Trip generation is the first of the four sequential steps utilized by CMAP to forecast travel behavior. It is the means by which land use planning/zoning quantities such as households and employment are converted into trip origins and destinations that serve as measures of transportation demand. The trip generation process links the region's current and forecasted socioeconomic characteristics, the variables which drive travel demand, with the remaining sequential steps used to estimate choices of a trip destination and its mode and route.

Person trip generation estimates all daily person trips for a number of trip types and for all modes. The model includes trips made by motorized trips, where automobiles or public transit is used, and by non motorized modes made by walking or bicycling. Since the remainder of the

regional modeling process is focused on roadway and transit, non-motorized trips are removed from the person trip information at this point and put aside.

Truck trips, air traveler trips and external trips also needed by the regional are created in an alternative fashion, described in Chapter 7.

4.1 TRIP GENERATION ANALYSIS ZONES

Figure 4 1 Central Area Subzones
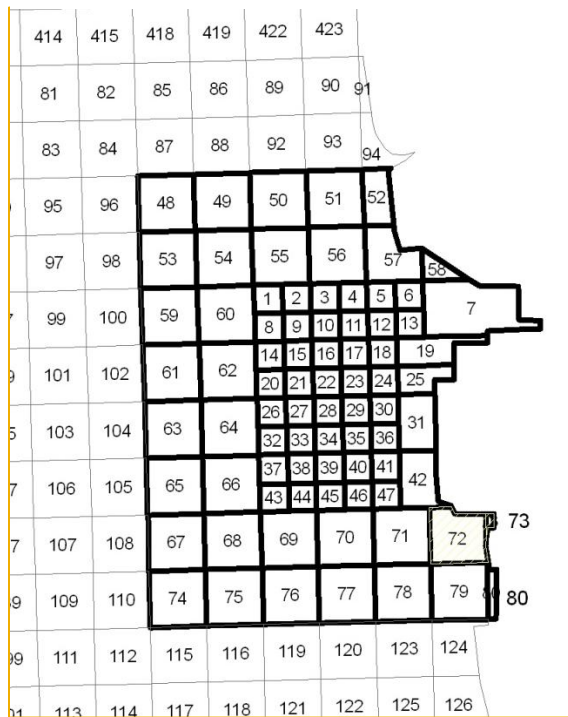
The CMAP trip generation model, its inputs and outputs uses a zone system referred to "subzones." In total, there are 16819 trip generation subzones, ranging in size from quarter-quartersections in the Chicago CBD to section size in much of the Chicago and suburban areas and even larger in rural and buffer areas. Figure 4.1 presents a map of the 80 subzones (subzone09) in the defined Chicago central area, while figure 4.2 shows the entire modeled area.

Figure 4.2: Trip Generation Zones for Modeled Area and County Boundaries for CMAP Planning Area
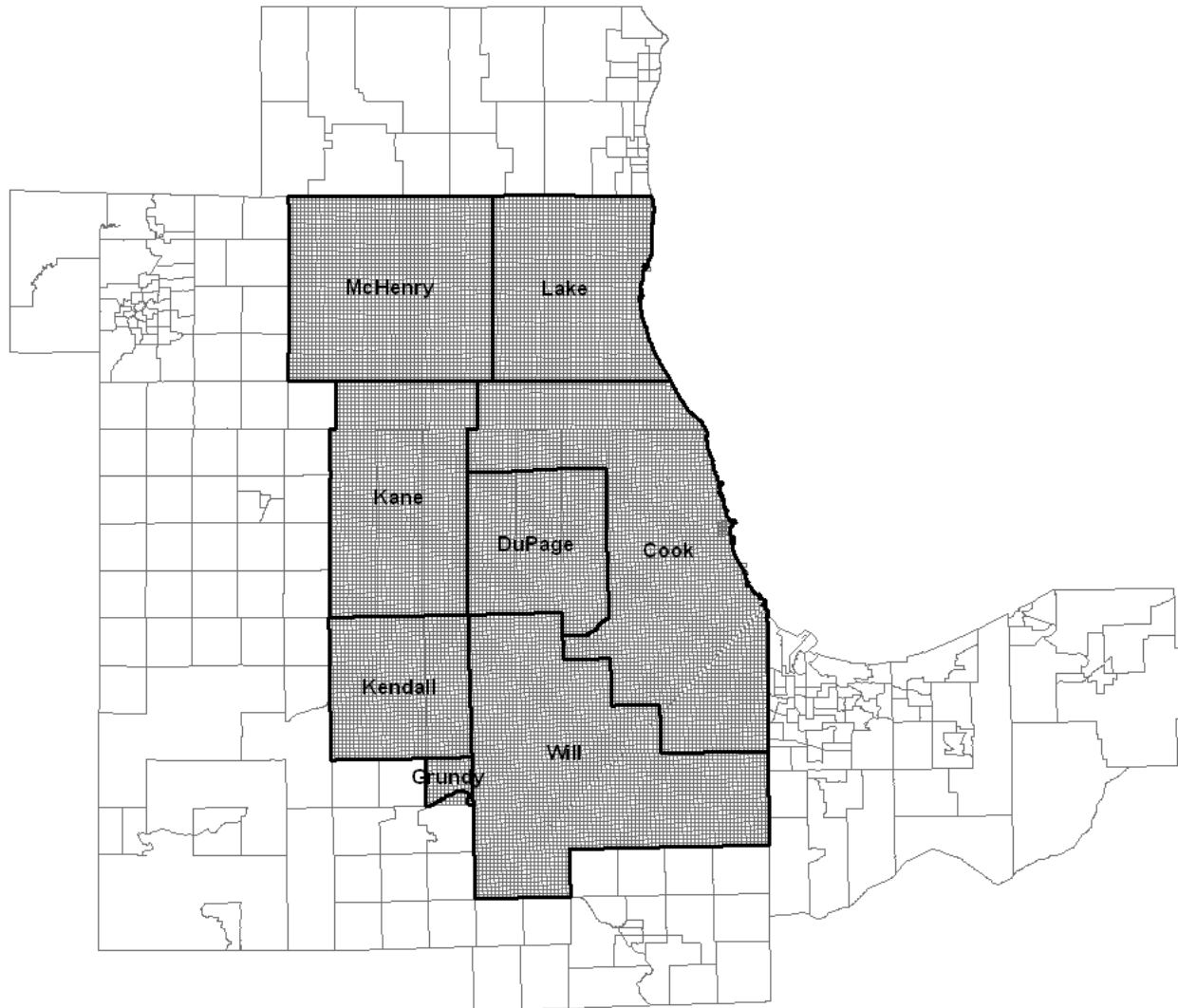
4.2 HOME BASED PERSON TRIP GENERATION

The trip generation rates were developed from the CATS 1990 Household Travel Survey[1] and all household, person and trip definitions are based on the definitions used in the survey. For application of the trip generation rates, households are cross-classified by four variables: (1) number of adults; (2) number of workers; (3) vehicles available for use, and; (4) the presence or absence of children in the household.

The four variable scheme used for the cross-classification of households defines 112 different household types. Permitted values for the cross-classification variables and the resulting household types are illustrated in Table 4.1.

The following definitions apply to the household definition system. Adults include all working and nonworking members of the household of driving age, sixteen years or older. Workers are adults who indicated in the household travel survey that they were employed either full or part time. Note that six combinations of workers and adults are not permitted because there may not be more workers than adults in the household. Children are individuals less than sixteen years of age, and by definition, a child cannot be a worker. For the purposes of defining household categories, children under the age of sixteen either are or are not present in the household. Vehicle availability is calculated as the number of autos, vans and pickups owned by the household. This definition is comparable to the one used by the census.

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[1] Anne C. Ghislandi, Alan R. Fijal and Ed J. Christopher. CMAP 1990 Household Travel Survey: Technical Documentation for the Household, Person and Trip Files. Working Paper 94-05, Chicago Area Transportation Study, April 1994.

Table 4.1 Household Categories Used for Trip Generation Rates

A. No Vehicles Available, Children Absent

Workers	Adults 1	2	3	4+
0	1	2	3	4
1	5	6	7	8
2		9	10	11
3			12	13
4+				14

B. No Vehicles, Children Present

Workers	Adults 1	2	3	4+
0	57	58	59	60
1	61	62	63	64
2		65	66	67
3			68	69
4+				70

C. One Vehicle Available, Children Absent

Workers	Adults 1	2	3	4+
0	15	16	17	18
1	19	20	21	22
2		23	24	25
3			26	27
4+				28

D. One Vehicle Available, Children Present

Workers	Adults 1	2	3	4+
0	71	72	73	74
1	75	76	77	78
2		79	80	81
3			82	83
4+				84

E. Two Vehicles Available, Children Absent

Workers	Adults 1	2	3	4+
0	29	30	31	32
1	33	34	35	36
2		37	38	39
3			40	41
4+				42

F. Two Vehicles Available, Children Present

Workers	Adults 1	2	3	4+
0	85	86	87	88
1	89	90	91	92
2		93	94	95
3			96	97
4+				98

G. Three or More Vehicles Available, Children Absent

Workers	Adults 1	2	3	4+
0	43	44	45	46
1	47	48	49	50
2		51	52	53
3			54	55
4+				56

H. Three or More Vehicles Available, Children Present

Workers	Adults 1	2	3	4+
0	99	100	101	102
1	103	104	105	106
2		107	108	109
3			110	111
4+				112

The number shown in the table is a category identification number. There are 112 categories.

Trip Definitions

Trip generation rates are estimated for workers, nonworking adults and children aged twelve to fifteen within each household category. There are, of course, no worker trip generation rates in the household cells corresponding to zero worker households. Similarly, there are no non-working adult trip generation rates in those household cells where the number of workers equals the adults in the household. Trip generation rates for children are present only for "children present" cells, households in the right half of Table 4.1.

Workers' and nonworking adults' trip generation rates include both vehicle and non-motorized trips. Trip generation rates for children are only vehicle trip rates and do not include schoolbus trips or walking trips. Trip generation rates for children are based on survey responses for children aged fourteen or fifteen, since younger children were not interviewed in the 1990 household travel survey. However, these rates are assumed applicable to all children in the twelve to fifteen age cohort.

Eleven different trip purposes are estimated; seven for workers, three for nonworking adults, and a single trip purpose for children aged twelve to fifteen. These purposes are listed in Table 4.2.

Trip purposes are defined using trip ends, which are designated with either a production or attraction trip purpose. Note that trip productions and attractions are not the same thing as trip origins and destinations since productions and attractions are independent of direction. Home trip ends are always trip productions, regardless of the direction of the trip. For example, a trip from home to work and the trip back again is represented by two productions from home to work. With the trip purposes defined in Table 4.2, work trip ends are also trip productions for work-other and work-shop purpose trips. For the remaining trip categories with the same purpose at either end of the trip (work to/from work and non- home/work to/from non-home/work purposes) the distinction between production and attraction is irrelevant. Although it may seem inconvenient to define trips in this manner, it greatly simplifies the later distribution of trips from productions to attractions.

Table 4.2 Trip Purposes Estimated

| | Trip Purposes | |
Trip Maker	Productions	Attractions
Workers	Home	Work
	Home	Shop
	Home	Other
	Work	Shop
	Work	Other
	Work	Work
	Non-Home/Work	Non-Home/Work
Non-Working Adults	Home	Shop
	Home	Other
	Non-Home	Non-Home
Children (12-15 Year Olds)	Home	Non-Home

Trip Linking

The trip distribution model assumes that travelers are seeking out a destination from a set of potential, but not equally attractive, destinations. This model is simplistic in that it does not recognize many of the subtleties of destination choice travel behavior. One of these subtleties is that many trip purposes are often accomplished during more consequential travel for principal trip purposes. In such cases, the destination selected for the intermediate purpose is governed by the location of the primary trip destination. For example, the grocery store you shop at on the way home from work depends on where you work. Another example of destination choice behavior that is difficult to model occurs when travelers make joint travel decisions, and the destination choice of one traveler is influenced by another. These problems can be partly alleviated by abstracting the trip making reported in the household travel survey to better match the uncomplicated destination choice behavior modeled in trip distribution.
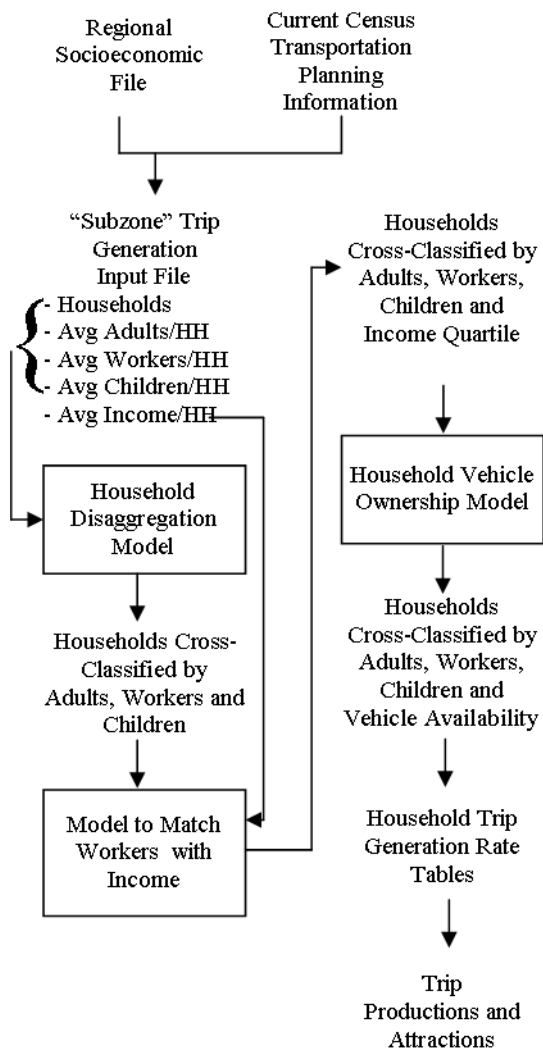
For this revision of the household trip generation, home to work trips are defined to eliminate incidental trip purposes that take place on the way to or from work. Examples of such incidental purposes are stopping at a convenience store on the way home from work to make a minor purchase, or stopping to pick up dry cleaning. In these cases, the primary purpose of the trip is home-work and the secondary trip purpose is accomplished with only a minor route deviation or time inconvenience.

In calculating the home to work trip rates from the survey data, four prerequisites had to be met before an intermediate trip purpose is considered incidental to the overall home-work trip purpose:

1. The additional time spent at the intermediate destination or destinations - the time spent inside the convenience store, for example - has to be less than thirty minutes.

2. Time in motion between home and the work place must be greater than the time spent at the intermediate destination. If one's travel time between home and work is fifteen minutes then stopping off at the health club for an hour workout after work breaks the work trip into two distinct trips, one with a work - other purpose and a second trip with a home - other purpose.

3. The additional distance traveled to reach one or more intermediate destinations, the excess distance between home and work, cannot be greater than five miles.

4. The distance between home and work must be greater than the extra distance traveled to reach intermediate destinations.

In addition to this work trip linking, trips with a serve passenger or change mode purpose are linked with a subsequent trip to form a combined trip with a trip purpose suitable for trip distribution. As an example of this linking, the wife who drops her husband off at his place of work on the way to her workplace is making a home-work trip, and the serve passenger trip purpose is eliminated. Home-to-home trips, including those that result from the linking of serve passenger trip purposes, are also excluded from the trip rates. These trips are not entirely unrepresented in the trip generation rates, however, since trips made by the passenger are still included in the rates. The vehicle trips made by children also account for some eliminated home-home trips made by their parents, such as when parents drive children to a school event and then return home without stopping for another trip purpose.

Figure 4.3 Trip Generation Model Flow

Application of the Trip Rate Tables

The entire household trip generation process is sketched out in this section. Some details are omitted, particularly the trip generation associated with workers and nonworking adults residing in group quarters. The study area also extends beyond the seven county region and base year and forecast socioeconomic data is required for all modeled areas.

Figure 4.3 is a schematic diagram of the household trip generation process, covering the steps that convert the socioeconomic data to household trip productions and attractions. A quarter-section (subzone) level trip generation input file is first developed from the regional socioeconomic file and the most current Census data. For future years, household worker and income data are factored from the census quantities using the CMAP forecasts of households and employment.

Based on the subzone characteristics, including the total households in the quarter-section and their average quarter-section characteristics, the Household Disaggregation Model generates

the number of households by household composition categories illustrated in Table 4.1. The result is households by number of adults, number of workers and number of children.

The mechanics of the program feature a matrix balancing estimating procedure to disaggregate households into worker-person cells. A "seed" three dimensional matrix of observed households, or proportions of households, cross-classified by adults, workers and children is factored by the quarter-section's household attributes (average adults per household, workers per household and children per household) to create an estimate of the quarter-section's households in each adult-worker-children cell.

The file produced by the program has one record for each quarter-section. Each of these quarter-section records contains the number of households in seventy different cross-classification cells. The seventy household types are formed by the fourteen worker-adult combinations discussed previously times five levels of children in the household (zero, one, two, three, or four plus children in the household).

Table 4.3 1990 Income Quartiles		
Income Range	Approximate Cumulative % of Census HHs	Cumulative % of Surveyed HHs Reporting Income
<$25,000	33.2%	30.2%
$25,000-$40,000	54.4%	53.4%
$40,000-$60,000	74.9%	76.1%
>$60,000	100.0%	100.0%

The model to match workers with income further subdivides the quarter-section three-way cross-classification of households into a four-way cross tabulation by separating the households into different income quartiles. Table 4.3 lists the approximate income ranges that make up the household income quartiles.

This program also uses matrix balancing, making use of the census two-way cross tabulation of households by workers and income levels as the seed matrix. The file produced by this program can contain up to 280 different household cells. For most quarter-sections, however, many of the household adult-worker-children-income quartile cells contain only a fraction of a household.

The next step in the process is to apply the Household Vehicle Ownership Model.[2]. All of the variables needed by this vehicle ownership model are now available in either the

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[2] Ronald W. Eash. *Household Vehicle Ownership Model for 1995 TIP Conformity Evaluation.* CMAP Intra-Office Memorandum, May 26, 1995.

disaggregate household file or the input trip generation file. The household vehicle ownership model produces the file for the application of the household trip generation rates. It replaces the income quartile household stratification with four levels of vehicle availability.

Once the household vehicle ownership model has been run, households are cross-classified into the same format as the trip generation rates. The worker, non-worker and child trip generation rates can then be multiplied by the number of individuals of each type in the cross-classified household file to produce the final estimates of trip productions and attractions.

4.3 HOUSEHOLD VEHICLE OWNERSHIP MODEL

The vehicle ownership model is a logit model similar to those used to predict mode choice behavior. The model estimates four possible vehicle ownership levels for each household, either zero, one, two, or three or more vehicles per household. A vehicle is defined as an auto or a van/pickup with one ton or less cargo capacity. This definition was used in the 1990 Household Travel Survey[3], and it is identical to the vehicle definition used to measure vehicle availability in the Census transportation planning questionnaire[4].

Each vehicle ownership level has an associated utility that contributes to a household's well-being. In a logit model, these utilities are linear functions of variables that describe the household and its environment. Model calibration consists of determining which variables best explain observed vehicle ownership levels and the relative importance of these variables in the utility expressions. The utilities may also include bias constants that indicate preferences toward certain levels of vehicle ownership that are not otherwise accounted for in the utility expressions.

The completed model has the following form:

$$\text{Probability of Vehicle Ownership Level } i = \frac{e^{u_i}}{\sum_i e^{u_i}}.$$

In the logit formulation, u_i is the utility of household vehicle ownership level i. The model is simply a representation that the probability of any level of vehicle ownership equals the

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[3] Anne C. Ghislandi, Alan R. Fijal and Ed J. Christopher. CMAP 1990 Household Travel Survey: Technical Documentation for the Household, Person and Trip Files. Working Paper 94-05, Chicago Area Transportation Study, April 1994.

[4] Census of Population and Housing, 2000: Summary Tape File 3 Technical Documentation. Bureau of the Census, Washington, 2001.

exponential utility of that level of vehicle ownership divided by the sum of the exponential utilities for all four vehicle ownership levels.

The utility of a level of vehicle ownership is computed by the following linear equation:

$$u_i = \sum_j \alpha_{ij} H_j + \beta_i.$$

In this expression, α_{ij} is the weight attached to the j'th household variable, H_j, for vehicle ownership level i. The constant β_i is the bias toward vehicle ownership level i, and it must equal zero for at least one ownership level alternative.

Household Variables Used in Auto Ownership Model Calibration

The selection of variables for the model calibration was driven by two hypotheses. First, larger or wealthier households should feature higher vehicle ownership levels. Second, vehicle ownership levels are reduced when the household is located in an area with reasonable alternatives to private vehicle travel. These alternatives can include non-motorized travel, pedestrian or bike modes, as well as public transportation.

The model calibration data set was built from the 1990 Household Travel Survey, census geography files and the socioeconomic data file to be used in the TIP conformity evaluation. Each record in the calibration data set is an observation for a single household in the travel survey. Households not reporting their income in the survey are excluded. The basic household characteristics - vehicle ownership, composition and income - come directly from the survey or are derived from survey data. After the household records were constructed, additional locale variables describing the quarter-section where the household is located were appended to the basic household variables. The workers per household and household income quartile variables are binary variables. They are defined such that additional 0,1 variables are turned on as the number of workers in a household and its income increase. For example, a household with three workers would have the three worker binary variables, WORKER1, WORKER2, and WORKER3, set equal to one. All three income variables - INCOME2, INCOME3, and INCOME4 - would be positive valued for households in the upper income quartile. These variables allow the higher ownership level utilities to substantially increase over utilities of the lower ownership levels in wealthier households and/or households with more workers.

Table 4.4 Household Variables for Calibration

Variable Name	Data Source	Variable Description
WORKER1	Travel Survey	1 = One or More Workers 0 = No Workers
WORKER2	"	1 = Two or More Workers 0 = Less Than Two Workers
WORKER3	"	1 = Three or More Workers 0 = Less Than Three Workers
INCOME2	"	1 = Income Not in Lowest Quartile 0 = Income in Lowest Quartile
INCOME3	"	1 = Income Above Regional Average 0 = Income Below Regional Average
INCOME4	"	1 = Income in Highest Quartile 0 = Income Not in Highest Quartile
NON-WORKERS	"	Nonworking Adults Sixteen Years of Age or Older
CHILDREN	"	Children Fifteen Years of Age or Younger
AVEPEF	Census	Average Pedestrian Environment for Household
AUTOMS	"	Average Work Trip Auto Mode Share for Household
RETAIL	Socioeconomic File	Nearby Retail Employment
EMPLOYMENT	"	Nearby Total Employment

Twelve different household variables were developed for the model calibration data set. These variables, along with brief definitions, are listed in Table 4.4 abov.

Workers are defined as all persons in the travel survey reported as employed, either full or part-time. Income quartiles are approximated with the income ranges used in the household travel survey. Table 4.3 shows the income ranges used for the quartiles. The table also lists the approximate percentage of regional households in the income range from the census and the corresponding proportion in the household travel survey determined from all households that reported their income.

Two other household composition variables were included in the calibration data set besides workers and income. These variables are the number of nonworking adults and the number of children in the household. For the purposes of model calibration, a nonworking adult is defined as a person of driving age, sixteen years or older, who was reported in the survey as not working full or part time. Children are defined as persons less than sixteen years of age in the household.

Two household environment variables were obtained for the calibration data set from the 1990 census. Variable AVEPEF is the average pedestrian environmental factor. The pedestrian environment of a quarter-section is measured by the number of census blocks in the quarter-section. For the model calibration data set, this quantity is averaged over the quarter-section containing the household and the quarter-sections surrounding the household's quarter-section.

In most parts of the region, this means that the average pedestrian environmental factor is averaged over nine quarter-sections. The use of this variable to measure the ease with which non-motorized trips can be accomplished is discussed later.

The second census variable in the calibration data set is the average auto work trip mode share. This auto mode share is initially calculated from the census journey to work data, although in planning applications it would more likely come from the mode choice model. It is the number of workers driving, sharing a ride or taking a taxi divided by the total number of workers. This calculation is also carried out over the home quarter-section and surrounding quarter-sections. In most cases, auto trips are totaled over nine quarter-sections and divided by the workers in the same nine quarter-sections.

The final two variables are two types of employment available within walking distance of a household. These quantities were obtained from the socioeconomic file. Retail and total employment within the household's quarter-section and adjacent quarter-sections were totaled and added to the calibration data set. As before, the two employment variables are accumulated with a floating grid of quarter-sections surrounding the home quarter-section.

Calibration Results

The utility equations are developed through trial and error. The software used for the calibration is the Urban Transportation Planning System program ULOGIT[5]. Utility expressions were first fit using only the binary variables for workers in a household. After estimating the household worker coefficients that provided the best possible fit without other variables, the binary variables for income were moved into the utility expressions. The remaining household variables were then shuffled in and out of the equations, retaining only the ones that improved the model's calibration.

Model calibration results are tabulated in Table 4.5. The calibration was initially carried out using one-half the data set. After selection of the variables in the utility expression, the calibration was repeated with the unused observations. No major differences in coefficient values where found when the two calibrations were compared. The results reported in Table 4.5 use all 15,340 unweighted household observations.

The utility expressions are defined so that zero vehicle ownership does not have a utility. The household variables CHILDREN, RETAIL and EMPLOYMENT were dropped during the model calibration process because they did not significantly contribute to the utility of any vehicle ownership level. Both employment variables, RETAIL and EMPLOYMENT, are quite

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[5] ULOGIT: Logit Calibration Program. Urban Transportation Planning System. Urban Mass Transportation Administration/Federal Highway Administration, U.S. Department of Transportation, Washington, DC, March 1982.

correlated with the other two household environment variables AUTOMS and AVEPEF. The standard errors of the coefficient and the T-statistics at the bottom of Table 4.5 indicate that all coefficients, except for the bias associated with single vehicle ownership, are significantly different from zero.

Table 4.5 Household Vehicle Ownership Model Calibration Results

A. Calibration Coefficients

Household Variables

Vehicle Ownership	WORKER1	WORKER2	WORKER3	NON-WORKERS	INCOME2	INCOME3	INCOME4	AUTOMS	AVEPEF	Unadjusted Bias
0										
1	0.763				1.158			2.718	-0.080	0.325
2	3.408	2.927		2.039	2.124	0.760		5.623	-0.132	-6.683
3+	5.329	4.322	2.638	3.173	2.124	0.760	0.481	5.623	-0.179	-11.383

B. Standard Error of Coefficient

Household Variables

Vehicle Ownership	WORKER1	WORKER2	WORKER3	NON-WORKERS	INCOME2	INCOME3	INCOME4	AUTOMS	AVEPEF	Unadjusted Bias
0										
1	0.093				0.096			0.286	0.006	0.316
2	0.134	0.068		0.059	0.114	0.059		0.355	0.007	0.275
3+	0.226	0.103	0.073	0.074	0.114	0.059	0.054	0.355	0.008	0.339

C. Coefficient T-Statistic

Household Variables

Vehicle Ownership	WORKER1	WORKER2	WORKER3	NON-WORKERS	INCOME2	INCOME3	INCOME4	AUTOMS	AVEPEF	Unadjusted Bias
0										
1	8.21				12.10			9.49	-13.62	1.03
2	25.53	43.00		34.60	18.62	12.97		15.83	-19.89	-25.49
3+	23.59	42.15	36.09	43.15	18.62	12.97	8.86	15.83	-23.73	-34.59

The signs of the variable coefficients seem appropriate. All model coefficients, except for the AVEPEF coefficient, have positive signs. Most would agree that additional workers, nonworkers and income in a household logically should add to the utility of greater vehicle ownership. It also seems reasonable that each added worker and each added quartile of income adds less to the utility of vehicle ownership than prior workers and income. The positive relationship between auto work trip mode share and vehicle ownership appears correct. An

Table 4.6 Model Calibration Statistics

Statistical Measure	Value
Test of Equal Probability (Chi Square, 20 Degrees of Freedom)	19,960
Test of Proportional Probability (Chi Square, 17 Degrees of Freedom)	13,800
Pseudo R-Square	0.469

improved pedestrian environment, however, almost surely reduces vehicle ownership levels, which is consistent with the negative sign on the AVEPEF coefficient.

Additional measures of how well the model fits the observed data are provided in Table 4.6. These are the standard goodness of fit statistical measures provided by the ULOGIT program. In order to evaluate them, one must first generally understand how the logit equation is fit to the observed data using the maximum likelihood procedure.

The likelihood of some sequence of events occurring is the probability of event one taking place times the probability of event two occurring, and so forth, until the end of the sequence of events is reached. For the households in the calibration data set, each of these probabilities is the probability determined by the model that the household owns the number of vehicles it actually owns, as shown below:

$$\text{Likelihood} = \prod_{k=1}^{15340} h_i^k * P_i^k.$$

In this equation, P_i^k is the probability given by the model that household k has vehicle ownership level i, while $\square_i^k$ is a binary 0,1 variable that is one when the actual vehicle ownership of household k is equal to i.

To simplify the calculations, the natural log of the likelihood is usually maximized rather than the likelihood itself, as follows:

$$\text{Ln}\{\text{Likelihood}\} = \quad .$$

In a perfect model, the probability of a particular household vehicle ownership level would be one for the actual number of vehicles owned by the household and zero otherwise. The maximum Ln{Likelihood} is, therefore, zero. All calibrated, but imperfect, models have a negative Ln{Likelihood}. The first measure of the model's quality listed in Table 4.6 is a hypothesis test that the calibrated model is not significantly better than a simple equal probability model of household vehicle ownership. The null hypothesis is that each household has an equal

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probability (0.25) of being in one of the four levels of vehicle ownership. A second similar hypothesis test is also evaluated in ULOGIT for a proportional model of household vehicle ownership. The null hypothesis is that the probabilities of vehicle ownership are proportional to their appearance in the calibration data set. These proportions are approximately 0.06, 0.31, 0.46 and 0.17 for zero, one, two and three plus vehicles owned, respectively. Both null hypotheses are easily rejected, since the calibrated model is far superior to either the equal or proportional probability models.

**Table 4.7 Final Household
Vehicle Ownership Bias**

Vehicle Ownership	Original Bias	Adjusted Bias
0	0.000	0.000
1	0.325	-0.656
2	-6.683	-8.114
3+	-11.383	-12.825

The final measure in Table 4.6 is termed the pseudo R-square, a statistic that varies between zero and one in much the same way that the R-square statistic varies in least squares regression. There is no other similarity, however. The pseudo R-square measures the quality of the calibrated model relative to the equal probability and perfect - zero Ln{Likelihood} - models. In this example, the calibrated model is approximately halfway between an equal probability model and a perfect fit to the data.

Bias Constant Adjustment

The calibration data set contains slightly different proportions of households at the four vehicle ownerships than the census. There are too few zero and one vehicle households and too many households with two or more vehicles. This bias is corrected by adjusting the bias coefficients to slightly increase the zero and one vehicle ownership probabilities. Final bias coefficients are listed in Table 4.7.

Mode Share Trip Generation Variable

Vehicle ownership does not totally depend on the composition of the household and its income, but also upon external factors that affect vehicle usage. For example, vehicle ownership generally increases for high income households, yet there are a sizable number of very wealthy households on Chicago's north side with low vehicle ownership levels. The household vehicle ownership model had to recognize that some households are able to substitute pedestrian, bike and transit travel for private vehicle travel, which reduces the need to own private vehicles.

Average automobile work trip mode share is an obvious location variable that helps indicate whether a private vehicle is necessary for work travel. In calibrating the model, this variable was developed from the 1990 census journey to work data. However, when this vehicle ownership model is used in a typical planning application, mode choice is estimated by subsequent models. How can an end product from the use of these sequential models be available as an input for one of the earliest models in the sequence?

While there is a question of comparability between the census auto mode share used for calibration and modeled mode share, the only solution is to iterate back through the household vehicle ownership model when the estimated auto mode share changes substantially from the base, as might be the case when major transit facilities are planned or when a major shift in the cost of using a mode is anticipated. Note that the auto mode share used for model calibration reflects workers who work at home or workers who commute by non-motorized modes. Auto mode share is here defined as auto work trips divided by all workers, and it is not exactly the auto mode choice produced by the model, which only deals with vehicle trips.

Figure 4.4 shows the average auto mode share variable used for model calibration for the six county northeastern Illinois region. The grayscale is reversed so that the lowest auto work trip mode shares have the darkest shading. The scattered low auto work trip mode share quarter-sections in the outlying collar counties seem incongruous, but they correspond to quarter-section where farming is the principal occupation, or where there are no workers and the variable is arbitrarily set to zero.

Figure 4.4 Work Trip Auto Mode Share   **Figure 4.5 Pedestrian Environmental Factors**
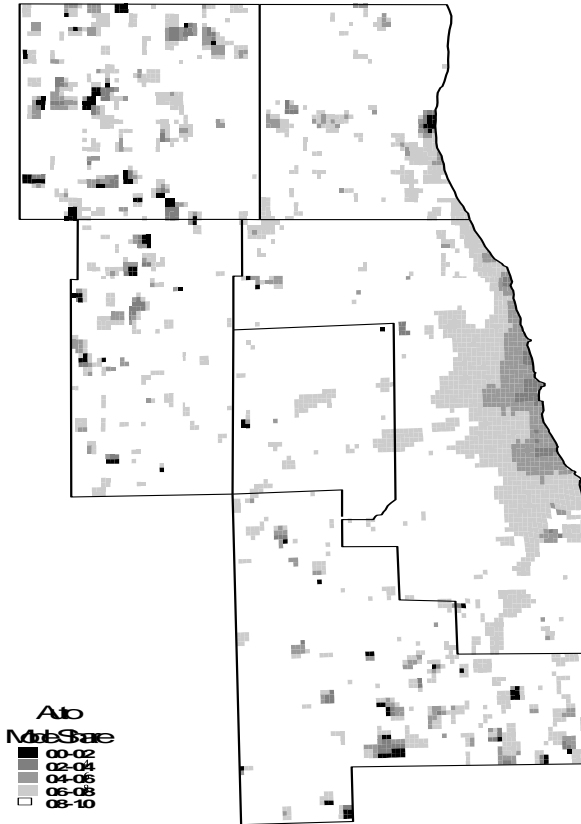
Auto
Mode Share
- 00-02
- 02-04
- 04-06
- 06-08
- 08-10

Pedestrian
Environmental Factor
- 0-8
- 8-16
- 16-24
- 24-32
- 32-40
- 40-48
- 48-56
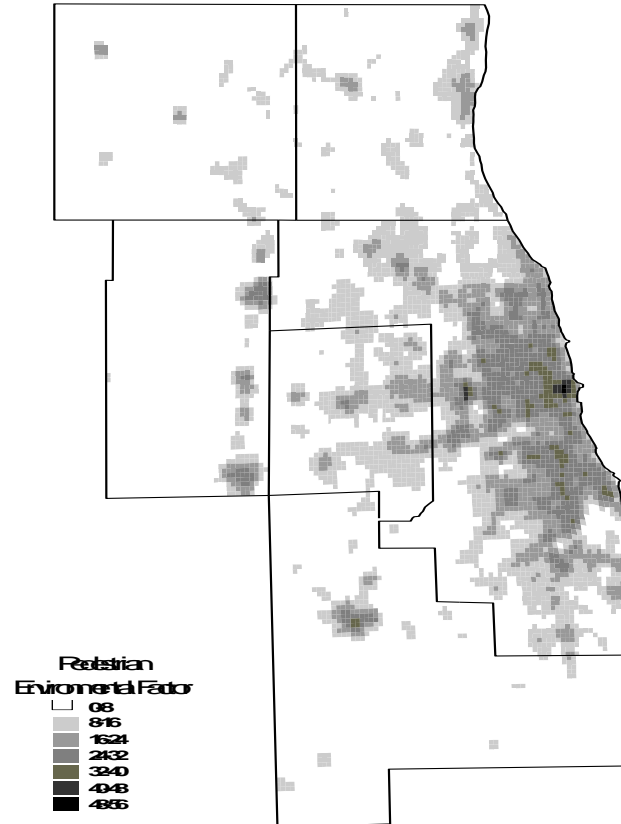
Pedestrian Environment Factor (PEF)

The average pedestrian environmental factor (PEF) shown in Figure 4.5 is a surrogate variable in the model that takes the place of an actual survey of pedestrian and bicycle facilities. It is defined as the number of census blocks in a quarter-section and was calculated this way for the calibration of the trip generation model. Census blocks are closed geographic areas that are generally formed from streets. They are not necessarily rectangular or always contiguous with city blocks due to alleys and cul-de-sacs. A greater density of census blocks implies a more regular street network and more local streets, both of which improve walking and biking conditions.

Highest PEFs are located in the densest part of the central area. A half city block street grid (one-sixteenth of a mile) would produce a maximum PEF of sixty-four. A dense city neighborhood with streets in a one-eighth by one-sixteenth mile pattern has a PEF of thirty-two. Established suburban areas feature PEFs on the order of ten to twenty. PEFs for newer suburban areas without regular street patterns may be five or less. The average PEFs in Figure 4.5 are also averaged over adjacent quarter-sections, as described earlier.

As described, the original pedestrian environmental factor was developed using census information and the trip generation zone geography. Currently, the pedestrian environment factor is developed using the trip generation zones and a Navteq™ street file. Since the PEF value is, simply speaking, a score related to street network density for a trip generation zone, the street file can be used instead of the Census geography. In the new process some modifications are made to both of the inputs. Streets identified as not appropriated for pedestrian use are filtered out of the Navteq file, and trip generation zones within the CMAP region have "catchment areas" generated for them (a buffering out of their original boundaries) to factor in the network density of neighboring areas into that zone's score. Since the street network does not change very much, the base year PEF is used in future scenarios.

Model Behavior

Figure 4.6 illustrates the behavior of the model for six typical households. These households feature different numbers of workers and nonworking adults and income levels. The distinction between urban and rural is created by alternate pedestrian environmental factors and auto mode shares. The urban household vehicle ownership examples assume an auto work trip mode share of forty percent and a PEF of twenty-five. Suburban households are located in areas with a ninety percent auto mode share and a PEF of five.

The model results shown in Figure 4.6 appear intuitively correct. Higher vehicle ownership levels are associated with the larger and higher employment typical households. The urban and suburban households also show markedly different vehicle ownership level probabilities.

Figure 4.6 Predicted Vehicle Ownership for Typical Households

A. No Workers, Low Income
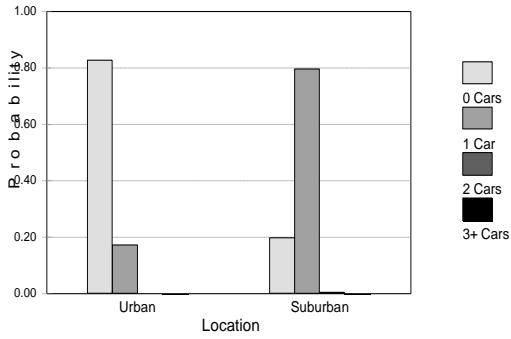
B. One Worker, Low Income
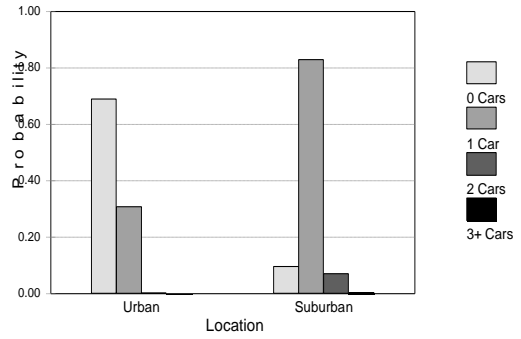
C. One Worker, One NonWorker, Average Income
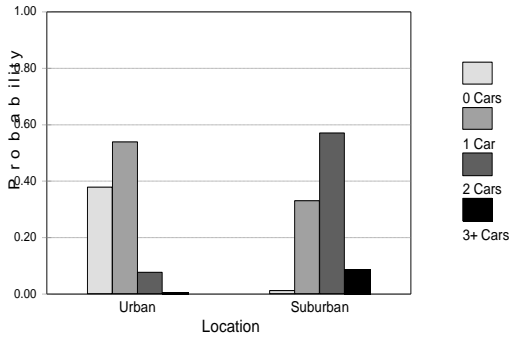
D. Two Workers, Average Income
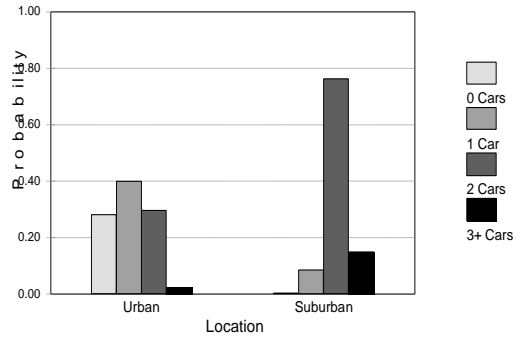
E. Two Workers, High Income
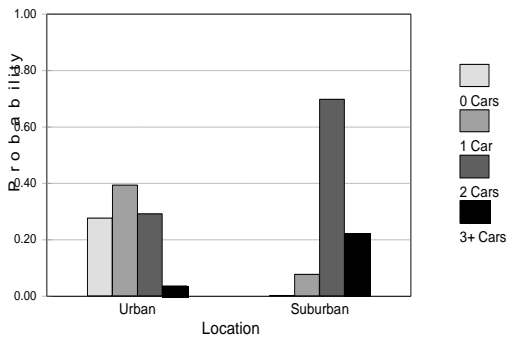
F. Two Workers, One NonWorker, High Income
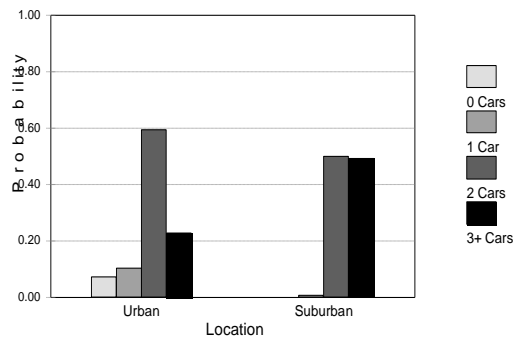
4.4 ALLOCATION OF NON-HOME LOCATION PRODUCTIONS/ATTRACTIONS

All home based trip *productions* are accounted for after the calculations described in the previous section are completed. However, we still don't know the locations of the home based *attractions* and we also don't know the locations of either non-home based trip *productions or attractions.*

Table 4.8 Zone Allocations of Home Based Trip Ends

Trip Purpose	Productions	Attractions
Employee		
Home to Work	Home Zone	Regression for Home to Work Attractions
Home to Other	Home Zone	Regression for Home to Other Attractions
Non-Home to Non-Home (Located at Work Site)	Regression for Non-Home to Non-Home Work Productions/Attractions	Regression for Non-Home to Non-Home Work Productions/Attractions
Non-Home to Non-Home (Not Located at Work Site)	Regression for Non-Home to Non-Home Non-Work Productions/Attractions	Regression for Non-Home to Non-Home Non-Work Productions/Attractions
Non-Employee		
Home to Other	Home Zone	Regression for Home to Other Attractions
Non-Home to Non-Home (Not Located at Work Site)	Regression for Non-Home to Non-Home Non-Work Productions/Attractions	Regression for Non-Home to Non-Home Non-Work Productions/Attractions

Non-home productions and attractions are allocated to zones by four regression equations for: (1) home to work attractions; (2) home to other attractions; (3) non-home to non-home attractions and productions at work sites; and (4) non-home to non-home trip attractions and productions not at work. These four regressions were calculated with zone trip productions and attractions from the 1990 Household Travel Survey as the dependent variables and zone employment and households from the socioeconomic file as independent variables.

Non-home trip productions and attractions are allocated proportionally to zones using the regression estimates as weights for the zones. Note that the total number of non-home trip productions and attractions is still equal to the totals established by the home based trip generation calculations. As shown in Table 4.8, no distinction is made between employee and non-employee trip ends for this allocation.

Table 4.9 summarizes the results of these regressions. Variables used in the regression equations are listed across the top of the table. These are seven different types of employment and the households contained within each zone in the socioeconomic file. As might be expected, the household variable shows up only in the regression equations for attractions to non-work trip ends. The regressions are constrained so that no productions or attractions are allocated to a zone that does not have employment or households.

Table 4.9 Summary of Trip Generation Equations for Allocation of Non-Home Located Productions and Attractions

Allocation Model	Variables in Model								Regression Adjusted R-Squared
	Manufact. Employment	Service Employment	Local Retail Employment	Regional Retail Employment	T.C.U.W. Employment	Government Employment	Other Employment	Households	
Home to Work Attractions									0.779
Parameter	0.466	0.703	2.408	1.092	0.481	1.262	2.974		
Standard Errors	0.082	0.052	0.138	0.160	0.111	0.086	0.396		
T for H_0 that	5.69	13.59	17.39	6.84	4.33	14.69	7.51		
Parameter = 0									
Home to Non-Work Attractions									0.663
Parameter		0.251	3.558	4.008		1.489	1.121	0.968	
Standard Errors		0.092	0.278	0.298		0.160	0.493	0.051	
T for H_0 that		2.71	12.80	13.43		9.32	2.27	19.08	
Parameter = 0									
Non-Home to Non-Home Work Attractions									0.679
Parameter	0.044	0.081	0.343	0.105		0.089	0.505		
Standard Errors	0.014	0.008	0.023	0.025		0.014	0.059		
T for H_0 that	3.10	9.87	15.17	4.10		6.43	8.59		
Parameter = 0									
Non-Home to Non-Home Non-Work Attractions									0.680
Parameter			0.915	0.922		0.143	0.356	0.182	
Standard Errors			0.055	0.058		0.032	0.092	0.010	
T for H_0 that			16.55	15.79		4.53	3.85	17.80	
Parameter = 0									

Trip generation for persons living in group quarters rather than in households is next added to the household trip generation. In most cases, the non-worker single person household trip generation rate is used for these individuals. As a precaution, zones with large numbers of persons in group quarters were examined individually to determine whether this rate was appropriate. The most important objectives of this zone by zone evaluation were to eliminate incarcerated persons from the trip generation and to estimate reasonable trip generation figures in the zones containing Great Lakes Naval Training Base.

5 TRIP DISTRIBUTION

The trip distribution model links the trip productions with the trip attractions. The model is applied after trip generation and before mode choice. The process estimates the destination choices of person trips, regardless of mode, by converting zone trip production and attraction vectors produced by the trip generation model into movements between zones. This results in trip tables which are two dimensional matrices. During this process, the intervening opportunity

trip distribution model is used to distribute person trips using composite impedance reflecting the relative ease of travel provided by both the highway and transit networks. The resulting person trip tables are then input to the mode choice model.

In addition, the resulting home based person trip tables (home based work, home based other) are in a special format referred to as "production/attraction" format. This means that all trips are represented as being produced from the home end and attracted to the destination end. The effect is that a trip from home to work and from work to home again is represented as two trips leaving home to the work destination. Care must be taken to keep this in mind if the trip tables are used for other purposes. One advantage of this format for analysis is that it provides an indication of the direction of daily travel. One knows that the origin side is the home, and the destination is not.   For example, if one looked at the daily travel to any location in origin/destination format, you would find that approximately the same number of people came to the zone as left it, but you wouldn't know if they started their day there in the morning and returned there later, or whether their home was somewhere else and they arrived in the morning and left the place sometime later.

Traffic Analysis Zones

While the trip productions and attractions are generated in a zone system based on survey quartersections, this level of detail is not used for the remaining modeling process. At this time, the space and computing capabilities required to complete calculations on matrices composed of 15,000 trip generation zone origins and destinations (or 225 million values) is not available. Therefore, the trip generation zones are aggregated into the CMAP traffic analysis zone system for the remaining three steps of the modeling process (trip distribution, mode split, and assignment).

Figure 5.2 shows the 1944 traffic analysis zones for the CMAP modeled region. These analysis zones generally follow the survey township geography. Zones are either sections (approximately one square mile) or regular subdivisions of townships (four square mile ninths of townships, nine square mile quarters of townships or whole townships). In the Chicago central area bounded by North Avenue, Ashland Avenue and Cermak Road, Figure 5.1, there are 77 zones to reflect the high density of trip making in this area. Of the 77 zones, 30 are quarter-section sized zones, one-half mile by one-half mile units; while the balance of 47 are quarter-quarter-section sized zones, one quarter-mile by one quarter-mile units. The 17 external zones, or points of entry, are not shown. They are arrayed around the outside of the pictured zone system, representing trips on major highways entering the region.

Figure 5.1: Central Area Zones
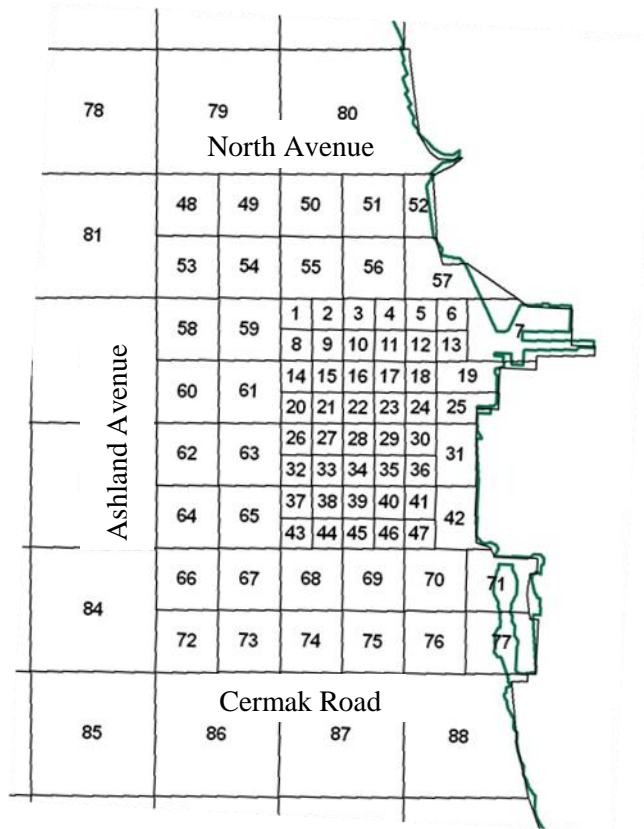
Figure 5.2 Traffic Analysis Zones 2009
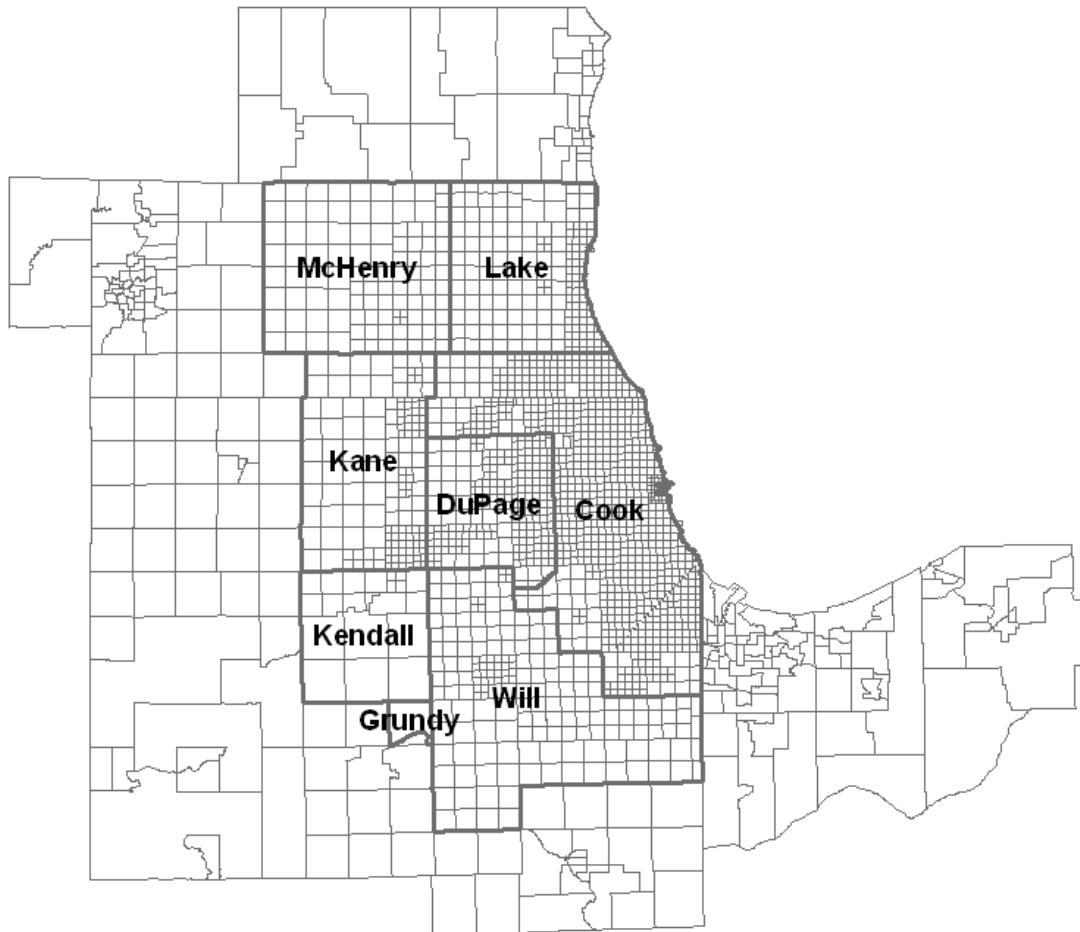
5.1 AN OVERVIEW OF THE INTERVENING OPPORTUNITY MODEL

The intervening opportunity model of trip distribution was originally formulated in the late 1950s. It is based on two simple premises. First, travelers try to minimize travel time and cost, and secondly, there is some constant probability that a traveler will find a potential destination acceptable. To illustrate, a person making a shopping trip does not always stop at the nearest store, they first consider whether the nearest store is acceptable or not, if not, move on to the next closest store, and so on, until an acceptable destination is found.

These premises can be restated as follows in terms of the analysis zones and trip attractions and trip productions that are built into the model. The probability that a trip production will end in a particular destination zone is the product of two probabilities, the probability that the trip has not already terminated nearer the origin zone times the probability that an acceptable attraction exists in the destination zone.

Mathematically, this probability can be expressed as:

$$\Delta P = \left(-P \right) * L * \Delta A$$

Where P equals the probability that the trip is completed before the destination zone is reached; ΔP is the marginal probability of completing the trip due to the added attractions (ΔA) of the destination zone. Finally, L is the constant probability of stopping at any single attraction.

Applying this simple model raises a number of complex questions. What is meant by nearest zone and in what sequence are attractions considered by the traveler? Is proximity determined by the shortest travel time or least cost mode or route, or by some measure that reflects the alternative modes and routes available between origin and destination zones? Even more fundamental model questions are associated with the L-values, including how travel and traveler characteristics affect these quantities, and how they change over time?

The balance of this section discusses how the intervening opportunity trip distribution model was applied by CMAP in the air quality conformity TIP and RTP network evaluations. The major change introduced into the model since its earliest applications is the use of a combined measure of transit and highway cost to rank zones in order of increasing cost from the origin zone.

The model was calibrated to data from the recent CMAP household survey. The following sections discuss how the L-values are calibrated and then smoothed into a monotonic function of accessible attractions. This function is used to estimate future L-values. Regression relationships were developed to estimate L-values as a function of the attractions that are accessible within a particular combined transit-highway cost from the origin zone.   This approach to L-value calibration allows the cost and time characteristics of the highway and transit networks, as well as trip productions and attractions, to influence the trip distribution.

5.2 THE DOUBLY CONSTRAINED INTERVENING OPPORTUNITY MODEL

The intervening opportunity trip distribution model is a member of the gravity model family of trip distribution models. After some algebra, the above relationship indicates that trips between zones are proportional to the trip productions in the origin zone and attractions at the destination zone, and inversely proportional to the difficulty of traveling between the two zones. This is the well-known general formulation of the gravity model. In most gravity models, the difficulty of traveling between zones, the impedance faced by the traveler, is related to the travel time or travel cost between zones. However in the intervening opportunity model, impedance also is a function of the attractions, or intervening opportunities, the traveler encounters while journeying between zone pairs.

The doubly constrained intervening opportunity model consists of four sets of equations shown below. To solve these equations, travel impedance is first determined, and then the remaining three sets of equations are simultaneously solved using an iterative matrix balancing algorithm:

$$1. \quad T_{ij} = \frac{\alpha_i \beta_j}{F_{ij}}, \text{ for all i, j zone pairs.}$$

$$2. \quad F_{ij} = e^{L_i V_{ij}} \text{ for all i, j zone pairs.}$$

$$3. \quad \alpha_i = \frac{P_i}{\sum_j \dfrac{\beta_j}{F_{ij}}}, \text{ for all origin zone i.}$$

$$4. \quad \beta_j = \frac{A_i}{\sum_i \dfrac{\alpha_i}{F_{ij}}}, \text{ for all destination zone j}$$

In the above equations, T_{ij} stands for person trips distributed from zone i to zone j. The α_i and β_j are balancing coefficients for zone i and zone j, P_i and A_j are the trip productions for zone i and trip attractions for zone j, and lastly, F_{ij} is the impedance between zones.

The equations are the actual trip distribution model that links together trip productions and attractions. Zone trip productions and attractions produced by the trip generation model are converted into movements between zones, or trip tables. There is one distribution equation for every origin zone - destination zone pair.

In the doubly constrained version of the intervening opportunity model, two sets of equations restrict the total trips distributed from an origin zone to the zone's trip productions, and the total trips received by a destination zone to the zone's trip attractions. These are the third and fourth sets of above equations. These equations ensure that the row sums of the trip table equal trip productions, and the trip table's column sums equal trip attractions. There is one production constraint equation for each origin zone and one attraction constraint equation for every destination zone.

The second equation in the model defines the impedance function, F_{ij} in the intervening opportunity model equals eL_iV_{ij}. The form of these functions is exponential, with an exponent that includes the bypassed opportunities, V_{ij}, and the previously discussed L-value parameter for the origin zone, L_i. The V_{ij} term equals the number of attractions that are closer to the origin zone than the destination zone (the destination zone's attractions are excluded from these "subtended" attractions). Note that impedance increases with higher L-values and increasing opportunities. An impedance value is determined for each zone pair.

To gain some sense of the magnitude of the calculations required for trip distribution, consider that there are nearly 7,600,000 equations in the above model that need to be solved. This figure is for the current 1944 traffic analysis zone included in the distribution model. The 17 external zones are treated separately. The model is also applied separately for three trip types, home productions to work attractions, home productions to non-work attractions and non-home productions to non-home attractions.

5.3 MODEL CALIBRATION

Travel time and cost are not explicitly included in the impedances (F_{ij}s), but they enter the model through the ranking of trip attractions from the origin zone. In the CMAP regional model, a generalized cost of travel across modes is used for ranking zones. This generalized cost reflects the cost and time of travel by both transit and auto. It is calculated using the same coefficients as the CMAP mode choice model.

Calibration of any trip distribution model usually means fitting the model's average trip lengths, or trip length distribution, to observed trip characteristics. The CMAP trip distribution model is calibrated to average trip lengths for outbound trips from subareas in the region, and to the average trip length for trips received by the central area. In the calibration process, the L-values primarily control the trip lengths for trips sent, while the generalized cost quantity is used to regulate the length of trips received by the central area.

The trip distribution model calibration, therefore, has two stages. L-values are calibrated to average sent trip lengths, and then the relative importance of transit and highway modes in the distribution generalized cost is calibrated from the trip lengths of trips received by the central area. In all the calibration calculations, the trips referred to are person trips made in any vehicle, auto or transit. Non-motorized modes such as walking and bicycling are not included. The calibration calculations are also repeated for the three trip purposes, home based work, home based other, and nonhome based.

This approach to trip distribution model calibration proceeds in the following manner:

1. Base year 1990 L-values were calibrated for fifteen subareas in the region. These L-values were estimated by matching model trip lengths to observed trip lengths from the household travel survey. L-values were repeatedly changed until the desired model trip lengths were obtained. Lower L-values produce longer average trip lengths and higher L-values result in shorter trip lengths.

2. Additional bias in favor of transit was added to the generalized cost until the average length of trips received by the Chicago central area roughly equaled the observed trip length in the 1990 household travel survey. Adding this bias toward transit reduces the cost of travel between zone pairs served by transit compared to zone pairs only served by auto. This substantially increases the accessibility of the central area compared to other destinations. The central area becomes a more attractive destination for longer distance trips located along the radial commuter rail and rail transit lines serving the central area.

3. Base year 1990 L-values for the fifteen subareas were readjusted so that model trip lengths matched observed trip lengths with the transit bias. The transit bias was then fine tuned to restore the trip length distribution for trips to the central area. This procedure was repeated until a reasonable fit was obtained for both subarea sent and central area received trip lengths.

5.4 GENERALIZED HIGHWAY-TRANSIT COST ESTIMATION

The generalized costs within trip interchanges are calculated using part of the mode choice model. The CMAP mode choice model simulates individual person trip mode choice behavior, first estimating the costs and times of making the trip by transit and auto, and then the probability of choosing each mode based on these alternative trip characteristics. Line-haul costs and times for travel by transit and auto are determined by the modeled network paths between zones, but the costs and times required to reach or depart line-haul facilities are simulated through Monte Carlo simulation models which estimate central area parking costs and transit access characteristics.

The cost calculation routine of the CMAP mode choice model is used before the application of the trip distribution model to estimate the generalized travel cost of driving or transit. When the cost model is applied prior to distribution, five person trips are simulated for each trip interchange between zones. The transit and highway costs and times for these five trips are estimated in the same manner as in mode choice, but mode choice calculations are not completed. The interchange's combined transit and highway cost is then calculated from the average of the five simulated trips' characteristics, resulting in a combined single impedance. The impedances are used within the trip distribution model application.

The values estimated by the mode choice model are the weighted sums of the cost and time variables used in the mode choice model's multinomial logit function. This logit model has the following form:

$$P_{auto} = \frac{e^{-\sum_i \omega_i V_i^{auto}}}{e^{-\sum_i \omega_i V_i^{auto}} + e^{-\sum_i \omega_i V_i^{transit} + \tau}}$$

In the above mode choice equation, P_{auto} is the probability that the person trip is by auto. The V_i^{auto} and $V_i^{transit}$ are cost and time mode choice variables for completing the trip by auto or transit, and the ω_is are the weights associated with each cost and time variable. Costs are in cents and measured in 1970 dollars, and times are in minutes.

Variables in the model and their weights in the linear multinomial cost expression are listed in Table 5.1. As the equation above shows, the exponents in the logit mode choice function are negatively signed because the cost and time quantities in the model have negative utilities. These cost and time quantities are multiplied by the positive ω_is listed in Table 5.1 to be consistent with the negative sign on the exponent. A more negative exponent, which equals a larger $\sum_i \omega_i V_i$, means a lower probability of choice. A mode that has high relative times and costs is an unlikely choice.

<div align="center">

Table 5.1 Mode Choice Parameters

</div>

Mode Choice Variable (V_i)	Weight (w_i)
Home to CBD Work Trips	
Auto and Transit In-Vehicle Time	0.0159
Auto and Transit Cost	0.0085
Auto and Transit Excess Time for	0.0468
Access/Egress	
Transit Bias (b)	-1.0000
Transit Out-of-Vehicle Time	0.0290
Transit First Headway	0.0173
Home to Non-CBD Work Trips	
Auto and Transit In-Vehicle Time	0.0186
Auto and Transit Cost	0.0072
Auto and Transit Excess Time for	0.0584
Access/Egress	
Transit Bias (b)	-2.0000
Transit Out-of-Vehicle Time	0.0399
Transit First Headway	0.0811
Home to Other Trips, Non-CBD Destinations	
Auto and Transit In-Vehicle Time	0.0114
Auto and Transit Cost	0.0329
Auto and Transit Excess Time for	0.0663
Access/Egress	
Transit Bias (b)	-1.9000
Transit Out-of-Vehicle Time	0.0589
Transit First Headway	0.0610
Non-Home to Non-Home Trips, Non-CBD Destinations	
Auto and Transit In-Vehicle Time	0.0114
Auto and Transit Cost	0.0329
Auto and Transit Excess Time for	0.0663
Access/Egress	
Transit Bias (b)	-2.0000
Transit Out-of-Vehicle Time	0.0589
Transit First Headway	0.0610

The τ quantity is the bias for or against transit. A negative τ indicates a bias toward auto away from transit. If the costs and travel times of the two modes are equal and the τ value is negative, then there will be less than a fifty percent probability that transit will be chosen. A positive τ indicates a greater than fifty percent chance of selecting transit.

The mode choice model actually estimates $\sum_i \omega_i V_i^{auto}$ and $\sum_i \omega_i V_i^{transit} + \tau$ for each zone pair. Some additional manipulations are necessary to obtain the generalized cost across modes, which is defined as the negative log sum of the logit function's denominator. It is calculated from these two sums as follows:

$$C^{auto/transit} = -Ln\left\{ e^{-\sum_i \omega_i V_i^{auto}} + e^{-\sum_i \omega_i V_i^{transit} + \tau} \right\}$$

This multi-mode generalized cost can also be interpreted as the cost belonging to some abstract mode whose service characteristics are equivalent to those of a joint transit-highway alternative. Calculation of the generalized cost from the values provided by the mode choice model is accomplished in a separate step that determines the log sum.

5.5 CALIBRATED L-VALUES

To start the calibration process average person trip lengths were tabulated from the household travel survey for trips from thirteen subareas: (1) Chicago; (2) the North Shore, Northwest, North Central, Central, Southwest and South Cook County regions, and; (3) the DuPage, Kane, Kendall, Lake, McHenry and Will collar counties. Calibration average trip lengths for two additional subareas, Grundy County and Lake County, Indiana, were estimated from trip lengths in adjacent counties and average travel times reported in the 1990 census journey to work data.

During the calibration of the trip distribution models, trip lengths for person trips to the central area were too short when the model was only calibrated to "sent trip" lengths from the subareas. The solution to this problem was to include a separate utility calculation for central area (see central area in Figure 5.1) destined trips for the nonwork purposes as it has already been included in the work purpose. The coefficients used are the same as the work to CBD coefficients.

Table 5.2 Additional Distribution Parameters

Mode Choice Variable (V_i)	Weight (w_i)
Home to Other Trips, CBD Destinations	
Auto and Transit In-Vehicle Time	0.0159
Auto and Transit Cost	0.0085
Auto and Transit Access/Egress	0.0468
Transit Bias (b)	-1.0000
Transit Out-of-Vehicle Time	0.0290
Transit First Headway	0.0173
Non-Home to Non-Home Trips, CBD Destinations	
Auto and Transit In-Vehicle Time	0.0159
Auto and Transit Cost	0.0085
Auto and Transit Access/Egress	0.0468
Transit Bias (b)	-1.0000
Transit Out-of-Vehicle Time	0.0290
Transit First Headway	0.0173

Two other minor adjustments were made in the cost calculations to improve the distribution. First, the combined transit-highway cost (after the log sum is taken) was increased by 0.3 for all trip interchanges across the Illinois-Indiana state line for all trip purposes, regardless of direction. This was done to reduce the number of trips made across the state line to match observed data. It can be argued that the state line is an additional barrier to movement that cannot be correctly represented in the F_{ij} impedance.

The second minor adjustment was caused by the way the CMAP' transit network is coded. Trips between adjacent zones can often travel between zones on walk links without boarding a transit line. For these short trips, the transit cost is computed assuming a walking speed of twenty minutes per mile (3 miles/hour), the transit out-of-vehicle time coefficient and the transit bias. All of these changes in the mode choice cost values take place outside of the mode choice model and apply only to the combined transit-highway cost used for trip distribution.

Table 5.3 summarizes the results of the person trip distribution calibration. It lists the average trip lengths from the household travel survey, the comparable trip length from the trip distribution and the L-value calibration coefficient for the subarea. The subareas in Cook County are approximately the same as the Regional Councils.

Table 5.3 1990 Calibrated Person Trip Lengths and L-Values

	Home to Work			Home to Other			Non-Home to Non-Home		
Subarea	Survey Trip Length (miles)	Calibrated Trip Length (miles)	Calibrated L-Values (10^{-6})	Survey Trip Length (miles)	Calibrated Trip Length (miles)	Calibrated L-Values (10^{-6})	Survey Trip Length (miles)	Calibrated Trip Length (miles)	Calibrated L-Values (10^{-6})
Chicago	8.6	9.0	1.30	4.8	5.3	2.23	5.8	6.1	2.57
Cook									
North Shore	10.3	10.4	1.40	4.7	4.6	4.07	5.6	5.7	5.21
Northwest	10.7	10.4	1.79	5.2	5.3	5.36	5.8	5.8	6.32
N. Central	8.5	8.7	1.55	4.7	4.7	3.61	5.8	5.8	4.06
Central	9.2	9.5	1.49	4.3	4.6	6.59	4.7	5.0	7.71
Southwest	11.8	11.7	1.88	4.5	4.7	7.23	4.8	5.0	9.65
South	13.5	13.4	3.01	5.3	6.0	9.67	5.5	5.7	11.34
DuPage	12.0	11.2	1.66	4.6	4.7	8.97	5.9	5.6	7.24
Kane	12.3	11.3	5.95	6.0	5.9	13.61	4.9	5.3	25.42
Kendall	11.7	11.1	18.29	5.2	5.2	73.54	5.5	5.6	67.58
Lake	13.2	12.1	4.59	5.7	5.9	17.72	6.5	6.5	15.47
McHenry	15.2	14.3	10.15	5.8	5.9	46.77	5.2	5.7	59.01
Will	14.7	13.1	5.43	6.2	6.2	18.91	6.1	6.6	28.94
Grundy		10.7	76.03		5.2	133.30		6.0	245.64
Lake, Indiana		10.1	9.77		3.8	18.91		4.9	28.94
To CBD	14.9	14.4		11.3	8.7		7.7	5.4	
Region	10.7	10.6		5.0	5.3		5.7	5.9	

Figure 5.3 L-Values Versus Trip Attraction Density

Home to Work Trips
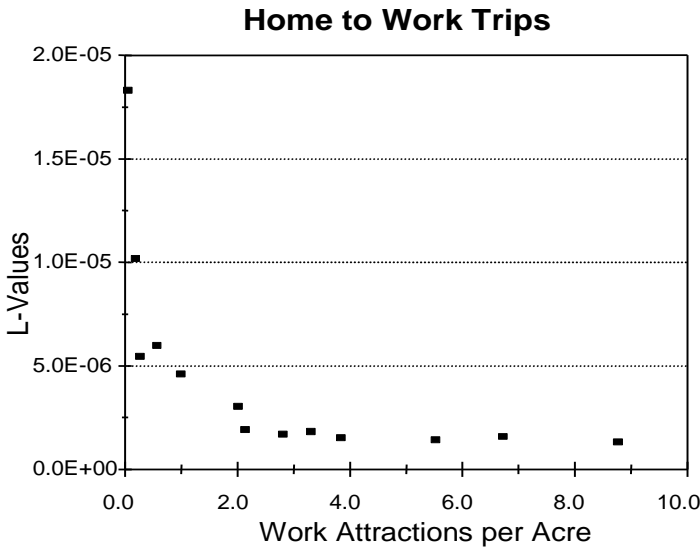
Figure 5.4 Work Trip L-Values Versus Accessible Attraction Opportunities

Home to Work Trips

5.6 FORECASTING L-VALUES

After calibrating the L-values to existing data, the next question to be asked is what are future L-values? The simplest assumption is to argue that these quantities should remain constant into the future. This assumption generally causes trip lengths to shorten as trip attraction opportunities increase over time. Future travelers encounter more opportunities to complete their trip as they travel from the origin zone due to additional development. If the probability of selecting a destination does not change over time, they will find an acceptable destination closer to the origin. The problem with this argument is that average trip lengths have historically not declined in spite of increased development.

The plot in Figure 5.3 is a first step toward understanding how L-values change with development. It compares the home to work trip L-values in Table 5.3 with the density of work attractions in each subarea. This plot shows that the relationship between L-values and density is not linear. L-values decline at a decreasing rate as density increases. They appear to become nearly constant after a threshold density of about two work attractions per acre is reached.

Figure 5.4 transforms the data points for home to work trips in several ways. L-values are now plotted against the average number of attraction opportunities that can be reached from a zone in each subarea in less than 3.9 cost units. Instead of attraction density, the X-axis now measures attractions that are reasonably accessible to the origin zone. This is a continuous

quantity across geographic boundaries, which means there are not abrupt changes in L-values between adjacent zones.

The cost measure in this calculation is the same transit-highway generalized cost used for ranking zones in distribution. The 3.9 value is slightly greater than the average travel cost for any calibration subarea.

The plot has also been changed to a log scale on both the X and Y-axes. There is a nearly linear relationship between the transformed L-values and accessible attractions. The linear relationship that best fits these values is also shown on the plot. It was determined by regression, weighting each data point by the number of zones in a subarea. Comparable plots for the remaining home to non-work and non-home to non-home trip purposes are in the two sections of Figure 5.5.

<p style="text-align:center">Figure 5.5   Non-Work Trip L-Values Versus
Accessible Attraction Opportunities</p>
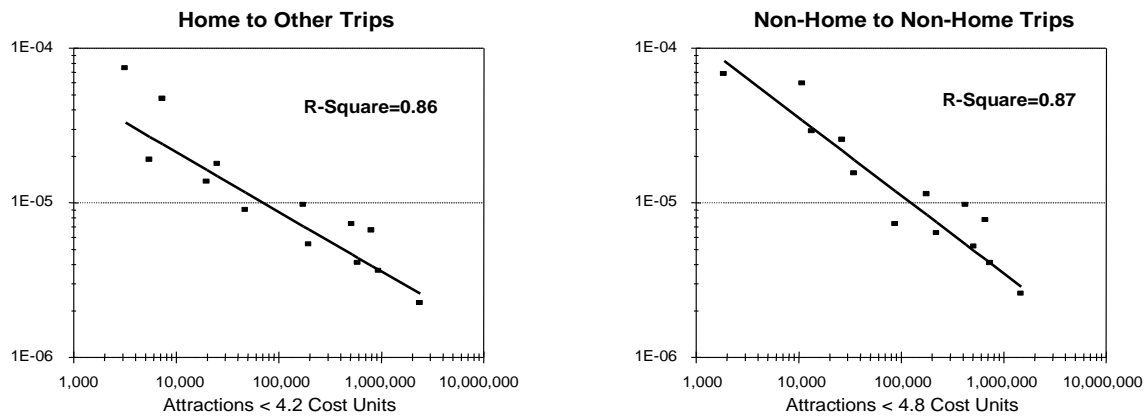
The relationships shown in these plots have the following form:

$$L_i = \frac{\lambda}{\left(V_{ik} \right)^{\gamma}}$$

The V_{ik} term again indicates accumulated attractions ranked in order of increasing cost from the origin. It is the same quantity as the subtended attraction opportunities in the distribution model. However, zone k is that zone furthest from the origin with a cost less than some specified value ($C_{ik} < \delta$). For work trips, V_{ik} are the attractions less than 3.9 cost units from the origin zone, the X-axis in Figure 3. Maximum values for C_{ik} for other trip purposes are shown on the remaining plots' X-axes in Figure 5.4.

Table 5.4 L-Value Equation Constants

Trip Purpose	λ (10^{-3})	γ	δ (Cost)
Home Production to Work Attractions	3.99	0.541	3.9
Home Productions to Non-Work Attractions	74.01	0.385	4.2
Non-Home Productions to Non-Home Attractions	3.68	0.503	4.8

The other terms in the above equation are as follows. L_i is the trip distribution L-value for origin zone i, the numerator λ and γ exponent for V_{ik} are trip purpose specific constants determined by the regression, and δ is the cost boundary used to define the number of attractions that are considered accessible attractions for origin zone i. The two regression constants and cost boundaries in this equation are listed in Table 5.4.

The relationship between L-values and attractions intuitively agrees with observed travel behavior. When trip makers have more attraction opportunities to choose from, they can be more selective (have lower L-values) than travelers who have few accessible attraction opportunities. If all other factors in the distribution remain constant, lower L-values result in longer trip lengths.

The sensitivity of the trip distribution to travel times and costs is greatly enhanced by this relationship between L-values and trip attractions. The distribution adjusts with the generalized cost of travel because increased or reduced costs change the number of attractions that are considered accessible. Highway congestion, transit service changes, new transportation facilities, highway operating costs and transit fare policies all affect generalized cost, increase or decrease the L-values and alter the trip distribution.

How these L-values change is shown in Figure 5.6, which is a cumulative frequency plot of the occurrence of L-values for three home to work trip distributions. The lowest plot corresponds to the base trip distribution for 1990, the 1990 distribution using the smoothed L-values. The middle plot labeled 2010 base is the trip distribution for 2010 including only those network improvements now programmed to be completed by 1996. These L-values are consistently lower. The difference between the 1990 base and 2010 base L-values is due to trip productions and attractions added during the period 1990 to 2010. Only developmental effects are being measured.

Figure 5.6 Cumulative Frequency of L-Values for Origin Zones

Home to Work Trips
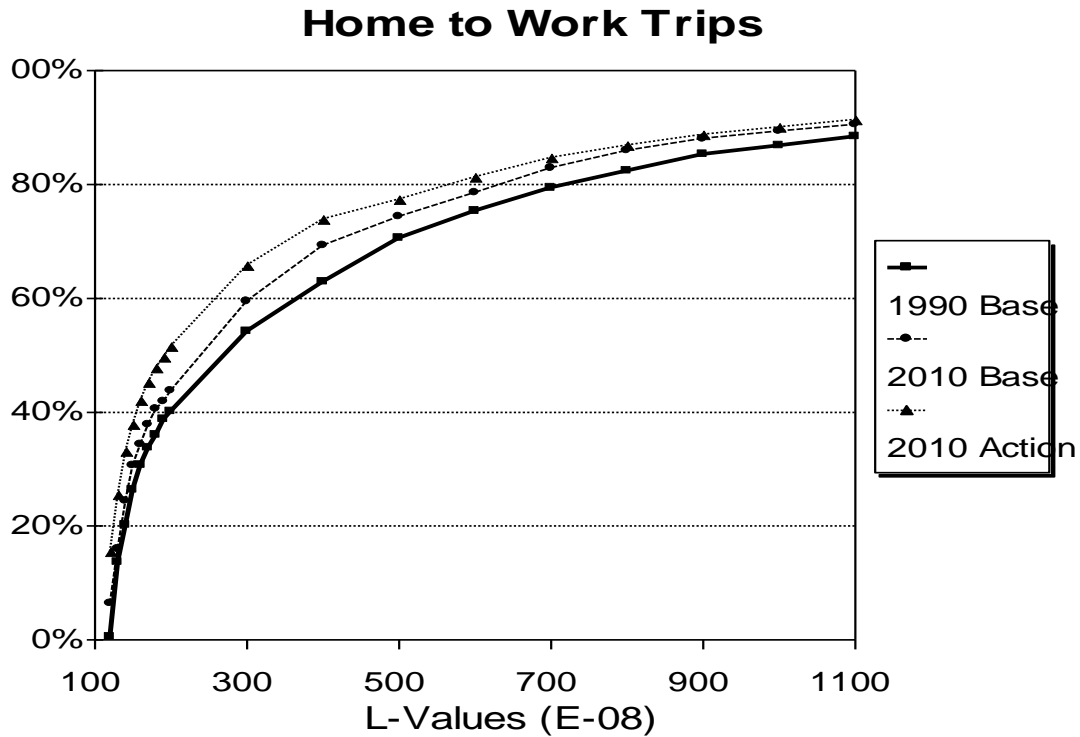
The top plot labeled 2010 action is for a trip distribution that includes the added trip ends plus the major facility improvements in the current TIP and revised 2010 plan. The difference between the 2010 base and 2010 action L-values is due just to the programmed and planned transit and highway improvements. A comparison of the two 2010 L-values, therefore, only measures the network improvement effects.

Table 5.5 compares the average trip lengths from the distribution using the smoothed L-values against the previously calibrated distribution. There are some differences between these two sets of average trip lengths, but there is generally good agreement between the trip lengths before and after smoothing the L-values. Regional average trip lengths are within one or two tenths of a mile of one another for the two distributions.

Table 5. 5 1990 Person Trip Lengths After Smoothing L-Values

Subarea	Home to Work			Home to Other			Non-Home to Non-Home		
	Survey Trip Length (miles)	Calibrated Trip Length (miles)	Smoothed L-Value Trip Length (miles)	Survey Trip Length (miles)	Calibrated Trip Length (miles)	Smoothed L-Value Trip Length (miles)	Survey Trip Length (miles)	Calibrated Trip Length (miles)	Smoothed L-Value Trip Length (miles)
Chicago	8.6	9.0	9.0	4.8	5.3	4.9	5.8	6.1	5.6
Cook									
North Shore	10.3	10.4	10.3	4.7	4.6	4.5	5.6	5.7	5.6
Northwest	10.7	10.4	9.6	5.2	5.3	4.2	5.8	5.8	5.0
N. Central	8.5	8.7	9.8	4.7	4.7	4.6	5.8	5.8	5.7
Central	9.2	9.5	10.2	4.3	4.6	5.2	4.7	5.0	6.0
Southwest	11.8	11.7	12.0	4.5	4.7	4.8	4.8	5.0	5.9
South	13.5	13.4	13.9	5.3	6.0	6.0	5.5	5.7	5.9
DuPage	12.0	11.2	10.4	4.6	4.7	4.2	5.9	5.6	4.6
Kane	12.3	11.3	11.5	6.0	5.9	5.5	4.9	5.3	6.0
Kendall	11.7	11.1	11.7	5.2	5.2	7.4	5.5	5.6	6.4
Lake	13.2	12.1	11.9	5.7	5.9	6.3	6.5	6.5	5.9
McHenry	15.2	14.3	14.9	5.8	5.9	7.9	5.2	5.7	7.9
Will	14.7	13.1	12.5	6.2	6.2	5.8	6.1	6.6	6.8
Grundy		10.7	16.9		5.2	11.2		6.0	11.5
Lake, Indiana		10.1	10.2		3.8	3.9		4.9	5.2
To CBD	14.9	14.4	15.2	11.3	8.7	9.0	7.7	5.4	4.6
Region	10.7	10.6	10.5	5.0	5.3	5.1	5.7	5.9	5.6

5.7 DISTRIBUTION VALIDATION

This final section provides two comparisons between the model distribution and data from the household interview survey and the 1990 census. Figure 5.7 includes three plots that compare the model's trip length frequency distributions with the distributions of trip lengths in the household interview survey. Intra-zonal trips that do not cover any distance are excluded from these plots.

Figure 5.7 Person Trip Length Frequency Distributions

Home to Work Trips

Home to Other Trips

Non-Home Trips
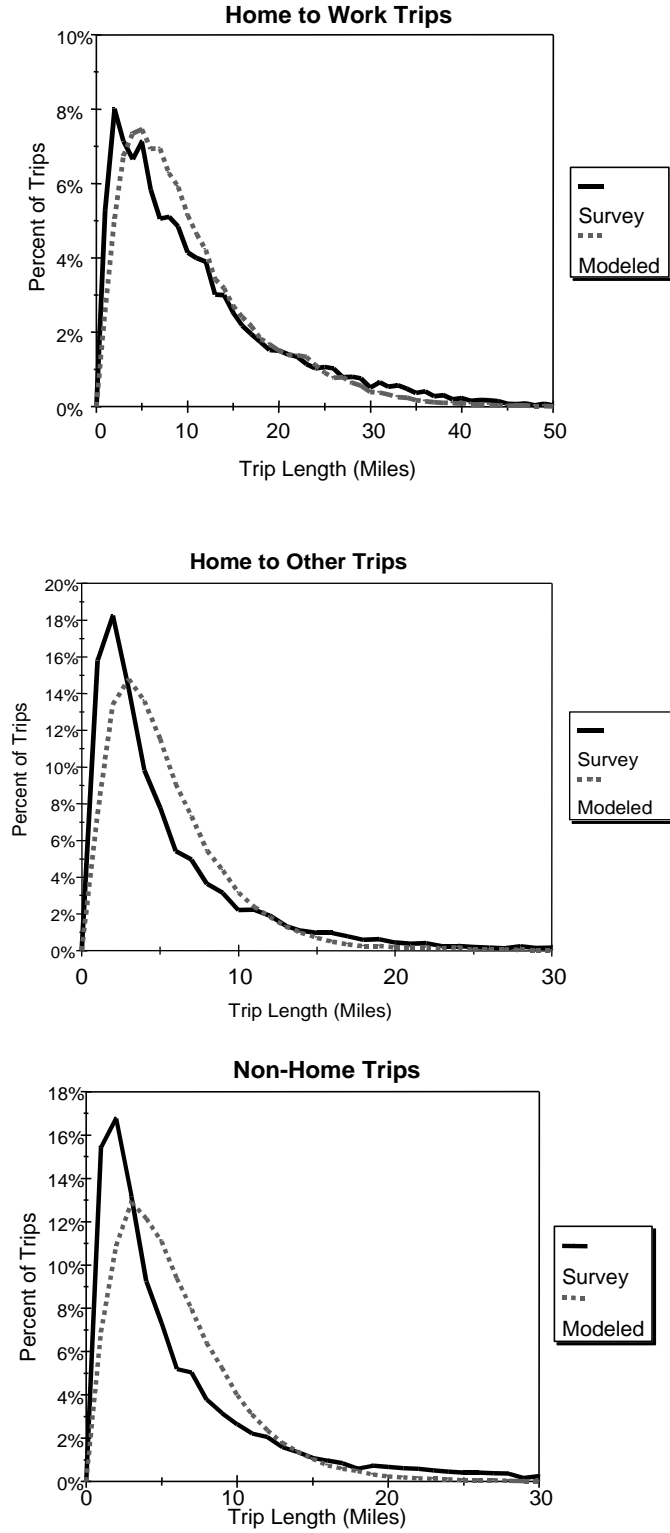
The three trip purpose distributions have roughly the same characteristics. The ability of
the model to fit the observed data is approximately the same for all purposes. The different Y-

axis mileage scales somewhat distort the comparison, but the three model trip length frequency distributions bulge slightly to the right compared to the survey frequency distributions. The model tends to underestimate very short trips, overestimate the number of trips in the middle distance ranges, and then underestimate the very longest trips.

The last comparison is between the 1990 county to county home to work trip table from the model and the census journey to county level work flows. These are not perfectly comparable since the census indicates the most likely work location during a typical week, while the trip table is in trip productions and attractions and includes trips returning home from work. The model trip table is also for a typical day so absenteeism is reflected in the flows.

The comparison of the census and modeled work trip tables is in Table 5.6. For this comparison, total home to work trips in the census have been normalized to the trips in the model work trip table. A value of 100 percent in Table 5.6 means the cell contains the same proportion of trips in both trip tables. When the percentage is greater than 100 percent, the model has distributed a larger proportion of trips in the interchange than appear in the census table. Interchanges between counties of less than 2000 trips are not included in this comparison.

Table 5.6 Comparison of Census and Model Home to Work Trip Distribution

Residence County						Work Location County				
	Cook	DuPage	Grundy	Kane	Kendall	Lake (Illinois)	McHenry	Will	Lake (Indiana)	Total
Cook	103%	86%		100%		80%	65%	95%	80%	102%
DuPage	97%	100%		129%		6%		107%		99%
Grundy			81%					175%		105%
Kane	84%	174%		82%	116%		114%			98%
Kendall		78%		146%	66%					102%
Lake IL	101%	4%				88%	187%			91%
McHenry	83%	3%		188%		148%	83%			94%
Will	111%	93%	141%	106%				96%		101%
Lake IN	103%								96%	96%
Total	102%	98%	100%	95%	98%	98%	89%	99%	94%	100%

The model compares favorably with the census table for most county interchanges. Intra-county trips, the main diagonal in the trip table, are reasonably close except for Kendall County. The larger differences tend to be associated with the far collar counties, and these may partly be due to boundary problems in the model process. There is also some slight underestimation of productions and attractions in the collar counties and overestimation in Cook County.

6 MODE CHOICE

The CMAP mode choice model uses two sophisticated analysis techniques, the logit model and the Monte Carlo simulation model. Each of these techniques will be described in this

section. The mode choice model equation is of the logit form. A Monte Carlo simulation of central area parking costs, transit access times, and traveler's income is used to provide some of the input to the logit equation. The Monte Carlo simulation decreases the aggregation error found in most other urban mode choice models. The mode choice model generates the estimated transit and highway trips originating from each of the analysis areas and destined to each of these areas. The mode choice model is applied to the person trips resulting from the trip distribution model, and divides the 3 distributed person trip tables into six modal person trip tables: home based work auto mode, home based work transit mode, home based other auto mode, home based work transit mode, nonhome based auto mode and nonhome based transit mode.

6.1 MODE CHOICE MODEL LOGIT STRUCTURE

The multinomial logit formulation is the most commonly used model form for mode choice models in the United States. The multinomial logit model is expressed mathematically as follows:

$$P_{g,i} = \frac{\exp[U_{g,i}(x_{g,i})]}{\sum_{g,m} \exp[U_{g,m}(x_{g,m})]}$$

where

$P_{g,i}$	is the probability of a traveler from group g choosing mode i,
$x_{g,m}$	are the attributes of mode i that describe its attractiveness to group g,
$U_{g,m}(x_{g,m})$	is the utility of mode m for travelers in group g, and
$\Sigma_{g,m}$	indicates the summation of utilities over all available alternatives
exp( )	is the exponential function

Typically, the utility function for each alternative takes the form:
$U_{g,m}(x_{g,m}) = a_m + b_m LOS_m + c_{g,m} SE_g + d_m TRIP$
where

LOS_m	represents the variables describing levels-of-service provided by mode m,
SE_g	represents the variables describing socioeconomic characteristics of group g,
$TRIP$	represents the variables describing characteristics of the trip (e.g., CBD trips)
b_m	is a vector of coefficients describing the importance of LOS_m variables,
$c_{g,m}$	is a vector of coefficients describing the importance of each $SE_{g,m}$ characteristic of group g with respect to mode m,
d_m	is a vector or coefficient describing the importance of each trip characteristic with respect to mode m, and
a_m	is a constant specific to mode m that captures the overall effect of any variables missing from the expression (comfort, safety, and so forth).

6.2 TRIP PURPOSES AND CHOICE SETS

The Chicago regional mode choice models are applied for three trip purposes:

1. Home Based Work: Trips made between a traveler's home and his place of work;

2. Home Based Non-Work: The trips made between home and all non-work locations (shopping and other); and

3. Non-Home Based: Trips that neither begin nor end at the traveler's home.

The mode choice models begin with person trips from the distribution model. These person trips are all trips made by any "motorized" mode, that is by transit, or as an automobile driver or passenger. The logit formulation is then used to separate the person trips into transit trips and highway person trips. The home based work model is also stratified by location at the destination (work) end of the trip. This stratification is between Central Business District zones (CBD destinations) and non-Central Business District zones (non-CBD destinations).

6.3 MODEL VARIABLES AND COEFFICIENTS

Table 6.1 presents the coefficients used in the logit model. All cost values used in the model are in 1970 dollars. There are separate coefficients on the different components of transportation system time and costs. The components of the transportation system which are used in the mode choice model are:

1. In-vehicle time: The time spent in the vehicle for a trip. This can be either automobile in-vehicle time or transit in-vehicle time. For transit trips that include auto access to a service, the auto access and transit in vehicle times are combined.

2. Walk time: The time spent walking to and from the transit service, and the time spent walking from a parking spot at the destination end to the final destination of the trip ends in the CBD.

3. Initial wait time: The wait time for the initial transit vehicle. This is one-half the headway of the first transit line the person uses. This variable is only used for transit travel.

4. Transfer time: This is the time a person would spend transferring between transit routes.

5. Cost: This is the cost of making a trip. For the transit system this is the transit fare and station parking cost. For the highway system, this includes the cost of operating the highway vehicle and the cost of parking the automobile.

Model Formulation

The specific logit model formulation for the Chicago model is the binary model formulation that is a derivation of the general logit model formulation. This formulation is as follows:

$$P_t = \frac{e^{C_i V_i}}{1 + e^{C_i V_i}}$$

Where:

P_t is the probability that the trip will be a transit trip
C_i is the coefficient for variable i
V_i is the value of variable i for the movement being investigated

Table 6.1
Mode Choice Model and Coefficients

	Home Based Work Coefficients	
Variable	Non-CBD Destinations	CBD Destinations
In Vehicle Time	0.0186	0.0159
Initial Wait Time	0.0811	0.0173
Transfer Time	0.0399	0.0290
Walk Time	0.0584	0.0486
Cost	0.0072	0.0085
Transit Bias	-2.0000	-1.0000

	Home Based Other Coefficients	
Variable	Non-CBD Destinations	CBD Destinations
In Vehicle Time	0.0114	0.0159
Initial Wait Time	0.0610	0.0173
Transfer Time	0.0589	0.0290
Walk Time	0.0663	0.0486
Cost	0.0329	0.0085
Transit Bias	-1.9000	-1.0000

	Nonhome Based Coefficients	
Variable	Non-CBD Destinations	CBD Destinations
In Vehicle Time	0.0114	0.0159
Initial Wait Time	0.0610	0.0173
Transfer Time	0.0589	0.0290
Walk Time	0.0663	0.0486
Cost	0.0329	0.0085
Transit Bias	-2.0000	-1.0000

The coefficients for the logit model are reasonable and "correspond" to normal mode choice procedures. The ratio of the out-of-vehicle time coefficients to the in-vehicle time coefficient, for work trips, ranges from 1.09 for headways to the CBD, to 4.36 for the headways to non-CBD destinations. While the "classical" value for this ratio is 2.5, the variation in the Chicago model is logical and rational. The CBD destined trips are more sensitive to the in-vehicle travel time than the non-CBD destined trips and to transfer time. For CBD destined trips the walk time and the transfer time is more sensitive (the coefficients are higher) than the initial headway time, while for the non-CBD trips the reverse is true with the first headway being the most sensitive of all variables. For the non-work trips the ratio of out-of-vehicle time to in-vehicle time ranges from 5.17, for transfer time, to 5.82, for walk time. It is normal that non-

work trips "emphasize" out of vehicle time rather than in-vehicle time. Typically there is minor highway congestion during the time most non-work trips occur (non-peak periods) and the transit service levels, in terms of headways and coverage, tend to be worse during these times.

The implied value of time for work trips range from $1.12 for in-vehicle time to CBD destinations to $6.76 for headways to non-CBD destinations. The value of time for the in-vehicle times ($1.12 and $1.55) are very similar to other urban areas. For example the Los Angeles model has a value of time of $1.12, the Washington region's value of time is $2.08, and Seattle's value of time is $2.09. The value of time for the non-work model is much lower, ranging from twenty-one cents for in-vehicle time to $1.21 for walk time. The sharp decrease in value of time for non-work trips is typical of mode choice models. A summary of the value of time and the out-of-vehicle time to in-vehicle time ratios (OVT/IVT) for the models is shown below:

Value of time and OVT/IVT ratio for Work Trips with CBD destinations				
	In-vehicle time	headway time	transfer time	walk time
Value of time (dollars per hour)	$1.12	$1.22	$2.05	$3.30
OVT/IVT	N/A	1.09	1.82	2.94

Value of time and OVT/IVT ratio for Work Trips with Non-CBD destinations				
	In-vehicle time	headway time	transfer time	walk time
Value of time (dollars per hour)	$1.55	$6.76	$3.32	$4.87
OVT/IVT	N/A	4.36	2.15	3.14

Value of time and OVT/IVT ratio for Non-Work Trips				
	In-vehicle time	headway time	transfer time	walk time
Value of time (dollars per hour)	$0.21	$1.11	$1.07	$1.21
OVT/IVT	N/A	5.35	5.17	5.82

Table 6.2 presents examples of using the mode choice model for work trips. These examples are presented to illustrate the actual calculations used in the model. The examples also show that for a given set of travel times and costs, there will be a higher usage of transit to the CBD than to the other areas of the region. This is, again, a logical property of the mode choice model.

Table 6.2
Example Application of the Home Based Work Trip Model

Example using CBD coefficients					
Variable	Highway	Transit	Difference	Coefficient	diff.*coeff.
in-vehicle time	25	45	-20	0.0159	-0.3180
first headway	0	5	-5	0.0173	-0.0865
transfer time	0	10	-10	0.0290	-0.2900
walk time	5	7	-2	0.0468	-0.0936
cost	200	100	100	0.0085	0.8500
Modal Coefficient				-2.0000	-2.0000
Sum Difference of values times the coefficients					-1.9381
exp(equation)					.14398
1+ exp(equation)					1.14398
transit probability	(exp(equation)/ (1.0+exp(equation))				.12586

Example using non-CBD coefficients					
Variable	Highway	Transit	Difference	Coefficient	diff.*coeff.
in-vehicle time	25	45	-20	0.0186	-0.3720
first headway	0	5	-5	0.0811	-0.4055
transfer time	0	10	-10	0.0399	-0.3990
walk time	5	7	-2	0.0584	-0.1168
cost	200	100	100	0.0072	0.7200
Modal Coefficient				-1.0000	-1.0000
Sum Difference of values times the coefficients					-1.5733
exp(equation)					0.2074
1+ exp(equation)					1.2074
transit probability	(exp(equation)/ (1.0+exp(equation))				0.1717

6.4 MONTE CARLO SIMULATION

A major source of the inaccuracy of mode choice models is the use of average values such as the average cost of parking in a traffic analysis zone or the average income of the traveler. The CMAP travel demand analysts recognized this potential source for inaccuracy very early, perhaps before anyone else was aware of the problems that could be generated by the use of average values. The solution the CMAP analysts devised was to identify the major areas which are affected by average values and to use a method which would "convert" the average values into individual values. This methodology is called a Monte Carlo simulation technique and, after the Chicago application, the technique was also used in the Dallas-Fort Worth region and the Cleveland region.

A Monte Carlo simulation focuses on selecting a representative value for a measure with this value being selected at random from a distribution of values for the measure. For example if there were six parking garages in an area with each lot having the following characteristics:

> Parking Lot A: 150 spaces with a cost of $3.50 a day
> Parking Lot B: 175 spaces with a cost of $3.75 day
> Parking Lot C: 275 spaces with a cost of $3.25 a day
> Parking Lot D: 75 spaces with a cost of $1.25 day
> Parking Lot E: 150 spaces with a cost of $3.50 a day
> Parking Lot F: 175 spaces with a cost of $3.25 day

In this case the average parking cost, for the 1000 spaces, is $3.26. But a few "lucky" people (seven and one-half percent) could park for $1.25 and some "unfortunate" people (seventeen and a half percent) have to pay $3.75. The difference between the average cost and the low cost is $2.00 while the difference between the average cost and the high cost is 50 cents. These differences are substantial given that a major determinant of mode usage is the cost of using the mode. In a Monte Carlo simulation a specific parking lot would be "picked" at random. The probability of being "picked" would be a function of a relative parameter, in this case the number of spaces. Therefore in approximately seven percent of the "picks" the inexpensive lot would be selected while in eighteen percent of the picks the most expensive lot would be picked.

In the Chicago mode choice model the Monte Carlo simulation technique is used to: (1) estimate the access attributes of the main transit network; (2) estimate the egress attributes from the main transit network; (3) estimate the traveler's annual income; (4) estimate the parking costs and the walk from the parking lot to the person's final destination; and (5) estimate the final selection of the mode used by the traveler. The access and egress attributes are estimated when

the trip is made on a subway, elevated or commuter rail mode. These attributes include the mode access used, such as walking, feeder bus, drive or be driven to the station. The attributes also include the time spent walking, driving, riding in the bus and waiting for the bus (if the access/egress mode is feeder bus) and the cost of using the access mode including the cost of parking at the stations. The access/egress attributes are estimated given the number of bus miles in the analysis area (traffic analysis zone), the size of the analysis area, the distance to the rail station, the cost of parking at the rail station, and the type of area.

The income of the traveler is estimated using the average income of the traveler's home area. The parking cost and walk time is estimated given a range of parking costs and spaces for each analysis area in the central business district. This procedure incorporates an estimate of the percent of "free spaces" available by income level. The quantity of CBD parking by price was updated in 1999.

Since the Monte Carlo simulation is applied using random probabilities to obtain specific values of time and cost rather than average values, the procedure must be applied several times to obtain stable and accurate results. For example, mode choice procedures were applied for each estimated person trip. If the distribution model estimated that 50 trips would be made from zone A to zone B, the mode choice model would be applied 50 times for this interchange, one per trip, and the resulting probabilities would be applied to each of the 50 trips. The Monte Carlo technique was also used to make the final mode choice estimate. The mode choice model estimates the probability that a trip would be a transit trip. This probability is then used with a Monte Carlo technique to estimate if the trip is a transit trip. For example if the mode choice model estimates that the probability of a trip being a transit trip is 0.25 then when the random number, generated by the Monte Carol technique was less than 0.26 the trip would be considered a transit trip, otherwise the trip would be considered a highway trip. Since there are approximately 17 million person trips in 1990, this results in a very large set of multiple applications.

This use of multiple applications is illustrated below:

Percent Transit (y-axis), Iterations of Monte Carlo Applications (x-axis)
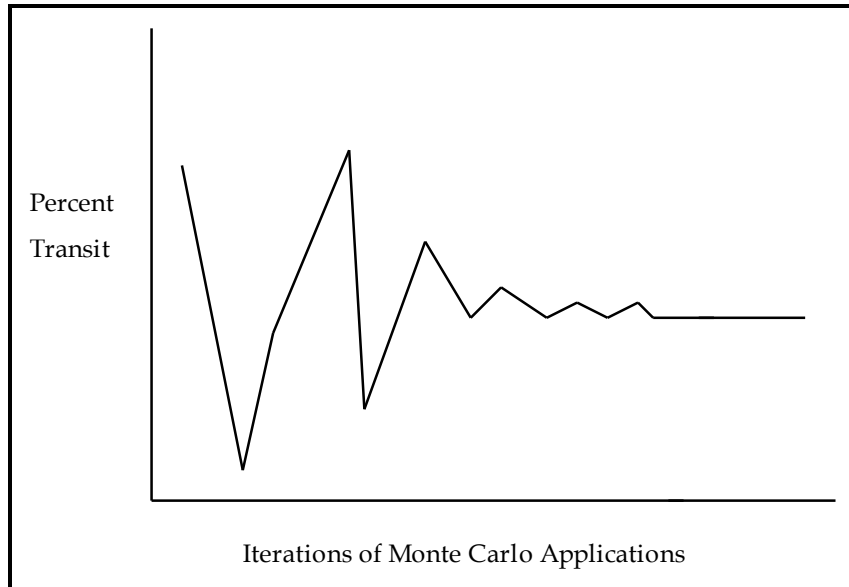
7 TRUCK TRIPS

CMAP models truck trips for 4 truck vehicle classes: B-plate, light trucks, medium trucks and heavy trucks. The geography of this process is the larger traffic analysis zones (aggregations of trip generation zones), not trip generation zones. (See section 5, Trip Distribution, for a description of the traffic analysis zone system).

B-plate trucks are vans and pickup trucks with performance characteristics similar to passenger cars and carrying "B" license plates. Light trucks are "step vans" and smaller delivery vans which carry weight plates D-J and MD-MJ. Medium trucks are heavy fixed wheelbase trucks such as concrete mixers, scavenger trucks, double rear axle refrigerator units, etc, and some other lighter weight articulated vehicles carrying weight plates K-T and MK-MT. Finally, heavy trucks comprise 73,280 and 80,000 lb maximum load vehicles which are tractor-trailer combinations. These carry weight plates of V-Z.

To create truck trip productions and attractions by traffic analysis zone, base year trip totals were estimated by reviewing vehicle registration files for the appropriate classes of trucks. For future years, the base year figures were factored up using the growth rates shown in the table, to represent natural truck traffic growth. Table 7.1 presents the trip totals by vehicle class.

Table 7.1 Truck Trip Totals by Vehicle Class

Truck Type	Base Year 2000 Total	(Growth Factors) & Future Year Trip Productions		
		2010 (base * 1.1)	2020 (base * 1.2)	2030 (base * 1.3)
B-Plate	1,530,000	1,683,000	1,836,000	1,989,000
Light Trucks	430,000	473,000	516,000	559,000
Medium Trucks	350,000	385,000	420,000	455,000
Heavy Trucks	109,000	120,000	131,000	141,000

Once the total number of trucks per class was determined, the trips were allocated to production and attraction zones based on development patterns. The measure of development was represented by non-home based trip productions, used because they are most closely related to total development with an emphasis on employment density. The process is a simple allocation of trips to zones based on the zonal share of the total regional development. The distribution of trips is then created based on a trip length distribution of distances ranging from 10 to 13 miles rather than by congested travel time. The method was validated by applying the regional model and comparing the assigned truck volumes to observed truck counts on the road.

Vehicles and Vehicle Equivalents

The size and operating characteristics of truck vehicles require them to be treated differently from auto vehicles. During the assignment process, truck vehicles are converted to vehicle equivalents using these factors: b-plate and light trucks are one 1 vehicle equivalent, medium trucks are 2 vehicle equivalents, and heavy trucks are 3 vehicle equivalents.

8 POINT OF ENTRY TRIPS

Points of entry trips represent three categories of travel; auto travel entering the region on major expressways, heavy truck travel entering the region on major expressways, and travel to and from the region's airports. Point of entry locations are external zones, not modeled in the same way as the rest of the region's travel because we have little knowledge about the traveler, trip purpose, or destination. We rely only on observed counts at the locations in question and some assumptions about the travel behavior of the trip maker, including an assumption that external travelers are indifferent about the actual trip length within the region (i.e. their destination is fixed).

Point of Entry Productions and Attractions

Highway point of entry base year trip production totals are derived from expressway traffic counts at locations around the region. Airport base year point of entry trips were based on an analysis of observed enplanements. To create future productions and attractions, the base

year total number of trips is factored up using the growth rates shown in the table. The trip totals are presented in table 8.1.

Table 8.1 Total Point of Entry Productions

Trip Type	Base Year 2000 Total	(Growth Factors) & Future Year Trip Productions		
		2010 (base * 1.1)	2020 (base * 1.2)	2030 (base * 1.3)
Auto External	306,000	337,000	367,000	398,000
Truck External	131,000	144,000	157,000	170,000
Air Traveler	61,000	67,000	73,000	79,000

8.1 Distribution of Point of Entry Trips

All point of entry trips are treated at the same time using a gravity model. To begin, an impedance file based on a gamma function was created. To accomplish this, a destination vector of non-work trip attractions plus a weighted number of point of entry trips was calculated. Again, this information was used as a measure of development density with an emphasis on employment density. The impedance matrix is proportional to the productions times the attractions and inversely proportional to the square of the midday travel distance (capped at 60 miles):

$$Impedance = \frac{(.0001 * (POE\ Productions * Destination\ Development))}{(60.max.travel\ distance)^2}$$

The impedance matrix was balanced using the original productions at the origin, and trip attractions apportioned to destinations based on zonal shares of non-work attractions and zonal point of entry totals as the attractions.

8.2 Apportionment of Point of Entry Trips to Auto, Truck and Air Passenger Trip Matrices

Until this point, all point of entry trips were treated in a group. However, the large trip table must be divided into its components to be used in the rest of the modeling stream. Trips with origins at the expressway points of entry (zones 1945 – 1961) were extracted to a matrix which was summed with its transpose matrix. This represented the total external expressway daily trip table. For truck trips, a matrix containing 30% of these trips was created. Auto

expressway externals received the other 70%. For airport trips, all trips with origins in the region were extracted to another matrix, also summed with its transpose matrix.

9 TIME OF DAY HIGHWAY ASSIGNMENT

The principal objective behind multiple time period highway assignments is to develop more accurate estimates of vehicle-miles by different speed ranges and vehicle classes for air quality conformity analyses. Separate assignments estimate highway vehicle-miles and travel speeds for eight time periods during the day: (1) the ten hour late evening-early morning off-peak period; (2) the shoulder hour preceding the AM peak hour; (3) the AM peak two hours; (4) the shoulder hour following the AM peak hour; (5) a five hour midday period; (6) the two hour shoulder period preceding the PM peak hour; (7) the PM peak two hours, and; (8) the two hour shoulder period following the PM peak hour. A recent improvement to this process is to iterate through the entire 4 step modeling process five times, with the period time of day assignment results being averaged through successive averaging (Method of Successive Averaging MSA). This results in a final volume for each period, and estimated AM peak and midday travel times which will be fed back into the rest of the modeling process.

After five passes through the time of day modeling process, the results of the separate MSA period assignments are accumulated into daily volumes, and also tabulated into the vehicle-mile by vehicle type by speed range tables needed for the vehicle emission calculations. The completion and summarizing of the eight time period assignments is highly simplified through the use of EMME$^®$ macros for repetitive sequences of control statements.

Figure 9.1 is a schematic diagram that shows the sequence of steps in the multiple time period assignment. The nine network scenarios are first assembled (eight time of day networks and a 9th to hold the sum of daily information). Although there are eight time periods modeled during the day, only three different highway networks are used, an AM peak period, a PM peak period and an off-peak period. The AM peak network is assigned in the pre AM peak, AM peak and post AM peak assignments, and the PM peak network in the three comparable PM periods. The night and midday periods are assigned onto the off-peak network.

The coding of the Kennedy Expressway reversible lanes is one example of how these networks differ. The reversible lanes are inbound in the AM and outbound in the PM network. They are not included in the off-peak network even though the lanes operate part of the night and midday time periods. Including a link that is available only during part of a time period can cause an over assignment of traffic on that link.

The current assignment macros includes ten daily trip tables, three auto driver/passenger tables by trip purpose, four truck trip tables by vehicle type, two external trip tables for autos and trucks, and a trip table of auto air passenger trips. The assignment macros can be modified to

accommodate different trip tables, either additional trip purposes if the trip distribution and mode choice models are revised or to include special trip tables for major developments.

The main macro starts the process by calling the macro for the first off-peak time period assignment. The appropriate network scenario is selected and the matrices used to store the off-peak period trip tables are initialized. The matrices are then filled with the off-peak trip tables factored from the daily trip tables. All period trip tables used for assignment are calculated on the fly. The slots used for the time period trip tables are reused, being overwritten by the trip tables from a subsequent period. Network link and node user variables are next initialized. Two macros to preprocess the network are then called by the assignment macro. The first one calculates uncongested link times and link capacities, the second estimates signal cycle lengths and green time to cycle length ratios for the j-node of arterial street and freeway to arterial ramp links.

For the first time period, the standard set of volume-delay functions are loaded, the scenario is prepared for assignment, and a full equilibrium assignment is completed. The logic of the process is slightly altered in subsequent periods. An initial set of volume-delay functions is loaded for the first all-or-nothing assignment. These volume-delay functions set link times to the final travel times of the previous time period to calculate the "initial solution." The scenario is then readied for the initial assignment. After the initial all-or-nothing assignment is completed, the standard set of volume-delay functions is reloaded. The assignment is then readied for additional iterations and the remaining equilibrium assignment iterations completed.

Figure 9.1 Multiple Time Period

Highway Assignment

Time of Day Assignment Process

Daily Trip Tables
- Purpose
- Vehicle Class

Create Network Scenarios
- Eight Time Periods
- Daily (Accumulated)

Select Time PeriodScenario (period *t)*

| Estimate Uncongested Times and Lane Capacities | Estimate Signal Cycle Lengths and Green/Cycle Ratios | Factor Trip Tables for Period *t* |

Period 1

Volume Delay Functions → *Assignment*

Periods 2-8

Assignment Initial Solution ← Previous Period Link Times

Assignment Remaining Iterations ← Volume Delay Functions

Calculate
Method of Successive Averages (MSA)
Vehicle Class Link Volumes
and Travel Times

5 Iterations

Emission Calculations

The procedure repeats through the remaining time periods. When the eight time periods are completed, the link volumes and travel times are successively averaged with the same time periods from previous iterations. This occurs for iterations $1 - 4$, since iteration 0 has no previous iteration to be averaged with. The result is a set of eight modeled scenarios representing each time period and containing the final MSA volumes and speeds. From this information, other macros generate the tables needed as input to the emission calculations: vehicle-miles are tabulated into one mile per hour speed ranges for six vehicle types.

9.1 ASSIGNMENT TIME PERIODS

The travel data that led to selecting the eight time periods is illustrated in Figure 9.2. This is a plot of the auto driver and auto passenger trips in motion reported in CATS' 1990 household travel survey. Trips were accumulated at the end of ninety-six fifteen minute periods throughout the day. The plot shows a moving average of these accumulated trips calculated over four consecutive fifteen minute periods. The moving average smoothes out the irregularities in the plot caused by the tendency of surveyed travelers to report trip start and completion times to the nearest quarter-hour or half-hour.

Figure 9.2 Time Distribution of Auto Driver and Passenger Trips
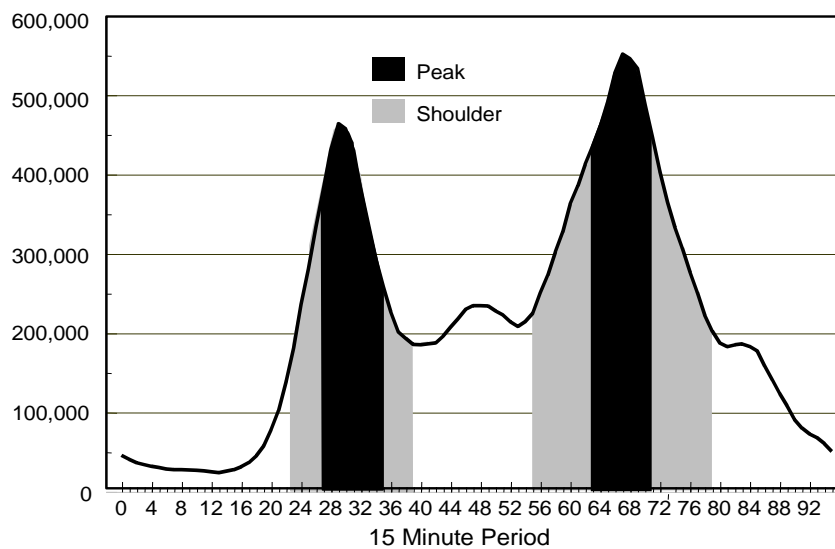
The plot shows the distinct peaking of auto travel during the morning and evening peak periods. The large number of trips in motion during peak travel periods is due not only to increased trip making during these time periods. Peak period auto trips also stay in motion longer because they are more likely to be lengthy work trips subjected to slower congested peak period travel speeds.

The Figure 9.2 plot is not symmetric because the evening peak period is longer and slightly worse than the morning peak. The two peak periods are separated by a midday period that has a fairly uniform number of trips in motion, except for a bulge in trip making around the noon lunch period. Trips in motion plateau between 8:00 PM and 9:00 PM after the evening peak period, and then quickly decline during the off-peak period.

The two assignment peak periods are defined differently because of these auto travel characteristics. The shading under the Figure 9.2 curve shows the peak and shoulder periods used in the multiple time period assignments. A two hour AM peak (7:00 AM to 9:00 AM) and

two one hour AM peak shoulder periods (6:00 AM to 7:00 AM and 9:00 AM to 10:00 AM) effectively cover the morning peak period. Six hours are needed to capture the evening peak period, a two hour PM peak (4:00 PM to 6:00 PM) plus two hour PM peak shoulder periods on either side of the PM peak (2:00 PM to 4:00 PM and 6:00 PM to 8:00 PM). This leaves a nearly uniform four hour midday period between the two peaks (10:00 AM to 2:00 PM), and an off-peak period (8:00 PM to 6:00 AM) covering the late evening and early morning hours.

9.2 TRIP TABLE FACTORS

Factors to allocate daily auto person trip tables into the eight time period trip tables were also derived from the CATS' 1990 household travel survey. Expanded survey auto driver and auto passenger trips were allocated to time periods by their start and completion times. Trips spanning two or more periods are apportioned to the separate periods according to time spent traveling in each period. For example, a survey trip with an expansion factor of 100 that spends thirty percent of its time in one time period and seventy percent of its time in a second period would have thirty trips allocated to the first period and seventy to the second period.

Table 9.1 lists the factors to create the eight time period trip tables from daily auto driver and auto passenger trip tables. Separate factors apply to central area work trips, destinations within the area bordered by Lake Michigan, Chicago Avenue, Halsted Avenue and Roosevelt Road. Adding together the home-work and home-other fractions does not total one because the trip tables are in home production and non-home attraction format (production/attraction format). The factors sum to the proportion of trips from home and to home. Fractions for non-home/work trips do sum to one, since this trip table is by trip direction.

Daily auto driver and auto passenger trip tables (that include auto access to transit trips) from full model iteration are multiplied by the Table 9.1 factors to obtain auto person trip matrices (driver or passenger) for the eight time periods. They are then divided by the auto occupancies in Table 9.2 to produce the auto vehicle trip tables that are assigned.

Table 9.1. Time Period Trip Table Factors for Auto Driver/Passenger Trips

Auto Person Trip Table	Off Peak (8:00 PM to 6:00 AM)	Pre AM Peak (6:00 AM to 7:00 AM)	AM Peak (7:00 AM to 9:00 AM)	Post AM Peak (9:00 AM to 10:00 AM)	Midday (10:00 AM to 2:00 PM)	Pre PM Peak (2:00 PM to 4:00 PM)	PM Peak (4:00 PM to 6:00 PM)	Post PM Peak (6:00 PM to 8:00 PM)
Home to Work								
To CBD Work	0.064	0.088	0.287	0.034	0.036	0.017	0.003	0.008
To Non-CBD Work	0.050	0.098	0.261	0.028	0.044	0.026	0.018	0.009
From CBD Work	0.085	0.000	0.003	0.003	0.017	0.056	0.195	0.104
From Non-CBD Work	0.070	0.000	0.003	0.002	0.034	0.083	0.208	0.064
To Airport Work	0.131	0.072	0.138	0.040	0.077	0.074	0.012	0.009
From Airport Work	0.147	0.025	0.019	0.001	0.042	0.103	0.091	0.042
Home to Non-Work								
From Home	0.024	0.009	0.071	0.044	0.114	0.042	0.060	0.107
To Home	0.147	0.001	0.010	0.012	0.111	0.080	0.077	0.090
Non-Home/Work								
All Trips	0.057	0.004	0.041	0.055	0.436	0.163	0.147	0.097

Table 9.2 Time Period Auto Occupancies

Auto Person Trip Table	Off Peak (8:00 PM to 6:00 AM)	Pre AM Peak (6:00 AM to 7:00 AM)	AM Peak (7:00 AM to 9:00 AM)	Post AM Peak (9:00 AM to 10:00 AM)	Midday (10:00 AM to 2:00 PM)	Pre PM Peak (2:00 PM to 4:00 PM)	PM Peak (4:00 PM to 6:00 PM)	Post PM Peak (6:00 PM to 8:00 PM)
Home to Work								
To CBD Work	1.09	1.21	1.24	1.27	1.35	1.10	1.23	1.06
To Non-CBD Work	1.11	1.10	1.07	1.07	1.07	1.10	1.14	1.14
From CBD Work	1.13	1.14	1.14	1.00	1.04	1.07	1.21	1.09
From Non-CBD Work	1.15	1.32	1.21	1.04	1.07	1.09	1.09	1.08
Home to Non-Work								
From Home	1.24	1.39	1.77	1.28	1.24	1.20	1.30	1.33
To Home	1.32	1.10	1.09	1.13	1.22	1.34	1.26	1.27
Non-Home/Work								
All Trips	1.34	1.16	1.17	1.10	1.17	1.15	1.15	1.28

Factors for external auto trips (point of entry) and auto air passenger trips are listed in Table 9.3. External auto trip factors are based upon the distribution of auto driver trips for all purposes in the survey, since there is no other suitable data on the time distribution of external travel.

Table 9.3 Time Period Trip Table Factors for Miscellaneous Auto Trips

Vehicle Trip Table	Off Peak (8:00 PM to 6:00 AM)	Pre AM Peak (6:00 AM to 7:00 AM)	AM Peak (7:00 AM to 9:00 AM)	Post AM Peak (9:00 AM to 10:00 AM)	Midday (10:00 AM to 2:00 PM)	Pre PM Peak (2:00 PM to 4:00 PM)	PM Peak (4:00 PM to 6:00 PM)	Post PM Peak (6:00 PM to 8:00 PM)
External								
To and From Region	0.121	0.040	0.140	0.049	0.224	0.129	0.172	0.126
Airports								
To Terminal	0.163	0.069	0.130	0.050	0.227	0.137	0.114	0.111
To Non Terminal	0.245	0.134	0.258	0.043	0.144	0.139	0.023	0.016
From Terminal	0.157	0.073	0.136	0.051	0.216	0.135	0.134	0.096
From Non Terminal	0.302	0.054	0.040	0.003	0.091	0.222	0.196	0.090

The last set of trip table factors for trucks is listed in Table 9.4. These were determined from the 1986 CATS' commercial vehicle survey. Factors for external truck trips are regional factors based upon the vehicle equivalent weighted total truck trip table.

Table 9.4 Time Period Trip Table Factors for Truck Trips in Vehicle Equivalents

Truck Trip Table	Off Peak (8:00 PM to 6:00 AM)	Pre AM Peak (6:00 AM to 7:00 AM)	AM Peak (7:00 AM to 9:00 AM)	Post AM Peak (9:00 AM to 10:00 AM)	Midday (10:00 AM to 2:00 PM)	Pre PM Peak (2:00 PM to 4:00 PM)	PM Peak (4:00 PM to 6:00 PM)	Post PM Peak (6:00 PM to 8:00 PM)
Truck Classes								
B Plate	0.022	0.026	0.144	0.115	0.358	0.229	0.094	0.012
Light	0.024	0.057	0.422	0.089	0.214	0.141	0.040	0.013
Medium	0.069	0.036	0.166	0.140	0.421	0.108	0.038	0.022
Heavy	0.210	0.039	0.135	0.082	0.315	0.104	0.071	0.043
External								
To and From Region	0.057	0.034	0.187	0.110	0.340	0.180	0.074	0.018

Table 9.5 lists the truck and auto trips in each period's trip table for the base year when the model was calibrated. Trucks are tabulated in vehicle equivalents, using these factors: b-plate and light trucks are 1 vehicle equivalent, medium trucks are two vehicle equivalents, and heavy trucks are 3 vehicle equivalents. As previously noted, auto and truck trip tables are assigned separately in a multiple vehicle class EMME® assignment, although both trip tables have to be in vehicle equivalents, and there is no single combined vehicle equivalent trip table. The relative importance of trips in the period trip tables is difficult to compare in Table 9.5 because the time periods cover different lengths of time.

Table 9.5 Calibration Year Auto and Truck (Vehicle Equivalents) by Time Period

Trip Table	Off Peak (8:00 PM to 6:00 AM)	Pre AM Peak (6:00 AM to 7:00 AM)	AM Peak (7:00 AM to 9:00 AM)	Post AM Peak (9:00 AM to 10:00 AM)	Midday (10:00 AM to 2:00 PM)	Pre PM Peak (2:00 PM to 4:00 PM)	PM Peak (4:00 PM to 6:00 PM)	Post PM Peak (6:00 PM to 8:00 PM)
Truck	126,574	73,290	404,937	229,775	709,353	372,159	154,243	39,452
Auto	1,595,114	486,823	1,704,014	653,981	3,070,325	1,683,091	2,208,415	1,675,629
Total	1,721,688	560,113	2,108,951	883,756	3,779,678	2,055,250	2,362,758	1,715,081

To make it easier to compare these time period trip tables, the Table 9.5 figures have been converted into trips per hour and plotted in Figure 9.3. This figure shows the trips in the truck and auto trip tables per hour and the total trips in the two trip tables per hour.

Perhaps the most striking feature of this graph is the different peaking characteristics of truck and auto trips. Truck travel does not exhibit the twice a day peaking associated with person travel. Truck trips build up in the morning peak and then continue throughout the day until declining before the evening peak. This daily truck trip pattern is caused by the more uniform schedule of goods pickups and deliveries during a typical work day. One effect of the different auto and truck peaking characteristics is to lengthen the AM peak period. The AM peak and post AM peak shoulder hours have nearly the same number of vehicle trips, although trucks account for a larger portion of the post AM peak shoulder traffic. The peaking characteristics of truck trips increase midday traffic between the morning and evening peak

Figure 9.3 Relative Sizes of Time Period Trip Tables
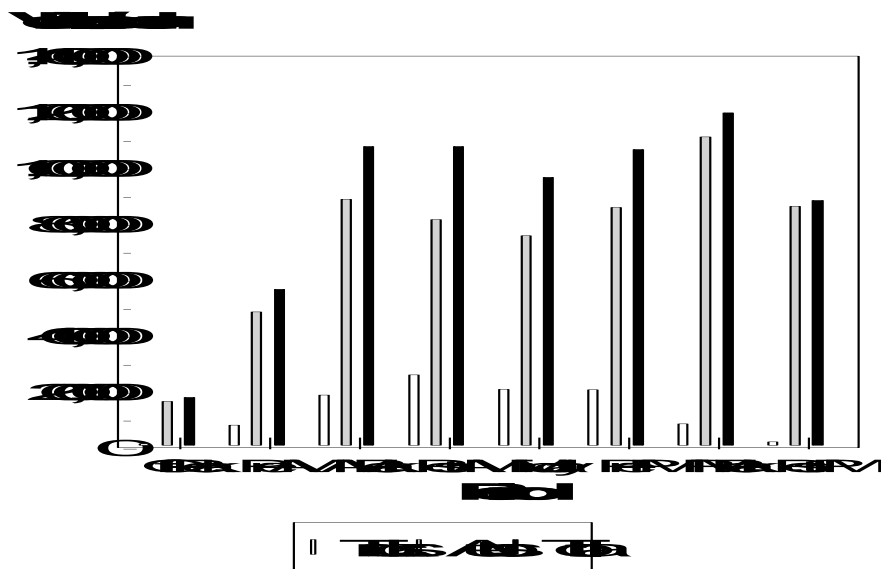
periods, which reduces the prominence of the two peak periods for total vehicle trips.

9.3 VOLUME-DELAY FUNCTIONS

The volume-delay functions have been revised for several reasons. Signal characteristics have been introduced into the volume-delay functions for links that end at signalized intersections. This means that assignments are now sensitive to signal characteristics and can

reflect major signal modernization programs. In addition to more accurately representing the characteristics of the network, these signal sensitive volume-delay functions allow the emission reductions from signal improvements to be evaluated.

The second reason for changing the volume-delay functions is because of the previous functions' limitations when they are used for time period assignments. Their most severe limitation is that freeways and expressways tend to be over assigned in the congested peak time periods. Several factors contribute to this peak period over assignment of freeways including: (1) an unrealistic initial peak period assignment since paths are built using uncongested travel times; (2) the inability to model bottlenecks in the freeway network that occur during peak periods, and; (3) not restricting freeway on-ramps whose peak period capacities are controlled by metering. The approach taken was to alter the volume-delay functions for freeways, expressway and metered freeway entrance ramps so that travel times increase far more quickly after capacity is reached. The capacities of metered on-ramps are also set to maximum metered flow rates.

Volume-Delay Functions for Links Ending at Signalized Intersections (vdf1 and vdf3)

Intersection delays in the volume-delay functions are based upon the Webster equation.[6] In this equation, intersection delay has uniform and incremental components, and both are fairly complicated to calculate. For the volume-delay functions, simpler regression equations were fit to calculated uniform and incremental delays for a range of signal cycle lengths and green time to cycle length ratios.

The regression equations for uniform and incremental signal delays are combined with link travel time estimates in the first (arterial) and third (freeway exit ramp to arterial) volume-delay functions as follows:

1. Link travel time between intersections is:

$$T_{link} = T_0 * \left(1 + 0.15 * \left(\frac{volau}{capacity}\right)^4\right).$$

This is the widely used BPR function where T_{link} equals the link's travel time without any intersection delay and T_0 is the uncongested link travel time without intersection delay. The uncongested link travel time is computed using the maximum speed permitted on the link. Quantity *volau* is the link's traffic volume for the time period

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[6] F. V. Webster and B. M. Cobbe. *Traffic Signals*. Road Research Laboratory, Ministry of Transport Road Research, Technical Paper No. 56, 1966.

in auto equivalents. Capacity represented within the link travel time function is approximately the service volume at level of service C. It is calculated as 75 percent of the level of service E time period link capacity. Note that link capacity is calculated by multiplying the hourly lane capacity by the number of lanes and the number of hours in the assignment time period.

2. Uniform intersection delay equals:

$$D_u = 6.0*\left(\frac{volau}{capacity}\right) - 0.39*green + 0.35*cycle - 4.5.$$

Where D_u is the average uniform intersection delay at the link's j-node in seconds. *Green* is the green time allowed the link at the j-node intersection and *cycle* is the cycle length at the intersection. Both quantities are in seconds. The uniform delay is restricted to positive values in the volume-delay functions.

3. Incremental delay at intersections equals:

$$D_i = 2.7*\left(\frac{volau}{capacity}\right)^8 - 7.3*\left(\frac{green}{cycle}\right) + 3.4.$$

Where D_i is the average incremental intersection delay at the link's j-node in seconds. Incremental delay is also restricted to positive values in the volume-delay functions.

Figure 9.4 Example Volume-Delay Function for Two Arterial Links

Minor Arterial Link

> Green Time = 30 Sec.
> Cycle Length = 90 Sec.

Major Arterial Link

> Green Time = 90 Sec.
> Cycle Length = 120 Sec.
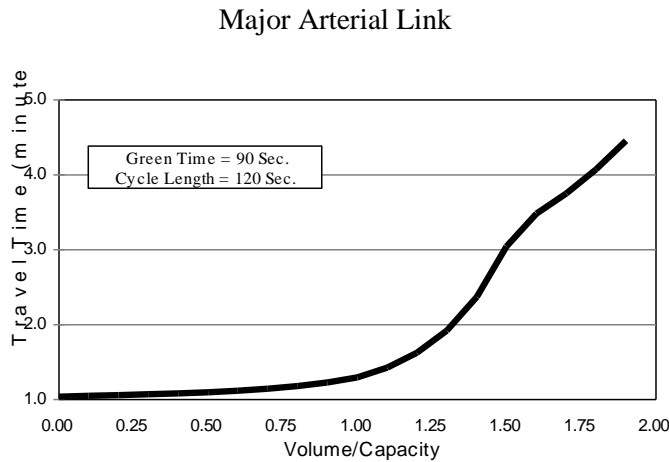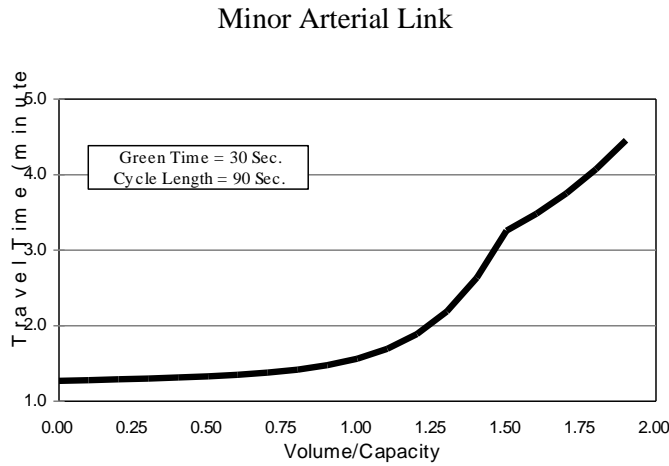
Figure 9.4 shows the volume-delay functions with intersection delay for two links. The top graph is for a minor arterial street with an uncongested travel time of one minute between intersections. Cycle length at the j-node is ninety seconds, and the link receives thirty seconds of green time in the cycle.

The bottom graph is for a major arterial street link, which also has an uncongested travel time of one minute between intersections. Cycle length at the downstream node is 120 seconds and the link is allowed ninety seconds of green time.

The major arterial link is allowed more green time at the j-node than the minor link and intersection delays on the major link are less than on the minor link at the same link volume to capacity ratios. Both volume-delay relationships have a kink in them because the maximum combined uniform and incremental intersection delay is limited to one cycle length.

Volume-Delay Functions for Freeways and Expressways (vdf2, vdf4 and vdf5)

The second (freeway), fourth (expressway) and fifth (freeway-freeway ramps) volume-delay functions were adjusted to increase the travel times for volume to capacity ratios greater than one. At the same time, uncongested link travel times on freeway and expressway links were

reduced fifteen percent to reflect drivers' tendency to exceed speed limits on high type facilities at low traffic volumes. The quantity T_0 is again determined by the maximum legal speed.

These adjustments were made to the basic BPR volume-delay relationship, as follows:

$$T_{link} = \frac{T_0}{1.15} * \left(1 + 0.15 * \left(\frac{volau}{capacity}\right)\right) * \left(1 + 0.15 * \left(\frac{volau}{capacity}\right)^8\right), \text{ for } \left(\frac{volau}{capacity}\right) \le 1.$$

$$T_{link} = T_0 * \left(1 + 0.15 * \left(\frac{volau}{capacity}\right)^8\right), \text{ for } \left(\frac{volau}{capacity}\right) > 1.$$

Figure 9.5 Revised BPR Volume-Delay Function for Freeway/Expressway Links
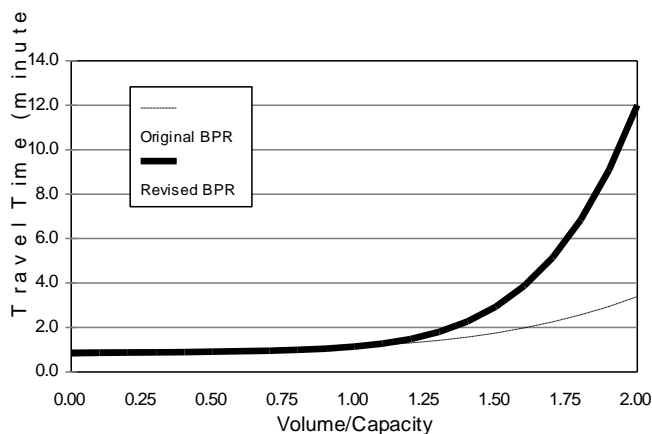
Figure 9.5 compares the revised BPR volume-delay function with the original BPR function for a one mile link with a maximum speed of 60 miles per hour. At a volume to capacity ratio of one, both functions predict the same link travel times. At lower volume to capacity ratios, the revised function's travel time is slightly less than the original function due to the lower initial uncongested travel time. For volume to capacity ratios greater than one, the travel time predicted by the revised function is higher and rapidly increases because the volume to capacity ratio is exponentiated to a higher power.

Volume-Delay Function for Metered Freeway Entrance Ramps (vdf8)

For metered freeway entrance ramps, the original BPR function is revised so that travel time greatly increases when the link volume exceeds the maximum metered flow rate. This effectively restricts the ramp's volume to the metered flow rate. The adjusted BPR function is:

$$T_{link} = T_0 * \left(1 + 0.15 * \left(\frac{volau}{metered\ flow}\right)^{10}\right).$$

The maximum metered flow rate is taken as 720 vehicles per hour per lane, or an average vehicle delay at the ramp metering signal of five seconds.

Volume-Delay Function for Links with Tolls (vdf7)

After the volume delay functions were originally developed, the Illinois State Toll Highway Authority implemented electronic tolling along its entire system (completed in 2006). Open road tolling is available at the mainline plazas, and no-stop tolling is available at ramp tollbooths. In 2009, the first all-electronic ramp plaza opened at Eola Road on the Reagan Memorial Tollway (I-88). At most locations, cash booths are available for those without toll transponders. Prices for trucks versus automobiles and for vehicles with transponders and without transponders differ. The difficulty of representing this complicated scheme led to removing the impact of tolls from the volume delay functions altogether. This is being addressed now as CMAP undertakes the development of a more advanced travel modeling system using a new household travel inventory.

9.4 ASSIGNMENT ITERATIONS

Table 9.6 shows the number of equilibrium assignment iterations by time period for the base 1990 and 2030 assignments. The congested peak periods require more equilibrium assignment iterations than the lesser congested time periods to reach the same level of closure. For the highway assignment runs discussed in this section, average zone to zone path times and average link travel times are within at least one half minute of one another, except for the AM peak period assignment, which terminates at twenty-five iterations with the two times less than a minute apart. Average path and link times are equal when network equilibrium is achieved.

Table 9.6 Assignment Iterations Required for Convergence

Time Period	Calibration Year Base 1990	Conformity 2010 2030
1: 8 pm – 6 am	3	6
2: 6am-7am	8	8
3: 7am-9am	25	21
4: 9am to 10 am	7	19
5: 10 am – 2 pm	5	10
6: 2 pm – 4 pm	7	13
7: 4 – 6 pm	15	24
8: 6 – 8 pm	6	8
Total	76	109

The time period assignments provide a more detailed and accurate picture of congestion effects in the highway network, which is advantageous for several reasons. While daily estimated traffic volumes may just be marginally improved compared to volumes produced by average daily assignments, estimates of network speeds are substantially improved and regional

vehicle-miles of travel agree more closely with state estimates of daily vehicle-miles. Since congestion is more correctly modeled, impacts from proposed highway improvements that reduce congestion are also more accurately reproduced by the time period assignments.

9.5 LINK SPEEDS

Traffic volume for each link for each time period of the day is one product of the time of day network assignment. The speed of travel for each link is calculated by an equation that uses the volume-capacity ratio for the link as the independent variable. The following equations are used to produce the final link speed:

For freeways:

$$S = S_0 \frac{1}{1 + .15\,(V/C)} \quad \text{x} \quad \frac{1}{1 + .15\,(V/C)^8} \qquad \text{for } V/C \leq 1$$

$$S = S_0 \frac{1}{1 + .15\,(V/C)^8} \qquad \text{for } V/C > 1$$

For arterials:

$$S = S_0 \frac{1}{(1n(S_0) * .249) + .153\,(V/(C * .75))^{3.98}}$$

Where S = Speed on link used for emission calculation
S_0 = Initial Speed on link

V/C = Volume-Capacity ratio for the link

These curves represent modifications to the Bureau of Public Roads (BPR) curves that have been used at CMAP and other agencies for many years. Consistent with a national trend for agencies to use modified curves based on local data, these curves are based on the information gathered from local empirical data. The freeway curve is the same as used in the volume delay functions in the time of day assignment iterations. The arterial curve is slightly modified to better correlate with the empirical data. The data used to develop the modification is from IDOT's traffic sensor system for the expressway system as well as CATS conducted speed runs for the arterial system. This data base is documented in CATS Working Paper 95-09, Travel Time Database and Structure Chicago Area Expressway System, September 1995, and CATS Working Paper 97-09, 1994, 1995 and 1996 Combined Travel Time Database Documentation: Arterial Highway System, July 1997. The methodology for the curve development is presented in CATS

Working Paper 97-12, Method for Adjusting Modeled Speeds Based on Empirical Speed Data, August 1997.

Figure 9.7 presents a comparison of the CMAP arterial V/C versus speed curve and the BPR curve for two initial speeds. As can be seen, the curves are similar for an initial speed of 55 mph. For the initial speed of 30 mph., the curves are similar for V/C ratios above one. For lower V/C ratios, the CMAP curve has higher speeds than the BPR curve consistent with observed data.

FIGURE 9.7 CMAP (CATS) TO BPR CURVE COMPARISON
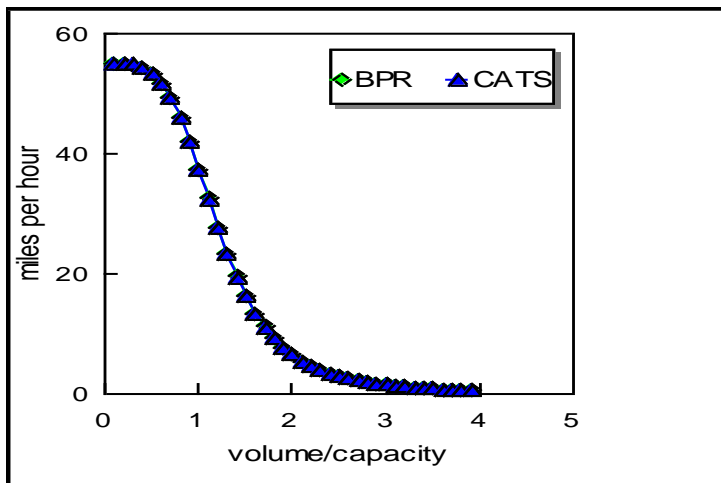
initial speed=55 mph
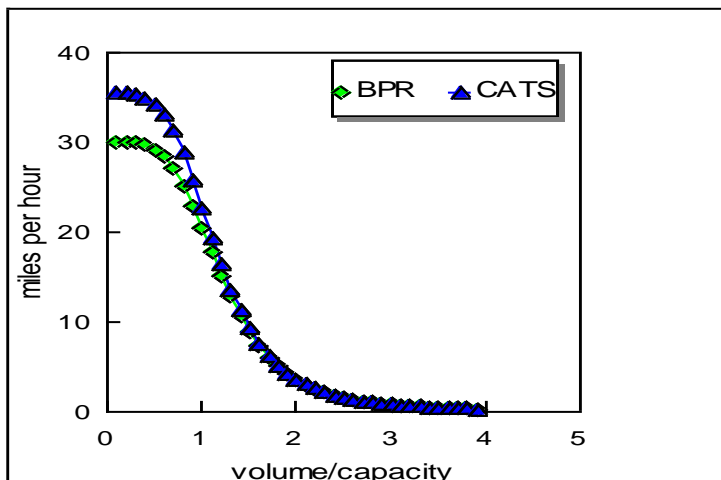
initial speed=30 mph

9.6 VALIDATION

The initial validation of the basic conformity modeling process was centered on 1996 data because this was then the most current available information. One approach was to compare assigned freeway traffic volumes (from the then new time of day highway assignment procedure) against hourly counts compiled for an earlier CATS' publication[7]. The four selected count locations on radial freeways in the region are shown in Figure 9.8.

Figure 9.8 Freeway Count Locations

Figure 9.9 shows the comparison between period assigned volumes and hourly counts. Average hourly assignment volumes for the eight time periods (the darker solid line in the plots) are plotted against hourly traffic counts (the fainter dashed line). Both inbound and outbound directions are plotted. In order to compare count data, which are measured in vehicles, against assignment results, which are produced in vehicle equivalents, assignment truck volumes have been factored downward using vehicle equivalencies to equal vehicles. These graphs demonstrate that the regional modeling approach and time of day highway

assignment procedure are capable of reflecting the variation in travel that occurs during the course of a typical day. For the current conformity analysis, regression analyses of expressway volumes and travel times were performed. The volume analysis found a high R^2 (~85%) and reasonable linear coefficients. Regression analysis of observed expressway travel times and comparable highway skims found a reasonable correlation between these variables in most cases.

For the arterial system, extensive traffic counts by time of day were not available . The initial validation did make comparisons to daily arterial count data by summing the time of day assignments results to a daily total. The observed data were drawn from a data base of IDOT AADT maps dating from 1992 to 1995. The estimated volumes were drawn from daily totals from a 1996 time-of-day assignment. The sample consisted of all matching arterial links between the two data bases. The results are shown in Table 9.7. The regression was performed against the data set stratified by volume range. The root mean squared error (RMSE) is a measure of the average departure of the estimated volume from the volume predicted by the best

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[7] *Transportation Facts.* Chicago Area Transportation Study, Volume 13, Number 3, April 1996.

fit. The coefficient of variation standardizes this error by dividing the RMSE by the mean of the dependent variable (i.e. the observed volume) with a perfect fit equaling zero.

Table 9.7 Arterial Volume Comparison					
Rounded directional volume	Number of observations	Observed directional volume	Modeled directional volume	Root mean square error	% Root mean square error
5000	3236	4877.77	5668.67	1338.12	27.4%
10000	2422	9778.95	10589.53	1399.70	14.3%
15000	1366	14611.23	14989.78	1320.40	9.0%
20000	363	19611.29	19258.32	1333.07	6.8%
25000	122	24467.21	23105.19	1230.15	5.0%

Further regression analysis of daily arterial volumes and travel times was done with more recent data. This included adding geographic stratification to the arterial volume stratification previously used. Additionally, a case study of the relationship between observed travel times and model results for the suburban portion of US12 was done. The specific objective was to examine the three components of arterial delay employed in CMAP's volume delay functions. Complete versions of these validation exercises were published in CATS' Working Paper 2000-04 Highway Assignment Validation Activities (CATS, 2000).

Figure 9.9 Assigned and Counted Hourly Volumes on Major Freeways

Kennedy Expressway at Sacramento

Inbound

Outbound

Eisenhower Expressway at Sacramento

Inbound

Outbound

I-290 at Church Road

Inbound

Outbound

Dan Ryan Expressway North of I-57, I-94 Interchange

Inbound

Outbound
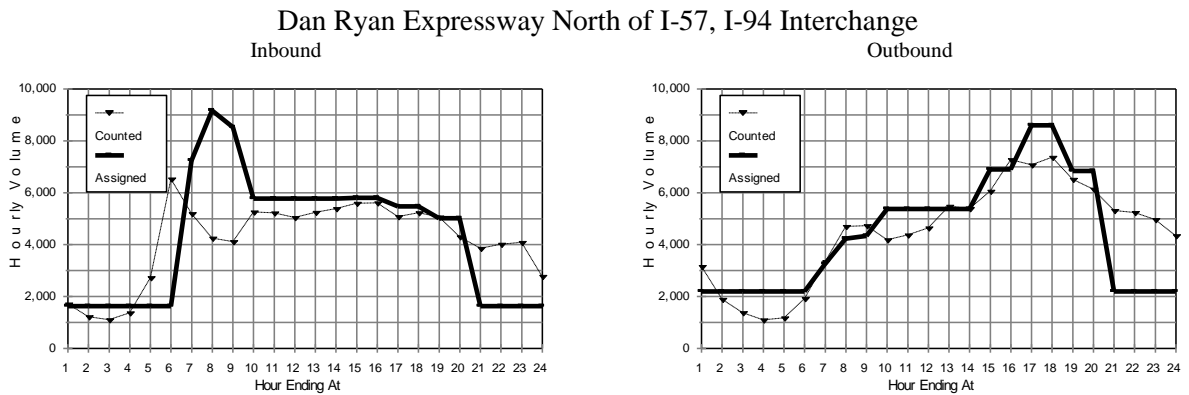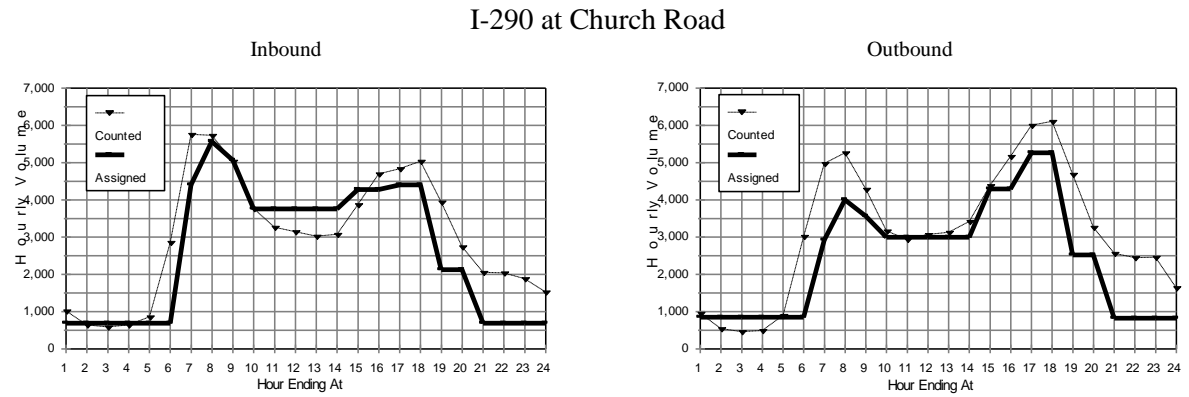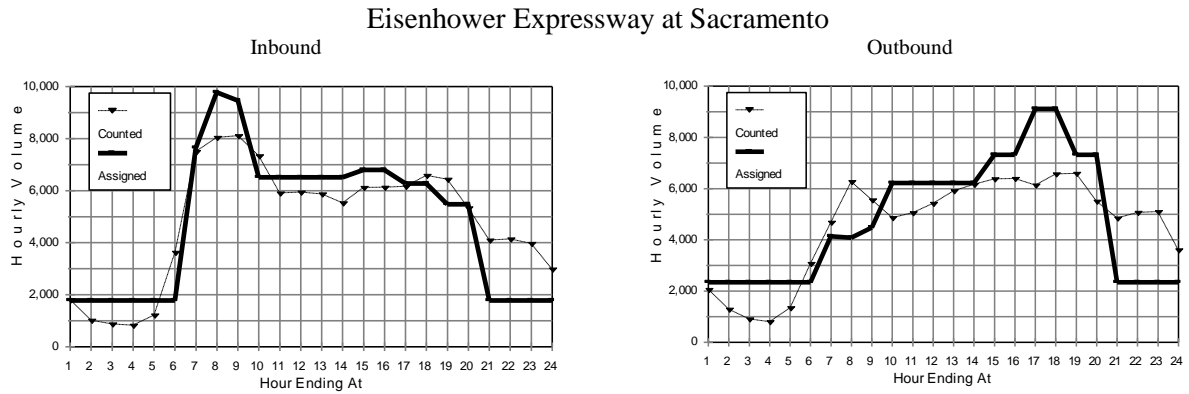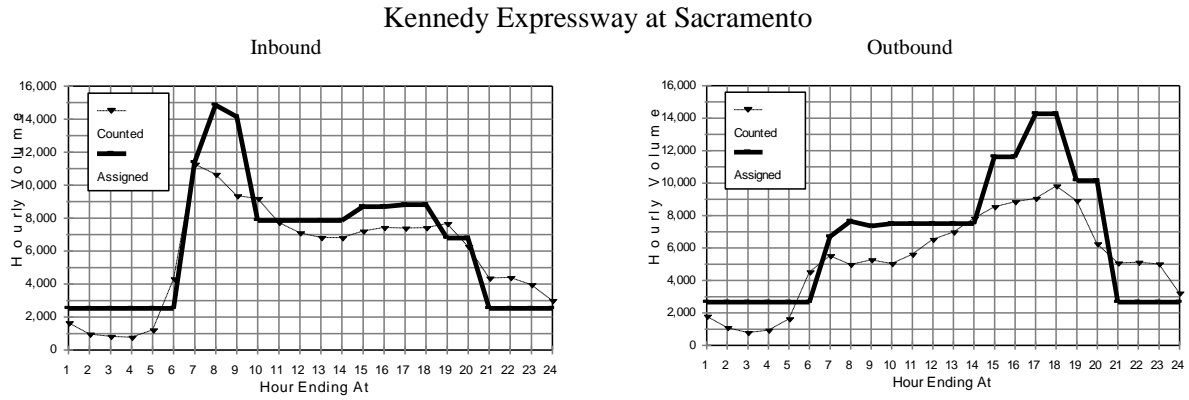
10 Emissions Calculation

10.1 Overview

The conformity test requires a calculation of total regulated emissions for each scenario alternative tested.   These total emissions must be lower than the corresponding approved emission budgets for ozone precursors or the corresponding baseline value for fine particulate matter ($PM_{2.5}$) and its precursor, nitrogen oxides (NOx). The geographic distribution of the emissions is not considered in conformity calculations.

The MOBILE model developed by the U.S. Environmental Protection Agency produces emission rates in grams per mile for various vehicle types, facility types and speeds. The time of day assignment from EMME$^{®}$ is used to produce a table of vehicle miles traveled (VMT) broken down by speed, facility type and vehicle type.   Multiplying each VMT value by the corresponding emission rate and summing yields the amounts of the various emissions emitted. Emission reduction credits may be calculated for strategies not accounted for in the model. This chapter explains how the mobile source emission rates are developed and how the total emissions are calculated from the assignment results.

10.2 Method

Highway networks were built with zone connectors coded to lengths proportional to zone size so connector link volumes represent the amount of "local" travel needed to reach the regional highway system. Thus, this conformity analysis does not have a separate off-network mobile emission component. Mobile source emission estimates based upon the network traffic assignment reflect both specifically coded non-local roadways and local non-coded roadways.

The highway assignment process produces two basic pieces of information essential to calculating emissions: link loads and link speeds. While essential, the information on link loading is not a perfect match for use with the MOBILE emission rates. The assignment model defines vehicles in terms of how much of a roadway's available capacity to carry traffic is used for a given loading. The MOBILE model defines vehicles in terms of engine type and size. For assignment, it makes no difference if a vehicle is diesel or gasoline powered, but this is a highly significant difference for the MOBILE model's calculation of emission rates.   Highway assignment accounts for the different operating characteristics of various vehicle types using the concept of vehicle equivalents[8] (VEQ). In the simplest case a standard passenger auto is one

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[8] Comparable terms also used are passenger car equivalents (pce) and passenger car units (pcu).

VEQ, while a semi-trailer truck is multiple VEQs. The truck occupies approximately the same physical space on the roadway as several standard passenger cars and interacts with other traffic in ways akin to multiple standard vehicles. For example, the truck takes more time to reach cruising speed from a stop than an individual standard passenger auto; the amount of time is similar to that needed by several standard passenger cars to reach cruising speed when driver reaction delay and vehicle spacing are considered. However, the emissions from large a truck and several standard autos are not the same (especially if the truck is diesel powered). The time-of-day (TOD) highway assignment process makes use of the additional options assignment procedure in EMME® to keep track of four truck classes: b-plate, light, medium and heavy, fixed route public transportation buses. These truck classes are subsequently converted into the required MOBILE truck classes before emissions are computed.

When the travel simulation process is complete, several additional steps need to be taken to calculate scenario emissions. The regional model results must be transformed to be compatible with the MOBILE model's emission rate structure. The MOBILE model must be run to produce emission rates that match the transportation data available and reflect the region's environmental and vehicular conditions. The steps completed to compute the scenario network-based mobile source emissions are given below.

10.3 Procedure

10.3.1 Output Travel Model Results

In addition to basic network link data (e.g., length and number of lanes), the following information is produced for every link in a scenario network by the TOD highway assignment:

final loaded speed
number of autos
number of autos not subject to emissions inspection (e.g., out-of-state vehicles operating in the region)
number of b-plate trucks
number of b-plate trucks not subject to emissions inspection
number of light trucks
number of medium truck VEQ
number of heavy truck VEQ
number of fixed route public transit buses

The link VMT for the nonattainment area are accumulated from each of the eight time periods into total daily VMT by speed (in one mile per hour increments from 2.5 mph to 65 mph), facility type and vehicle type. To compute VMT, link distance is multiplied by the

volume in vehicles (not vehicle equivalents) accumulated for each of the speed/facility type/vehicle type combinations.

The travel model produces separate estimates of VMT for IM and non-IM vehicles based on the vehicles geographic "home-base".

10.3.2 Convert Travel Model Vehicle Types to MOBILE Vehicle Types

The VMT for the eight assignment vehicle types are then converted to the MOBILE vehicle types. MOBILE6 generates emission rates for twenty-eight vehicle types. To convert the six basic vehicle types from EMME® (auto, b-plate truck, light truck, medium truck, heavy truck, bus) to the twenty-eight types, two separate allocation steps are taken. First the six types are converted to sixteen types based on vehicle weight, then the sixteen types are expanded to twenty-eight based on the split between gasoline and diesel engines.

To convert the VMT from six types to sixteen types based on vehicle weight, allocation factors taken from national data on the percentage of VMT generated by each of the sixteen types are used. For example, medium duty trucks from the travel model are broken into heavy-duty vehicles 7 (HDV7) and heavy-duty vehicles 8A (HDV8A). The national data (from Technical Guidance on the Use of MOBILE6 for Emission Inventory Preparation, table 4.1.2) indicate that 1.04% of the VMT will be generated by type HDV7 and 1.12% by HDV8A in 2016. Thus the VMT for medium duty trucks is allocated 48.15% to HDV7 and 51.85% to HDV8A (0.4815 = 1.04 / (1.04 + 1.12)). Similarly, the remaining modeled VMT is converted to the remaining types using the appropriate percentages.

The VMT for the sixteen vehicle types are then expanded to twenty-eight, based on the split between gasoline and diesel engines. In the case of medium duty trucks, the two types, HDV7 and HDV8A, are further split into heavy-duty gasoline vehicles 7 (HDGV7), heavy-duty diesel vehicles 7 (HDDV7), HDGV8A AND HDDV8A. To identify the appropriate splits, vehicle registration data is summarized in terms of the relative number of gasoline versus diesel vehicles in a given class. These rates are applied to obtain the more detailed split. For example, HDV7 vehicles are 17.98% gasoline engines and 82.02% diesel, so the HDV7 VMT is allocated 17.98% to HDGV7 and 82.02% to HDDV7. National data were used for this allocation, since the northeastern Illinois registration data available are only for gasoline vehicles. The national data are in User's Guide to MOBILE6.1 and MOBILE6.2: Mobile Source Emissions Factor Model, Appendix E.

This process is repeated for the two vehicle types not subject to emissions inspections, generating five additional vehicle types for which emission rates are generated.

The travel model vehicle classifications do not correspond exactly to the MOBILE classifications. The light-duty, medium-duty, and heavy-duty trucks correspond to MOBILE

heavy-duty vehicle classifications, but the travel model auto and b-plate truck classifications correspond to a combination of MOBILE light-duty vehicle, light-duty truck, gasoline bus, and motorcycle. To obtain the VMT for these vehicle classifications, the travel model VMT for auto and b-plate trucks were combined (both subject to inspection and not subject to inspection). The combined mileage was then allocated among the MOBILE classifications based on the national VMT data previously referenced.

Definitions of the sixteen vehicle types can be found in Technical Guidance on the Use of MOBILE6 for Emission Inventory Preparation, table 4.1.1. Definitions of the twenty-eight types can be found in the User's Guide to MOBILE6.1 and MOBILE6.2: Mobile Source Emissions Factor Model, section 1.2.3

10.3.3 Compute Emission Rates

This conformity analysis used MOBILE6.2.03, the current version of the emissions model. Batch file listings used to supply the input to calculate the emission rates for each of the emissions types (VOC and NOx for ozone, direct PM2.5 and NOx for PM2.5) are included in section 8.4. Descriptions of the input commands and changes for other scenario years are also given. Since emission rates vary with the input values, multiple MOBILE runs are executed to provide the necessary rates.

In the Fall of 2005, USEPA announced that MOBILE6 has an error whereby specifying a fuel program results in summer fuel sulfur levels being applied to winter months as well, rather than using the default higher winter sulfur levels. The impacts of this error are discussed under the Fuel Program parameter in section 8.4.

In the Spring of 2006 a second problem with MOBILE6 was discovered that misestimated the impacts of new diesel engine regulations after 2007. A corrected parameter file, PMDZML.csv, was issued by USEPA. This file was installed and used for all MOBILE6 runs for years after 2007. The baseline year of 2002 was unaffected.

For ease of execution, multiple MOBILE batch files were created for each scenario year. For ozone conformity, one file was created for vehicles subject to emissions inspection, and one for vehicles not subject to emissions inspection. Within each of these files one "run" is executed for each facility type (expressway, arterial, local streets and freeway ramps). Within the freeway and arterial runs, "scenarios" (not to be confused with scenario years) were created for each speed from 2.5 to 65 miles/hour. Under MOBILE6.2, local streets and freeway ramps have a constant speed, so no speed scenarios were executed for these two runs.

For PM2.5 conformity, more runs were created for each scenario year. Because the PM2.5 standard is an annual one, runs needed to be created to reflect the conditions in each month. Direct PM2.5 emissions are not sensitive to environmental factors – temperature and

humidity – nor are they sensitive to application of an inspection and maintenance program. As a result, emission rates for individual months were not required. Since the emission rates do vary with fleet age, three runs were created for each year. January through March were represented by a run with the month parameter set to 1 (e.g., year = 2010, month = 1). April through September were represented by a run with the month parameter set to 7 (e.g., year = 2010, month = 7). Finally, October through December were represented by a run with the month parameter set to 1, but the year advanced by one (e.g., for scenario year 2010, year = 2011, month = 1).

In contrast NOx emissions are temperature sensitive, so a separate run was created for each month of each scenario year. NOx emissions are also sensitive to inspection & maintenance programs, so another "non-I/M" run was also created for each month. Each scenario year thus required 24 MOBILE runs.

10.3.4 Calculate Total Emissions for Scenario

This final step multiplies the emission rates (grams per mile of emissions by speed by facility type by vehicle type) by the scenario VMT (by speed by facility type by vehicle type). These products are summed and converted from grams to tons, yielding the total mobile source emissions.

10.4 MOBILE6 Model Settings Used in the Conformity Analysis

This section describes the various inputs used to obtain emission rates from MOBILE6 for the conformity analysis:

Basic MOBILE6 input files.
File defining northeastern Illinois inspection & maintenance program.
File defining the vehicle age profile in northeastern Illinois.
File defining the distribution of VMT by hour of the day in the region.
Dummy files assigning all VMT to local streets or freeway ramps to generate emission rates for those facilities.
Changes to MOBILE6 input for analysis years 2020, 2030 and 2040.
Further information on the inspection & maintenance program file and the vehicle age profile file can be found in the SIP, since these two files are the same ones used in developing the SIP.

10.4.1 Basic MOBILE6 Input

10.4.1.1 Ozone Conformity

The following listing shows the input for obtaining the ozone precursor emission rates for the 2016 scenario year with inspection & maintenance in place. A similar file was used to generate emission rates for 2016 without inspection & maintenance; the only difference, other

than comments, was that the four lines (one in each run) starting with "I/M DESC FILE" were omitted. A description of the input values used follows the listing.

```
******************************************************************************
*                                                                            *
* DESCRIPTION: 2016 emission rates by facility type, all 28                   *
* vehicle types & speeds in 1 mph increments (<2.5 to > 64.5).                *
* I&M case - I/M external description file IM07ON.d included for all          *
* runs. Local inputs are in external files.  Temperature and humidity         *
* are at the values specified by IEPA for 8-hour ozone test.  Vehicle         *
* registration data updated to 2008                                          *
*                                                                            *
* CREATED:  November 5, 2008                                                 *
* MODIFIED: February 11, 2009 - update registration input file               *
* MODIFIED: May 21, 2010      - change year to 2016                          *
*                                                                            *
* AUTHOR:  Ross Patronsky                                                    *
*                                                                            *
******************************************************************************
MOBILE6 INPUT FILE :
POLLUTANTS            : HC NOX
REPORT FILE          : C:\rtp\mobile6\ozone\rates16.txt
SPREADSHEET          : C:\rtp\mobile6\ozone\rates16.tab
*************  Run #1 non-ramp freeway  *********************
RUN DATA
ABSOLUTE HUMIDITY  : 97.0
MIN/MAX TEMP       : 61. 81.
FUEL PROGRAM       : 2 N
FUEL RVP           : 6.8
NO REFUELING       :
EXPRESS HC AS VOC  :
I/M DESC FILE      : C:\rtp\mobile6\DefFiles\IM07ON.d
REG DIST           : C:\rtp\mobile6\DefFiles\CHRD08AA.d
VMT BY HOUR        : C:\rtp\mobile6\DefFiles\vbyhr07.def

SCENARIO RECORD    : non-ramp freeway @ 2.5 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 7
AVERAGE SPEED      : 2.5 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 3 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 7
AVERAGE SPEED      : 3.0 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 4 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 7
AVERAGE SPEED      : 4.0 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 5 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 7
AVERAGE SPEED      : 5.0 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 6 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 7
AVERAGE SPEED      : 6.0 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 7 mph scenario w/ I&M
CALENDAR YEAR      : 2016
```

```
EVALUATION MONTH    : 7
AVERAGE SPEED       : 7.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 8 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 8.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 9 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 9.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 10 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 10.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 11 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 11.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 12 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 12.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 13 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 13.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 14 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 14.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 15 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 15.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 16 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 16.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 17 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 17.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 18 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 18.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 19 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 19.0 NON-RAMP
```

```
SCENARIO RECORD       : non-ramp freeway @ 20 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 20.0 NON-RAMP

SCENARIO RECORD       : non-ramp freeway @ 21 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 21.0 NON-RAMP

SCENARIO RECORD       : non-ramp freeway @ 22 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 22.0 NON-RAMP

SCENARIO RECORD       : non-ramp freeway @ 23 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 23.0 NON-RAMP

SCENARIO RECORD       : non-ramp freeway @ 24 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 24.0 NON-RAMP

SCENARIO RECORD       : non-ramp freeway @ 25 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 25.0 NON-RAMP

SCENARIO RECORD       : non-ramp freeway @ 26 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 26.0 NON-RAMP

SCENARIO RECORD       : non-ramp freeway @ 27 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 27.0 NON-RAMP

SCENARIO RECORD       : non-ramp freeway @ 28 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 28.0 NON-RAMP

SCENARIO RECORD       : non-ramp freeway @ 29 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 29.0 NON-RAMP

SCENARIO RECORD       : non-ramp freeway @ 30 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 30.0 NON-RAMP

SCENARIO RECORD       : non-ramp freeway @ 31 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 31.0 NON-RAMP

SCENARIO RECORD       : non-ramp freeway @ 32 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
```

```
AVERAGE SPEED        : 32.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 33 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 33.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 34 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 34.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 35 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 35.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 36 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 36.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 37 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 37.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 38 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 38.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 39 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 39.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 40 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 40.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 41 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 41.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 42 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 42.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 43 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 43.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 44 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 44.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 45 mph scenario w/ I&M
```

```
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 45.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 46 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 46.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 47 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 47.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 48 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 48.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 49 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 49.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 50 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 50.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 51 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 51.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 52 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 52.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 53 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 53.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 54 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 54.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 55 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 55.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 56 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 56.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 57 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 57.0 NON-RAMP
```

```
SCENARIO RECORD     : non-ramp freeway @ 58 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 58.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 59 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 59.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 60 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 60.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 61 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 61.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 62 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 62.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 63 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 63.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 64 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 64.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 65 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 65.0 NON-RAMP

END OF RUN

************** Run #2 ARTERIAL  **********************

ABSOLUTE HUMIDITY   : 97.0
MIN/MAX TEMP        : 61. 81.
FUEL PROGRAM        : 2 N
FUEL RVP            : 6.8
NO REFUELING        :
EXPRESS HC AS VOC   :
I/M DESC FILE       : C:\rtp\mobile6\DefFiles\IM07ON.d
REG DIST            : C:\rtp\mobile6\DefFiles\CHRD08AA.d
VMT BY HOUR         : C:\rtp\mobile6\DefFiles\vbyhr07.def

SCENARIO RECORD     : arterial @ 2.5 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 2.5 ARTERIAL

SCENARIO RECORD     : arterial @ 3 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
```

```
AVERAGE SPEED        : 3.0 ARTERIAL

SCENARIO RECORD      : arterial @ 4 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 4.0 ARTERIAL

SCENARIO RECORD      : arterial @ 5 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 5.0 ARTERIAL

SCENARIO RECORD      : arterial @ 6 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 6.0 ARTERIAL

SCENARIO RECORD      : arterial @ 7 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 7.0 ARTERIAL

SCENARIO RECORD      : arterial @ 8 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 8.0 ARTERIAL

SCENARIO RECORD      : arterial @ 9 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 9.0 ARTERIAL

SCENARIO RECORD      : arterial @ 10 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 10.0 ARTERIAL

SCENARIO RECORD      : arterial @ 11 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 11.0 ARTERIAL

SCENARIO RECORD      : arterial @ 12 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 12.0 ARTERIAL

SCENARIO RECORD      : arterial @ 13 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 13.0 ARTERIAL

SCENARIO RECORD      : arterial @ 14 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 14.0 ARTERIAL

SCENARIO RECORD      : arterial @ 15 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 15.0 ARTERIAL

SCENARIO RECORD      : arterial @ 16 mph scenario w/ I&M
```

```
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 16.0 ARTERIAL

SCENARIO RECORD      : arterial @ 17 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 17.0 ARTERIAL

SCENARIO RECORD      : arterial @ 18 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 18.0 ARTERIAL

SCENARIO RECORD      : arterial @ 19 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 19.0 ARTERIAL

SCENARIO RECORD      : arterial @ 20 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 20.0 ARTERIAL

SCENARIO RECORD      : arterial @ 21 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 21.0 ARTERIAL

SCENARIO RECORD      : arterial @ 22 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 22.0 ARTERIAL

SCENARIO RECORD      : arterial @ 23 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 23.0 ARTERIAL

SCENARIO RECORD      : arterial @ 24 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 24.0 ARTERIAL

SCENARIO RECORD      : arterial @ 25 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 25.0 ARTERIAL

SCENARIO RECORD      : arterial @ 26 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 26.0 ARTERIAL

SCENARIO RECORD      : arterial @ 27 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 27.0 ARTERIAL

SCENARIO RECORD      : arterial @ 28 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 28.0 ARTERIAL
```

```
SCENARIO RECORD      : arterial @ 29 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 29.0 ARTERIAL

SCENARIO RECORD      : arterial @ 30 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 30.0 ARTERIAL

SCENARIO RECORD      : arterial @ 31 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 31.0 ARTERIAL

SCENARIO RECORD      : arterial @ 32 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 32.0 ARTERIAL

SCENARIO RECORD      : arterial @ 33 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 33.0 ARTERIAL

SCENARIO RECORD      : arterial @ 34 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 34.0 ARTERIAL

SCENARIO RECORD      : arterial @ 35 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 35.0 ARTERIAL

SCENARIO RECORD      : arterial @ 36 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 36.0 ARTERIAL

SCENARIO RECORD      : arterial @ 37 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 37.0 ARTERIAL

SCENARIO RECORD      : arterial @ 38 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 38.0 ARTERIAL

SCENARIO RECORD      : arterial @ 39 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 39.0 ARTERIAL

SCENARIO RECORD      : arterial @ 40 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 7
AVERAGE SPEED        : 40.0 ARTERIAL

SCENARIO RECORD      : arterial @ 41 mph scenario w/ I&M
CALENDAR YEAR        : 2016
```

```
EVALUATION MONTH    : 7
AVERAGE SPEED       : 41.0 ARTERIAL

SCENARIO RECORD     : arterial @ 42 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 42.0 ARTERIAL

SCENARIO RECORD     : arterial @ 43 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 43.0 ARTERIAL

SCENARIO RECORD     : arterial @ 44 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 44.0 ARTERIAL

SCENARIO RECORD     : arterial @ 45 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 45.0 ARTERIAL

SCENARIO RECORD     : arterial @ 46 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 46.0 ARTERIAL

SCENARIO RECORD     : arterial @ 47 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 47.0 ARTERIAL

SCENARIO RECORD     : arterial @ 48 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 48.0 ARTERIAL

SCENARIO RECORD     : arterial @ 49 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 49.0 ARTERIAL

SCENARIO RECORD     : arterial @ 50 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 50.0 ARTERIAL

SCENARIO RECORD     : arterial @ 51 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 51.0 ARTERIAL

SCENARIO RECORD     : arterial @ 52 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 52.0 ARTERIAL

SCENARIO RECORD     : arterial @ 53 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 7
AVERAGE SPEED       : 53.0 ARTERIAL
```

```
SCENARIO RECORD       : arterial @ 54 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 54.0 ARTERIAL

SCENARIO RECORD       : arterial @ 55 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 55.0 ARTERIAL

SCENARIO RECORD       : arterial @ 56 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 56.0 ARTERIAL

SCENARIO RECORD       : arterial @ 57 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 57.0 ARTERIAL

SCENARIO RECORD       : arterial @ 58 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 58.0 ARTERIAL

SCENARIO RECORD       : arterial @ 59 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 59.0 ARTERIAL

SCENARIO RECORD       : arterial @ 60 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 60.0 ARTERIAL

SCENARIO RECORD       : arterial @ 61 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 61.0 ARTERIAL

SCENARIO RECORD       : arterial @ 62 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 62.0 ARTERIAL

SCENARIO RECORD       : arterial @ 63 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 63.0 ARTERIAL

SCENARIO RECORD       : arterial @ 64 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 64.0 ARTERIAL

SCENARIO RECORD       : arterial @ 65 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 7
AVERAGE SPEED         : 65.0 ARTERIAL

END OF RUN

************** Run #3 LOCAL  **********************
```

```
ABSOLUTE HUMIDITY  : 97.0
MIN/MAX TEMP       : 61. 81.
FUEL PROGRAM       : 2 N
FUEL RVP           : 6.8
NO REFUELING       :
EXPRESS HC AS VOC  :
I/M DESC FILE      : C:\rtp\mobile6\DefFiles\IM07ON.d
REG DIST           : C:\rtp\mobile6\DefFiles\CHRD08AA.d
VMT BY HOUR        : C:\rtp\mobile6\DefFiles\vbyhr07.def
VMT BY FACILITY    : C:\rtp\mobile6\DefFiles\FVMTLCL.d

SCENARIO RECORD    : local vmt only w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 7

END OF RUN


**************  Run #4 RAMP  **********************

ABSOLUTE HUMIDITY  : 97.0
MIN/MAX TEMP       : 61. 81.
FUEL PROGRAM       : 2 N
FUEL RVP           : 6.8
NO REFUELING       :
EXPRESS HC AS VOC  :
I/M DESC FILE      : C:\rtp\mobile6\DefFiles\IM07ON.d
REG DIST           : C:\rtp\mobile6\DefFiles\CHRD08AA.d
VMT BY HOUR        : C:\rtp\mobile6\DefFiles\vbyhr07.def
VMT BY FACILITY    : C:\rtp\mobile6\DefFiles\FVMTRMP.def

SCENARIO RECORD    : ramp vmt only w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 7

END OF RUN
```

Input values

The input values used are described below:

POLLUTANTS   : HC NOX

This instructs MOBILE6 to report emission rates for hydrocarbons and oxides of nitrogen, the two regulated ozone precursors in the region.

REPORT FILE   : C:\rtp\mobile6\ozone\rates16.txt

The general log file, listing input commands, warnings, and error messages is put in this file

SPREADSHEET   : C:\rtp\mobile6\ozone\rates16.tab

The emission rates are put in this file in a format suitable for importing into a spreadsheet.

ABSOLUTE HUMIDITY   : 97.0

Humidity affects emission rates; MOBILE6 requires an absolute humidity input (in grains per pound). This value was developed using relative humidity data at O'Hare International Airport for summer weekdays. This figure is used in the current maintenance SIP submitted by the Illinois Environmental Protection Agency on March 18, 2009. The method for converting relative humidity to absolute humidity was developed by the U.S. Environmental Protection Agency, and applied by IEPA.

MIN/MAX TEMP   : 61. 81.

MOBILE6 requires the maximum and minimum temperature to calculate emission rates. These values were developed using climatic data at O'Hare International Airport for summer weekdays. These same data were used in the current maintenance SIP submitted by the Illinois Environmental Protection Agency on March 18, 2009.

FUEL PROGRAM   : 2 N

This input specifies that reformulated gasoline for northern states will be used in the region during the period for which emission rates are being calculated. This is consistent with values used in the SIP.

In the Fall of 2005, USEPA announced that MOBILE6 has an error whereby specifying a fuel program results in summer fuel sulfur levels being applied to winter months as well, rather than using the default higher winter sulfur levels. For years after 2007, winter and summer sulfur levels will be the same, and the error has no effect. This is the case for analysis years currently used.

The 2002 baseline year for $PM_{2.5}$ conformity is affected by the error. The nature of the error is to underestimate particulate and NOx emissions, so in fact the baseline values for these emissions are understated. Since emissions for the subsequent analysis years are all less than the understated baseline emissions, they are also less than the unknown, but higher, baseline emissions that would result from correcting winter sulfur levels. Because the correction would not affect the analysis, the baseline emissions have not been recalculated.

FUEL RVP   : 6.8

MOBILE6 requires the refueling Reid vapor pressure (in pounds per square inch) to determine the effect of fuel volatility on emissions. This value derives from the fuel program in place, based on the table on page 151 of *User's Guide to MOBILE6.1 and MOBILE6.2: Mobile Source Emissions Factor Model*.

NO REFUELING   :

No emissions due to refueling are included in the emission rates. In the *SIP*, these are treated as area emissions, not mobile emissions.

EXPRESS HC AS VOC :

The hydrocarbon emissions are expressed in terms of volatile organic compounds.

I/M DESC FILE   : C:\rtp\mobile6\DefFiles\IM07ON.d

This is the file which defines the inspection and maintenance program. It is discussed further in a following section.

REG DIST   : C:\rtp\mobile6\DefFiles\CHRD08AA.d

This is the file which defines the vehicle age distribution. It is discussed further in a following section.

VMT BY HOUR   : C:\rtp\mobile6\DefFiles\Vbyhr07.def

This is the file which defines the distribution of VMT by hour of the day. It is discussed further in a following section.

SCENARIO RECORD   : non-ramp freeway @ 2.5 mph scenario w/ I&M

This record is simply a header record for each scenario section. The text to the right of the colon is placed in the output as a descriptive field.

CALENDAR YEAR   : 2016

The emission rates are generated for 2016.

EVALUATION MONTH   : 7

The emission rates generated are for the month of July, which is the standard month for generating emission rates for ozone precursors. The alternative month, January, is not applicable.

AVERAGE SPEED   : 2.5 NON-RAMP

The emission rates generated by this scenario assume that all vehicles travel at 2.5 mph on a freeway (not the ramp). A scenario is run for each mile per hour from 2.5 through 65 on the freeway and from 2.5 mph to 65 mph on arterial streets, to match the VMT at each speed and facility. One additional scenario is run for local streets and one for freeway ramps; these facilities use only one speed in the MOBILE6 model.

VMT BY FACILITY   : C:\rtp\mobile6\DefFiles\FVMTRMP.def
VMT BY FACILITY   : C:\rtp\mobile6\DefFiles\FVMTLCL.d

These two commands are used to specify that emission rates are to be generated as though all VMT are on local streets (FVMTLCL.d) or freeway ramps (FVMTRMP.def). For arterials and freeways, the AVERAGE SPEED command accomplishes the same thing.

10.4.1.2 PM$_{2.5}$ Conformity – Direct PM$_{2.5}$

The following listing shows the input for obtaining the direct PM2.5 emission rates for the 2016 scenario year for the months January - March. A similar file was used to generate emission rates for the other months of the year, and for the other scenario years. Most of the input values have been described in the previous section on the ozone MOBILE runs; a description of the input values unique to PM2.5 follows the listing.

```
****************************************************************************
*                                                                        *
* DESCRIPTION: PM emission rates for facilities & speeds individually     *
*              for January - March 2016.                                  *
*              Rates for all particulate types are generated              *
*              Used temperature & humidity from Sam Long table,           *
*              although these do not have an effect on the rates.         *
*              Note that I/M does not have effect either, even though      *
*              it is included.                                            *
*                                                                        *
* CREATED:     July 13, 2005                                              *
* REVISIONS:   based on Example PM-1 from July 2004 training materials     *
*              July 13, 2006 - used 2003 registration data (CHIRD03.d)     *
*                        and new I/M file (IM07ON.D)                       *
*              April 29, 2008 - changed to 2007 vehicles by hour           *
*                 (Vbyhr07.def)                                           *
*              April 30, 2010 - changed to 2008 registration file          *
*                 (CHRD08AA.d)                                            *
*              May 24, 2010 - changed year to 2016, updated temps - see  *
*                  PATROTEMP.xlsx                                         *
*                                                                        *
* AUTHOR:      Ross Patronsky                                             *
*                                                                        *
****************************************************************************

MOBILE6 INPUT FILE :
PARTICULATES        :
REPORT FILE         : C:\rtp\mobile6\PM25\PM16J-M.txt
SPREADSHEET         : C:\rtp\mobile6\PM25\PM16J-M.tab

RUN DATA            :
**************  Run #1 non-ramp freeway  **********************

ABSOLUTE HUMIDITY  : 23.0
MIN/MAX TEMP       : 21. 37.
FUEL PROGRAM       : 2 N
FUEL RVP           : 6.8
NO REFUELING       :
I/M DESC FILE      : C:\rtp\mobile6\DefFiles\IM07ON.D
```

```
REG DIST             : C:\rtp\mobile6\DefFiles\CHRD08AA.d
VMT BY HOUR          : C:\rtp\mobile6\DefFiles\Vbyhr07.def

***************      Scenario Sections     ***************

SCENARIO RECORD      : non-ramp freeway @ 2.5 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 2.5 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 3 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 3.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 4 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 4.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 5 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 5.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 6 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 6.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 7 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 7.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 8 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 8.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 9 mph scenario w/ I&M
CALENDAR YEAR        : 2016
```

```
EVALUATION MONTH    : 1
AVERAGE SPEED       : 9.0 NON-RAMP
PARTICULATE EF      : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 10 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 10.0 NON-RAMP
PARTICULATE EF      : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 11 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 11.0 NON-RAMP
PARTICULATE EF      : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 12 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 12.0 NON-RAMP
PARTICULATE EF      : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 13 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 13.0 NON-RAMP
PARTICULATE EF      : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 14 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 14.0 NON-RAMP
PARTICULATE EF      : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 15 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 15.0 NON-RAMP
PARTICULATE EF      : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 16 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 16.0 NON-RAMP
PARTICULATE EF      : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0
```

```
SCENARIO RECORD      : non-ramp freeway @ 17 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 17.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 18 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 18.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 19 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 19.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 20 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 20.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 21 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 21.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 22 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 22.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 23 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 23.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 24 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 24.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
```

```
DIESEL SULFUR        : 15.0

SCENARIO RECORD     : non-ramp freeway @ 25 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 25.0 NON-RAMP
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 26 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 26.0 NON-RAMP
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 27 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 27.0 NON-RAMP
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 28 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 28.0 NON-RAMP
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 29 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 29.0 NON-RAMP
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 30 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 30.0 NON-RAMP
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 31 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 31.0 NON-RAMP
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 32 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 32.0 NON-RAMP
```

```
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : non-ramp freeway @ 33 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 33.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : non-ramp freeway @ 34 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 34.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : non-ramp freeway @ 35 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 35.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : non-ramp freeway @ 36 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 36.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : non-ramp freeway @ 37 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 37.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : non-ramp freeway @ 38 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 38.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : non-ramp freeway @ 39 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 39.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : non-ramp freeway @ 40 mph scenario w/ I&M
CALENDAR YEAR      : 2016
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EVALUATION MONTH   : 1
AVERAGE SPEED      : 40.0 NON-RAMP
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : non-ramp freeway @ 41 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 41.0 NON-RAMP
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : non-ramp freeway @ 42 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 42.0 NON-RAMP
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : non-ramp freeway @ 43 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 43.0 NON-RAMP
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : non-ramp freeway @ 44 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 44.0 NON-RAMP
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : non-ramp freeway @ 45 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 45.0 NON-RAMP
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : non-ramp freeway @ 46 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 46.0 NON-RAMP
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : non-ramp freeway @ 47 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 47.0 NON-RAMP
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0
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SCENARIO RECORD     : non-ramp freeway @ 48 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 48.0 NON-RAMP
PARTICULATE EF      : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 49 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 49.0 NON-RAMP
PARTICULATE EF      : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 50 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 50.0 NON-RAMP
PARTICULATE EF      : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 51 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 51.0 NON-RAMP
PARTICULATE EF      : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 52 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 52.0 NON-RAMP
PARTICULATE EF      : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 53 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 53.0 NON-RAMP
PARTICULATE EF      : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 54 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 54.0 NON-RAMP
PARTICULATE EF      : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : non-ramp freeway @ 55 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 55.0 NON-RAMP
PARTICULATE EF      : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
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DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 56 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 56.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 57 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 57.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 58 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 58.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 59 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 59.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 60 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 60.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 61 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 61.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 62 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 62.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : non-ramp freeway @ 63 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 63.0 NON-RAMP
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PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE         : 2.5
DIESEL SULFUR         : 15.0

SCENARIO RECORD       : non-ramp freeway @ 64 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 1
AVERAGE SPEED         : 64.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE         : 2.5
DIESEL SULFUR         : 15.0

SCENARIO RECORD       : non-ramp freeway @ 65 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 1
AVERAGE SPEED         : 65.0 NON-RAMP
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE         : 2.5
DIESEL SULFUR         : 15.0

END OF RUN

************** Run #2 ARTERIAL  **********************

ABSOLUTE HUMIDITY  : 23.0
MIN/MAX TEMP       : 21. 37.
FUEL PROGRAM       : 2 N
FUEL RVP           : 6.8
NO REFUELING       :
EXPRESS HC AS VOC  :
I/M DESC FILE      : C:\rtp\mobile6\DefFiles\IM07ON.D
REG DIST           : C:\rtp\mobile6\DefFiles\CHRD08AA.d
VMT BY HOUR        : C:\rtp\mobile6\DefFiles\Vbyhr07.def

SCENARIO RECORD       : arterial @ 2.5 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 1
AVERAGE SPEED         : 2.5 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE         : 2.5
DIESEL SULFUR         : 15.0

SCENARIO RECORD       : arterial @ 3 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 1
AVERAGE SPEED         : 3.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE         : 2.5
DIESEL SULFUR         : 15.0

SCENARIO RECORD       : arterial @ 4 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 1
AVERAGE SPEED         : 4.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE         : 2.5
DIESEL SULFUR         : 15.0

SCENARIO RECORD       : arterial @ 5 mph scenario w/ I&M
CALENDAR YEAR         : 2016
EVALUATION MONTH      : 1
AVERAGE SPEED         : 5.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
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PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 6 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 6.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 7 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 7.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 8 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 8.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 9 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 9.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 10 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 10.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 11 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 11.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 12 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 12.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 13 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 13.0 ARTERIAL
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PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 14 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 14.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 15 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 15.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 16 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 16.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 17 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 17.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 18 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 18.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 19 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 19.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 20 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 20.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 21 mph scenario w/ I&M
CALENDAR YEAR       : 2016
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EVALUATION MONTH     : 1
AVERAGE SPEED        : 21.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : arterial @ 22 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 22.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : arterial @ 23 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 23.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : arterial @ 24 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 24.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : arterial @ 25 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 25.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : arterial @ 26 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 26.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : arterial @ 27 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 27.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : arterial @ 28 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 28.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0
```

```
SCENARIO RECORD     : arterial @ 29 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 29.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 30 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 30.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 31 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 31.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 32 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 32.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 33 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 33.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 34 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 34.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 35 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 35.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 36 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 36.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
```

```
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : arterial @ 37 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 37.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV    PMGDR1.CSV    PMGDR2.CSV    PMDZML.CSV    PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : arterial @ 38 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 38.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV    PMGDR1.CSV    PMGDR2.CSV    PMDZML.CSV    PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : arterial @ 39 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 39.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV    PMGDR1.CSV    PMGDR2.CSV    PMDZML.CSV    PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : arterial @ 40 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 40.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV    PMGDR1.CSV    PMGDR2.CSV    PMDZML.CSV    PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : arterial @ 41 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 41.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV    PMGDR1.CSV    PMGDR2.CSV    PMDZML.CSV    PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : arterial @ 42 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 42.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV    PMGDR1.CSV    PMGDR2.CSV    PMDZML.CSV    PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : arterial @ 43 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 43.0 ARTERIAL
PARTICULATE EF        : PMGZML.CSV    PMGDR1.CSV    PMGDR2.CSV    PMDZML.CSV    PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE        : 2.5
DIESEL SULFUR        : 15.0

SCENARIO RECORD      : arterial @ 44 mph scenario w/ I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 44.0 ARTERIAL
```

```
PARTICULATE EF         : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : arterial @ 45 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 45.0 ARTERIAL
PARTICULATE EF         : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : arterial @ 46 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 46.0 ARTERIAL
PARTICULATE EF         : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : arterial @ 47 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 47.0 ARTERIAL
PARTICULATE EF         : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : arterial @ 48 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 48.0 ARTERIAL
PARTICULATE EF         : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : arterial @ 49 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 49.0 ARTERIAL
PARTICULATE EF         : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : arterial @ 50 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 50.0 ARTERIAL
PARTICULATE EF         : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : arterial @ 51 mph scenario w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 51.0 ARTERIAL
PARTICULATE EF         : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

SCENARIO RECORD    : arterial @ 52 mph scenario w/ I&M
CALENDAR YEAR      : 2016
```

```
EVALUATION MONTH    : 1
AVERAGE SPEED       : 52.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 53 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 53.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 54 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 54.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 55 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 55.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 56 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 56.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 57 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 57.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 58 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 58.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 59 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 59.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0
```

```
SCENARIO RECORD     : arterial @ 60 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 60.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 61 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 61.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 62 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 62.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 63 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 63.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 64 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 64.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

SCENARIO RECORD     : arterial @ 65 mph scenario w/ I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 65.0 ARTERIAL
PARTICULATE EF       : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE       : 2.5
DIESEL SULFUR       : 15.0

END OF RUN

**************  Run #3 LOCAL  ***********************

ABSOLUTE HUMIDITY : 23.0
MIN/MAX TEMP      : 21. 37.
FUEL PROGRAM      : 2 N
FUEL RVP          : 6.8
NO REFUELING      :
EXPRESS HC AS VOC :
I/M DESC FILE     : C:\rtp\mobile6\DefFiles\IM07ON.D
REG DIST          : C:\rtp\mobile6\DefFiles\CHRD08AA.d
VMT BY HOUR       : C:\rtp\mobile6\DefFiles\Vbyhr07.def
VMT BY FACILITY   : C:\rtp\mobile6\DefFiles\FVMTLCL.d

SCENARIO RECORD     : local vmt only w/ I&M
```

```
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

END OF RUN

**************  Run #4 RAMP  ***********************

ABSOLUTE HUMIDITY  : 23.0
MIN/MAX TEMP       : 21. 37.
FUEL PROGRAM       : 2 N
FUEL RVP           : 6.8
NO REFUELING       :
EXPRESS HC AS VOC  :
I/M DESC FILE      : C:\rtp\mobile6\DefFiles\IM07ON.D
REG DIST           : C:\rtp\mobile6\DefFiles\CHRD08AA.d
VMT BY HOUR        : C:\rtp\mobile6\DefFiles\Vbyhr07.def
VMT BY FACILITY    : C:\rtp\mobile6\DefFiles\FVMTRMP.def

SCENARIO RECORD    : ramp vmt only w/ I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
PARTICULATE EF        : PMGZML.CSV   PMGDR1.CSV   PMGDR2.CSV   PMDZML.CSV   PMDDR1.CSV
PMDDR2.CSV
PARTICLE SIZE      : 2.5
DIESEL SULFUR      : 15.0

END OF RUN
```

Input values

The input values used that are unique to the direct PM2.5 emissions are described below. Values that have the same use as in the ozone conformity are described in the section on ozone inputs.

Note that the humidity and temperature inputs are required by the MOBILE model, even though direct PM2.5 emissions are not sensitive to these inputs. Input values consistent with the months being modeled were used.

PARTICULATES   :
This input record specifies that particulate emission factors are to be generated.
PARTICULATE EF   : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
This command specifies the data files that contain the particulate emission factors. The files used are national defaults supplies with the MOBILE model.
PARTICLE SIZE   : 2.5
This value specifies the size of particulate emissions to use in generating the emission rates. Since the NAAQS that the region does not attain are for fine particulates (2.5 microns or less in size), the value 2.5 is used.
DIESEL SULFUR   : 15.0
This record gives the amount of sulfur in diesel fuel, in parts per million. As of fall 2006, all diesel fuel for on-road use in the United States (with very limited exceptions) were required to contain no more than 15 parts per million of sulfur. Since the scenario years are all later than 2006, the 15 parts per million value is used.

10.4.1.3 PM$_{2.5}$ Conformity – NOx

The following listing shows the input for obtaining the NOx emission rates for the 2016 scenario year for the month of January. A similar file was used to generate emission rates for the other months of the year, and for the other scenario years. Note that the temperature and humidity values for all months are shown in the comment section at the beginning of the file. These are the same values used by IEPA in developing emissions inventories for their PM$_{2.5}$ SIP submission.

As with the ozone MOBILE files, a similar file was used to generate emission rates for 2016 without inspection & maintenance; the only difference, other than comments, was that the four lines (one in each run) starting with "I/M DESC FILE" were omitted.

All of the input values have been described in the previous section on the ozone MOBILE runs; no further description is given here.

```
************************************************************************
*                                                                      *
* DESCRIPTION: NOx emission rates by facility type and speed           *
*                                                                      *
*              Note that the only difference among the NOx runs is the *
*              temperature, evaluation month and presence/absence of   *
*              I/M                                                      *
*                                                                      *
*              The evaluation month is 1 for Jan-Mar, 7 for Apr-Sep,   *
*              and 1 of the following year for Oct-Dec                 *
*                                                                      *
* CREATED:     April 25, 2008                                          *
*              based on NOx2009 input file from same date              *
*                                                                      *
* REVISIONS:   April 30, 2009 updated temperature to match IEPA        *
*              (This was originally done in June 2008, but the files   *
*              must have been deleted)                                 *
*              April 30, 2009 changed to 2008 vehicle registration     *
*              (CHRD08AA.d)                                            *
*              May 21, 2010 - Changed year to 2016                     *
*                                                                      *
* AUTHOR:      Ross Patronsky                                          *
*                                                                      *
************************************************************************

************************************************************************
*                                                                      *
*    I/M status:  I&M case                                             *
*                                                                      *
*    affects whether I/M external description file IM07ON.D            *
*    is/is not included:                                               *
*                                                                      *
*    I/M DESC FILE     : C:\rtp\mobile6\DefFiles\IM07ON.D              *
*                                                                      *
************************************************************************

************************************************************************
*                                                                      *
* Year evaluated in this run:   2016                                   *
* Month evaluated in this run:  January                                *
*                                                                      *
```

```
* Monthly temperature/humidity inputs                                      *
*      Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec          *
* Max 30°  35°  46°  58°  70°  79°  84°  81°  74°  62°  47°  34°           *
* Min 14°  19°  29°  38°  48°  57°  63°  62°  54°  42°  32°  20°           *
* Hum 21   22   25   45   48   92   98   101  75   43   28   21            *
*                                                                          *
****************************************************************************

MOBILE6 INPUT FILE :

POLLUTANTS          : NOX
REPORT FILE         : C:\rtp\mobile6\NOx\NOx16-1I.txt
SPREADSHEET         : C:\rtp\mobile6\NOx\NOx16-1I.tab

RUN DATA
******************* Run #1 non-ramp freeway ***************************

ABSOLUTE HUMIDITY   : 21.0
MIN/MAX TEMP        : 14. 30.
FUEL PROGRAM        : 2 N
FUEL RVP            : 6.8
NO REFUELING        :
I/M DESC FILE       : C:\rtp\mobile6\DefFiles\IM07ON.D
REG DIST            : C:\rtp\mobile6\DefFiles\CHRD08AA.d
VMT BY HOUR         : C:\rtp\mobile6\DefFiles\Vbyhr07.def

************************  Scenario Sections  ************************

SCENARIO RECORD     : non-ramp freeway @ 2.5 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 2.5 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 3 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 3.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 4 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 4.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 5 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 5.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 6 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 6.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 7 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 7.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 8 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 8.0 NON-RAMP
```

```
SCENARIO RECORD    : non-ramp freeway @ 9 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 9.0 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 10 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 10.0 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 11 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 11.0 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 12 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 12.0 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 13 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 13.0 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 14 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 14.0 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 15 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 15.0 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 16 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 16.0 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 17 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 17.0 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 18 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 18.0 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 19 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 19.0 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 20 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 20.0 NON-RAMP

SCENARIO RECORD    : non-ramp freeway @ 21 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
```

```
AVERAGE SPEED        : 21.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 22 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 22.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 23 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 23.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 24 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 24.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 25 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 25.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 26 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 26.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 27 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 27.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 28 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 28.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 29 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 29.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 30 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 30.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 31 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 31.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 32 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 32.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 33 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 33.0 NON-RAMP

SCENARIO RECORD      : non-ramp freeway @ 34 mph scenario with I&M
```

```
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 34.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 35 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 35.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 36 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 36.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 37 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 37.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 38 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 38.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 39 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 39.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 40 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 40.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 41 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 41.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 42 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 42.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 43 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 43.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 44 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 44.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 45 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 45.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 46 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 46.0 NON-RAMP
```

```
SCENARIO RECORD     : non-ramp freeway @ 47 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 47.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 48 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 48.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 49 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 49.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 50 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 50.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 51 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 51.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 52 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 52.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 53 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 53.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 54 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 54.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 55 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 55.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 56 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 56.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 57 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 57.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 58 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 58.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 59 mph scenario with I&M
CALENDAR YEAR       : 2016
```

```
EVALUATION MONTH    : 1
AVERAGE SPEED       : 59.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 60 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 60.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 61 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 61.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 62 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 62.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 63 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 63.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 64 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 64.0 NON-RAMP

SCENARIO RECORD     : non-ramp freeway @ 65 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 65.0 NON-RAMP

END OF RUN

****************** Run #2 ARTERIAL  *********************************

ABSOLUTE HUMIDITY   : 21.0
MIN/MAX TEMP        : 14. 30.
FUEL PROGRAM        : 2 N
FUEL RVP            : 6.8
NO REFUELING        :
I/M DESC FILE       : C:\rtp\mobile6\DefFiles\IM07ON.D
REG DIST            : C:\rtp\mobile6\DefFiles\CHRD08AA.d
VMT BY HOUR         : C:\rtp\mobile6\DefFiles\Vbyhr07.def

SCENARIO RECORD     : arterial @ 2.5 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 2.5 ARTERIAL

SCENARIO RECORD     : arterial @ 3 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 3.0 ARTERIAL

SCENARIO RECORD     : arterial @ 4 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 4.0 ARTERIAL

SCENARIO RECORD     : arterial @ 5 mph scenario with I&M
CALENDAR YEAR       : 2016
```

```
EVALUATION MONTH    : 1
AVERAGE SPEED       : 5.0 ARTERIAL

SCENARIO RECORD     : arterial @ 6 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 6.0 ARTERIAL

SCENARIO RECORD     : arterial @ 7 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 7.0 ARTERIAL

SCENARIO RECORD     : arterial @ 8 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 8.0 ARTERIAL

SCENARIO RECORD     : arterial @ 9 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 9.0 ARTERIAL

SCENARIO RECORD     : arterial @ 10 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 10.0 ARTERIAL

SCENARIO RECORD     : arterial @ 11 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 11.0 ARTERIAL

SCENARIO RECORD     : arterial @ 12 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 12.0 ARTERIAL

SCENARIO RECORD     : arterial @ 13 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 13.0 ARTERIAL

SCENARIO RECORD     : arterial @ 14 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 14.0 ARTERIAL

SCENARIO RECORD     : arterial @ 15 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 15.0 ARTERIAL

SCENARIO RECORD     : arterial @ 16 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 16.0 ARTERIAL

SCENARIO RECORD     : arterial @ 17 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 17.0 ARTERIAL
```

```
SCENARIO RECORD     : arterial @ 18 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 18.0 ARTERIAL

SCENARIO RECORD     : arterial @ 19 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 19.0 ARTERIAL

SCENARIO RECORD     : arterial @ 20 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 20.0 ARTERIAL

SCENARIO RECORD     : arterial @ 21 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 21.0 ARTERIAL

SCENARIO RECORD     : arterial @ 22 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 22.0 ARTERIAL

SCENARIO RECORD     : arterial @ 23 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 23.0 ARTERIAL

SCENARIO RECORD     : arterial @ 24 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 24.0 ARTERIAL

SCENARIO RECORD     : arterial @ 25 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 25.0 ARTERIAL

SCENARIO RECORD     : arterial @ 26 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 26.0 ARTERIAL

SCENARIO RECORD     : arterial @ 27 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 27.0 ARTERIAL

SCENARIO RECORD     : arterial @ 28 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 28.0 ARTERIAL

SCENARIO RECORD     : arterial @ 29 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
AVERAGE SPEED       : 29.0 ARTERIAL

SCENARIO RECORD     : arterial @ 30 mph scenario with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
```

```
AVERAGE SPEED        : 30.0 ARTERIAL

SCENARIO RECORD      : arterial @ 31 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 31.0 ARTERIAL

SCENARIO RECORD      : arterial @ 32 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 32.0 ARTERIAL

SCENARIO RECORD      : arterial @ 33 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 33.0 ARTERIAL

SCENARIO RECORD      : arterial @ 34 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 34.0 ARTERIAL

SCENARIO RECORD      : arterial @ 35 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 35.0 ARTERIAL

SCENARIO RECORD      : arterial @ 36 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 36.0 ARTERIAL

SCENARIO RECORD      : arterial @ 37 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 37.0 ARTERIAL

SCENARIO RECORD      : arterial @ 38 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 38.0 ARTERIAL

SCENARIO RECORD      : arterial @ 39 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 39.0 ARTERIAL

SCENARIO RECORD      : arterial @ 40 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 40.0 ARTERIAL

SCENARIO RECORD      : arterial @ 41 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 41.0 ARTERIAL

SCENARIO RECORD      : arterial @ 42 mph scenario with I&M
CALENDAR YEAR        : 2016
EVALUATION MONTH     : 1
AVERAGE SPEED        : 42.0 ARTERIAL

SCENARIO RECORD      : arterial @ 43 mph scenario with I&M
```

```
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 43.0 ARTERIAL

SCENARIO RECORD    : arterial @ 44 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 44.0 ARTERIAL

SCENARIO RECORD    : arterial @ 45 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 45.0 ARTERIAL

SCENARIO RECORD    : arterial @ 46 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 46.0 ARTERIAL

SCENARIO RECORD    : arterial @ 47 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 47.0 ARTERIAL

SCENARIO RECORD    : arterial @ 48 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 48.0 ARTERIAL

SCENARIO RECORD    : arterial @ 49 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 49.0 ARTERIAL

SCENARIO RECORD    : arterial @ 50 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 50.0 ARTERIAL

SCENARIO RECORD    : arterial @ 51 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 51.0 ARTERIAL

SCENARIO RECORD    : arterial @ 52 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 52.0 ARTERIAL

SCENARIO RECORD    : arterial @ 53 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 53.0 ARTERIAL

SCENARIO RECORD    : arterial @ 54 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 54.0 ARTERIAL

SCENARIO RECORD    : arterial @ 55 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 55.0 ARTERIAL
```

```
SCENARIO RECORD    : arterial @ 56 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 56.0 ARTERIAL

SCENARIO RECORD    : arterial @ 57 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 57.0 ARTERIAL

SCENARIO RECORD    : arterial @ 58 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 58.0 ARTERIAL

SCENARIO RECORD    : arterial @ 59 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 59.0 ARTERIAL

SCENARIO RECORD    : arterial @ 60 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 60.0 ARTERIAL

SCENARIO RECORD    : arterial @ 61 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 61.0 ARTERIAL

SCENARIO RECORD    : arterial @ 62 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 62.0 ARTERIAL

SCENARIO RECORD    : arterial @ 63 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 63.0 ARTERIAL

SCENARIO RECORD    : arterial @ 64 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 64.0 ARTERIAL

SCENARIO RECORD    : arterial @ 65 mph scenario with I&M
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
AVERAGE SPEED      : 65.0 ARTERIAL

END OF RUN

****************** Run #3 LOCAL  ************************************

ABSOLUTE HUMIDITY  : 21.0
MIN/MAX TEMP       : 14. 30.
FUEL PROGRAM       : 2 N
FUEL RVP           : 6.8
NO REFUELING       :
I/M DESC FILE      : C:\rtp\mobile6\DefFiles\IM07ON.D
REG DIST           : C:\rtp\mobile6\DefFiles\CHRD08AA.d
VMT BY HOUR        : C:\rtp\mobile6\DefFiles\Vbyhr07.def
```

```
VMT BY FACILITY     : C:\rtp\mobile6\DefFiles\FVMTLCL.d

SCENARIO RECORD     : local vmt only with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1

END OF RUN

******************* Run #4 RAMP  *************************************

ABSOLUTE HUMIDITY : 21.0
MIN/MAX TEMP      : 14. 30.
FUEL PROGRAM      : 2 N
FUEL RVP          : 6.8
NO REFUELING      :
I/M DESC FILE     : C:\rtp\mobile6\DefFiles\IM07ON.D
REG DIST          : C:\rtp\mobile6\DefFiles\CHRD08AA.d
VMT BY HOUR       : C:\rtp\mobile6\DefFiles\Vbyhr07.def
VMT BY FACILITY   : C:\rtp\mobile6\DefFiles\FVMTRMP.def

SCENARIO RECORD     : ramp vmt only with I&M
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1

END OF RUN
```

10.4.2 Northeastern Illinois Inspection & Maintenance Program

The following listings show the input files describing the inspection & maintenance program for northeastern Illinois. These files are the same as those used by the Illinois Environmental Protection Agency in developing the 8-hour and PM2.5 SIPs.

The file used to describe the inspection & maintenance program for the 2002 baseline year for the PM2.5 analysis is as follows:

```
* ILLINOIS ENHANCED I/M DESCRIPTION Filename: ILLOBDIM.D
*  Name changed to ILL0BDIM.D ("O" changed to "0"[zero]
*  by SL on 27.viij.02 when replacement file was given
*  the name with O.
*
* OBD EXH AND GAS CAP 1996+ BEGINNING IN 2002
* First I/M program--IDLE test for MY 1968+ LDVs
I/M PROGRAM       : 1 1986 2050 2 T/O IDLE
I/M MODEL YEARS   : 1 1968 1980
I/M VEHICLES      : 1 22222 11111111 1
I/M STRINGENCY    : 1 20.0
I/M COMPLIANCE    : 1 95.0
I/M WAIVER RATES  : 1 0.5 2.2      '01 data
I/M GRACE PERIOD  : 1 4
*
* Second I/M program--IM240 for MY 1981 to 1995 LDVs
I/M PROGRAM       : 2 1999 2050 2 T/O IM240
I/M MODEL YEARS   : 2 1981 1995
I/M VEHICLES      : 2 22222 11111111 1
I/M STRINGENCY    : 2 20.0
I/M CUTPOINTS     : 2 C:\rtp\mobile6\DefFiles\Mycuts.d
```

```
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 0.5 2.2     '01 data
I/M GRACE PERIOD   : 2 4
*
* Third I/M program Gas Cap Check for MY 1968 to 1995 LDVs
I/M PROGRAM        : 3 1992 2050 2 T/O GC
I/M MODEL YEARS    : 3 1968 1995
I/M VEHICLES       : 3 22222 11111111 1
I/M COMPLIANCE     : 3 95.0
I/M WAIVER RATES   : 3 0.5 2.2     '01 data
I/M GRACE PERIOD   : 3 4
*
* Forth I/M program--EVAP OBD & Gas Cap Check for 1996+ ldv
I/M PROGRAM        : 4 2002 2050 2 T/O EVAP OBD & GC
I/M MODEL YEARS    : 4 1996 2050
I/M VEHICLES       : 4 22222 11111111 1
I/M STRINGENCY     : 4 20.0
I/M COMPLIANCE     : 4 95.0
I/M WAIVER RATES   : 4 0.5 2.2     '01 data
I/M GRACE PERIOD   : 4 4
*
* Fifth I/M program--HDV IDLE for MY 1968+ HDVs
I/M PROGRAM        : 5 1986 2050 2 T/O IDLE
I/M MODEL YEARS    : 5 1968 2050
I/M VEHICLES       : 5 11111 22222222 2
I/M STRINGENCY     : 5 20.0
I/M COMPLIANCE     : 5 95.0
I/M WAIVER RATES   : 5 1.2 1.5     '01 data
I/M GRACE PERIOD   : 5 4
*
* SIXTH I/M program--Gas Cap Check for MY 1968+ HDVs
I/M PROGRAM        : 6 1992 2050 2 T/O GC
I/M MODEL YEARS    : 6 1968 2050
I/M VEHICLES       : 6 11111 22222222 2
I/M COMPLIANCE     : 6 95.0
I/M WAIVER RATES   : 6 1.2 1.5     '01 data
I/M GRACE PERIOD   : 6 4
*
* SEVENTH I/M program--"Exhaust" OBD for MY 1996+ LDVs
I/M PROGRAM        : 7 2002 2050 2 T/O OBD I/M
I/M MODEL YEARS    : 7 1996 2050
I/M VEHICLES       : 7 22222 11111111 1
I/M STRINGENCY     : 7 20.0
I/M COMPLIANCE     : 7 95.0
I/M WAIVER RATES   : 7 0.5 2.2     '01 data
I/M GRACE PERIOD   : 7 4
*
* ----------------
*
* NOTES:
* This was the standard I/M input for the OBD
*  case, to be used for regular M6 runs for future
*  years.  (Cf the non-OBD input ILLIM240.D)  It was
*  used between March and August 2002.
*
* It was received from Jim Matheny of IEPA/BOA/VIM
*  on 12.iij.02.  This is the OBD I/M program as it
*  exists after early March 2002.  JM's original
*  file is ILIM3.D.  Only comments have been edited
*  or added here.  The actual inputs have not been
*  changed in any way.
*
* All Illinois I/M is Biennial Test Only (2 T/O)
```

```
*  and applies to LDGVs and LDGTs.  Special I/M
*  for HDVs in 5th & 6th programs.  Note Exhaust &
*  Evaporative OBD for MY '96+ vehicles in 4th & 7th
*  programs.  IM240 remains for pre-'96 LDVs and idle
*  test for pre-'81 LDVs and all HDVs.
*
*  ---------------
```

The following listing describes the inspection & maintenance program in place since 2007, which was used for ozone and/or PM2.5 analysis years after that date.

```
* ILLINOIS ENHANCED I/M DESCRIPTION

*  Filename: IMO7ON.D

* I/M INPUT FILE FOR ILLINOIS OBD/IDLE/GC PROGRAM
* All program start years set to 1986 per USEPA guidance in
*  "Frequently Asked Questions on MOBILE6".

* This represents the NEW I/M program in which only 1996 & newer
*  vehicles are tested; and OBD applies only to LDVs.  This
*  program will come into effect in February 2007.

*------------------------------------------------------
*  Program description for post MY'96 LDV OBD I/M
*======================================================

* FIRST I/M program--"Evap" OBD for MY 1996+ LDVs
*------------------------------------------------------
I/M PROGRAM        : 1 1986 2050 2 T/O EVAP OBD
I/M MODEL YEARS    : 1 1996 2050
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 20.0
I/M COMPLIANCE     : 1 95.0
I/M WAIVER RATES   : 1 0.5 2.2      '01 data
I/M EXEMPTION AGE  : 1 25
I/M GRACE PERIOD   : 1 4

* Second I/M program--"Exhaust" OBD for MY 1996+ LDVs
*------------------------------------------------------
I/M PROGRAM        : 2 1986 2050 2 T/O OBD I/M
I/M MODEL YEARS    : 2 1996 2050
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 20.0
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 0.5 2.2      '01 data
I/M EXEMPTION AGE  : 2 25
I/M GRACE PERIOD   : 2 4
*

*--------------------------------------------------------
*  Program description for post MY'96 HDV Idle & GC I/M
*========================================================

* Third I/M program--HDV IDLE for MY 1996+ HDVs
*------------------------------------------------------
I/M PROGRAM        : 3 1986 2050 2 T/O IDLE
I/M MODEL YEARS    : 3 1996 2050
I/M VEHICLES       : 3 11111 22222222 2
```

```
I/M STRINGENCY       : 3 20.0
I/M COMPLIANCE       : 3 95.0
I/M WAIVER RATES     : 3 1.2 1.5      '01 data
I/M EXEMPTION AGE    : 3 25
I/M GRACE PERIOD     : 3 4

* Fourth I/M program--Gas Cap Check for MY 1996+ HDVs
*---------------------------------------------------
I/M PROGRAM          : 4 1986 2050 2 T/O GC
I/M MODEL YEARS      : 4 1996 2050
I/M VEHICLES         : 4 11111 22222222 2
I/M COMPLIANCE       : 4 95.0
I/M WAIVER RATES     : 4 1.2 1.5      '01 data
I/M EXEMPTION AGE    : 4 25
I/M GRACE PERIOD     : 4 4

* NOTES


* This is a standard Illinois I/M input, describing
*  the I/M program with OBD as it is supposed to exist
*  after January 2007.  It is the file to be used for
*  regular M6 I/M runs for 2007 and future years.
*
* This file was originally SB397.D, by Jim Matheny of
*  IEPA/BOA/VIM, supplied to SL by JM 24.viij.05 and
*  verified by SL.  JM's original SB397.D has been
*  slightly revised by the addition of comments such
*  as this one.  The actual inputs have not been
*  changed, except to move and renumber "Exhaust OBD",
*  Program 6 in JM's original SB397 to Program 2, and
*  renumber JM's Programs 4 and 5 in the original SB397
*  to Programs 3 and 4.  This was done to put the two
*  LDV OBD programs (exhaust and evaporative) together,
*  and the two HDV programs together too.  The order of
*  the programs in the I/M file is not significant and
*  has no effect in M6, but the programs must be numbered
*  sequentially.
* JM verified that this file as shown is correctly
*  describes the I/M program planned (summer 2005) for
*  introduction in January '07.
* ----------------
* COMPARISON WITH ILLOBDIM.D:
* The first three programs in ILLOBDIM.D, covering the idle
*  test for MY'68-'81 LDVs, IM240 for '81-'95 LDVs, and gas
*  cap check for MY'68-'95 LDVs have been eliminated from
*  IM07ON; and the two HDV programs now refer only to MY'96
*  and later.
```

The next listing gives emission level "cutpoints," values which determine whether a vehicle passes or fails an I & M test. This file does not apply to the inspection & maintenance program currently in force, but only to the program as it existed when creating the 2002 PM baseline values.

```
* This file was created automatically by a Mobile6 conversion utility.
* The same cutpoints are used for each model year and vehicle type.
I/M CUTPOINTS       : CUTP015.D
*
*
```

```
* Block 1 (LDGV, LDGT1)
   0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800
   0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800
   0.800    0.800    0.800    0.800    0.800
  15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000
  15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000
  15.000   15.000   15.000   15.000   15.000
 999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000
 999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000
 999.000  999.000  999.000  999.000  999.000
*
* Block 2 (LDGT2, LDGT3)
   0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800
   0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800
   0.800    0.800    0.800    0.800    0.800
  15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000
  15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000
  15.000   15.000   15.000   15.000   15.000
 999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000
 999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000
 999.000  999.000  999.000  999.000  999.000
*
* Block 3 (LDGT4)
   0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800
   0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800
   0.800    0.800    0.800    0.800    0.800
  15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000
  15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000
  15.000   15.000   15.000   15.000   15.000
 999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000
 999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000
 999.000  999.000  999.000  999.000  999.000
*
* Block 4 (HDGV)
   0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800
   0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800    0.800
   0.800    0.800    0.800    0.800    0.800
  15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000
  15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000   15.000
  15.000   15.000   15.000   15.000   15.000
 999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000
 999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000  999.000
 999.000  999.000  999.000  999.000  999.000
```

10.4.3 Age Profile of Vehicles in Northeastern Illinois

The following listing provides the vehicle registration data by vehicle age for the region. The age of the fleet is used to adjust the emission rates; older vehicles are expected to produce higher emissions, due to gradual deterioration of their emissions controls. This file uses the same data that the Illinois Environmental Protection Agency used in developing the 8-hour ozone maintenance SIP.

Although the data are based on 2008 registration data, they are read in as a percentage of vehicles made in the current year, one year ago, two years ago, and so on for twenty-five years. This means that the file can be used for any scenario year, and it was used for all scenario years. The alternative would have been to use MOBILE default values, which was deemed less desirable.

```
REG DIST

* CNAA M6 LDV RD = SOSLDV (Light-duty Vehicles--passenger cars) RD from
*  08VADbyCounty.xls for Chicago omitting '09 counts & '08 = 75% of '07
 1 0.0550  0.0733  0.0675  0.0656  0.0649  0.0666  0.0698  0.0665  0.0680  0.0598
   0.0524  0.0500  0.0415  0.0421  0.0325  0.0263  0.0218  0.0166  0.0134  0.0103
   0.0074  0.0057  0.0043  0.0033  0.0154


* CNAA M6 LDT1 RD = SOSLDT1 (ISOS "light" or type 1 LD trucks) RD from
*  08VADbyCounty.xls for Chicago omitting '09 counts & '08 = 75% of '07
 2 0.0526  0.0702  0.0769  0.0872  0.0796  0.0729  0.0835  0.0670  0.0669  0.0586
   0.0583  0.0478  0.0385  0.0342  0.0294  0.0219  0.0148  0.0118  0.0076  0.0065
   0.0051  0.0031  0.0020  0.0012  0.0024


* CNAA M6 LDT2 RD = Same as M6 LDT1 RD; see above.
 3 0.0526  0.0702  0.0769  0.0872  0.0796  0.0729  0.0835  0.0670  0.0669  0.0586
   0.0583  0.0478  0.0385  0.0342  0.0294  0.0219  0.0148  0.0118  0.0076  0.0065
   0.0051  0.0031  0.0020  0.0012  0.0024


* CNAA M6 LDT3 = SOSLDT21 (ISOS "heavy" or type 2 LD trucks) RD from
*  08VADbyCounty.xls for Chicago omitting '09 counts & '08 = 75% of '07
 4 0.0457  0.0609  0.0635  0.0720  0.0854  0.0843  0.0729  0.0689  0.0705  0.0800
   0.0517  0.0472  0.0349  0.0375  0.0294  0.0203  0.0162  0.0095  0.0104  0.0099
   0.0075  0.0049  0.0041  0.003  0.0094


* CNAA M6 LDT4 = same as LDT3 RDs; see above.
 5 0.0457  0.0609  0.0635  0.0720  0.0854  0.0843  0.0729  0.0689  0.0705  0.0800
   0.0517  0.0472  0.0349  0.0375  0.0294  0.0203  0.0162  0.0095  0.0104  0.0099
   0.0075  0.0049  0.0041  0.003  0.0094


*  Above from 2008 Chicago-area data from DVIM (Gebhardt), as modifed by
*   OTAQ (16.j.09) from SL's CRD08X09.d file, & renamed CHRD08AA.d.
*
*  Heavy-Duty & MC RDs are all assumed same as default
*
* HDV2B (Heavy-duty vehicles 2B--M6 Default RDs)
 6 0.0503 0.0916 0.0833 0.0758 0.0690 0.0627 0.0571 0.0519 0.0472 0.0430
   0.0391 0.0356 0.0324 0.0294 0.0268 0.0244 0.0222 0.0202 0.0184 0.0167
   0.0152 0.0138 0.0126 0.0114 0.0499
* HDV3 (Heavy-duty vehicles3, same RD as HDV2B, M6 Default RDs)
 7 0.0503 0.0916 0.0833 0.0758 0.0690 0.0627 0.0571 0.0519 0.0472 0.0430
   0.0391 0.0356 0.0324 0.0294 0.0268 0.0244 0.0222 0.0202 0.0184 0.0167
   0.0152 0.0138 0.0126 0.0114 0.0499
* HDV4 (Heavy-duty vehicles 4, M6 default RDs)
 8 0.0388 0.0726 0.0679 0.0635 0.0594 0.0556 0.0520 0.0486 0.0455 0.0425
   0.0398 0.0372 0.0348 0.0326 0.0304 0.0285 0.0266 0.0249 0.0233 0.0218
   0.0204 0.0191 0.0178 0.0167 0.0797
* HDV5 (Heavy-duty vehicles 5, same RD as HDV4, M6 Default)
 9 0.0388 0.0726 0.0679 0.0635 0.0594 0.0556 0.0520 0.0486 0.0455 0.0425
   0.0398 0.0372 0.0348 0.0326 0.0304 0.0285 0.0266 0.0249 0.0233 0.0218
   0.0204 0.0191 0.0178 0.0167 0.0797
* HDV6 (Heavy-duty vehicless 6, same RD as HDV4, M6 Default)
10 0.0388 0.0726 0.0679 0.0635 0.0594 0.0556 0.0520 0.0486 0.0455 0.0425
   0.0398 0.0372 0.0348 0.0326 0.0304 0.0285 0.0266 0.0249 0.0233 0.0218
   0.0204 0.0191 0.0178 0.0167 0.0797
* HDV7 (Heavy-duty vehicles 7, same RD as HDV4, M6 Default)
11 0.0388 0.0726 0.0679 0.0635 0.0594 0.0556 0.0520 0.0486 0.0455 0.0425
   0.0398 0.0372 0.0348 0.0326 0.0304 0.0285 0.0266 0.0249 0.0233 0.0218
   0.0204 0.0191 0.0178 0.0167 0.0797
* HDV8A (Heavy-duty vehicles 8A same RD as HDV4, M6 Default)
12 0.0388 0.0726 0.0679 0.0635 0.0594 0.0556 0.0520 0.0486 0.0455 0.0425
   0.0398 0.0372 0.0348 0.0326 0.0304 0.0285 0.0266 0.0249 0.0233 0.0218
   0.0204 0.0191 0.0178 0.0167 0.0797
* HDV8B (Heavy-duty vehicles 8B,same RD as HDV4, M6 Default)
13 0.0388 0.0726 0.0679 0.0635 0.0594 0.0556 0.0520 0.0486 0.0455 0.0425
```

```
   0.0398 0.0372 0.0348 0.0326 0.0304 0.0285 0.0266 0.0249 0.0233 0.0218
   0.0204 0.0191 0.0178 0.0167 0.0797
* HDBS (HDV School buses; this M6 RD default is assumed)
14 0.0393 0.0734 0.0686 0.0641 0.0599 0.0559 0.0522 0.0488 0.0456 0.0426
   0.0398 0.0372 0.0347 0.0324 0.0303 0.0283 0.0264 0.0247 0.0231 0.0216
   0.0201 0.0188 0.0176 0.0165 0.0781
* HDBT (HDV Transit buses; this M6 RD default is assumed)
15 0.0307 0.0614 0.0614 0.0614 0.0614 0.0614 0.0614 0.0614 0.0614 0.0613
   0.0611 0.0607 0.0595 0.0568 0.0511 0.0406 0.0254 0.0121 0.0099 0.0081
   0.0066 0.0054 0.0044 0.0037 0.0114
* MC (Motorcycles; this M6 default RD is assumed)
16 0.1440 0.1680 0.1350 0.1090 0.0880 0.0700 0.0560 0.0450 0.0360 0.0290
   0.0230 0.0970 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
   0.0000 0.0000 0.0000 0.0000 0.0000*
```

10.4.4 Distribution of VMT by Hour of the Day in the Region

The following listing shows the input for distributing VMT over the day. MOBILE uses this information to adjust emission rates, since rates are generally higher in warmer parts of the day.

The travel model's use fixed factors to apportion vehicle trip tables by time-of-day. At present, these factors do not vary by scenario year.

```
VMT BY HOUR
*
*  Fraction of all vehicle miles traveled by hour of the day.
*  First hour is 6 a.m.
*  These values developed from run iepa07 300_20070830 by CMAP
*
         0.033579 0.066392 0.066392 0.076578 0.062532 0.062532
         0.062532 0.062532 0.069056 0.069056 0.077490 0.077490
         0.052616 0.052616 0.010861 0.010861 0.010861 0.010861
         0.010861 0.010861 0.010861 0.010861 0.010861 0.010861
```

10.4.5 5. Dummy Files Assigning All VMT to Local Streets or Freeway Ramps

The following listing shows the input file used to assign all VMT to local streets. This is used in one of the MOBILE6 "runs" to generate emission rates for these facilities. A similar file (not shown) assigns all VMT to local streets. For brevity's sake, the file is truncated after the first vehicle type. For arterials and freeways, the AVERAGE SPEED command performs the function of assigning all VMT to one facility type.

```
VMT BY FACILITY
*
* This is [D:\]AREASPEC\FVMTLCL.DEF, based on FVMT.DEF, the
* "default" FVMT file supplied with the M6 model.
*
* VMT fractions are listed for 28 vehicle classes for each hour of
* the day starting at 6AM. There are 24 sets of four values for
* each vehicle type.  The VMT fractions by hour are the same
* for all vehicle classes.
*
* The four values in each line represent the VMT distribution on
* freeway, arterial, local and ramps--in that order--as shown.
*
* See M6UG 2.8.5.1.f., p. 49, or CLASLIST.TXT for further info.
```

```
        * (The CLASLIST file describes the vehicle classes.)
        * This file is modified to give 100% LOCAL
        *
        * Veh  Int&   Arts&  Local
        *Class Fwys   Colls  Rd/St  Ramps
        *----- ----   -----  -----  -----
        *
            1 0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
            2 0.000  0.000  1.000  0.000
              0.000  0.000  1.000  0.000
```

Note that there are additional lines in the definition file for each of the twenty-eight vehicle types; each vehicle type having one line for each hour of the day.

10.4.6 Changes to MOBILE6 Input for Analysis Years 2020, 2030 and 2040

A review of the preceding listings shows that the year record in each scenario is different, so this record is changed in each batch file.

As discussed previously, the inspection & maintenance and vehicle age profile data are not known to be different for different scenario years, so the same local data were used for all scenario years. The distribution of VMT by hour of the day does not vary from year to year, owing to the way in which the travel assignment model is run. As a result, the same data were used for all scenario years.