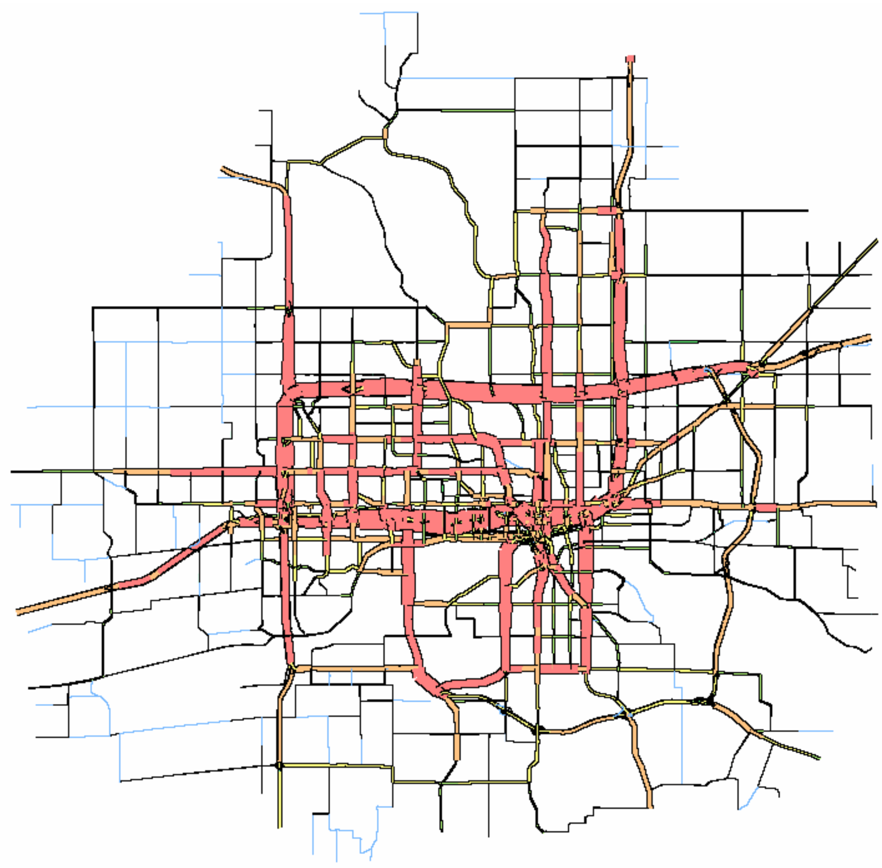
DRAFT—FOR REVIEW AND DISCUSSION ONLY

Des Moines Area

Travel Demand Model

Documentation & User Guide



February 2006

THE MPO
DES MOINES AREA
METROPOLITAN PLANNING ORGANIZATION

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1. Introduction

The purpose of this report is to describe in detail the trip based travel demand model developed for the Des Moines metropolitan area. Travel demand models are used for simulating current travel conditions and for forecasting future travel patterns and conditions. Once travel demand is known, the planner can assess the performance of alternative transportation systems and identify various impacts that the system will have on the urban area, such as delay and emission. With information on how transportation systems perform, and the magnitude of their impacts, planners can provide decision-makers with some of the information they need to evaluate alternative methods of supplying a community with transportation services.

This travel demand model was developed by staff of the Des Moines Area Metropolitan Planning Organization (MPO), Iowa, using Caliper's TransCAD software. An important, essential use of the 2001 National Household Travel Survey (NHTS) Add-on data in the Des Moines metropolitan area is the survey's input in the Des Moines Area MPO's travel demand model. The Des Moines Area MPO used the traditional modeling process of trip generation, trip distribution, and trip assignment to develop the travel demand model. The Des Moines Area MPO does not conduct mode choice modeling. The 2001 NHTS Add-on data was able to assist the Des Moines Area MPO in determining whether mode choice modeling would be a valuable use of time and resources. Transit usage accounted for less than one percent of the total trips, according to the 2001 NHTS Add-on data. Based on the 2001 NHTS Add-on survey data, it was decided that at the present time transit usage was not a large enough percentage of total trips to warrant the creation of a mode choice model.

Trip generation forecasts the number of trips from urban activity. For example, the number of trips that are generated by a shopping center is quite different from the number of trips generated by an industrial complex that takes up about the same amount of space. In trip generation, the planner attempts to quantify the relationship between urban activity and travel. The output of the trip generation model is a table of trip ends: the number of trips that are produced and the number that are attracted. The 2001 NHTS Add-on data, the 2000 U.S. Census data, and the 2000 Census Transportation Planning Package (CTPP) were the main input data for trip generation analysis of Des Moines Area MPO's travel demand model.

Trip distribution procedures determine where the trips produced in each zone will go and how they will be divided among all other zones in the study area. The trip distribution analysis used the gravity model which is base on travel time as measures of trip impedance. The output of trip distribution is a set of tables that show the travel flow between each pair of zones.

The trip assignment model predicts the paths that the trips will take. For example, if a trip goes from a suburb to downtown, the model predicts which specific roads are used. The trip assignment process begins by constructing a network map. The network maps show the possible paths that trips can take. The output of the trip assignment model shows the paths that include the flow of traffic.

The Des Moines Area MPO serves a planning area population of 395,174, from fifteen member cities and portions of three member counties. In 2000, the Des Moines Metropolitan Statistical Area (MSA) consisted of three central Iowa counties: Dallas, Polk, and Warren. The release of the 2000 U.S. Census data revealed that two additional counties would join the classification of the Des Moines MSA: Madison and Guthrie.

The Des Moines Area MPO had completed the development of the travel demand model with a process of updating the long-range transportation plan to Year 2030. The Year 2000 was selected as the calibrated model base year largely due to the release of the 2000 U.S. Census data, the 2000 CTPP, and the Des Moines Area MPO's purchase of an add-on survey to the 2001 NHTS.

This report has six chapters, including the introduction, and three appendices. The second chapter describes the model inputs including network, screenlines, TAZ, land use, and NHTS data. The third to fifth chapters discuss the trip generation model, the trip distribution model, and the trip assignment model, successively. Chapter six provides the result of the model validation with the Model Validation and Reasonableness Checking Manual by Travel Model Improvement Program (TMIP), 2001. Appendices include TransCAD modeling procedures, TAZ data, and trip table. Figure 1 shows interstates, major streets, rivers, parks, and city boundaries of the Des Moines metropolitan area.

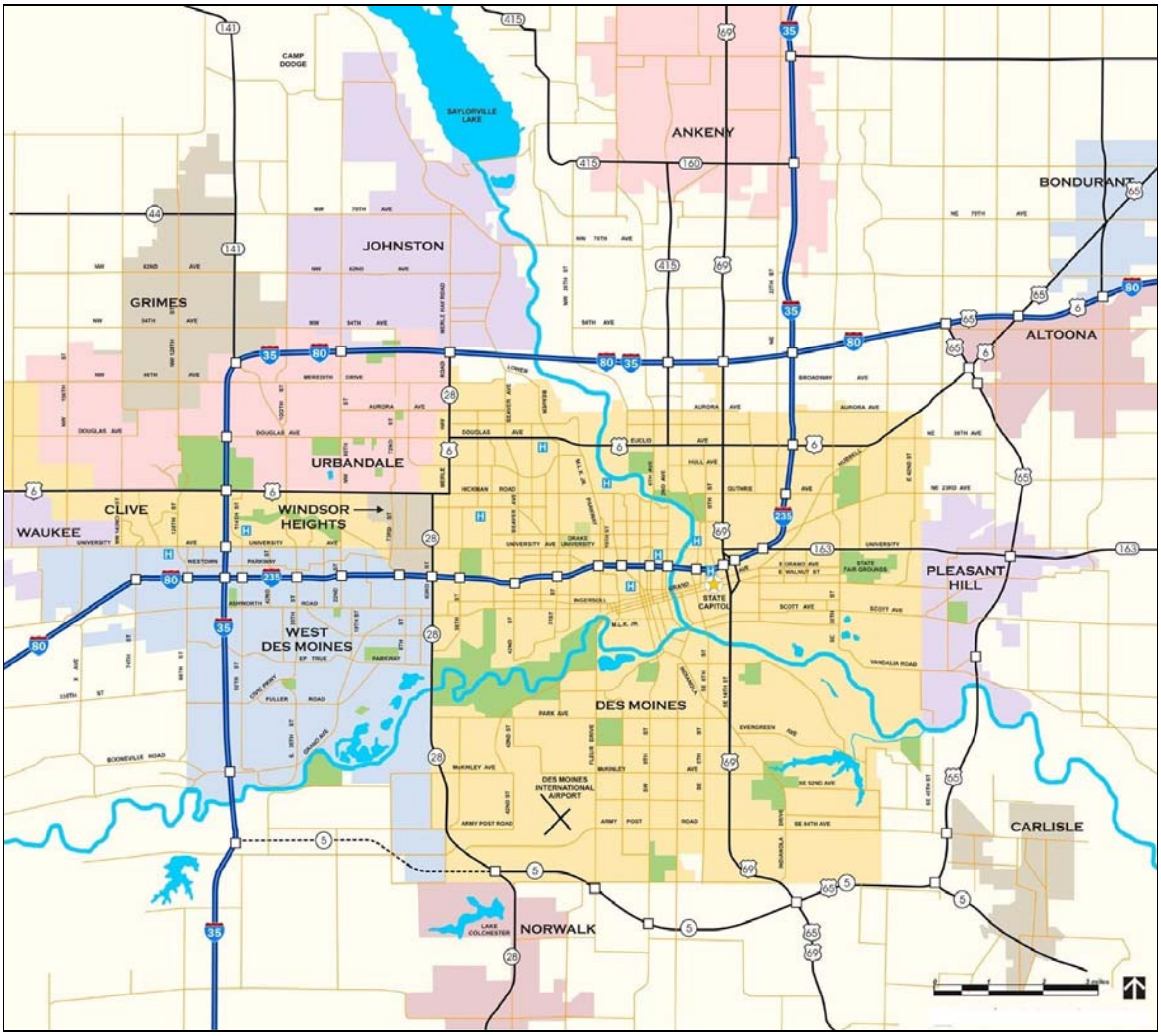

Figure 1 Geographical Features of Des Moines Metropolitan Area

2. Model Inputs

The two basic components of a travel forecasting model are the transportation network and socioeconomic data. The transportation network is a special data structure that stores important characteristics of transportation system and facilities. Socioeconomic data describe population, households, employment, and land use characteristics of the region by transportation analysis zone (TAZ).

Highway Network

The travel demand network's purpose is to represent the street and highway system operating in the planning area. The network depicts those streets, generally, that are functionally classified as collector and higher in the planning area's federal functional classification system. Streets are represented as lines, called links, in the travel demand network. Centroid connectors are represented on the network, not as links, but as generalized connections to the links. Other information about the network's streets and highways is incorporated into the network through the travel demand modeling process. That other information includes number of lanes for that link (street); speed associated with that link; length, in miles; capacity; and other additional information that may affect a trip along that link (Figure 2). Daily directional capacities at level of service (LOS) D with different facility types of Des Moines Area's travel demand model are shown in Table 1.

The location of each node and link is to provide a unique identification consistent with the U.S. State Plane Coordinates (North America NAD 83, Zone 1402). In order to develop an accurate representation of the major corridors within the Des Moines Area MPO boundary, the geographic street files from the Iowa Department of Transportation (DOT) were used as a base network.

Centriods represent the center of activity of a TAZ. They should be located in the center of existing development for model. They should represent, as closely as possible, local streets within the TAZ, and the nodes connecting them with the roadway network should represent reasonable access points. Zones should not be split by any major physical barriers. The size and density of zones should be corresponded to the level of detail of the coded highway network.[1]

The Des Moines Area MPO developed a computerized street and highway network to represent existing roadway conditions in the planning area using TransCAD software. Figure 3 shows the travel demand model network of the Des Moines planning area.

Dataview1 - Highways/Streets

ID	Length	Dir	Street	From	To	FFC	Speed	[TOTAL LANES]	[Total Capacity]	Count_Year_DOT	Count_DOT	Flow2000
3924	0.01	1	I-235 (SB)	Guthrie Avenue south ramp	Easton Boulevard N. ramp	Interstate	55.00	2	40620	2000	27650	38502
1406	0.01	1	15th Street	I-235 north ramp	I-235 south ramp	Principal	35.00	4	28130	2000	18000	14765
4534	0.01	0	Mulberry Street	8th Street	8th Street (lower)	MinorA	25.00	4	23360	2000	13200	8166
3034	0.01	0	100th Street diagonal	I-35/80 north ramp	I-35/80 south ramp	MinorA	35.00	4	34240	2000	9500	9959
4533	0.01	0	Mulberry Street	9th Street (lower)	9th Street	Collector	25.00	4	23360	2000	14200	5146
2614	0.01	0	1st Avenue N (Altoona)	I-80 north ramp	I-80 south ramp	MinorA	45.00	2	11240	2000	1800	3643
3038	0.01	0	University Avenue	I-35/80 west ramp	I-35/80 east ramp	MinorA	35.00	4	34140	2000	22400	24427
1677	0.02	0	1st Avenue N (Altoona)	I-80 north ramp	I-80 south ramp	MinorA	45.00	4	23430	2000	5400	4824
1791	0.02	0	Pleasant Hill Boulevard	SE Diagonal	Vandalia Road	MinorA	45.00	2	11590	2000	5660	1961
1713	0.01	1	Center Street	9th Street	8th Street	MinorA	25.00	2	12250	2000	2400	4116
2715	0.02	0	Hickman Road	114th Street	100th Street	Principal	50.00	4	34140	2000	24200	17333
4542	0.01	0	42nd Street	I-235 north ramp	I-235 south ramp	MinorA	30.00	2	15330	1996	15400	14523
2530	0.01	1	School Street	5th Street	3rd Street	Local	25.00	2	12250	1988	3430	6458
1599	0.01	0	Hubbell Avenue	E University Avenue	E 22nd Street	MinorA	30.00	4	23360	1996	14400	16608
3816	0.02	1	19th Street	Day Street	I-235 ramp	Principal	30.00	3	21070	1998	853	4557
2611	0.03	0	King Parkway	I-35/80 south ramps	Morningstar Drive	MinorA	55.00	4	23430	2000	2870	5135
1714	0.01	1	8th Street	9th Street	Center Street	MinorA	25.00	2	12250	1996	5900	5152
3060	0.01	1	9th Street	8th Street	Center Street	Collector	25.00	2	12250	2000	9000	5771
3322	0.03	1	I-235 (EB)	19th Street ramp	Keo Way west ramp	Interstate	55.00	3	60935	2000	55200	63370
3226	0.04	1	I-235 (EB)	12th Street ramp	7th Street ramp	Interstate	55.00	3	60935	2000	61481	65989

Figure 2 Attributes Table of Links

[1] Model Validation and Reasonableness Checking Manual, Travel Model Improvement Program, June 2001

Table 1 Daily Directional Capacity of Link

Number of Lanes	Turn Lanes	Access Condition (side friction)							
		Minimal		Light (Residential)		Moderate (Mixed Zoning)		Heavy	
		Facility Code	Capacity	Facility Code	Capacity	Facility Code	Capacity	Facility Code	Capacity
2 Lanes Undivided	Gravel	1	2,500						
	Without turn lanes (2 Lane div. w/o turn lanes)	2	6,030	3	5,795	4	5,620	5	5,195
	With left turn lanes (2 Lane div. with turn lanes) (3 Lane two-way unbalanced)	6	7,980	7	7,665	8	6,980	9	6,965
3 Lane	With center turn lane	10	7,955	11	7,640	12	6,955	13	6,940
4 Lanes Undivided	Without turn lanes	14	12,145	15	11,715	16	11,680	17	10,955
	With left turn lanes	18	16,045	19	15,465	20	15,430	21	14,540
5Lanes	With center turn lane	22	16,020	23	15,440	24	15,405	25	14,515
4 Lanes Divided	Without turn lanes	26	13,540	27	13,080	28	13,045	29	11,670
	With left turn lanes	30	17,720	31	17,120	32	17,070	33	16,230
	With left and right turn lanes (With left and right turn lanes and frontage roads)	34	18,770	35	18,120	36	17,215	37	17,190
6 Lanes Divided	Without turn lanes	38	20,340	39	20,715	40	19,615	41	18,690
	With left turn lanes	42	26,620	43	25,715	44	25,115	45	24,490
	With left and right turn lanes	46	28,180	47	27,220	48	27,170	49	25,930

One Way Arterial Streets- Outside CBD

Number of Lanes	Facility Code	One-way Capacity
1 Lane	86	6,950
2 Lane	87	14,010
3 Lane	88	21,070
4 Lane	89	28,130

One Way Arterial Streets- CBD

Number of Lanes	Facility Code	One-way Capacity
1 Lane	90	5,500
2 Lane	91	12,250
3 Lane	92	18,900
4 Lane	93	25,480

Freeways- I-235 (Coded as one-way)

Facility	Facility Code	One-way Capacity		Two-way Capacity	
(I-235)	94	2 Lane	40,620	4 Lane	81,240
(I-235)	95	3 Lane	60,935	6 Lane	121,870
(I-235)	96	4 Lane	81,245	8 Lane	162,490
(I-235)	97	5 Lane	101,555	10 Lane	203,110

Freeways- I-35, I-80, I-35/80, Iowa 5, U.S. 65 (Coded as one-way)

Facility	Facility Code	One-way Capacity		Two-way Capacity	
(I-35, I-80, Iowa 5, US 65)	98	2 Lane	37,865	4 Lane	75,730
(I-35, I-80, Iowa 5, US 65)	99	3 Lane	58,425	6 Lane	116,850
(I-35, I-80, Iowa 5, US 65)	100	4 Lane	77,900	8 Lane	155,800
(I-35, I-80, Iowa 5, US 65)	101	5 Lane	97,375	10 Lane	194,750

Freeway Ramp Facilities

Number of Lanes	Facility Code	One-way Capacity
1 Lane	102	16,800
2 Lane	103	28,200
3 lane	104	35,200

Note: 2000 Des Moines Area Daily Directional Capacities at Level of Service D.
(Assumes "random arrivals" for traffic signal progression for all arterials.)

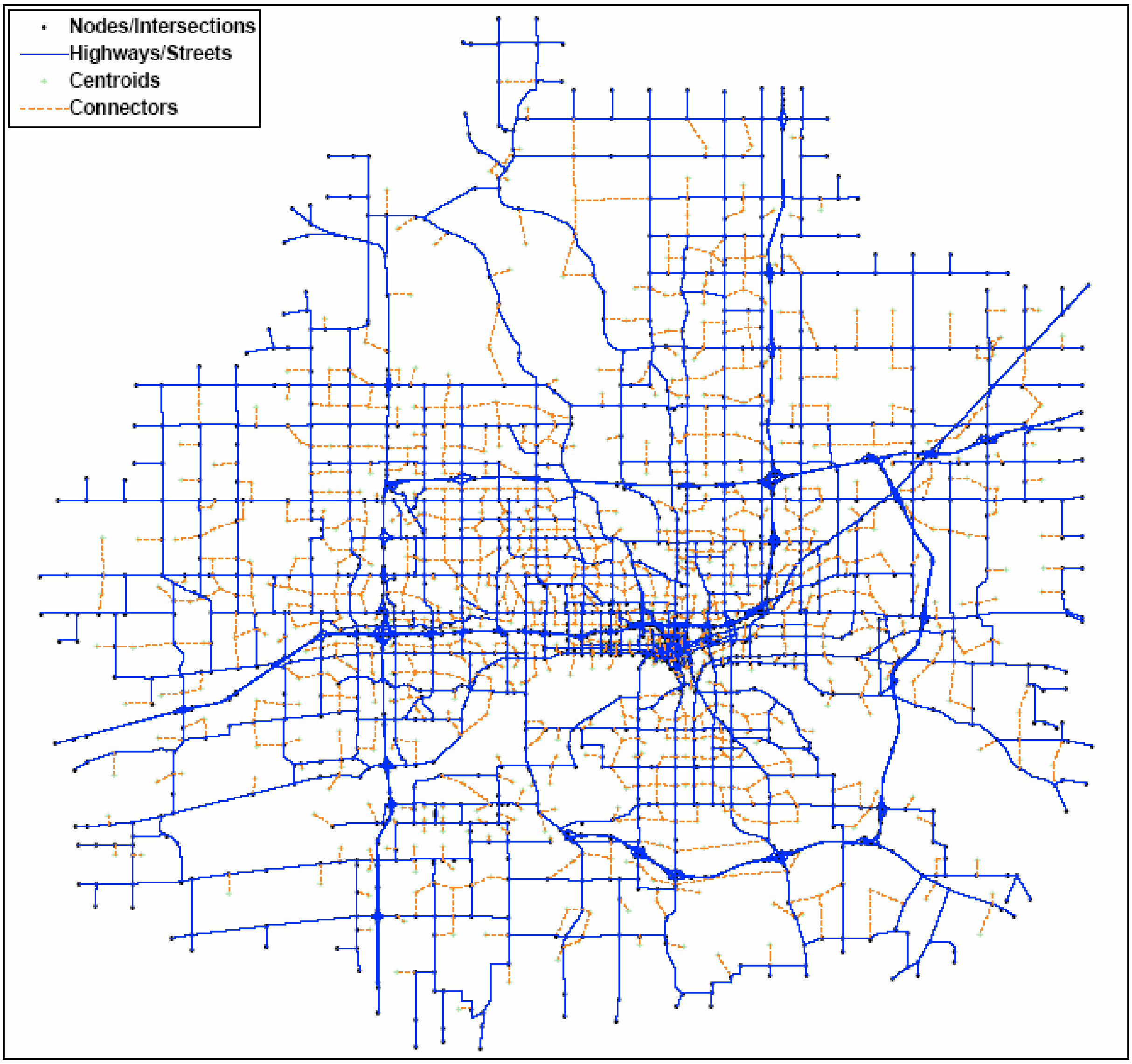

Figure 3 Travel Demand Network of Des Moines Area

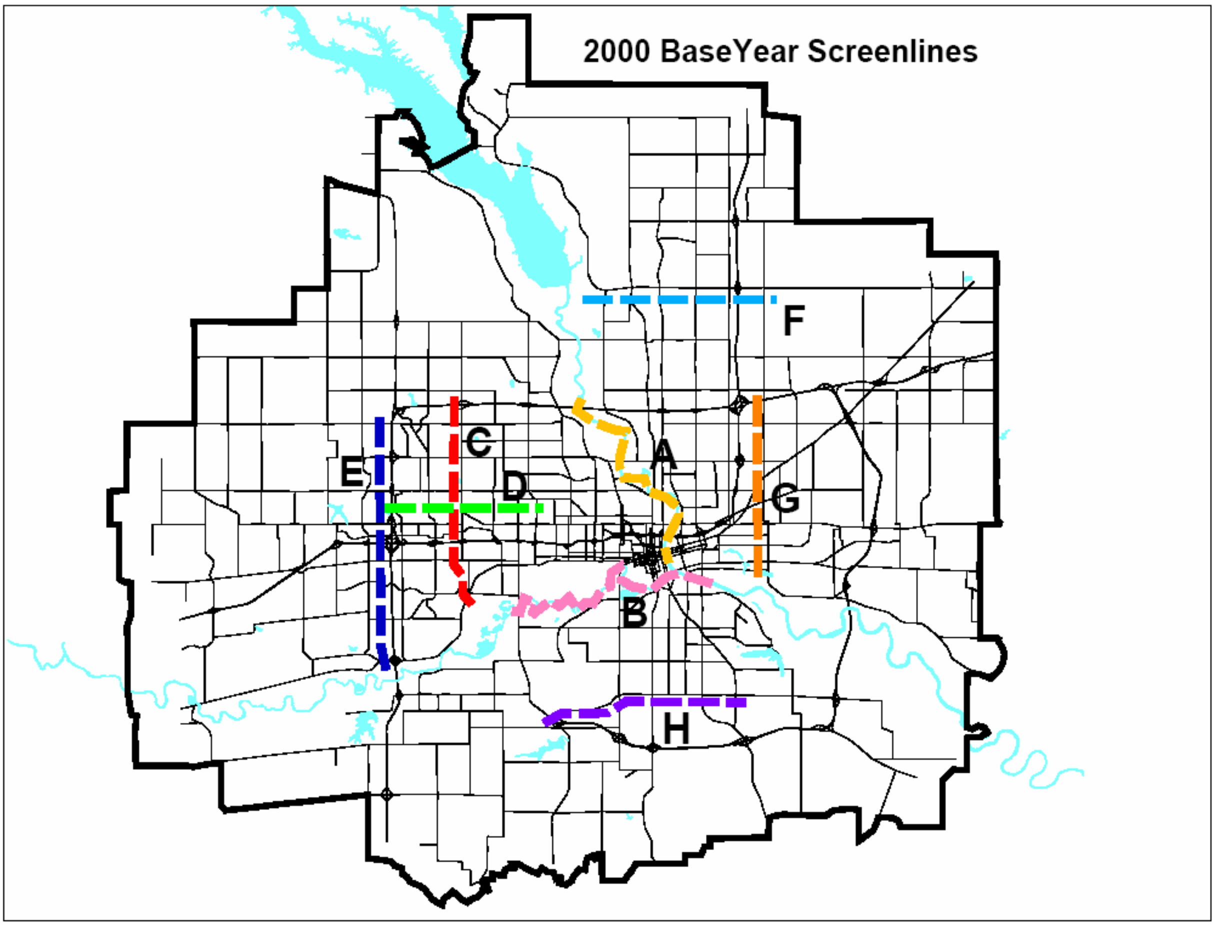

Figure 4 Screenlines of Des Moines Area Planning Area (2000)

Screenlines

Screenlines are imaginary lines that intersect one or more roads, which are used to evaluate traffic flows in an area. Screenlines are identified to monitor travel patterns in the study area and compare forecast traffic volumes to observed traffic counts where network links cross each screenline. A total eight of screenlines of Des Moines planning area are shown in Figure 4.

Transportation Analysis Zone (TAZ)

Zones are subdivisions of geographical areas used in transportation planning to summarize demographic characteristics and travel data and represent the origins and destinations of travel activity within the region.

In general, the use of smaller zones can have a beneficial effect on trip assignment. The zones for aggregate models should be compact in shape, homogeneous in terms of characteristics, and equal in size in order to increase spatial precision in a trip assignment. For example, a residential neighborhood typically has its own TAZ or set of TAZs, as does a community's central business district or industrial area. The boundaries used for zones correspond to some common level of social or political division and should be defined with reference to the travel demand model network.

After the construction of the Des Moines area's travel demand model network was complete, the 642 of Traffic Analysis Zones (TAZ) were constructed based on US Census block, block group geography, and CTPP boundary. Socioeconomic data was assembled and assigned to TAZs using population and household data from the 2000 U.S. Census Summary File 1 (SF 1) at the census block geographic level. The census blocks were aggregated into TAZs and summed to establish the Base Year 2000 total population and total number of households for each TAZ within the Des Moines metropolitan area.

Another vital piece of the socioeconomic data was employment. TAZ level data for the Base Year 2000 total employment was obtained from the Third Quarter 2000 Iowa Workforce Development (IWD) *ES202* database. Using the CTPP *Part 2: Data by Place of Work* allowed for the comparison of the *ES202* data to the CTPP 2000 *Part 2*'s estimate of total number of workers by place of work. The CTPP 2000 *Part 2* data were not available in time to be used during the socioeconomic data assignment to TAZs. As observed in previous CTPP Status Reports, workers-at-work counts obtained from CTPP are usually smaller than the official reported employment total. In the Des Moines metropolitan area, the CTPP 2000 *Part 2* workers-at-work counts were lower than data provided by the Third Quarter IWD *ES202* database by nearly five-percent. The spatial distributions of socioeconomic data (population, household, and employment) by each TAZ are shown Figure 5, 6, and 7.

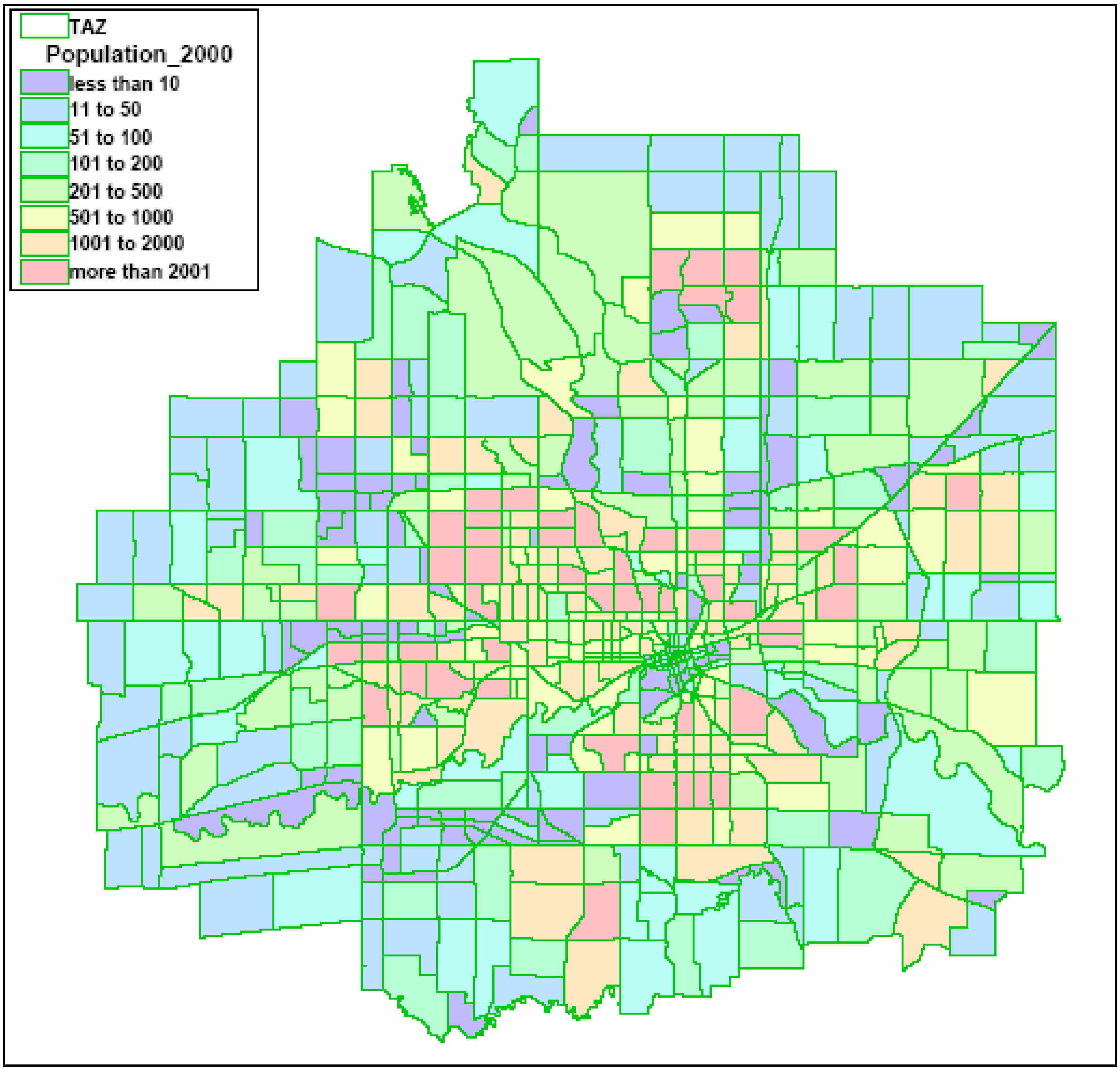

Figure 5 Distribution of each TAZ Population (2000)

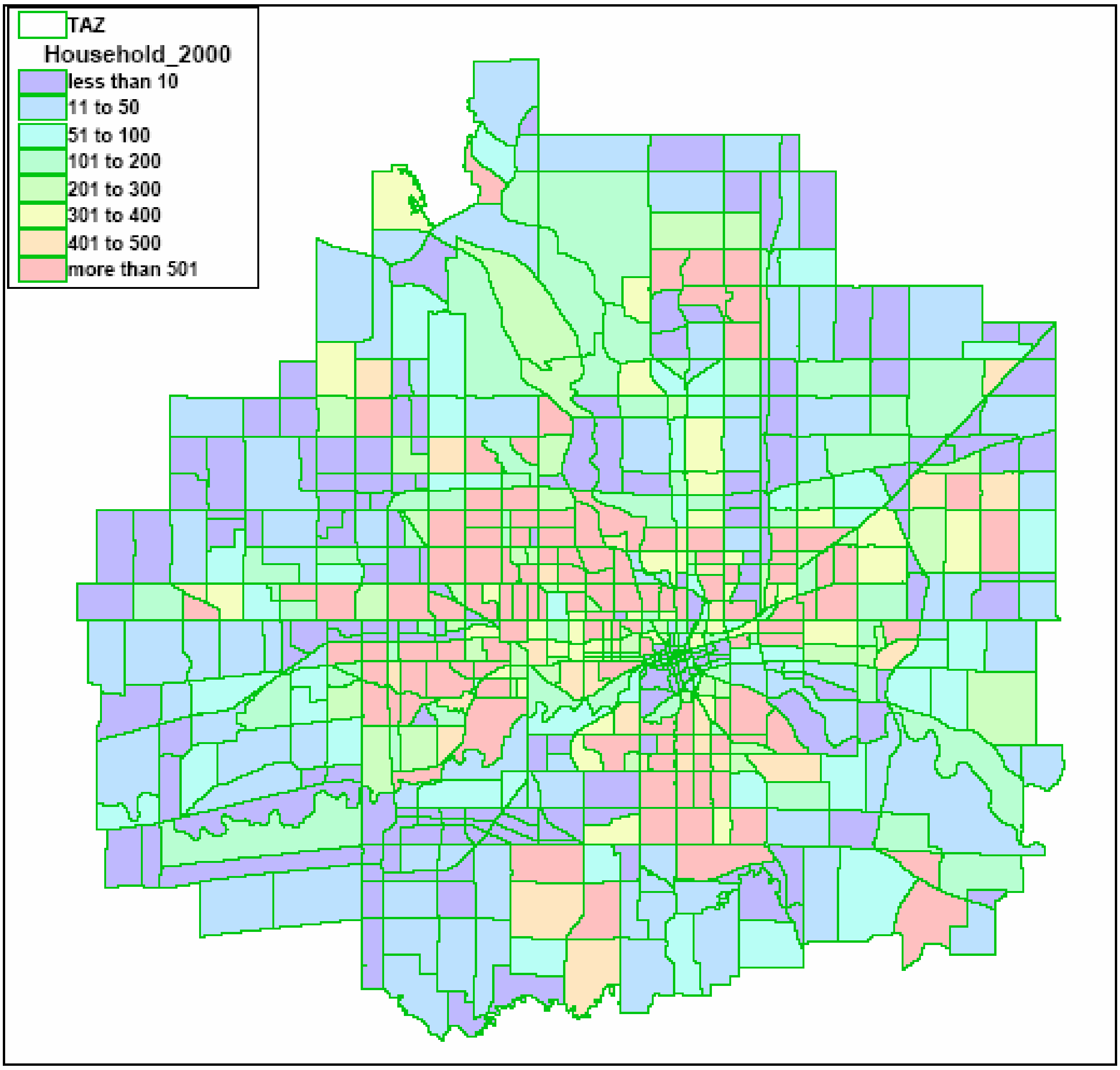

Figure 6 Distribution of each TAZ Household (2000)

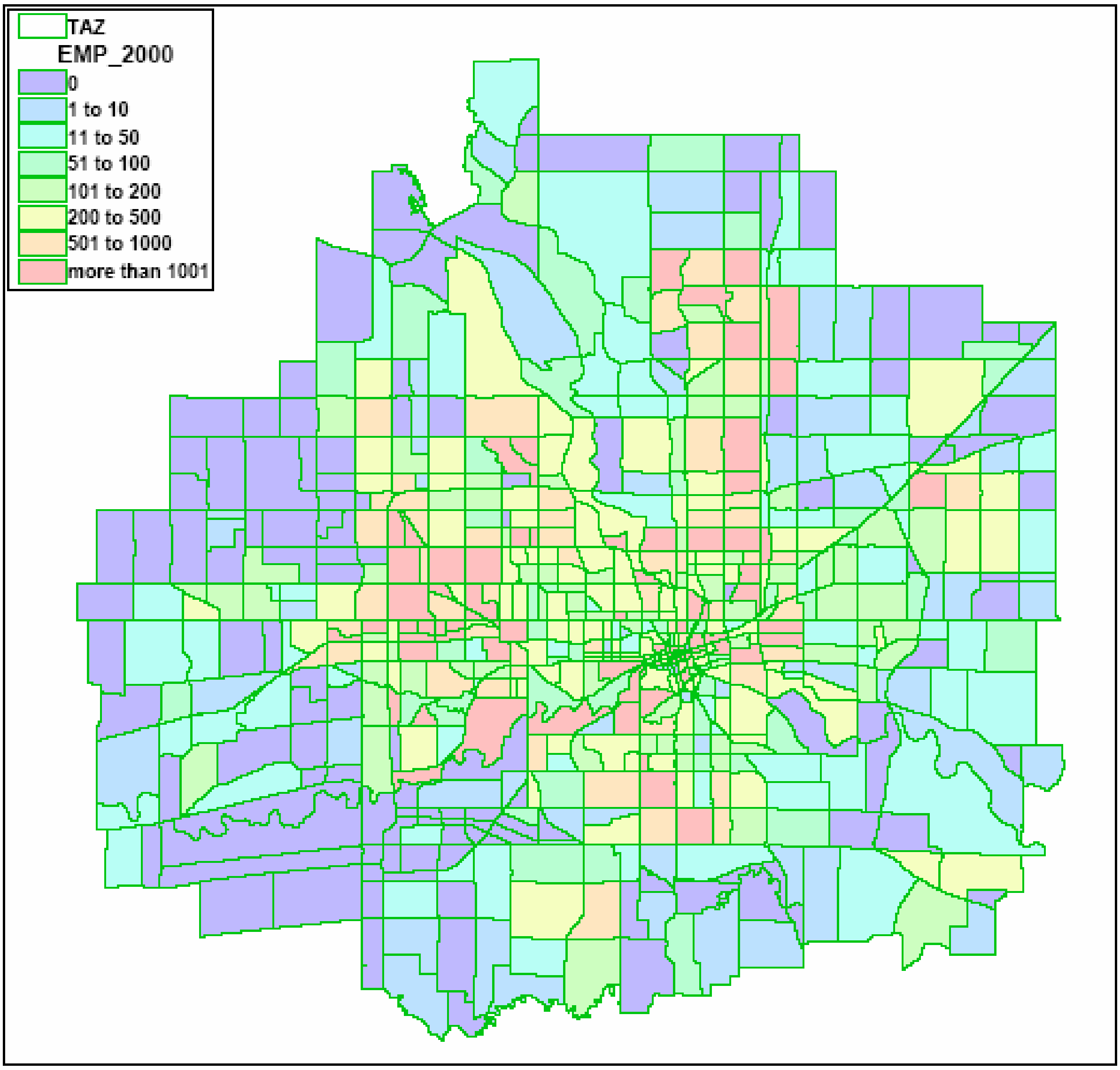

Figure 7 Distribution of each TAZ Employment (2000)

Land Use

The Des Moines Area MPO acknowledges the strong connection between transportation and land use. The connection is an important concept in transportation planning. Much of what happens to land use has transportation implications and transportation actions affect land use. Various land use designations require a need for transportation and infrastructure improvements to generate a demand for land use development.

The Des Moines Area MPO worked all of with the Metro Area's Planning Director's to produce the first generalized future land use map for the Des Moines metropolitan planning area. The comprehensive plan compilation map is illustrated in Figure 8. This map had successfully generated discussions among member governments regarding coordinated planning efforts. The Des Moines Area MPO uses land use information as a reference, and incorporates certain types of land uses in the travel demand modeling process by identifying special traffic generations such as airports, colleges, hospitals, regional activity centers, and large commercial areas.

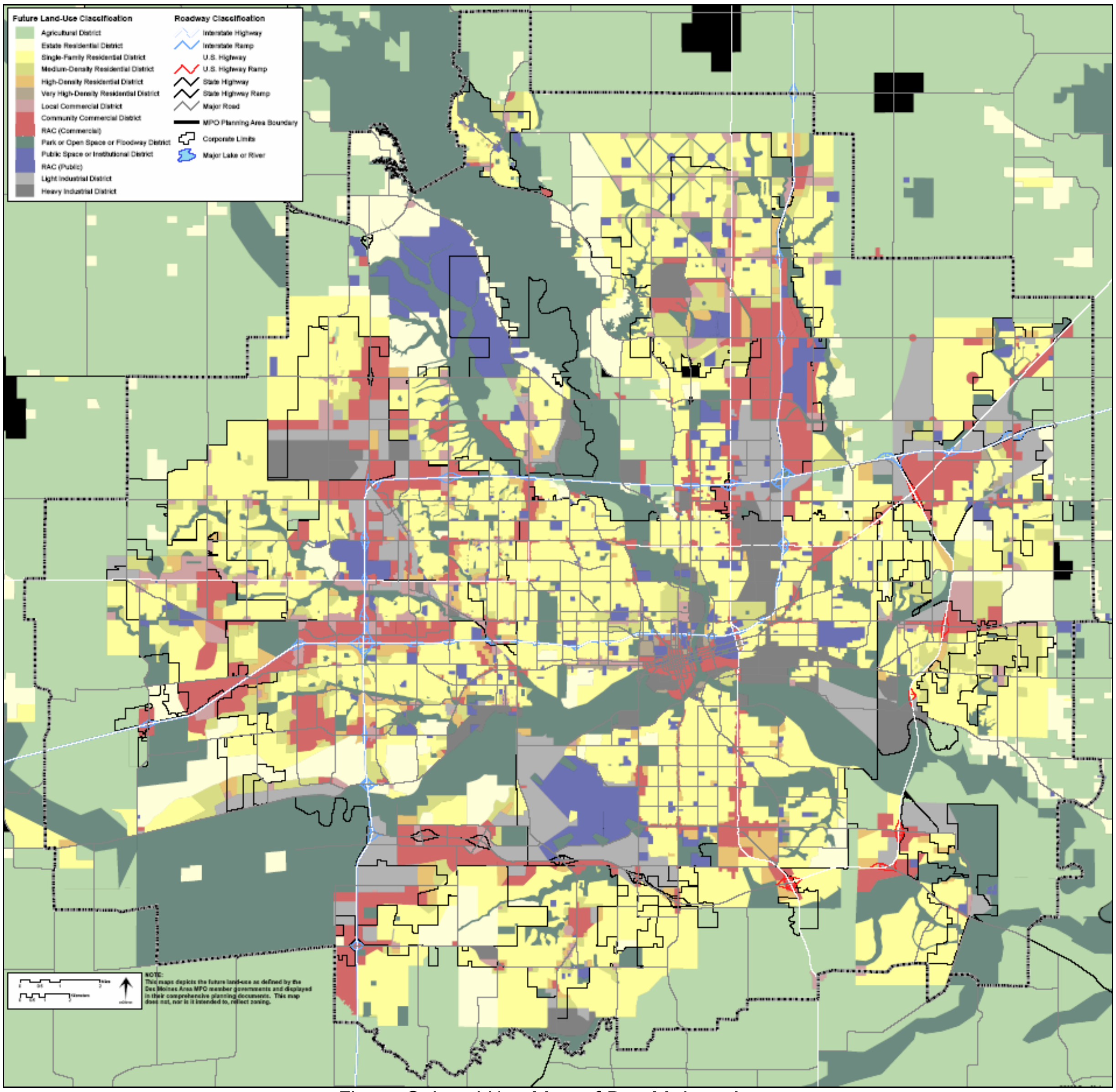

Figure 8 Land Use Map of Des Moines Area

Using land use information in the future will identify possible conflicting land uses, the relationship between land use and truck routes, and/or the relationship between land use and roadway classifications. Along with traffic generation rates for land use types, this land use information will be useful in assessing the needs for future transportation system improvements in the Des Moines metropolitan area.

National Household Travel Survey (NHTS)

An important, essential use of the 2001 NHTS Add-on data in the Des Moines metropolitan area is the survey's input in the Des Moines Area MPO's travel demand model.

In early 2000, the opportunity to participate as an Add-on to the 2001 NHTS arose. The Des Moines Area MPO purchased 1,231 NHTS Add-on surveys for a four-county area, the three counties (Polk, Warren, Dallas) in the Des Moines Metropolitan Statistical Area (MSA) plus one additional county (Madison) expected to join the Des Moines MSA with the release of the 2000 U.S Census data.

The 1,231 NHTS Add-on survey respondents were geographically located within the four-county area. Households in Polk County, the most populous county in Iowa, completed 597 surveys and accounted for nearly half of all the responses. In Dallas County, the fastest growing county in the state of Iowa, 262 household surveys were completed. Households in Warren County completed 241 surveys, and 131 surveys were completed in Madison County. The survey responses were weighted based on their geographic location and population, and then limited to the Des Moines Area MPO Planning Area Boundary. The 2001 NHTS Add-on recorded total of 7,506 vehicle trips prior to weighting.

Travel Time

The 2001 NHTS Add-on data for the four-county central Iowa area shows that the most heavily traveled three days of the week in terms of vehicle trips are Tuesday (17.4 %), Monday (15.8 %), and Friday (15.0 %). The remaining four days of the week rated as follows: Saturday (14.6 %), Wednesday (13.2 %), Sunday (12.2 %), and Thursday (11.8 %).

Comparing vehicle trips to person trips from the 2001 NHTS Add-on data, the rankings change slightly as follows: Saturday (16.1 %) rated highest among person trip days, Tuesday (15.8 %), and Sunday (15.4 %). The remaining four days of the week rated as follows: Monday (15.3 %), Friday (14.1 %), Wednesday (12.3 %), and Thursday (11.1 %). As shown in Table 2, the days persons most typically travel are the weekend days and Tuesdays. While the rankings by day do shift from vehicle trips to person trips, Wednesday and Thursday are not among the three most heavily or typically traveled days of the week in either category.

Table 2 Distribution of Trips by Day

Day	Percent of Vehicle Trips	Percent of Person Trips
Monday	15.8 %	15.3 %
Tuesday	17.4 %	15.8 %
Wednesday	13.2 %	12.3 %
Thursday	11.8 %	11.1 %
Friday	15.0 %	14.1 %
Saturday	14.6 %	16.1 %
Sunday	12.2 %	15.4 %

Table 3 Distribution of Trips by Month

Month	Percent of Vehicle Trips	Percent of Person Trips
January	9.6 %	9.3 %
February	5.5 %	5.3 %
March	8.0 %	7.4 %
April	7.9 %	7.3 %
May	4.1 %	3.7 %
Jun	4.1 %	3.8 %
July	9.5 %	9.9 %
August	11.7 %	12.3 %
September	9.6 %	10.2 %
October	10.2 %	10.5 %
November	9.8 %	9.3 %
December	10.0 %	10.9 %

In terms of person trips, the afternoon/evening commute is the most heavily traveled time of day. The 2001 NHTS Add-on data has shown the peak travel times as follows: 1) 3:00 p.m. - 4:00 p.m. (9.1 %); 2) 4:00 p.m. - 5:00 p.m. (9.0 %); 3) 5:00 p.m. - 6:00 p.m. (8.9 %); 4) 11:00 a.m. - 12:00 p.m. (8.1%); and, 5) 12:00 p.m. - 1:00 p.m. (7.3 %). Surprisingly, according to the 2001 NHTS Add-on data, the morning commute hours of 7:00 a.m. to 8:00 a.m. and 8:00 a.m. to 9:00 a.m. rank sixth (7.3 %) and eleventh (5.0 %), respectively, in terms of person trips.

From Table 3, it is shown that several of the peak travel months are in the Summer and Winter. In ranking order, the most heavily traveled months, in terms of vehicle trips, are as follows: 1) August (11.7 %); 2) October (10.2 %); 3) December (10.0 %); 4) November (9.8 %); 5) January (9.6 %); 6) September (9.6 %); 7) July (9.5 %); 8) March (8.0 %); 9) April (7.9 %); 10) February (5.5 %); 11) June (4.1 %); and, 12) May (4.1 %).

Likewise, for person trips, several of the peak travel months occur in the Summer and Winter seasons. In ranking order, the most heavily traveled months, in terms of person trips, are as follows: 1) August (12.3 %); 2) December (10.9 %); 3) October (10.5 %); 4) September (10.2 %); 5) July (9.9 %); 6) January (9.3 %); 7) November (9.3 %); 8) March (7.4 %); 9) April (7.3 %); 10) February (5.3 %); 11) June (3.8 %); and, 12) May (3.7 %)

Based on this 2001 NHTS Add-on information, typical travel days shifted from Wednesday and Thursday to other days of the week, peak travel times were not centered as much around morning work commute times, and heavy travel months did not necessarily occurring in the spring and fall seasons.

Household, Person, and Vehicle Data

In the four county survey area, 1231 households were surveyed for the 2001 NHTS Add-on effort, equating to 184,740 households after weighting. Likewise, persons surveyed equaled 2,986, for a weighted total of 470,041 persons residing in the four counties. The 2001 NHTS Add-on data reported 2.5 persons per

Table 4 Average Number of Vehicles by Household Size

Household Size	Average Number of Vehicles
1	1.3
2	2.2
3	2.7
4	2.5
5	2.5
6	3.3
7+	2.7

Table 5 Average Number of Vehicles by Household Income

Household Income	Average Number of Vehicles
Less Than $5,000	1.8
$5,001 to $10,000	1.1
$10,001 to $15,000	1.4
$15,001 to $20,000	1.5
$20,001 to $25,000	1.5
$25,001 to $30,000	1.8
$30,001 to $35,000	1.8
$35,001 to $40,000	2.1
$40,001 to $45,000	2.1
$45,001 to $50,000	2.1
$50,001 to $55,000	2.2
$55,001 to $60,000	2.4
$60,001 to $65,000	2.4
$65,001 to $70,000	2.7
$70,001 to $75,000	2.6
$75,001 to $80,000	2.4
$80,001 to $100,000	2.6
More Than $100,000	2.6

Table 6 Average Number of Daily Person Trips by Age

Age Cohort	Average Number of Daily Person Trips
15 to 24	3.8
25 to 34	4.1
35 to 44	4.5
45 to 54	4.9
55 to 64	3.9
65 and older	3.7

household. Of those 2.5 persons per household, 1.9 are drivers aged 15 years or older. From the total population, 93.9 % of persons aged 15 years and older are reported as drivers.

Each household averages 2.1 vehicles, meaning there are more vehicles than drivers in the Des Moines metropolitan area. This finding corresponds with the national 2001 NHTS, which reported 1.8 drivers per household and 1.9 vehicles per household.[2]

Household size affects the number of vehicles per household. As shown in Table 4, the average number of vehicles owned by a household of two is 2.2, while the average number of vehicles owned by a household of six is 3.3. Table 2 shows the four county average numbers of vehicles by household size.

Household income also is a determining factor for the number of vehicles the household can access. As shown in Table 5, households earning $20,001 to $25,000 have average 1.5 vehicles, households earning $60,001 to $65,000 average 2.4 vehicles, and households more than $100,000 annually average 2.6 vehicles. Table 3 shows the average number of vehicles by household income level. Average number of vehicles per household peaked at the $65,001 to $70,000 income level, with 2.7 vehicles.

The number of person trips per day averaged 3.9. Females made an average 4.2 trips per day and males averaged 3.8 trips per day. Age, rather than gender, had a greater effect on number of daily trips. As shown in Table 6, persons aged 45 to 54 averaged 4.9 trips per day, making the greatest number of trips per day of any age cohort, while those aged 65 and older averaged only 3.7 trips per day, making the least number of trips per day of any age cohort. Table 4 shows the average number of daily trips per person by age cohort. Those age groups averaging more than four trips per day would likely have work, social activities, and children's activities increasing the number of daily trips over the other age cohorts.

Average Trip Lengths

An example of other general travel information determined from the 2001 NHTS Add-on data was that the mileage persons travel to work or social/recreational activities is longer than the mileage persons travel to run errands or obtain services. This would indicate that persons are willing to travel to reach their workplace or a social activity, but would rather do business closer to home or work for shopping and services. The average work trip length in the Des Moines metropolitan area is 10.7 miles and the average social/recreational trip length is 13.2 miles. Shopping/errand trips are an average 5.6 miles and medical/dental services trips are approximately 7.3 miles in length. By comparison, the average length of all trips is 8.3 miles. Clustering service type businesses around large corporate locations and housing developments could prove appealing to persons when selecting a home or workplace. Housing and workplace proximity are not necessarily deciding factors, however, when choosing those respective locations.

Vehicle Occupancies

Vehicle occupancies are higher for social/recreational activities (2.3 persons) and errand trips (1.8 persons) than for work trips (1.4 persons). This phenomenon is not surprising. Families or friends tend to go to social/recreational activities or run errands together, where persons are more likely to drive alone to work.

Annual Vehicle Mileage

Of those vehicle owners knowledgeable of miles vehicles are driven annually, the majority of vehicles (61.4 %) were driven fewer than 10,000 miles annually. More specifically, vehicles driven 5,000 miles or less totaled 35.5 % and vehicles driven 5,001 through 10,000 miles totaled 25.8 %. Other mileage percentages of note include: 10,001 to 15,000 annual miles driven (22.2 %); 15,001 to 20,000 annual miles driven (8.3 %); and, more than 20,000 annual miles driven (8.2 %). According to the U.S. Environmental Protection Agency, the average annual miles nationally for a passenger car is 12,500 miles and for a light truck is 14,000 miles.[3]

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[2] http://www.bts.gov/publications/highlights_of_the_2001_national_household_travel_survey/html/section_01.html, accessed January 2006

[3] http://www.epa.gov/otaq/consumer/f00013.htm, accessed January 2006

Table 7 Distribution of Annual Vehicle Mileage

Mile Cohort	Percent of Annual Mileage
Less than 5,000	35.5 %
5001 to 10,000	25.8 %
10,001 to 15,000	22.2 %
15,001 to 20,000	8.3 %
20,001 and more	8.1 %

Therefore, with a majority of vehicles driven under 10,000 miles annually, the Des Moines metropolitan area is below the national average. Accounting for this fact may be the age of the population in the Des Moines metropolitan area and/or the compactness of the region.

As explained earlier, average work trips and shopping/errand trips average only 10.7 miles and 5.6 miles, respectively. The services and employment opportunities the general population requires are all available in a compact area, with the Des Moines Area MPO Planning Area measuring only 499.7 square miles. Thus, there is not a need by the majority of the vehicles to be driven greater than 10,000 miles annually.

The State of Iowa ranks fourth in terms of the percent of total population aged 65 and over (14.9%).[4] According to the 2001 NHTS Add-on data, the average age in the four county central Iowa survey area was 34.4 years. These older populations tend to drive less than younger populations. As an example, the percentage of travel day vehicle miles traveled by the 21- to 25-age cohort was 3.6 %, while the 71- to 75-age cohort traveled 2.0 % of the travel day vehicle miles.

Vehicle Type

The majority (56.2 %) of household vehicles owned in the four-county survey area were automobiles/cars/station wagons with pickup trucks a distant second place (16.0 %). Combined, sport utility vehicles and vans were 23.9 % of the total household vehicles owned.

Work Trips

Work trips made by public transit/commuter/school bus amounted to 1.1 % of total work trips, while work trips made by car/sport utility vehicle/van/pickup truck amounted to 93.2 % of total work trips. By comparison, work trips made by walking and taxicab/ motorcycle/bicycle accounted for 4.2 % and 1.5%, respectively, in the four-county area.

[4] http://www.prb.org/Template.cfm?Section=PRB&template=/ContentManagement/ContentDisplay.cfm&ContentID=8429, accessed. January 2006

3. Trip Generation

Trip generation is the travel demand modeling step involving locating zones where trips are generated and, in turn, locating zones where generated trips are attracted. This process is often completed by identifying places of residence and places of employment, commonly expressed as socioeconomic data, and assigning those places to a geographic location. The collected socioeconomic data, as described in the previous section, are also incorporated into the travel model.

The 2001 NHTS Add-on recorded a total of 7,506 vehicle trips, prior to weighting. These trips were classified and queried. Each trip recorded in NHTS Add-on was stratified into three purpose:

1. Home Based Work (HBW): Any trip that has home at one end and work at the other. This is a typical trip purpose that is obviously related to the employment and the income of the travel or the household.

2. Home Based Other (HBO): Any trip that has home at one end and does not have work at the other. This includes trips made for shopping, school, social visits, recreational trips, or personal-business.

3. Non-Home Based (NHB): This includes any trip that does not start or end at home.

The trip generation model consists of the trip production model by purpose and the trip attraction model by purpose.

Trip Production Model

The goal of the trip production model is to estimate the total number of trips, by purpose, produced or originated in each zone. The number of trips produced in any particular TAZ is usually determined using trip production rates based on that TAZ's socioeconomic or demographic information.

There are two primary methods that are used in developing trip production model: Cross-Classification and Regression Models. While earlier trip generation models were based on the regression model, most of the recently developed models are now based on cross-classification. Cross-classification methods are better than regression models in their ability to handle non-linear function of variables and to calibrate using the disaggregate household data, which requires a smaller sample size than is required for more aggregate zone level calibration. The use of disaggregate data can be reduced errors due to averaging[5]. The Des Moines Area MPO's trip production model is structured as a cross-classification. The data results from 2001 NHTS were used to develop the Des Moines Area MPO's trip production rates. The Des Moines Area MPO's cross-classification is based on household size (1, 2, or 3+) and number of automobiles available (1, 2, or 3+). These cross-classified households then were analyzed to determine updated cross-classification trip production rates.

The CTPP 2000 *Part 1 Data by Place of Residence, Table 1-063* was used to determine the estimated number of households in each cross-classification category, household size by auto ownership. The estimated number of households were conjoined with the updated cross-classification trip production rates to calculate the total number of productions for each TAZ. Data from the CTPP 2000 *Part 1 Table Number 1-063* was extracted at the TAZ level. The extracted data provided the estimated household totals for nine household cross-classification categories assigned to their respective TAZ. Cross-classification percentages were derived from the CTPP data, and used with the 2000 U.S. Census SF 1 data total number of households, table number P015001, previously assigned to the TAZ data. *CTPP 2000, Table 1-063, and 2000 U.S. Census SF 1 Table Number P015001* for households were used with trip production rates to determine the total number of trips for each TAZ. The total number of HBW, HBO, and NHB trips then were compared to the weighted results from the 2001 NHTS Add-on.

[5] Model Validation and Reasonableness Checking Manual, Travel Model Improvement Program, June 2001

The number of households of 2001 NHTS Add-on data are stratified by household size and vehicles available in Table 8. Table 9 shows the trip production rates used in the trip generation model. All of the trip production rates were developed from the 2001 NHTS Add-on data. The commercial vehicle (CV) trip rates are developed by regression method with variables such as dwelling unit, retail employment, and other employment (= total employment – retail employment). The number of total trips excluded Internal-External trips and effects of special generators of each cross-classification by trip purpose are shown in Table 10.

Table 8 Number of Households by Vehicles Available in Households (4-County Totals)

Household Size	Vehicle Ownership			
	0	1	2	3+
1	7,485 (4.0 %)	34,520 (18.7 %)	6,160 (3.3 %)	1,475 (0.8 %)
2	2,210 (1.2 %)	13,360 (7.2 %)	37,495 (20.3 %)	10,010 (5.4 %)
3+	1,640 (0.9 %)	10,560 (5.7 %)	35,290 (19.1 %)	24,730 (13.4 %)

Table 9 Trip Production Rates

Trip Purpose	Household Size	Vehicles Ownership		
		1	2	3+
HBW	1	0.64	0.78	0.46
	2	0.74	1.53	1.90
	3+	1.10	1.93	2.29
HBO	1	1.97	2.49	1.84
	2	2.85	3.07	3.12
	3+	4.51	4.40	5.54
NHB	1	1.57	1.81	0.54
	2	1.83	2.14	1.83
	3+	5.96	2.47	3.01
CV	0.357 × Dwelling Unit + 0.263 × Retail Employment + 0.034 × Other Employment			

Table 10 Total Trips by Trip Purpose

Trip Purpose	Household Size	Vehicles Ownership		
		1	2	3+
HBW	1	19670	3917	463
	2	8555	49600	13565
	3+	10221	59325	46673
HBO	1	60547	12503	1851
	2	32948	99524	22275
	3+	135401	247275	129780
NHB	1	48253	9089	543
	2	21156	69375	13065
	3+	55379	75923	57404

Trip Attraction Model

Trip attractions are defined as the number of trips attracted to each zone, which is associated with the non-home end of trip. For attraction models, estimates relate to a number of explanatory variables, such as population, households, employment, density, and school enrollment.
Regression models are the primary method used to estimate trip attractions, because of the high correlation between the attraction trips made and explanatory variables such as employment. The trip attraction rates were developed from the 2001 NHTS Add-on data. The equations used to determine HBW, HBO, NHB, and CV attractions for all TAZ are listed below in Table 11. CV trips are same in both production and attraction model.

Table 11 Trip Attraction Models

HBW = 0.830 × Total Employment

HBO = 2.330 × Retail Employment + 0.8 × School Enrollment + 1.630 × Other Employment

NHB = 0.322 × Population + 0.710 × Total Employment

CV = 0.357 × Dwelling Unit + 0.263 × Retail Employment + 0.034 × Other Employment

Special Generators

Trip production and trip attraction models are for average or usual conditions and development types. Special generators are for zones or activity centers that have trip rates significantly different from standard trip rates. For each identified special generator within an urban area, trip productions and attractions are considered separately using individual trip production and attraction rates for special generators. Generally special trip generators include airport, recreational facilities, universities, malls, military bases, and so forth. ITE trip generation rates were used for special generator trips of Des Moines Area model. Thirteen zones containing large, unusual sites were selected as special generators. Percentages of total trips for each purpose in special generators are shown in Table 12 and the number of special generator trips are shown Table 13.

Table 12 Percentage of Total Trips for Each Purpose in Special Generators

TAZ	Special Generator	Production				Attraction			
		HBW	HBO	NHB	CV	HBW	HBO	NHB	CV
20	Lutheran Hospital	0%	0%	5%	5%	55%	25%	5%	5%
81	Airport Terminal	0%	0%	5%	3%	24%	60%	5%	3%
127	Truck stop	0%	0%	3%	40%	7%	7%	3%	40%
143	Merle Hay Mall	0%	0%	10%	5%	20%	50%	10%	5%
157	Drake University	3%	5%	5%	3%	55%	21%	5%	3%
193	Methodist Hospital	0%	0%	5%	5%	55%	25%	5%	5%
207	Southridge Mall	0%	0%	10%	5%	20%	50%	10%	5%
221	Truck Stop	0%	0%	3%	40%	7%	7%	3%	40%
332	Jordan Creek Town Center	0%	0%	10%	5%	20%	50%	10%	5%
362	DMACC	0%	0%	9%	4%	34%	40%	9%	4%
442	Adventureland	0%	0%	9%	5%	22%	50%	9%	5%
472	Retail Area	0%	0%	10%	5%	20%	50%	10%	5%
514	Valley West Mall	0%	0%	10%	5%	20%	50%	10%	5%

Table 13 Number of Trips in Special Generators

TAZ	Special Generator	Production				Attraction			
		HBW	HBO	NHB	CV	HBW	HBO	NHB	CV
20	Lutheran Hospital	0	0	414	414	4550	2068	414	414
81	Airport terminal	0	0	709	425	3403	8508	709	425
127	Truck stop	0	0	141	1886	330	330	141	1886
143	Merle Hay Mall	0	0	3368	1684	6737	16842	3368	1684
157	Drake University	358	597	597	358	6570	2509	597	358
193	Methodist Hospital	0	0	879	879	9668	4395	879	879
207	Southridge Mall	0	0	2996	1498	5992	14980	2996	1498
221	Truck stop	0	0	141	1886	330	330	141	1886
332	Jordan Creek Town Center	0	0	6776	3388	13552	33879	6776	3388
362	DMACC	0	0	975	433	3684	4334	975	433
442	Adventureland	0	0	0	1369	6025	13694	2465	1369
472	Retail Area	0	0	4157	2078	8313	20784	4157	2078
514	Valley West Mall	0	0	2800	1400	5600	14000	2800	1400

Balancing Productions/ Attractions

In trip generation, the number of trips produced will not invariably match the number of trips attracted. This is to be expected, since different models are used to predict productions and attractions. Table 14 shows a comparison of production and attraction trips including external-internal trips and special generators. The total number of regional trip productions must be equal to the total number of regional trip attractions for each of the trip purposes in other to apply the trip distribution model. To conserve trips, balancing methods are used so that the number of productions equals the number of attractions. Since the production equations are generally considered to be more reliable than the attraction equations, the number of trip attractions of all trip purposes were balanced to the estimated number of trip productions.

Table 14 Production and Attraction Comparison

Trip Purpose	Productions	Attractions	Difference
HBW	233,106	307,989	32.12%
HBO	527,308	597,948	13.40%
NHB	360,135	368,377	2.29%
CV	86,440	86,440	0.00%

External Trips

External stations are used to represent trips coming to or going from the study area. External trips are trips that have at least one trip end outside of the study area. External-External (E-E) trips or through trips have both the origin and destination of a trip outside of the study area. Internal-External (I-E) trips or External-Internal (E-I) trips have one trip end outside the study area.

The estimation of external trips assumes that counts of the average daily traffic (ADT) on each of the major highways entering the study area at the cordon line are available. The sum of the counts for all stations, representing total cordon crossings, are greater than the total number of external trips because through trips cross the cordon twice.[6] In practically, an external station does not have socioeconomic characteristics. Consequently, productions and attractions by trip purpose for external stations are developed by referencing the ground counts of the station.

There are total 93 external stations for the Des Moines Area MPO's model (Figure 9). Since the external-external trips mostly follow specific paths through the network, thirteen stations were manually selected to assign the external-external trips considering the ground counts at the external cordon. Table 15 summarizes the external trips by purpose. Internal-external trips are percentages of total ground counts. Percentage of I-E trips were calculated based on the count trends of cordon station and allocated by each trip purpose. All of the home-based trips can be considered attractions (internal-external), since the production-ends of the respective trips were homes in the region. While non-home-based trips have no directional distinction. An origin-destination matrix for the external-external trips at thirteen external stations is shown in Table 13. For future years, growth factors are used to update the external station volumes.

[6] Travel Estimation Techniques for Urban Planning, NCHRP Report 365, 1998

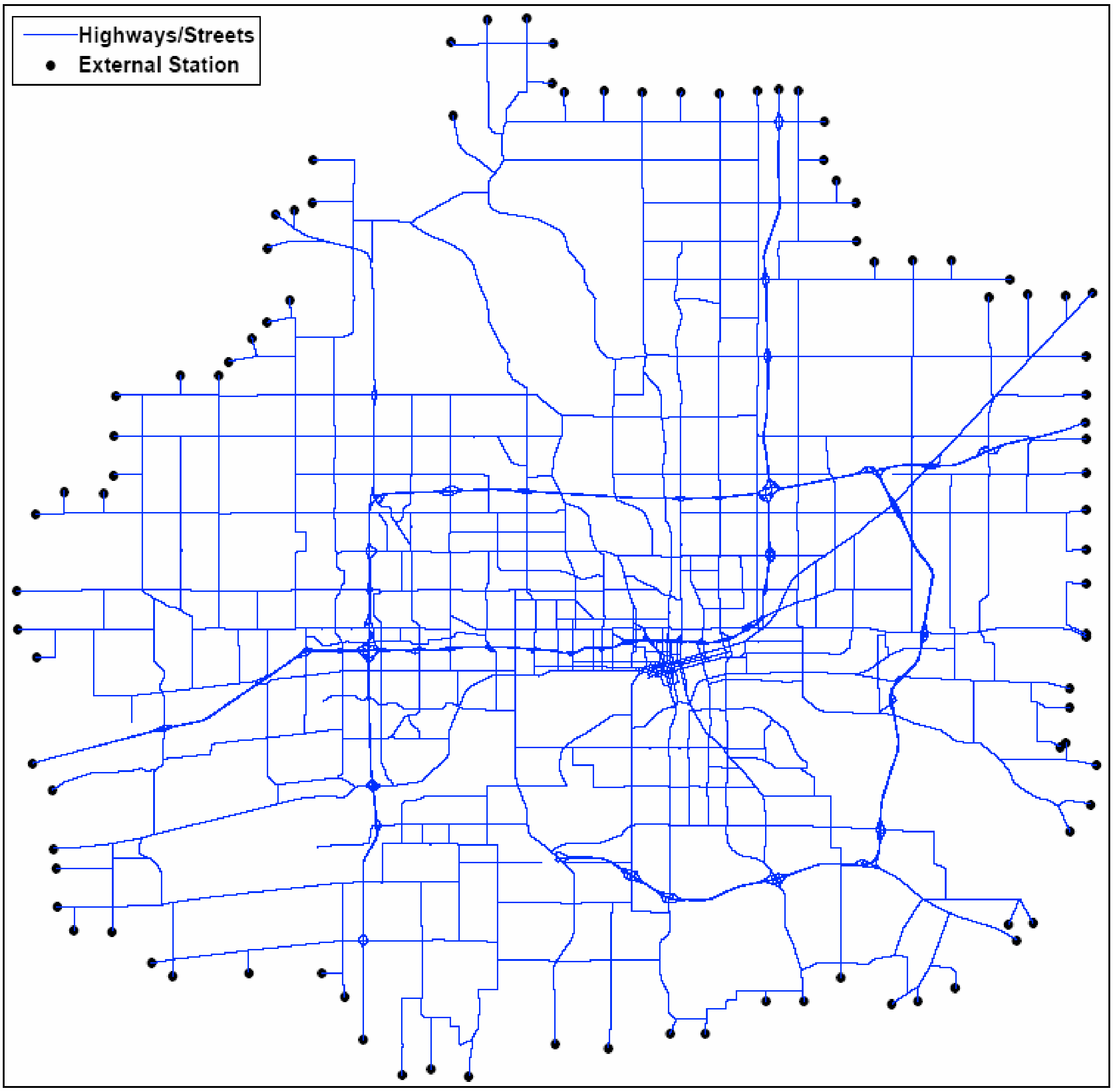


Figure 9 External Stations

Table 15 External Station Trips Based on Count Trends

External Station	TAZ	Ground Count (2000)	I-E Trips (%)	E-E Trips	Internal-External Trips					
					Productions			Attractions		
					HBW (15%)	HBO (10%)	NHB (5%)	HBW (35%)	HBO (25%)	NHB (10%)
I-80 West	601	32900	49	8390	2418	1612	806	5642	4030	1612
US 6 West	605	6400	98	64	941	627	314	2195	1568	627
Iowa 141 NW	620	8600	75	1075	968	645	323	2258	1613	645
US 69 North	632	4600	67	759	462	308	154	1079	771	308
I-35 North	634	25400	61	4953	2324	1549	775	5423	3874	1549
NE 72nd St. North	644	1150	52	276	90	60	30	209	150	60
US 65 NE	646	7200	85	540	918	612	306	2142	1530	612
I-80 East	650	34100	56	7502	2864	1910	955	6684	4774	1910
Iowa 163 East	657	12500	93	438	1744	1163	581	4069	2906	1163
Iowa 5 SE	667	7100	95	178	1012	675	337	2361	1686	675
US65/69 South	672	15600	88	936	2059	1373	686	4805	3432	1373
Iowa 28 South	677	4770	97	72	694	463	231	1619	1157	463
I-35 South	681	19600	68	3136	1999	1333	666	4665	3332	1333

Table 16 Origin-Destination Matrix for E-E Trips

TAZ	601	605	620	632	634	644	646	650	657	667	672	677	681
601				128	2300		338	4256			460		908
605					38				26				
620					62	48		455	76	41	71		322
632	128							271			96		264
634	2288	39	63					1533	230	74	198		529
644			43				48	81					104
646	353					26					30		131
650	4239		462	270	1533	90					45	72	792
657		25	70		232					63			48
667			33		56				51				38
672	478		76	100	206		30	47					
677								72					
681	904		327	261	528	113	125	789	54		36		

4. Trip Distribution

Trip distribution is the third step of travel demand modeling by which the production trips for each zone are linked to the attraction trips for each zone. The production and the attraction trips are balanced and are distributed among TAZs based on distance or on travel times.

The trip tables for each trip purpose are produced by the gravity model that has been extensively used for trip distribution. Basically, the gravity model predict that relative number of trips between two zones is proportional to the number of trips produced and attracted and is inversely proportional to the impedance between them. The measure of impedance between zones most commonly used for trip distribution is roadway travel time, calculated from the computerized transportation networks. The trip matrix by the gravity model is consistent with the number of productions in each zone and is not consistent with the number of attractions. Thus, a doubly-constrained growth factor was applied to preserve both forecasted productions and attractions.

Friction Factors

Friction factors are an inverse function of a measure of zone separation. Travel time by vehicle is commonly used as impedance. As travel time increase, the friction factor decreases. Trip length frequency distributions form the basis for model calibration because there is a reasonable degree of statistical significance to the average trip lengths and trip length frequency distribution data collected in household travel surveys[7].

The 2001 NHTS Add-on data was used to replicate the reported trip lengths. The 2001 NHTS Add-on trips were tabulated by trip purpose and graphed, to create a trip length frequency distribution. The trip length frequency distribution describes the shape of the curve that is summarized by the average trip length. The trip length distributions by trip purpose are shown Figure 10, 11, and 12. These curves display the average trip length in one minute.

Friction factors were created using the trip length frequency distribution and applied to the travel demand network to attempt to replicate the trip lengths reported in the 2001 NHTS Add-on. Friction factors by trip purpose are shown in Table 17.

Intrazonal Travel Time

The intrazonal travel time is the average travel for trips within the zone. The number of trips that stay within the zone are determined by the intrazonal travel time. TransCAD can calculate the intrazonal travel times along the shortest path matrix, by averaging the travel times between the origin zone and its closet neighbor zone. Three neighbor zones for the calculation of average travel time were chosen and a final factor, 0.5, was applied to the end result.

Convert PA to OD

Before a trip assignment, the production-attraction format of the trip table should be converted into an origin-destination format to get actual directions of trips between TAZs. Production-attraction format of trips expresses the directions going from home-end of the trip (production) to non-home end of the trip (attraction). That does not reflect the real directions from origin to destination. The conversion productions and attractions to origins and destinations was done with the P-A to O-D procedures of TransCAD.

[7] Model Validation and Reasonableness Checking Manual, Travel Model Improvement Program, June 2001.

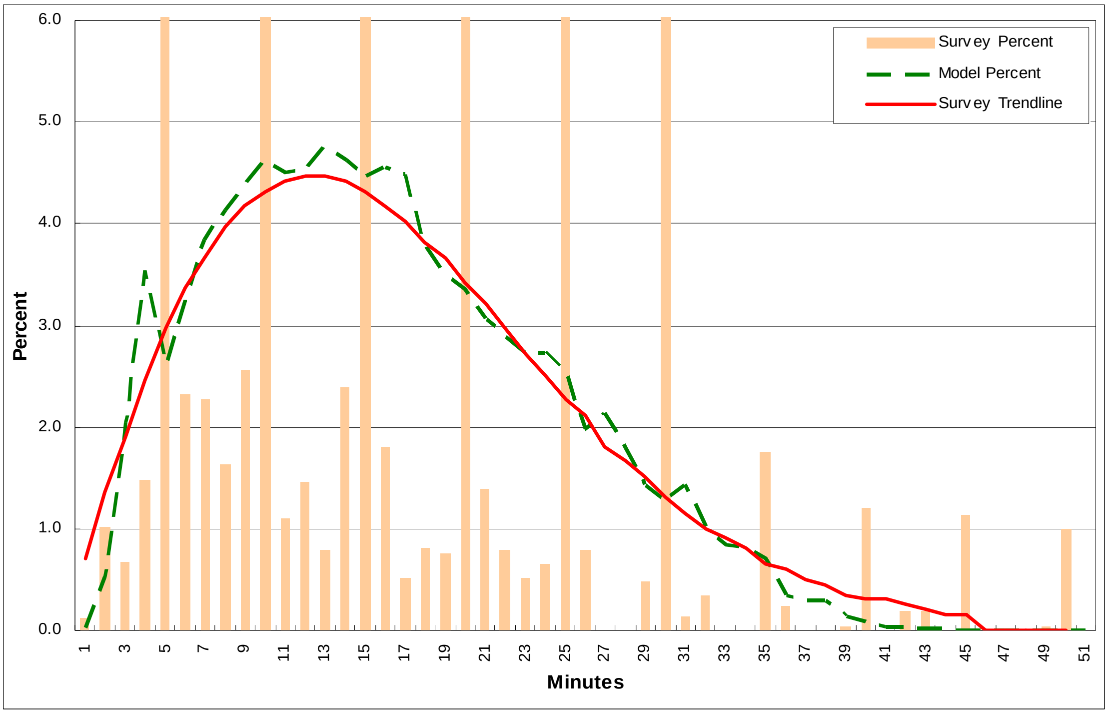


Figure 10 HBW Trip Length Frequency Distribution

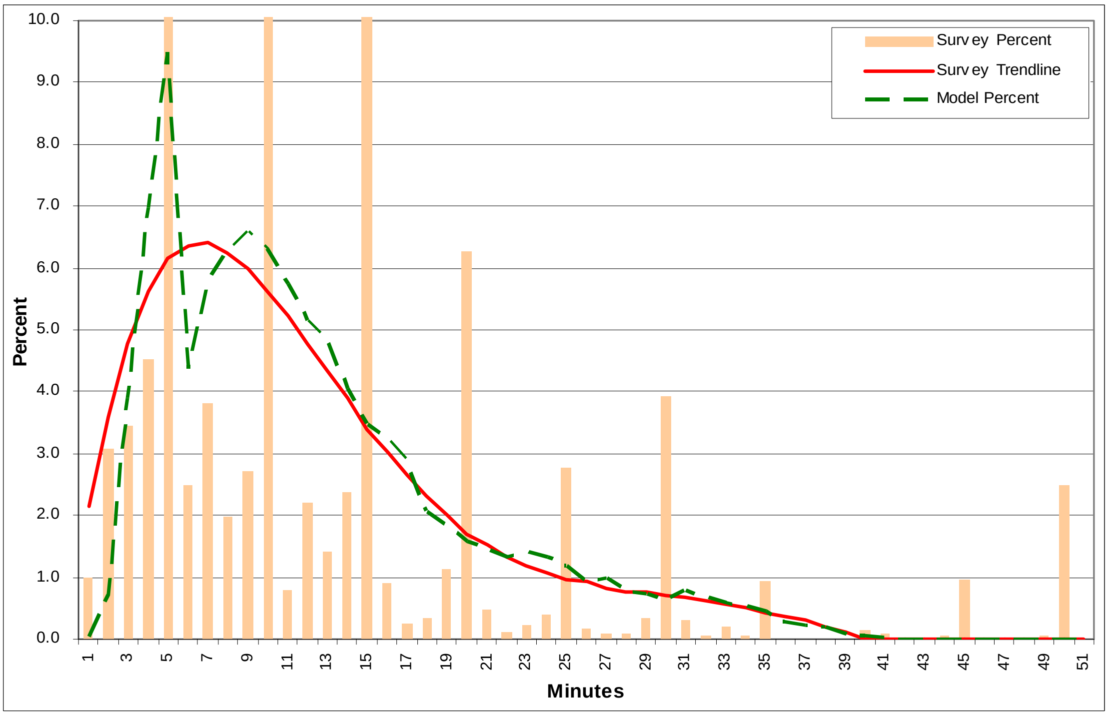


Figure 11 HBO Trip Length Frequency Distribution

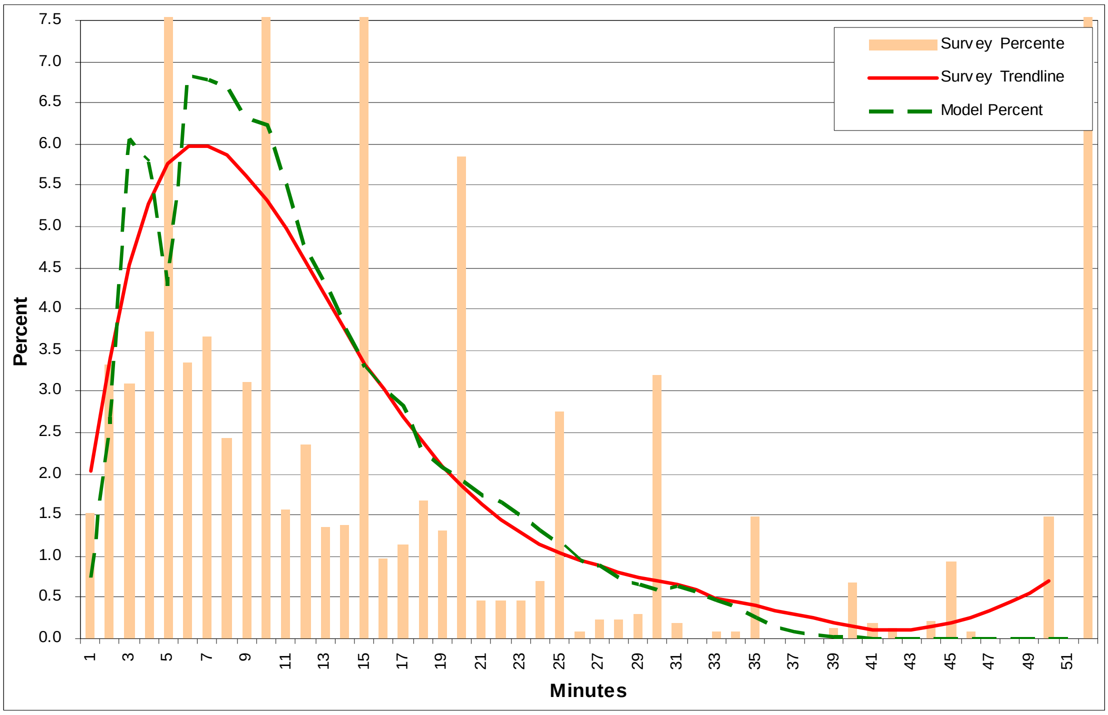


Figure 12 NHB Trip Length Frequency Distribution

Table 17 Calibrated Friction Factors

MINUTES	HBW	HBO	NHB	CV	IE
1	1350	2600	3200	7500	10000
2	1250	2500	3100	7000	8900
3	1000	2000	1960	6300	7800
4	395	1600	950	5600	6400
5	340	480	990	5000	5000
6	300	480	880	3000	3300
7	280	455	755	1100	1900
8	265	420	640	760	1250
9	260	365	545	500	870
10	255	320	450	380	670
11	245	275	370	270	530
12	235	230	305	230	420
13	230	190	255	195	345
14	215	155	215	170	290
15	195	130	185	150	240
16	185	110	170	135	205
17	170	85	155	120	170
18	160	80	155	106	145
19	165	75	155	97	125
20	165	75	155	88	110
21	165	75	165	80	98
22	170	85	165	74	88
23	185	90	165	67	80
24	200	100	165	62	73
25	220	110	175	57	67
26	240	125	205	52	61
27	265	145	235	48	56
28	290	175	280	44	52
29	310	205	375	41	49
30	340	255	460	37	45
31	360	320	560	33	42
32	385	400	700	32	39
33	410	510	820	29	37
34	440	640	810	27	35
35	470	780	800	25	33
36	465	770	790	23	31
37	460	760	780	21	29
38	455	750	770	19	27
39	450	740	760	18	25
40	445	730	750	16	24
41	440	720	740	15	23
42	435	710	730	14	21
43	430	700	720	13	20
44	425	690	710	12	18
45	420	680	700	11	17
46	415	670	690	10	15
47	410	660	680	9	14
48	405	650	670	8	13
49	400	640	660	7	12
50	395	630	650	6	11
51	390	620	640	0	10

5. Trip Assignment

In the trip assignment step, vehicle trips from one zone to another are assigned to specific travel routes between zones. Therefore, the output of assignment shows the number of vehicles on the roadway. The traffic assignment is usually based on the relative travel time along each available path, computed from roadway networks.

There are several methods for loading trips on the network: all-or-nothing assignment, STOCH assignment, capacity restraint assignment, incremental assignment, user equilibrium (UE), stochastic user equilibrium (SUE), and system optimum assignment (SO). The Des Moines MPO had tried to develop the travel model with different assignment methods and found the best result with the user equilibrium method. The Des Moines Area's model has used the user-equilibrium assignment. By definition, user equilibrium is reached when "no travelers can reduce his or her travel time from origin to destination by switching to another path." The network link flows are calculated with considering link capacity and link travel time using TransCAD.

The traffic assignment procedures in TransCAD update travel time iteratively based on volume-delay relationships. As traffic volumes increase, travel time increase due to increased congestion. The Bureau of Public Roads (BPR) function is one of the most commonly used link performance functions and has been used to estimate link travel times as a function of the volume-to-capacity ratio according to:

$$T_f = T_o \times \left(1 + \alpha \times \left[\frac{V}{C}\right]^{\beta}\right)$$

Where,

T_f	=	congested link travel time,
T_o	=	link free-flow travel time,
V	=	assigned link traffic volume (vehicles),
C	=	link capacity, and
α, β	=	volume/delay coefficients

In the Des Moines Area's Model, the coefficient values for α and β are set as 0.56 and 3.6, respectively. Figure 13 shows the effect of the BPR function on travel time with the α =0.56 and the β =3.6. As can be seen in the figure, the congested link travel time increase very slowly at V/C ratios less than 1.0 and rapidly at V/C ratios larger than 1.0. This speed adjustment is not applied to centroid connectors, since they are not real roads and not subject to the normal constraints on roadways.

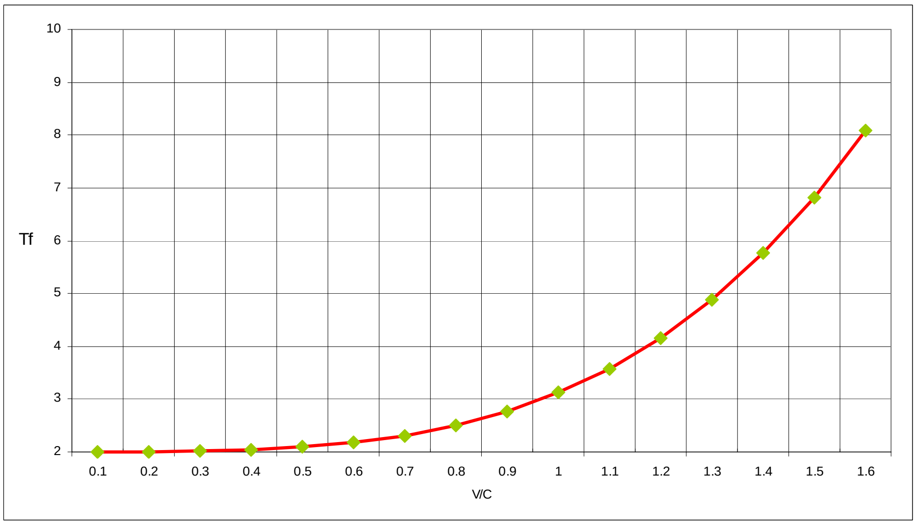


Figure 13 BPR Curve with α =0.56 and β =3.6

6. Model Validation

To ensure the accuracy of the travel demand model, the assignments of the model were validated by comparing the estimated model results to the actual traffic count data. The scatter plot, vehicle miles of travel (VMT), volume, root mean square error (RMSE), and screenline volumes are common methods for a travel demand model validation.

Scatter Plot

This is the comprehensive check for the trip assignment. Plot shows the assigned traffic volumes on each link of the network. These volumes are compared with actual traffic count data considering whether the trip assignment results seem reasonable in general and whether there are links with overestimated or underestimated volumes when compared in detail.

The graph plots values for the modeled volume (estimated) along the Y axis and the corresponding traffic count (observed) along the X axis. If all of the modeled counts perfectly matched the counts, R^2 would be 1.00 and the points on the graph would match up with the line of slope one (45 degree line) drawn in the graph below. Points above the 45 degree line are locations where the model overestimates traffic. Likewise, points below the 45 degree line are locations where the model underestimates traffic.

Figure 14 shows a scatter plot of estimated versus count traffic for all available count locations in the model network. At the time of this model, the 1,855 traffic counts were available for this comparison. The results of the comparison are good. The coefficient of determination, R^2, is 0.89, which is well above the guideline of 0.88 and indicates that the goodness of fit between modeled volumes and observed counts is good.

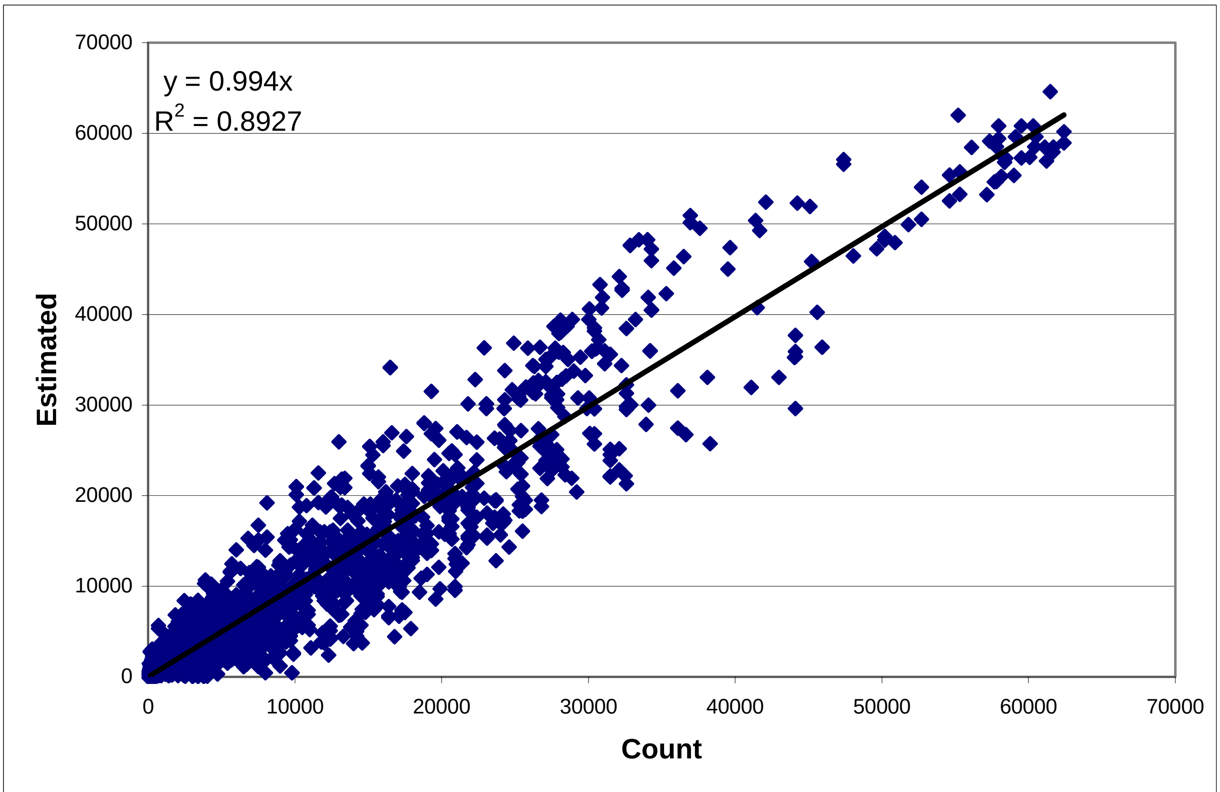


Figure 14 Estimated vs. Count Traffic Assignment Scatter Plot (2000)

Vehicle Miles of Travel (VMT)

Vehicle miles of travel (VMT) is obtained by multiplying the assigned volume and the distance of the link. Typical distribution of VMT by functional classification were analyzed and are presented in Table 18. VMT distribution of network by functional classification are freeway 42.9%, principal arterial 24.5%, minor arterial 23.1%, and collector 8.1%. This number is close to the acceptable range by FHWA manual.

Comparisons of VMT by functional classification is considered for checking the reasonableness of the model and are shown in Table 19. Difference between actual VMT and estimated VMT were calculated and compared. The VMT difference for freeway, principal arterials, minor arterials, and collectors were 11.15%, 2.05%, 11.42%, and 1.45%, respectively. The results of the comparison are good since if the VMT difference for arterials is 10% or less and collectors is 20% or less, then they are acceptable[8].

Table 18 Typical Distribution of VMT by Functional Classification

FFC	Urban Area Population[9]		Des Moines Area (390K, 2000)	
	Medium Urban (200K-1M, 1990)	Large Urban (>1M, 1990)	% of VMT	% of Length
Freeway (ramp)	33-38 %	40 %	42.91 %	17.89 %
Principal	27-33 %	27 %	24.57 %	14.19 %
Minor	18-22 %	18-22 %	23.07 %	25.17 %
Collector	8-12 %	8-12 %	8.07 %	27.74 %
Local	-	-	1.38 %	15.02 %

Table 19 Difference of VMT by Functional Classification

FFC	Estimated VMT	Count VMT	Absolute Error[10]	Average Error [11]	% Error[12]	Number of Links
Total	7853653	7611289	242364	130.70	3.19 %	1855
Freeway	3616095	3253263	362831	1524.50	11.15 %	238
Principal	1976574	1936905	39669	122.82	2.05 %	323
Minor	1552301	1751229	-198928	-316.74	-11.42 %	632
Collector	625589	617992	7597	17.56	1.45 %	509
Local	83092	51898	31194	203.88	60.11 %	153

[8] Model calibration and validation seminar by TMIP, FHWA
[9] Model Validation and Reasonableness Checking Manual, Travel Model Improvement Program, June 2001.
[10] Absolute Error = Estimated VMT - Count VMT
[11] Average Error = (Estimated VMT - Count VMT) / Number of Links
[12] % Error = ((Estimated VMT - Count VMT) / Count VMT) *100

In year 2000, the Des Moines Area MPO had a population of 395,174 and 158,339 households. VMT per household and VMT per person are shown in the Table 20. Regarding VMT per household, the acceptable range is 40 to 60 VMT per household and Des Moines model's result is 59.79. Estimated VMT per person is 23.96 while the acceptable range is 17 to 24 VMT per person.

Table 20 Typical Range of VMT/HH and VMT/person

	Small Urban (mile/day, 1990))	Large Urban (mile/day, 1990)	Des Moines Area (2000, mile/day)
VMT/HH	30-40	40-60	59.79
VMT/Person	10-16	17-24	23.96

Percent Error and Percent RMSE

Another method for model validating using traffic volume is comparing the estimated model results with traffic count data results according to the road classifications. The Federal Highway Administration (FHWA) and Michigan Department of Transportation (MDOT) defined targets with percent error by facility type as shown in Table 21.

Percent error and percent RMSE by road classification are shown on Table 21. Table 22 shows the difference by individual link's ADT. Acceptable range for percent error by FHWA is 5% and Des Moines model's result is 0.73%.

The percent root mean square error (% RMSE) is a measure of the relative error of the assignment compared to ground counts and can be calculated as follows:

$$\%RMSE = \frac{(\sum_j (Model_j - Count_j)^2 / (NumberofCounts - 1))^{0.5} * 100}{(\sum_j Count_j / NumberofCounts)}$$

Table 21 Percent Difference Targets for ADT by Facility Types (2000)

FFC	FHWA (1990)	MDOT (1993)	Number of Links	Average Error [13]	% Error[14]	% RMSE
Total	5 %	-	1855	-83	-0.73 %	35.78 %
Freeway	7 %	6 %	238	2732	8.91 %	20.10 %
Principal	10 %	7 %	323	-127	-0.73 %	29.73 %
Minor	15 %	10 %	632	-1105	-11.18 %	38.67 %
Collector	25 %	20 %	509	-217	-6.51 %	76.48 %
Local	25 %	-	153	302	44.28 %	153.18 %

[13] Average Error = (Estimated Volume - Count Volume) / Number of Links
[14] % Error = ((Estimated Volume - Count Volume) / Count Volume) *100

The % RMSE is often used to compare the accuracy between estimated and measured traffic volumes. The Montana Department of Transportation (MDT) suggests that acceptable range for the % RMSE by facility types is less than 30%. The Des Moines Area's model by facility types has 35.8% of percent RMSE. The percent errors by link volume cohort of Des Moines Area's model are under the acceptable range by FHWA manual.

Table 22 Percent Difference Targets for ADT by Individual Link Volume (2000)

ADT	FHWA (1990)	MDOT (1993)	Number of Links	Average Error	% Error	% RMSE
< 1,000	60 %	200 %	276	310	85.22 %	227.42 %
1,000 – 2,500	47 %	100 %	193	553	32.50 %	97.64 %
2,500 – 5,000	36 %	50 %	237	532	14.62 %	68.62 %
5,000 – 10,000	29 %	25 %	368	-474	-6.50 %	44.69 %
10,000 – 25,000	25 %	20 %	558	-923	-5.72 %	31.42 %
25,000 – 50,000	22 %	15 %	184	1996	6.37 %	23.14 %
≥ 50,000	60 %	200 %	39	-1102	-1.92 %	4.61 %

Screenline Volumes

As described in Chapter 2, the model was validated using screenlines of the highway network. Table 23 shows percent error and percent RMSE at each screenline.

The FHWA suggests that acceptable range for the screenline is 5-10% error on higher volume and 20% error on low volume. Michigan Department of Transportation (MDOT) has targets of 5% and 10% for screenlines and cutline, respectively. Travel Model Improvement Program (TMIP) Peer Review of Iowa Department of Transpiration (March, 2004) recommended 10% error for screenlines. The percent error of screenlines of Des Moines Area's model is 6.2% that is in acceptable range. NCHRP 255 provides the maximum desirable deviation in total screen volumes. With NCHRP 255 reference, most screenlines are within an acceptable level of error of traffic count totals.

Table 23 Deviation Targets for the Screenline Volume

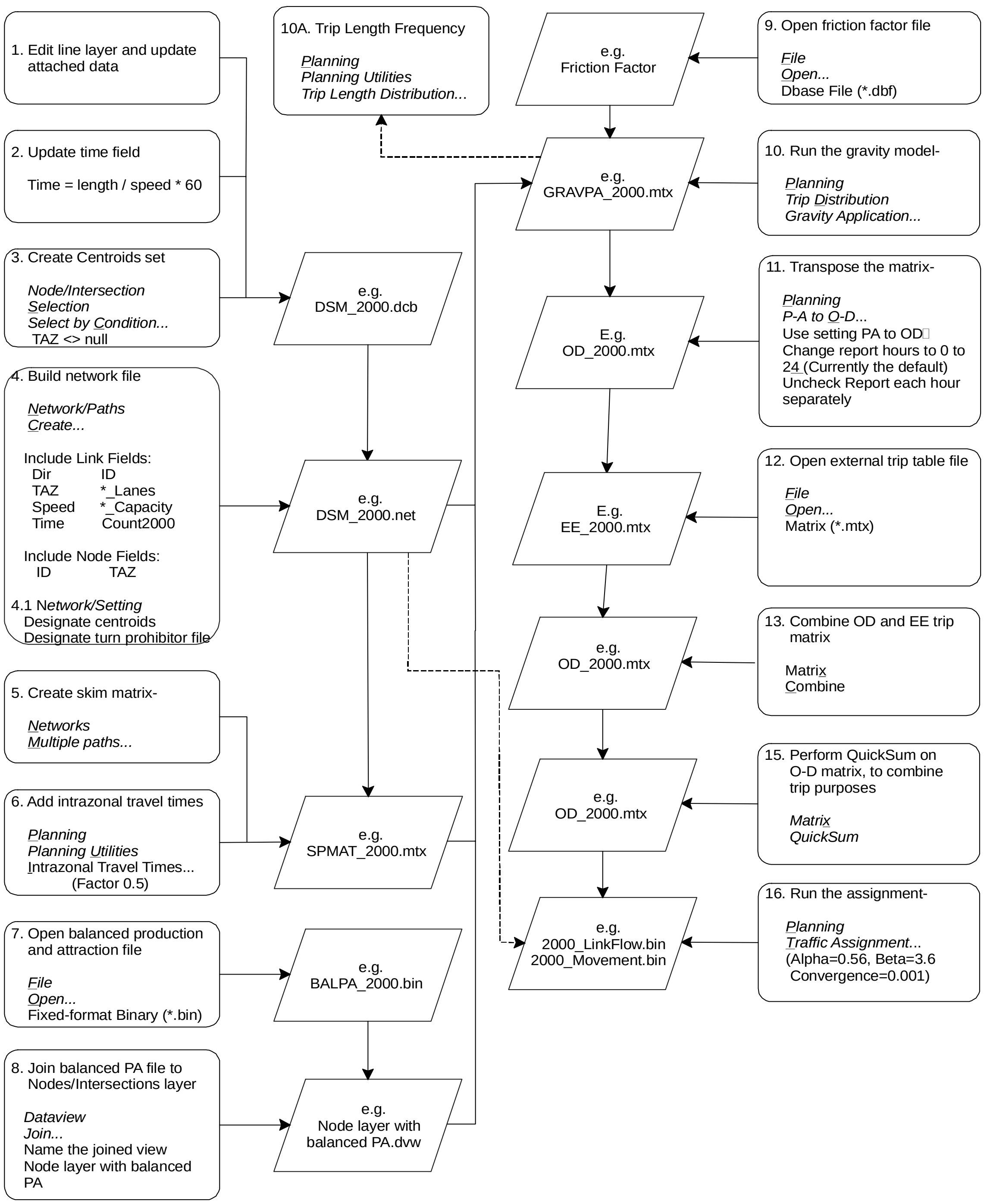
Screenline	NCHRP 255	Number of Links	Average Error	% Error	% RMSE
Total	5-10 %	62	1174	6.17 %	30.69 %
A	18 %	12	2891	12.66 %	34.79 %
B	22 %	6	2243	10.69 %	32.13 %
C	18 %	8	-1868	-6.57 %	26.17 %
D	21 %	6	1212	5.27 %	32.48 %
E	23 %	7	311	1.94 %	14.20 %
F	25 %	8	2887	24.35 %	32.18 %
G	20 %	10	-1046	-6.68 %	27.52 %
H	32 %	5	3507	34.63 %	68.57 %

Appendix

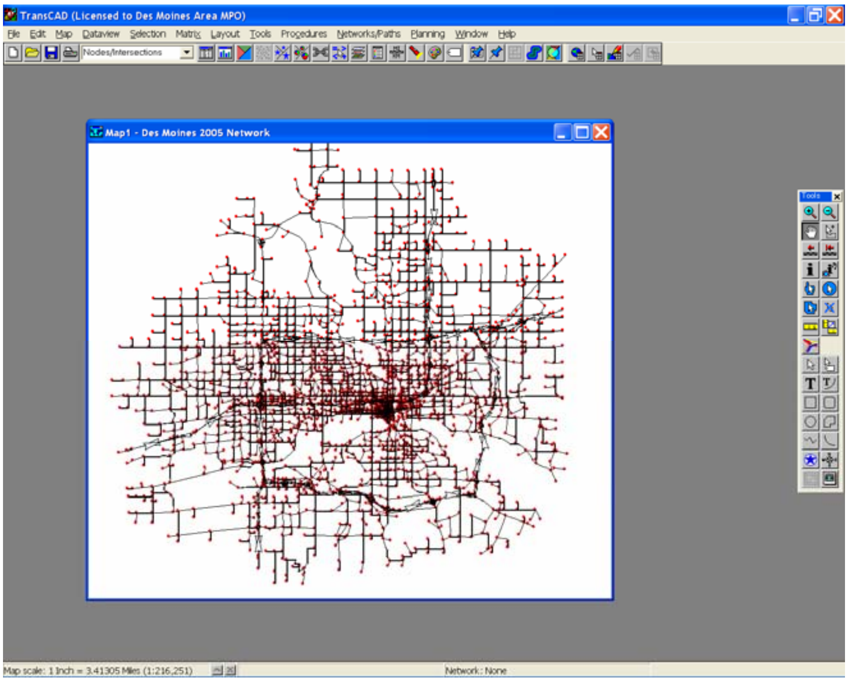
Appendix A. TransCAD Modeling Procedures

The following is a detailed step by step process that details Des Moines Area travel demand model run using the TransCAD. This particular process assumes trip productions, attractions, and E-E trips are available in table format.

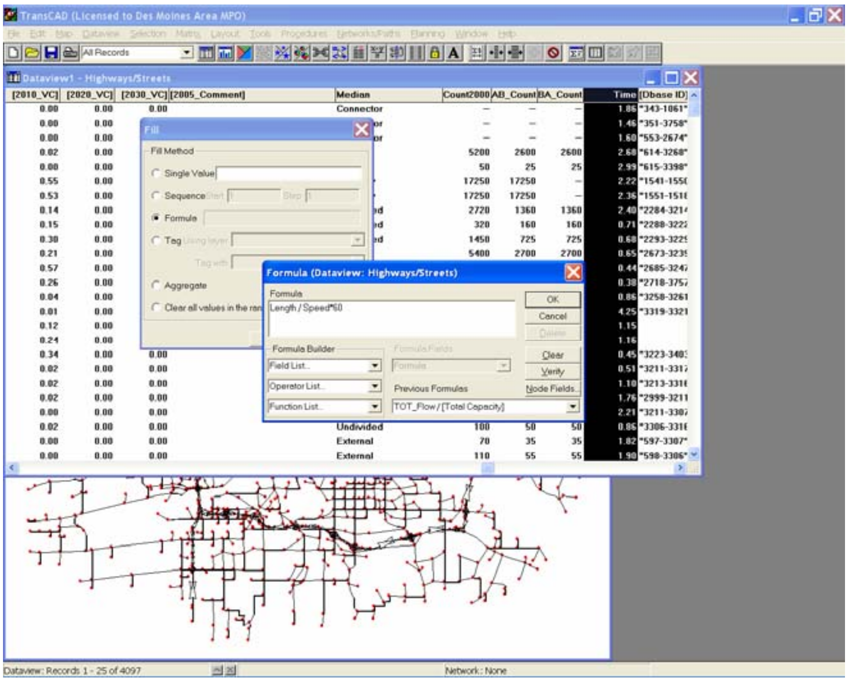
Travel Demand Modeling Flow with TransCAD



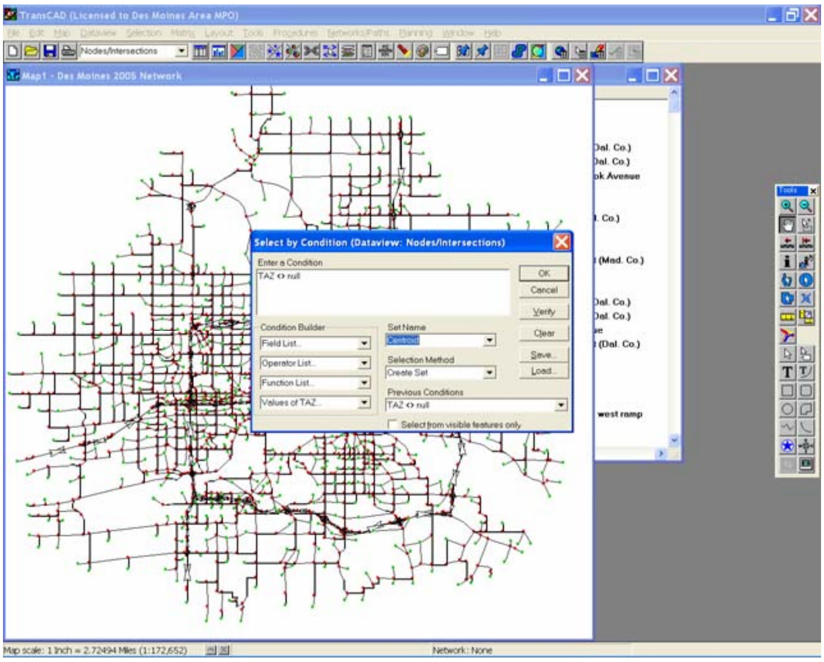
1. Edit line layer
   Update line and node layer for a specific scenario test and coded line layer with the following attributes: *speed*, *capacity*, *number of lanes*, *FFC*, *count*, *direction*



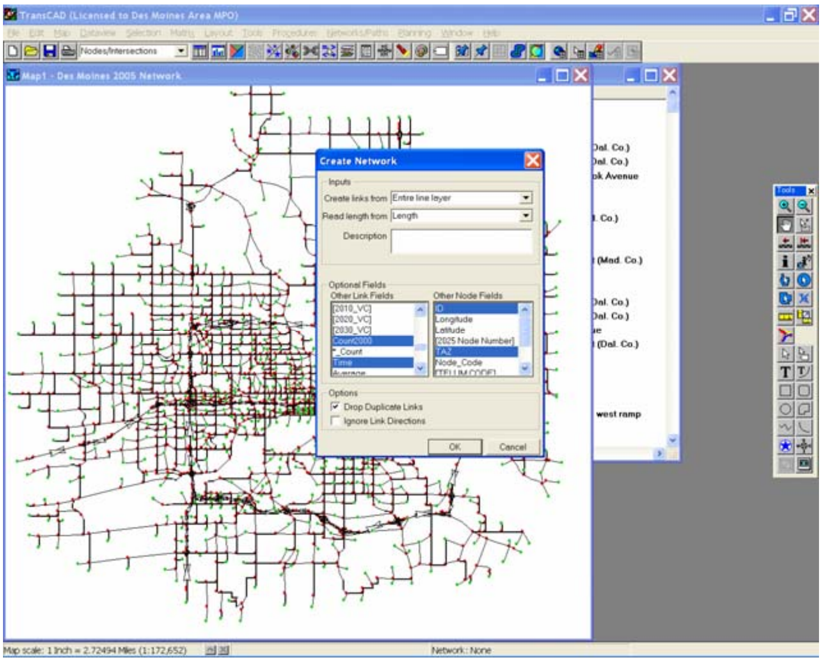
2. Update travel time field
   Update the travel time in minutes by *Time = length/speed*60*



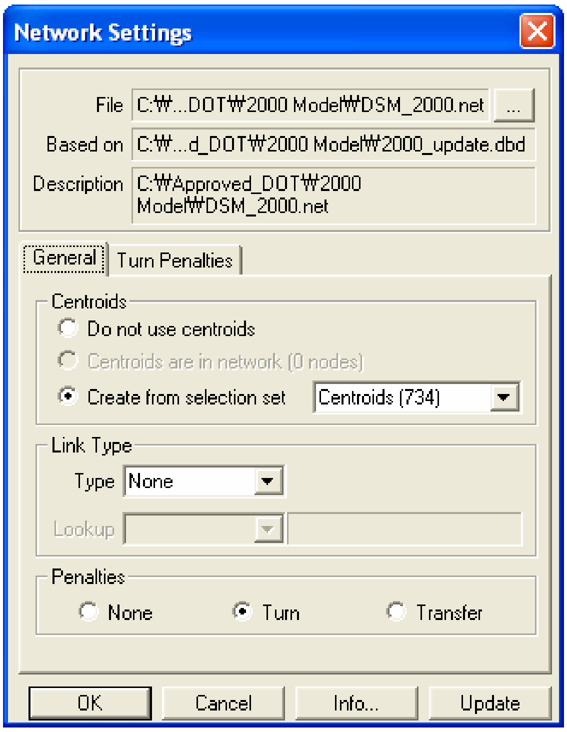
3. Create selection set for centroids
   Select *Nodes/Intersections* layer and
   Go to *Selections* > *Select By Conditions*; Write the query as *TAZ<>null*

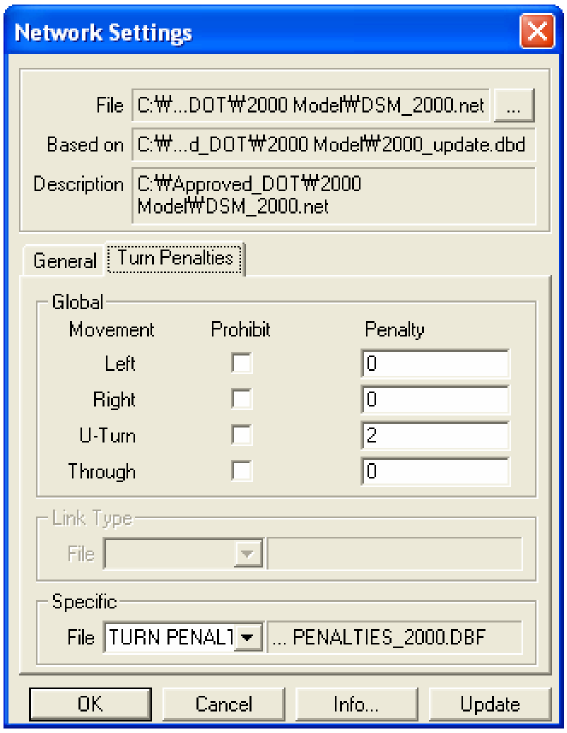


4. Build TransCAD network file
   Go to *Networks/ Paths* > *Create,*
   Include parameters in *link fields* - ID, TAZ, Speed, AB/BA_Lanes, AB/BA_Capacity, Count 2000, Time,
   In *node fields* - ID, TAZ
   Save the network file, *DSM_2000.net*, in the appropriate folder

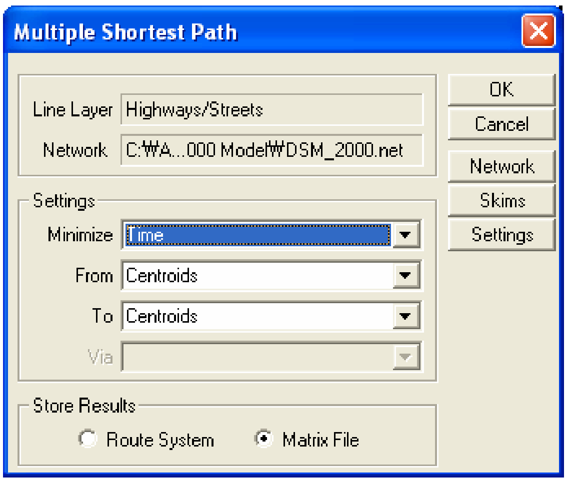


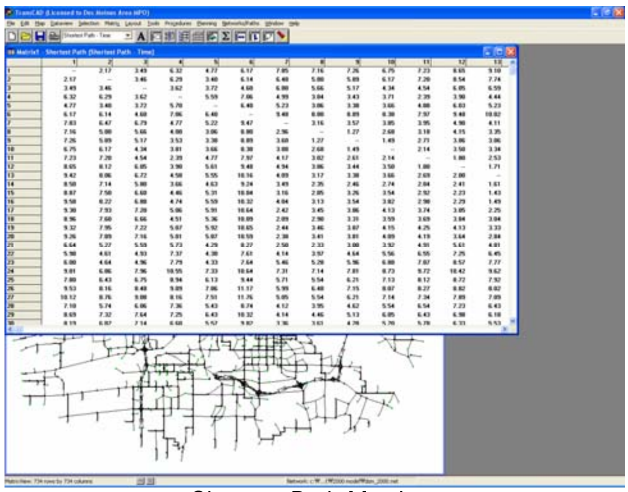
5. Designate Centroid and Turn Penalties
   Go to *Networks/Paths* > *Settings*
   Click *Create from selection set* button from *General* tab,
   Click the radio button *Turn,*
   Select *Turn Penalties* tab and set 2 on *U-Turn's Penalty,* and
   Designate turn penalties file on *Specific* drop down menu





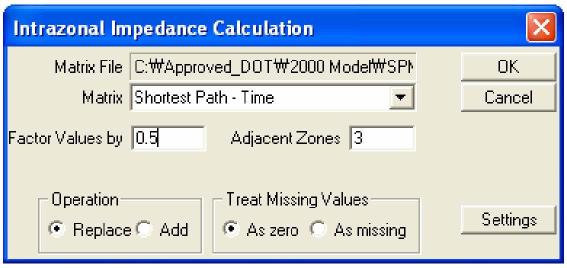
6. Create Shortest Path Matrix
   Go to *Networks* > *paths* > *Multiple paths*,
   Minimize *Travel Time* from *Centroids* to *Centroids*, and
   Save the network file, *SPMAT_2000.net*, in the appropriate folder

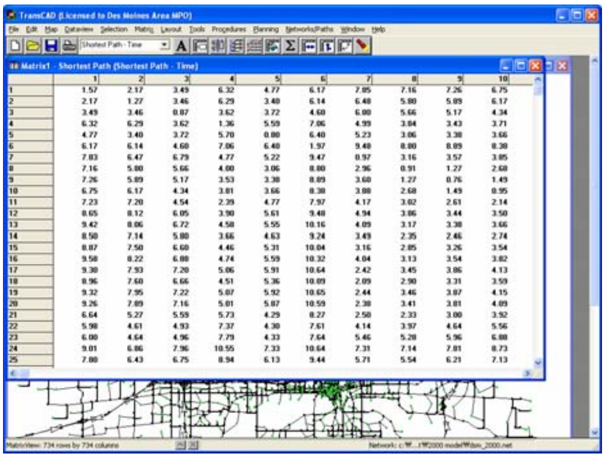




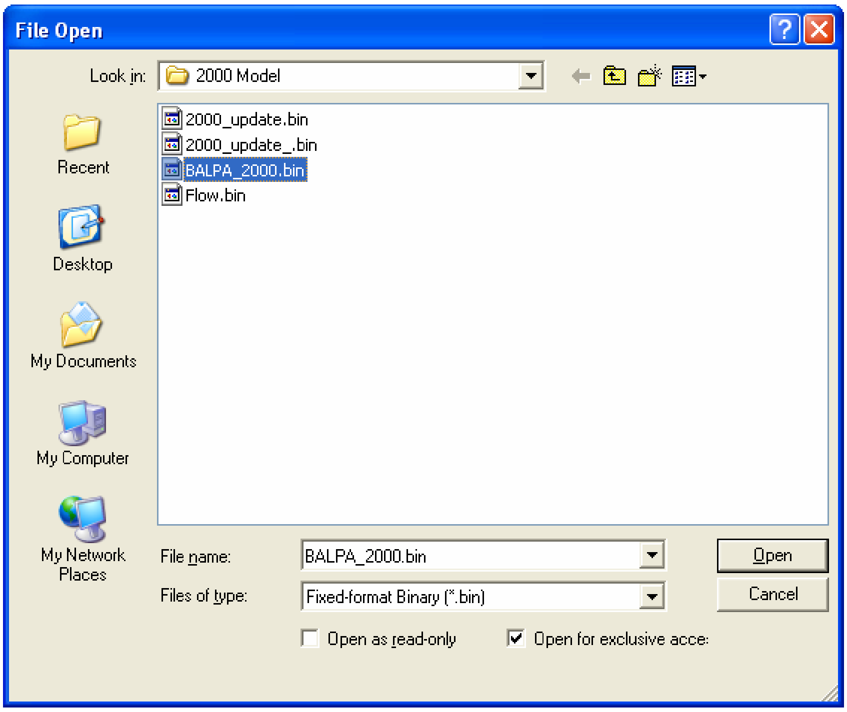
Shortest Path Matrix

7. Add intrazonal travel time
   Go to *Planning* > *Planning Utilities* > *Intrazonal Travel Times* and
   Set 0.5 for *Factor Values* and 3 for *Adjacent Zones*

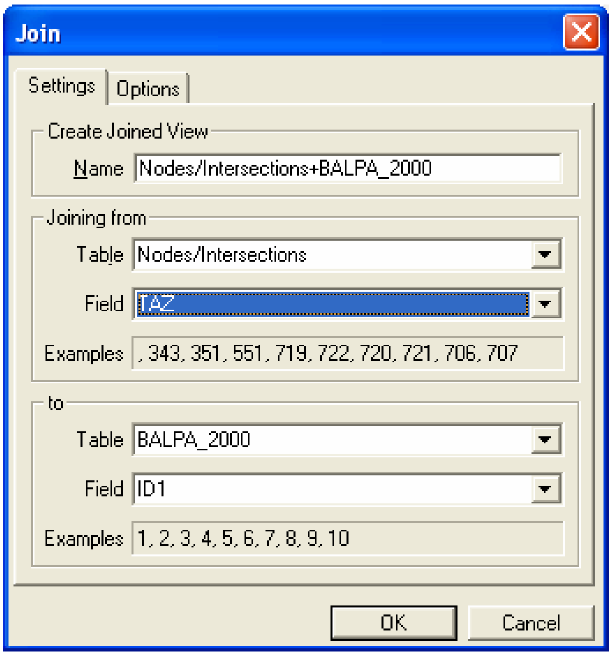




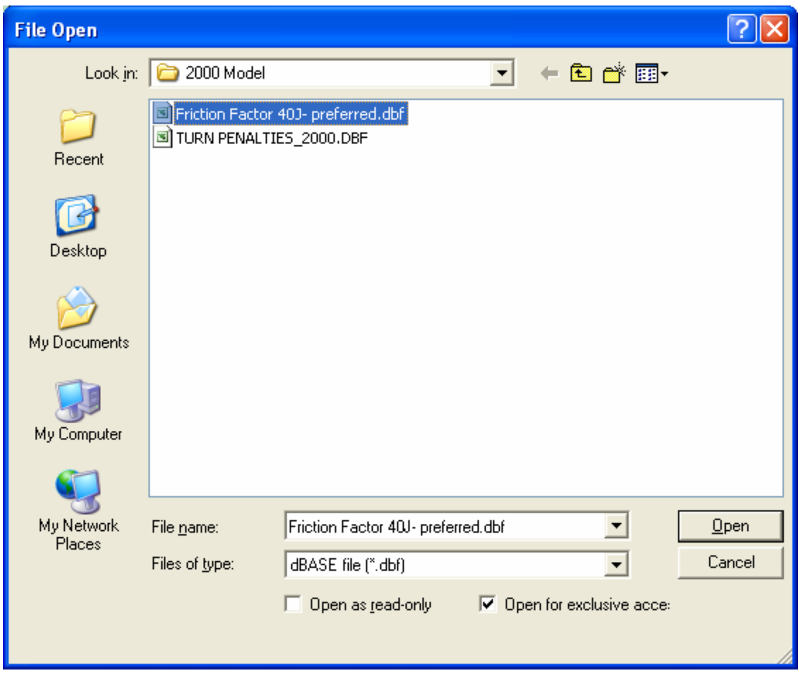
8. Open balanced production and attraction table



9. Join balanced PA table to Nodes/Intersection table
   Go to *Dataview* > *Join* and
   Select *TAZ* field of *Nodes/Intersection table* and *ID1* field of *balanced PA table*.

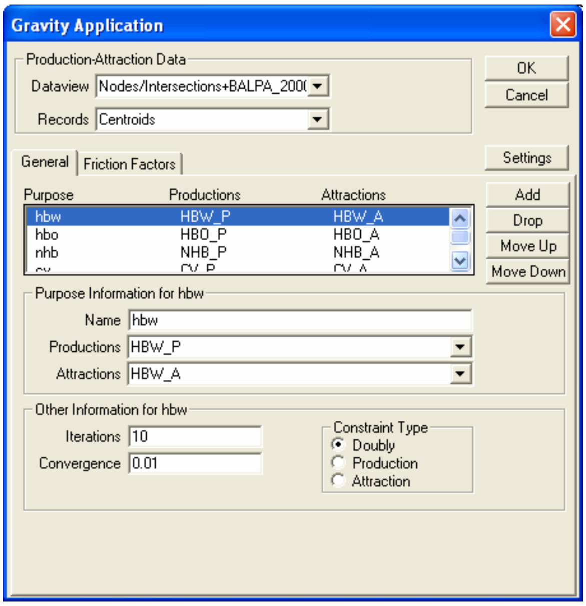


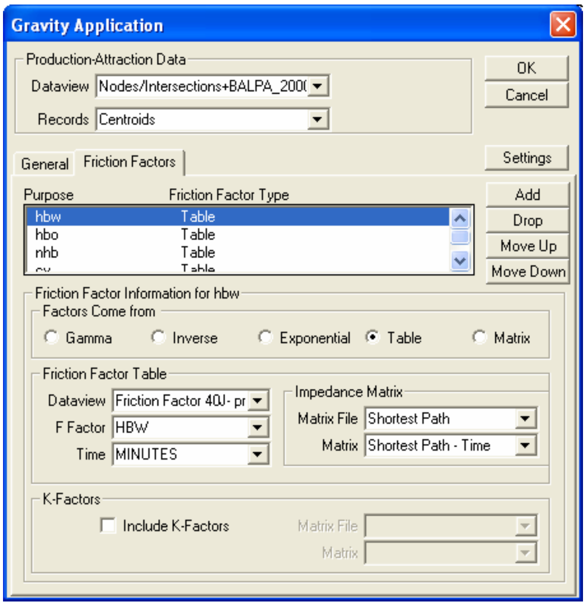
10. Open friction factors table



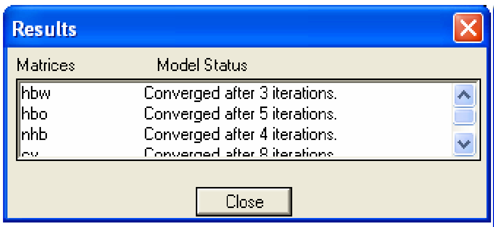
11. Run the gravity model

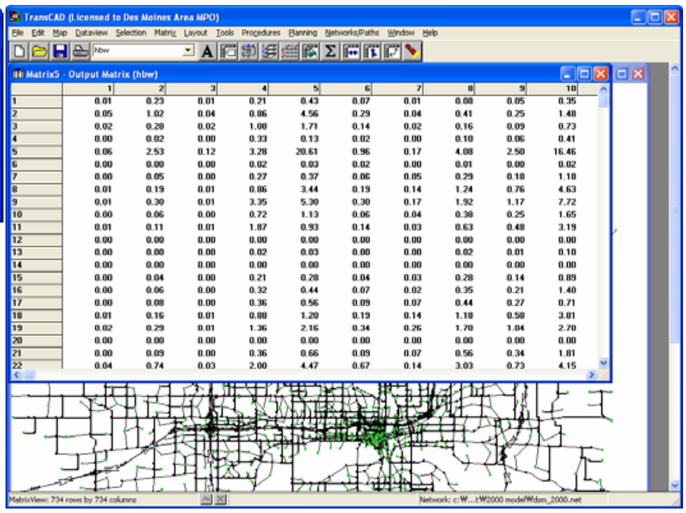
Go to *Planning* > *Trip Distribution* > *Gravity Application*,
Select joined table In the *Dataview* drop down menu,
Select *Centriods* In the *Records* drop down menu,
Specify the correct Productions and Attractions for each trip type,
Select *Doubly Constraint Type*,
Click the radio button, *Table*, from *Friction Factors* tab,
Specify the correct *F Factor* for each trip type, and
Save the network file, *GRAVPA_2000.mtx*, in the appropriate folder.



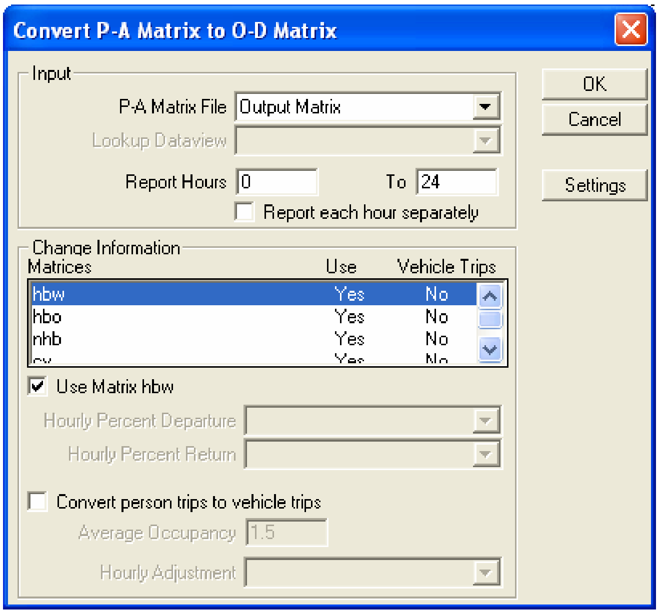


If the Gravity Application worked and is successful, the following prompt occur. In addition, If no warnings occur, TransCAD create the trip tables for each purpose.

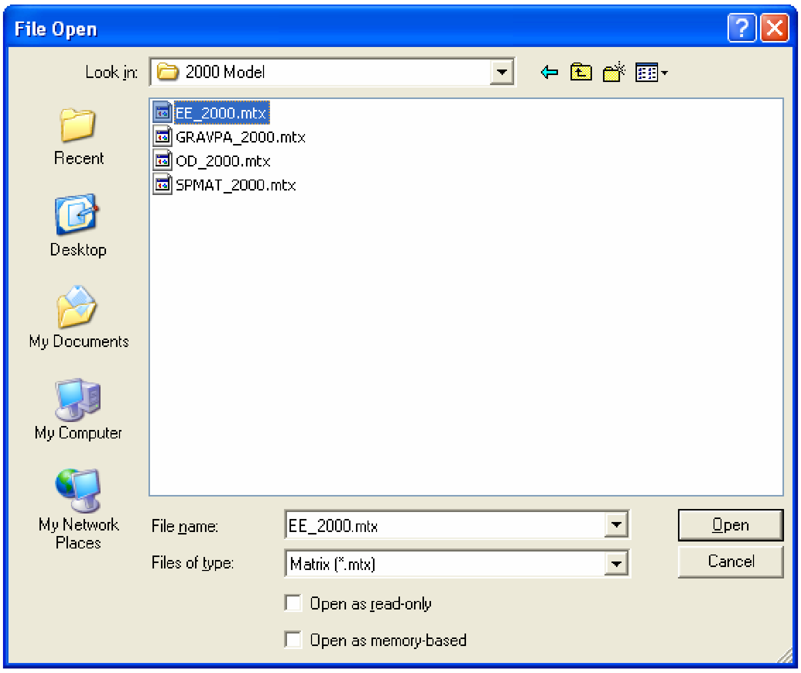




12. Convert PA matrix to OD matrix
 Go to *Planning > P-A to O-D*,
 Select the *Output Matrix* in the *input P-A matrix file* drop down menu,
 Uncheck *Report each hour separately* box,
 Check the *Use Matrix box HBW* (*HBO, NHB, and CV*) box,
 Uncheck the *Convert person trips to vehicle trips* box, and
 Save the network file, *PA2OD_2000.mtx*, in the appropriate folder.

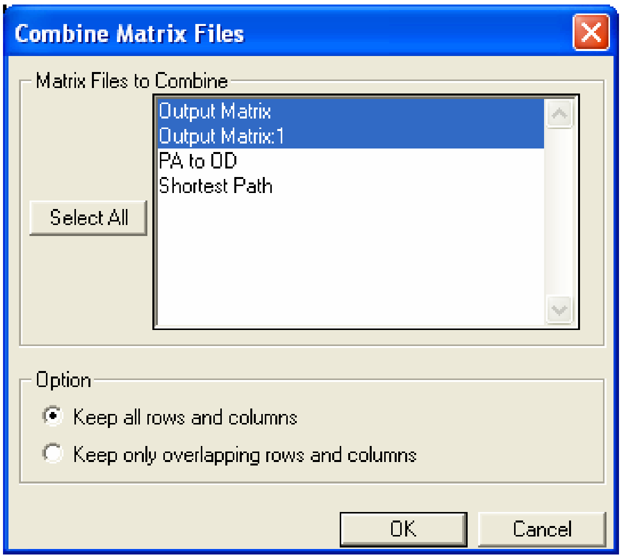


13. Open external-external trip table



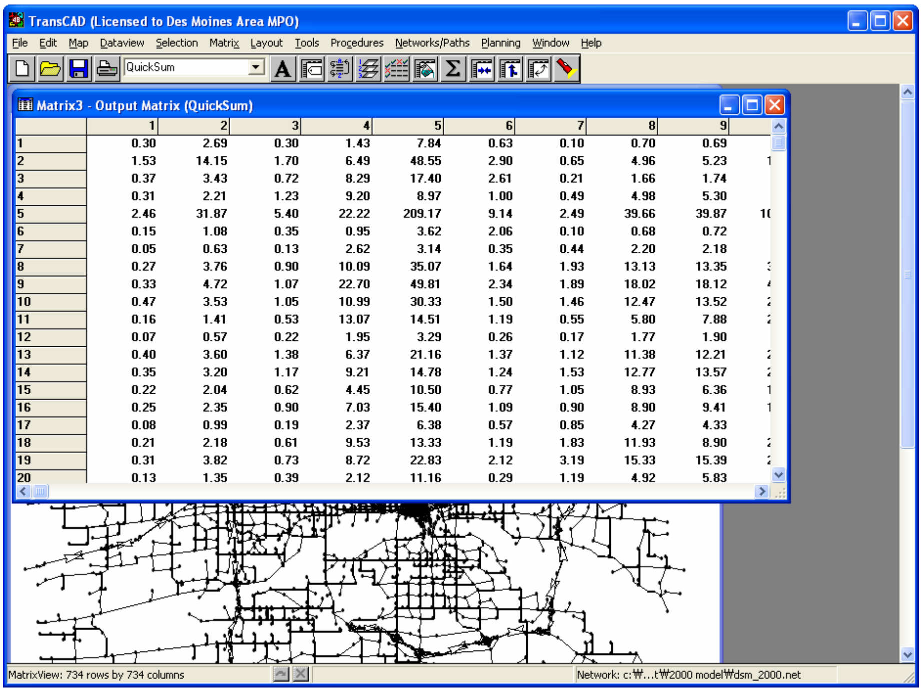
14. Combine OD and EE trip matrix

Go to *Matrix* > *Combine* to display the Combine Matrix Files dialog box.
Choose *OD and EE trip matrix* files from the scroll list.
Choose *Keep all rows and columns* to include from the Options radio list
Click *OK* to display the *Save Matrix File* As dialog box.
Type a file name for the new matrix file in the appropriate folder and click Save.



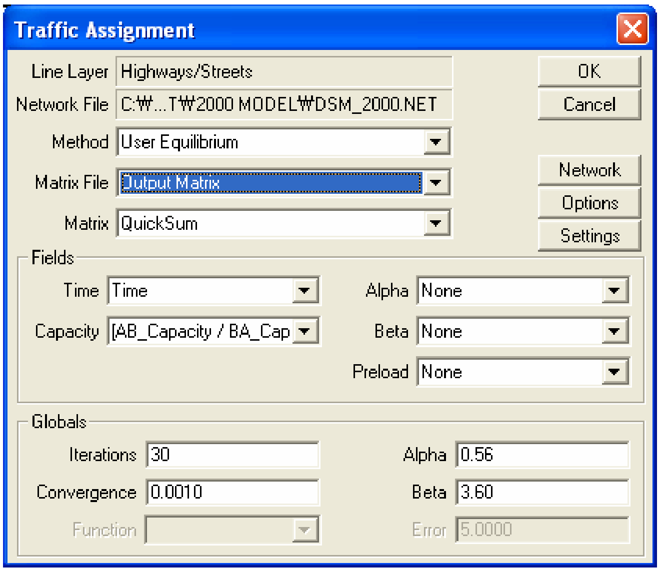
16. Sum up all trip purposes matrix

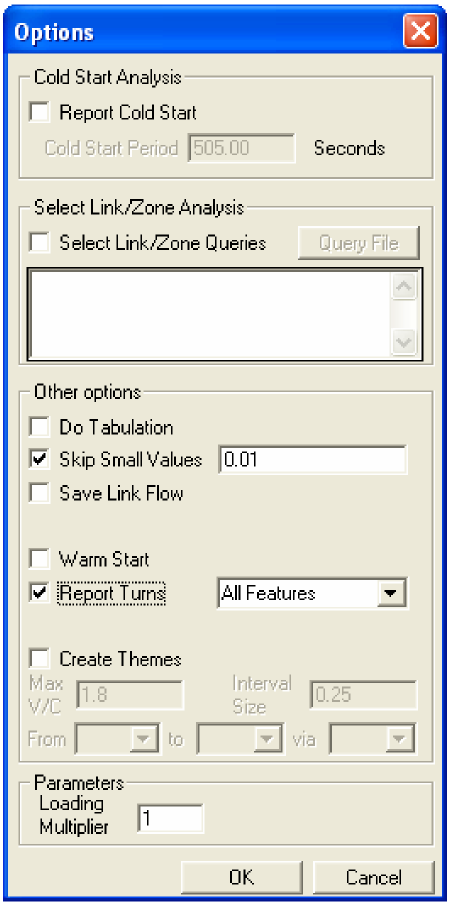
Choose *Matrix* > *QuickSum*

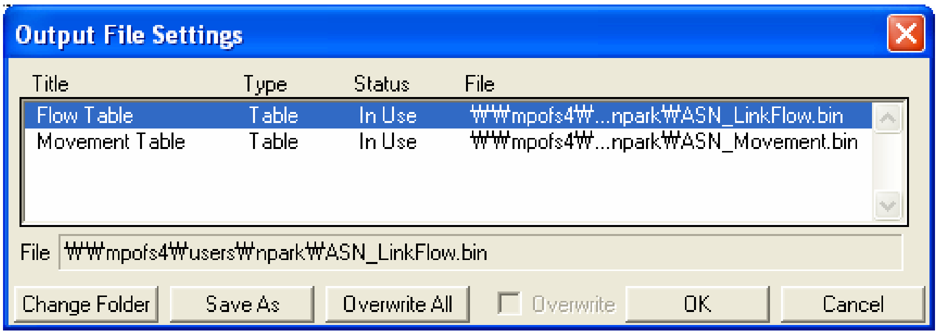


	1	2	3	4	5	6	7	8	9
1	0.30	2.69	0.30	1.43	7.84	0.63	0.10	0.70	0.69
2	1.53	14.15	1.70	6.49	48.55	2.90	0.65	4.96	5.23
3	0.37	3.43	0.72	8.29	17.40	2.61	0.21	1.66	1.74
4	0.31	2.21	1.23	9.20	8.97	1.00	0.49	4.98	5.30
5	2.46	31.87	5.40	22.22	209.17	9.14	2.49	39.66	39.87
6	0.15	1.08	0.35	0.95	3.62	2.06	0.10	0.68	0.72
7	0.05	0.63	0.13	2.62	3.14	0.35	0.44	2.20	2.18
8	0.27	3.76	0.90	10.09	35.07	1.64	1.93	13.13	13.35
9	0.33	4.72	1.07	22.70	49.81	2.34	1.89	18.02	18.12
10	0.47	3.53	1.05	10.99	30.33	1.50	1.46	12.47	13.52
11	0.16	1.41	0.53	13.07	14.51	1.19	0.55	5.80	7.88
12	0.07	0.57	0.22	1.95	3.29	0.26	0.17	1.77	1.90
13	0.40	3.60	1.38	6.37	21.16	1.37	1.12	11.38	12.21
14	0.35	3.20	1.17	9.21	14.78	1.24	1.53	12.77	13.57
15	0.22	2.04	0.62	4.45	10.50	0.77	1.05	8.93	6.36
16	0.25	2.35	0.90	7.03	15.40	1.09	0.90	8.90	9.41
17	0.08	0.99	0.19	2.37	6.38	0.57	0.85	4.27	4.33
18	0.21	2.18	0.61	9.53	13.33	1.19	1.83	11.93	8.90
19	0.31	3.82	0.73	8.72	22.83	2.12	3.19	15.33	15.39
20	0.13	1.35	0.39	2.12	11.16	0.29	1.19	4.92	5.83

17. Run the assignment
    Go to Planning > Traffic Assignment With the network layer set,
    Choose *User Equilibrium* in the *Method* drop down menu,
    Choose *QuickSum* in the *Matrix* drop down menu,
    Set 30 on iterations, 0.56 on *Alpha*, 3.6 on *Beta*, and 0.001 on *Convergence* box,
    Click *Options* button to open the Options window,
    Check *Skip Small Values* and *Report Turns* box,
    Click *OK* to return to the *Traffic Assignment* window,
    Click *OK* to run the *Traffic Assignment, and*
    Click *Save As* button to change the holder and to file name and click *Save*





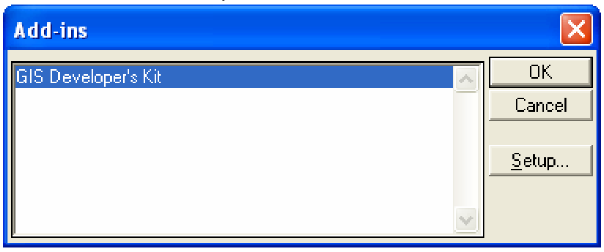


Appendix B. TransCAD GISDK Scripts

A GISDK program is created using the batch mode tools and can run the model faster, easier, and more consistency because it does not require the additional user intervention. The following are the steps to run the GISDK program and the batch code to run the Des Moines Area's model.

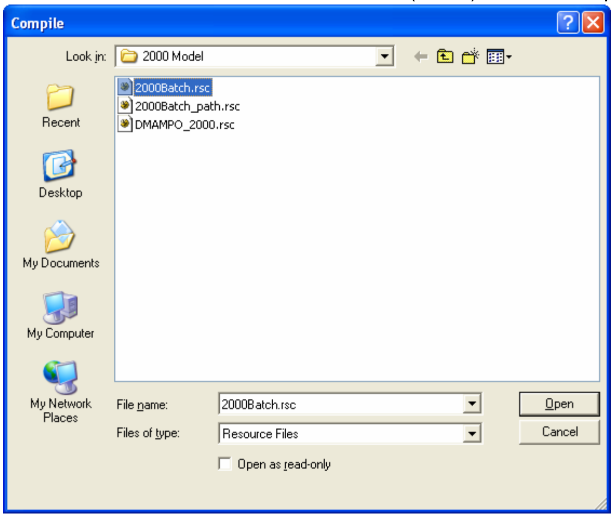
Steps to compile the GISDK program

1. Go to *Tools* > *Add-Ins...*, and
   Click *OK* button to open the *GISDK Toolbox*

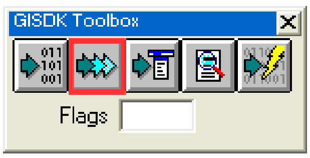


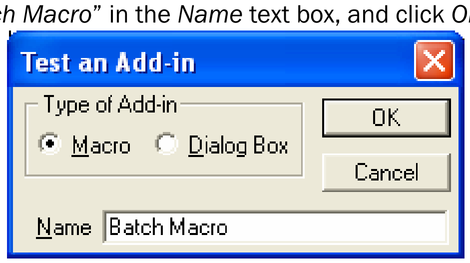
2. Click *Compile* button to open Compile Box

3 Choose the *batch mode resource file* (*.rsc) and click *Open* to compile the resource file



4. Click *Test* button, type "*Batch Macro*" in the *Name* text box, and click *OK*.





Batch mode resource code

```
Macro "Batch Macro"
   RunMacro("TCB Init")

   TransCAD = "C:\\Approved_DOT"
   Model_2000 = TransCAD + "\\2000 Model\\"

// STEP 1: Fill Dataview
    Opts = null
    Opts.Input.[Dataview Set] = {Model_2000 + "2000_update.DBD|Highways/Streets", "Highways/Streets"}
    Opts.Global.Fields = {"Time"}
    Opts.Global.Method = "Formula"
    Opts.Global.Parameter = "Length/ Speed*60"

    ret_value = RunMacro("TCB Run Operation", 1, "Fill Dataview", Opts)

    if !ret_value then goto quit

// STEP 2: Build Highway Network
    Opts = null
    Opts.Input.[Link Set] = {Model_2000 + "2000_update.DBD|Highways/Streets", "Highways/Streets",
"Network", "Select * where Link_Status= 'yes'"}
    Opts.Global.[Network Options].[Node ID] = "[Nodes/Intersections].ID"
    Opts.Global.[Network Options].[Link ID] = "[Highways/Streets].ID"
    Opts.Global.[Network Options].[Turn Penalties] = "Yes"
    Opts.Global.[Network Options].[Keep Duplicate Links] = "FALSE"
    Opts.Global.[Network Options].[Ignore Link Direction] = "FALSE"
    Opts.Global.[Link Options] = {{"Length", "[Highways/Streets].Length", "[Highways/Streets].Length"}, {"ID",
"[Highways/Streets].ID", "[Highways/Streets].ID"}, {"TAZ", "[Highways/Streets].TAZ", "[Highways/Streets].TAZ"},
{"Speed", "[Highways/Streets].Speed", "[Highways/Streets].Speed"}, {"*_LANES",
"[Highways/Streets].AB_LANES", "[Highways/Streets].BA_LANES"}, {"*_Capacity",
"[Highways/Streets].AB_Capacity", "[Highways/Streets].BA_Capacity"}, {"Time", "[Highways/Streets].Time",
"[Highways/Streets].Time"}, {"Count_DOT", "[Highways/Streets].Count_DOT", "[Highways/Streets].Count_DOT"}}
    Opts.Global.[Node Options].ID = "[Nodes/Intersections].ID"
    Opts.Global.[Node Options].TAZ = "[Nodes/Intersections].TAZ"
    Opts.Output.[Network File] = Model_2000 + "DSM_2000.net"

    ret_value = RunMacro("TCB Run Operation", 2, "Build Highway Network", Opts)

    if !ret_value then goto quit

// STEP 3: Highway Network Setting
    Opts = null
    Opts.Input.Database = Model_2000 + "2000_update.DBD"
    Opts.Input.Network = Model_2000 + "DSM_2000.net"
    Opts.Input.[Centroids Set] = {Model_2000 + "2000_update.DBD|Nodes/Intersections",
"Nodes/Intersections", "Centroids", "Select * where TAZ <> null"}
    Opts.Input.[Spc Turn Pen Table] = {Model_2000 + "TURN PENALTIES_2000.DBF"}
    Opts.Global.[Global Turn Penalties] = {0, 0, 0, 2}


    ret_value = RunMacro("TCB Run Operation", 3, "Highway Network Setting", Opts)

    if !ret_value then goto quit
```

```
// STEP 4: TCSPMAT
    Opts = null
    Opts.Input.Network = Model_2000 + "DSM_2000.net"
    Opts.Input.[Origin Set] = {Model_2000 + "2000_update.DBD|Nodes/Intersections", "Nodes/Intersections",
"Centroids", "Select * where TAZ <> null"}
    Opts.Input.[Destination Set] = {Model_2000 + "2000_update.DBD|Nodes/Intersections",
"Nodes/Intersections", "Centroids"}
    Opts.Input.[Via Set] = {Model_2000 + "2000_update.DBD|Nodes/Intersections", "Nodes/Intersections"}
    Opts.Field.Minimize = "Time"
    Opts.Field.Nodes = "[Nodes/Intersections].ID"
    Opts.Output.[Output Matrix].Label = "Shortest Path"
    Opts.Output.[Output Matrix].[File Name] = Model_2000 + "SPMAT_2000.mtx"

    ret_value = RunMacro("TCB Run Procedure", 4, "TCSPMAT", Opts)

    if !ret_value then goto quit

// STEP 5: Intrazonal
    Opts = null
    Opts.Input.[Matrix Currency] = {Model_2000 + "SPMAT_2000.mtx", "Shortest Path - Time", "RCIndex",
"RCIndex"}
    Opts.Global.Factor = 0.5


    ret_value = RunMacro("TCB Run Procedure", 5, "Intrazonal", Opts)

    if !ret_value then goto quit

// STEP 6: Gravity
    Opts = null
    Opts.Input.[PA View Set] = {{Model_2000 + "2000_update.dbd|Nodes/Intersections", Model_2000 +
"BALPA_2000.bin", "TAZ", "ID1"}, "Nodes/Intersections+BALPA_2000_", "Centroids", "Select * where TAZ <>
null"}
    Opts.Input.[FF Matrix Currencies] = {{Model_2000 + "SPMAT_2000.mtx", "Shortest Path - Time", "RCIndex",
"RCIndex"}, {Model_2000 + "SPMAT_2000.mtx", "Shortest Path - Time", "RCIndex", "RCIndex"}, {Model_2000 +
"SPMAT_2000.mtx", "Shortest Path - Time", "RCIndex", "RCIndex"}, {Model_2000 + "SPMAT_2000.mtx",
"Shortest Path - Time", "RCIndex", "RCIndex"}}
    Opts.Input.[Imp Matrix Currencies] = {{Model_2000 + "SPMAT_2000.mtx", "Shortest Path - Time", "RCIndex",
"RCIndex"}, {Model_2000 + "SPMAT_2000.mtx", "Shortest Path - Time", "RCIndex", "RCIndex"}, {Model_2000 +
"SPMAT_2000.mtx", "Shortest Path - Time", "RCIndex", "RCIndex"}, {Model_2000 + "SPMAT_2000.mtx",
"Shortest Path - Time", "RCIndex", "RCIndex"}}
    Opts.Input.[FF Tables] = {{Model_2000 + "Friction Factor 40J- preferred.dbf"}, {Model_2000 + "Friction
Factor 40J- preferred.dbf"}, {Model_2000 + "Friction Factor 40J- preferred.dbf"}, {Model_2000 + "Friction
Factor 40J- preferred.dbf"}}
    Opts.Input.[KF Matrix Currencies] = {{Model_2000 + "SPMAT_2000.mtx", "Shortest Path - Time", "RCIndex",
"RCIndex"}, {Model_2000 + "SPMAT_2000.mtx", "Shortest Path - Time", "RCIndex", "RCIndex"}, {Model_2000 +
"SPMAT_2000.mtx", "Shortest Path - Time", "RCIndex", "RCIndex"}, {Model_2000 + "SPMAT_2000.mtx",
"Shortest Path - Time", "RCIndex", "RCIndex"}}
    Opts.Field.[Prod Fields] = {"[Nodes/Intersections+BALPA_2000_].HBW_P",
"[Nodes/Intersections+BALPA_2000_].HBO_P", "[Nodes/Intersections+BALPA_2000_].NHB_P",
"[Nodes/Intersections+BALPA_2000_].CV_P"}
    Opts.Field.[Attr Fields] = {"[Nodes/Intersections+BALPA_2000_].HBW_A",
"[Nodes/Intersections+BALPA_2000_].HBO_A", "[Nodes/Intersections+BALPA_2000_].NHB_A",
"[Nodes/Intersections+BALPA_2000_].CV_A"}
    Opts.Field.[FF Table Fields] = {"[Friction Factor 40J- preferred].HBW", "[Friction Factor 40J- preferred].HBO",
"[Friction Factor 40J- preferred].NHB", "[Friction Factor 40J- preferred].CV"}
```

```
    Opts.Field.[FF Table Times] = {"[Friction Factor 40J- preferred].MINUTES", "[Friction Factor 40J-
preferred].MINUTES", "[Friction Factor 40J- preferred].MINUTES", "[Friction Factor 40J- preferred].MINUTES"}
    Opts.Global.[Purpose Names] = {"hbw", "hbo", "nhb", "cv"}
    Opts.Global.Iterations = {10, 10, 10, 10}
    Opts.Global.Convergence = {0.01, 0.01, 0.01, 0.01}
    Opts.Global.[Constraint Type] = {"Double", "Double", "Double", "Double"}
    Opts.Global.[Fric Factor Type] = {"Table", "Table", "Table", "Table"}
    Opts.Global.[A List] = {1, 1, 1, 1}
    Opts.Global.[B List] = {0.3, 0.3, 0.3, 0.3}
    Opts.Global.[C List] = {0.01, 0.01, 0.01, 0.01}
    Opts.Flag.[Use K Factors] = {0, 0, 0, 0}
    Opts.Output.[Output Matrix].Label = "Output Matrix"
    Opts.Output.[Output Matrix].[File Name] = Model_2000 + "GRAVPA_2000.mtx"


    ret_value = RunMacro("TCB Run Procedure", 6, "Gravity", Opts)

    if !ret_value then goto quit

// STEP 7: PA2OD
    Opts = null
    Opts.Input.[PA Matrix Currency] = {Model_2000 + "GRAVPA_2000.mtx", "hbw", "Row ID's", "Col ID's"}
    Opts.Field.[Matrix Cores] = {1, 2, 3, 4}
    Opts.Field.[Adjust Fields] = {, , , }
    Opts.Field.[Peak Hour Field] = {, , , }
    Opts.Global.[Method Type] = "PA to OD"
    Opts.Global.[Average Occupancies] = {1.5, 1.5, 1.5, 1.5}
    Opts.Global.[Adjust Occupancies] = {"No", "No", "No", "No"}
    Opts.Global.[Peak Hour Factor] = {0, 0, 0, 0}
    Opts.Flag.[Separate Matrices] = "No"
    Opts.Flag.[Convert to Vehicles] = {"No", "No", "No", "No"}
    Opts.Flag.[Include PHF] = {"No", "No", "No", "No"}
    Opts.Flag.[Adjust Peak Hour] = {"No", "No", "No", "No"}
    Opts.Output.[Output Matrix].Label = "PA to OD"
    Opts.Output.[Output Matrix].[File Name] = Model_2000 + "OD_2000.mtx"

    ret_value = RunMacro("TCB Run Procedure", 7, "PA2OD", Opts)

    if !ret_value then goto quit

// STEP 8: Add Matrix Core
    Opts = null
    Opts.Input.[Input Matrix] = Model_2000 + "OD_2000.mtx"
    Opts.Input.[New Core] = "Matrix 5"

    ret_value = RunMacro("TCB Run Operation", 8, "Add Matrix Core", Opts)

    if !ret_value then goto quit

// STEP 9: Rename Matrix Core
    Opts = null
    Opts.Input.[Input Matrix] = Model_2000 + "OD_2000.mtx"
    Opts.Input.[Target Core] = "Matrix 5"
    Opts.Input.[Core Name] = "ee"

    ret_value = RunMacro("TCB Run Operation", 9, "Rename Matrix Core", Opts)
```

```
    if !ret_value then goto quit

// STEP 10: Merge Matrices
    Opts = null
    Opts.Input.[Target Currency] = {Model_2000 + "OD_2000.mtx", "ee", "Rows", "Cols"}
    Opts.Input.[Source Currencies] = {{Model_2000 + "EE_2000.mtx", "EE", "Row ID's", "Col ID's"}}
    Opts.Global.[Missing Option].[Force Missing] = "No"

    ret_value = RunMacro("TCB Run Operation", 10, "Merge Matrices", Opts)

    if !ret_value then goto quit

// STEP 11: Matrix QuickSum
    Opts = null
    Opts.Input.[Input Currency] = {Model_2000 + "OD_2000.mtx", "ee", "Rows", "Cols"}

    ret_value = RunMacro("TCB Run Operation", 11, "Matrix QuickSum", Opts)

    if !ret_value then goto quit

// STEP 12: Assignment
    Opts = null
    Opts.Input.Database = Model_2000 + "2000_update.DBD"
    Opts.Input.Network = Model_2000 + "DSM_2000.net"
    Opts.Input.[OD Matrix Currency] = {Model_2000 + "OD_2000.mtx", "QuickSum", "Rows", "Cols"}
    Opts.Input.[Turning Movement Node Set] = {Model_2000 + "2000_update.DBD|Nodes/Intersections",
"Nodes/Intersections"}
    Opts.Field.[FF Time] = "Time"
    Opts.Field.Capacity = "*_Capacity"
    Opts.Field.Alpha = "Alpha"
    Opts.Field.Beta = "Beta"

    Opts.Field.Preload = "None"
    Opts.Global.[Alpha Value] = 0.56
    Opts.Global.[Beta Value] = 3.6
    Opts.Global.Convergence = 0.001
    Opts.Global.Iterations = 30
    Opts.Global.[Movement Set Name] = "All Features"
    Opts.Flag.[Do Skipping] = 1
    Opts.Flag.[Do Turn Movement] = 1
    Opts.Output.[Flow Table] = Model_2000 + "Flowpath.bin"
     Opts.Output.[Movement Table] = Model_2000 + "Movementpath.bin"

    ret_value = RunMacro("TCB Run Procedure", 12, "Assignment", Opts)

    if !ret_value then goto quit

   quit:
       Return( RunMacro("TCB Closing", ret_value, True ) )
endMacro
```