2018 Iowa Travel Analysis Model (iTRAM) Update

FINAL STUDY REPORT

Prepared by

metro analytics

In association with

Alliance Transportation Group

Michael Baker International

Quetica Consulting & Engineering

For

IOWA DOT

June 2021

Table of Contents

1 Introduction

In early 2019, the team of Metro Analytics, Alliance Transportation Group, Michael Baker International, and Quetica Consulting & Engineering was selected by the Iowa Department of Transportation (DOT) to update the Iowa Travel Analysis Model (iTRAM) to new base and horizon years. The iTRAM Update described in this report represents a third version of the model, preceded by base year 2005 and 2010 models. Our team recommended initiating the project with a workshop on strengths, weaknesses, opportunities, and threats (SWOT) to refine the project approach, budget, and priorities for implementation during this model update.

1.1 SWOT Workshop

The SWOT workshop was held at Iowa DOT offices in Ames, Iowa in July 2019. The study team went through each component of the model update scope and discussed current model capabilities, desired refinements, potential new features, and parts of the model that did not require modification. The original scope included 22 tasks. The consulting team grouped these tasks into the following six phases:

1. Phase I: Model Algorithm & Software Refinements
2. Phase II: Network, Demographic, Zonal Input Development
3. Phase III: Freight/Truck Model Refinements
4. Phase IV: Calibration, Validation, and Post Processing
5. Phase V: GUI and Enhanced User Applications
6. Phase VI: Documentation and Project Management

Appendix A includes a complete set of notes from the SWOT workshop while **Appendix B** itemizes each task and its respective refinements for the model update. Among the many decisions reached during the SWOT workshop was selecting the model base year of 2018 and horizon year of 2050.

1.2 Data Overview

A number of data sources were used to update the previous 2010 base year model to the new base year of 2018. The following bullets list data sources and how these were used in this model update.

- 2010 U.S. Census data – proportion of households (HHs) by size, income, and workers per HH.
- Census 2018 population estimates by County – control totals for population and HH growth.
- IMPLAN 2018 employment estimates by County – control totals for employment by category.
- 2017 National Household Travel Survey (NHTS) Midwest Region Data – person trip generation and auto occupancy rates for all trip purposes except Airport and Trucks and time-of-day factors.
- 1995 American Travel Survey (ATS) – used in conjunction with 2017 NHTS for long-distance trips.
- NCHRP Report 716 – initial trip attraction rates and various validation benchmarks.
- Iowa DOT Roadway Asset Management System (RAMS) –2018 number of lanes and traffic counts.
- Freight Analysis Framework Version 4 (FAF4) – heavy-duty truck trip tables and external network.
- Google Map satellite imagery – zone centroid and centroid connector locations.
- StreetLight InSight data – proportion of trips crossing state line that are through trips.
- Other State DOTs – 2018 count estimates for trucks and all vehicles at iTRAM external boundary.
- Woods & Poole – 2050 population control totals for all Iowa Counties.
- EBP data – 2050 employment and freight forecasts.

- Federal Aviation Administration – 2018 and 2045 airport passenger enplanements.
- Iowa College and University Enrollment Report – 2018 enrollment at all Iowa colleges/universities.
- American Hospital Directory – location and number of beds at all Iowa hospitals.
- World Casino Directory – location and number of slot machines at all Iowa casinos.

While trip production rates and auto occupancies were based on the 2017 NHTS, other HH travel surveys were analyzed for consideration, as follows:

- 2009 National Household Travel Survey (NHTS) Cedar Rapids Add-On Data,
- 2009 NHTS Omaha Add-On Data,
- 2009 NHTS Iowa State Add-On Data,
- 2017 Des Moines Add-On Data,
- 2017 Iowa Northland Regional COG Add-On Data,
- 2014 Bi-state travel survey data.

1.3 Report Organization

The following is a list of subsequent chapters of this report and a brief summary of contents. Chapters of the report generally follow the project phases outlined on the previous page.

- Phase I – the next chapter (2) of this report describes the iTRAM software platform and models for trip generation, trip distribution, mode split/auto occupancy, and traffic assignment.
- Phase II – this is followed by a chapter (3) on base, interim and forecast years, highway network data, traffic analysis zones (TAZs), external networks and stations, and socioeconomic data and forecasting.
- Phase III – the report continues with a chapter (4) on freight and truck modeling that describes the FAF network and zone system, FAF disaggregation to iTRAM TAZs, conversion of FAF tonnages to trucks, and modeling of Iowa medium-duty trucks.
- Phase IV – this chapter (5) focuses on procedures, adjustments, and results for calibrating and validating trip generation, trip distribution, mode split/auto occupancy, and traffic assignment along with post-processing procedures.
- Phase V – the next chapter (6) serves as a User Guide on the 2018/2050 version of iTRAM, including model installation, model execution, maps and reports, and model utilities.
- Phase VI covers Documentation and Project Management so the report instead concludes with a short chapter (7) on next steps and future considerations.

2 Model Algorithm & Software Refinements

Travel demand models are computer-based mathematical models that estimate present travel conditions and associated demand on transportation infrastructure. Once a model is developed that replicates existing travel conditions, future conditions and alternatives can be evaluated in terms of their impact on the transportation system.

2.1 Software Platform and Compatibility

The iTRAM uses TransCAD travel demand modeling software. The model was developed using TransCAD's GISDK programming language to create a dialog box that steps through the entire model process. From 2014 to 2016, the iTRAM model was calibrated, validated, and updated with new data, new model years and a new model interface. Using the model interface, the user can complete an entire model run.

The graphical user interface (GUI) developed for the 2010 version of iTRAM was updated for the 2018 iTRAM Update. This new interface uses TransCAD 8.0, making it more compatible with the Iowa Standardized Model Structure (ISMS), while providing similar functionality to the previous GUI (that used TransCAD 6.0).

2.2 Trip Generation

Updating the trip generation component of iTRAM began with an evaluation of the variables and parameters adopted in the previous iTRAM passenger model. Trip rate estimation was then conducted using the most recent available travel survey data and studies applicable to the state of Iowa. This section summarizes the available travel survey data, analysis methods, and the resulting trip production and attraction rates recommended to update the iTRAM trip generation step. **Appendix C** presents trip rate comparisons between 2009 and 2017 NHTS data, the current iTRAM, and other available datasets.

Available Survey Data

The Iowa DOT provided the following survey data to support redevelopment of the statewide model passenger components:

- 2009 National Household Travel Survey (NHTS) Cedar Rapids Add-On Data,
- 2009 NHTS Omaha Add-On Data,
- 2009 NHTS Iowa State Add-On Data,
- 2017 Des Moines Add-On Data,
- 2017 Iowa Northland Regional COG Add-On Data,
- 2014 Bi-state travel survey data.

The following additional publicly available data was assimilated to support the estimation of trip rates:

- 2017 NHTS Midwest Region Data and
- 1995 American Travel Survey (ATS) data.

Table 2-1 summarizes the number of sampled households and the coverage of the available data sets.

Table 2-1: Survey Data Summary

Surveys	Number of Sampled Households[1]	Data Coverage Note
2014 Bi-state Household Travel Survey	1,793	Includes Illinois and Iowa trips in Quad Cities region
2009 NHTS Add-on – Cedar Rapids	1,268	Trip end location information cannot be obtained
2009 NHTS Add-on – Iowa Statewide	2,439	Covers entire state of Iowa
2009 National Household Travel Survey (NHTS) Add-on - Omaha	1,273	Includes Iowa and Nebraska trips
2017 NHTS Add-on – Des Moines Area MPO	1,293	Covers Des Moines Metropolitan Area
2017 NHTS Add-on – Iowa Northland Regional COG	1,221	Covers Iowa Northland Regional COG Area (Waterloo)
2017 NHTS (Midwest Region)	19,965	Includes two Census Divisions: West North Central Division (includes 7 iTRAM States – IA, ND, SD, NE, KS, MO, MN) East North Central Division (includes 2 iTRAM States – IL and WI, and 3 other States – IN, OH, MI)
1995 American Travel Survey (ATS)	8,223	Includes all iTRAM States

Previous 2010/2040 iTRAM Trip Generation Structure

The previous iTRAM included three short-distance passenger trip purposes – Home Based Work (HBW), Home Based Other (HBO), and Non-Home Based (NHB) trips; and two long-distance passenger trip purposes – Long-Distance Work (LNGW) and Long-Distance Non-Work (LNGNW) trips. Long-distance trips are defined as trips over 100 miles.

In the previous iTRAM, trip production rates for short-distance trips were stratified by household size and household vehicle ownership and were estimated for three area types: urban areas, towns/suburban areas, and rural areas. The production rates for long-distance trips were not stratified by household characteristics.

Survey Data Analysis Methods

Trip rates were estimated from the eight survey datasets separately to provide a comparison across the model study area for different time periods. Trip rates were also derived for different cross-

[1] Number of sampled households is from the original dataset. Household records with incomplete information or traveled during weekends are excluded from trip rate estimation.

classifications and compared to determine the cross-classification that best explains trip rate variations for iTRAM.

The 2009 and 2017 NHTS datasets and the 2014 Bi-state travel survey data were processed to estimate short-distance trip rates. The Midwest Region NHTS data includes all Iowa Add-On samples referenced earlier in **Table 2-1**. The estimation used weighted weekday (Monday to Friday) samples for motorized modes with a known household income, and produced trip rates by the following commonly used cross-classifications:

- Household size and income group,
- Household size and vehicle ownership,
- Household size and number of workers (for HBW), and
- Income group and number of workers (for HBW).

The 2017 NHTS Midwest Region dataset and the 1995 ATS dataset were processed to estimate long-distance trip rates. The estimation used weighted weekday samples in the 2017 NHTS data and the 1995 ATS data for motorized modes with a known household income. Trip rates cross-classified by household size and income group were estimated for long-distance trips.

The stratification variables are defined as:

- Household size (HHSize) – 1, 2, 3, and 4+
- Number of vehicles per household (Veh) – 0, 1, 2, and 3+
- Number of workers per household (Worker) – 0, 1, and 2+
- Income group (INC) – four income groups.

Table 2-2 presents the percentage of households with 0, 1, 2, and 3+ workers in the state of Iowa, according to 2017 5-year estimates from the American Community Survey (ACS). ACS data shows that households with 3+ workers account for 6.1% of the total households in the state of Iowa; however, the sample size of households with 3+ workers are limited to 4.4% in the 2017 NHTS dataset. Therefore, households with 3+ workers are grouped with households of two workers.

Table 2-2 Worker Group Distribution

Number of Workers	% of Households in Iowa (2017 ACS 5-year data)
0	25.3
1	35.3
2	33.4
3+	6.1

Table 2-3 shows the defined income group ranges. Short-distance trip rates were derived based on the location of production trip ends using the "MSASIZE" variable in the NHTS data for evaluation. The "MSASIZE" variable in the NHTS data is defined based on the population of a metropolitan statistical area (MSA). **Table 2-4** presents the "MSASIZE" categories as defined in the NHTS data and the testing groups used for trip rate estimation.

Table 2-3: Income Group Definition

Income Group	Income Range	% of Households in Iowa (2017 ACS 5-year data)
1	Less than $24,999	20.3
2	$25,000 to $49,999	23.9
3	$50,000 to $99,999	33.5
4	$100,000 or more	22.3

Table 2-4: MSASIZE Variable in the 2017 NHTS Midwest Region Data

MSASIZE Variable in the 2017 NHTS	Testing Group	Applicable MSA[2]
Not in MSA or CMSA	1	
In an MSA of Less than 250,000	2	Waterloo-Cedar Falls, Iowa City, Ames, Sioux City, and Dubuque
In an MSA of 250,000 - 499,999	3	Cedar Rapids and Davenport-Moline-Rock Island[3]
In an MSA of 500,000 - 999,999	4	Des Moines-West Des Moines and Omaha-Council Bluffs[4]
In an MSA or CMSA of 1,000,000 - 2,999,999 or 3 million plus		Only applies to NHTS outside Iowa

The following conclusions were reached from review and evaluation of trip rates estimated from each survey dataset:

- Trip rates estimated from 2009 and 2017 NHTS data show a general drop in trip rates from 2009 to 2017. This trend is consistent with national samples from the 2009 and 2017 NHTS datasets. **Table C-1** in Appendix A provides a comparison between the 2009 and 2017 trip rates for all U.S. regions.
- The HBW and LNGW trip rates in the current iTRAM were underestimated compared to 2017 NHTS data. **Table C-2** and **Table C-3** in Appendix A provide a comparison between the current iTRAM trip rates and those estimated from the 2009 and 2017 NHTS data.

These findings support the decision that the current iTRAM trip rates should be updated based on the 2017 NHTS data to better capture trips generated in the state of Iowa.

Trip rates were estimated using the previously mentioned variable stratifications (HH size, income group, etc.). The estimated trip rates by different cross-classifications were based on different survey datasets and are presented in a separate spreadsheet attached to this memorandum (Appendix A

[2] Based on 2019 US Census Bureau Population Estimates.
[3] Bi-State Regional Commission Household Travel Survey includes households in Iowa and Illinois.
[4] 2009 NHTS Add-on Survey for Omaha includes households in Iowa and Nebraska.

TripRateComparison.xlsx). Analysis of variance (ANOVA) was performed to evaluate the trip rate stratifications. The ANOVA showed that:

- All variables (number of vehicles, household income, number of workers, household size) are statistically significant in explaining the variation in short-distance trip rates.
- Number of workers has the best explanatory power compared to all other variables for HBW trips.
- Cross-classification of household income and household size has a slightly higher explanatory power than the cross-classification of number of vehicles and household size for HBO and NHB trip rates.
- Long-distance trip rate variation among household income groups is statistically significant.
- Trip rate variation among the four MSA size categories are not statistically significant; however, short-distance trip rate variation between Non-MSA and MSA households is statistically significant.

Recommended Updates

Based on survey analysis results, the MA team selected the following cross-classifications for iTRAM trip production rates:

- Use number of workers and household size for HBW,
- Use income and household size for HBO and NHB,
- Use income for LNGW and LNGNW, and
- Separate short-distance trip rates by Non-MSA vs. MSA.

The MA team also selected the 2017 NHTS Midwest Region Data to serve as the basis for the estimation of all trip rates because the 2017 NHTS:

- represents the most recent and comprehensive data,
- includes Add-On data for the Des Moines Area MPO and Iowa Northland Regional COG (Waterloo) regions,
- provides a consistent data source for all trip purposes across the entire model area,
- has large enough samples for all previously mentioned stratifications and can be used to separate trip rates for Non-MSA and MSA areas, and
- long-distance trip rates are consistent with those estimated from the 1995 ATS.

Raw trip rates estimated using 2017 NHTS Midwest Region data are presented in **Table C-4** through **Table C-7** in Appendix C, by the recommended cross-classification schemes. Due to sample size limitations for some cross-classification cells, several illogical trends were observed in the raw trip rates. An Iterative Proportional Fitting (IPF) procedure was used along with minor manual adjustments to smooth the trip production rates and ensure logical patterns for higher household sizes, income rates, and numbers of workers. Manual adjustments were applied to trip rates derived from classifications with smaller sample sizes and based on patterns in adjacent classifications. **Table C-8** through **Table C-12** in Appendix C present the household trip sample sizes in the 2017 NHTS Midwest Region data.**Table 2-5** through **Table 2-8** below present recommended trip production rates for updating the iTRAM trip generation model.

Table 2-5: Recommended HBW Trip Production Rates

	Non-MSA				MSA			
	HH1	HH2	HH3	HH4	HH1	HH2	HH3	HH4
0-worker	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
1-worker	1.19	1.19	1.29	1.29	1.05	1.05	1.36	1.36
2+ worker	N/A	2.75	2.89	3.31	N/A	2.55	2.70	2.90

Table 2-6: Recommended HBO Trip Production Rates

	Non-MSA				MSA			
	HH1	HH2	HH3	HH4	HH1	HH2	HH3	HH4
INC1	1.36	2.95	3.39	5.41	1.53	2.99	3.79	6.50
INC2	1.42	2.99	3.40	5.69	1.63	3.15	3.98	6.72
INC3	1.48	3.03	3.41	5.97	1.65	3.16	4.17	7.09
INC4	1.73	3.16	4.20	7.70	1.73	3.33	4.43	7.97

Table 2-7: Recommended NHB Trip Production Rates

	Non-MSA				MSA			
	HH1	HH2	HH3	HH4	HH1	HH2	HH3	HH4
INC1	0.86	1.98	2.27	2.76	1.27	2.23	3.03	3.27
INC2	1.04	2.06	2.59	3.09	1.37	2.31	3.09	3.48
INC3	1.22	2.13	2.91	3.41	1.43	2.37	3.37	3.61
INC4	1.73	2.48	4.12	4.61	1.50	2.44	3.86	4.07

Table 2-8: Recommended Long-Distance Trip Production Rates

INC	LNGW	LNGNW
1	0.001	0.018
2	0.006	0.041
3	0.019	0.044
4	0.032	0.086

The previous iTRAM version adopted attraction rates from the Transportation Research Board's (TRB) NCHRP 365 (TRB, 1998). The NCHRP 716 (TRB, 2012), a newer travel demand forecasting guide, was reviewed to determine its usefulness in updating iTRAM attraction rates. The current iTRAM model adopted the NCHRP 365 recommended HBW attraction rate of 1.45 trips per employee. The more recent NCHRP 716 indicated that a lower HBW attraction rate of 1.2 trips per employee was consistently adopted by 16 sample travel demand models. Considering the increasing trend of remote working, a lower HBW attraction rate is reasonable.

Therefore, the NCHRP 716 HBW attraction rate of 1.2 is recommended for use in the iTRAM update. Table 4.4 in NCHRP 716 also provides select MPO trip attraction rates for HBO and NHB purposes. Per NCHRP 716, "trip attraction rates shown in Table 4.4 may provide reasonable starting points for models for areas lacking the locally collected data necessary to develop trip attraction models." Since Iowa does not have the benefit of a recent workplace survey from which to compute attraction rates, the following trip attraction rates from NCHRP 716 Table 4.4 were used as a starting point for model validation:

- HBW=1.2*total employment
- HBO=0.4*households+1.1*school enrollment+4.4*retail employment+3.1*non-retail employment
- NHB=0.6*households+2.6*retail employment+1.7*non-retail employment

Additionally, Table 4.22 in NCHRP 716 provides trip attraction rates for truck trips that were considered during model validation.

It is worth noting here that iTRAM includes 13 airports as special generators and uses annual enplanements as an input for calculating trips for the Airport trip purpose. Special generator estimates are described later in Chapter 3 under the section on *Socioeconomic Data Collection and Forecasting*.

2.3 Trip Distribution

This section summarizes reported average trip lengths from the eight travel survey datasets used to estimate trip production rates, presents an evaluation of the previous iTRAM trip distribution model, and describes updates to the trip distribution model.

Reported Average Trip length from Travel Surveys

The eight travel survey datasets used to estimate trip rates were processed to summarize the reported average trip length for metropolitan statistical areas (MSA) and Non-MSA geographic regions by trip purpose. **Table 2-9** through **Table 2-12** present the reported average trip length by trip purpose developed from each household travel survey dataset. Note that "N/A" is used when a dataset does not provide information on trip length for that particular trip purpose.

In summary:

- Average travel distance for short-distance trips (HBW, HBO, NHB) are relatively stable across MSA and Non-MSA regions.
- In general, average travel time is longer in MSA than in Non-MSA regions, which is logical due to the expected increase in congestion levels of MSA regions.
- Average long-distance travel length is around 250 miles.

Table 2-9 Reported Average HBW Trip Length

Survey	Average Travel Time (Minutes)		Average Travel Distance (Miles)	
	Non-MSA	MSA	Non-MSA	MSA
2017 NHTS Midwest Region	19.4	26.0	10.8	11.4
2017 NHTS DMAMPO Add-on	N/A	20.4	N/A	9.6
2017 NHTS INRCOG Add-on	N/A	15.0	N/A	7.2
2014 Bi-State	18.8	20.2	N/A	N/A
2009 NHTS Iowa State Add-on	17.3	19.1	11.2	9.6
2009 NHTS CMPO Add-on	N/A	15.3	N/A	6.9
2009 NHTS OM Add-on	N/A	19.7	N/A	8.3

Table 2-10 Reported Average HBO Trip Length

Survey	Average Travel Time (Minutes)		Average Travel Distance (Miles)	
	Non-MSA	MSA	Non-MSA	MSA
2017 NHTS Midwest Region	16.6	16.9	7.6	5.8
2017 NHTS DMAMPO Add-on	N/A	13.5	N/A	4.7
2017 NHTS INRCOG Add-on	N/A	13.3	N/A	4.8
2014 Bi-State	14.6	13.1	N/A	N/A
2009 NHTS Iowa State Add-on	13.8	15.8	7.2	7.5
2009 NHTS CMPO Add-on	N/A	12.4	N/A	4.8
2009 NHTS OM Add-on	N/A	13.1	N/A	4.8

Table 2-11 Reported Average NHB Trip Length

Survey	Average Travel Time (Minutes)		Average Travel Distance (Miles)	
	Non-MSA	MSA	Non-MSA	MSA
2017 NHTS Midwest Region	14.5	16.6	6.3	6.5
2017 NHTS DMAMPO Add-on	N/A	15.0	N/A	6.0
2017 NHTS INRCOG Add-on	N/A	13.7	N/A	5.8
2014 Bi-State	13.6	13.1	N/A	N/A
2009 NHTS Iowa State Add-on	12.5	13.9	6.2	6.4
2009 NHTS CMPO Add-on	N/A	15.0	N/A	6.1
2009 NHTS OM Add-on	N/A	13.9	N/A	5.7

Table 2-12 Reported Average Long-Distance Travel Distance (Miles)[5]

Survey	LNGW	LNGNW
2017 NHTS Midwest Region	269	333
1995 ATS	216	201

Previous 2010/2040 iTRAM Trip Distribution Model Evaluation

The previous iTRAM documentation does not clearly describe the destination choice model structure and variables. The evaluation of the current iTRAM trip distribution model is based on the decoding of the model scripts.

Destination Choice Model Structure

The previous iTRAM model used TransCAD's built-in gravity model procedure to implement the destination choice model. The traditional gravity model can be written as the following:

$$Trip_{ij} = P_i * \frac{A_j F_{ij} K_{ij}}{\sum_m A_m F_{im} K_{im}}$$

Where,

P_i represents the production for zone i;

A_j represents the attraction for zone j;

F_{ij} represents the friction factors between zone i and j, in current iTRAM, it is set as 1;

K_{ij} represents the K factors between zone i and j;

i, j, m is the zone index.

The K factor of the current iTRAM is expressed in the following way to represent the utilities associated with destinations, including accessibility, impedance, and physical barriers.

$$K_{ij} = \exp\left(\sum_k \beta_{acc}^k * accessibility_{ij}^k + \sum_k \beta_{barrier}^k * Barrier_{ij}^k\right)$$

Where,

β represents model parameters;

$Accessibility_{ij}^k$ represents accessibility of type k between zone i and j;

$Barrier_{ij}^k$ represents the type k barrier that was skimmed between zone i and j; and

i, j is the zone index, k refers to the different type of variables.

[5] The NHTS data for MPOs has limited long-distance trip samples and is not used to calculate average long-distance travel distance.

The iTRAM trip distribution format can be transformed into a standard destination choice model format, as shown in the following formula:

$$Trip_{ij} = P_i * \frac{\exp{(V_{ij})}}{\sum_k \exp{(V_{ij})}}$$

$$V_{ij} = \sum\nolimits_k \beta_{acc}^k * accessibility_{ij}^k + \sum\nolimits_k \beta_{barrier}^k * Barrier_{ij}^k + \ln(A_j) + \ln{(F_{ij})}$$

Therefore, the current iTRAM model is consistent with the state-of-the-practice destination choice model formulation. The current iTRAM includes five factors within the destination choice model:

- Attractions,
- Accessibility,
- Impedance (free flow travel time), and
- Physical/psychological barriers.

These factors are described in more details in the follow subsections. The destination choice model parameters are listed in

Table 2-13.

Table 2-13 iTRAM Destination Choice Model Parameters

Variable	HBW	HBO	NHB	LNGW	LNGNW
Theta	1	0.353674	1	0.6493	0.584415
Accessibility to employment	0.064644				
Accessibility to complements		0.329848	0.510616		
Accessibility to substitutes		-0.386	-0.427652		
Residential Accessibility x Impedance	-0.012741	-0.006703			
Ln (Residential Accessibility x Impedance +1)	-0.475856	-0.391147			
River Crossing	0	-0.018133		-0.276637	-0.090398
Railroad Crossing	-0.222				
Interstate Crossing		-0.579484	-0.170651		
County Boundary	-0.630475	-1.848683	-0.539838		
Intervening Rural Area		-0.004166	-0.189364		
Intrazonal Constant	0.760592	1.283458	1.043257		
Intrazonal General Accessibility (i.e. Intrazonal Constant x Residential Accessibility)	0.031559	0.077009	0.100735		
Intrazonal General Accessibility Square (i.e. Intrazonal Constant x Residential Accessibility ^{2})	-0.008761	-0.000985	-0.002246		
Impedance			-0.075	-0.004	-0.006
LN (Impendence + 1)			-0.706423	-0.496812	-1.947312
Residential Accessibility					-0.1356

Attractions

The previous iTRAM applied the attraction rates in **Table 2-14** to calculate attractions for TAZs without special generators.

Table 2-14 Current iTRAM Attraction Rates

Variable	Variable Description	HBW	HBO	NHB	LNGW	LNGNW
Total Employment	Total employment	1.45				
Household	Number of households		1.4129			0.004
Employment A	Farm employment		0.5		0.036647	
Employment B	Forestry, mining, utilities, construction & manufacturing, wholesale & warehousing		1.0635		0.092296	
Employment C	Information, financial & insurance, real estate, rental and leasing, professional & technical services, and management (FIRE)		2.135601		0.04	0.0058
Employment D	Educational, health and social assistance, food services entertainment		0.25		0.055814	0.003
Employment E	Retail trade		5.3138		0.01	0.0016
Employment F	Federal civilian and military, state and local government, other services		1.7		0.015	0.0001
HBWA	HBW attraction			0.112754		
HBOA	HBO attraction			0.887246		

For TAZs with special generators, attractions are calculated as:

- Casino
  HBO trips = regular HBO trips + 3 × casino slots
  LNGNW trips = regular LNGNW trips + 0.0016 × casino slots
- Hospital
  HBO trips = regular HBO trips + (7.42 × hospital beds + 1733.31) × 2.1
  LNGNW trips = regular LNGNW trips + 0.0016 × hospital beds
- Mall
  HBO trips = regular HBO trips + (250 × number of shops)
  LNGNW trips = regular LNGNW trips + 0.0008 × number of shops
- University
  HBO trips = regular HBO trips + (2.23 × enrollment + 440) × 1.2 × 0.9961
  LNGNW trips = regular LNGNW trips + 0.0066 × enrollment
- Airport
  LNGNW trips = regular LNGNW trips + 0.0008 × enplanement

However, additional hard coded adjustment factors were applied to attractions for specific trip purpose and area type classifications:

- A factor of 0.92 was applied to HBW attractions and a factor of 1.192528 was applied to HBO attractions for TAZs with an area type of 3.
- A factor of 1.418 was applied to HBW attractions and a factor of 0.7434 was applied to HBO attractions for TAZs with an area type of 1 or 2.

It should be noted that adjustments were made to some of these rates during the 2018 model validation and these modifications are described in Chapter 5.

Accessibility

Several accessibility measures are used in the destination choice model: "residential accessibility", "near accessibility", "accessibility to employment", "accessibility to compliments", and "accessibility to substitutes". The names of these accessibilities were identified from the GISDK script. The current iTRAM documentation does not provide definition for these accessibilities.

"General accessibility", "near accessibility", and "accessibility to employment" were defined in a similar way in the GISDK script, as shown in the formula below:

$$Accessibility_i = ln\left(\sum_j activity_i * \exp\left(\alpha * time_{ij}\right)\right)$$

$$activity_i = \beta_{demo} * Demo_i$$

"Accessibility to compliments" and "accessibility to substitutes" are coded in the iTRAM destination choice model scripts as the following:

$$AccessD_i = ln\left(\sum_j activity_i * mcd_{ij} * \exp\left(\alpha * time_{ij}\right)\right)$$

$$mcd_{ij} = 1 - \sum_k \left(\frac{activity_{i,m}}{\sum_k activity_{i,k}}\right)^2$$

$$AccessS_i = ln\left(\sum_j activities_i * mcs_{ij} * \exp\left(\alpha * time_{ij}\right)\right)$$

$$mcs_{ij} = 1 - mcd_{ij}$$

A variable of zonal activity is used to estimate all types of accessibility.

Table 2-15 and **Table 2-16** provide variables and parameters used to calculate zonal activity and accessibility, respectively.

Table 2-15 Variables and Parameters to Calculate Activities

Variable	Variable Description	Work Activity	Retail Activity	General Activity	Near Activity	Other Activity
Household	Number of households			4.201901		0.2605
EMP	Total Employment	1.464899		1.464899		
SCHL	Employment D			1.543055		
RET	Employment E		4.142491	4.142491	3.4111	1.0
SRVC	Employment C+D+F			0.003246	2.7404	0.272

Table 2-16 Variables and Parameters (the α) to Calculate Accessibility

Type of Accessibility	Activities Used	Parameter on Impedance
Residential Accessibility	General Activity	-0.39692
Near Accessibility	Near Activity	-0.5
Accessibility to Employment	Work Activity	-0.31837
Accessibility to Retail	Retail Activity	-0.18
Accessibility to Other	Other Activity	-0.3825
Accessibility to Compliment	General Activity	-0.300638
Accessibility to Substitute	General Activity	-0.100249

Impedance and Physical/Psychological Barriers

The iTRAM does not include a feedback loop and uses free flow travel time as impedance in the trip distribution process. Physical and psychological barriers include river crossings, railroad crossings, freeway crossings, county boundary crossings, and urban or rural locations. Attributes in the roadway network were used to define these variables. Modeled results and metrics are also documented in Chapter 5 of this report.

Updates to iTRAM Trip Distribution Model

The structure of the iTRAM destination choice model is different from a typical destination choice model structure. The iTRAM uses a gravity model with an exponential format K factor to accomplish the destination choice selection, with HBW trips being doubly constrained and HBO trips being singly constrained to productions. Since the transformation of this model structure is consistent with the state-of-the-practice destination choice model, it was recommended to keep the current structure.

The gravity format of the iTRAM trip distribution model introduces difficulties when applying different parameters for MSA and Non-MSA regions. However, based on the reported survey trip lengths, average trip distance does not vary significantly between MSA and Non-MSA regions. The average travel time variation between MSA and Non-MSA is due to different congestion levels. It was recommended to report modeled average travel time and travel distance for a better evaluation of the model performance.

The previous 2010 destination choice model parameters were used as a starting point for 2018 model validation. The 2018 trip distribution model was subsequently validated using updated trip generation results (with new socioeconomic data and trip production rates) and parameters adjusted based on average trip lengths summarized from the aforementioned survey data.

2.4 Mode Split

This section presents factors used in converting 2018 person trips to vehicle trips for input to the iTRAM highway assignment step.

Converting Person Trips to Vehicle Trips

iTRAM estimates motorized person trips in the trip generation and distribution steps. Then person trips are converted to vehicle trips for the highway assignment step by applying conversion factors. To derive the conversion factors for iTRAM, mode split factors and auto occupancy rates were first estimated using survey data.

Mode split factors are used to apportion total trips for each purpose into four auto modes – drive alone (DA), shared ride with 2 persons (SR2), shared ride with 3 or more persons (SR3), and transit/air (other). The 2017 Midwest Region dataset includes samples from large cities outside Iowa (for example, Chicago) that may skew the short-distance trip mode splitting in Iowa. Therefore, the 2017 NHTS De Moines Add-on and the 2017 Iowa North Land Regional COG Add-on datasets were used to estimate the mode split factors for short-distance trips. The 1995 ATS dataset was used to estimate the mode split factors for long-distance trips, since it has a larger sample size than the 2017 Midwest Region dataset. **Table 2-17** presents the mode split factors for all trip purposes.

Table 2-17 Mode Split Factors

Mode	HBW	HBO	NHB	LNGW	LNGNW
DA	85%	41%	52%	47%	14%
SR2	11%	32%	30%	23%	32%
SR3	3%	23%	16%	20%	50%
Other	1%	4%	2%	10%	4%

Auto occupancy rates for DA, SR2 and SR3 modes are presented in **Table 2-18**. The SR3 auto occupancy rates for short-distance trips were estimated using the 2017 Midwest Region dataset. The SR3 auto occupancy rates for long-distance trips were estimated using the 1995 ATS dataset.

Table 2-18 Auto Occupancy Rates

Trip Purpose	Occupancy Rate		
	DA	SR2	SR2
HBW	1	2	3.3
HBO	1	2	3.4
NHB	1	2	3.5
LNGW	1	2	3.8
LNGNW	1	2	3.8

Conversion factors were calculated as a combination of the mode split factors from **Table 2-17** and auto occupancy rates from **Table 2-18**. **Table 2-19** presents the recommended conversion factors for each trip purpose. Please note that only the conversion factors in **Table 2-19** were applied in the initial iTRAM 2018 modeling process. Minor adjustments to these rates were made during model validation.

Table 2-19 Recommended Conversion Factors

Trip Purpose	Conversion Factor
HBW	1.1
HBO	1.6
NHB	1.4
LNGW	1.7
LNGNW	2.4

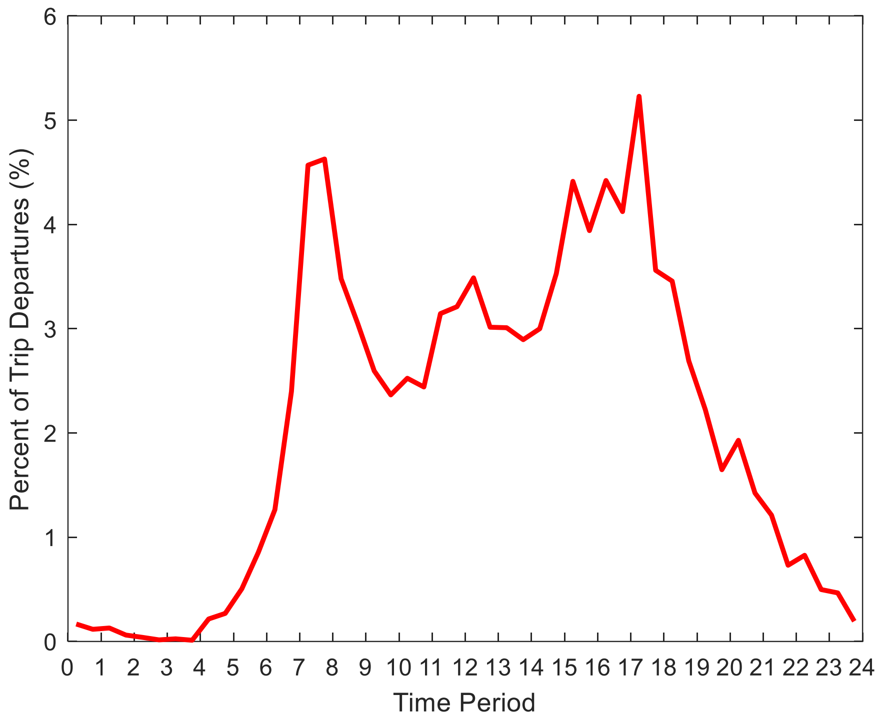
2.5 Traffic Assignment

This section of Chapter 2 describes recommended time periods with the associated diurnal factors used to update the previous iTRAM daily assignment procedure to the time-of-day assignment procedure found in the 2018 version of the model.

Time Period

To convert the previous iTRAM daily assignment procedure to a time-of-day assignment procedure, trip departure time in the 2017 NHTS Midwest Region data was analyzed to determine the appropriate time periods. Error! Reference source not found. presents the trip departure time distribution derived from t he 2017 NHTS Midwest Region data.

Figure 2-1 Departure Time Distribution



Based on the trip departure time distribution, four time periods – morning (AM) peak period, mid-day (MD) period, afternoon (PM) peak period and night (NT) period have been implemented in the 2018 iTRAM assignment procedure. Time of Day factors, calculated using 2017 NHTS Midwest Region data, are presented in **Table 2-20**.

Table 2-20 Recommended Time of Day Percentages

Time Period	Time Range	% of Trips
AM	7:00 – 8:00	9%
MD	8:00 - 14:30	38%
PM	14:30 - 18:30	33%
NT	18:30 - 7:00	20%

Diurnal factors are also needed to convert trip tables in a production-attraction (PA) format produced in the trip distribution step to trip tables in an origin-destination (OD) format by the four time periods. The diurnal factors for short-distance trips, derived from the 2017 NHTS Midwest Region data, are presented in **Table 2-21**. The 2017 NHTS Midwest Region dataset does not include a large enough sample size to derive meaningful diurnal factors for long-distance trips, while the 1995 ATS dataset does not include trip departure time information. Therefore, the departure and return times of long-distance trips are divided evenly between 6 AM and 8PM based on 90% of the long-distance trips occurring at these times in the 2017 NHTS Midwest Region data.

Table 2-21 Recommended Diurnal Factors

Period	HBW Departure	HBW Return	HBO Departure	HBO Return	NHB Departure	NHB Return
24:00-1:00	0.023%	0.781%	0.012%	0.187%	0.061%	0.061%
1:00-2:00	0.001%	0.462%	0.004%	0.151%	0.053%	0.053%
2:00-3:00	0.001%	0.164%	0.004%	0.050%	0.001%	0.001%
3:00-4:00	0.031%	0.114%	0.004%	0.012%	0.008%	0.008%
4:00-5:00	1.538%	0.200%	0.118%	0.065%	0.059%	0.059%
5:00-6:00	4.188%	0.197%	0.578%	0.077%	0.263%	0.263%
6:00-7:00	8.960%	0.197%	2.378%	0.337%	0.828%	0.828%
7:00-8:00	13.993%	0.856%	8.398%	0.986%	2.889%	2.889%
8:00-9:00	7.252%	0.364%	5.549%	1.161%	2.816%	2.816%
9:00-10:00	2.661%	0.259%	3.498%	1.548%	2.982%	2.982%
10:00-11:00	1.269%	0.263%	3.163%	1.932%	3.382%	3.382%
11:00-12:00	0.950%	1.083%	3.222%	2.701%	4.764%	4.764%
12:00-13:00	1.620%	2.307%	2.648%	2.805%	4.730%	4.730%
13:00-14:00	1.485%	1.699%	2.384%	2.780%	4.237%	4.237%
14:00-15:00	0.727%	1.329%	1.123%	1.399%	2.108%	2.108%
15:00-16:00	2.177%	7.502%	3.527%	8.619%	6.341%	6.341%
16:00-17:00	1.047%	9.671%	3.029%	4.659%	4.388%	4.388%
17:00-18:00	0.638%	11.079%	3.837%	5.038%	3.667%	3.667%
18:00-19:00	0.100%	2.968%	1.932%	1.944%	1.624%	1.624%
19:00-20:00	0.245%	2.606%	3.288%	5.634%	2.619%	2.619%
20:00-2100	0.232%	1.558%	0.705%	3.811%	1.199%	1.199%
21:00-22:00	0.266%	1.573%	0.349%	2.131%	0.566%	0.566%
22:00-23:00	0.424%	1.675%	0.187%	1.259%	0.342%	0.342%
23:00-24:00	0.172%	1.093%	0.064%	0.712%	0.073%	0.073%

Adjustments to highway assignment capacities by time period are described later in Chapter 5.

3 Network, Demographic, Zonal Input Development

This Chapter is focused on key input data, including highway networks, traffic analysis zones (TAZs), external networks and stations, and socioeconomic data. The most significant changes from 2010 iTRAM are expansion to a nationwide model network for modeling heavy-duty trucks and the addition of socioeconomic variables to implement the new trip generation model described in the previous chapter.

3.1 Base, Interim and Forecast Years

The consulting team discussed potential analysis years with Iowa DOT staff during the aforementioned SWOT workshop. Iowa DOT felt that, based on significant recent infrastructure improvements and data availability, 2018 should represent the updated iTRAM base year. The horizon year of the model was determined to be 2050, consistent with upcoming statewide and MPO area long-range planning efforts. Linear interpolation was used for interim year socioeconomic data with a reasonableness check against a sample of county level interim year control totals available from Woods & Poole Economics in interpolating interim year forecasts.

3.2 Highway Network

Iowa DOT staff initiated updating 2010 highway network data to represent 2018 conditions. The line work and ABLANES, BALANES, SPEED, and FACTYPE fields were updated in the master network to reflect roadway capacity projects constructed during the period of 2010-2018. The 2018 version of the Iowa DOT Roadway Asset Management System (RAMS) was used as a primary source of information for updating these characteristics. Previous speed lookup tables were refined as part the iTRAM 2018 validation.

Consulting team members subsequently reviewed the 2018 initial network with a focus on comparing differences in the fields described above vs. the earlier 2010 and 2040 models. Another focus was adding missing roadway segments and roadways recently opened to traffic. A memo is provided in Appendix D that lists initial road additions/updates to the iTRAM 2018 Base Year Network. These updates cover roadway links inside Iowa and with no such changes were made to roads outside Iowa.

RAMS was then used as a source for adding 2018 traffic count data to the model network, in a series of new attributes, as follows:

1. COUNT_AADT_2018
2. COUNT_AAWDT_2018
3. SU_TRUCKS_2018
4. MT_TRUCKS_2018
5. TOT_TRUCKS_2018
6. MOTORCYCLE_2018
7. AUTOMOBILE_2018
8. PICKUP_2018
9. BUS_2018

It is important to note that not every count station has counts for all of the above vehicle classifications. Furthermore, the model was validated solely to the attributes COUNT_AADT_2018 for all vehicles and TOT_TRUCKS_2018 for trucks. Daily traffic counts with a value of less than 2,000 are ignored when running calibration summaries, as are truck counts below 500. A number of traffic counts were deactivated for model validation purposes, and are now stored as ORG2018AADT, ORG2018SU, ORG2018MT, and ORG2018TRK. Statewide models, such as iTRAM, have larger zones and less roadways than typically found in MPO model networks. Thus, one rationale for select count removal was the need to eliminate multiple counts on roadway segments without intermediate intersecting network links. Most network counts inside MPO areas were also deactivated since the focus of iTRAM, as with other statewide models, is to forecast freight, intercity and rural travel with MPO models used to forecast travel on urban streets. Statewide models do not have sufficient zone or network detail to accurately simulate intra-urban travel patterns.

Screenlines were updated in accordance with SWOT recommendations and identification of available 2018 traffic counts. The previous 2010 model had screenlines located on a series of concurrent links along major highways. Instead, the 2018 model network has screenlines located on a series of different parallel highways, consistent with traditional procedures used to define screenlines. For example, the 2010 model had I-80 screenline designations assigned to links located on I-80; whereas the 2018 model now has an I-80 screenline coded on overpasses and underpasses of roadways crossing I-80. Thus, this 2018 example screenline now summarizes volumes crossing I-80 rather than overlapping volumes on I-80 links. The new 2018 screenlines are more helpful in understanding trip distribution patterns into, out of, and across Iowa. Screenlines are defined by two attributes, ScrnLine_Name and SCREENLINE_2018. The former is an alphanumeric description while the latter is a numeric designation (1-16). Screenlines are further described in Chapter 5 on model validation.

Facility types and area types were largely maintained from the previous 2010 model; however, during validation it was recommended that non-Interstate expressways be coded as Facility Type 2 rather than Facility Type 3 (Principal Arterials). This not only maintains consistency with FHWA functional classification categories but also distinguishes expressways from other principal arterials in terms of speed, access, and capacity. Facility type categories are listed below in **Table 3-1**. There are only 3 Area types used in iTRAM: Urban (1); Suburban and Town (2); and Rural (3).

Table 3-1 2018 iTRAM Facility Types

Facility Type No.	Facility Type Description
1	Interstates
2	Other Expressways
3	Other Principal Arterials
4	Minor Arterials
5	Major Collectors
6	Minor Collectors (trips not assigned to these links)
7	Ramps (not included in assignment statistics)
999	Centroid Connectors

A series of TransCAD bookmarks, color themes, and labels were added to iTRAM to facilitate network review and analysis. The highway network uses a master network philosophy, enabling the storage of network characteristics for a specific year of analysis within a single file, for consistent editing. The file

Sample_Projects (.BIN, DCB) contains information on existing-plus-committed projects for implementation.

3.3 Traffic Analysis Zones (TAZs)

The study team discussed pros, cons, and alternate procedures for adopting MPO zone systems, socioeconomic data and/or trip tables into iTRAM during the SWOT workshop. On the plus side, nearly all MPO models include data on population, households, and employment. However, consistency between MPO and iTRAM TAZs would require a zone correlation table methodology in order to incorporate MPO data or trip tables into future model updates. Timing and consistency would also become an issue whenever an MPO modifies demographic or trip table assumptions. Thus, it was decided to maintain the 2010 iTRAM zone system for the 2018 model and maximize use of 2010 base year demographic and network assumptions as a starting point for year 2018 and 2050 data updates. The only exception was the addition of FAF zones in areas outside the original iTRAM study area. FAF zones are described later in Chapter 4.

Existing TAZ System

iTRAM uses a maximum six-digit numbering scheme for its zone system, as depicted in **Table 3-2**. In Iowa's 99 counties, the first one to two digits (out of five digits) represent a county number in alphabetic order (Adair County through to Wright County), while the remaining three digits represent the sequential zone number within each county. In buffer states surrounding Iowa, all zone numbers have six digits with the first three digits representing a state number (992-998) and the last three digits representing a zone sequence within each state. There are a total of seven buffer states included in the model (North and South Dakota are both included but merged as "The Dakotas"). Finally, external zones also use six-digit numbers starting with "999" for the first three digits and the final three digits representing the sequential numbering of external zones. The 14 iTRAM external zones are situated along interstate highways connecting buffer states with other states not included in the original model.

Table 3-2 iTRAM Zone Numbering System

Place	Number Sequence Starting	Number Sequence Highest	Description
Iowa	1001	1099	Iowa County #1
	2001	2099	Iowa County #2
	3001	3099	Iowa County #3
	4001	98999	Iowa County #4-#98
	99001	99999	Iowa County #99
Buffer States	992001	I-24 E	Illinois
	993001	I-55 S	Wisconsin
	994001	I-44 W	Minnesota
	995001	I-35 S	The Dakotas
	996001	I-70 W	Nebraska
	997001	I-29 N	Kansas
	998001	I-35 N	Missouri
Externals	999001	999014	External Zones

Updates to the TAZ System

The existing iTRAM zone system within the state of Iowa is generally sufficient for simulating travel flows between urban areas and along rural highway segments. Iowa already has nine regional travel demand models in place to simulate travel flows within urbanized areas. The Consultant team discussed the existing iTRAM zone system with Iowa DOT staff during the SWOT workshop. While the team observed that the zone system is sparse relative to the dense model network, the decision was made to largely stick with the existing 2010 zone system for the 2018 model update. This approach is being taken to minimize efforts required to update the model network and socioeconomic data from the previous base year 2010 to 2018 conditions for the new model.

Standard model practice is to have roadways in the model network form TAZ boundaries whereas, the iTRAM network includes many low volume roadway segments that bisect TAZs. Traffic counts are unavailable on many of these low volume roadways, making it difficult to assess model validity on individual links. Thus, the 2018 model continues the 2010 model process that “deactivates” Facility Type 6 links during the assignment process. Roadway links designated for deactivation remain in the model for visualization purposes but are not assigned trips by the model. While consideration was given to adding zones on a case-by-case basis using simplified techniques for disaggregating socioeconomic data, validation adjustments were focused on centroid locations and centroid connectors instead of zone splits.

Future considerations for defining TAZs are included in **Appendix E**.

3.4 External Networks and Stations

External zones are located outside of Iowa, as depicted by small green triangles in **Figure 3-1**. These zones are unchanged from those in the 2010 model. Analysis of origin-destination patterns was conducted using Iowa DOT’s StreetLight Insight dataset; however, these data are limited locations within the State of Iowa. Summarizing through trips at major Iowa state line crossings using StreetLight Insight was still helpful in assessing the logic of previous 2010 estimated external-external flows that pass through the state.

Existing External Zone System

As noted earlier, external zones use six-digit numbers starting with “999” for the first three digits and the final three digits representing the sequential numbering of external zones. The 14 iTRAM external zones are situated along interstate highways connecting buffer states with other states not included in the original model. **Table 3-3** describes the location of each external zone, 2018 traffic counts representing external trips and truck counts for the same locations, where available, along with truck assumptions.

As indicated, the year of readily available online counts varies by state, though the variation is not significant enough to impact use of these numbers. Somewhat similar to Iowa, North Dakota counts traffic by region using a series of rotating years and then averages these years to estimate AADT for the most recent year, as indicated in the table. While truck counts were available for all except two external stations, it should be noted that the definition of truck counts varies from state to state.

The passenger counts (latest count minus truck count) are used as control totals for external trips at each external station for the 2018 iTRAM Update. The truck counts are used to validate FAF truck volumes entering and exiting the states comprising the iTRAM passenger model. The nationwide FAF network, described later in Chapter 4, is joined with the iTRAM passenger network at these external zone locations.

Figure 3-1 2018 iTRAM External Zones

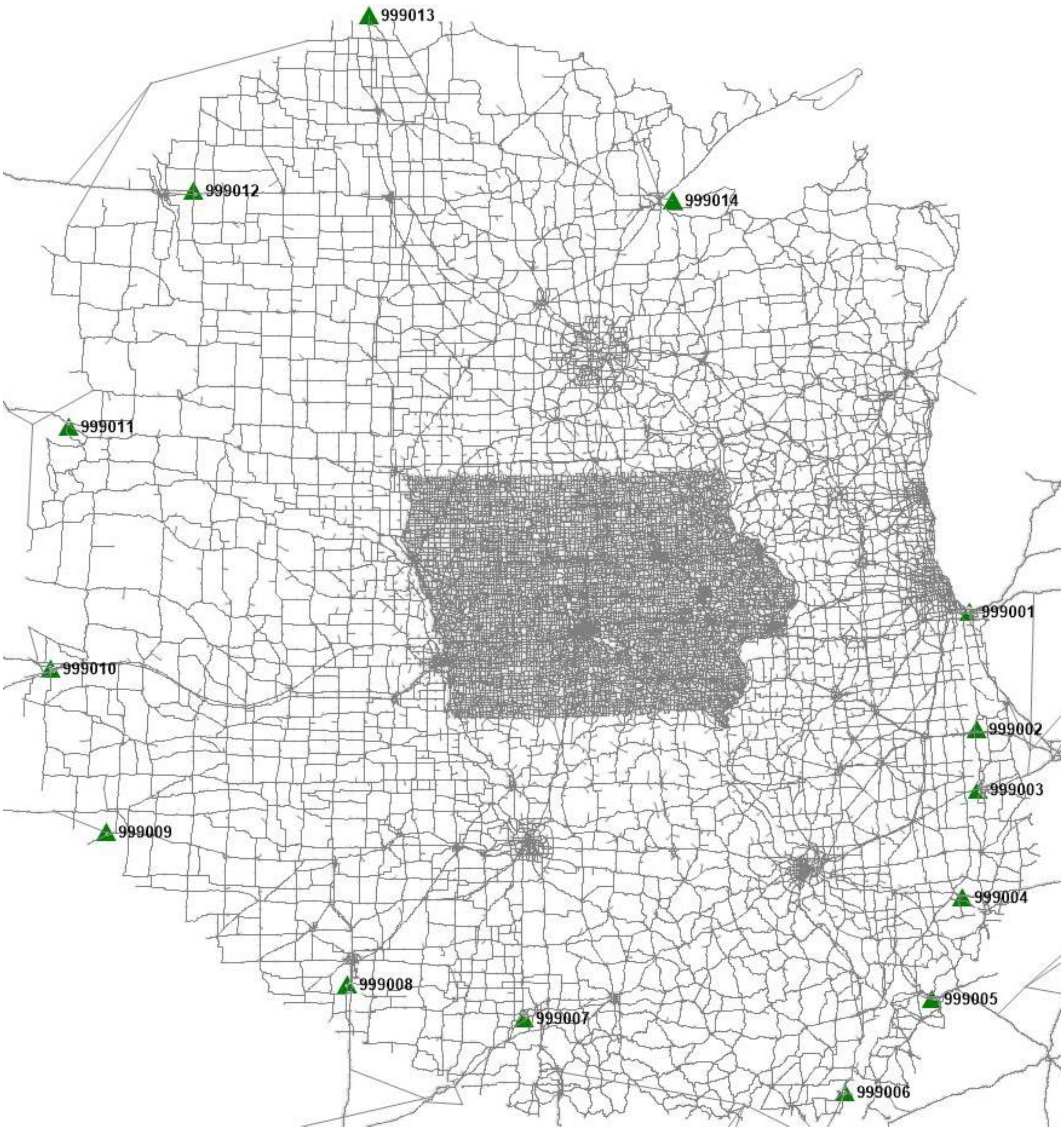


Table 3-3 iTRAM External Zones

Zone #	Highway	State 1	State 2/Other	Original	New	Latest Count	Count Year	Truck Count	Notes on Truck Counts
999001	I-80/94 E	IL	IN	X		206,000	2018	43,500	Multi-Unit Trucks Only
	I-90 E	IL	IN		X	34,000	2016	3,500	Multi-Unit Trucks Only
999002	I-74 E	IL	IN	X		18,100	2019	6,700	Multi-Unit Trucks Only
999003	I-70 E	IL	IN	X		27,900	2019	10,000	Multi-Unit Trucks Only
999004	I-64 E	IL	IN	X		15,400	2018	5,200	Multi-Unit Trucks Only
999005	I-24 E	IL	KY	X		31,100	2018	6,900	Multi-Unit Trucks Only
999006	I-55 S	MO	AR	X		20,679	2019	7,965	Multi-Unit Trucks Only
999007	I-44 W	MO	OK	X		23,584	2019	6,225	Multi-Unit Trucks Only
999008	I-35 S	KS	S of Wichita	X		21,800	2018	5,060	Heavy Commercial Volume
999009	I-70 W	KS	Grainfield, KS	X		12,100	2018	3,965	Heavy Commercial Volume
999010	I-80 W	NE	at I-76 fork	X		7,078	2019	4,445	Truck ADT
	I-76 W	NE	at I-80 fork		X	7,509	2019	2,140	Truck ADT
999011	I-90 W	SD	E of Wall	X		7,280	2018	n/a	truck count unavailable here
999012	I-94 W	ND	E of Bismarck	X		8,755	2018 (16*)	2,130	COMMERCIAL TRUCK TRAFFIC
999013	I-29 N	ND	Canada	X		2,870	2018 (18*)	1,325	COMMERCIAL TRUCK TRAFFIC
999014	I-35 N	MN	Duluth	X		18,800	2019 draft	n/a	truck count unavailable here

Year 2010 external trip matrices were updated to the base year 2018 and forecast year 2050 using linear growth forecasts found in available iTRAM external trip tables. Modifications were made to external trip tables during the 2018 validation process and these adjustments were likewise carried over to 2050 forecasts for consistency.

Updates to the External Zone System

A few of the 2010 iTRAM external zone locations were adjusted during the model validation process, as described below:

- I-90 East was missing in 2010 but an external connector was added from zone 999001 (I-80/94)
- I-76 West was missing in 2010 but an external connector was added from zone 999010 (I-80)
- I-35 North external zone was not at the Canadian border and was zeroed out during validation
- Wisconsin/Michigan border: external zone is missing; no need was identified during validation

Since all external zones are far from the Iowa state line, the 2018 iTRAM validation included numerous tests with and without various external trip components. External zones remain limited to Interstate highways, as is the external FAF network. There was no overwhelming evidence that adding major US highways as external zones would have a significant impact on validation within the state of Iowa.

Analysis of StreetLight Data

Iowa DOT has an active license with StreetLight Data to conduct a wide range of traffic related analyses; however, this license is limited to data analysis of territory within the state of Iowa. Since all iTRAM external zones are located outside of Iowa, use of the StreetLight InSight dashboard focused on analyzing patterns of trip making between Interstate highway “pass through” locations near the Iowa state line. StreetLight analyses were conducted separately on personal and commercial vehicles. While locations along the state line are not the same as iTRAM external zones, several interstate highways passing through Iowa also comprise external stations in the model, including I-80, I-35, and I-29. Logic would dictate that the number of trips passing through the entire model area would be smaller than the number of trips passing through Iowa since the model study area includes either the entirety or majority of adjacent states. According to StreetLight Insight summaries and depicted in **Table 3-4**, there are less than 2,000 daily passenger trips that pass through the state of Iowa non-stop via Interstate highways. This is a small number of trips divided up among seven Iowa Interstate entry and exit points.

Table 3-4 Non-Stop Auto Trips Passing Through Iowa

Origin Station	Origin Location	Destination Station	Destination Location	By O/D Pair	Totals by Station
367	I-88 East of Quad Cities	548	I-80 West of Omaha	20	
367	I-88 East of Quad Cities	623	I-29 North of Sioux City	-	
367	I-88 East of Quad Cities	700a	I-35 North	3	23
371	I-80 East of Quad Cities	548	I-80 West of Omaha	57	
371	I-80 East of Quad Cities	623	I-29 North of Sioux City	6	
371	I-80 East of Quad Cities	636	I-29 South	-	
371	I-80 East of Quad Cities	700a	I-35 North	34	97
375	I-74 South of Quad Cities	548	I-80 West of Omaha	15	
375	I-74 South of Quad Cities	700a	I-29 North of Sioux City	10	
473	I-74 South of Quad Cities	367	I-35 North	52	77
473	I-80 West of Omaha	371	I-88 East of Quad Cities	18	
473	I-80 West of Omaha	375	I-80 East of Quad Cities	62	
473	I-80 West of Omaha	548	I-74 South of Quad Cities	14	
473	I-80 West of Omaha	700a	I-29 North of Sioux City	111	
548	I-80 West of Omaha	367	I-29 South	26	
548	I-80 West of Omaha	371	I-35 North	58	289
548	I-29 North of Sioux City	375	I-80 East of Quad Cities	3	
548	I-29 North of Sioux City	473	I-74 South of Quad Cities	3	
548	I-29 North of Sioux City	636	I-80 West of Omaha	125	
623	I-29 North of Sioux City	367	I-29 South	277	
623	I-29 North of Sioux City	371	I-35 North	-	408
623	I-35 South	700a	I-88 East of Quad Cities	-	
636	I-35 South	367	I-35 South	628	
636	I-35 South	371	I-35 North	-	
636	I-29 South	473	I-80 West of Omaha	33	
636	I-29 South	548	I-29 North of Sioux City	262	923
700a	I-29 South	367	I-35 North	-	
700a	I-35 North	371	I-88 East of Quad Cities	3	
700a	I-35 North	375	I-80 East of Quad Cities	37	
700a	I-35 North	473	I-74 South of Quad Cities	60	
700a	I-35 North	548	I-80 West of Omaha	61	
700a	I-35 North	623	I-29 North of Sioux City	-	
700a	I-35 North	636	I-35 South	4	165
			Total Through Auto Trips		1,982

Unless a given trip passes entirely through the iTRAM network, from one external zone to another, it is not considered an external-to-external trip in the model. Very long travel times and distances between iTRAM external zones means that nearly all of the 2,000 or so passenger trips tagged as passing through Iowa would either terminate in adjacent states within iTRAM or include an overnight stop in an adjacent state within the model, thus becoming an internal trip end point.

Truck trips are somewhat different from passenger trips as freight generally moves across a longer distance than most auto trips. Trucks are also driven by professional drivers trained for maximum endurance. Not unexpectedly, StreetLight Data shows considerably more trucks passing through the state of Iowa than passenger vehicles. Even so, trucking regulations include limits on how long drivers can remain behind the wheel continuously. Thus, it would be improper to assume all trucks passing through Iowa would also pass entirely through the iTRAM study area without necessary breaks. **Table 3-5** shows that approximately 15,000 trucks travel through the state of Iowa, according to StreetLight InSight.

While Iowa through trip patterns summarized using StreetLight Data do not necessarily represent iTRAM external-external trips, these numbers were used during model validation in comparison to select link assignments at these same locations in the highway network to validate patterns of travel between locations along the Iowa state line for both auto and truck trips.

External Trip Summary

External station traffic counts summarized in **Table 3-3** were used to represent control totals for external trips at each location. Separate counts provided for passenger and commercial traffic at these external stations were used to adjust trip tables for external and truck trips during validation. Based on analysis of StreetLight InSight, external passenger trips were limited to the internal-external (IX-XI) trip purpose within the model. Validation of the 2018 iTRAM was completed under the assumption that zero passenger trips pass between any pair of model external zones (i.e., no X-X/external-external passenger trips).

A new screenline 1 (State Line Cordon) was added to the 2018 iTRAM network to summarize passenger flows into and out of Iowa. Total volumes and truck estimates from the 2018 model were compared to available counts, StreetLight InSight, and select link assignments to validate modeled trip patterns among Iowa state line crossing points.

Another cordon line, screenline 16, was added to the 2018 iTRAM network to validate the conversion of FAF tonnages to trucks entering and exiting the original iTRAM study area. Iterative adjustments were made to external and FAF zone centroid connectors, as well as network links near the iTRAM study boundary to validate truck flow patterns along with available truck counts, StreetLight InSight data on commercial vehicles and select link assignments.

Table 3-5 Truck Trips Passing Through Iowa

Origin Station	Origin Location	Destination Station	Destination Location	By O/D Pair	Totals by Station
367	I-88 East of Quad Cities	473	I-80 West of Omaha	130	
367	I-88 East of Quad Cities	548	I-29 North of Sioux City	3	
367	I-88 East of Quad Cities	623	I-35 South	2	
367	I-88 East of Quad Cities	700a	I-35 North	31	166
371	I-80 East of Quad Cities	473	I-80 West of Omaha	1,016	
371	I-80 East of Quad Cities	548	I-29 North of Sioux City	32	
371	I-80 East of Quad Cities	623	I-35 South	1	
371	I-80 East of Quad Cities	636	I-29 South	1	
371	I-80 East of Quad Cities	700a	I-35 North	286	1,336
375	I-74 South of Quad Cities	473	I-80 West of Omaha	248	
375	I-74 South of Quad Cities	548	I-29 North of Sioux City	32	
375	I-74 South of Quad Cities	700a	I-35 North	531	811
473	I-80 West of Omaha	367	I-88 East of Quad Cities	184	
473	I-80 West of Omaha	371	I-80 East of Quad Cities	1,204	
473	I-80 West of Omaha	375	I-74 South of Quad Cities	235	
473	I-80 West of Omaha	548	I-29 North of Sioux City	682	
473	I-80 West of Omaha	636	I-29 South	886	
473	I-80 West of Omaha	700a	I-35 North	488	3,679
548	I-29 North of Sioux City	367	I-88 East of Quad Cities	2	
548	I-29 North of Sioux City	371	I-80 East of Quad Cities	20	
548	I-29 North of Sioux City	375	I-74 South of Quad Cities	27	
548	I-29 North of Sioux City	473	I-80 West of Omaha	767	
548	I-29 North of Sioux City	636	I-29 South	2,971	
548	I-29 North of Sioux City	700a	I-35 North	3	3,790
623	I-35 South	367	I-88 East of Quad Cities	1	
623	I-35 South	371	I-80 East of Quad Cities	1	
623	I-35 South	700a	I-35 North	5	7
636	I-29 South	367	I-88 East of Quad Cities	1	
636	I-29 South	371	I-80 East of Quad Cities	1	
636	I-29 South	473	I-80 West of Omaha	1,045	
636	I-29 South	548	I-29 North of Sioux City	2,757	
636	I-29 South	700a	I-35 North	1	3,805
700a	I-35 North	367	I-88 East of Quad Cities	30	
700a	I-35 North	371	I-80 East of Quad Cities	352	
700a	I-35 North	375	I-74 South of Quad Cities	668	
700a	I-35 North	473	I-80 West of Omaha	678	
700a	I-35 North	548	I-29 North of Sioux City	5	
700a	I-35 North	623	I-35 South	23	
700a	I-35 North	636	I-29 South	1	1,757
			Total Through Truck Trips		15,185

3.5 Socioeconomic Data Collection and Forecasting

Iowa DOT staff began efforts to update 2010 socioeconomic (SE) data to reflect base year 2018 conditions using Census 2018 population estimates as a control. Year 2018 households (HHs) were estimated based on 2010 ratios of population per HH for each traffic analysis zone (TAZ). Initial year 2018 TAZ employment estimates were derived using 2010 employment/population ratios and previous iTRAM interim year employment estimates by category, though these were later updated using economic data purchased from IMPLAN (Impact Analysis for Planning).

Socioeconomic Variables and iTRAM TAZ structure

The iTRAM uses a zone system with 1,951 zones in Iowa and 1,363 outside Iowa for a total of 3,314 zones, including the aforementioned 14 external zones. There are total of 697 counties within the 9 states in the iTRAM study area. **Table 3-6** shows number of counties and zones in each State.

Table 3-6 Number of Counties and Zones in Each iTRAM State

No.	State	Number of Counties	Zones
1	Iowa	99	1,951
2	Illinois	102	287
3	Wisconsin	72	142
4	Minnesota	87	218
5	South Dakota	57	78
6	North Dakota	19	19
7	Nebraska	82	284
8	Kansas	64	71
9	Missouri	115	250
	Externals		14
	Total	697	3,314

Socioeconomic data were developed for each of the 3,300 internal zones. There were no proposed changes to the internal zone structure and therefore the zone boundary and zone numbering are the same as in the previous 2010 iTRAM version. Based on existing model requirements and results of the trip generation survey analysis, the socioeconomic variables mentioned below were estimated.

1. Population and households
2. Employment by six categories
3. Stratification of households by income quartile
4. Stratification of household by number of workers
5. School enrollment

Corrections and Revisions to iTRAM Socioeconomic Data

A few minor issues were noticed and corrected while working on the 2018 model update. These corrections were necessitated because the iTRAM socioeconomic data files were linked to different data sources for updating the SE data. These corrections are mentioned below:

1. "Lake of the Woods" County in Minnesota was misspelled as "Lake of the Wood" in the socioeconomic data file. It was corrected in the socioeconomic data field NAME. The County is represented by a single TAZ 994095.
2. TAZ 998099 falls in St. Louis County while the socioeconomic data file listed this zone in Jefferson County. This correction was made in the data field COUNTY_NAME. The FIPS value in the COUNTY field was correct.
3. TAZ 993089 represents Menominee County in Wisconsin. The FIPS value was incorrect, so it was changed from 55901 to 55078.
4. TAZ 993120 represents Shawano County in Wisconsin. The FIPS value was incorrect, so it was changed from 55901 to 55115.
5. The SE data file shows North and South Dakota together as "The Dakotas" in the STATE_NAME field. This column is being revised by showing the two states separately.

Population Updates

Population estimates for 2018 were refined using data from the 2018 American Community Survey (ACS). The ACS is a continuous survey that obtains data every year giving communities and states current information needed to plan investments and services. The ACS is also used to produce periodic updates to Census Transportation Planning Products (CTPP). ACS has one-year estimates and five-year estimates available for 2018. However, one-year estimates are based on a smaller sample size and had missing values for several counties. Therefore, five-year estimates from ACS Table B01003 (Total Population) were used.

Depending on the ACS table employed, ACS data are often available at different geographic units that include State, County, Tract, Block Group, Block, and zip code. For ACS Table B01003, data were not available at zip code but rather available at Block level and higher. However, downloading the data at Block and Block group required selecting a state, followed by selecting each county one by one. Block level data even required selecting each tract within the county. Tract level data were available to download by selecting a state. However, the tract boundaries do not match with TAZs, and therefore aggregation was not a straightforward process. Thus, the best approach determined was to download the data at county level and allocate to TAZs based on the iTRAM 2010 proportion of TAZ to County. It was considered reasonable that the ratio of TAZ population to the County population would be similar between 2010 and 2018.

The following approach was taken to estimate population for each TAZ:

- The population in each county was obtained using 2018 ACS
- The share of the county population was calculated for each TAZ in that county, using iTRAM 2010 population data
- Each county's population was allocated to TAZs using the shares calculated for each TAZ

A summary of estimated population by state for 2018 compared with 2010 population used in iTRAM is presented in **Table 3-7**. According to these estimates, Iowa experienced a growth rate of 2.8 percent between 2010 and 2018, while the average growth rate for the entire modeling region is 1.8 percent.

Table 3-7 2010 iTRAM and 2018 Estimated Population

State	2010 POP (iTRAM)	2018 POP	% Increase
Iowa	3,046,355	3,132,499	2.8%
Illinois	12,830,632	12,821,497	-0.1%
Wisconsin	5,686,986	5,778,394	1.6%
Minnesota	5,303,925	5,527,358	4.2%
South Dakota	620,458	658,260	6.1%
North Dakota	315,994	342,215	8.3%
Nebraska	1,738,552	1,819,210	4.6%
Kansas	2,491,321	2,556,873	2.6%
Missouri	5,988,927	6,090,062	1.7%
Total	**38,023,150**	**38,726,368**	**1.8%**

After 2018 population was assigned to each TAZ, quality control checks were performed to identify TAZs with zero population in 2018. There were nine such TAZs found. These same TAZs did not have any population in 2010 and therefore had no share of their respective county population for 2018. Since the previous version of iTRAM provided population forecasts for future years 2020, 2025, 2030, 2035 and 2040, the population for these years was also checked with the understanding that forecasts would account for future potential development. It was found that none of these zones include population for 2020, and therefore no revisions were needed to 2018 population estimates. The existing iTRAM population by year for those zones is summarized in **Table 3-8**.

Table 3-8 iTRAM Zones with Zero Population in 2018

TAZ	State	County	County FIPS	POP_15	POP_20	POP_25	POP_30	POP_35	POP_40
77018	Iowa	Polk	19153	0	0	0	2,157	2,212	2,268
78066	Iowa	Pottawattamie	19155	0	0	0	1,766	1,780	1,794
78068	Iowa	Pottawattamie	19155	0	0	0	931	938	946
97029	Iowa	Woodbury	19193	0	0	0	2,846	2,863	2,882
97050	Iowa	Woodbury	19193	0	0	0	0	0	0
993117	Wisconsin	Sauk	55111	0	0	0	0	0	0
996171	Nebraska	Douglas	31055	0	0	0	3,891	4,011	4,132
996176	Nebraska	Douglas	31055	0	0	0	648	668	689
998142	Missouri	Marion	29127	0	0	0	0	0	0

Household Updates

The number of households were estimated using 2018 ACS five-year data found in Table DP04 (Selected Household Characteristics). Five-year estimates were used to be consistent with population data. For the same reasons as explained in the earlier section on population updates, household estimates were obtained at the County level. ACS Table DP04 provided occupied as well as vacant households, both of which are needed for the iTRAM socioeconomic data file.

The approach used to allocate households to TAZs was similar to that of population, as described below:

- Occupied and vacant households in each county were obtained from the 2018 ACS
- The share of county households by TAZ was calculated from iTRAM 2010 zonal data. This was done separately for occupied and vacant households
- 2018 occupied and vacant households for each TAZ were estimated by applying the corresponding ratios of 2018 occupied and vacant households for the county in which the TAZ is located
- The total 2018 households for any TAZ were calculated by adding the occupied and vacant households for that TAZ

Comparisons of 2018 estimated occupied, vacant, and total households by state with 2010 iTRAM households are shown in **Table 3-9**, **Table 3-10**, and **Table 3-11**, respectively. Iowa experienced 2.9 percent growth in occupied, 13.1 percent growth in vacant and 3.8 percent growth in total households between 2010 and 2018. Average growth for the entire modeling region is lower than Iowa alone at 1.8 percent in occupied, 7.2 percent in vacant and 2.4 percent in total households.

Table 3-9 2010 iTRAM and 2018 Estimated Occupied Households

State	2010 HH Occ	2018 HH Occ	% Increase
Iowa	1,221,576	1,256,855	2.9%
Illinois	4,836,972	4,830,038	-0.1%
Wisconsin	2,279,768	2,343,129	2.8%
Minnesota	2,087,227	2,167,801	3.9%
South Dakota	244,550	260,142	6.4%
North Dakota	133,932	147,582	10.2%
Nebraska	684,646	718,235	4.9%
Kansas	973,620	990,624	1.7%
Missouri	2,375,611	2,396,271	0.9%
Total	**14,837,902**	**15,110,677**	**1.8%**

Table 3-10 2010 iTRAM and 2018 Estimated Vacant Households

State	2010 HH Vac	2018 HH Vac	% Increase
Iowa	114,841	129,867	13.1%
Illinois	459,736	517,230	12.5%
Wisconsin	342,669	338,103	-1.3%
Minnesota	259,765	252,672	-2.7%
South Dakota	30,669	33,323	8.7%
North Dakota	14,174	17,199	21.3%
Nebraska	70,330	70,615	0.4%
Kansas	100,980	116,219	15.1%
Missouri	337,111	379,364	12.5%
Total	**1,730,275**	**1,854,592**	**7.2%**

Table 3-11 2010 iTRAM and 2018 Estimated Total Households

State	2010 HH Total	2018 HH Total	% Increase
Iowa	1,336,417	1,386,722	3.8%
Illinois	5,296,708	5,347,268	1.0%
Wisconsin	2,622,437	2,681,232	2.2%
Minnesota	2,346,992	2,420,473	3.1%
South Dakota	275,219	293,465	6.6%
North Dakota	148,106	164,781	11.3%
Nebraska	754,976	788,850	4.5%
Kansas	1,074,600	1,106,843	3.0%
Missouri	2,712,722	2,775,635	2.3%
Total	**16,568,177**	**16,965,269**	**2.4%**

Employment Estimates

The main data source for estimating employment, was the IMPLAN (Impact Analysis for Planning) economic impact assessment model. Several other data sources were compared, reviewed, and summarized prior to selecting IMPLAN, including Longitudinal Employer Household Dynamics (LEHD) and others noted later in this section. However, IMPLAN was selected because its job estimates include workers that are not accounted for by most other data sources. IMPLAN employment includes both wage and salary employees and self-employed persons in a region. The total employment figure reported by IMPLAN represents full and part-time annual averages including all federal, state, and local government employment and military employment. Full-time, part-time, and seasonal workers are measured to create an estimate of annual average jobs.

There are three primary datasets containing non-disclosed elements that are used to estimate IMPLAN employment and labor income data:

- Bureau of Labor Statistics (BLS) Census of Employment and Wages (CEW)
- Census Bureau County Business Patterns (CBP)
- Bureau of Economic Analysis (BEA) and Regional Economic Accounts (REA) data

CEW data, REA data, and CBP data are used in conjunction to create IMPLAN estimates as no single dataset provides enough information to create a complete employment database. In general, CEW data provide the county level industry structure for IMPLAN, while CBP data are used to make non-disclosure adjustments to CEW data. REA data are used as controls for data not covered by CEW and proprietors. Differences among the datasets are summarized in

Table 3-12.

The iTRAM socioeconomic dataset consists of total employment divided into six employment categories for each TAZ. Individual employment categories include the following:

1. FARM: Farm Employment
2. MANU: Forestry, Mining, Utilities, Construction & Manufacturing, Wholesale & Warehousing Employment

3. RETL: Retail Trade Employment
4. FIRES: Information, Financial & Insurance, Real Estate, Rental and Professional& Technical Services, and Management (FIRE) Employment
5. EDUC: Educational, Health and Social Assistance, Food Services Entertainment Employment
6. GOVT: Federal Civilian and Military, State and Local Government, Other Services Employment

Table 3-12 Difference in datasets used by IMPLAN

Category	CEW	CBP	REA
Timing vs. IMPLAN Reference Year	Same year (IMPLAN 2010 data uses 2010 CEW)	Lagged 1 year (IMPLAN 2010 data uses 2009 CBP)	Lagged 1 year (IMPLAN 2010 data uses 2009 REA)
Coverage Ideal	All participants in Unemployment Insurance programs	Known employers for covered industries	Known employers in all industries
Employment Types	Wage and Salary	Wage and Salary	Wage and Salary and Proprietors
Major coverage exclusions by industry	-Railroads -Elected officials -Members of judiciary -Military	-Agriculture -Administrative government -Military -Railroads -Private households -Funds and trusts	None
Known coverage limitations by industry, i.e. not fully covered / ”undercoverage”	-Agriculture -Higher education-(public and private) -Private households -Fishing -Religious organizations	None	None
Disclosure Rules	Protect disclosure of single or dominant establishment in an area-industry combination; establishment count always disclosed	Protect disclosure of single or dominant establishment in an area-industry combination; establishment count by size class always disclosed	Protect disclosure of single or dominant establishment in an area-industry combination
Detail of Coverage	6-digit NAICS by establishment owner type (private, federal, state, local)	6-digit NAICS by legal form of organization	3-digit NAICS approximation for state; 2-digit NAICS approximation for counties
Frequency of Collection	Quarterly	Annually	Produced annually based on variety of sources with different release schedules, but primarily on CEW
Maximum Geographic Detail	County	Zip-Code	County
Notable Adjustments made by Reporting Agency to Collected Data	Review of business classifications; data are meant to reflect administrative records	Review of business classifications; noise infusion[1]	Adjustments to compensate for incomplete coverage in source dat

Source: IMPLAN

IMPLAN provides employment data for each geographic unit (state, county, or zip) specified by North American Industry Classification System (NAICS) 2-digit and 3-digit codes. The six employment categories can be estimated by aggregating the employment provided by NAICS categories. The aggregation scheme used in the existing iTRAM model is shown in **Table 3-13**.

Table 3-13 iTRAM Employment Aggregation Scheme

iTRAM KEY	NAICS	EMPLOYMENT DESCRIPTION
1	111	FARM EMPLOYMENT
2	112	FORESTRY, FISHING, RELATED ACTIVITIES and OTHER EMPLOYMENT
	21	MINING EMPLOYMENT
	22	UTILITIES EMPLOYMENT
	23	CONSTRUCTION EMPLOYMENT
	31-33	MANUFACTURING EMPLOYMENT
	42	WHOLESALE TRADE EMPLOYMENT
	48-49	TRANSPORTATION and WAREHOUSE EMPLOYMENT
3	44-45	RETAIL TRADE EMPLOYMENT
4	51	INFORMATION EMPLOYMENT
	52	FINANCE and INSURANCE EMPLOYMENT
	53	REAL ESTATE and RENTAL and LEASE EMPLOYMENT
	54	PROFESSIONAL and TECHNICAL SERVICES EMPLOYMENT
	55	MANAGEMENT of COMPANIES and ENTERPRISES EMPLOYMENT
	56	ADMINISTRATIVE and WASTE SERVICES EMPLOYMENT
5	61	EDUCATIONAL SERVICES EMPLOYMENT
	62	HEALTH CARE and SOCIAL ASSISTANCE EMPLOYMENT
	71	ARTS, ENTERTAINMENT, and RECREATION EMPLOYMENT
	72	ACCOMODATION AND FOOD SERVICES
6	81	SERVICES, except PUBLIC ADMINISTRATION EMPLOYMENT
	92	FEDERAL CIVILIAN GOVERNMENT EMPLOYMENT
	92	FEDERAL MILITARY EMPLOYMENT
	92	STATE and LOCAL GOVERNMENT EMPLOYMENT

As shown in **Table 3-13**, employment for iTRAM categories 3, 4, 5 and 6 can be obtained by aggregating the 2-digit NAICS employment values from IMPLAN. However, iTRAM categories 1 and 2 do not include 2-digit categories of NAICS in their entirety. iTRAM category 1 (FARM) uses NAICS code 111, and category 2 (MANU) uses NAICS code 112, both of which belong to 2-digit NAICS code 11. There are three additional 3-digit NAICS categories, 113, 114 and 115, that are part of 2-digit code 11 but not included in **Table 3-13**.

All five 3-digit NAICS sub-categories of 2-digit category 11 are shown in **Table 3-14**. **Table 3-13** does not specifically address NAICS categories 113, 114 and 115, but the description of NAICS code 112 in that table (FORESTRY, FISHING, RELATED ACTIVITIES and OTHER EMPLOYMENT), covers NAICS categories 113, 114 and 115 as seen in **Table 3-14**. In fact, the actual description “Animal Production and

Aquaculture” is not included in NAICS code 112 of **Table 3-13**. After discussion with Iowa DOT, it was decided that the employment in NAICS category 112 would be added to FARM (iTRAM category 1) and NAICS categories 113, 114 and 115 could be added to MANU (iTRAM category 2). While recommended trip attraction rates do not differentiate between agriculture and manufacturing employment, disaggregation of FAF data for freight modeling works better with NAICS 113-115 added to the FARM category. The allocation of employment in the five 3-digit categories of NAICS code 11, are shown in **Table 3-14**.

Table 3-14 iTRAM Employment Aggregation Scheme

NAICS 3-Digit	Allocation
111 - Crop Production	FARM
112 - Animal Production and Aquaculture	FARM
113 - Forestry and Logging	MANU
114 - Fishing, Hunting and Trapping	MANU
115 - Support Activities for Agriculture and Forestry	MANU

IMPLAN data were purchased as part of the 2018 iTRAM Update contract. Since these data were purchased through the state of Iowa, detailed employment numbers were available by each geographic unit (state, county, and zip) only for Iowa. For the other eight iTRAM states, only total employment values were available by each geographic unit. Therefore, the following methodologies were used in estimating the 2018 employment by category:

Approach used for Iowa:

- For Iowa, employment by 3-digit NAICS code was obtained for each county in Iowa
- Employment by 3-digit NAICS code was aggregated into the six iTRAM categories by County.
- The share of county employment was computed for each employment category, in each TAZ using iTRAM 2010 employment values.
- The same 2010 shares by category were then applied to the 2018 employment estimates to develop the 2018 employment by category for each TAZ.

Approach used for other states:

- Total employment by 3-digit NAICS code was obtained for each county.
- For each TAZ, the share of the “total” county employment was calculated for each TAZ using iTRAM 2010 total employment.
- The 2010 shares were next applied to the 2018 county estimates to develop total employment for each TAZ.
- For each TAZ, the share of total TAZ employment by category was estimated using iTRAM 2010 employment.
- The 2010 category shares were then applied to the estimated total TAZ employment to develop the employment for each of the six categories.

The 2018 estimated total employment by state, compared with 2010 total employment, is depicted in **Table 3-15**. In Illinois and Minnesota, more than 50% of the counties have lower employment estimates in 2018 than in 2010. Despite across the board increasing statewide employment, 42% of all counties in the model region have lower employment estimates in 2018 than in 2010. The counties with negative growth are shown in **Figure 3-2** and the counties with positive growth are shown in **Figure 3-3**.

Table 3-15 2018 vs 2010 Employment Estimates by State

	State Employment Totals			Summary of Counties with Decreasing/Increasing Employment				
	2010	**2018**	**% Diff**	**Total**	**2018<2010**	**Percent**	**2018>=2010**	**Percent**
Iowa	1,941,206	2,084,914	7%	99	35	35%	64	65%
Illinois	7,315,212	7,928,499	8%	102	63	62%	39	38%
Wisconsin	3,417,198	3,728,502	9%	72	18	25%	54	75%
Minnesota	3,462,278	3,798,316	10%	87	47	54%	40	46%
North Dakota	239,816	274,204	14%	19	9	47%	10	53%
South Dakota	432,016	476,029	10%	57	23	40%	34	60%
Nebraska	1,159,991	1,275,635	10%	82	29	35%	53	65%
Kansas	1,587,557	1,721,487	8%	64	28	44%	36	56%
Missouri	3,467,280	3,761,202	8%	115	40	35%	75	65%
Total	**23,022,555**	**25,048,788**	**9%**	**697**	**292**	**42%**	**405**	**58%**

Figure 3-2 Counties with Negative Employment Growth (2010-2018)

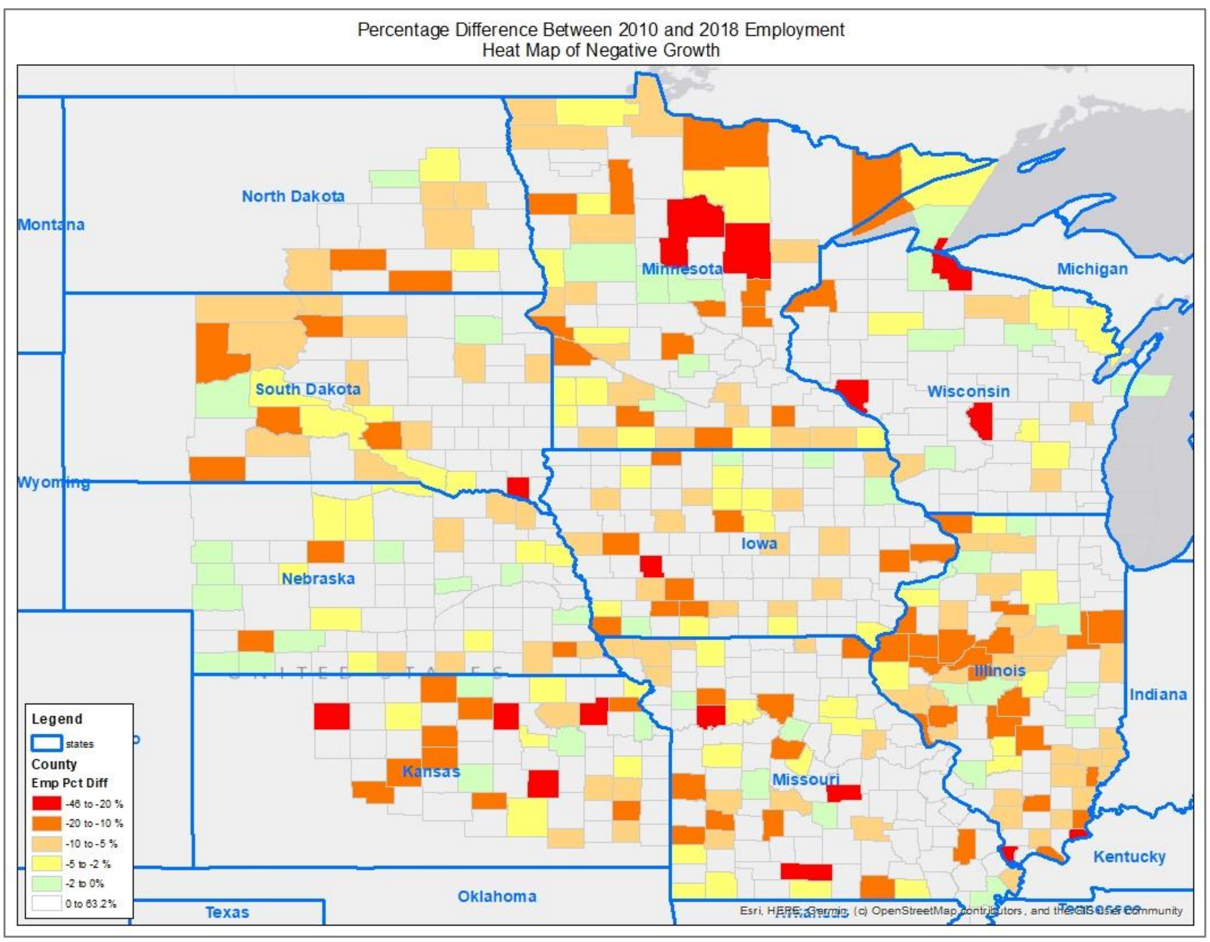
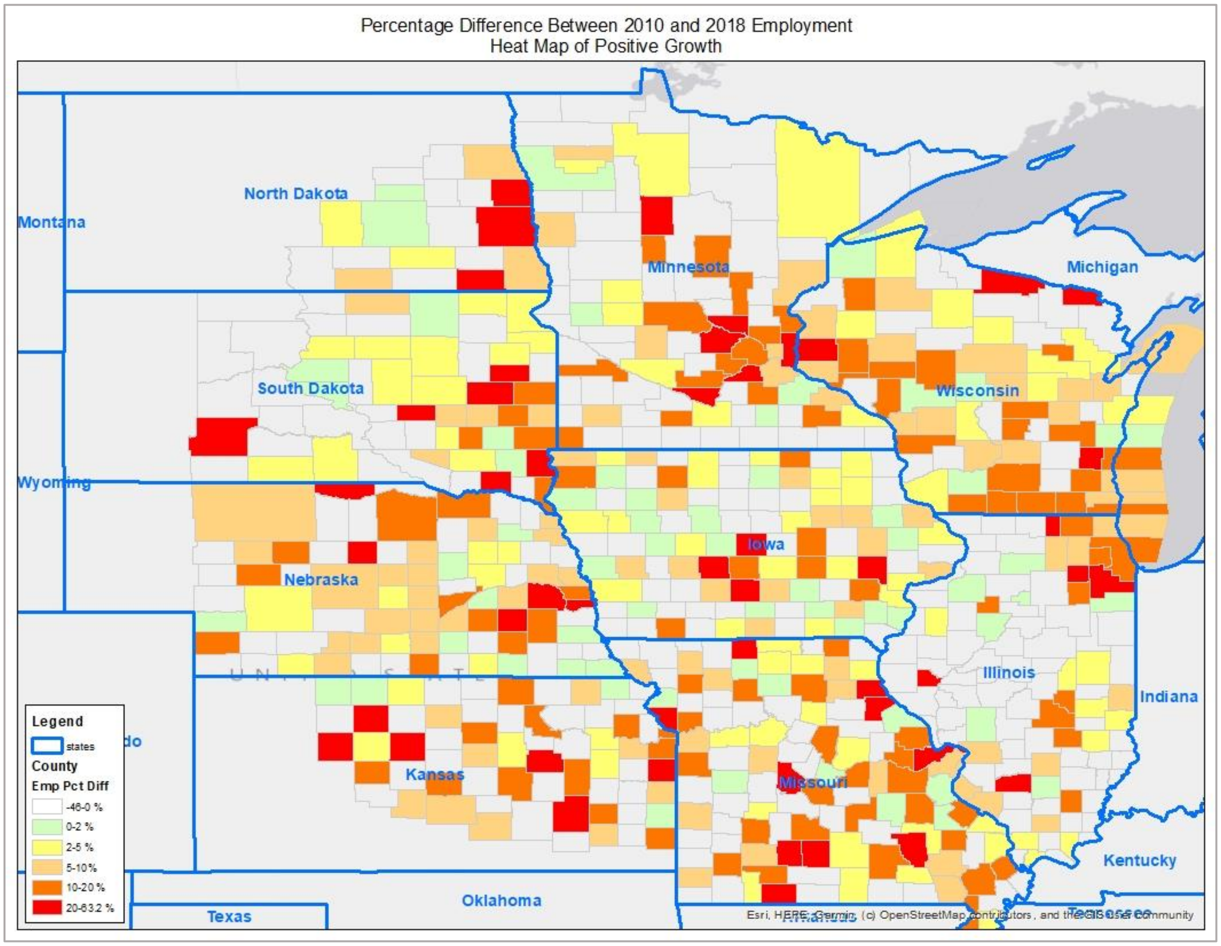


Figure 3-3 Counties with Positive Employment Growth (2010-2018)



Stratification of Households by Number of Workers

Stratification of households by number of workers for 2018 was accomplished using ACS Table B08202. Table B08202 provides the percentage of households by the following categories of workers per household: 0 worker, 1 worker, 2 workers, 3+ workers. The approach taken to develop household stratifications by number of workers for each model TAZ is described below:

- Number of households by the four categories of workers per household were obtained for each county from ACS.
- The percentage of households in each category was calculated for each county.
- The household stratification by number of workers for any TAZ was assumed to be same as that of the county in which the TAZ is located.

A sample of the household stratification by numbers of workers estimated by TAZ is shown in **Table 3-16**. As seen from the table, all the TAZs within a county receive the same distribution. The minimum, maximum and average value of shares in each income group among all the iTRAM TAZs, are depicted in **Table 3-16**.

Table 3-16 Household Distribution by Income Group (Sample records)

TAZ ID	County, State	<25K	25K-50K	50K-100K	>100K	Total
2003	Adams County, Iowa	19%	32%	34%	15%	100%
2004	Adams County, Iowa	19%	32%	34%	15%	100%
2005	Adams County, Iowa	19%	32%	34%	15%	100%
3001	Allamakee County, Iowa	24%	26%	32%	19%	100%
3002	Allamakee County, Iowa	24%	26%	32%	19%	100%
3003	Allamakee County, Iowa	24%	26%	32%	19%	100%
3004	Allamakee County, Iowa	24%	26%	32%	19%	100%

Table 3-17 Minimum, Maximum and Average Income Levels in 2018 iTRAM

Income Group	Minimum	(In County)	Maximum	(In County)	Average
<25K	7%	Kendall, IL	51%	Todd, SD	22%
25K-50K	14%	Carver, MN	38%	Jones, SD	25%
50K-100K	17%	Mellette, SD	48%	Hamlin, SD	33%
>100K	4%	Buffalo, SD	49%	Carver, MN	20%

School Enrollment

Point location-based school enrollment data were compiled by the Iowa DOT. Data were provided in shape file format for four different school types, listed below with the number of students in each category:

- College On-Campus (173,135)
- College Off-Campus (44,804)
- Public Grade Schools (272,072)
- Private Grade Schools (25,177)

iTRAM TAZs were overlaid on top of the school location point data for aggregation to the zone level and collapsed into a single enrollment category. School enrollment data were only provided for the State of Iowa. Since enrollment data are only used to compute home-based other trip attractions, and the focus of the model is on travel forecasts for Iowa highways, it is not felt that the lack of school enrollment data outside of Iowa is not crucial to model accuracy.

Socioeconomic forecasts

Year 2050 employment forecasts were prepared by EBP, under subcontract to Metro Analytics for a pilot implementation of methods from the NCHRP Guidebook on Right-Sizing Transportation Investments. Iowa DOT staff provided 2050 occupied HH and population control totals by County, through their Woods & Poole license. County forecasts were disaggregated to TAZs based on 2018 zonal allocations. Vacant occupied percentages were maintained from 2018 to 2050 and total HHs were calculated as occupied plus vacant. Likewise, 2018 proportions of HH size, HH income, and HH workers were maintained for 2050. School enrollment by zone was factored to 2050 based on County population growth rates. Special generator university enrollment was forecasted to 2050 based on statewide Iowa population growth while airport enplanements was extrapolated from 2045 FAA forecasts.

4 Freight/Truck Model Refinements

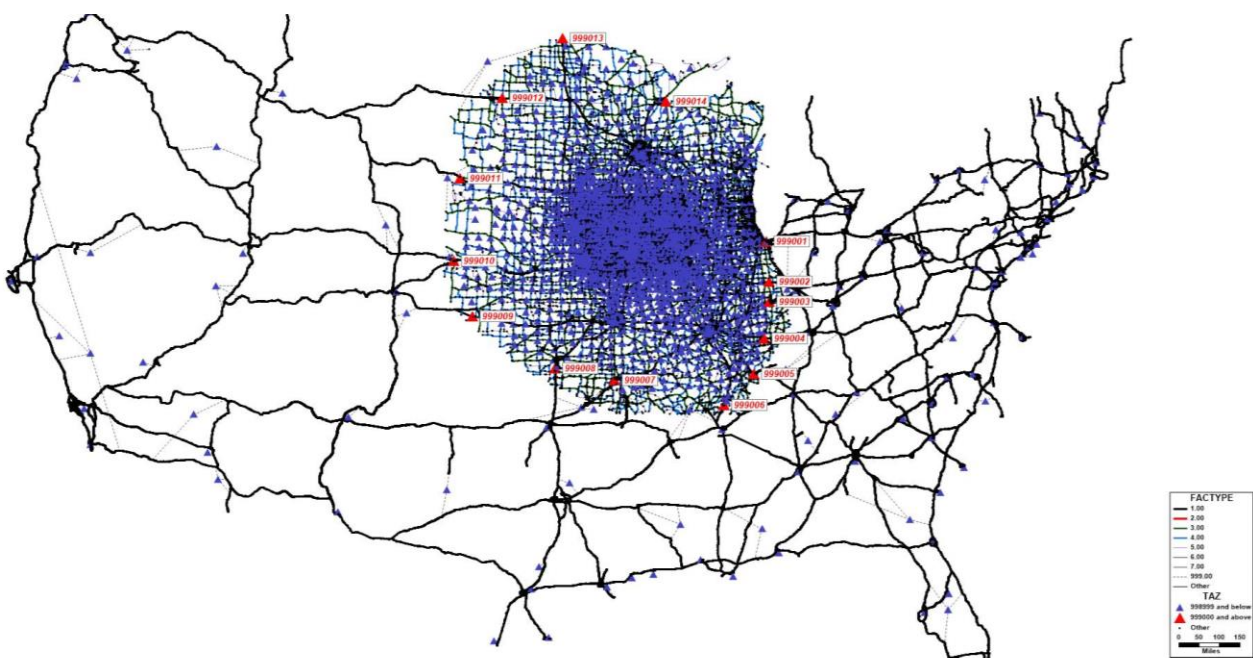
The 2018 iTRAM Update includes incorporating elements of the FHWA Freight Analysis Framework Version 4 (FAF4) into the model structure. The rationale behind this change is that a large portion of freight movement is at the national level. Thus, it would make sense to tap into the wealth of available data on nationwide freight flows to estimate base and future trucks. This process required expanding the iTRAM zone and network system to cover the entire U.S. for truck travel; disaggregating FAF tonnage flows from FAF zones to iTRAM zones within the original iTRAM study area. Next, these tonnage flows had to be converted to truck estimates. Finally, medium-duty trucks were added back into the model to complete the spectrum of truck trips and simulate available truck counts.

4.1 FAF Network and Zone System

FAF4 includes a complete set of TransCAD files available for download. While this presented a good starting point for developing a network and zone system, FAF TransCAD files include far too much network and too little in the way of zone specificity. The process for integrating FAF into the iTRAM network and zone system started with stitching the FAF network to the iTRAM network at each external zone; removing any non-Interstate highways outside the iTRAM study area from the network; adding appropriate FAF centroids and centroid connectors outside the iTRAM study area; and adding network attributes necessary to make the FAF and iTRAM networks compatible within the model.

During validation, a series of iterative adjustments were made to FAF and external centroid locations and connectors, as well as network roadways in areas adjacent to the iTRAM study boundary. **Figure 4-1** depicts the combined FAF/iTRAM network. External zone centroids are labeled and depicted in red while all other centroids are displayed with purple triangles. All centroid connectors are displayed with dashed lines. Any centroids depicted outside the external zones represent FAF zones.

Figure 4-1 Combined FAF/iTRAM Network



The *FAF4 User's Guide* (October 2015) includes a table of FAF zone descriptions (i.e., FAF Domestic Regions) and shape files of these zones are available for downloading. Metro Analytics staff discovered that there are some inconsistencies between the PDF table of FAF zones and the FAF zone shape files for downloading. Therefore, the consulting team modified the FAF zone shape files for consistency with the FAF4 User's Guide descriptions. The *FAF4 User's Guide* is available for download here:

https://www.bts.gov/sites/bts.dot.gov/files/legacy/FAF4_0%20User%20Guide.pdf.

Since all iTRAM zones are 4-to-6-digit numbers, it was not necessary to renumber the FAF zones, which are numbered from 11 to 560. The iTRAM zone system replaces the FAF4 zones within the iTRAM study area, where tonnages and truck estimates have been disaggregated. **Figure 4-2** depicts the FAF4 zone system while

Figure 4-3 is an inset of the Northeast U.S. These maps are consistent with regional descriptions in the User's Guide.

Figure 4-2 Freight Analysis Framework V. 4 Zone System

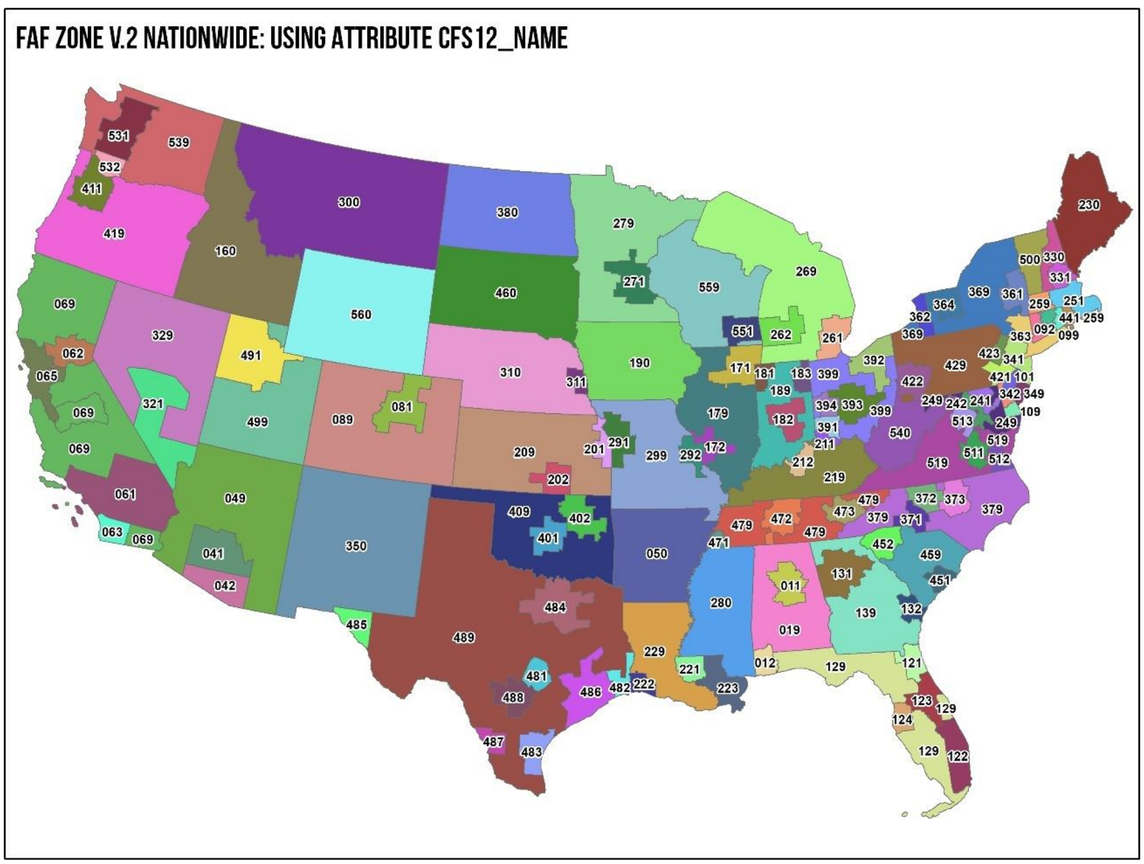
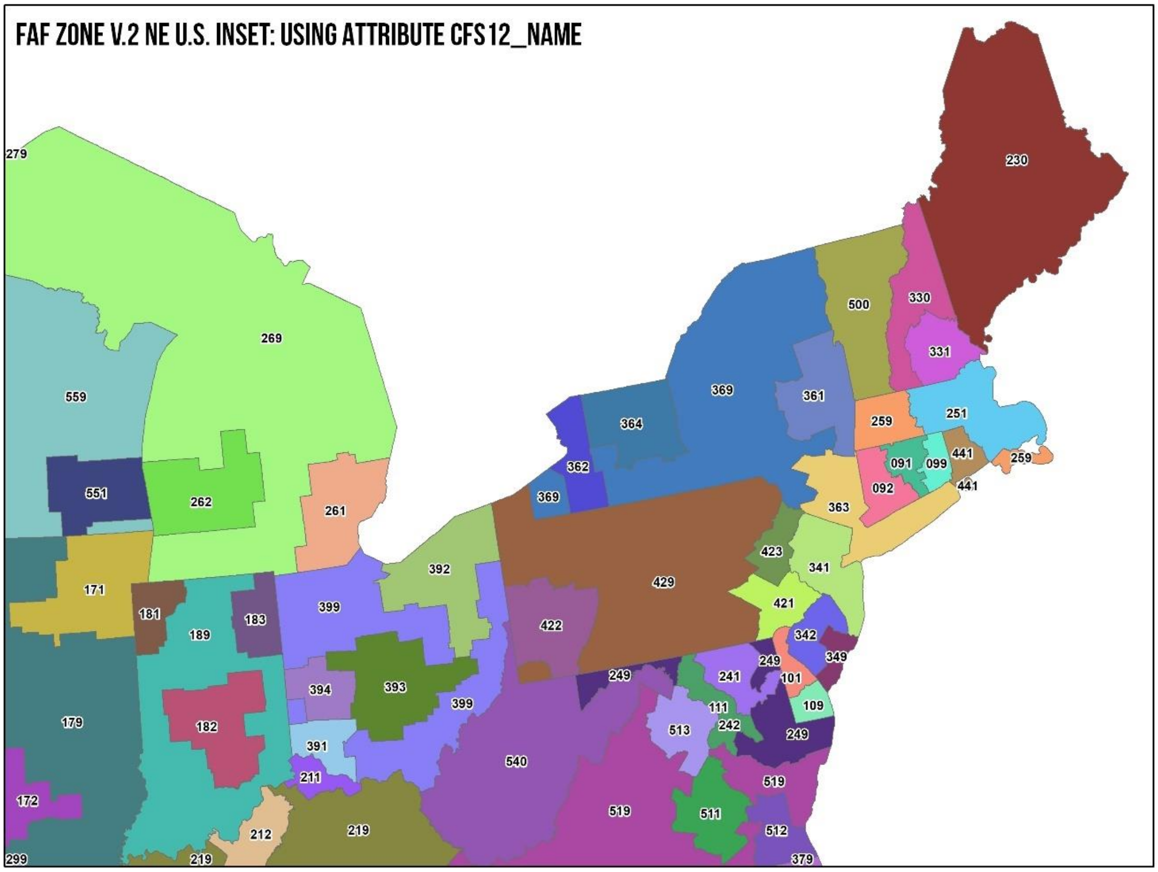


Figure 4-3 Freight Analysis Framework V. 4 Zone System NE U.S. Inset



4.2 FAF Disaggregation to iTRAM TAZs

These efforts focused on disaggregating truck commodity flow data from the existing county level data in the Iowa Freight Optimization Model (iFROM) to the TAZ level for the iTRAM Update. The disaggregated commodity flow data includes all domestic and import/export flows originating from or terminating in iTRAM zones. The disaggregated data includes all 2-digit SCTG commodity groups in version 4 of the Freight Analysis Framework (FAF 4). The TAZ Level disaggregated data are provided in csv flat file format, one file for each 2-digit SCTG commodity group.

Through traffic originating from and terminating in areas outside of iTRAM zones were developed at the FAF zone level using a set of relevant origin-destination zone pairs identified by Metro Analytics. No disaggregation was needed for the through traffic data. The following describes the disaggregation methods and data sources used.

County Level Commodity Flow Data for Eight iFROM States

iFROM includes 2014 county level commodity flow data. The domestic flow data resulted from a process to disaggregate FAF4 data from the FAF zone level to the county level. The import/export data in iFROM was developed using actual 2014 import/export data from the U.S. Census Bureau as the base and augmented and adjusted using additional data sources including USDA agriculture export data in order to identify the true origin of the agriculture product export. The 2014 county level commodity flow data from iFROM was then adjusted using growth factors from FAF 4.5.1 to estimate the 2018 county level commodity flows. The 2018 dataset includes commodity flows originated from or terminated in an 8-state region including Iowa, Illinois, Kansas, Minnesota, Missouri, Nebraska, South Dakota, and Wisconsin.

Disaggregating Base Year Commodity Flow Data for Eight iFROM States

A three-step process was used to disaggregate county level iFROM commodity flow data in the 8-state region to the TAZ level:

- Step 1: regression models were developed using employment and other socioeconomic data. The base year employment numbers were provided by Metro Analytics. The employment numbers were initially provided for each 3-digit NAICS code, and then the numbers were aggregated to six categories described in **Table 4-1** below. In addition, agriculture acreage, year 2010 rail and barge facility location data, and population data were also used to develop the regression models for each 2-digit SCTG commodity group.
- Step 2: a commodity flow allocation table was developed using the regression models and base year TAZ level socioeconomic data. The allocation table specified the weight in percentage assigned to each TAZ within a county for both attraction and production flows. A data processing script was then developed and run to disaggregate commodity flows from county level to TAZ level using the allocation table.
- Step 3: a QA/QC process was carried out to verify the disaggregated data. The total commodity flows for each commodity group and for each county were checked to ensure the disaggregation process was run correctly. Once QA/QC was complete, the dataset was extracted to generate one csv flat file for each commodity category. The files include data items defined in **Table 4-2**.

Table 4-1 NAICS Employment Categories Used in FAF4 Disaggregation

NAICS Code Range	Employment Category
111 to 112	FARM
113 – 115, 211 – 339, 42, 481 – 493	MANU
441 – 454	RETAIL
511 – 562	FIRE
611 – 722	EDUC
811-814, 9A, 93, 9B	GOVT

Table 4-2 FAF4 Disaggregation File Format

Column Name	Description
OZone	Origin TAZ Zone ID
OFAF	Origin FAF Zone ID
DZone	Destination TAZ Zone ID
DFAF	Destination FAF Zone ID
SCTG2	Commodity code. SCTG 10 (stone) and 12 (gravel) are combined into a new code 80 (stone and gravel)
Mode	Transportation mode. 1 = Truck
Trade_Type	1 = domestic, 2 = import, 3 = export
Tonnage	Short ton in 2018 from FAF version 4.51
Value	Commodity value in USD in 2018 from FAF version 4.51

Disaggregating Base Year Commodity Flow Data for North Dakota

iTRAM includes part of North Dakota in its set of buffer zones. However, iFROM does not have county level commodity flow data for North Dakota. Thus North Dakota data required disaggregation from FAF zone level to county level first, and then from county level to TAZ level.

The same methodology and regression models used in iFROM to disaggregate the 8-state FAF4 data to the county level were used to disaggregate North Dakota domestic and import/export flow data in FAF4.5.1. Due to resource constraints, the agriculture product adjustments done for the 8-state dataset in iFROM were not carried out for the North Dakota import/export flow data.

After commodity flow data were disaggregated to the county level, the same method used to disaggregate the 8-state data to the TAZ level was used to disaggregate the North Dakota commodity flow data to the TAZ level.

Disaggregating Forecast Year Commodity Flow Data

The forecast year for FAF4 is presently 2045. Thus, year 2050 forecast year commodity flows were disaggregated using the county level commodity flow and employment forecasts prepared by EBP economic consultants under a separate NCHRP demonstration project. A three-step process similar to the base year disaggregation process was carried out to develop the TAZ level disaggregated data:

- Step 1: regression models were developed using forecasted employment and other socioeconomic data such as agriculture acreage and population data provided by EBP and Metro Analytics. The employment numbers were aggregated to the six employment categories used for the base year.
- Step 2: a commodity flow allocation table was developed using the regression models and forecast year TAZ level socioeconomic data. Similar to the base year disaggregation, the table specified percentage weights by TAZ within a county for each set of flows. The base year data processing script was modified and run to disaggregate forecast year commodity flows from county level to TAZ level using the allocation table.

- Step 3: a QA/QC process was carried out to verify the disaggregated data. The total commodity flows for each commodity group and for each county were checked to ensure the disaggregation process was run correctly. Once QA/QC was done, the disaggregated EBP data were provided to Metro Analytics. Metro Analytics applied EBP growth factors to the base year TAZ level FAF4 commodity flow data to derive the forecast year TAZ level commodity flow data.

4.3 Conversion of FAF Tonnages to Trucks

Zone-to-zone FAF tonnages are converted to trucks using payload factors documented in the FHWA report entitled *Quick Response Freight Methods, Third Edition* (July 2019). FAF tonnages and Quick Response payload factors are specified by commodity group. FAF flows are provided in annual equivalents and alternate factors were tested to convert annual truck estimates to daily values. Validation of freight truck estimates to truck counts, especially those along Screenline 16, were used to identify the best conversion factor, in conjunction with testing of different trip production rates for medium-duty trucks and a review of truck flows among different zone groupings. After testing with a conversion factor of 365, based on the number of days in a year, it was determined that the model validated better using an average weekday truck estimate, computed using a factor of 260. **Table 4-** provides a summary of 2018 truck trips between Iowa zones, border state zones, and FAF zones outside the iTRAM study area.

Table 4-3 Daily Truck Trip Origin/Destination Pattern Summary

Updated Truck Trips Based on FHWA Payload Factors				
	FAF	Iowa	Buffer	Grand Total
FAF	4,177	2,896	55,071	62,145
Iowa	3,903	89,491	9,885	103,279
Buffer	54,634	6,246	241,882	302,762
Grand Total	62,715	98,633	306,838	468,186
Iowa-to-Iowa truck trips include 78,691 medium-duty trucks				

4.4 Modeling of Iowa Medium-Duty Trucks

Freight Analysis Framework flows do not account for all truck movements as not all trucks carry freight. Therefore, it was still necessary to estimate medium-duty trucks in order to validate commercial vehicle flows to available counts. Pre-existing iTRAM medium-duty truck trip production rates were reviewed and tested with a series of alternate adjustment factors during the validation process. These truck trip production rates vary by commodity group. The final validation factors all medium-duty trucks by 0.75 (25 percent reduction from original production rates).

5 Calibration, Validation, and Post Processing

According to the Transportation Research Board (TRB) Travel Forecasting Resource (TFR) (located online at https://tfresource.org/topics/Model_calibration_and_validation.html), "travel model calibration can be defined as the approach and methods used to make travel models reasonably reproduce a snapshot of travel in the modeling area. Travel model validation can be defined as the approach and methods used to demonstrate that travel models have reasonable sensitivities and will provide reasonable forecasts of travel based on alternative conditions or assumptions regarding the population or transportation system." Another way of differentiating these terms is to ascribe "calibration" to the ability of a model to mimic results from a household travel survey; whereas "validation" is an iterative adjustment process used to get model outputs to match traffic counts and other model metrics.

Since model estimates of traffic are not 100 percent accurate, post processing is conducted to summarize model results, compare results against standards of accuracy, and in some cases, provide reasonability adjustments to model outputs. Procedures employed, adjustments made, output results, and benchmark comparisons are provided throughout this Chapter of the report. Each step in the traditional four-step modeling structure has its own section.

5.1 Calibrate Trip Generation

As described in Chapter 2 of this report, a key component of the 2018 iTRAM Update is a restructuring of the trip generation model to reflect analysis of 2017 NHTS data for the Midwest U.S. Census region. As the first step in the traditional four-step modeling process, it is vital to confirm that the trip generation model provides results comparable to survey analysis and comparative benchmark statistics from other models and guidance documents. Errors in trip generation will impact subsequent steps in the process. It is vital that the trip generation model reflect defensible trip rates, demographic assumptions, and logical adjustments, where needed.

During model validation, a series of careful, iterative adjustments were made to improve model performance. Calibration of trip generation relied heavily on the aforementioned 2017 NHTS data analysis, in conjunction with the following validation adjustments:

- Trip attraction rate adjustments to close the gap between trip productions and attractions
- Trip rates for the airport trip purpose
- Medium-duty truck trip adjustment factors reflecting available truck counts
- Home-based work trip production rates to reflect typical trip purpose percentages
- Rural trip rate adjustments relative to urban trip rates for select household types
- Testing with and without special generators
- Factoring special generator trips
- Reconfirming special generator locations and network access

Trip generation results from the 2018 version of iTRAM were compared against metrics from the 2005 and 2010 iTRAM versions, as well as benchmark statistics from the 2017 NHTS, NCHRP Reports 716 and 735, and other statewide models. These benchmark comparisons provide confidence that trip purpose percentages and aggregate trip rates derived from running 2018 iTRAM are generally consistent with results found in guidance documents, prior versions of iTRAM and other statewide models. Final trip production rates are depicted in Appendix F for each trip purpose and HH category described previously.

Table 5-1 provides a trip purpose summary for the 2018 version of iTRAM. The number of person trips and percent of trips are provided for each trip purpose in the model, along with comparisons to previous versions of iTRAM, NHTS, other statewide models, and NCHRP guidance documents. Numerous sources have documented a recent reduction in home-based trip-making due to a variety of factors including increases in work from home, shopping on the Internet, and the use of delivery services. Not surprisingly, trip productions are lower in 2018 iTRAM than the previous 2010 model for all trip purposes except long-distance nonwork. Percent trips by purpose appear reasonable when compared to other statewide models and guidance documents. Nonhome-based trip making continues to increase as a percentage due to more complex household/work dynamics and 2018 iTRAM better reflects a typical average of 1/3 of all trips being nonhome-based.

Table 5-1 Trip Generation - Trip Purpose Summary

TRIP GENERATION - Trip Purpose Summary												
	Prior iTRAM Models		2018 iTRAM Model		Other Statewide Models: Percent Trips by Purpose					NHTS Midwest Region Trip Purpose%	NCHRP Urban/Rural Trip Purpose Targets	
	2010 iTRAM Run		Latest iTRAM Run		Arkansas	Florida	Georgia	Tennessee	Texas			
Person Trip Purpose	Person Trips	% Person Trips	Person Trips	% Person Trips							NCHRP 716 (Urb)	NCHRP 735 (Rur)
Home-based Work (HBW)	1,885,147	15.7%	1,666,159	18.05%	15.1%	20.0%	11.2%	27.7%	15.4%	19.0%	15.0%	12.1%
Home-based Other (HBO)	6,508,302	54.1%	4,416,420	47.84%	52.2%	49.8%	55.4%	50.3%	53.9%	48.0%	54.0%	55.2%
Nonhome-based (NHB)	3,562,807	29.6%	3,069,546	33.25%	32.3%	30.1%	32.3%	21.6%	28.8%	33.0%	31.0%	32.7%
Long-Distance Work	32,418	0.3%	19,580	0.21%	0.1%	0.1%	0.2%	0.1%	1.9%	0.0%	n/a	n/a
Long-Distance Nonwork	47,340	0.4%	60,655	0.66%	0.3%	n/a	0.9%	0.3%	n/a	0.0%	n/a	n/a
Total	12,036,014	100%	9,232,360	100%	100.0%	100.0%	100.0%	100.0%	100.0%	100%	100%	100%

Error! Reference source not found. provides a summary of aggregate trip rates, including person trips p er household, person trips per person, and HBW trips per employee. The 2018 version of iTRAM, as expected, results in lower person trips per household and person, as well as HBW trips per employee than the 2010 model. While at the low end of other recent statewide models, these aggregate rates still fall within the range of those documented in NCHRP guidance and are similar to estimates from households sampled in the 2017 NHTS Midwest Region. These aggregate rates reflect a 10 percent reduction in HBW trip rates made during validation, along with a reduction in select rural household trip rates for consistency with urban trip rates for these same household types. These adjustments helped reduce model over-assignments.

Table 5-2 Trip Generation - Aggregate Trip Rate Comparisons

TRIP GENERATION - Aggregate Trip Rate Comparisons									
	Aggregate Trip Rates		Other Statewide Models					2017 NHTS Midwest Region Aggregate Trip Rates	NCHRP Targets & Additional Statewide Models
Validation Measure (Aggregate Rates)	2010 iTRAM	Latest 2018 Model Run	Arkansas	Florida	Georgia	Tennessee	Texas		
Person Trips Per Household	9.79	6.66	8.7	9.48	9.21	5.82	9.42	7.78	5.41 - 10.33
Person Trips Per Person	3.92	2.95	3.44	3.63	3.29	n/a	3.25	3.25	1.95 - 4.25
HBW Trips Per Employee	0.97	0.80	n/a	1.57	n/a	n/a	n/a	1.22	1.38 - 1.73
P/A Ratio (HBW)	*0.51*	0.94	n/a	n/a	n/a	n/a	n/a		0.9 - 1.1
P/A Ratio (HBO)	*1.14*	0.99	n/a	n/a	n/a	n/a	n/a		0.9 - 1.1
P/A Ratio (LNGW+NW)	*0.22*	1.00	n/a	n/a	n/a	n/a	n/a		0.9 - 1.1
Trips per TAZ (Iowa: 1,951)	6,170	4,728	n/a	n/a	n/a	n/a	n/a		<15k

5.2 Validate Trip Distribution

Unlike the trip generation model, the 2018 iTRAM trip distribution model operates largely the same as the 2010 model version. Despite the similarities, much of the validation process was expended on achieving a satisfactory distribution of trips among different regions contained within the model. This included focusing on inter-urban and intra-urban trip patterns, flows between rural and urban areas, travel between Iowa and border states, and trips passing through Iowa between border states. Validation of the trip distribution model included the following iterative adjustments:

- River crossing penalties (destination choice factor, AKA DCParams)
- Interstate crossing penalties (DCParams)
- Rural crossing penalties (DCParams)
- Intrazonal constant (DCParams)
- Impedance setting (DCParams)
- Facility type penalties (NETPARAMS)
- Network link penalties
- K-Factors

Table 5-3 provides a summary of average trip lengths for the 2018 version of iTRAM in minutes of travel time by trip purpose. Comparisons are provided against the 2010 model, other statewide models, the 2017 NHTS Midwest sample, and NCHRP targets. As expected, average trip lengths increased between 2010 and 2018 for most trip purposes, reflecting additional roadway congestion, urban sprawl, and a gradual recovery from the days of the Great Recession. The exception to this trend was a slight decrease in average trip lengths for nonhome-based trips, consistent with a proportionate increase in shorter nonhome-based trip activity. Average trip lengths by purpose are within the ranges depicted from other statewide models, the 2017 NHTS Midwest sample, and NCHRP guidance documents. Final destination choice factors (DCParams) and network parameters (NETPARAMS) are depicted in Appendix G.

Table 5-3 Trip Distribution - Average Trip Lengths (Minutes)

TRIP DISTRIBUTION: Average Trip Lengths (Minutes)									
Purpose	2010 iTRAM	Latest 2018 iTRAM Run	Other Statewide Models					2017 NHTS Midwest Region Avg. Trip Lengths	NCHRP Targets & Additional Statewide Models
			Arkansas	Florida	Georgia	Tennessee	Texas		
HBW	*23.10*	24.5	20.16-22.22	28.7	27-40	20.5	12.4-28.2	15.5 - 26	11-25
HBO	*20.40*	23.2	13.67-18.44	12.7-25.7	22-37	15.8	9.7-14.4	12.5 - 17	9-20
NHB	18.30	17.5	13.44-23.89	20.5	20-34	16.9	7.5-15.3	12.5 – 16.5	9-20
LDW	*145.20*	163.0	162.66	105.4	138	178.3	12.0	216 - 229 mi	90-200
LDNW	*132.90*	168.5	198.13	n/a	122-140	169.5-169.8	n/a	201 - 265 mi	85-213
Airport	*96.90*	115.0	n/a	n/a	n/a	n/a	n/a		n/a
Autos I-I	***20.40***	**21.8**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**		**9-25**
Med. Truck	*25.90*	22.6	20.89	n/a	n/a	49.5	24.4		n/a
HD Truck	*87.50*	87.5	34.70	n/a	n/a		38.8		n/a
Trucks I-I	***56.20***	**60.9**	**n/a**	**n/a**	**n/a**	**n/a**	**17.2**		**n/a**

Table 5-4 provides a synopsis of intrazonal trips for the 2018 model. These trips are those that get distributed within to the same TAZ where the trips originate. Intrazonal trips typically represent a higher percent of trips in statewide models than in MPO models. Unfortunately, intrazonal summaries were not available for prior versions of iTRAM. These metrics were recently added to a set of new 2018 model outputs. As depicted in the table below, percent intrazonal trips by purpose are consistent with NCHRP documented ranges in other statewide models.

Table 5-4 Trip Distribution - Intrazonal Trips

TRIP DISTRIBUTION - Intrazonal Number & Percent			
Trip Purpose	Latest 2018 iTRAM Run		NCHRP Statewide Model Range
	Intrazonal Trips	Percent Intrazonal	
HBW	228,815	14.37%	5.5-29.2
HBO	732,072	16.85%	15.6-54.0
NHB	786,884	26.40%	8.3-54.4
Airport	3	0.18%	n/a
Autos I-I	1,747,774	19.60%	n/a

5.3 Mode Split Statistics

While iTRAM does not include a mode choice (AKA mode split) model, there are a series of trip table manipulations made prior to highway assignment that are often included as part of the mode choice process in other models. Since iTRAM is a "highway only" model, the only transportation modes included are passenger autos and trucks. Person trips from the trip distribution step must be converted to vehicle trips, using auto occupancy factors, in order to load passenger trips onto the highway network during assignment. Daily trips are also apportioned to one of four time periods using diurnal factors. The basis of these factors was presented earlier in Chapter 2 of this report, along with **Table 2-17** through **Table 2-21**.

During validation, a few iterative adjustments were made to the initial 2017 NHTS vehicle occupancy rates in an attempt to reduce the loading of vehicle trips to the model network and correct for over-assignments compared to available traffic counts. The first of these adjustments was a rounding of the NHTS auto occupancy factors to one decimal point. While this improved the relationship between assignment volumes and counts somewhat, the impact was small. Thus, a switch was made from the 2017 Midwest NHTS auto occupancies to those documented in NCHRP Report 716 for the home-based other and nonhome-based purposes and computed from the 2009 NHTS nationwide sample. (Home-based work auto occupancy rates from 2009 nationwide NHTS and 2017 Midwest NHTS were the same.) Application of these rates seemed to improve highway assignment more significantly and thus were maintained in the final 2018 model validation.

Table 5-5 presents the number of person trips by purpose and compares these against vehicle trips resulting from the auto occupancy process, along with a series of alternate references for auto occupancy rates.

Table 5-5 Mode Choice - Vehicle Trips and Occupancy Factors

2018 iTRAM MODE CHOICE/AUTO OCCUPANCY								
Trip Purpose	Person or Vehicle Trips	Latest Model Person Trips (Distribution)	Latest Model Run Vehicle Trips (IA-IA)	Person/ Vehicle Trip Ratio	*2017 NHTS Midwest Region Auto Occupancies	NCHRP 836-91 Statewide	NCHRP 735 Rural Auto Occupancies	NCHRP 716 Urban Auto Occupancies
HBW	person trips	1,591,919	1,447,199	1.10	1.1	1.1-1.19	1.11	1.10
HBO	person trips	4,343,922	2,525,536	1.72	1.6	1.49-1.94	1.69	1.72
NHB	person trips	2,980,081	1,795,230	1.66	1.4	1.33-2.06	1.67	1.66
LDW	vehicle trips	19,580	119	1.64	1.7	1.19-1.86	n/a	n/a
LDNW	vehicle trips	60,655	326	2.63	2.4	1.31-3.44	n/a	n/a
Airport	vehicle trips	1,660	1,660	0.00	n/a	n/a	n/a	n/a
Autos I-I	vehicle trips	8,997,817	5,770,070	1.56	n/a	n/a	n/a	n/a
FAF Trucks	vehicle trips		468,186					
Med. Truck	vehicle trips	-	49,182	0.00	n/a	n/a	n/a	n/a
HD Truck	vehicle trips	-	84,575	0.00	n/a	n/a	n/a	n/a
FAF Trucks I-I	vehicle trips	-	40,309	0.00	n/a	n/a	n/a	n/a
All	combination	8,997,817	5,944,136	1.514		n/a	1.54	1.55

5.4 Traffic Assignment Validation

As with the previous version of iTRAM, the 2018 assignment model reflects the TransCAD constrained user equilibrium algorithm. Similar to most travel demand models; however, the iTRAM traffic assignment model includes a pre-load of truck trips from the FAF and medium-duty truck trip tables. The rationale is that trucks are largely limited to preset travel routes such that switching routes due to congestion is likely not an option. However, once the passenger auto trips are loaded on the highway network, truck volumes are added to auto traffic for the purposes of computing volume/capacity ratios. TransCAD includes a passenger car equivalent (PCE) factor to account for an individual truck requiring more capacity than an automobile.

Validation of the traffic assignment model included the following iterative adjustments:

- Free-flow speed changes for select groupings of area type and facility type
- Time-of-day capacity adjustments for consistency with the one-hour capacity for the AM peak
- Switching from the 2010 iTRAM PCE value of 2.9 to a value of 2.5, consistent with most research
- Testing alternate BPR beta factors from the 2010 value of 4.0 to a value of 4.5 and then later 6.5
- Applying alternate annualization and payload factors to FAF truck tonnage tables
- Internal-external/external-internal/external-external trip tables (IX-XI-XX)

The previous version of iTRAM included IX-XI-XX truck and auto trip tables in five-year increments for 2010 through 2040. Probing of available iTRAM documentation, Iowa DOT staff, and existing consultant team members provided little insight on trip table estimation. Testing of the model with and without these trip tables was conducted early in the validation process to gage their impact on Iowa highway assignment volumes. FAF trip tables generated for 2018 iTRAM replace the previous IX-XI-XX truck trip tables. Findings from the previously described analysis of StreetLight InSight data resulted in a decision to also eliminate the auto component of the XX trip table. As validation progressed, it was found that including interpolated 2018 auto IX-XI trip tables made a slight improvement in assignment validation; however, comparisons against traffic counts from other state DOTs showed that some external zones were loading too many trips onto the network. Therefore, trip estimates were factored at select external zones to better match available counts. **Table 5-6** provides final volume/count ratios at each external zone.

Table 5-6 Validation of External Passenger Trips

iTRAM External Zones					ALL	TRUCKS	AUTOS	AUTOS		Final
Link No.	Zone #	Final Link ID	Highway	State 1	Latest Count	Truck Count	Estimated Autos	IX-XI Adj Factor	Final Refinements	Volume /Count
1	999001	124483	I-80/94 E	IL	206,000	43,500	162,500	1.00	(OK) Poss shift trips fm I-90 to I-80	0.34
2		124604	I-90 E	IL	34,000	3,500	30,500	N/A		3.44
3	999002	123196	I-74 E	IL	18,100	6,700	11,400	1.00	OK	1.25
4	999003	122922	I-70 E	IL	27,900	10,000	17,900	1.00	OK	0.94
5	999004	122261	I-64 E	IL	15,400	5,200	10,200	0.85	~Re-adjusted	0.86
6	999005	116745	I-24 E	IL	31,100	6,900	24,200	1.00	OK	0.91
7	999006	116181	I-55 S	MO	20,679	7,965		-	Fixed CC loading	0.89
8	999007	105290	I-44 W	MO	23,584	6,225	17,359	1.00	OK	0.87
9	999008	102724	I-35 S	KS	21,800	5,060	16,740	1.00	OK	1.15
10	999009	101619	I-70 W	KS	12,100	3,695	*8,405*	-	*Moved Ext Zone*	*1.16*
11	999010	101727	I-80 W	NE	7,078	4,445			*Moved Ext Zone*	*1.17*
12		101767	I-76 W	NE	7,509	2,140			*Moved Ext Zone*	*0.68*
13	999011	101932	I-90 W	SD	7,280	1,692	5,588	1.00	OK	1.06
14	999012	102131	I-94 W	ND	8,384	2,156	*6,228*	-	Got auto trips to	1.46
15	999013	111942	I-29 N	ND	3,293	1,306	1,987	0.93	load at 999012	1.42
16	999014	128955	I-35 N	MN	46,000	1,200	44,800	0.49	Set IX-XI to zero	1.34
					490,207	111,684	357,807	0.91	within 10% acc.	1.07

Table 5-7 and **Table 5-8** provide summaries of statewide 2018 assignment model statistics for total traffic, and truck traffic respectively, including comparisons against the 2010 model and established validation targets. As indicated, total 2018 RMSE is better than the 2010 model and R-Squared meets previously

established targets. Vehicle-miles traveled (VMT) per capita and household meet targets found in current model validation guidelines. Truck metrics improved greatly as the validation progressed but, even after 70+ base year validation runs, results were only moderately acceptable. While validation proved that truck validation could be improved further, additional changes to truck trip tables would result in further degradation to the overall validation for all trips. Given that trucks constitute a smaller share of traffic counts than automobiles, all models are more accurate for total trips and auto trips than truck trips. **Table 5-9** breaks down the difference between model estimated VMT and HPMS (Highway Performance Monitoring System) VMT by functional class, separately for all vehicles and trucks. Total variance is only 2 percent for trucks and -6 percent for all vehicles.

Table 5-7 Statewide Total Validation Statistics

Total Traffic Validation Statistics				
Total Traffic Metrics	**2010 iTRAM**	**Previous Targets**	**Latest 2018 iTRAM Run**	**Updated Targets**
Total VMT per Capita	28	17-24	27	17-33
Total VMT per Household	69	40-60	62	45-82
Total Modeled VMT	83,797,300	86,500,000	85,857,713	91,900,000
R Squared (Iowa Counts)	0.664	0.8	0.805	0.8
Total RMSE	56%	45%	52.6%	56%

Table 5-8 Statewide Truck Validation Statistics

Total *Truck* Validation Statistics				
Truck Traffic Metrics	**2010 iTRAM**	**Previous Targets**	**Latest 2018 iTRAM Run**	**Updated Targets**
Total VMT per Capita	3	2-3	4	TBD
Total VMT per Household	7	5-8	8	TBD
Total Modeled VMT	8,940,489	10,200,000	11,158,620	11,700,000
R Squared (Iowa Counts)	0.731	0.8	0.542	0.8
Total RMSE	63.9%	45.0%	95.6%	64%

Table 5-9 VMT by Functional Class - Variance from HPMS

VMT by Functional Class		Truck VMT by Functional Class	
Functional Class Group	**Variance from HPMS**	**Functional Class Group**	**Variance from HPMS**
Interstate	16%	Interstate	-3%
Expressway	-28%	Expressway	28%
Principal Arterial	16%	Principal Arterial	20%
Minor Art/Collector	-11%	Minor Art/Collector	-45%
Total	-6%	Total	2%

Table 5-9 depicts percent error and root mean square error (RMSE) by volume group for 2005, 2010 and 2018 versions of iTRAM, along with these same metrics for 2018 trucks and a series of updated targets (accuracy standards) based on nationwide model validation guidelines. Accuracy standards are more

stringent for higher volume roadways than lower volume roadways because percent difference equals a greater number on high volume roadways. All traffic results for 2018 iTRAM meet established accuracy standards, are comparable to those of the 2010 model, and better in some cases. All truck volume groups meet accuracy standards except for links with truck counts less than 1,000.

Table 5-10 ADT Validation by Volume Class

ADT Validation by Volume Class										
Volume Group	2005 iTRAM		2010 iTRAM		2018 iTRAM (ALL)		2018 iTRAM Trucks		Updated Targets (ALL)	
	Percent Error	% RMSE	Percent Error	% RMSE	Percent Error	RMSE	Percent Error	% RMSE	Percent Error	RMSE
< 1,000 (0-2k in 2005)	26.6%	168	0%	n/a	0%	0.00	-3%	115.88	+/-25%-50%	45-100
1,000 - 2,500 (2-4k in 2005)	6.4%	96	21%	86.58	20%	87.05	5%	77.55	+/-25%-50%	45-100
2,500 - 5,000 (4-6k in 2005)	-3.8%	77	12%	65.78	17%	89.07	3%	46.70	+/-25%-50%	45-100
5,000 - 10,000 (6-10k in 2005)	1.1%	60-71	-5%	48.05	-2%	54.59	-38%	54.91	+/-25%-50%	35-45
10,000 - 25,000	-0.5%--9.2%	38-49	-2%	35.51	0%	38.73	0%	n/a	+/-20%-30%	15-35
25,000 - 50,000	0.6%-7.6%	13-28	-6%	24.16	-18%	26.80	n/a	n/a	+/-15%-25%	15-27
> 50,000	4.3%	38	6%	17.95	1%	20.37	n/a	n/a	+/-5%-20%	10-20
Overall	1.3%	92	1%	56%	**-1%**	**52.6%**	**-4%**	**95.6%**	+/-5%	35-45

Table 5-11 is another evaluation of assignment accuracy but, in this case, percent error and RMSE are summarized by facility type and area type. As indicated, percent error meets all accuracy standards by functional classification except the newly added facility type 2; however, providing a separate facility type for expressways improved validation statistics for other principal arterials as a group.

Table 5-11 ADT Validation by Volume Class

ADT Validation by Facility Type and Area Type											
Functional Class (Facility Type)	2005 iTRAM			2010 iTRAM			Latest 2018 iTRAM Run			Targets	
	# of Links	Percent Error	% RMSE	# of Links	Percent Error	% RMSE	# of Links	Percent Error	RMSE	FHWA % Error Target	FHWA % RMSE
Interstate	35,926	1.1%-5.3%	26-30	1,513	-7%	27.93	496	1%	33.86	+/- 7%	18.33
Expressway	n/a	n/a	n/a	n/a	n/a	n/a	40	-30%	61.09	+/- 7%	18.33
Principal Arterial	13,966	-0.1%-0.5%	58-71	12,305	4%	49.46	631	8%	72.38	+/- 10%	36.77
Minor Arterial	7,078	-0.2%--2.1%	77-88	8,450	1%	62.35	449	-3%	73.96	+/- 15%	43.90
Major Collector	6,734	-4.8%-19.9%	144-159	1,986	-1%	89.14	248	-11%	87.97	+/- 25%	77.48
Urban	n/a	n/a	n/a	7,413	0%	49.99	268	-13%	47.74	n/a	n/a
Suburban	n/a	n/a	n/a	5,803	1%	50.45	369	-9%	38.19	n/a	n/a
Rural	n/a	n/a	n/a	11,038	8%	47.67	1,227	15%	59.45	n/a	n/a
Overall	68,402	1.3%	92	24,254	1%	52.00	1,864	-1%	52.6%	n/a	36.77

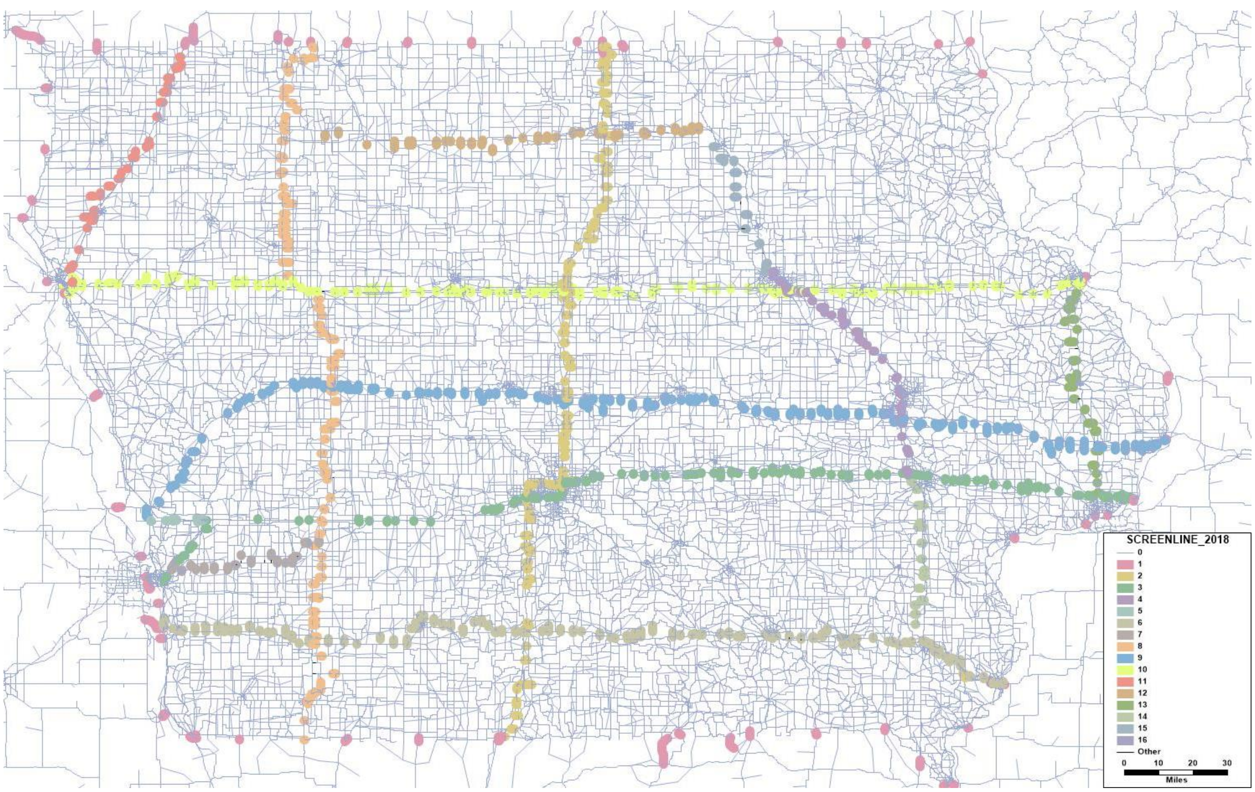
The final set of systemwide validation metrics is a comparison of percent error by screenline, depicted in **Table 5-12**. This table shows percent error for the 2005, 2010, and 2018 versions of iTRAM. Percent error for trucks is depicted for the 2010 and 2018 models also. As noted, screenline locations were modified with each model version, resulting in ranges of percent error being displayed for the earlier model versions. Accuracy standards reflect the sum of traffic counts on each screenline, with the highest volume screenlines deserving of the highest accuracy standards. In addition to identifying broad corridors where assignment issues might exist, screenlines can also assist with assessing the validity of trip distribution (e.g., are the correct number of trips crossing the State Line cordon). The high priority cross state screenlines 2 (east of I-35) and 3 (I-80 median crossings) validated very well at -4% and -7%

respectively and well within the +/_10% accuracy standard. This means that total flows crossing the state in both the north/south and east/west directions are good. **Figure 5-1** displays the location of all screenlines, except screenline 16, which follows the external stations depicted earlier in **Figure 3-1.**

Table 5-12 ADT Validation by Screenline

ADT Validation by Screenline													
Screenline Number	New Screenline Names *(note: Screenlines differ for all 3 models; hence, some results are reported by ranges for 2005 and 2010)*	Maximum Desirable Percent Deviation	2005 iTRAM Old SLs		2010 iTRAM Old SLs		Latest 2018 iTRAM Run New Screenlines						
			Deviation vs. Counts	% RMSE	Percent Deviation vs. Counts	Truck % Deviation vs. Counts	Count	Volume	Volume to Count Ratio	Percent Deviation vs. Counts	SL	Percent Deviation vs. Truck Counts
2	E of I-35	(+/-) 10%	0.3-16.6%	20-27	-11--29%	-28--44%	679,562	651,948	0.96	-4%	2	8%
8	E of US 71	(+/-) 10%	0.5%	39	2-6%	0--16%	124,320	127,998	1.03	3%	8	24%
4	I-380 Median	(+/-) 10%	-16.7%	20	-18%	-14%	499,686	362,335	0.73	-27%	4	-29%
3	I-80 Median (I-235 through Des Moines)	(+/-) 10%	2-6%	17-23	-18-0%	-6--35%	906,517	844,593	0.93	-7%	3	-28%
5	I-880 Median	(+/-) 20%	n/a	n/a	n/a	n/a	3,365	1,881	0.56	-44%	5	-47%
12	N of SR US 18 East of I-35/S of US 18 West of I-35	(+/-) 10%	10.4--21%	28-50	-10-26%	-10--42%	74,985	75,972	1.01	1%	12	6%
10	N of US 20	(+/-) 10%	-14.5%	29	8-24%	0--53%	477,125	373,220	0.78	-22%	10	-2%
6	N of US 34	(+/-) 10%	-6.5%	35	15%	-23%	259,774	228,067	0.88	-12%	6	8%
7	N of US 6 (Council Bluffs-Atlantic)	(+/-) 20%	16.9%	49	n/a	n/a	46,270	41,771	0.90	-10%	7	-41%
9	S of US 30	(+/-) 10%	5.9-21.9%	20-34	4%	0%	362,508	340,123	0.94	-6%	9	21%
1	State Line Cordon	(+/-) 10%	n/a	n/a	-1-49%	-14-64%	638,698	540,318	0.85	-15%	1	-50%
11	W of SR 60/US 75	(+/-) 20%	-27.2%	55	8%	-27%	63,992	97,120	1.52	52%	11	-12%
14	W of SR US 218/SR 27, Mt. Pleasant to Iowa City	(+/-) 20%	n/a	n/a	27%	-2%	35,510	49,765	1.40	40%	14	-37%
15	W of SR US 218/SR 27, Waterloo to Charles City	(+/-) 20%	n/a	n/a	33%	-18%	39,483	29,564	0.75	-25%	15	112%
13	W of SR US 61, Davenport to Dubuque	(+/-) 10%	-14.7%	23	n/a	n/a	55,782	41,647	0.75	-25%	13	-51%
16	iTRAM External Trucks	(+/-) 15%	n/a	n/a	n/a	n/a	455,136	359,337	0.79	-21%	16	0%
TOTAL (ALL SCREENLINES)		(+/-) 5%	2.5%	28	-3%	-13%	4,722,713	4,165,659	0.88	-12%	TOT	-12%

Figure 5-1 2018 iTRAM Screenline Location Map



5.5 Model Post Processing

The term "post processing" can refer to any procedure applied to assignment model outputs. This can include running statistical summaries and making post-model adjustments to assignment volumes. In terms of statistical summaries, the 2018 version of iTRAM generates two such files when selecting to run Maps & Reports. The first of these is named Assignment_Report.txt and can be opened and edited using Notepad++, Notepad, or WordPad. The other files, new to iTRAM 2018, is a file called iTRAMModel.xml and opens in Internet Explorer or XML Handler. Summary statistics from these files can be copied and pasted into Excel for additional post processing and analysis. By default, iTRAMModel.xml is stored in the Outputs/6MapsandReports folder. Assignment_Report.txt is now automatically generated and saved in the "MapsAndReports" folder of the selected scenario. All of the 2018 model statistics in Chapter 5 tables were generated in the TXT and XML files, then copied and pasted into Excel summary tables for further analysis and comparison against other metrics.

The second type of post processing involves a critical assessment of link/corridor specific assignment volumes. The analyst should be careful to check the logic of assignment forecasts before using them in capacity analyses, micro-simulation, or reporting. NCHRP 765 provides guidance on how to adjust model forecasts into reasonable traffic projections, including mathematical formulae to automate the adjustment process. While final procedures have not yet been added to the model, the current plan is to export four different volumes from each model run. The RAW future year traffic assignment is computed by the assignment process. The RATIO adjusted future year traffic forecast applies base year volume/ count ratios to the RAW volume, as a way of accounting for validation anomalies. The DIFF adjusted future year traffic forecast is similar but applies the base year difference between volume and count. Finally, the MRATIO forecast is a hybrid method that alternates between the RATIO and DIFF computations based on the total link volume. The network attributes AdjForecast1, AdjForecast2, and AdjForecast3 represent the RATIO, DIFF, and MRATIO methods, respectively, generated during model runs for all links with counts.

Subarea validation is an important step in post processing of network assignments. While iTRAM has been validated at the statewide level, there are many study area assumptions in the model that should be reviewed and adjusted when estimating traffic forecasts for corridor studies. Subarea validation for a corridor study area should include a review of the following:

- Network characteristics – laneages (ABLANES, BALANES, facility types (FACTYPE), center left turn lanes (CENTER_LEFT), passing lanes (AB_PASSLANES, BA_PASSLANES), etc. should be confirmed.
- Penalties – check for the presence of link penalties at corridor locations parallel to any new corridors being studied; potentially test with and without penalties on the proposed corridor.
- Network coverage – select local roadways might be added to the network due to their impact on local traffic circulation; this might require recoding/activating minor collectors in the subarea.
- Centroids and connectors – local land use and roadway access patterns should be reviewed for all TAZs surrounding the corridor under study to ensure proper trip loadings.
- Traffic counts – as noted elsewhere in this report, traffic counts were streamlined during validation to eliminate duplication and inconsistencies between adjacent links; should centroid connectors be added or local roadway links activated, some deactivated counts might be relevant at the subarea level (ORG2018AADT, etc.)
- Demographic assumptions – identify other potential data sources that could be reviewed and compared against assumptions in the model; this is particularly relevant for interim years.

- Special generators - iTRAM includes many special generators, some of which might improve model validity on nearby roadway links while others might actually result in over-assignments; consideration could be given to removing select special generators or updating special generator assumptions, as necessary.

6 GUI and Enhanced User Applications

The existing iTRAM model interface was developed using GISDK to create a dialog box that steps through the entire model process. Using the interface, the user can complete an entire model run. This section documents how to operate the individual portions of the model process and how to use the modules contained within it.

6.1 Model Installation

The model installation process involves opening TransCAD and going to Tools-GIS Developer's Kit-Setup Add-ins as shown in **Figure 6-1**. Next, TransCAD will bring up a dialogue box called Setup Add-ins, as shown in **Figure 6-2**. The analyst must then link to the interface DBD file iTRAM_2018 and make sure that the contents of this dialogue box match what is shown in **Figure 6-2**. After clicking the Add button, the analyst should be able to open the model interface by clicking Tools-iTRAM_2018, as shown in **Figure 6-1**.

Figure 6-1 Model Installation Part 1

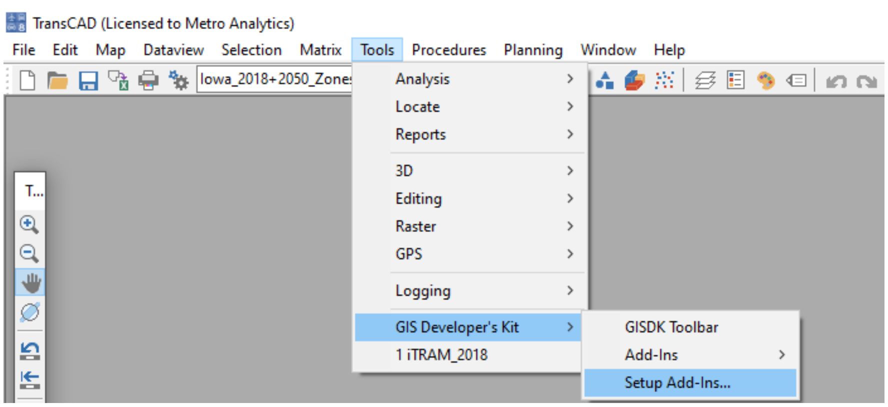
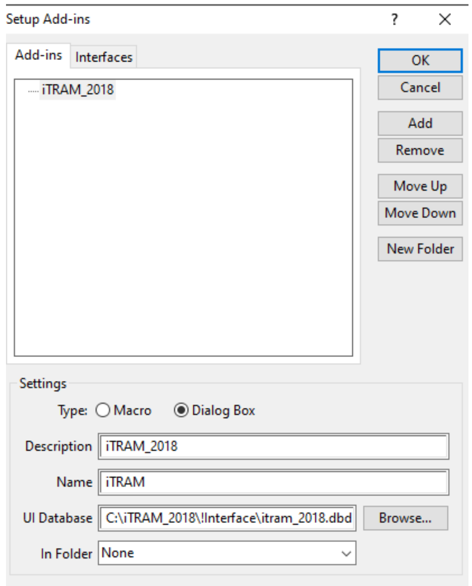


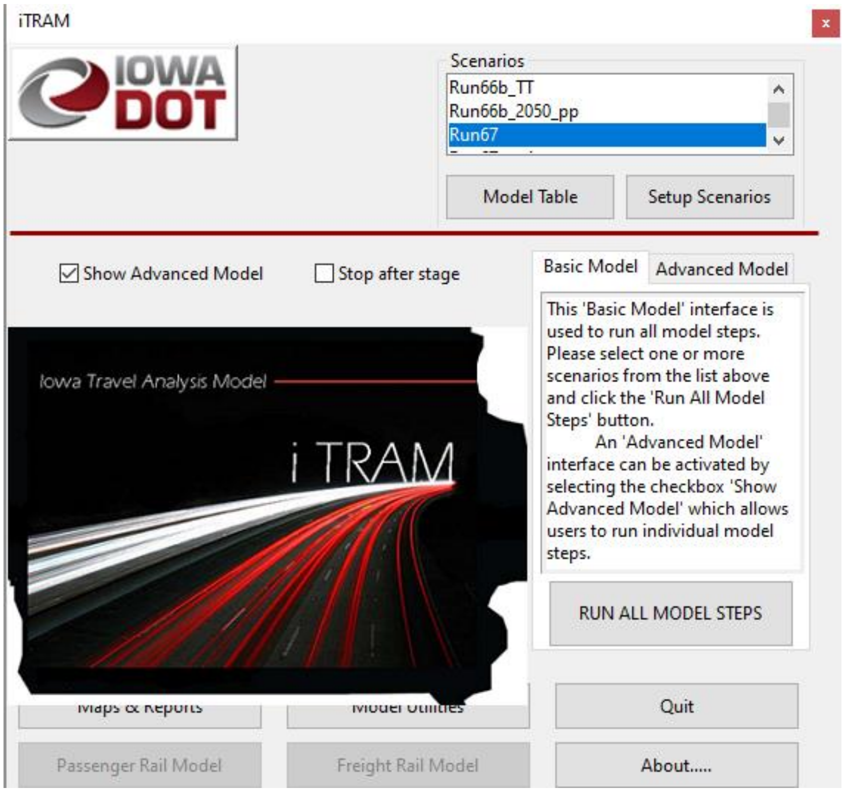
Figure 6-2 Model Installation Part 2



6.2 Model Execution

When the iTRAM model is initially launched in TransCAD, an interface like the one shown in **Figure 6-1** is the typical result. The iTRAM interface contains several buttons that serve different functions in the execution and management of the model. These buttons can best be divided into the following categories: "scenario settings", "travel model step settings", "create reports and maps", and "model utilities". In addition to executing the auto and truck travel demand models, the GUI provides two buttons to launch exogenous passenger rail and freight rail model applications. Each of these models consist of multiple resource files, compiled along with the main iTRAM model during compilation of the TransCAD resource list file. The following sections describe in detail each of these button categories.

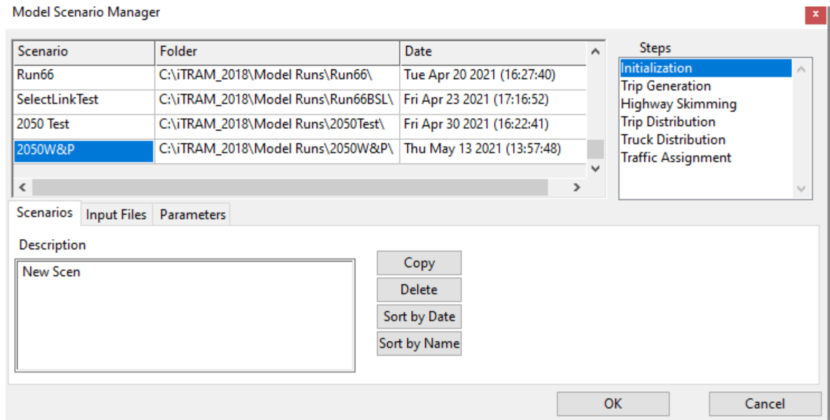
Figure 6-3 ITRAM model Interface



6.3 Scenario Settings

Model runs are managed by scenarios. The scenarios control which files and settings are used in the application of the model. Scenarios are edited using by clicking on the "Setup Scenarios" button, accessed from the main menu interface. The Scenario Manager dialogue box opens after clicking the button. **Figure 6-** shows the scenario manager dialogue box.

Figure 6-4 Scenario Manager Interface



There are three content boxes depicted in the Scenario Manager:

1. In the upper left is the list of scenarios including a file folder for storing model outputs and a creation date – **Figure 6-** depicts a scenario selection of "2050W&P"
2. In the upper right is the list of model steps – **Figure 6-** depicts selection of the Initialization step
3. At the bottom is a specifications box, where the contents of each scenario are defined – **Figure 6-** depicts options for creating a new scenario by copying an existing scenario, along with options to delete scenarios or to sort scenarios by date or name. if the user clicks on the Input Files tab, a list of file names will be displayed for the Initialization step. Clicking on the Parameters tab will display model parameters for the Initialization Step, which in this case includes the iTRAM Directory and Scenario Year.

Figure 6-5 and

Figure 6- depict the Input Files and Parameters tabs for the Initialization Step, respectively. These tabs will depict different information, depending on the Step selected. The user can simply type or update the existing file name and directory path by double clicking on the current assumption.

Figure 6-5 Input Files Tab

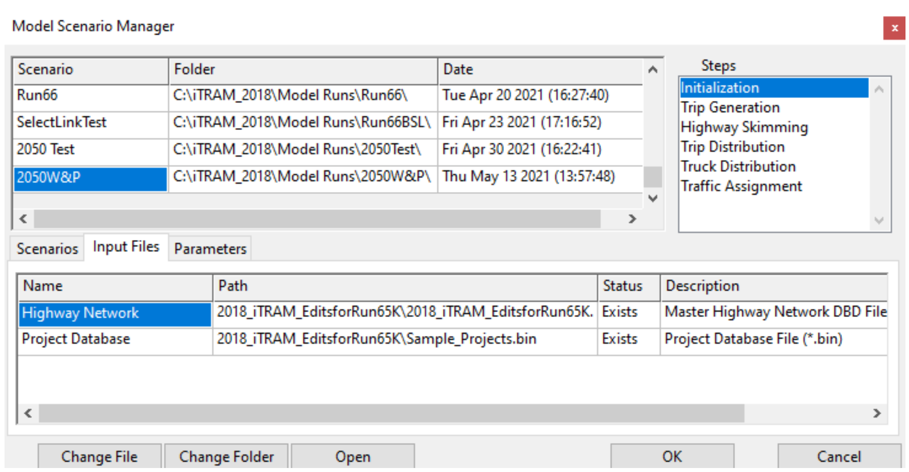
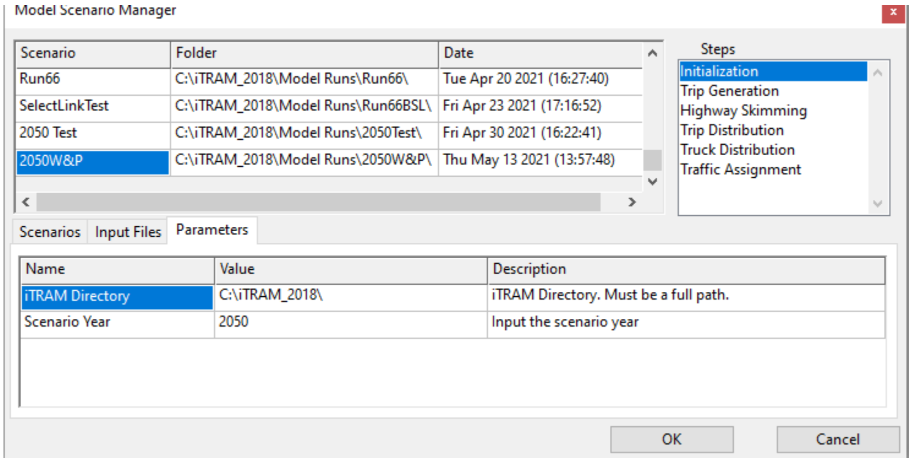


Figure 6-6 Parameters Tab



Once the user has confirmed the correct assumptions for Input Files and Parameters for each of the six model steps, the user should click the OK button and return to the main model Interface.

At this point, the user would generally click the RUN ALL MODEL STEPS button to execute the specified scenario and its related file and parameter assumptions. The option does exist to run individual model steps by clicking just below the box called "Show Advanced Model." This will bring up the dialogue box depicted in **Figure 6-7**, where the user can click on specific steps to be run, one at a time.

Figure 6-7 ITRAM model Interface

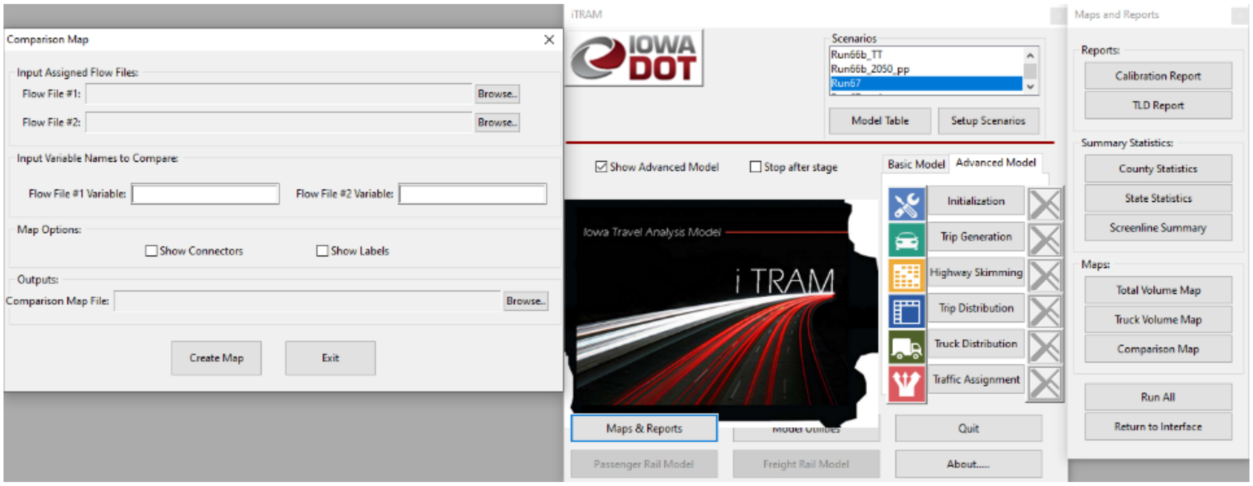
6.4 Maps and Reports

The iTRAM model has built-in capability to launch pre-designed maps and reports that have information from the just-completed model run. These tools allow the user to quickly run a report or build a map that provides results of a model run. This interface is accessed by clicking the "Maps and Reports" button on the main interface and provides access to the following reports:

- Calibration Report – This report evaluates the model run against 2018 traffic count and vehicle miles of travel (VMT) data. This step will output the Assignment_Report.txt and iTRAMModel.xml files.
- Trip Length Distribution (TLD) Report – The TLD Report is a subset of data that is also included in the Calibration Report. For any analysis year, this report provides the average trip lengths by purpose (in minutes) as a separate text file.
- County Statistics (Iowa) – This report produces a summary performance measure database with tabulations of total and truck VMT, total VHT, and estimated total delay for each county in Iowa.
- State (Socioeconomic) Statistics – This report provides a summary of the demographic data used in the analysis run. The data includes population, households, and employment for each state in the model.
- Screenline Summary – The screenline statistics file is another subset of data that is also included in the calibration report. This report compares the analysis year run results against 2010 traffic count data for pre-defined screenlines in the state of Iowa.
- Total/Truck Traffic Maps - The total/truck traffic map buttons produce various TransCAD map files. The maps are temporarily created in TransCAD and then closed. The user can then open the maps separately outside of the GUI. These maps include posted volume-to-count ratios, volume bandwidth, and Level-of-Service (LOS) for total traffic and truck traffic separately.
- Comparison Map – This button initiates a separate tool that allows the user to compare the outputs of any two assignment BIN output files for user specified attributes. The map includes color coding of volume increases and decreases between the two model runs. The user can also specify a file location and name for the output map. The user can also decide on whether to depict centroid connectors and/or labels.
- Run All – If there is any doubt about what reports and/or maps are desired, clicking on "Run All" will generate all of these outputs rather quickly. The user can then review the contents to determine which individual maps and/or reports would be most relevant in subsequent analyses.
- Return to Interface – closes the Maps and Reports dialogue box, returning the user back to the iTRAM interface.

The "Calibration Report" provides metrics previously described in Chapter 5 and already includes the "TLD (trip length distribution) Report" and "Screenline Summary." Thus, these two buttons should only be pushed if the remainder of the Calibration Report is not desired for a given model run. The optional "Maps and Reports" buttons are depicted in **Figure 6-8**, along with the dialogue box for Comparison Maps.

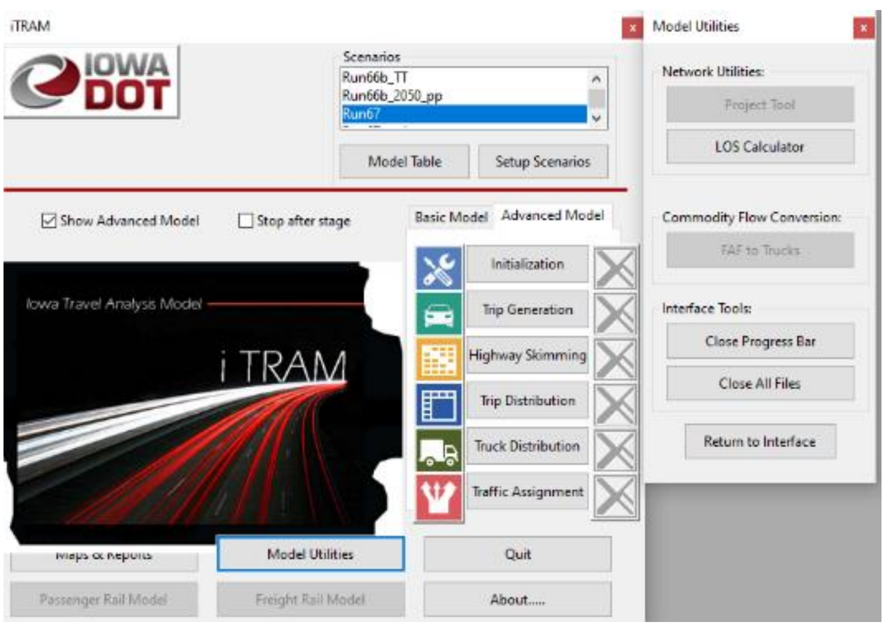
Figure 6-8 ITRAM Maps and Reports Dialogue Boxes



6.5 Model Utilities

The iTRAM model has built-in capabilities for performing additional tasks. These tasks have been organized together in the “Model Utilities” button on the main interface. **Figure 6-9** shows the utilities interface.

Figure 6-9 ITRAM Model Utilities Dialogue Boxes



- Project Tool - Helps in coding of projects in the master highway network. This tool is useful in querying, modifying attributes, and adding/deleting projects from the project database table. *Currently disabled, awaiting further discussion.*
- LOS Calculator — This utility calculates LOS values for the selected scenario run.
- FAF to Trucks — This tool has been disabled, *awaiting further discussion,* since FAF tonnage tables are now the source for freight truck trip tables.

- Close Progress Bar — Clicking on this button removes the progress bar from the screen if the model crashes or stops in the middle of a step. This allows users to go back to the main interface screen without having to shut down TransCAD (and then restart) to remove the progress bar.
- Close All Files — Clicking on this button closes all active windows in the TransCAD environment. This is useful if you have multiple windows open and want to exit quickly.
- Return to Interface – closes the Network Utilities dialogue box, returning the user back to the iTRAM interface.

6.6 Fill Links DBF Utility

This is a simple utility that enables the user to summarize output statistics for user specified network links. This tool was developed and used by Metro Analytics during iTRAM model validation to monitor and compare truck and total volumes vs. counts on key Iowa highway segments. Running this utility requires that the user do the following:

- Copy a LINKS.DBF file from an existing network to the current scenario network (An example LINKS.DBF is depicted in **Figure 6-10**.)
- Edit the fill_LinksDBF.rsc file and modify file directories and file names, if necessary (An example fill_LinksDBF.rsc file is depicted in **Figure 6-3** with highlighted text for checking/editing.)
- Open GIS Developer's Kit and click on first icon (Compile) to locate and select the fill_LinksDBF.rsc file (See first and second screenshots in

- **Figure** 6-4.)
- After compiling, click on second icon (Test) and the LINKS.DBF file will be updated (See third screenshot in

- **Figure** 6-4.)
- Open LINKS.DBF in TransCAD to view volumes, counts, ratios for all vehicles and trucks only

If desired, highlight and copy contents, then open Excel, and paste into spreadsheet for additional summary and analysis.

Figure 6-10 Example LINKS.DBF

TransCAD (Licensed to Metro Analytics) - [Dataview1 - links]

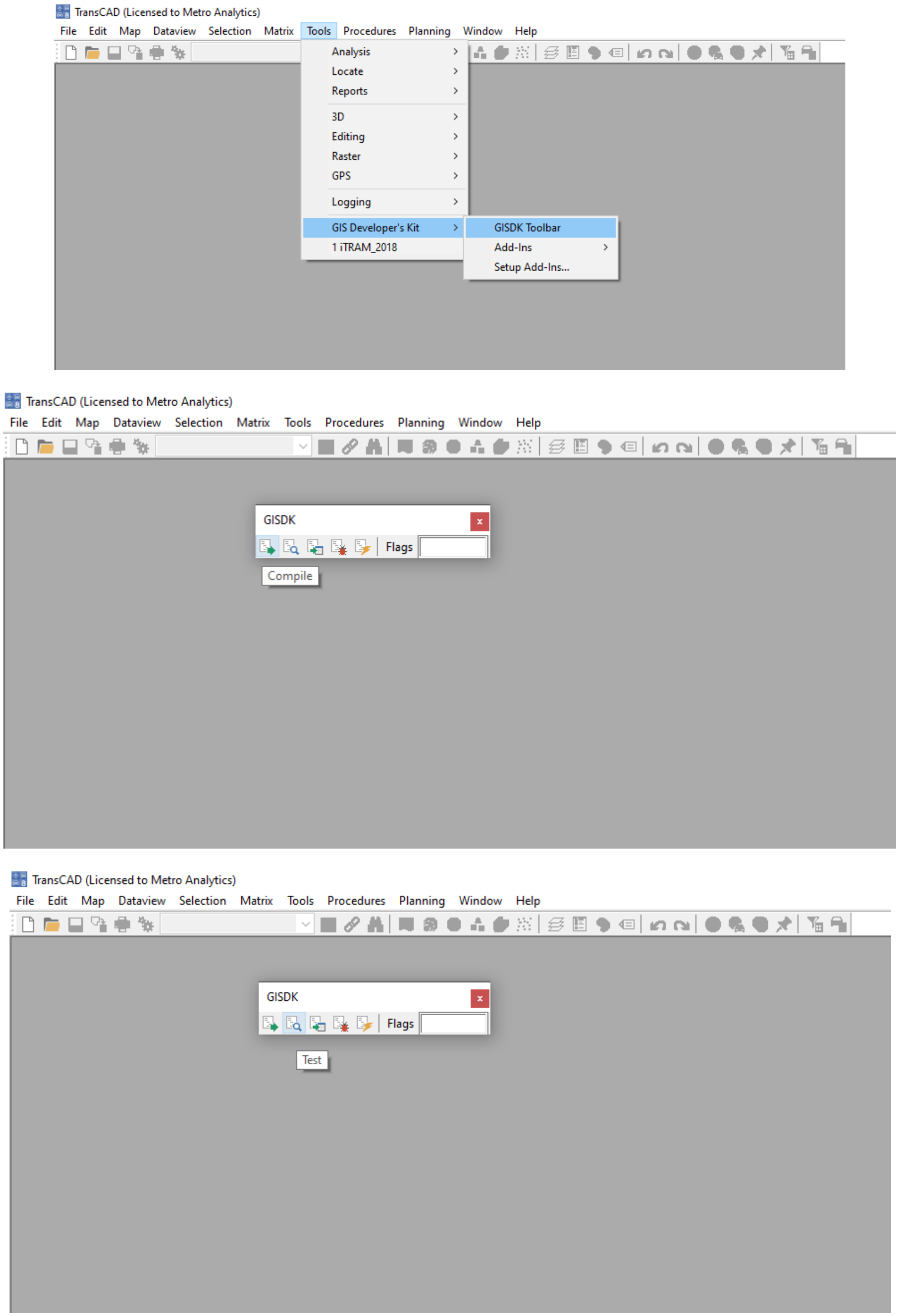
ID	FORSMRY	COUNT_AADT	COUNT_TRK	TOT_AB	TOT_BA	TOT	TRK_AB	TRK_BA	TOT_TRK
--	--	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
--	--	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
--	--	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
591	1	7250.00	2418.00	8841.00	0.00	8841.00	1452.00	0.00	1452.00
592	1	7250.00	2418.00	0.00	9243.00	9243.00	0.00	1902.00	1902.00
2946	1	9150.00	1026.00	5142.00	0.00	5142.00	488.00	0.00	488.00
2947	1	9150.00	1026.00	0.00	4482.00	4482.00	0.00	604.00	604.00
4877	1	12250.00	4266.00	0.00	14973.00	14973.00	0.00	4553.00	4553.00
4878	1	12250.00	4266.00	13805.00	0.00	13805.00	3575.00	0.00	3575.00
12788	1	6100.00	2320.00	0.00	6837.00	6837.00	0.00	1807.00	1807.00
12790	1	6100.00	2320.00	9147.00	0.00	9147.00	1755.00	0.00	1755.00
35191	1	16150.00	2312.00	13197.00	0.00	13197.00	1006.00	0.00	1006.00
51318	--	4450.00	1270.00	2356.00	0.00	2356.00	1010.00	0.00	1010.00
51325	--	4450.00	1270.00	0.00	1998.00	1998.00	0.00	1302.00	1302.00
60462	1	9200.00	3290.00	0.00	9278.00	9278.00	0.00	1656.00	1656.00
60525	1	9200.00	3290.00	9276.00	0.00	9276.00	1642.00	0.00	1642.00
73118	1	5300.00	304.00	1839.00	0.00	1839.00	168.00	0.00	168.00
73119	1	5300.00	304.00	1768.00	0.00	1768.00	94.00	0.00	94.00
79724	1	19850.00	4590.00	11133.00	0.00	11133.00	2646.00	0.00	2646.00
79726	1	18200.00	4366.00	0.00	11481.00	11481.00	0.00	1091.00	1091.00
88547	1	8600.00	2090.00	0.00	11199.00	11199.00	0.00	5041.00	5041.00
88548	1	8600.00	2090.00	10681.00	0.00	10681.00	4669.00	0.00	4669.00
98751	1	9800.00	845.00	0.00	10012.00	10012.00	0.00	781.00	781.00
98754	1	9800.00	845.00	9495.00	0.00	9495.00	595.00	0.00	595.00
101619	1	0.00	3695.00	6787.00	7259.00	14046.00	6787.00	7259.00	14046.00
101727	1	0.00	4445.00	1942.00	6352.00	8294.00	1942.00	2351.00	4293.00
101767	1	0.00	2140.00	4471.00	609.00	5080.00	470.00	609.00	1079.00
101932	1	7280.00	1692.00	3872.00	3841.00	7713.00	1078.00	1047.00	2125.00
102131	1	0.00	2156.00	6687.00	5601.00	12288.00	3604.00	2518.00	6122.00
102724	1	21800.00	5060.00	9638.00	10088.00	19726.00	4616.00	5066.00	9682.00
105290	1	23584.00	6225.00	10267.00	10276.00	20543.00	1587.00	1596.00	3183.00
111942	1	3293.00	1306.00	2398.00	2294.00	4692.00	1330.00	1226.00	2556.00
116181	1	20679.00	7965.00	9138.00	9170.00	18308.00	3647.00	3679.00	7326.00

Figure 6-3 Edit "fill_LinksDBFnew.rsc" File

C:\iTRAM_2018\!Interface\fill_LinksDBFnew.rsc - Notepad++

```


Macro "update"

    // highwaydbd = "C:\\Data\\IOWA\\5_FAF\\2_FreightFlows\\4_Asignment\\9_Run12a\\Iowa_STM_net_2018Base_merged2FAFRun12\\Iowa_STM_net_2018Base_merged2FAFRun10Edits.dbd"
    // linkfile = "C:\\iTRAM_2018\\Run11\\links.dbf"
folder="C:\\iTRAM_2018\\Model Runs\\Run66B\\"

    highwaydbd = folder + "2018_iTRAM_EditsforRun65K.dbd"
    linkfile = folder + "links.dbf"


RunMacro("TCB Init")
layers = RunMacro("TCB Add DB Layers", highwaydbd)
nlayer = layers[1]
llayer = layers[2]


// STEP 1: Clear values
    Opts = null
    Opts.Input.[Dataview Set] = {linkfile, "links"}
    Opts.Global.Fields = {"COUNT_AADT","COUNT_TRK", "TOT_AB","TOT_BA","TOT","TRK_AB","TRK_BA","TOT_TRK"}
    Opts.Global.Method = "Value"
    Opts.Global.Parameter = {0}

    ret_value = RunMacro("TCB Run Operation", "Fill Dataview", Opts, &Ret)
    if !ret_value then goto quit



// STEP 1: Fill Dataview
    Opts = null
    Opts.Input.[Dataview Set] = {{highwaydbd + "|" + llayer, linkfile, {"ID"}, {"ID"}}, "joined"}
    Opts.Global.Fields = {"COUNT_AADT"}
    Opts.Global.Method = "Formula"
    Opts.Global.Parameter = "nz(COUNT_AADT_2018)"

    ret_value = RunMacro("TCB Run Operation", "Fill Dataview", Opts, &Ret)
    if !ret_value then goto quit
```

Figure 6-4 Compile and Test “fill_LinksDBFnew.rsc” File



7 Concluding Steps and Future Considerations

7.1 Concluding Steps

Iowa DOT staff and consulting team members developed a "punch list" of cleanup items that were recently addressed while completing project documentation and conducting staff training. Work continues on developing additional mapping and analysis tools through an NCHRP Right-Sizing study.

7.2 Future Considerations

The SWOT workshop identified a number of enhancements that are included in the 2018 version of iTRAM, along with other items that were slotted for future phases of iTRAM. The notes in Appendix A should be reviewed as a first draft cut on future model enhancements. One item in particular was an extensive discussion during the SWOT Workshop on the pros and cons of different zonal equivalencies to MPO models. The next validation effort should study the best approach to zone structure moving forward.

Having worked with the model extensively over a two-year period has also identified a few issues that should be addressed in the future:

- Since the 2018 base year demographic data are still rooted in Census 2010 numbers, and 2020 traffic patterns were disrupted by the COVID-19 pandemic, the next model update should use a base year of 2021, with a primary data source being the 2020 Census.
- There are far too many highway links relative to the number of zones in iTRAM. One solution could be to further split zones while the alternative would be to merge links for consistency with the current zone system. There is also the potential to develop a multi-tiered zone system and/or maintain a multi-level network with different levels of aggregation, depending on the analysis.
- Now that FAF trip tables are the basis of external truck trips, consideration should be given to whether or not current external station locations are important to Iowa travel and whether the existing border state network and zone detail is necessary. These components currently add a lot of overhead to the model that might not be needed. While analysis of Iowa StreetLight InSight data provided some clarity on the propensity for through passenger travel on Interstate highways crossing Iowa, a big data license covering all border states would enable the Iowa DOT to determine if the 2018 border state zone, network, and external zone system could be collapsed. If an IX-XI trip table is still desirable, big data should be used to update this origin-destination matrix, as the source data for these current assumptions pre-dates the availability of location-based services (LBS) data.
- There are potentially too many validation adjustment tools in the 2010 and 2018 models. At the start of this modeling effort, our consulting team felt that the schedule would best be served to largely maintain the current parameter structure and 2010 parameter settings. In hindsight, it might be best for the next validation to begin with all link penalties set to zero, network factors set to zero, and destination choice and k-factors set to values that have no impact on trip distribution. As the next model validation progresses, the validation team could then adjust values to these tools, one at a time, to see if all factors are truly helpful to improving model replication of traffic counts.
- Area types are currently assigned by zone in the demographic file. Consideration could be given to area type overrides in the model network where conditions differ from adjacent zones.

Appendix A:

iTRAM SWOT Workshop Notes

iTRAM SWOT Workshop Notes

July 24, 2019

Iowa DOT Systems Planning Conference Room

8am – 5pm

Introductions

Those in the room and on the phone introduced themselves.

Overview of Topics/Groups

- *1.1 Consideration of one Statewide Model for the DOT and MPOs that would incorporate both iTRAM and the MPO models? Complexity, other issues to work through.*
    - *1.1.1 iTRAM would be maintained by the DOT, who would administer the model process.*
    - *1.1.2 Free access anytime for the MPOs, but the DOT would likely need to formally review and approve any changes that an MPO made to the model... and perhaps vice-versa. Could be cumbersome.*
    - *1.1.3 Perhaps prepare a white paper identifying various issues re: "One Model" and explore the pros and cons of said issues. This is largely a brainstorming piece.*
    - *1.1.4 This will be a long-term effort if implemented and will likely be done in parallel with updates to the traditional iTRAM model.*
    - *1.1.5 The Metro Analytics team recommended tabling the option to run a single combined statewide / multi-MPO model indefinitely, and instead recommended potentially exploring "plugging in" MPO trip-tables directly to the iTRAM model (discussed in 2.3) as a first step.*
- *1.2 Standardize iTRAM to conform with recent Iowa MPO model standards (ISMS). Same processing flows, naming conventions, protocols, GUIs, etc. All agreed that this would be a good thing to implement.*
- *1.3 Should we build iTRAM from the ground-up this time, restructure it to interact with MPO models, or just update the current model files?*
    - *1.3.1 Discussed using the MPO model TAZs, networks, trip tables, etc. to build outward. If implemented, this would not be done all at once, probably due to timing for using iTRAM by early 2021. Use an incremental approach, a parallel effort alongside the existing iTRAM.*
    - *1.3.2 We could prepare a memo with advantages, disadvantages, and implications of this integration approach. What Trip generation is used? Mode split? How are trip tables obtained from MPOs, and how are MPO external tables given back to MPOs? What does iTRAM gain/loose? How are external trips handled? Etc.*

1.3.3 *The Metro Analytics (MA) team can put together some possible early steps and potential long-term approaches for an incremental approach, including costs. An exploratory effort.*

1.4 *Tony – build the model for the tasks that you want to use it for. "What are you using the model for, what questions are you trying to answer, and what do you WANT to use it for?" Sensitivity analyses - Impacts to the state transportation system from construction detours along significant routes, major changes in SE data in large, geographic rural areas, statewide corridor studies, etc. How Interstate travel affected?*

1.5 *iTRAM is for use in the rural and "rural-to-suburbanizing" areas/area types, not the urban core (use MPO models there).*

1.6 *Iowa Standardized Model System (ISMS) – standardization* of *processing flows, naming conventions, protocols, GUIs, etc. across all the MPOs. A draft document is done, under review, but Jeff will send to the MA team.*

2. Group I: Model Algorithm and Software Refinements

2.1 *Software Platform & Compatibility – set up model for standard set of maps and outputs. Jeff to look at each existing utility and comment on pros/ cons. There are potentially utilities and maps in MPO models to include. iTRAM will be converted from TransCAD 6 to TransCAD 8.0 as part of this update though TransCAD 7 is presently used for Iowa's MPO models.*

2.2 *Trip Generation –suggested that the TransCAD network and zonal checking tools be run BEFORE updating is started, so that you can identify link connectivity and zone boundary issues prior to updating. More efficient. Consideration must be given to adding income data to model.*

2.2.1 *Household trip rates – use 2017 NHTS and recent MPO surveys*

2.2.2 *Airport trip rates – Iowa DOT will look at getting enplanement data from Kansas City, Minneapolis, Des Moines, Cedar Rapids, Moline, Sioux City, etc. NOTE: need to make sure that the airport long-distance (LD) trips aren't double-counted in E-I or LD passenger or freight trips. Trip rates from Dallas airports could be considered.*

2.2.3 *Local visitor trips – rely on MPO models only to simulate. Not needed in statewide model as these largely take place in urban core.*

2.2.4 *Iowa DOT has "Bronze Level" Streetlight data. Iowa DOT will provide additional details and access such that the MA team can examine it to see how best it can be used and if we need supplemental data.*

2.3 *Trip Distribution – consider distribution checks against StreetLight Data*

2.3.1 *Destination choice (DC) vs. gravity model (GM): the group agreed to stick with the DC approach unless there was a reason to change. The DOT is open to changing back to a GM approach if warranted (using K factors for bridges, rivers, etc.). One* *issue: there is a lack of documentation re: how RSG developed the DC factors in the current iTRAM. NOTE: ATG will be updating DC for the model update.*

2.4 Mode Choice – at a minimum, auto occupancy rates should be updated to reflect 2017 NHTS and recent Iowa MPO surveys.

2.4.1 Should mode choice model split passenger trips into auto, bus, rail, TNC, air?

2.4.2 Similarly, should freight be splits into truck modes, rail, air, water?

2.4.3 The general sentiment of meeting attendees was that the existing mode choice (auto occupancy) model should be carried forward so as to remain functional, as with limited funds, mode choice enhancements seemed less useful than other options.

2.5 Trip Assignment – numerous issues to address in model update.

2.5.1 Assignment algorithm: Pre-assignment of trucks in the current iTRAM – Paul supports continuing this approach. The issue is what happens if there is a significant detour due to construction? Currently the trucks will use the next closest/fastest path. But they may start diverting from that path as congestion builds to the next fastest path, etc., more like a capacity-restraint assignment. MA will investigate this.

2.5.2 There was discussion about the value of defining both maximum capacity (LOS E) for plotting volume/capacity ratios vs. "Practical Capacity" (LOS C/D) for use in the BPR equation.

2.5.3 Discussed creating new attributes such as "with/without passing lanes" to help reflect that roads with passing lanes have both higher speed and capacity than those that do not.

2.5.4 How were the capacities developed? What were the sources? Florida and Michigan were referenced. Jeff will send out the previous speed and capacity lookup table documentation so that the MA team can review. The MA team will then make recommendations re: adjusting/updating the methodology to the DOT.

2.5.5 Need capacities to be distinguished for "Super 2" roadways.

2.5.6 How much seasonal variation is there (especially for trucks)? Garrett thought that TOD was more important to be modeled than seasonal variation in iTRAM. Not much seasonal variation exists in Iowa.

2.5.7 TOD – Consider TOD structure for iTRAM because it's best practice and because the Iowa MPOs use TOD models. Biggest issue is getting good TOD data for validation. Recommendation: develop a TOD structure for iTRAM. Use NCHRP default parameters to factor the daily assignment to four TOD periods (AM, Noon, PM and off-peak), unless Iowa data is available. This would be the minimum for developing a TOD structure though TOD is not a priority for iTRAM at this point.

2.5.8 *Cost functionality is needed in case future toll roads are tested.*

3. Group II: Network, Demographic, Zonal Input Development

3.1 *Base, Interim & Forecast Years – Is there a need for the iTRAM model years to be consistent with the MPO model years? The socio-economic (SE) data is in 5-year increments, so the DOT can interpolate for in-between years using straight-line interpolation. OR – ATG has a process that they can use to run for a single in-between year such as opening or design years, including processing of external trips.*

3.2 *Highway Network – All agreed that for the iTRAM Highway network, it would be good to remove extraneous, old, or temporary attributes.*

3.2.1 *Mike B suggested to consider using segment IDs to supplement or replace link IDs. Segment IDs are useful for data management, corridor analysis, etc. GIS-based system that is easy for DOT staff to create with guidance.*

3.2.2 *Mike B also suggested "input / output automated error checking" to red-flag mistakes in data, such as 1-lane freeways; zones generating trips, but not connected to the network; improbable district-level jobs/housing balances, etc.*

3.2.3 *There are currently three area types in iTRAM – urban, suburban, and rural. Mike B. likes to use six area types – wilderness, rural, transitional (rural-to-suburban), suburban, urban, and urban core. Tony argued that you would need to be able to develop and forecast trips by these area types. Rob noted that the NHTS does not have data on some of these area types. Mike B responded that 6-types are useful not only for establishing speeds and capacities, but also for general planning and display, so you can see how areas are changing over time. Worthy of further discussion at a later time.*

3.2.4 *Add traditional screenlines that cut across routes. These can be supplemented by "route summaries" comparing assignments to counts for major corridors.*

3.2.5 *iTRAM facility types currently equate with FHWA functional classifications, although MPO models have additional categories that could be added to iTRAM.*

3.2.6 *Establish standard color themes and bookmarks in scenario files but use only distinct TransCAD colors, if possible. Too many gradations in the TransCAD color scheme. Consider coordinating with MPOs to standardize common displays such as number of lanes, functional class, area types, levels of congestion, etc.*

3.2.7 *Base year should ideally be 2018 (see below). Start with the 2010 or 2015 network and build it up to reflect 2018 conditions. Build up the new iTRAM from the MPO model networks and zones then add rural network and zones? If the new iTRAM is built up from the MPO models, should there be ONE IOWA MODEL FOR STATEWIDE AND MPO APPLICATIONS? See earlier overview section.*

3.2.8 Zone-to-Network compatibility: too many links/TAZs in iTRAM. Delete or deactivate some links or split TAZs or a combination of the two (likely the former). Another option is to keep the links and zones as is, but do not validate to these "local links".

3.2.9 MPO/Statewide TAZ consistency: look at nesting the MPO zones into the iTRAM zones as much as possible. Mike B. discussed a data management technique of creating small, medium, and large districts with numbering in a "telescoping" fashion (where zones 1-10 = small district 1; small districts 1-3 = medium district 1; medium 1-4 = large 1). Also, possible to designate say 10 MPO zones as one iTRAM zone and manage data transfer between MPOs and iTRAM that way.

3.2.10 The group decided it would be better to keep validating iTRAM to AADT, not to AAWDT. Also, consider validating only for roads of 1,000+ AADT, like before, since there are still many rural roads with small volumes in the network. Start with the validation criteria from last time, and supplement/adjust as needed.

3.2.11 2018 is the latest year for which the DOT has count information (actual counts or factored to 2018). Iowa DOT uses a 4-year count cycle, so all counts were either factored to 2018 or taken in 2018. Recommended to use the 2018 counts. Adjust the 2010 network to reflect 2018 conditions and use 2018 as the new base year.

3.3 Rail Network – For the rail network, there are only minor changes from the existing rail model. These can be done in about a week. For now, keep the 2010 rail passenger network (presently limited to Iowa and buffer states) until the Iowa legislature decides to fund an update of the rail passenger model. BUT – keep and update the national rail freight network.

3.4 Traffic Analysis Zones – MA will conduct zone-by-zone review for potential splits and consider zone nesting within districts to represent MPOs, DOT districts, regional councils, etc.

3.5 External Networks and Stations – External structure: Use a buffer area approach again but import a national network that was used in Texas or Arkansas Statewide models or use the Caliper national network for the buffer area, and the TransCAD FAF network beyond the buffer area.

3.5.1 Identify needs for external zones on major non-Interstate highways.

3.5.2 Previously purchased ATRI and StreetLight Insight data might be limited to non-external links.

3.6 SE Data Collection & Forecasting – Continuing rural to urban migration.

3.6.1 For the SE data, start with the 2010 data and factor it up to 2015 or 2018, rather than starting from scratch using various sources to develop 2015/2018 data. County control totals will be used to identify growth since 2010 while percent zone distribution within each county should remain roughly the same for a new base year.

3.6.2 *The approach described above would eliminate the need to purchase an employment database. Iowa DOT has already validated 2010 employment and did not renew its subscription to the InfoGroup data (there were many problems with the data).*

3.6.3 *For the current iTRAM TAZ SE data, data was forecast at the county level, then down allocated using a method that the CDM Smith team developed. REMI data was used as county control totals.*

3.6.4 *Consider adding school enrollment in iTRAM. The MPOs use it already for HBSchool trips.*

4. Group III: Freight, Externals, and MPO Integration

4.1 *Truck Model – current model uses truck trip rates from unknown sources.*

4.1.1 *Iowa DOT prefers a commodity-based approach for developing and forecasting truck trips. The MA team agrees. This is a better approach than generating truck trips using trip rates. Consider replacing the Quick Response Freight Manual approach to generating truck trips with a commodity tonnage generating model.*

4.1.2 *ATRI data used last time, had good results with it. Coupled with the Streetlight data, do we need more sources for the truck model?*

4.2 *Commodity Flow Optimization Model – this discussion was tabled until the 7/26/19 conference call with Quetica on the iFROM approach.*

4.3 *External Trips – There are not any documented details for how base year external trips were developed. Paul and Jeff were pretty sure that the methodology is documented in the overall report or the User Guide.*

4.3.1 *This time look at using FAF truck forecasts and the national travel analysis framework O/D table to generate a seed matrix of external trips.*

4.3.2 *The MA team will check "logic flows" at all external stations to prevent "U-turns".*

5. Group IV: Calibration, Validation, and Post Processing

5.1 *For forecasting applications, consider using the difference between the base year count and base year model forecast, and carrying that relationship forward to adjust the future year forecast. This makes the model more useful for project-level forecasts.*

5.2 *Dynamic validation: utilize sensitivity analysis for a future year to see if validation is making sense, show results that we could expect. For example, "what happens when you close I-80 for 20 miles, or 4 interchanges? What is the impact to the transportation system?"*

5.3 *Use two different data sources for estimation and calibration and one for validation.*

5.4 *Paul will send the group the Utah DOT Statewide compliance matrix that was used in the Utah DOT statewide plan. It has the Federal regs re: Performance Measures related to* *things like reliability, resiliency/ sustainability, freight, tourism, etc. Not how to, but the regs.*

- 5.5 *Add capabilities for bottleneck analysis?*
- 5.6 *Create preformatted maps of results. Create "planning useful" data-mining algorithms such as district to district flows by purpose, before / after scenario comparisons, etc. Look at several other models outside Iowa for useful post-processors.*
- 5.7 *Add model speed summaries to validation and forecasting post-processors.*

6. Group V: GUI and Enhanced User Applications
   - 6.1 *The MA team will explore implementing the Caliper equivalent of the Cube Application Manager for iTRAM (available in TransCAD 7 and 8).*
   - 6.2 *Consider filling in blanks with default file locations for utilities.*
   - 6.3 *Consider/cost out adding a help function to the GUI?*
   - 6.4 *The MA team will examine the difference between the ISMS GUI and the current iTRAM GUI, then discuss what to do. Three possible approaches for the GUI:*
     - *Enhance the current iTRAM GUI*
     - *Use the flow chart approach in TransCAD 8.0*
     - *Look at implementing ISMS GUI or a combination of the ISMS and iTRAM GUIs.*
7. Group VI: Documentation and Project Management
   - 7.1 *Documentation enhancements:*
     - *Include what you can and cannot use statewide models for.*
     - *Interactive maps - For shields, legends, names of major cities, insets, etc. have these pop-up automatically when the map come up.*
     - *Show a flow chart of the entire modeling process – inputs/outputs of each step.*
     - *Include text on "right-sizing" iTRAM to fit what it will be used for. The "right-sizing" was the result of an NCHRP study that Iowa DOT applied for and won. $80k-$100k additional budget for iTRAM.*
8. Other Potential Enhancements
   - 8.1 Web-based model output visualization. For example, accessibility via MetroScape, where you can click any zone to see travel time contours to all other zones, and also see population, employment, and supply-chain accessibility all across the state.
   - 8.2 Implementing economic components for benefit/cost analyses?
   - 8.3 Adding feedback mechanism into model.
9. Summary/Next Steps – current cost range for iTRAM refinement is between $250k and $700k
10. Project Schedule – SWOT memo in August; right-sizing workshop in September

Appendix B:

iTRAM SWOT Workshop Model Evaluation Checklist

iTRAM SWOT Workshop Model Evaluation Checklist

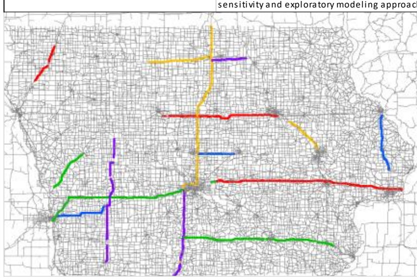
iTRAM SWOT Analysis	**Overview**	original cost lowered	original cost increased					
Model Evaluation Checklist								
	Low End Costs			High End Total Costs by Phase (includes basic low end cost elements)				
Proposed Task Activities		**Group I: Model Algorithm & Software Refinements**	**Group II: Network, Demographic, Zonal Input Development**	**Group III: Freight, Externals & MPO Integration**	**Group IV: Calibration, Validation & Post Processing**	**Group V: GUI & Enhanced User Applications**	**Group VI: Documentation & Project Management**	**Other Potential Enhancements**
Task 1. Existing iTRAM Evaluation & Recommended Improvements	*$ 49,544*	*$ 49,544*						
Task 2. Software Platform & Compatibility	$ 5,000	$ 15,000	*TBD*					
Task 9. Trip Generation	$ 25,000	$ 40,000	*update trip rates (2017 NHTS OR NCHRP)*					
Task 10. Trip Distribution	$ 25,000	$ 50,000	*test & update destination choice factors*					
Task 11. Mode Split	$ 5,000	$ 35,000	*switch to nested logit passenger model*					
Task 12. Traffic Assignment	$ 20,000	$ 45,000	*time-of-day & capacity modifications*					
Task 3. Base, Interim & Forecast Years	$ 500	*data interpolation/extrapolation*	$ 15,000					
Task 4. Highway Network	$ 25,000	*multi-modal network format*	$ 35,000					
Task 5. Rail	$ 5,000	*TBD-cost difference placeholder*	$ 25,000					
Task 6. Traffic Analysis Zones (TAZs)	$ 5,000	*MPO/SWM TAZ consistency*	$ 70,000					
Task 7. External Networks and Stations	$ 5,000	*additional external zones/trips*	$ 40,000					
Task 8. SE Data Collection & Forecasting	$ 15,000	*source to MPO or restart SE data*	$ 45,000					
Task 13. Truck Model	$ 5,000		*includes national truck network/zones*	$ 30,000				
Task 14. Commodity Flow Tool	$ 5,000		*includes FAF5 disaggregation*	$ 60,000				
Task 15. External Trips	$ 10,000		*external truck adjustments consistent with above/purchase passive data*	$ 30,000				
Task 16. Calibration and Validation	$ 35,000			*"dynamic validation" process*	$ 60,000			
Task 17. Post Processing	$ 7,500			*more utilities and maps*	$ 12,500			
Task 18. Graphical User Interface	$ 15,000				*common GUI for ALL Iowa models; flow charting capability?*	$ 25,000		
Task 19. Model Documentation	$ 15,000					*enhanced graphics; add flow charts*	$ 30,000	
Web-Based Enhancements	$ -						*TBD (Mike Brown?)*	$ 35,000
Total Budget Range	$ 277,544	$ 234,544	$ 230,000	$ 120,000	$ 72,500	$ 25,000	$ 30,000	$ 35,000
Total Budget Range Minus SWOT	*$ 228,000*	$ 185,000	$ 230,000	$ 120,000	$ 72,500	$ 25,000	$ 30,000	$ 35,000
	All Phases-Low	Phase I High End Cost	Phase II High End Cost	Phase III High End Cost	Phase IV High End Cost	Phase V High End Cost	Phase VI High End Cost	Other High End Cost
	All Phases-High	*$ 697,500*	$ 747,044	<high end including SWOT				
All-phases-high original estimate	All-phases-	$730,000	$780,000	<high end including SWOT				

iTRAM SWOT Analysis	**Phase I**			
Model Evaluation Checklist				
	Proposed Model Update Phases			
	Group I: Model Algorithm & Software Refinements			
Proposed Task Activities	**Items to Evaluate**	**Reviewed?**	**Current Status**	**Comments and Recommendations**
Task 1. Existing iTRAM Evaluation & Recommended Improvements	single statewide vs. multiple MPO models	n/a	n/a	not my personal preference but we'll discuss further during the SWOT workshop
	budgeting & schedule	n/a	n/a	to be refined after SWOT workshop
Task 2. Software Platform & Compatibility	current maps and reports - keep/modify/move?	✓	was able to execute successfully (failed first time as "Load Scenario" button wasn't pushed before running utilities)	will discuss additional needs for maps and reports at SWOT but maps & bins should be added for volume-over-count ratios, screenlines, counts, number of lanes, area types, and facility types
	current model utilities - keep/modify/move?	✓	issues encountered running "FAF3 to truck conversion" (must 1st modify folder names; base/forecast commodity years both 2007)	will discuss additional needs for model utilities at SWOT
	potential TransCAD 8.0 incompatibilities?	TBD	n/a	discuss with Caliper once decision is made on which enhancements to incorporate?
Task 9. Trip Generation	data checking routines	✓	thus far only see demographic totals listed by state	if not existing, it would be beneficial to flag zones with missing data or peculiar data ratios
	validation reasonableness statistics	✓	NHTS aggregate trips/HH and percent trips/purpose provided; aggregate trip rates in model output differ a bit from report	if aggregate rates are from NHTS, rates from iTRAM trip generation model should be provided as well
	source for routine trip generation rates	✓	analysis of Iowa households in the raw weighted 2009 NHTS person trip data file ; unclear on 365 weekday weighting factor	logic of trip rates by HH size & # of vehicles is odd in some cases; consider updating with 2017 NHTS data, along with data from other recent Iowa MPO HH travel surveys; borrow NCHRP 716 attraction rates
	airport trip rates	✓	based on FAA enplanement data and ITE vehicle occupancy rate	these data should be updated with new FAA and ITE Trip Generation assumptions
	source for long-distance trip generation rates	✓	NCHRP 735 transferable trip rates adjusted to reflect 2009 NHTS Iowa Add-On Survey	consider adjusting with 2017 NHTS data, in conjunction with data from other recent Iowa MPO HH travel surveys (recognizing limited sample of long-distance trips)... include data from adjacent states
	stratifying trip rates by urban & rural zones	✓	separate trip rates for rural areas based on 2009 NHTS URBRUR attribute	consider updating with 2017 NHTS data, plus other recent Iowa MPO HH surveys; look at consistency between NHTS RUR category and network rural area type coding; high % rural HH 2009 sample size
Task 10. Trip Distribution	gravity model vs. destination choice	✓	recently switched to destination choice for HB, NHB, LD trips	will evaluate current 8 factors in DC model to identify relevance/extent of use for new model
	sources for benchmark statistics	✓	iTRAM validation benchmarks are consistent with NCHRP 836-91; average trip lengths in report don't exactly match model outputs	team will supplement/identify new validation benchmarks from recent statewide models
	new destination choice factors	n/a	n/a	consider/test factors from TX-SAM and other appropriate destination choice models
Task 11. Mode Split	estimate percent trips by mode	✓	mode choice modeling seems limited to freight/passenger rail	should the mode choice outputs be fed into the auto/truck highway assignment or not compatible?
	auto occupancy rates	✓	auto occupancy rates/factors based on NCHRP 365	should be computed from 2017 NHTS or borrowed from NCHRP 716/735
	needs for mode choice modeling	n/a	mode choice modeling seems limited to freight/passenger rail	TBD based on anticipated model needs from Iowa DOT and their planning partners
Task 12. Traffic Assignment	quantifying highway capacity and LOS	n/a	not entirely clear how capacity or LOS is calculated in networks	include assumptions in model user manual or references to other documents; update assumptions?
	assignment algorithm	✓	all-or-nothing for trucks; user equilibrium algorithm for autos	would be helpful to know assignment parameter settings tested previously and those selected
	needs for modeling time-of-day	n/a	not entirely clear if modeling is accomplished by time period	include assumptions in model user manual or references to other documents; add/modify capabilities

iTRAM SWOT Analysis	**Phase II**			
Model Evaluation Checklist				
	Proposed Model Update Phases			
	Group II: Network, Demographic, Zonal Input Development			
Proposed Task Activities	**Items to Evaluate**	**Reviewed?**	**Current Status**	**Comments and Recommendations**
Task 3. Base, Interim & Forecast Years	consistency with MPO model years	✓	SE data report: MPO data used regardless of base yr consistency	it would seem that maintaining SE data in 5-year increments would suffice for MPO consistency
	SE data interpolation/extrapolation ability	✓	SE data already exists in 5-year increments (2010-2040)	TBD based on discussions with Iowa DOT, reflecting prior process & need for more analysis years
Task 4. Highway Network	new network attributes	✓	existing network attributes are generally sufficient	recommend removing informational (old/temporary) attributes from master network to minimize clutter; add screenline number to all screenline links (recode screenlines per my other comments)
	color themes & bookmarks	✓	fairly basic workspace file; no pre-existing bookmarks	already adding bookmarks and additional color themes... to be continued
	2010 network format sufficient for 2015?	✓	appears sufficient as starting point for 2015 network	more network than needed along with some unnecessary attributes that could be removed
	2015 traffic counts, other network attributes	✓	it's unclear why AAWDT is used when NHTS trip rates include weekends	determine yr of counts for new model/need for common yr; might include counts = <1k in new model; a few quick checks show counts on nearly every link (unlikely), some interstates with count in 1 direction
	network refinement outside Iowa?	✓	network detail in adjacent states appears sufficient	consider removing some portions of network (e.g., ND, SD, No. MN); adding national freight network?
	multimodal network format?	TBD	n/a	to be discussed at the SWOT workshop
	integration with MPO model networks?	TBD	n/a	to be discussed at the SWOT workshop
Task 5. Rail	anticipated uses of rail network	✓	no user guide specific to freight rail model & no default model assumptions; passenger rail has instructions but no defaults	there's a lot to absorb here without prior involvement; it appears that the freight rail model was the outcome of a Federal grant; it is hoped that additional context can be provided at SWOT workshop
	integration of freight & passenger rail networks?	✓	passenger rail network includes all AMTRAK routes; freight network is nationwide & overlays on iTRAM p-rail/hwy networks	both freight and passenger rail models include mode choice components; passenger rail model also includes air and bus networks consistent with iTRAM highway net extent; unsure how to improve yet
Task 6. Traffic Analysis Zones (TAZs)	network/zone compatibility	✓	network appears excessive when compared to zone system	there are a lot of network links that can either be removed or deactivated
	identify irregular, overly large TAZs	TBD	n/a	zone-by-zone assessment can be made as part of post-SWOT efforts, or identify during validation
	MPO/statewide TAZ consistency	TBD	n/a	importance TBD based on SWOT discussions
Task 7. External Networks and Stations	external zone locations	✓	14 interstate locations in (mostly) border states	somewhat surprised at how far away external zones are from Iowa; what about non-interstates?
	external trip purposes & other assumptions	✓	Fratar of assumptions from 1995 American Travel Survey	not quite sure how specific road segment O/D was derived from ATS... update with passive O/D data
Task 8. SE Data Collection & Forecasting	top down estimates of 2010-2015 growth	✓	2015 SE data already available in iTRAM; adjust to match new control totals and incorporate new major employers	initially recommending simple process based on existing 2015 estimates, updated control totals, major new employers, and new attributes unless it is felt that prior 2015 estimates are flawed
	new SE data attributes (e.g., schools, income, etc.)	TBD	n/a	dependent on new trip generation rates and predominant explanatory variables
	consistency with MPO SE data	✓	documentation implies that iTRAM totals match MPO totals	would it be preferable to import MPO SE data and aggregate or maintain separate iTRAM datasets?
	correlation between MPO and iTRAM TAZs			if aggregating MPO SE data to iTRAM zones, would need to develop correlation/equivalency tables
	need for purchase of employment database?	✓	appeared to be significant adjustments made to 2010 employmt	if starting with existing 2015 SE data, shouldn't be a need to purchase employment data

iTRAM SWOT Analysis	Phase III			
Model Evaluation Checklist				
	Proposed Model Update Phases			
	Group III: Freight, Externals & MPO Integration			
Proposed Task Activities	**Items to Evaluate**	**Reviewed?**	**Current Status**	**Comments and Recommendations**
Task 13. Truck Model	Quick Response Freight Manual approach (pro/con)	✓	Medium-duty and heavy duty QRFM trip rates adjusted by 4 employment categories using 6 truck index adjustment factors and 3 truck generator types; gravity model used for distribution	QRFM trip rates were based on Phoenix area truck survey; thus, QRFM II didn't provide truck trip rates, recommending use of local data. Testing with MAG truck distribution patterns did not improve model. Need to identify other trip generation/distribution sources and coordinate with commodity flow tool
	comparisons against truck patterns by source	✓	combination of ATRI and FAF information; data assumptions from ATRI limited use of data for estimating O/D patterns	determine if new ATRI data purchase is warranted (or perhaps StreetLight Insight fleet *and* personal navigation data); FAF flows should be updated to reflect FAF4
Task 14. Commodity Flow Tool	FAF4 disaggregation process	✓	FAF 2010-2040 District-District growth rates developed and applied along with input of FAF mode choice adjustments	updated adjustment factors? Merge iFROM into iTRAM?
	national trade network models	✓	the only national network detected was for rail freight	haven't reviewed iFROM… plan to discuss further with Quetica and identify what iFROM includes
	large national scale model data sources	✓	FAF is used in the current model, though not sure of details	will further investigate how FAF and other sources are used in iTRAM
	integration with iFROM process	n/a	TBD	haven't reviewed iFROM… plan to discuss further with Quetica and identify what iFROM includes
Task 15. External Trips	purchase of passive O/D data for external flows?	✓	need more information on availability/age of ATRI data	as noted above, consider purchase of StreetLight Insight data for both passenger cars and trucks
	logic check on external splits/EE patterns	✓	zero thru truck trips in 2010 & 2040 external input trip matrices; Top 5 external flows (below) all eminate from I-80 east:	unsure why input matrix has zero external trips while output file does have external trips. Surprising that I-70 west to I-70 east (100 trips) is so much lower than I-80 west to east (575 trips). Trucks only?
			OD_Final: zone 999001 (I-80 E) to 999003 (I-70 E) = 313 truck trips	illogical flow (u-turn)!
			OD_Final: zone 999001 (I-80 E) to 999006 (I-55 S) = 399 truck trips	
			OD_Final: zone 999001 (I-80 E) to 999007 (I-44 W) = 515 truck trips	
			OD_Final: zone 999001 (I-80 E) to 999009 (I-70 W) = 354 truck trips	
			OD_Final: zone 999001 (I-80 E) to 999010 (I-80 W) = 575 truck trips	
	source of base external trip tables?	✓	origin/generation of base (input) external trip tables is unclear	external trips are generated using a Fratar approach but little info is available on the data source and how base tables were generated… might it be better to start with input data file to be modified?

iTRAM SWOT Analysis	Phase IV			
Model Evaluation Checklist				
	Proposed Model Update Phases			
	Group IV: Calibration, Validation & Post Processing			
Proposed Task Activities	**Items to Evaluate**	**Reviewed?**	**Current Status**	**Comments and Recommendations**
Task 16. Calibration and Validation	assess current model validation	✓	trip generation & trip distribution statistics are in range of model benchmarks but .txt outputs don't match report. percent assignment error is good but RMSE is higher than typical standards by volume group, facility type, and area type (also 7 diff. outputs, yet none match report). north boundary screenline is very high; several other SLs are over/under assigning	scripted calculation of RMSE should be checked due to the disparity with percent error; display of screenlines should be improved (number each screenline with larger map, more colors, legend, route shields, etc.)… variable accuracy standards should also be depicted in the screenline validation table (varying by total screenline count); screenline coding and validation must improve, particularly at state line (should be easy to fix); improvement in RMSE validation should be expected with an updated model; source of cited truck validation standards could use clarification/improvement
	identify new validation benchmark statistics	✓	iTRAM validation benchmarks consistent with NCHRP 836-91	team will supplement/identify new validation benchmarks from recent statewide models
	identify new validation accuracy standards	✓	iTRAM validation accuracy standards consistent w NCHRP 836-91	"Statewide and Megaregional Travel Forecasting Models" (2017) cites these same accuracy standards
	dynamic assignment validation?	n/a	no indication of this concept in current model	Modifying input parameters & examining resulting impact on reasonableness to be done in new model
Task 17. Post Processing	review current model utilities	✓	see Group1, task 2 tab	will discuss additional needs for model utilities at SWOT
	consistency with FHWA performance measures?	✓	current utilities produce very basic statistics	need to consider how to quantify/measure reliability, resiliance, tourism, and freight
	range of forecasts vs. link specific estimates?	n/a	current model produces specific numbers	consider adding volume ranges to reflect volume groups and assignment error
	sensitivity and exploratory modeling approaches?	n/a	no evidence of prior documented sensitivity testing	incorporate sensitivity testing into model validation process; check logic of initial model forecasts



Color(s)	The current screenlines are located as follows:	Additional screenlines were added at the following locations: *(not depicted on map or coded in network)*
yellow/purple	1. I-35 (North and South of Des Moines)	1. Northern state boundary of Iowa
green/red	2. I -80 (East and West of Des Moines)	2. Western state boundary of Iowa
yellow	3. I-380	3. Southern state boundary of Iowa
blue	4. US 6 (Just Southeast of I-80)	4. Southeastern crossings of the Mississippi River
yellow/purple	5. US 18 (East and West of I-35)	5. Northeastern crossings of the Mississippi River
red	6. US 20 (East and West of I-35)	*an unconventional way of defining original screenlines was employed as SLs are defined on adjacent links instead of parallel links; e.g., instead of I-80 screenline residing on roadways crossing I-80, the screenline consists of I-80 links; it'd be more appropriate to call these "link groups" and instead define parallel links crossing I-80 as screenline links; this recommended approach would be more consistent with how screenlines would be defined on state line, river and rail crossings; another concern with the current approach is duplicative counts*
blue	7. US 30 (East of I-35)	
green	8. US 30 (East of I-29)	
green	9. US 34 (Southeastern portion in Iowa)	
blue	10. US 61 (Along Mississippi River Crossing)	
purple	11. US 71 (Across the state crossing I-80)	
red	12. SR 60 (Northwest corner of Iowa)	

iTRAM SWOT Analysis	Phase V			
Model Evaluation Checklist				
	Proposed Model Update Phases			
	Group V: GUI & Enhanced User Applications			
Proposed Task Activities	**Items to Evaluate**	**Reviewed?**	**Current Status**	**Comments and Recommendations**
Task 18. Graphical User Interface	user friendliness	✓	fairly easy to install and run, though I did encountered difficulties on the first go around	in the event of installation or model run errors, adding some diagnostics could be helpful for debugging; also, it might be good to have default file names filled in when running the first time; folder structure described in user manual is not exactly the same as folders provided by Iowa DOT
	streamlining steps	✓	rail models are currently separate from other model steps	should passenger and freight rail steps be folded into remainder of 4-step model structure?
	include default file name assumptions for utilities	✓	"FAF3 to Trucks" starts with all blank fields, leaving me unsure on what to type in; main model steps also missing defaults	assuming a typical model flow, perhaps default filenames and folders should be listed for the user to accept or modify
	incorporate unlimited interpolation/extrapolation?	✓	current model includes demographic data in 5-year increments	discuss additional needs at SWOT workshop
	consistency with MPO model interfaces?	TBD	not familiar with MPO model interfaces at this time	there are user friendliness advantages to using a common interface throughout the state
	exports to other file formats?	✓	TransCAD already allows for many exportable file formats	discuss with potential model users on what/whether or not additional export options are desirable
	flow chart-based model interface?	✓	confirm feature to be available with TransCAD 8	approach found in Cube models makes input/output flow more obvious; allows for running sub-steps

iTRAM SWOT Analysis	Phase VI			
Model Evaluation Checklist				
	Proposed Model Update Phases			
	Group VI: Documentation & Project Management			
Proposed Task Activities	**Items to Evaluate**	**Reviewed?**	**Current Status**	**Comments and Recommendations**
Task 19. Model Documentation	review current documentation	✓	generally well written reports but visuals could be improved	might want to consider an appendix describing uses of statewide model for MPOs, corridor studies, etc
	schedule/frequency of technical memoranda?	TBD	n/a	to be discussed at the SWOT workshop
	desirable enhancements to documentation?	✓	n/a	most maps appear to have been generated directly from the model without regard to including legends, insets, route shields, major cities, etc. an experienced cartographer or graphic artist should be employed to enhance map completeness and legibility. an easy table to add would be the percent of intazonal trips by purpose… this would help indicate whether overall zonal structure is adequate. the user guide should include a flow chart(s) depicting each model step, its input and output files, and the flow of files from outputs for one step to inputs for other step(s)… some of this is not obvious

iTRAM SWOT Analysis	Other			
Model Evaluation Checklist				
	Proposed Model Update Phases			
	Other Potential Enhancements			
Proposed Task Activities	**Items to Evaluate**	**Reviewed?**	**Current Status**	**Comments and Recommendations**
Web-Based Enhancements	current capabilities?			
	data mining/enhanced data accessibility tools			

Appendix C:

Trip Rate Comparisons

Table C-1 through **Table C-3** presents trip rate comparisons between 2009 and 2017 NHTS data, the current iTRAM, and other available datasets. The attached spreadsheet (Appendix A TripRateComparison.xlsx) contains estimated trip rates stratified by the several variables described in the *Trip Rate Estimation Methodology* section from different datasets.

Table C-1: National Trip Rate Comparison between 2009 and 2017 NHTS

Region	2009 NHTS - All Modes Every Day				2017 NHTS - All Modes Every Day			
	All	HBW	HBO	NHB	All	HBW	HBO	NHB
Northeast	9.39	1.10	5.40	2.88	8.51	1.18	4.67	2.66
Midwest	9.43	1.11	5.33	2.99	8.31	1.20	4.47	2.64
South	9.16	1.04	5.21	2.91	8.50	1.14	4.59	2.76
West	10.21	1.18	5.97	3.07	9.14	1.21	5.00	2.93
All Regions	9.50	1.10	5.44	2.96	8.60	1.18	4.68	2.75

Table C-2: Short-Distance Trip Rate Comparison for iTRAM

Trip Rate Source	HBW	HBO	NHB	Total
Current iTRAM	1.24	4.21	2.56	8.01
2017 NHTS DAMMPO Add-On (Des Moines)	1.68	3.82	2.58	8.08
2017 NHTS INRCOG Add-On (Waterloo)	1.56	4.12	2.61	8.29
2017 NHTS Midwest Region (include all Iowa Add-Ons)	1.45	3.73	2.54	7.72
2009 NHTS Cedar Rapids Add-On	1.88	5.04	3.18	10.10
2009 NHTS Iowa Statewide Add-On	1.60	4.11	2.55	8.26
2009 NHTS Omaha Add-On	1.67	4.24	2.31	8.22
2014 Bi-State (Quad Cities)	1.10	4.31	2.30	7.71

Table C-3: Long-Distance Trip Rate Comparison for iTRAM

Trip Purpose	Current iTRAM	1995 ATS (All days)	2017 NHTS Midwest Region (All days)	2017 NHTS Midwest Region (Weekday only)
LNGW	0.005	0.010	0.012	0.014
LNGNW	0.039	0.041	0.068	0.047

Table C-4 through **Table C-7** presents the unadjusted HBW, HBO, and NHB trip production rates estimated directly from the 2017 NHTS Midwest Region weighted samples.

Table C-4: Unadjusted HBW Trip Production Rates

	Non-MSA				MSA			
	HH1	HH2	HH3	HH4	HH1	HH2	HH3	HH4
0-worker	0.03	0.02	0.02	0.01	0.02	0.02	0.01	0.18
1-worker	1.22	1.17	0.88	1.54	1.09	1.01	1.27	1.43
2+ worker	N/A	2.75	2.89	3.31	N/A	2.55	2.70	2.90

Table C-5: Unadjusted HBO Trip Production Rates

	Non-MSA				MSA			
	HH1	HH2	HH3	HH4	HH1	HH2	HH3	HH4
INC1	1.40	3.94	4.09	3.49	1.76	3.37	3.74	5.60
INC2	1.70	3.68	3.45	8.36	1.64	3.09	4.55	6.80
INC3	1.51	3.00	3.26	6.09	1.28	3.13	4.56	7.25
INC4	1.94	3.04	4.51	7.62	1.53	3.16	4.34	8.02

Table C-6: Unadjusted NHB Trip Production Rates

	Non-MSA				MSA			
	HH1	HH2	HH3	HH4	HH1	HH2	HH3	HH4
INC1	0.89	2.34	2.48	1.74	1.09	3.06	3.25	2.62
INC2	1.80	2.76	4.03	4.97	1.53	2.32	2.74	3.37
INC3	0.92	2.27	2.13	4.30	1.43	2.19	3.69	3.62
INC4	1.77	2.41	4.46	5.93	1.43	2.33	3.70	4.25

Table C-7: Unadjusted Long-Distance Trip Production Rates

INC	LNGW	LNGNW
1	0.001	0.018
2	0.006	0.041
3	0.019	0.044
4	0.032	0.086

Table C-8 through **Table C-13** presents household sample sizes by the different cross-classifications and trip sample sizes contained in the 2017 Midwest Region Dataset.

Table C-8: Household Sample Distribution by Household Size and Workers

	Non-MSA				MSA				Total
	HH1	HH2	HH3	HH4	HH1	HH2	HH3	HH4	
0-worker	643	688	22	12	1,916	1,633	85	43	5,042
1-worker	446	493	87	98	1,874	1,457	342	371	5,168
2+ worker	0	535	209	287	0	1,966	838	1,226	5,061
Total	1,089	1,716	318	397	3,790	5,056	1,265	1,640	15,271

Table C-9: Household Sample Distribution by Household Size and Income Group

	Non-MSA				MSA				Total
	HH1	HH2	HH3	HH4	HH1	HH2	HH3	HH4	
INC1	500	225	44	33	1,282	434	111	103	2,732
INC2	359	492	68	60	1,289	1,121	233	170	3,792
INC3	194	699	139	171	953	2,024	446	546	5,172
INC4	36	300	67	133	266	1,477	475	821	3,575
Total	1,089	1,716	318	397	3,790	5,056	1,265	1,640	15,271

Table C-10: HBW Trip Sample Distribution by Household Size and Workers

	Non-MSA				MSA				Total
	HH1	HH2	HH3	HH4	HH1	HH2	HH3	HH4	
0-worker	10	24	4	1	36	57	9	8	149
1-worker	481	495	107	111	2,010	1,580	384	467	5,635
2+ worker	0	1,252	564	730	0	4,633	2,028	2,869	12,076
Total	491	1,771	675	842	2,046	6,270	2,421	3,344	17,860

Table C-11: HBO Trip Sample Distribution by Household Size and Income Group

	Non-MSA				MSA				Total
	HH1	HH2	HH3	HH4	HH1	HH2	HH3	HH4	
INC1	829	668	161	163	2,085	1,418	434	665	6,423
INC2	586	1,657	226	380	2,263	3,815	991	1,057	10,975
INC3	267	2,083	525	993	1,535	6,794	1,960	3,621	17,778
INC4	55	859	269	897	427	4,653	2,042	6,170	15,372
Total	1,737	5,267	1,181	2,433	6,310	16,680	5,427	11,513	50,548

Table C-12: NHB Trip Sample Distribution by Household Size and Income Group

	Non-MSA				MSA				Total
	HH1	HH2	HH3	HH4	HH1	HH2	HH3	HH4	
INC1	482	437	100	90	1,390	854	247	261	3,861
INC2	476	1,115	193	200	1,826	2,465	621	533	7,429
INC3	222	1,540	362	666	1,381	4,720	1,380	1,903	12,174
INC4	52	762	202	544	393	3,701	1,443	3,556	10,653
Total	1,232	3,854	857	1,500	4,990	11,740	3,691	6,253	34,117

Table C-13: Long-Distance Trip Sample Distribution by Income[6]

INC	LNGW	LNGNW	Total
1	2	67	69
2	21	176	197
3	60	321	381
4	107	402	509
Total	190	966	1,156

[6] **Table** only includes sampled weekday trips that were used to estimate long-distance trip rates presented in **Table 2-8**. The 2017 NHTS Midwest Region Data has 212 LNGW trips and 1,472 LNGNW trips in total.

Appendix D:

Model Network Update

Technical Memorandum

To: Jeff Von Brown, Iowa Department of Transportation

From: Avinash Sinha, Michael Baker International

Date: Feb 18, 2020

Re: iTRAM Model Update: Model Network Update

The memo lists the road additions/updates to the iTRAM 2018 Base Year Network. These updates cover the roads inside Iowa and no changes were made to roads outside Iowa.

1. Added MLK Jr. Pkwy between Fleur Dr. and SE 30th St. (Des Moines Area)
2. Added MLK Jr. Pkwy between Fleur Dr. and University Ave. (Des Moines Area)
3. Updated direction and lanes on 19th St between I-235 and Washington Ave. (Des Moines Area)
4. Updated direction/lanes on MLK Jr. Pkwy between Washington Ave and I-235 (Des Moines Area)
5. Added NW 98th Ave. between Sunset Dr. and US 69 (Des Moines Area)
6. Extended 104th St. from New York Ave. to Hickman Rd. (Des Moines Area)
7. Added E P True Pkwy between 60th St. and 74th St. (Des Moines Area)
8. Added 68th St. between E P True Pkwy and Mills Civic Pkwy (Des Moines Area)
9. Updated connection of Mills Civic Pkwy with 60th St. (Des Moines Area)
10. Added Walnut St. between 14th St. and 6th St. (Des Moines Area)
11. Added SE 16th St. between Dayton Ave. and Duff Ave. (Ames Area)
12. Extended 270th St. to X Ave. (Ames Area)
13. Extended 250th St. to X Ave. (Ames Area)
14. Extended Lucore Rd. to 35th St. (Cedar Rapids Area)
15. Extended 29th Ave. to Indian Creek Rd. (Cedar Rapids Area)
16. Extended 44th St. to 29th Ave. (Cedar Rapids Area)
17. Extended 31st St. to 7th Ave. (Cedar Rapids Area)
18. Extended 33rd Ave. to 12th St. (Cedar Rapids Area)
19. Extended 1st Ave. to 80th St. (Cedar Rapids Area)
20. Added Holiday Rd. between 12th Ave. and Coral Ridge Ave. (Iowa City Area)
21. Added Heartland Dr. between Jones Blvd. and Coral Ridge Ave. (Iowa City Area)
22. Added Oakdale Blvd. between 12th Ave. and Coral Ridge Ave. (Iowa City Area)
23. Added Oakdale Blvd. between 12th Ave. and Dubuque St. (Iowa City Area)
24. Added Mormon Trek Blvd. between Hwy 1 and Oak Crest Hill Rd. (Iowa City Area)
25. Added McCollister Blvd. between Oak Crest Hill Rd. and Gilbert St. (Iowa City Area)
26. Added Camp Cardinal Blvd. between Melrose Ave. and 2nd St. (Iowa City Area)
27. Added Scott Blvd. between Lower W Branch Rd. and American Legion Rd. (Iowa City Area)
28. Added Scott Blvd. between Rochester Ave. and Dodge St. (Iowa City Area)
29. Added Court St. between Scott Blvd. and Peterson St. (Iowa City Area)
30. Added 1st Ave. between Scott Blvd. and Rochester Ave. (Iowa City Area)

31. Added E24 near Whiting
32. Added Wesley Pkwy between Hamilton Blvd. and W 7th St. (Sioux City Area)
33. Connected Court St. near 14th St. intersection (Sioux City Area)
34. Extended Cheyenne Blvd. to 27th St. (Sioux City Area)
35. Added Outer Dr. N between 28th St. and Floyd Blvd. (Sioux City Area)
36. Added Kansas St. between 3rd St. and Wesley Pkwy. (Sioux City Area)
37. Added 3rd St. connection between Wesley Blvd. and Pearl St. (Sioux City Area)
38. Added Pearl St. between 3rd St. and 8th St. (Sioux City Area)
39. Added 7th St. connection between Wesley Blvd. and Pearl St. (Sioux City Area)
40. Added Ranchero Rd between Grundy Rd. and Hudson Rd. (Waterloo Area)
41. Added Viking Rd. between Iowa 58 and Cedar Heights Dr. (Waterloo Area)
42. Added Greenhill Rd. between Hudson Rd and 27th St. (Waterloo Area)
43. Added Shaulis Rd. between Ansborough Ave. and Hawkeye Rd. (Waterloo Area)
44. Added Kaufmann Ave. between Kane St. and Grandview Ave. (Dubuque Area)

Appendix E:

Future Considerations for Defining TAZs

Future considerations for an updated 2020 base year iTRAM zone system include implementing a multi-tiered zone structure. This approach would consist of a data management technique that creates small, medium, and large districts with numbering in a "telescoping" fashion (where zones 1-10 = small district 1; small districts 1-3 = medium district 1; medium 1-4 = large 1). Other considerations include designating 10 MPO zones as one iTRAM zone to manage data transfer between MPOs and iTRAM. Zone nesting within districts could be considered to represent MPOs, DOT districts, and regional councils, in addition to current zone nesting and numbering by county and state.

Consistency with Existing MPO TAZs and Demographic Data

One topic discussed at length with Iowa DOT during the aforementioned SWOT workshop was TAZ data consistency between iTRAM and MPO urban models. Some statewide models incorporate the same zone systems, socioeconomic data, and networks as MPO models within their states, though usually with a smaller number of MPOs. This section of the Technical Memorandum looks at different ways to maximize consistency between statewide and MPO model zone systems in the future, along with pros and cons, ranging from the simplest approach to complete model integration.

Use of MPO Socioeconomic Data in Statewide Model

The simplest approach to integrating regional models into iTRAM would be direct use of MPO socioeconomic data in the statewide model. Even this approach could take different forms.

- iTRAM using MPO Socioeconomic Data Only: At its most basic level, MPO demographic data could form the basis of TAZ data in iTRAM urban zones. This approach requires splitting iTRAM zones such that MPO zones nest completely within iTRAM zones. Zonal data could be aggregated from MPO zones to larger TAZs within iTRAM using TransCAD routines that operate on zonal equivalency tables and merge similar data for rural TAZs located outside MPO model boundaries into a single statewide TAZ file for use in a unified trip generation model. *PROS:* Easy to implement; could represent a first step towards further model integration. *CONS:* Requires maintenance of zonal equivalency tables; potential iTRAM process for aggregating MPO data; and coordination process with MPOs on all updates to socioeconomic data for consistency.
- iTRAM using MPO Socioeconomic Data with Single Zone System: This option would differ from the first only in that iTRAM would operate with the same zone system as the MPO models. *PROS:* No need to aggregate MPO data using zonal equivalency tables and new model routines for doing so. *CONS:* Coordination on updates of MPO socioeconomic data would still be necessary; zone splitting would require additional coordination among MPOs and Iowa DOT; iTRAM network would need to incorporate MPO zone centroids/connectors; and an increased number of zones in iTRAM would result in much longer model run times.

Use of MPO Productions and Attractions in Statewide Model

This option maintains existing processes for calculating trip productions and attractions using MPO models but then aggregates the outputs of MPO trip generation into iTRAM. *PROS:* Allows for MPO models to maintain unique trip generation modules and input data requirements. *CONS:* iTRAM would not operate with a singular statewide set of demographic data; would require TransCAD routines to merge productions and attractions from MPO models; and necessitates standard set of trip purposes across all Iowa models.

Integration of MPO Trip Tables into iTRAM

This process would keep both MPO trip generation and trip distribution processes in place but with iTRAM using MPO trip tables in place of existing iTRAM trip tables, for intra-urban travel. *PROS:* This would eliminate duplication in distributing intra-urban trips and potentially improve the accuracy of intra-urban trips in iTRAM. *CONS:* This could add significant complexity to iTRAM as rural and long-distance trip tables are merged with MPO intra-urban trip tables. This process might require MPO trip tables to be aggregated to the iTRAM zone system (as opposed to socioeconomic data or productions and attractions). Decisions would be needed on how to deal with trips from rural areas into urban area. These trips could potentially be categorized as infrequent long-distance trip purposes, or a method could be developed to distribute a portion of rural trips into urbanized areas.

Replacement of MPO Models with Single Statewide Model

The ultimate approach to model integration would involve replacing individual MPO models with iTRAM for all modeling in the state. This would include merging not only demographic data and trip generation processes but highway networks as well. *PROS:* There would only be one travel demand model to maintain in the state of Iowa. *CONS:* Model run times for iTRAM (and in turn, MPOs) would increase dramatically and might necessitate scaling back network and zone systems in iTRAM buffer states. MPOs would have to run a model that includes a wide geographic area that has minimal impact on local travel patterns. While there are examples where MPO models are entirely consistent with statewide models, this is most effective in states with a minimal number of MPO areas.

Appendix F:

Final 2018 iTRAM Trip Production Rates

TransCAD (Licensed to Metro Analytics) - [Dataview1 - P_rates_Iowa_RuralReduction]

File Edit Map Dataview Selection Matrix Tools Procedures Planning Window Help

All Records

MSA	HHSize	INCGP	WKCount	R_HBW_P	R_NHB_P	R_HBO_P	R_LNGW_P	R_LNGNW_P
1	1	1	0	0.0270	1.2700	1.5300	0.0010	0.0180
1	1	2	1	0.9450	1.3700	1.6300	0.0060	0.0410
1	1	3	2	0.0000	1.4300	1.6500	0.0190	0.0440
1	1	4	99	0.0000	1.5000	1.7300	0.0320	0.0860
1	2	1	0	0.0270	2.2300	2.9900	0.0010	0.0180
1	2	2	1	0.9450	2.3100	3.1500	0.0060	0.0410
1	2	3	2	2.2950	2.3700	3.1600	0.0190	0.0440
1	2	4	99	0.0000	2.4400	3.3300	0.0320	0.0860
1	3	1	0	0.0270	3.0300	3.7900	0.0010	0.0180
1	3	2	1	1.2240	3.0900	3.9800	0.0060	0.0410
1	3	3	2	2.4300	3.3700	4.1700	0.0190	0.0440
1	3	4	99	0.0000	3.8600	4.4300	0.0320	0.0860
1	4	1	0	0.0270	3.2700	6.5000	0.0010	0.0180
1	4	2	1	1.2240	3.4800	6.7200	0.0060	0.0410
1	4	3	2	2.6100	3.6100	7.0900	0.0190	0.0440
1	4	4	99	0.0000	4.0700	7.9700	0.0320	0.0860
0	1	1	0	0.0270	0.8600	1.3600	0.0010	0.0180
0	1	2	1	0.9450	1.0400	1.4200	0.0060	0.0410
0	1	3	2	0.0000	1.2200	1.4800	0.0190	0.0440
0	1	4	99	0.0000	1.5000	1.7300	0.0320	0.0860
0	2	1	0	0.0270	1.9800	2.9500	0.0010	0.0180
0	2	2	1	0.9450	2.0600	2.9900	0.0060	0.0410
0	2	3	2	2.2950	2.1300	3.0300	0.0190	0.0440
0	2	4	99	0.0000	2.4400	3.1600	0.0320	0.0860
0	3	1	0	0.0270	2.2700	3.3900	0.0010	0.0180
0	3	2	1	1.1610	2.5900	3.4000	0.0060	0.0410
0	3	3	2	2.4300	2.9100	3.4100	0.0190	0.0440
0	3	4	99	0.0000	3.8600	4.2000	0.0320	0.0860
0	4	1	0	0.0270	2.7600	5.4100	0.0010	0.0180
0	4	2	1	1.1610	3.0900	5.6900	0.0060	0.0410
0	4	3	2	2.6100	3.4100	5.9700	0.0190	0.0440
0	4	4	99	0.0000	4.0700	7.7000	0.0320	0.0860

Appendix G:

Final 2018 iTRAM DCParams and NETPARAMS

KEY	NAME	FORMULA	VALUE	MIN	MAX	DOTSTAT	TAGAINST	TSIG
hbwaemp	HBW attraction - total emp		0.8500	0.9200	2.0000	1	0.00	--
hboah	HBO attraction - HH		0.2100	0.2000	2.0000	1	0.00	--
hboaA	HBO attraction - non retail		1.5000	0.1000	2.0000	1	0.00	--
hboaB	HBO attraction - non retail		1.5000	0.1000	2.0000	1	0.00	--
hboaC	HBO attraction - non retail		1.5000	0.5000	4.0000	1	0.00	--
hboaD	HBO attraction - non retail		1.5000	0.5000	4.0000	1	0.00	--
hboaE	HBO attraction -retail		2.1200	2.0000	15.0000	1	0.00	--
hboaF	HBO attraction - non retail		1.5000	0.5000	4.0000	1	0.00	--
xhbwr	No longer referenced in script		0.9200	0.5000	2.0000	1	0.00	--
xhbor	No longer referenced in script		1.1925	0.5000	2.0000	1	0.00	--
xhbwu	No longer referenced in script		1.4180	0.5000	2.0000	1	0.00	--
xhbou	No longer referenced in script		0.7434	0.5000	2.0000	1	0.00	--
xcasn	Casino HBO Attraction Adjustment Factor		0.7000	0.8000	1.2500	1	0.00	--
xhosp	Hospital HBO Attraction Adjustment Facto		0.7000	0.8000	1.2500	1	0.00	--
xmall	Mall HBO Attraction Adjustment Factor		0.7000	0.8000	1.2500	1	0.00	--
xuniv	University HBO Attraction Adjustment Fac		0.7000	0.8000	1.2500	1	0.00	--
lngwA	LNGW Attraction Rate * EMPA		0.0070	0.0000	0.1000	1	0.00	--
lngwB	LNGW Attraction Rate * EMPB		0.0176	0.0000	0.1000	1	0.00	--
lngwC	LNGW Attraction Rate * EMPC		0.0076	0.0000	0.1000	1	0.00	--
lngwD	LNGW Attraction Rate * EMPD		0.0106	0.0000	0.1000	1	0.00	--
lngwE	LNGW Attraction Rate * EMPE		0.0019	0.0000	0.1000	1	0.00	--
lngwF	LNGW Attraction Rate * EMPF		0.0029	0.0000	0.1000	1	0.00	--
lngnwh	LNGNW Attraction Rate * HH		0.0196	0.0000	0.0100	1	0.00	--
lngnwC	LNGNW Attraction Rate * EMPC		0.0284	0.0000	0.0100	1	0.00	--
lngnwD	LNGNW Attraction Rate * EMPD		0.0147	0.0000	0.0100	1	0.00	--
lngnwE	LNGNW Attraction Rate * EMPE		0.0078	0.0000	0.0100	1	0.00	--
lngnwF	LNGNW Attraction Rate * EMPF		0.0005	0.0000	0.0100	1	0.00	--
lngnwU	LNGNW Attraction Rate * UNIV		0.0323	0.0000	0.0100	1	0.00	--
lngnwair	LNGNW Attraction Rate * AIRP		0.0039	0.0000	0.0100	1	0.00	--
lngnwcasn	LNGNW Attraction Rate * CASN		0.0078	0.0000	0.0100	1	0.00	--
lngnwhosp	LNGNW Attraction Rate * HOSP		0.0039	0.0000	0.0100	1	0.00	--
lngnwmall	LNGNW Attraction Rate * MALL		0.0078	0.0000	0.0100	1	0.00	--
InHomeActs	in Home Acts	HH	4.2019	0.0000	5.0000	1	0.00	--
WorkActs	Work Acts	EMP	1.4649	0.0000	5.0000	1	0.00	--
SchlActs	School Acts	SCHL	1.5431	0.0000	25.0000	1	0.00	--
ShopActs	Shop Acts	RET	4.1425	0.0000	5.0000	1	0.00	--
OthrActs	Other Acts	SRVC	0.0032	0.0000	5.0000	1	0.00	--
nearret	NEARATT	RET	3.4111	0.0000	3.0000	0	0.00	--
nearsrv	NEARATT	SRV	2.7404	0.0000	5.0000	0	0.00	--
othrhh	OTHRATT	HH	0.2605	0.0000	1.0000	0	0.00	--
othrret	OTHRATT	RET	1.0000	0.0000	3.0000	0	0.00	--
othrosv	OTHRATT	SVC	0.2720	0.0000	1.0000	0	0.00	--
genaccdecay	Parameter Deactivated		-0.3969	-0.7500	-0.1000	1	0.00	--
nearaccdecay	Parameter Deactivated		-0.5000	-0.7500	-0.1000	1	0.00	--
othaccdecay	Parameter Deactivated		-0.3825	-0.7500	-0.1000	1	0.00	--
empaccdecay	Parameter Deactivated		-0.3184	-0.7500	-0.1000	1	0.00	--
retaccdecay	Parameter Deactivated		-0.1800	-0.7500	-0.1000	1	0.00	--
hbwae	HBW Access to Emp		0.0646	-5.0000	5.0000	1	0.00	--
hboaccd	HBO Access to Retail and service employm		0.3298	0.0000	2.0000	1	0.00	--
hbwai	HBW Impedance		-0.1500	-0.0400	0.0000	1	0.00	--
hbwriv	HBW River Xing		-0.1000	-4.0000	0.0000	1	0.00	--
hbwrrx	HBW RRD Xing		-0.2220	-0.5000	0.0000	1	0.00	--

hbwfwy	HBW Interstate Xing	-0.0250	-2.0000	0.0000	1	0.00	--
hbwira	HBW Intervening Rural Area	-0.2500	-2.0000	0.0000	1	0.00	--
hbwitz	HBW Intrazonal Constant	1.0000	-4.0000	4.0000	1	0.00	--
hboai	HBO Impedance	-0.1500	-0.0600	0.0000	1	0.00	--
hboriv	HBO River Xing	-0.6000	-4.0000	0.0000	1	0.00	--
hborrx	HBO RRD Xing	0.0000	-0.7000	0.0000	1	0.00	--
hbofwy	HBO Interstate Xing	-0.7000	-2.0000	0.0000	1	0.00	--
hboira	HBO Intervening Rural Area	-0.5000	-2.0000	0.0000	1	0.00	--
hboitz	HBO Intrazonal Constant	1.5000	-4.0000	4.0000	1	0.00	--
nhbow	NHB Weight on HBO relative to HBW	0.8872	0.1000	0.9000	1	0.50	--
nhbad	NHB Access to retail and service	0.5106	0.0000	2.0000	1	0.00	--
nhbi	NHB Impedance	-0.1000	-1.0000	0.0000	1	0.00	--
nhbriv	NHB River Xing	-0.4000	-4.0000	0.0000	1	0.00	--
nhbrrx	NHB RRD Xing	0.0000	-0.5000	0.0000	1	0.00	--
nhbfwy	NHB Interstate Xing	-0.2000	-2.0000	0.0000	1	0.00	--
nhbira	NHB Intervening Rural Area	-1.1000	-2.0000	0.0000	1	0.00	--
nhbitz	NHB Intrazonal Constant	1.2000	-4.0000	4.0000	1	0.00	--
lngwi	LNGW Impedance	-0.0100	-1.0000	0.0000	1	0.00	--
lngwriv	LNGW River Xing	-0.6000	-4.0000	0.0000	1	0.00	--
lngnwi	LNGNW Impedance	-0.0100	-1.0000	0.0000	1	0.00	--
lngnwriv	LNGNW River Xing	-0.3000	-4.0000	0.0000	1	0.00	--
hboak12	HBO attraction - school enrollment	0.5300	--	--	--	--	--
hbwrc	HBW accessibility to retail	0.0000	--	--	--	--	--
hbwrh	HBW accessibility to retail, service, hh	0.0000	--	--	--	--	--
hborc	HBW accessibility to retail	0.0000	--	--	--	--	--
hborh	HBW accessibility to retail, service, hh	0.0000	--	--	--	--	--
nhbrc	HBW accessibility to retail	0.0000	--	--	--	--	--
nhbrh	HBW accessibility to retail, service, hh	0.0000	--	--	--	--	--
hbwrg	HBW accessibility to emp and HH	0.0000	--	--	--	--	--
hborg	HBO accessibility to emp and HH	0.0000	--	--	--	--	--
nhbrg	NHB accessibility to emp and HH	0.0000	--	--	--	--	--

TransCAD (Licensed to Metro Analytics)

File Edit Map Dataview Selection Matrix Tools Procedures Planning Window Help

All Records

Dataview1 - netparams_v11

KEY	NAME	VALUE	MIN	MAX
CLTP	Car Left Turn Penalty	0.6500	0.0500	1.5000
CRTP	Car Right Turn Penalty	0.0150	0.0000	0.5000
TPCE	Truck Passenger Car Equivalency	2.5000	1.5000	3.0000
CFCP7	Car Functional Class 7 (Ramp) Penalty	0.9200	0.0000	2.0000
CFCP5	Car Functional Class 5 Penalty	0.0001	0.0000	1.0000
CFCP4	Car Functional Class 4 Penalty	1.0000	0.0000	1.0000
CFCP3	Car Functional Class 3 Penalty	1.0000	0.0000	1.0000
CFCP1	Car Functional Class 1 Penalty	0.6700	0.0000	1.0000
TFCP7	Truck Lower Functional Class 7 (Ramp) Penalty	0.5500	0.0000	1.0000
TFCP5	Truck Lower Functional Class 5 Penalty	0.2000	0.0000	50.0000
TFCP4	Truck Lower Functional Class 4 Penalty	0.0500	0.0000	1.0000
TFCP3	Truck Lower Functional Class 3 Penalty	0.5000	0.0000	1.0000
TFCP1	Truck Lower Functional Class 1 Penalty	0.4500	0.0000	1.0000
CFCP2	Car Functional Class 2 Penalty	0.5700	0.0000	1.0000
TFCP2	Truck Lower Functional Class 2 Penalty	0.4000	0.0000	1.0000