# A FREIGHT FLOW MODEL AND FORECAST FOR THE TULSA TMA

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## 1.0 INTRODUCTION

This report documents the Freight Flow Model and Freight Flow Forecasts for the Tulsa TMA, Oklahoma. The Freight Flow Model and its reasonably reliable forecasts will be an asset for Tulsa TMA long-term transportation planning. As the second largest city in Oklahoma, Tulsa's economy and growth will continue to rely on the efficient movement of freight into, from, through, and within its five-county region.

### 1.1 Research Tasks

a) *Data collection*: Data collection from secondary sources related to inter-state, intra-state freight movement that has an impact on the Tulsa Transportation Management Area for the base year 2000 (or most recently available data.).
b) *Forecast Comparison*: Compilation of forecasts for the state and the region in year 2030.
c) *Mathematical Model*: Development of regional mathematical model that fits the historical freight movement through the region.
d) *Analysis of O and D*: Origin (O) and Destination (D) by mode of travel for the freight movement through the Tulsa Region, including inter-modal freight relationship such as rail-to-truck and barge-to-truck flows.
*Model Validation*: Validation of the model with INCOG data.

### 1.2 Expected Results

a) Development of a multimodal, multi-commodity, regional freight model.
b) Data synthesis for combining federal, state, local and private databases to provide the required input set. The detailed data is expected to point out congestion and capacity problems, and identify needed freight improvements.
c) Use of GIS-based analysis tools in freight modeling and data analysis.
d) Incorporation of results in TRANPLAN/TP+ software package for the distribution and assignment steps and use of a geographic information system for the analysis of results.
e) Provide insight to the nature of freight transportation that would be useful to generate the policy recommendations desired of a freight planning model.
f) Ability of the model to forecast the effect of changes in demand or other variables on freight transportation and the impact of network changes, including inter-modal freight flows between the major modes, such as rail-to-truck and barge-to-truck.
g) Provide a well organized plan for the validation process and high quality data for the validation.
h) Development of a plan for continuously collecting necessary data and comparing them to model output, and if necessary adjusting model parameters or base data.

### 1.3 Research Team

The team consists of Dr. Shen, who has six years of research and consulting experience in transportation, Geographical Information Systems (GIS), and spatial analysis. His Ph.D. dissertation in 1998 was on hub location and network design; and Dr. Pulat, who brings 23 years of research experience in network modeling, analysis, and optimization. She has developed several algorithms to determine the best flow pattern across a given network. Recently, Dr. Pulat worked with an HVAC service parts distributor to study their part distribution network and determine the trade-off between cost and level of service as a function of the network structure and the number of distribution centers.

The research team also has several graduate research assistants (Natraj, Yasin, and Sandip, Monica) from Industrial Engineering and Regional and City Planning at the University of Oklahoma.

### 1.4 Structure of the Report

This report is organized into several major parts. The first part is the executive summary, which summarizes the major issues and results of the study. The second part is the main body of the report, which contains the methodology, data, and results. The third part provides appendices on detailed methodologies, models, and computer software (i.e., TransCAD) procedures. Conclusions are provided at the end of the report, followed by references.

## 2.0 FREIGHT FLOWS IN, OUT, THROUGH, AND WITHIN OKLAHOMA

The focus of this study is to estimate freight flows in, out, through, and within Tulsa TMA for the base-year and future-year. The freight flows are estimated or forecasted using the 4-step modeling process and by mode and commodity groups.

### 2.1 The Freight Flow Model

The most direct and relevant literature with respect to freight flow movement is in the transportation engineering and planning literature. Most transportation planning models were developed for aggregated regional and urban passenger travel demand analyses by government planning agencies for the purpose of providing efficient transportation infrastructure and effective policies. The commonly used demand modeling process involves sequential or combined trip generation, distribution, mode split, and assignment. Detailed models for each step in the process were also developed accounting for geographic, socio-economic, and physical disparities ([2], [3]).

The past two decades have seen an increasing number of reports and publications on using conventional urban transportation models to regional and local freight flow movement modeling. The basic notion is that freight flow results from other social, economic, and demographic factors. The Quick Response Freight Manual [5] gives a detailed description of freight characteristics affected by direct and indirect factors. NCHRP Report 388 [4] contains an extensive review of the existing literature on freight transportation demand, freight flow factors, and freight modeling processes. The most popular approach to freight movement is analogy to the four-step urban transportation planning model, which involves trip generation, distribution, mode-split and assignment. The primary purpose of our freight flow model is to generate incoming, outgoing, within, and through freight movements by commodity, by mode, by route for Tulsa TMA from the perspective of the United States. Such a 4-step modeling process is summarized in Figure 2.1:

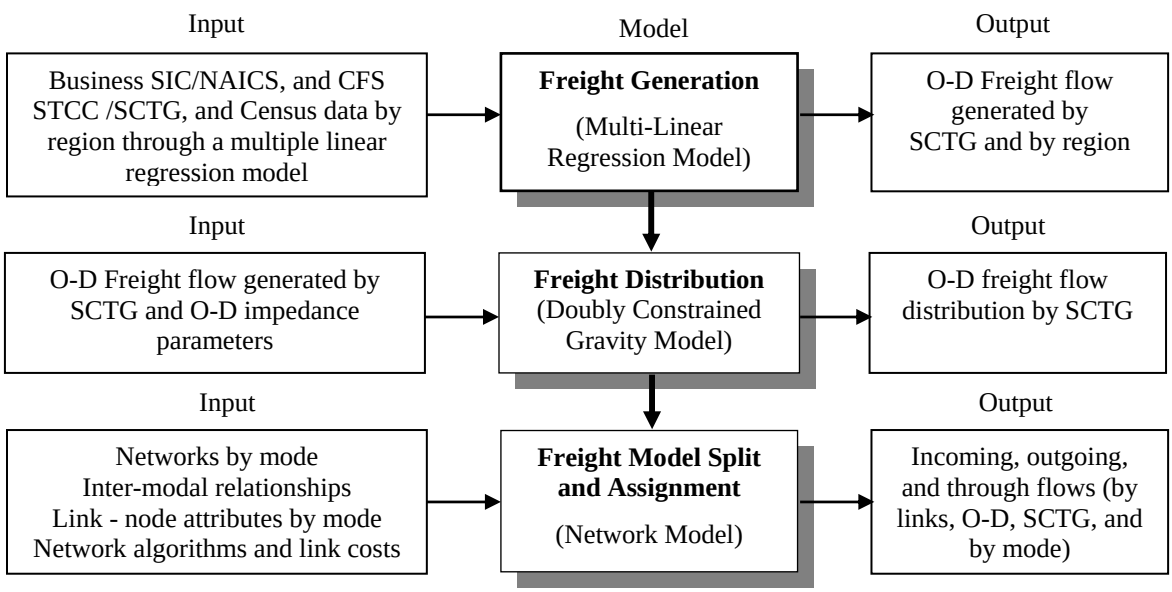



Figure 2.1: Freight Flow Model and Modeling Process

The above modeling was performed twice, one at the state-level involving all 52 states/regions (Oklahoma was split into two: Tulsa TMA region and the rest of Oklahoma). For each state, production and attraction from regression results are split into two: out-state and in-state components. The out-state results were used to predict freight distribution and assignment at the state level for “to”, “from”, and “through” flows.

2.1.1 Freight Generation by Regression Model. Freight generation, including freight flow production and attraction by commodity and/or mode, is the process of using relevant and important factors to forecast freight flows produced from and attracted to a region. Generally, historical freight information, such as freight flows of a base-year, must be available to predict freight flow for a future-year.

Many techniques exist for freight generation. One technique is to use a simple growth-factor model, in which one assumes a growth factor to each commodity group and calculates the cumulative flow matrix accordingly. The most popular technique is linear regression, which establishes the relationship between a dependent variable and a set of independent variables [3]. In forecasting freight flow production, independent variables may include economic and business factors, such as industry employment, number of establishment, payroll, and revenue, etc. In estimating freight flow attraction, independent variables, such as population, household income, capital expenditure, floor space, etc. are logical contributing factors. Commonly used dependent variables include tonnage, value, and ton-mile.

In this project, we started with many independent variables, but through multiple regression analysis decided to use employment as the key independent variables in production and attraction regressions and in the subsequent forecasts.

However, regression can also be performed for total freight by aggregating independent variable data at a commodity level. The aggregated production and attraction results can then be split into 2, 3, or more commodities or commodity groups based on SCTG codes by using base-year commodity group freight ratios. In fact, this freight project started with regression analysis on total freight, which was then split into freight for commodity groups by using the base-year commodity group ratios, which are assumed relatively constant over time.

We experimented with numerous independent variables. The final model at the state level takes employment and population as the major variables. At the traffic analysis zone (TAZ) level within Tulsa TMA, the model also considers dwelling units, population, and sub-categories of employment. The INCOG 1995 truck data was also used in partitioning production and attraction to TAZs.

2.1.2 Freight Distribution by Gravity Model. Freight distribution takes on the production and attraction from the regression model and distribute using a doubly constrained gravity model with primarily inverse distance function. The distance matrices are based on centroid (state centroids or TAZ centroids). The results of freight distribution provide “from” and “to” flows from one state to another or from one TAZ to another.

2.1.3 Mode Split. The mode split process specifies the portions of flows from one state (or TAZ) to another by available modes. In this student, we consider 4 major modes: highway, rail, water, and air. The mode split rates were obtained from Bureau of Transportation Statistics (BTS) 1998 freight data. When mode split rates are multiplied by distributed flows, we obtain "from" and "to" flows by mode.

2.1.4 Freight Assignment using Network Model. This step assign O-D flows from one state (or TAZ) to another through transportation networks of different modes.

## 2.2 Commodity Groups

There are 43 categories of commodities based on SCTG in CFS. Forecasting single commodity raises many issues about forecasting accuracy, data requirement, and complexity, particularly at the metro level. Forecasting aggregated commodity groups provides reasonable forecast accuracy for Tulsa region (see the Validation section). The 2-digit SCTG codes provide the base for the level of commodity grouping needed. Table 2.2.1 shows the case for Oklahoma in commodity groupings.

Table 2.2.1: Commodity Groups Using 1997 CFS: Oklahoma as An Example

| SCTG | Commodity Groups | Production Tons (000) | SCTG | Commodity Groups | Attraction Tons (000) |
|---|---|---|---|---|---|
| 01-09 | Food | 11016 | 01-09 | Food | 16544 |
| 10-19 | Mining | 45059 | 10-19 | Mining | 65697 |
| 20-23 | Chemicals | 5301 | 20-23 | Chemicals | 4057 |
| 24-43 | Manufactured | 30320 | 24-43 | Manufactured | 29723 |
| | Others | 29708 | | Other | 27421 |
| | Total | 121404 | | Total | 143442 |

The 43 commodities and their2-digit SCTG codes are provided in Table 2.2.2.

Table 2.2.2: Commodity Groups and SCTG and Descriptions

| Commodity Group | SCTG | Commodity type |
|---|---|---|
| Group 1: Food and Consumables | 01 | Live animals and live fish |
| | 02 | Cereal grains |
| | 03 | Other agricultural products |
| | 04 | Animal feed and products of animal origin, n.e.c. |
| | 05 | Meat, fish, seafood, and their preparations |
| | 06 | Milled grain products and preparations, and bakery products |
| | 07 | Other prepared foodstuffs and fats and oils |
| | 08 | Alcoholic beverages |
| | 09 | Tobacco products |
| Group 2: Mining Products | 10 | Monumental or building stone |
| | 11 | Natural sands |
| | 12 | Gravel and crushed stone |
| | 13 | Nonmetallic minerals n.e.c. |
| | 15 | Coal |
| | 17 | Gasoline and aviation turbine fuel |
| | 18 | Fuel oils |
| | 19 | Coal and petroleum products, n.e.c. |
| Group 3: Chemicals Products | 20 | Basic chemicals |
| | 21 | Pharmaceutical products |
| | 22 | Fertilizers |
| | 23 | Chemical products and preparations, n.e.c. |
| Group 4: Manufactured Products | 24 | Plastics and rubber |
| | 25 | Logs and other wood in rough |
| | 26 | Wood products |
| | 27 | Pulp, newsprint, paper, and paperboard |
| | 28 | Paper or paperboard articles |
| | 29 | Printed products |
| | 30 | Textiles, leather, and articles of textiles or leather |
| | 31 | Nonmetallic mineral products |
| | 32 | Base metal in primary or semifinished forms and in finished shapes |
| | 33 | Articles of base metal |
| | 34 | Machinery |
| | 35 | Electronic and other electrical equip and comp and office equip |
| | 36 | Motorized and other vehicles (including parts) |
| | 37 | Transportation equipment, n.e.c. |
| | 38 | Precision instruments and apparatus |
| | 39 | Furniture, mattresses & mattress supports, lamps, lighting fittings |
| | 40 | Miscellaneous manufactured products |
| | 41 | Waste and scrap |
| | 42 | Mixed freight |

## 2.3 The Base and Forecast Years

Many relevant databases were found to have different base years and dates of completion. For example, Commodity Flow Survey (CFS) was collected for years 1993, 1997, 2002. The economic census was collected for 1992, 1997, 2002. The population census is collected for 1990 and 2000. County Business Flow Pattern is reported annually by the BTS. INCOG has some data for 1995. We decided to use 2000 as the base year to forecast freight for the future-year 2030. However, available databases for 1995 and 1997 were used when 2000 data bases are not available.

The production and attraction results (hence the distribution, assignment, and other flows) documented in this report have lower, middle (average), upper bounds for the year

2030, while only the middle year results are reported for the base-year. The middle results for the base year are based on actual CFS data, while the middle results for the 2030 are the regression estimated results. The upper and lower bound production and attraction results are generated using +/-one-standard deviation from their regression estimated results. The upper and lower bound flows (in, out, through, within) are corresponding to the upper and lower bound production and attraction.

Other than the above 4 commodity groups, there is the group "Other", which was defined as the difference between the total commodity for a region and the missing data in the above four categories. In CFS, there are quite few missing data for the SCTG 01-43 due to confidentiality or error of margin in survey. Hence, we have a total of five commodity groups including the "Other" category.

## 2.4 Breakdown Oklahoma into Tulsa and Oklahoma Other

For each state, production and attraction from regression results are split into two: out-state and in-state components.

Oklahoma was broken down into Oklahoma Other (OKCO) and Tulsa TMA, which covers 5-county region, including Tulsa, Roger, Creek Osage, and Wagoner counties. Tulsa's production and attraction from regression results are split into two: out-Tulsa and in-Tulsa components. Tulsa TMA in-state component was then partitioned and distributed among TAZs and assigned to the Tulsa network, which is primarily the highway network. Figure 2.4.1 shows the splits of state-level model results into Tulsa TAZ level results.

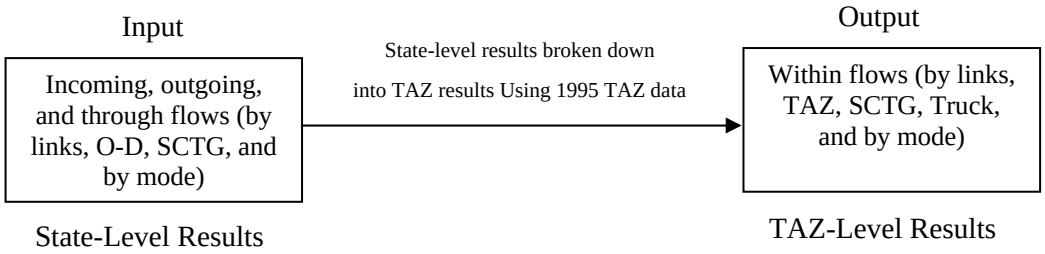



Figure 2.4.1: Within Freight Flow Calculation Process

### 2.4.1 Breakdown of Production

Total Oklahoma production is split into OKCO and Tulsa TMA according to their employment shares. Table 2.4.1 shows the employment values and corresponding percentages for OKCO and Tulsa TMA.

Table 2.4.1: Employment Values and Shares with respect to Tulsa and OKCO for Regression Analysis

| | TOTAL Employment 1997 Breakdown | |
|---|---|---|
| | Employment 97 | Emp Percentage |
| OKCO | 834523 | 74% |
| Tulsa TMA | 293211 | 26% |
| OK | 1127734 | |

Table 2.4.2 shows the production values split into OKCO and Tulsa TMA. Production shares of OKCO and Tulsa have been calculated by multiplying their corresponding employment percentages with total Oklahoma production.

Table 2.4.2: Production Flow Calculation Table for Tulsa and OKCO

| OKLAHOMA PRODUCTION SPLIT TABLE | | |
|---|---|---|
| | Production 97 | Production 97 |
| OK | 121404000 | 121404000 |
| OKCO | = 74%*121404000 | 89839000 |
| Tulsa TMA | = 26%*121404000 | 31565000 |

### 2.4.2 Breakdown of Attraction

Table 2.4.3 contains the required data to perform regression analysis to obtain regression coefficients for population and employment percentages (independent variables). Regression coefficients of population and employment percentages are then used to breakdown state total attraction value (dependent variable), obtained from 1997 CFS, into Tulsa TMA and OKCO.

Table 2.4.3: Regression Input Table in order to split OK's Attraction

| ATTRACTION SPLITTING REGRESSION INPUT TABLE | | | | | | |
|---|---|---|---|---|---|---|
| STATE | TotalCFSAj97 | Pop97 | Emp97Total | TotalCFSOi97 | Pop% | Emp% |
| Alabama | 253122 | 4367935 | 1591179 | 256234 | 1.60% | 1.51% |
| Alaska | 20571 | 612968 | 188923 | 19673 | 0.22% | 0.18% |
| Arizona | 145476 | 4736990 | 1701357 | 121647 | 1.74% | 1.62% |
| Arkansas | 159934 | 2601090 | 925498 | 162735 | 0.95% | 0.88% |
| California | 823934 | 32486010 | 11565015 | 778805 | 11.92% | 10.98% |
| Colorado | 123979 | 4018293 | 1675514 | 127429 | 1.47% | 1.59% |
| Connecticut | 52579 | 3349348 | 1471970 | 47158 | 1.23% | 1.40% |
| Delaware | 32535 | 751487 | 348009 | 24149 | 0.28% | 0.33% |
| District of Columbia | 7103 | 567736 | 396328 | 3244 | 0.21% | 0.38% |
| Florida | 465063 | 15186304 | 5550307 | 397287 | 5.57% | 5.27% |
| Georgia | 433317 | 7685099 | 3106872 | 373554 | 2.82% | 2.95% |
| Hawaii | 23932 | 1211640 | 426129 | 22290 | 0.44% | 0.40% |
| Idaho | 45566 | 1228520 | 404670 | 47764 | 0.45% | 0.38% |
| Illinois | 648294 | 12185715 | 5089899 | 670949 | 4.47% | 4.83% |
| Indiana | 375506 | 5955267 | 2487609 | 338332 | 2.18% | 2.36% |
| Iowa | 212460 | 2891119 | 1179660 | 218894 | 1.06% | 1.12% |
| Kansas | 113467 | 2635292 | 1049359 | 141428 | 0.97% | 1.00% |
| Kentucky | 283128 | 3952747 | 1422605 | 363393 | 1.45% | 1.35% |
| Louisiana | 458557 | 4421071 | 1531663 | 507887 | 1.62% | 1.45% |
| Maine | 49655 | 1254774 | 447063 | 44607 | 0.46% | 0.42% |
| Maryland | 151427 | 5157328 | 1906880 | 126667 | 1.89% | 1.81% |
| Massachusetts | 104611 | 6226058 | 2859594 | 90866 | 2.28% | 2.72% |
| Michigan | 388841 | 9809051 | 3844460 | 382277 | 3.60% | 3.65% |
| Minnesota | 226619 | 4763390 | 2195621 | 279607 | 1.75% | 2.09% |
| Mississippi | 148086 | 2777004 | 909746 | 121577 | 1.02% | 0.86% |
| Missouri | 224096 | 5481193 | 2281643 | 187537 | 2.01% | 2.17% |
| Montana | 47343 | 889865 | 273746 | 95778 | 0.33% | 0.26% |
| Nebraska | 107313 | 1686418 | 701132 | 120354 | 0.62% | 0.67% |
| Nevada | 39629 | 1764104 | 768708 | 24727 | 0.65% | 0.73% |
| New Hampshire | 30988 | 1189425 | 497878 | 40586 | 0.44% | 0.47% |
| New Jersey | 230991 | 8218808 | 3300923 | 223902 | 3.01% | 3.13% |
| New Mexico | 44910 | 1774839 | 533858 | 61653 | 0.65% | 0.51% |
| New York | 327231 | 18656546 | 6895924 | 281014 | 6.84% | 6.55% |
| North Carolina | 315052 | 7656825 | 3167303 | 280915 | 2.81% | 3.01% |
| North Dakota | 69247 | 649716 | 242047 | 87831 | 0.24% | 0.23% |
| Ohio | 528418 | 11277357 | 4709180 | 510450 | 4.14% | 4.47% |
| Oklahoma | 143442 | 3372917 | 1127734 | 121404 | 1.24% | 1.07% |
| Oregon | 182618 | 3304310 | 1292579 | 165754 | 1.21% | 1.23% |
| Pennsylvania | 553646 | 12227814 | 4840877 | 548166 | 4.48% | 4.60% |
| Rhode Island | 20541 | 1025353 | 390914 | 22669 | 0.38% | 0.37% |
| South Carolina | 139732 | 3859696 | 1473831 | 115922 | 1.42% | 1.40% |
| South Dakota | 33586 | 744223 | 279187 | 36853 | 0.27% | 0.27% |
| Tennessee | 267550 | 5499233 | 2247944 | 208604 | 2.02% | 2.13% |
| Texas | 968235 | 19740317 | 7250925 | 913505 | 7.24% | 6.89% |
| Utah | 87709 | 2119784 | 824120 | 96429 | 0.78% | 0.78% |
| Vermont | 15656 | 597239 | 232476 | 10455 | 0.22% | 0.22% |
| Virginia | 263495 | 6829183 | 2626844 | 254798 | 2.50% | 2.49% |
| Washington | 269922 | 5674747 | 2081017 | 264047 | 2.08% | 1.98% |
| West Virginia | 110049 | 1819113 | 542782 | 233760 | 0.67% | 0.52% |
| Wisconsin | 275424 | 5266213 | 2277849 | 238700 | 1.93% | 2.16% |
| Wyoming | 45148 | 489451 | 161772 | 275466 | 0.18% | 0.15% |

Table 2.4.4: Population and Employment Coefficients for Regression Analysis

| | Coefficients |
|---|---|
| **Intercept** | 38777.69196 |
| **Pop%** | -7123852.527 |
| **Emp%** | 16235923.24 |

Table 2.4.5: Population & Employment Shares for Tulsa and OKCO for regression analysis

| TOTAL Employment 1997 Breakdown | | | | OK Population 1997 Breakdown | | |
|---|---|---|---|---|---|---|
| | **Employment 97** | **Emp. Percentage** | | | **Population1997** | **Population%** |
| **OKCO** | 834523160 | 74% | | **OKCO** | 2651927000 | 79% |
| **Tulsa TMA** | 293210840 | 26% | | **Tulsa TMA** | 720990000 | 21% |
| **OK** | **1127734000** | | | **OK** | **3372917000** | |

In order to be able to find the attraction shares of Tulsa and OKCO, the weighted percentage values have been calculated using regression coefficients as seen in the following tables.

Table 2.4.6: Attraction Flow Percentages Calculation Table for Tulsa and OKC Other

| TOTAL ATTRACTION (TO) FLOW PERCENTAGES BREAKDOWN TABLE 1997 | |
|---|---|
| | Attraction Percentage |
| OK | 100% |
| OKCO | A = (Intercept+Coefficient Pop%*79%+Coefficient Emp%*74%)/(CoefficientPop%+CoefficientEmp%) |
| Tulsa TMA | B = (Intercept+Coefficient Pop%*21%+Coefficient Emp%*26%)/(CoefficientPop%+CoefficientEmp%) |

Using the weighted percentage method, the corresponding percentages are multiplied with the total attraction value of Oklahoma.

Table 2.4.7: Attraction Flow Calculation Table for Tulsa and OKC Other

| TOTAL ATTRACTION(TO) FLOW BREAKDOWN TABLE | | |
|---|---|---|
| | Attraction97 | Attraction97 |
| OK | 143442000 | 143442000 |
| OKCO | = A*143.442.000 | 100350969 |
| Tulsa TMA | = B*143.442.000 | 43091031 |

Table 2.4.8: Tulsa TMA's Attraction and Production Values for 1997 and 2030

| | INSTATE PRODUCTION AND ATTRACTION VALUES OF TULSA | | | | | |
|---|---|---|---|---|---|---|
| | Instate Chemicals | Instate Food | Instate Mining | Instate Manu. | Instate Others | Instate Total |
| Instate 97 Oi | 716607 | 1044609 | 5621411 | 6258220 | 8146632 | 21787480000 |
| Instate 97 Aj | 514525 | 1429383 | 8403437 | 4946897 | 9879293 | 25173535200 |
| Instate 2030 Oi | 1341815 | 1955985 | 10525848 | 11718245 | 15254214 | 40796107454 |
| Instate 2030 Aj | 652779 | 1813460 | 10661448 | 6276133 | 12533869 | 31937688354 |

## 3.0 DATA SOURCES AND ISSUES

Various forms of inputs required for the models described in the previous section come from a wide range of publicly available databases. This section of the report includes a classification of the databases used thus far and a description of the application of the data contained in these databases at the appropriate places in the multi-step modeling approach.

### 3.1 Classification of Databases

Based on the nature of the databases and their application, the databases are classified into three categories. The schematic representation is shown in Figure 3.1.1.

Commodity Flow: These types of databases quantify/describe the flow of commodities based on various attributes like origin, destination, mode, reliability, weight, dollar value, distance shipped, etc.

Auxiliary Databases: These types of databases quantify the factors that are either responsible for the generation of freight flow or are affected by the change in freight flow. They cover areas of economy like businesses, manufacturing, trading which may contribute to the flow of freight and include demographic data like population, income and other socio-economic factors.

Network Databases: These types of databases contain geographic network of routes by different modes of transportation and also quantify attributes such travel time and distance.

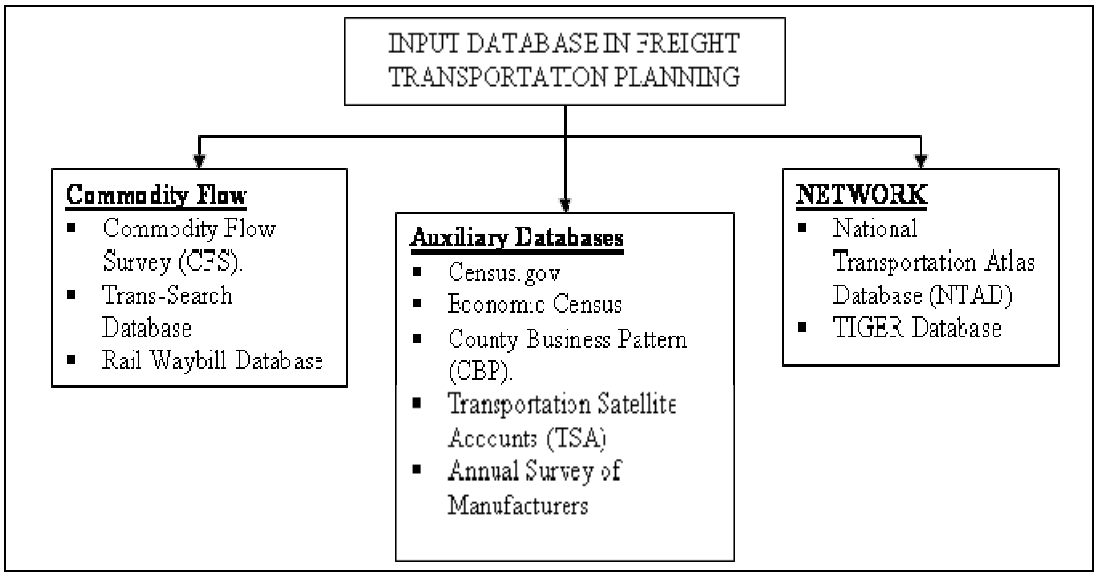



Figure 3.1.1: Classification of Databases

There are many public/commercial databases falling in the above-mentioned three categories. In the next section, the nature of the data needed within the regional freight model is described. A schematic diagram relating the modeling steps to data sources is shown in Figure 3.1.2.

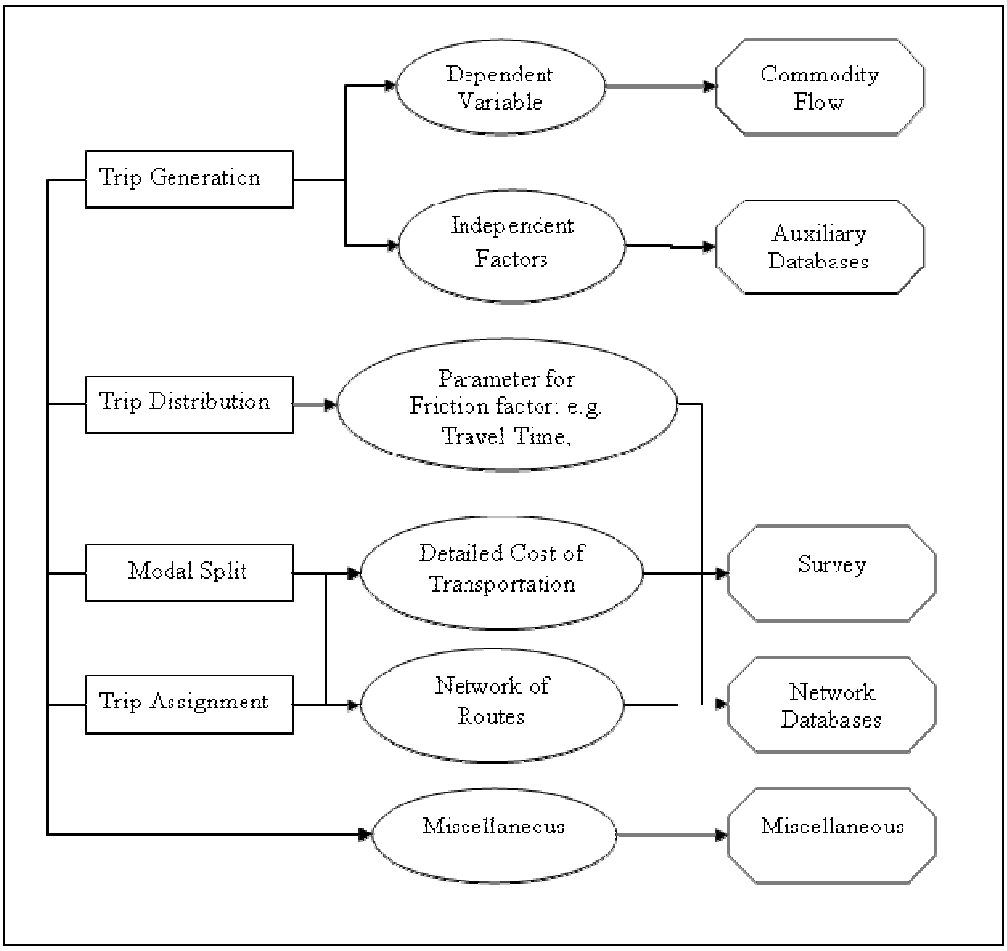



Figure 3.1.2: Data Requirements at Different Stages

## 3.2 Key Databases

### 3.2.1 Commodity Flow Survey (1997)

The Commodity Flow Survey is a sample of shipments from approximately 100,000 domestic establishments randomly selected from a universe of about 800,000 establishments engaged in mining, manufacturing, wholesale, auxiliary establishments (warehouses) of multi-establishment companies, and some selected activities in retail and

service [6]. For the 1997 CFS, each selected establishment reported a sample of about 25 outbound shipments for a one-week period in each of four calendar quarters in 1997. This produced a total sample of over 5 million shipments. For each sampled 1997 CFS shipment, zip code of origin and destination, 5-digit Standard Classification of Transported Goods (SCTG) code, weight, value, and modes of transport, have been provided. The 1997 CFS coverage of inter-modal freight movement is more than that of 1997 due to needs of changing business scenarios.

### 3.2.2 Socio Economic Demographics

The U.S. Census Bureau's Economic Census- 1997 [1] is the major source for economic indicator variables used in the model formulation. The data is collected on establishment basis. The reports and data are classified using the North American Industry Classification System (NAICS) codes that are being adopted by Canada and Mexico. The 1997 Economic Census does not cover agricultural industry for it is partially covered by U.S. Department of Agriculture. The 20 NAICS sectors are subdivided into 96 sub sectors (three-digit codes), 313 industry groups (four-digit codes), and, as implemented in the United States, 1170 industries (five- and six-digit codes). The details are available at National, State, Economic Region, and County Level.

The social demographic data is obtained from Population Census 1990 conducted once in 10 years by the U.S. Census Bureau. The census provides estimates of population for the year 1997 based on 1990 data. Data for disposable income, median house hold income and gross income are obtained as estimates from the Census archives.

### 3.2.3 Network Databases

Quite a few databases covering the entire USA are available for freight modeling. Some specific databases have information for Mexico and Canada. The most useful and comprehensive databases are National Transportation Atlas Database (NTAD) developed by Bureau of Transportation Statistics (BTS), North American Transportation Atlas Database (NORTAD), and the Oak Ridge Transportation Network by Oak Ridge National Lab.

National Transportation Atlas Database (NTAD). NTAD is updated annually by BTS. It contains a set of national geographic databases of transportation facilities. These databases include geospatial information for transportation modal networks and inter-modal terminals, and related attribute information. Included are the descriptions of the file formats and database metadata as prescribed by the Federal Geographic Data Committee (FGDC) [7].

Files can be downloaded from the BTS website. These files can also be read into GIS software (i.e., ArcView GIS). The Table 3.2.3 lists relevant files and networks.

Table 3.2.3: List of networks & relevant files available from BTS

| Data Type | Description |
|---|---|
| Polygon Layers | County Boundaries<br>Federally Adjusted Urbanized Areas<br>State Boundaries |
| Point Layers | Air ports<br>Amtrak Stations<br>National Highway Planning Network Nodes<br>Inter-Modal Terminals<br>Railway Nodes (1:100,000 and 1:2,000,000 base scale)<br>U.S. Army Corps of Engineers Ports<br>U.S. Army Corps of Engineers Navigable Waterway Nodes |
| Poly-line Layers | Railway Network (1:2,000,000 base scale)<br>Runways Associated with Public Use Airports<br>Fixed Guide-way Transit Network<br>National Highway Planning Network<br>Railway Network (1:100,000 base scale)<br>U.S. Corps of Engineers Navigable Waterway Network |

## 4.0 SOFTWARE USED IN MODELING

### 4.1 TransCAD

The major software packaged used in this project is TransCAD of Caliper Corporation in Cambridge, MA (Caliper Corp., 2004). This package was used in trip distribution for “from” and “to” flows based on centroid distances; shortest path for “through” flows based on real network distances; and trip assignment using all-or-nothing process for total flows. Each of these flows is studied using TransCAD at the state level and TAZ level.

### 4.2 ArcView GIS

The ArcView GIS was used to process geographical files, such as state and TAZ boundaries, networks, and state and TAZ centroids. ArcView GIS was also used to produce linkages for tables, which are from different sources and with different formats.

### 4.3 Microsoft Office

This includes Microsoft Excel, Access, PowerPoint, and Word in processing data from TransCAD and ArcView GIS and for presentation and report writing.

### 4.4 Sharing of Results and Databases

The databases and results from TransCAD, ArcView GIS, and Microsoft Excel and Access can be saved or converted into specific formats for sharing with other transportation and database programs at INCOG. Common formats may be .SHP, .DBF, .TXT, or .XLS files. Extensive results and databases have been saved in the above formats.

# 5.0 FREIGHT GENERATION METHODOLOGY, DATA, AND RESULTS

## 5.1 Freight Production Methodology

Freight generation includes freight production and attraction. Freight production concerns the total freight origins from state or TAZ. The freight production is generally considered as a function of factors such as employment, establishment and is estimated using linear regression. The detailed regression formulation can be seen in Appendix 1.

Notice that for the base year, we directly used 1997 CFS data at the state level. Oklahoma's production was broken down into Tulsa TMA and Oklahoma Other using employment percentage. The freight production for the forecast year 2030 was estimated using 2030 state employment, and establishments based on the regression in Appendix 1 to fit1997 state-level CFS to employment and establishments.

## 5.2 Freight Production Data

For the base year, the 1997 CFS was directly used for the dependent variable data.

The independent variables include 1997 employment and establishments. Then employment and establishment data for the period of 1988-2004 were used to project 2030 employment and establishment, which were put into the regression from the base year to predict 2030 production.

To break down production by commodity groups, the 1997 CFS at the state level was used. Table 5.2.1 shows the break-down percentages for all state by commodity groups.

Table 5.2.1: Commodity Group Percentage Using 1997 CFS

| State | Chem Oi | Chem Aj | Food Oi | Food Aj | Mining Oi | Mining Aj | Manu Oi | Manu Aj | Oth Oi | Oth Aj |
|---|---|---|---|---|---|---|---|---|---|---|
| AL | 4.35% | 3.58% | 6.31% | 7.83% | 35.53% | 42.57% | 42.74% | 37.26% | 11.07% | 8.75% |
| AK | 0.10% | 1.11% | 2.85% | 4.75% | 52.92% | 48.15% | 2.84% | 12.40% | 41.30% | 33.60% |
| AZ | 4.55% | 5.19% | 6.99% | 8.77% | 32.86% | 36.49% | 24.80% | 26.10% | 30.80% | 23.45% |
| AR | 3.11% | 4.32% | 17.01% | 20.05% | 21.04% | 27.15% | 34.07% | 25.81% | 24.77% | 22.68% |
| CA | 1.78% | 4.36% | 13.87% | 14.46% | 52.58% | 50.89% | 28.66% | 29.65% | 3.11% | 0.65% |
| CO | 0.99% | 2.51% | 19.89% | 19.02% | 51.14% | 50.38% | 20.89% | 27.91% | 7.08% | 0.18% |
| CT | 2.47% | 2.13% | 7.18% | 10.24% | 47.51% | 53.32% | 27.50% | 31.41% | 15.33% | 2.89% |
| DE | 12.56% | 4.24% | 16.82% | 17.83% | 0.88% | 20.97% | 7.69% | 14.39% | 62.07% | 42.58% |
| DC | 3.97% | 4.12% | 14.04% | 13.63% | 42.03% | 43.86% | 24.59% | 24.81% | 15.37% | 13.58% |
| FL | 15.88% | 13.85% | 9.35% | 9.05% | 39.56% | 47.67% | 25.20% | 28.89% | 10.02% | 0.54% |
| GA | 3.76% | 3.40% | 8.31% | 9.88% | 51.40% | 52.68% | 28.69% | 33.35% | 7.84% | 0.68% |
| HI | 0.59% | 0.92% | 8.48% | 10.73% | 76.13% | 71.08% | 13.44% | 16.51% | 1.36% | 0.78% |
| ID | 6.85% | 6.64% | 23.49% | 16.06% | 25.58% | 31.42% | 20.80% | 21.56% | 23.29% | 24.33% |
| IL | 3.47% | 4.21% | 22.30% | 17.10% | 35.51% | 35.52% | 12.64% | 15.23% | 26.08% | 27.94% |
| IN | 3.50% | 4.16% | 13.66% | 8.53% | 53.41% | 64.87% | 28.99% | 22.11% | 0.44% | 0.33% |
| IA | 2.63% | 3.59% | 47.71% | 33.99% | 31.07% | 44.86% | 15.94% | 17.19% | 2.65% | 0.37% |
| KS | 7.85% | 5.54% | 44.04% | 36.63% | 33.36% | 38.15% | 14.06% | 19.43% | 0.68% | 0.25% |
| KY | 1.45% | 2.41% | 5.42% | 6.26% | 78.58% | 71.22% | 12.60% | 18.61% | 1.95% | 1.50% |
| LA | 14.47% | 8.45% | 13.06% | 33.15% | 50.88% | 41.66% | 9.22% | 14.05% | 12.38% | 2.69% |
| ME | 1.81% | 1.59% | 3.46% | 5.27% | 15.74% | 16.36% | 32.73% | 22.92% | 46.27% | 53.86% |
| MD | 2.16% | 2.29% | 10.78% | 10.03% | 30.26% | 41.88% | 29.70% | 28.44% | 27.10% | 17.37% |
| MA | 1.85% | 2.40% | 9.99% | 14.97% | 44.90% | 44.32% | 28.23% | 36.62% | 15.04% | 1.68% |
| MI | 2.41% | 5.05% | 8.04% | 8.23% | 47.82% | 48.10% | 37.34% | 34.50% | 4.39% | 4.12% |
| MN | 1.45% | 2.69% | 28.08% | 26.10% | 46.20% | 47.19% | 19.42% | 22.48% | 4.86% | 1.53% |
| MS | 4.79% | 5.27% | 8.43% | 8.84% | 28.51% | 41.38% | 54.45% | 41.94% | 3.82% | 2.58% |
| MO | 6.00% | 5.04% | 26.43% | 19.21% | 39.52% | 51.25% | 25.08% | 23.91% | 2.98% | 0.59% |
| MT | 1.32% | 3.03% | 6.56% | 5.76% | 72.18% | 49.00% | 7.17% | 15.56% | 12.77% | 26.65% |
| NE | 3.53% | 4.74% | 53.37% | 35.90% | 21.34% | 37.98% | 13.04% | 18.02% | 8.71% | 3.36% |
| NV | 3.62% | 4.09% | 9.27% | 9.88% | 28.88% | 34.52% | 53.16% | 44.62% | 5.07% | 6.90% |
| NH | 0.14% | 1.36% | 5.07% | 6.77% | 10.20% | 13.12% | 41.81% | 16.48% | 42.79% | 62.27% |
| NJ | 4.07% | 4.69% | 8.49% | 11.28% | 49.95% | 49.32% | 23.32% | 23.22% | 14.17% | 11.49% |
| NM | 13.81% | 9.94% | 2.53% | 8.47% | 67.35% | 53.44% | 13.16% | 23.45% | 3.14% | 4.71% |
| NY | 2.85% | 3.03% | 15.81% | 14.64% | 53.90% | 55.79% | 24.60% | 24.99% | 2.85% | 1.56% |
| NC | 4.44% | 5.97% | 11.78% | 14.88% | 42.98% | 44.12% | 39.90% | 34.41% | 0.90% | 0.62% |
| ND | 0.55% | 1.31% | 40.02% | 16.38% | 50.41% | 63.63% | 4.75% | 9.33% | 4.27% | 9.34% |
| OH | 3.75% | 3.06% | 14.90% | 10.11% | 43.87% | 53.19% | 29.60% | 27.13% | 7.87% | 6.51% |
| OKCO | 4.74% | 3.17% | 10.58% | 14.05% | 41.09% | 51.13% | 20.77% | 20.94% | 22.82% | 10.71% |
| OR | 1.12% | 4.90% | 18.94% | 22.37% | 18.94% | 23.37% | 51.35% | 43.89% | 9.65% | 5.47% |
| PA | 1.52% | 2.18% | 7.24% | 8.53% | 57.10% | 59.46% | 26.35% | 24.46% | 7.79% | 5.37% |
| RI | 1.17% | 1.80% | 10.44% | 6.54% | 15.55% | 13.19% | 8.44% | 15.18% | 64.41% | 63.29% |
| SC | 6.07% | 7.83% | 7.31% | 8.90% | 34.93% | 30.79% | 50.65% | 40.64% | 1.03% | 11.83% |
| SD | 0.23% | 3.92% | 13.97% | 20.19% | 5.10% | 6.94% | 12.26% | 15.96% | 68.44% | 52.99% |
| TN | 3.00% | 3.95% | 11.21% | 10.70% | 43.59% | 53.26% | 34.56% | 27.49% | 7.64% | 4.61% |
| TX | 11.79% | 10.37% | 9.91% | 10.95% | 52.66% | 51.89% | 22.24% | 23.40% | 3.41% | 3.40% |
| UT | 3.29% | 2.04% | 4.79% | 5.68% | 25.80% | 33.38% | 28.72% | 19.65% | 37.39% | 39.24% |
| Tulsa TMA | 3.24% | 3.94% | 4.35% | 7.21% | 33.70% | 28.20% | 15.59% | 21.94% | 43.13% | 38.71% |
| VT | 2.50% | 1.28% | 20.73% | 15.68% | 42.53% | 32.22% | 22.35% | 31.06% | 11.89% | 19.76% |
| VA | 2.03% | 3.31% | 8.66% | 8.96% | 60.72% | 57.92% | 27.40% | 28.55% | 1.19% | 1.26% |
| WA | 3.20% | 3.11% | 21.73% | 26.51% | 28.98% | 27.35% | 41.37% | 40.55% | 4.72% | 2.48% |
| WV | 2.61% | 5.14% | 0.47% | 3.27% | 84.96% | 72.08% | 10.52% | 18.86% | 1.44% | 0.65% |
| WI | 2.58% | 3.08% | 15.58% | 12.74% | 41.22% | 49.78% | 32.61% | 27.36% | 8.02% | 7.04% |
| WY | 4.49% | 4.11% | 0.20% | 1.92% | 92.76% | 73.25% | 0.70% | 5.88% | 1.86% | 14.83% |

## 5.3. Freight Production Results

Table 5.3.1 Base Year Total Production by Commodity Group (CFS 1997, ‘000s)

| State | ChemCFSOi | FoodCFSOi | MiningCFSOi | ManuCFSOi | OthCFSOi | TotalCFSOi97 |
|---|---|---|---|---|---|---|
| AL | 11146 | 16164 | 91044 | 109503 | 28377 | 256234 |
| AK | 19 | 560 | 10410 | 559 | 8125 | 19673 |
| AZ | 5537 | 8503 | 39972 | 30173 | 37462 | 121647 |
| AR | 5063 | 27679 | 34243 | 55442 | 40308 | 162735 |
| CA | 13851 | 107991 | 409526 | 223218 | 24219 | 778805 |
| CO | 1262 | 25351 | 65166 | 26624 | 9026 | 127429 |
| CT | 1164 | 3386 | 22407 | 12970 | 7231 | 47158 |
| DE | 3032 | 4061 | 212 | 1856 | 14988 | 24149 |
| DC | 1963 | 6939 | 20780 | 12157 | 7600 | 49439 |
| FL | 63074 | 37134 | 157147 | 100108 | 39824 | 397287 |
| GA | 14040 | 31040 | 192018 | 107183 | 29273 | 373554 |
| HI | 132 | 1890 | 16970 | 2995 | 303 | 22290 |
| ID | 3270 | 11220 | 12216 | 9933 | 11125 | 47764 |
| IL | 23268 | 149638 | 238273 | 84819 | 174951 | 670949 |
| IN | 11841 | 46203 | 180699 | 98099 | 1490 | 338332 |
| IA | 5763 | 104430 | 68004 | 34896 | 5801 | 218894 |
| KS | 11107 | 62288 | 47182 | 19889 | 962 | 141428 |
| KY | 5271 | 19697 | 285554 | 45799 | 7072 | 363393 |
| LA | 73492 | 66317 | 258400 | 46807 | 62871 | 507887 |
| ME | 807 | 1542 | 7022 | 14598 | 20638 | 44607 |
| MD | 2734 | 13657 | 38324 | 37625 | 34327 | 126667 |
| MA | 1679 | 9073 | 40800 | 25648 | 13666 | 90866 |
| MI | 9198 | 30742 | 182823 | 142742 | 16772 | 382277 |
| MN | 4063 | 78503 | 129168 | 54292 | 13581 | 279607 |
| MS | 5827 | 10245 | 34660 | 66203 | 4642 | 121577 |
| MO | 11246 | 49565 | 74110 | 47036 | 5580 | 187537 |
| MT | 1267 | 6279 | 69134 | 6869 | 12229 | 95778 |
| NE | 4243 | 64238 | 25688 | 15699 | 10486 | 120354 |
| NV | 894 | 2292 | 7141 | 13146 | 1254 | 24727 |
| NH | 56 | 2057 | 4141 | 16967 | 17365 | 40586 |
| NJ | 9107 | 19017 | 111837 | 52220 | 31721 | 223902 |
| NM | 8517 | 1561 | 41524 | 8113 | 1938 | 61653 |
| NY | 7999 | 44416 | 151474 | 69129 | 7996 | 281014 |
| NC | 12471 | 33083 | 120747 | 112089 | 2525 | 280915 |
| ND | 483 | 35151 | 44273 | 4170 | 3754 | 87831 |
| OH | 19141 | 76081 | 223948 | 151090 | 40190 | 510450 |
| OKCO | 4263 | 9503 | 36915 | 18657 | 20501 | 89839 |

| | | | | | | |
|---|---|---|---|---|---|---|
| OR | 1852 | 31398 | 31396 | 85115 | 15993 | 165754 |
| PA | 8351 | 39666 | 312997 | 144451 | 42701 | 548166 |
| RI | 265 | 2367 | 3524 | 1913 | 14600 | 22669 |
| SC | 7040 | 8470 | 40497 | 58717 | 1198 | 115922 |
| SD | 83 | 5149 | 1881 | 4519 | 25221 | 36853 |
| TN | 6249 | 23385 | 90940 | 72090 | 15940 | 208604 |
| TX | 107672 | 90519 | 481043 | 203126 | 31145 | 913505 |
| Tulsa TMA | 1038 | 1513 | 8144 | 9067 | 11803 | 31565 |
| UT | 3126 | 4190 | 32492 | 15032 | 41589 | 96429 |
| VT | 261 | 2167 | 4446 | 2337 | 1244 | 10455 |
| VA | 5170 | 22059 | 154702 | 69825 | 3042 | 254798 |
| WA | 8446 | 57382 | 76511 | 109238 | 12470 | 264047 |
| WV | 6098 | 1110 | 198594 | 24603 | 3355 | 233760 |
| WI | 6154 | 37193 | 98383 | 77835 | 19135 | 238700 |
| WY | 12358 | 542 | 255519 | 1924 | 5123 | 275466 |

Table 5.3.2 Base Year Out-State Production by Commodity Group (CFS 1997, ‘000s)

| State | ChemCFSOi | FoodCFSOi | MiningCFSOi | ManuCFSOi | OthCFSOi | TotalCFSOi97 | InstProdPer |
|---|---|---|---|---|---|---|---|
| AL | 3539 | 5132 | 28905 | 34765 | 9009 | 81350 | 0.68 |
| AK | 2 | 63 | 1177 | 63 | 919 | 2225 | 0.89 |
| AZ | 786 | 1207 | 5673 | 4282 | 5317 | 17265 | 0.86 |
| AR | 2058 | 11249 | 13917 | 22532 | 16382 | 66138 | 0.59 |
| CA | 1217 | 9488 | 35982 | 19612 | 2128 | 68427 | 0.91 |
| CO | 384 | 7708 | 19813 | 8095 | 2744 | 38744 | 0.70 |
| CT | 474 | 1380 | 9132 | 5286 | 2947 | 19219 | 0.59 |
| DE | 1696 | 2271 | 118 | 1038 | 8383 | 13507 | 0.44 |
| DC | 901 | 3187 | 9544 | 5584 | 3491 | 22708 | 0.54 |
| FL | 9102 | 5359 | 22677 | 14446 | 5747 | 57330 | 0.86 |
| GA | 3368 | 7446 | 46060 | 25710 | 7022 | 89605 | 0.76 |
| HI | 1 | 18 | 166 | 29 | 3 | 218 | 0.99 |
| ID | 962 | 3299 | 3592 | 2921 | 3272 | 14046 | 0.71 |
| IL | 7324 | 47102 | 75002 | 26699 | 55070 | 211198 | 0.69 |
| IN | 4142 | 16162 | 63208 | 34315 | 521 | 118348 | 0.65 |
| IA | 1924 | 34862 | 22702 | 11649 | 1937 | 73074 | 0.67 |
| KS | 5499 | 30837 | 23358 | 9846 | 476 | 70016 | 0.50 |
| KY | 2416 | 9027 | 130867 | 20989 | 3241 | 166540 | 0.54 |
| LA | 28600 | 25807 | 100557 | 18215 | 24466 | 197645 | 0.61 |
| ME | 203 | 389 | 1770 | 3680 | 5203 | 11245 | 0.75 |
| MD | 902 | 4506 | 12645 | 12414 | 11326 | 41794 | 0.67 |
| MA | 457 | 2470 | 11109 | 6983 | 3721 | 24741 | 0.73 |
| MI | 2506 | 8375 | 49809 | 38889 | 4569 | 104149 | 0.73 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| MN | 1905 | 36806 | 60561 | 25455 | 6367 | 131094 | 0.53 |
| MS | 2349 | 4131 | 13975 | 26693 | 1872 | 49020 | 0.60 |
| MO | 4566 | 20125 | 30091 | 19098 | 2266 | 76146 | 0.59 |
| MT | 752 | 3725 | 41016 | 4075 | 7255 | 56823 | 0.41 |
| NE | 1707 | 25843 | 10334 | 6316 | 4219 | 48419 | 0.60 |
| NV | 266 | 682 | 2126 | 3914 | 373 | 7362 | 0.70 |
| NH | 30 | 1096 | 2206 | 9038 | 9250 | 21619 | 0.47 |
| NJ | 2984 | 6230 | 36639 | 17108 | 10392 | 73353 | 0.67 |
| NM | 3758 | 689 | 18320 | 3579 | 855 | 27200 | 0.56 |
| NY | 1803 | 10011 | 34141 | 15581 | 1802 | 63338 | 0.77 |
| NC | 3165 | 8396 | 30645 | 28448 | 641 | 71296 | 0.75 |
| ND | 181 | 13208 | 16635 | 1567 | 1411 | 33002 | 0.62 |
| OH | 6493 | 25809 | 75970 | 51255 | 13634 | 173161 | 0.66 |
| OKCO | 1320 | 2944 | 11435 | 5779 | 6351 | 27828 | 0.69 |
| OR | 456 | 7725 | 7724 | 20941 | 3935 | 40780 | 0.75 |
| PA | 2191 | 10409 | 82137 | 37907 | 11206 | 143851 | 0.74 |
| RI | 70 | 630 | 937 | 509 | 3884 | 6031 | 0.73 |
| SC | 2479 | 2982 | 14258 | 20673 | 422 | 40814 | 0.65 |
| SD | 38 | 2327 | 850 | 2043 | 11400 | 16658 | 0.55 |
| TN | 2196 | 8220 | 31965 | 25339 | 5603 | 73323 | 0.65 |
| TX | 17415 | 14641 | 77806 | 32854 | 5038 | 147754 | 0.84 |
| Tulsa TMA | 322 | 469 | 2523 | 2808 | 3656 | 9778 | 0.69 |
| UT | 943 | 1264 | 9798 | 4533 | 12542 | 29079 | 0.70 |
| VT | 98 | 810 | 1663 | 874 | 465 | 3910 | 0.63 |
| VA | 1713 | 7310 | 51267 | 23139 | 1008 | 84438 | 0.67 |
| WA | 1900 | 12906 | 17209 | 24570 | 2805 | 59390 | 0.78 |
| WV | 4370 | 795 | 142311 | 17630 | 2404 | 167511 | 0.28 |
| WI | 1671 | 10096 | 26706 | 21129 | 5194 | 64796 | 0.73 |
| WY | 10684 | 469 | 220900 | 1663 | 4429 | 238144 | 0.14 |

Table 5.3.3 Year 2030 Total Production by Lower, Middle, and Upper Bounds, ‘000s

| | LOWER | MIDDLE | UPPER |
|---|---|---|---|
| State | CFSOi2030 | CFSOi2030 | CFSOi2030 |
| AL | 173300 | 256893 | 340487 |
| AK | 37938 | 87877 | 137817 |
| AZ | 223285 | 319306 | 415327 |
| AR | 112197 | 180599 | 249001 |
| CA | 1191113 | 1527754 | 1864396 |
| CO | 200292 | 290596 | 380901 |
| CT | 137333 | 211984 | 286636 |
| DE | 54388 | 108418 | 162448 |

| | | | |
|---|---|---|---|
| DC | 51238 | 104484 | 157731 |
| FL | 670992 | 878321 | 1085651 |
| GA | 370941 | 503672 | 636403 |
| HI | 58651 | 113741 | 168831 |
| ID | 61757 | 117619 | 173480 |
| IL | 451674 | 604477 | 757280 |
| IN | 249732 | 352328 | 454924 |
| IA | 125570 | 197297 | 269023 |
| KS | 117085 | 186703 | 256320 |
| KY | 156763 | 236245 | 315728 |
| LA | 142387 | 218295 | 294202 |
| ME | 61153 | 116864 | 172576 |
| MD | 210282 | 303070 | 395858 |
| MA | 266235 | 372934 | 479633 |
| MI | 361978 | 492480 | 622983 |
| MN | 241252 | 341740 | 442228 |
| MS | 105353 | 172054 | 238755 |
| MO | 226664 | 323525 | 420386 |
| MT | 42756 | 93894 | 145032 |
| NE | 86174 | 148107 | 210039 |
| NV | 116476 | 185942 | 255408 |
| NH | 69508 | 127296 | 185085 |
| NJ | 317569 | 437031 | 556493 |
| NM | 71565 | 129866 | 188166 |
| NY | 564272 | 745069 | 925866 |
| NC | 347352 | 474219 | 601085 |
| ND | 40390 | 90940 | 141489 |
| OH | 426411 | 572932 | 719454 |
| OKCO | 76664 | 123091 | 169518 |
| OR | 147526 | 224712 | 301898 |
| PA | 417316 | 561577 | 705838 |
| RI | 48067 | 100525 | 152983 |
| SC | 169056 | 251594 | 334132 |
| SD | 47531 | 99856 | 152181 |
| TN | 269906 | 377518 | 485130 |
| TX | 743356 | 968676 | 1193997 |
| Tulsa TMA | 36811 | 59104 | 81397 |
| UT | 112456 | 180922 | 249388 |
| VT | 40811 | 91466 | 142120 |
| VA | 305285 | 421693 | 538101 |
| WA | 246322 | 348071 | 449819 |
| WV | 57906 | 112810 | 167714 |
| WI | 236611 | 335945 | 435279 |
| WY | 29992 | 77956 | 125920 |

To obtain production by commodity groups and for in-state and out-state portions, Table 5.3.3 can be multiplied by Table 5.2.1 and Table 5.3.2 using relevant columns (in-state, out-of-state, and commodity split percentages).

## 5.4 Freight Attraction Methodology

Freight attraction concerns the total freight destinations to state or TAZ. The freight attraction is generally considered as a function of factors such as population, business spending, etc. and is estimated using linear regression. In this research, we treated freight attraction as a function of total population and total freight production. The detailed regression formulation can be seen in Appendix 1.

Notice that for the base year, we directly used 1997 CFS data at the state level. Oklahoma's attraction was broken down into Tulsa TMA and Oklahoma Other using population percentage. The freight attraction for the forecast year 2030 was estimated using 2030 state population and freight production based on the regression in Appendix 2 to fit 1997 state-level CFS to population and 1997 production.

## 5.5 Freight Attraction Data

For the base year, the 1997 CFS was directly used for the dependent variable data.

The independent variables include 1997 population and 1997 production. Then population data for the period of 1988-2004 were used to project 2030 population, which was put into the regression from the base year to predict 2030 attraction.

## 5.6 Freight Attraction Results

Table 5.6.1 Base Year Total Attraction by Commodity Group (CFS 1997 Origins, '000s)

| State | ChemCFSAj | FoodCFSAj | MiningCFSAj | ManufCFSAj | OthCFSAj | TotalCFSAj97 |
|---|---|---|---|---|---|---|
| AL | 9071 | 19823 | 107758 | 94319 | 22151 | 253122 |
| AK | 228 | 977 | 9904 | 2550 | 6912 | 20571 |
| AZ | 7543 | 12765 | 53088 | 37965 | 34115 | 145476 |
| AR | 6908 | 32070 | 43419 | 41271 | 36266 | 159934 |
| CA | 35954 | 119116 | 419265 | 244263 | 5336 | 823934 |
| CO | 3109 | 23582 | 62463 | 34608 | 217 | 123979 |
| CT | 1122 | 5382 | 28037 | 16517 | 1521 | 52579 |
| DE | 1379 | 5801 | 6822 | 4681 | 13852 | 32535 |

| | | | | | | |
|---|---|---|---|---|---|---|
| DC | 1030 | 3407 | 10965 | 6202 | 3395 | 24999 |
| FL | 64390 | 42102 | 221676 | 134367 | 2528 | 465063 |
| GA | 14731 | 42832 | 228281 | 144524 | 2949 | 433317 |
| HI | 219 | 2567 | 17010 | 3950 | 186 | 23932 |
| ID | 3025 | 7316 | 14317 | 9824 | 11084 | 45566 |
| IL | 27280 | 110845 | 230285 | 98744 | 181140 | 648294 |
| IN | 15639 | 32040 | 243591 | 83009 | 1227 | 375506 |
| IA | 7618 | 72221 | 95309 | 36524 | 788 | 212460 |
| KS | 6283 | 41568 | 43282 | 22047 | 287 | 113467 |
| KY | 6829 | 17725 | 201630 | 52703 | 4241 | 283128 |
| LA | 38765 | 152011 | 191035 | 64420 | 12326 | 458557 |
| ME | 790 | 2615 | 8126 | 11381 | 26743 | 49655 |
| MD | 3463 | 15190 | 63412 | 43061 | 26301 | 151427 |
| MA | 2513 | 15664 | 46367 | 38308 | 1759 | 104611 |
| MI | 19632 | 31992 | 187048 | 134144 | 16025 | 388841 |
| MN | 6099 | 59154 | 106950 | 50939 | 3477 | 226619 |
| MS | 7807 | 13084 | 61273 | 62103 | 3819 | 148086 |
| MO | 11293 | 43054 | 114855 | 53582 | 1312 | 224096 |
| MT | 1436 | 2727 | 23196 | 7365 | 12619 | 47343 |
| NE | 5083 | 38530 | 40759 | 19333 | 3608 | 107313 |
| NV | 1620 | 3916 | 13678 | 17682 | 2733 | 39629 |
| NH | 421 | 2097 | 4067 | 5106 | 19297 | 30988 |
| NJ | 10822 | 26052 | 113936 | 53636 | 26545 | 230991 |
| NM | 4463 | 3802 | 23998 | 10530 | 2117 | 44910 |
| NY | 9913 | 47904 | 182549 | 81765 | 5100 | 327231 |
| NC | 18822 | 46866 | 139000 | 108406 | 1958 | 315052 |
| ND | 910 | 11342 | 44060 | 6464 | 6471 | 69247 |
| OH | 16168 | 53422 | 281081 | 143346 | 34401 | 528418 |
| OKCO | 3176 | 14097 | 51312 | 21015 | 10750 | 100351 |
| OR | 8947 | 40845 | 42683 | 80151 | 9992 | 182618 |
| PA | 12096 | 47235 | 329179 | 135395 | 29741 | 553646 |
| RI | 370 | 1343 | 2709 | 3118 | 13001 | 20541 |
| SC | 10947 | 12438 | 43019 | 56794 | 16534 | 139732 |
| SD | 1316 | 6782 | 2331 | 5359 | 17798 | 33586 |
| TN | 10568 | 28622 | 142487 | 73537 | 12336 | 267550 |
| TX | 100386 | 106026 | 502405 | 226528 | 32890 | 968235 |
| Tulsa TMA | 881 | 2447 | 14385 | 8468 | 16911 | 43091 |
| UT | 3452 | 6322 | 24733 | 19246 | 33956 | 87709 |
| VT | 201 | 2455 | 5044 | 4863 | 3093 | 15656 |
| VA | 8713 | 23621 | 152606 | 75235 | 3320 | 263495 |
| WA | 8388 | 71563 | 73825 | 109463 | 6683 | 269922 |
| WV | 5656 | 3594 | 79324 | 20756 | 719 | 110049 |
| WI | 8496 | 35078 | 137100 | 75353 | 19397 | 275424 |
| WY | 1856 | 869 | 33072 | 2655 | 6696 | 45148 |

Table 5.6.2 Base Year Out-State Attraction by Commodity Group (CFS 1997, ‘000s)

| State | ChemCFSAj | FoodCFSAj | MiningCFSAj | ManufCFSAj | OthCFSAj | TotalCFSAj97 | InstAtrPer |
|---|---|---|---|---|---|---|---|
| AL | 2804 | 6127 | 33307 | 29153 | 6847 | 78238 | 0.69 |
| AK | 35 | 148 | 1504 | 387 | 1049 | 3123 | 0.85 |
| AZ | 2131 | 3606 | 14996 | 10724 | 9637 | 41094 | 0.72 |
| AR | 2736 | 12700 | 17195 | 16344 | 14362 | 63337 | 0.60 |
| CA | 4955 | 16417 | 57784 | 33665 | 735 | 113556 | 0.86 |
| CO | 885 | 6713 | 17782 | 9852 | 62 | 35294 | 0.72 |
| CT | 526 | 2522 | 13139 | 7740 | 713 | 24640 | 0.53 |
| DE | 507 | 2134 | 2510 | 1722 | 5096 | 11970 | 0.63 |
| DC | 776 | 2565 | 8258 | 4670 | 2557 | 18826 | 0.25 |
| FL | 17321 | 11326 | 59633 | 36146 | 680 | 125106 | 0.73 |
| GA | 5078 | 14765 | 78690 | 49819 | 1017 | 149368 | 0.66 |
| HI | 17 | 200 | 1322 | 307 | 14 | 1860 | 0.92 |
| ID | 787 | 1902 | 3723 | 2554 | 2882 | 11848 | 0.74 |
| IL | 7934 | 32237 | 66974 | 28718 | 52681 | 188543 | 0.71 |
| IN | 6477 | 13270 | 100887 | 34380 | 508 | 155522 | 0.59 |
| IA | 2389 | 22653 | 29895 | 11456 | 247 | 66640 | 0.69 |
| KS | 2329 | 15407 | 16042 | 8171 | 106 | 42055 | 0.63 |
| KY | 2081 | 5401 | 61441 | 16060 | 1292 | 86275 | 0.70 |
| LA | 12538 | 49166 | 61788 | 20836 | 3987 | 148315 | 0.68 |
| ME | 259 | 858 | 2666 | 3734 | 8775 | 16293 | 0.67 |
| MD | 1522 | 6676 | 27870 | 18926 | 11560 | 66554 | 0.56 |
| MA | 925 | 5763 | 17058 | 14093 | 647 | 38486 | 0.63 |
| MI | 5590 | 9109 | 53257 | 38194 | 4563 | 110713 | 0.72 |
| MN | 2102 | 20388 | 36861 | 17557 | 1198 | 78106 | 0.66 |
| MS | 3982 | 6673 | 31251 | 31675 | 1948 | 75529 | 0.49 |
| MO | 5680 | 21653 | 57764 | 26948 | 660 | 112705 | 0.50 |
| MT | 254 | 483 | 4110 | 1305 | 2236 | 8388 | 0.82 |
| NE | 1676 | 12702 | 13437 | 6374 | 1189 | 35378 | 0.67 |
| NV | 910 | 2200 | 7684 | 9934 | 1535 | 22264 | 0.44 |
| NH | 163 | 813 | 1578 | 1981 | 7486 | 12021 | 0.61 |
| NJ | 3769 | 9073 | 39678 | 18679 | 9244 | 80442 | 0.65 |
| NM | 1039 | 885 | 5588 | 2452 | 493 | 10457 | 0.77 |
| NY | 3319 | 16038 | 61116 | 27374 | 1707 | 109555 | 0.67 |
| NC | 6299 | 15684 | 46517 | 36278 | 655 | 105433 | 0.67 |
| ND | 189 | 2362 | 9174 | 1346 | 1347 | 14418 | 0.79 |
| OH | 5848 | 19323 | 101667 | 51848 | 12443 | 191129 | 0.64 |
| OKCO | 1321 | 5862 | 21336 | 8738 | 4470 | 41727 | 0.58 |
| OR | 2824 | 12893 | 13473 | 25300 | 3154 | 57644 | 0.68 |
| PA | 3263 | 12740 | 88787 | 36519 | 8022 | 149331 | 0.73 |
| RI | 124 | 451 | 909 | 1047 | 4364 | 6895 | 0.66 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SC | 5063 | 5752 | 19896 | 26266 | 7647 | 64624 | 0.54 |
| SD | 525 | 2704 | 929 | 2137 | 7096 | 13391 | 0.60 |
| TN | 5225 | 14150 | 70441 | 36355 | 6099 | 132269 | 0.51 |
| TX | 20993 | 22173 | 105066 | 47373 | 6878 | 202484 | 0.79 |
| Tulsa TMA | 366 | 1017 | 5981 | 3521 | 7032 | 17917 | 0.58 |
| UT | 801 | 1467 | 5741 | 4467 | 7882 | 20359 | 0.77 |
| VT | 117 | 1429 | 2935 | 2830 | 1800 | 9111 | 0.42 |
| VA | 3080 | 8349 | 53940 | 26593 | 1173 | 93135 | 0.65 |
| WA | 2028 | 17303 | 17850 | 26467 | 1616 | 65265 | 0.76 |
| WV | 2251 | 1430 | 31571 | 8261 | 286 | 43800 | 0.60 |
| WI | 3132 | 12930 | 50534 | 27775 | 7150 | 101520 | 0.63 |
| WY | 322 | 151 | 5733 | 460 | 1161 | 7826 | 0.83 |

Table 5.6.3 Year 2030 Total Attraction by Lower, Middle, and Upper Bound, ‘000s

| | LOWER | MIDDLE | UPPER |
|---|---|---|---|
| State | CFSAj2030 | CFSAj2030 | CFSAj2030 |
| AL | 191271 | 251150 | 311030 |
| AK | 46199 | 74227 | 102254 |
| AZ | 255712 | 335602 | 415492 |
| AR | 126560 | 172650 | 218739 |
| CA | 1309497 | 1629673 | 1949849 |
| CO | 223803 | 292768 | 361733 |
| CT | 151282 | 201603 | 251925 |
| DE | 62733 | 93799 | 124865 |
| DC | 58407 | 88011 | 117614 |
| FL | 736891 | 923161 | 1109432 |
| GA | 407843 | 517836 | 627829 |
| HI | 68233 | 101009 | 133785 |
| ID | 73802 | 109009 | 144217 |
| IL | 490264 | 616141 | 742018 |
| IN | 270922 | 347069 | 423217 |
| IA | 137828 | 184739 | 231650 |
| KS | 129786 | 175498 | 221210 |
| KY | 174148 | 230591 | 287034 |
| LA | 161088 | 215930 | 270772 |
| ME | 70438 | 103442 | 136445 |
| MD | 231786 | 301035 | 370284 |
| MA | 285407 | 363007 | 440607 |
| MI | 392445 | 495935 | 599424 |
| MN | 258495 | 330113 | 401731 |
| MS | 120360 | 165700 | 211039 |
| MO | 247156 | 318600 | 390045 |

| | | | |
|---|---|---|---|
| MT | 52147 | 81902 | 111658 |
| NE | 96156 | 134213 | 172270 |
| NV | 134470 | 184089 | 233708 |
| NH | 79118 | 113880 | 148641 |
| NJ | 346381 | 440582 | 534783 |
| NM | 85046 | 123116 | 161187 |
| NY | 622574 | 783775 | 944977 |
| NC | 381343 | 484862 | 588380 |
| ND | 47663 | 75384 | 103104 |
| OH | 455816 | 570154 | 684492 |
| OKCO | 90315 | 124931 | 159702 |
| OR | 165584 | 220868 | 276151 |
| PA | 450301 | 565711 | 681121 |
| RI | 57300 | 87896 | 118493 |
| SC | 187600 | 247146 | 306693 |
| SD | 55435 | 84926 | 114417 |
| TN | 291058 | 370824 | 450591 |
| TX | 836091 | 1055814 | 1275537 |
| Tulsa TMA | 40618 | 54670 | 68567 |
| UT | 127359 | 173904 | 220450 |
| VT | 48506 | 76622 | 104738 |
| VA | 331682 | 421829 | 511975 |
| WA | 272637 | 352056 | 431475 |
| WV | 69032 | 102845 | 136658 |
| WI | 254852 | 326387 | 397922 |
| WY | 37916 | 64251 | 90585 |

To obtain production by commodity groups and for in-state and out-state portions, Table 5.6.2 can be multiplied by Table 5.2.1 and Table 5.6.1 using relevant columns (in-state, out-of-state, and commodity group split percentages).

## 5.7 Validation of internal to internal freight flow for Tulsa TMA

We validated the tonnages by the four commodity groups predicted by the research team based on the comparison study with the truck counts recorded by INCOG (based on NCHRP estimations).

### 5.7.1 Methodology

To aggregate the predicted production and attraction tonnage for each of the four commodity groups and to compare "Aggregated freight tonnage (AFT)" vs. "INCOG truck count (ITC)" the following steps were followed:

- Classify the 504 TAZ's into 5 groups based on total employment
  - Group 1: Employment > 2000
  - Group 2: 1000 – 2000
  - Group 3: 500 – 1000
  - Group 4: 250 – 500
  - Group 5: < 250
- Perform regression analysis with AFT as independent variable and the ITC as the dependent variable for each of the five aforementioned TAZ groups. A high correlation between AFT and ITC will be signified by high R-square and ANOVA
- Compare the ITC with the predicted truck count obtained from the regression.

### 5.7.2 Results

The results observed indicate a strong correlation between AFT and ITC and thus validates the methodology employed for freight tonnage prediction. The summary of this result indicates high R-square values, which indicate the usefulness of using aggregated production and attraction in predicting truck tonnages or trucks. Details on AFT, ITC, regression analysis results on each commodity group are illustrated in a series of tables and figures in this section.

| TAZ group | R-square |
|---|---|
| Group 1 | 0.8918 |
| Group 2 | 0.932 |
| Group 3 | 0.9505 |
| Group 4 | 0.9201 |
| Group 5 | 0.9487 |

Table 5.7.1: Group 1: Employment greater than 2000

| ZONE | Total Employment | Agg Tonnage prediction | INCOGS truck count | Predicted | R-square |
|---|---|---|---|---|---|
| 82 | 12236 | 881703 | 3030 | 2853 | **0.8918** |
| 166 | 6649 | 583874 | 1298 | 1889 | |
| 13 | 5654 | 403467 | 1037 | 1305 | |
| 293 | 5317 | 438231 | 810 | 1418 | |
| 294 | 5053 | 360196 | 664 | 1165 | |
| 254 | 4854 | 346782 | 1952 | 1122 | |
| 12 | 4662 | 333548 | 858 | 1079 | |
| 282 | 4492 | 320432 | 1126 | 1037 | |
| 19 | 4229 | 301439 | 775 | 975 | |
| 246 | 3933 | 357266 | 1520 | 1156 | |
| 275 | 3883 | 463015 | 1206 | 1498 | |
| 17 | 3568 | 254359 | 654 | 823 | |
| 274 | 3552 | 388075 | 1018 | 1256 | |
| 257 | 3532 | 255520 | 1199 | 827 | |
| 289 | 3470 | 493521 | 1385 | 1597 | |
| 165 | 3442 | 314030 | 697 | 1016 | |
| 298 | 3434 | 244806 | 1972 | 792 | |
| 309 | 2906 | 388535 | 1117 | 1257 | |
| 295 | 2886 | 267749 | 488 | 866 | |
| 231 | 2854 | 203411 | 868 | 658 | |
| 284 | 2838 | 202274 | 410 | 654 | |
| 253 | 2754 | 328020 | 1371 | 1061 | |
| 465 | 2654 | 259765 | 941 | 840 | |
| 280 | 2653 | 190837 | 667 | 617 | |
| 176 | 2644 | 195188 | 1116 | 632 | |
| 18 | 2544 | 181403 | 466 | 587 | |
| 123 | 2471 | 185176 | 907 | 599 | |
| 297 | 2457 | 317318 | 1707 | 1027 | |
| 250 | 2387 | 274949 | 686 | 890 | |
| 457 | 2375 | 222046 | 761 | 718 | |
| 59 | 2346 | 169212 | 637 | 547 | |
| 263 | 2275 | 162168 | 570 | 525 | |
| 178 | 2258 | 263842 | 1323 | 854 | |
| 249 | 2202 | 230841 | 589 | 747 | |
| 228 | 2189 | 195561 | 739 | 633 | |
| 296 | 2157 | 297814 | 1470 | 964 | |
| 273 | 2102 | 373487 | 1074 | 1208 | |
| 197 | 2001 | 271538 | 945 | 879 | |

Table 5.7.2: Group 2: TAZ's with employment in range: 1000 – 2000

| ZONE | Total Employment | Agg Tonnage prediction | INCOGS truck count | Predicted | R-square |
|---|---|---|---|---|---|
| 279 | 1947 | 239014 | 829 | 808 | |
| 232 | 1940 | 140537 | 594 | 475 | |
| 25 | 1911 | 136239 | 350 | 461 | |
| 95 | 1838 | 142147 | 471 | 480 | |
| 174 | 1810 | 134491 | 766 | 455 | |
| 30 | 1806 | 135756 | 350 | 459 | |
| 278 | 1804 | 301079 | 1021 | 1018 | |
| 443 | 1758 | 150596 | 517 | 509 | |
| 23 | 1756 | 125170 | 322 | 423 | |
| 227 | 1752 | 160932 | 600 | 544 | |
| 147 | 1739 | 272076 | 964 | 920 | |
| 252 | 1737 | 139739 | 730 | 472 | |
| 182 | 1728 | 255637 | 734 | 864 | |
| 315 | 1725 | 213915 | 1165 | 723 | |
| 259 | 1710 | 137109 | 467 | 463 | |
| 251 | 1708 | 136720 | 716 | 462 | |
| 235 | 1669 | 209643 | 802 | 709 | |
| 97 | 1661 | 121012 | 490 | 409 | |
| 139 | 1650 | 161710 | 345 | 547 | |
| 248 | 1621 | 269935 | 771 | 912 | |
| 96 | 1601 | 114369 | 468 | 387 | |
| 114 | 1532 | 136945 | 494 | 463 | |
| 258 | 1529 | 184808 | 629 | 625 | |
| 244 | 1451 | 195856 | 726 | 662 | |
| 303 | 1416 | 200351 | 562 | 677 | |
| 260 | 1411 | 101375 | 356 | 343 | |
| 202 | 1400 | 99772 | 690 | 337 | |
| 146 | 1383 | 204507 | 768 | 691 | |
| 148 | 1383 | 156936 | 786 | 530 | |
| 140 | 1366 | 157839 | 330 | 534 | |
| 215 | 1360 | 291889 | 822 | 987 | |
| 106 | 1355 | 159866 | 540 | 540 | |
| 143 | 1305 | 111469 | 305 | 377 | **0.93** |
| 256 | 1304 | 201171 | 737 | 680 | |
| 216 | 1278 | 272309 | 1290 | 920 | |
| 351 | 1274 | 176387 | 490 | 596 | |
| 151 | 1266 | 156030 | 493 | 527 | |
| 320 | 1255 | 89461 | 379 | 302 | |
| 171 | 1253 | 90022 | 259 | 304 | |
| 159 | 1250 | 140406 | 342 | 475 | |
| 11 | 1226 | 87414 | 225 | 295 | |
| 196 | 1169 | 113247 | 372 | 383 | |
| 449 | 1150 | 132864 | 429 | 449 | |
| 90 | 1144 | 236241 | 545 | 799 | |
| 312 | 1120 | 176887 | 305 | 598 | |
| 365 | 1120 | 135474 | 317 | 458 | |
| 173 | 1119 | 88517 | 483 | 299 | |
| 16 | 1109 | 86588 | 224 | 293 | |
| 73 | 1088 | 88421 | 348 | 299 | |
| 110 | 1087 | 246881 | 698 | 835 | |
| 464 | 1082 | 108311 | 387 | 366 | |
| 376 | 1069 | 203606 | 957 | 688 | |
| 108 | 1062 | 211361 | 526 | 714 | |
| 198 | 1059 | 75512 | 374 | 255 | |
| 195 | 1057 | 75783 | 298 | 256 | |
| 261 | 1045 | 150463 | 455 | 509 | |
| 79 | 1042 | 79768 | 211 | 270 | |
| 152 | 1031 | 78964 | 324 | 267 | |
| 342 | 1031 | 236899 | 625 | 801 | |
| 411 | 1027 | 125375 | 369 | 424 | |
| 207 | 1024 | 191579 | 481 | 648 | |
| 333 | 1018 | 148459 | 604 | 502 | |
| 160 | 1011 | 83944 | 206 | 284 | |
| 311 | 1006 | 72700 | 255 | 246 | |
| 29 | 1005 | 71917 | 185 | 243 | |

Table 5.7.3: Group 3: TAZ's with employment in range: 500 – 1000

| ZONE | Total Employment | Agg Tonnage prediction | INCOGS truck count | Predicted | R-square |
|---|---|---|---|---|---|
| 167 | 998 | 156142 | 370 | 424 | |
| 326 | 998 | 121293 | 355 | 329 | |
| 220 | 991 | 149585 | 636 | 406 | |
| 142 | 989 | 149349 | 360 | 405 | |
| 314 | 982 | 232437 | 806 | 630 | |
| 446 | 968 | 73820 | 307 | 200 | |
| 209 | 965 | 260951 | 608 | 708 | |
| 313 | 964 | 246272 | 486 | 668 | |
| 208 | 959 | 110427 | 312 | 300 | |
| 210 | 935 | 201318 | 519 | 546 | |
| 107 | 934 | 110451 | 334 | 300 | |
| 229 | 928 | 89816 | 323 | 244 | |
| 81 | 925 | 85710 | 260 | 232 | |
| 224 | 908 | 151379 | 377 | 411 | |
| 245 | 901 | 262065 | 619 | 711 | |
| 119 | 893 | 145764 | 456 | 395 | |
| 26 | 890 | 88010 | 231 | 239 | |
| 281 | 889 | 65234 | 226 | 177 | |
| 233 | 886 | 217898 | 614 | 591 | |
| 325 | 885 | 132125 | 362 | 358 | |
| 461 | 883 | 79018 | 302 | 214 | |
| 109 | 876 | 212370 | 499 | 576 | |
| 491 | 856 | 116518 | 312 | 316 | |
| 57 | 853 | 182865 | 621 | 496 | **0.9505** |
| 93 | 853 | 137748 | 333 | 374 | |
| 204 | 851 | 112944 | 295 | 306 | |
| 211 | 844 | 114003 | 423 | 309 | |
| 336 | 831 | 219943 | 714 | 597 | |
| 28 | 806 | 58066 | 149 | 158 | |
| 120 | 806 | 77525 | 324 | 210 | |
| 129 | 793 | 168778 | 390 | 458 | |
| 170 | 786 | 167026 | 372 | 453 | |
| 345 | 785 | 165757 | 330 | 450 | |
| 24 | 780 | 55572 | 143 | 151 | |
| 306 | 767 | 78059 | 251 | 212 | |
| 21 | 753 | 53677 | 138 | 146 | |
| 149 | 737 | 122358 | 338 | 332 | |
| 168 | 735 | 84640 | 214 | 230 | |
| 299 | 730 | 108070 | 461 | 293 | |
| 324 | 730 | 98225 | 281 | 266 | |
| 332 | 726 | 97119 | 415 | 263 | |
| 302 | 723 | 54526 | 223 | 148 | |
| 177 | 719 | 185988 | 547 | 505 | |
| 277 | 718 | 115787 | 394 | 314 | |
| 398 | 716 | 52551 | 206 | 143 | |
| 500 | 714 | 123900 | 303 | 336 | |
| 337 | 710 | 69113 | 427 | 187 | |

continued on next page

| ZONE | Total Employment | Agg Tonnage prediction | INCOGS truck count | Predicted | R-square |
|---|---|---|---|---|---|
| 467 | 704 | 110264 | 313 | 299 | |
| 20 | 700 | 52064 | 134 | 141 | |
| 192 | 689 | 101123 | 377 | 274 | |
| 310 | 685 | 122457 | 286 | 332 | |
| 80 | 681 | 53991 | 141 | 146 | |
| 456 | 676 | 124103 | 301 | 337 | |
| 52 | 676 | 84837 | 407 | 230 | |
| 212 | 671 | 97483 | 347 | 264 | |
| 269 | 666 | 89007 | 300 | 241 | |
| 344 | 658 | 98948 | 218 | 268 | |
| 247 | 652 | 132626 | 352 | 360 | |
| 450 | 648 | 83434 | 254 | 226 | |
| 463 | 647 | 180707 | 449 | 490 | |
| 335 | 642 | 97029 | 249 | 263 | |
| 469 | 638 | 116497 | 352 | 316 | |
| 75 | 638 | 165789 | 284 | 450 | |
| 219 | 635 | 172652 | 583 | 468 | |
| 377 | 632 | 161978 | 498 | 439 | **0.9505** |
| 161 | 608 | 45183 | 111 | 123 | |
| 105 | 606 | 90205 | 272 | 245 | |
| 236 | 604 | 260037 | 568 | 705 | |
| 205 | 593 | 82556 | 213 | 224 | |
| 234 | 589 | 136890 | 373 | 371 | |
| 334 | 585 | 162442 | 298 | 441 | |
| 150 | 562 | 110687 | 285 | 300 | |
| 122 | 558 | 75759 | 260 | 205 | |
| 111 | 556 | 234789 | 525 | 637 | |
| 158 | 553 | 54777 | 134 | 149 | |
| 214 | 552 | 116761 | 347 | 317 | |
| 144 | 542 | 101483 | 231 | 275 | |
| 102 | 524 | 37466 | 92 | 102 | |
| 91 | 520 | 169044 | 338 | 459 | |
| 94 | 517 | 63618 | 170 | 173 | |
| 181 | 511 | 102948 | 259 | 279 | |
| 112 | 501 | 100787 | 302 | 273 | |
| 321 | 501 | 48336 | 170 | 131 | |

Table 5.7.4: Group 4: TAZ's with employment in range: 250 – 500

| ZONE | Total Employment | Agg Tonnage prediction | INCOGS truck count | Predicted | R-square |
|---|---|---|---|---|---|
| 131 | 500 | 42409 | 138 | 92 | |
| 51 | 483 | 91948 | 264 | 198 | |
| 271 | 480 | 34292 | 171 | 74 | |
| 283 | 480 | 34829 | 70 | 75 | |
| 391 | 479 | 86462 | 194 | 187 | |
| 56 | 475 | 125700 | 310 | 271 | |
| 316 | 475 | 51709 | 277 | 112 | |
| 78 | 457 | 47088 | 104 | 102 | |
| 189 | 456 | 71375 | 64 | 154 | |
| 363 | 454 | 161954 | 335 | 349 | |
| 268 | 450 | 45305 | 202 | 98 | |
| 338 | 439 | 31692 | 39 | 68 | |
| 476 | 422 | 111995 | 280 | 242 | |
| 101 | 421 | 52266 | 111 | 113 | |
| 346 | 418 | 30177 | 91 | 65 | |
| 364 | 415 | 160755 | 341 | 347 | |
| 255 | 411 | 58668 | 223 | 127 | |
| 193 | 406 | 67228 | 233 | 145 | |
| 301 | 405 | 141687 | 349 | 306 | |
| 331 | 401 | 67175 | 253 | 145 | |
| 470 | 394 | 57991 | 170 | 125 | |
| 448 | 391 | 85533 | 189 | 185 | |
| 46 | 389 | 146548 | 301 | 316 | |
| 43 | 387 | 99795 | 205 | 215 | 0.9201 |
| 425 | 386 | 83687 | 226 | 181 | |
| 213 | 381 | 177381 | 394 | 383 | |
| 169 | 373 | 85019 | 190 | 183 | |
| 272 | 372 | 147051 | 334 | 317 | |
| 87 | 369 | 73734 | 146 | 159 | |
| 266 | 369 | 39639 | 172 | 86 | |
| 60 | 367 | 35284 | 152 | 76 | |
| 225 | 364 | 113927 | 251 | 246 | |
| 72 | 362 | 27431 | 100 | 59 | |
| 497 | 362 | 82874 | 182 | 179 | |
| 305 | 361 | 49389 | 140 | 107 | |
| 371 | 337 | 144600 | 185 | 312 | |
| 2 | 333 | 24819 | 64 | 54 | |
| 40 | 330 | 78686 | 186 | 170 | |
| 31 | 329 | 24733 | 64 | 53 | |
| 393 | 327 | 34049 | 103 | 73 | |
| 68 | 325 | 124183 | 200 | 268 | |
| 69 | 325 | 139744 | 222 | 302 | |
| 133 | 322 | 46363 | 120 | 100 | |
| 104 | 321 | 39220 | 84 | 85 | |
| 453 | 321 | 85962 | 145 | 185 | |
| 267 | 318 | 80911 | 213 | 175 | |
| 434 | 315 | 99639 | 181 | 215 | |
| 136 | 314 | 23348 | 52 | 50 | |

continued on next page

| ZONE | Total Employment | Agg Tonnage prediction | INCOGS truck count | Predicted | R-square |
|---|---|---|---|---|---|
| 191 | 312 | 75614 | 212 | 163 | |
| 64 | 308 | 92956 | 195 | 201 | |
| 33 | 306 | 25700 | 67 | 55 | |
| 39 | 297 | 53026 | 123 | 114 | |
| 155 | 296 | 68740 | 219 | 148 | |
| 77 | 294 | 59344 | 107 | 128 | |
| 291 | 294 | 77964 | 174 | 168 | |
| 8 | 291 | 20773 | 53 | 45 | |
| 327 | 291 | 30396 | 70 | 66 | |
| 397 | 290 | 57677 | 184 | 124 | |
| 466 | 290 | 101740 | 216 | 220 | |
| 154 | 289 | 23275 | 127 | 50 | |
| 14 | 288 | 20600 | 53 | 44 | |
| 67 | 285 | 238061 | 373 | 514 | |
| 406 | 285 | 105264 | 153 | 227 | **0.9201** |
| 183 | 282 | 121243 | 263 | 262 | |
| 203 | 278 | 62585 | 208 | 135 | |
| 153 | 271 | 33131 | 135 | 71 | |
| 38 | 270 | 65896 | 138 | 142 | |
| 156 | 269 | 82137 | 226 | 177 | |
| 290 | 269 | 33591 | 93 | 72 | |
| 404 | 269 | 118181 | 155 | 255 | |
| 201 | 267 | 61918 | 202 | 134 | |
| 89 | 266 | 47223 | 131 | 102 | |
| 48 | 264 | 73948 | 147 | 160 | |
| 322 | 258 | 25042 | 88 | 54 | |
| 356 | 257 | 59103 | 218 | 128 | |
| 474 | 255 | 46771 | 96 | 101 | |
| 458 | 254 | 96732 | 147 | 209 | |
| 341 | 253 | 123149 | 227 | 266 | |

Table 5.7.5: Group 5: TAZ's with employment less than 250

| ZONE | Total Employment | Agg Tonnage prediction | INCOGS truck count | Predicted | R-square |
|---|---|---|---|---|---|
| 226 | 248 | 59297 | 153 | 105 | |
| 99 | 247 | 46200 | 91 | 82 | |
| 121 | 247 | 97635 | 219 | 173 | |
| 375 | 242 | 57752 | 106 | 103 | |
| 230 | 241 | 17210 | 73 | 31 | |
| 113 | 236 | 22189 | 78 | 39 | |
| 157 | 236 | 74295 | 179 | 132 | |
| 421 | 232 | 60674 | 150 | 108 | |
| 383 | 231 | 65519 | 160 | 116 | |
| 175 | 224 | 45830 | 148 | 81 | |
| 7 | 221 | 15769 | 41 | 28 | |
| 270 | 220 | 72122 | 163 | 128 | |
| 276 | 212 | 15179 | 85 | 27 | |
| 3 | 210 | 15970 | 41 | 28 | |
| 373 | 208 | 42422 | 116 | 75 | |
| 88 | 206 | 105601 | 212 | 188 | |
| 70 | 204 | 86458 | 138 | 154 | |
| 179 | 202 | 14405 | 62 | 26 | |
| 74 | 196 | 29246 | 81 | 52 | |
| 372 | 196 | 52044 | 120 | 92 | |
| 479 | 193 | 48530 | 97 | 86 | |
| 163 | 188 | 34287 | 83 | 61 | |
| 190 | 186 | 96395 | 198 | 171 | |
| 349 | 184 | 60343 | 122 | 107 | |
| 35 | 183 | 58790 | 126 | 104 | |
| 222 | 180 | 56246 | 114 | 100 | **0.9487** |
| 496 | 179 | 77533 | 141 | 138 | |
| 86 | 177 | 83069 | 152 | 148 | |
| 15 | 175 | 12673 | 33 | 23 | |
| 132 | 174 | 56618 | 116 | 101 | |
| 374 | 174 | 24432 | 53 | 43 | |
| 84 | 173 | 13787 | 53 | 24 | |
| 419 | 173 | 92237 | 176 | 164 | |
| 384 | 171 | 63014 | 104 | 112 | |
| 63 | 170 | 128134 | 205 | 228 | |
| 237 | 170 | 220246 | 452 | 391 | |
| 53 | 170 | 16164 | 95 | 29 | |
| 319 | 167 | 129812 | 196 | 231 | |
| 194 | 164 | 47069 | 119 | 84 | |
| 472 | 164 | 186515 | 268 | 331 | |
| 9 | 162 | 11524 | 30 | 20 | |
| 22 | 156 | 11254 | 29 | 20 | |
| 42 | 154 | 48282 | 108 | 86 | |
| 410 | 151 | 26855 | 67 | 48 | |
| 343 | 150 | 30349 | 86 | 54 | |
| 6 | 147 | 10517 | 27 | 19 | |
| 125 | 147 | 36066 | 95 | 64 | |
| 392 | 147 | 92354 | 144 | 164 | |
| 317 | 144 | 28801 | 113 | 51 | |
| 489 | 141 | 59556 | 77 | 106 | |
| 355 | 140 | 55397 | 94 | 98 | |

to be continued

| ZONE | Total Employment | Agg Tonnage prediction | INCOGS truck count | Predicted | R-square |
|---|---|---|---|---|---|
| 71 | 138 | 18108 | 40 | 32 | |
| 199 | 137 | 32749 | 116 | 58 | |
| 409 | 133 | 50922 | 99 | 90 | |
| 488 | 133 | 76715 | 98 | 136 | |
| 460 | 132 | 38561 | 86 | 69 | |
| 4 | 130 | 9249 | 24 | 16 | |
| 486 | 130 | 31590 | 64 | 56 | |
| 92 | 129 | 12240 | 40 | 22 | |
| 100 | 129 | 41283 | 76 | 73 | |
| 436 | 127 | 61946 | 106 | 110 | |
| 468 | 127 | 80117 | 149 | 142 | |
| 206 | 125 | 32608 | 72 | 58 | |
| 329 | 124 | 10608 | 38 | 19 | |
| 134 | 123 | 28473 | 63 | 51 | |
| 221 | 123 | 55604 | 148 | 99 | |
| 85 | 121 | 69170 | 125 | 123 | |
| 200 | 118 | 69523 | 188 | 124 | |
| 390 | 118 | 83444 | 128 | 148 | |
| 292 | 116 | 65509 | 123 | 116 | |
| 455 | 116 | 57868 | 118 | 103 | |
| 381 | 115 | 41297 | 53 | 73 | |
| 471 | 115 | 66897 | 126 | 119 | |
| 368 | 115 | 41464 | 73 | 74 | |
| 286 | 110 | 24094 | 30 | 43 | |
| 340 | 110 | 50954 | 64 | 91 | |
| 141 | 107 | 65106 | 136 | 116 | **0.9487** |
| 477 | 105 | 21723 | 62 | 39 | |
| 473 | 104 | 58665 | 92 | 104 | |
| 498 | 104 | 27053 | 39 | 48 | |
| 318 | 103 | 8193 | 53 | 15 | |
| 262 | 103 | 7354 | 26 | 13 | |
| 50 | 102 | 33070 | 75 | 59 | |
| 354 | 102 | 54478 | 87 | 97 | |
| 145 | 101 | 77853 | 155 | 138 | |
| 399 | 100 | 58083 | 115 | 103 | |
| 116 | 98 | 21627 | 45 | 38 | |
| 47 | 96 | 67142 | 117 | 119 | |
| 287 | 96 | 115137 | 170 | 205 | |
| 494 | 95 | 20861 | 46 | 37 | |
| 352 | 95 | 43433 | 104 | 77 | |
| 27 | 93 | 13129 | 35 | 23 | |
| 350 | 93 | 13343 | 36 | 24 | |
| 405 | 90 | 97194 | 134 | 173 | |
| 438 | 89 | 132717 | 172 | 236 | |
| 359 | 87 | 43609 | 116 | 77 | |
| 487 | 87 | 14757 | 46 | 26 | |
| 493 | 87 | 84022 | 113 | 149 | |
| 395 | 85 | 18081 | 42 | 32 | |
| 137 | 84 | 13111 | 27 | 23 | |
| 432 | 84 | 17451 | 27 | 31 | |
| 187 | 83 | 77385 | 109 | 137 | |

continued

| ZONE | Total Employment | Agg Tonnage prediction | INCOGS truck count | Predicted | R-square |
|---|---|---|---|---|---|
| 380 | 82 | 46591 | 75 | 83 | |
| 162 | 81 | 11151 | 26 | 20 | |
| 485 | 81 | 71643 | 90 | 127 | |
| 138 | 80 | 8306 | 18 | 15 | |
| 103 | 79 | 5610 | 14 | 10 | |
| 164 | 79 | 13005 | 32 | 23 | |
| 241 | 79 | 141437 | 219 | 251 | |
| 454 | 79 | 60287 | 111 | 107 | |
| 98 | 78 | 52981 | 93 | 94 | |
| 358 | 77 | 47673 | 118 | 85 | |
| 61 | 77 | 43988 | 95 | 78 | |
| 130 | 76 | 27475 | 55 | 49 | |
| 401 | 76 | 7110 | 26 | 13 | |
| 54 | 74 | 20084 | 46 | 36 | |
| 243 | 73 | 18466 | 50 | 33 | |
| 45 | 73 | 31167 | 59 | 55 | |
| 403 | 73 | 50600 | 82 | 90 | |
| 388 | 72 | 56105 | 85 | 100 | |
| 437 | 72 | 105505 | 175 | 187 | |
| 366 | 71 | 11150 | 24 | 20 | |
| 34 | 70 | 5004 | 13 | 9 | |
| 172 | 70 | 35829 | 85 | 64 | |
| 433 | 69 | 47208 | 78 | 84 | |
| 452 | 69 | 63414 | 98 | 113 | |
| 62 | 68 | 15466 | 51 | 27 | |
| 499 | 68 | 34256 | 60 | 61 | |
| 400 | 67 | 16691 | 37 | 30 | |
| 55 | 67 | 45174 | 84 | 80 | |
| 360 | 67 | 17015 | 20 | 30 | |
| 462 | 67 | 54502 | 88 | 97 | |
| 413 | 65 | 32433 | 48 | 58 | **0.9487** |
| 124 | 62 | 33421 | 69 | 59 | |
| 180 | 60 | 62677 | 109 | 111 | |
| 495 | 57 | 40816 | 55 | 73 | |
| 126 | 56 | 11124 | 26 | 20 | |
| 430 | 56 | 24723 | 39 | 44 | |
| 362 | 56 | 7837 | 9 | 14 | |
| 128 | 54 | 17783 | 36 | 32 | |
| 482 | 54 | 29378 | 57 | 52 | |
| 394 | 54 | 27364 | 45 | 49 | |
| 58 | 52 | 14329 | 42 | 25 | |
| 44 | 50 | 40426 | 67 | 72 | |
| 367 | 50 | 12608 | 25 | 22 | |
| 127 | 49 | 131796 | 209 | 234 | |
| 184 | 46 | 16634 | 38 | 30 | |
| 408 | 44 | 44233 | 73 | 79 | |
| 492 | 44 | 71465 | 97 | 127 | |
| 480 | 41 | 38305 | 59 | 68 | |
| 389 | 41 | 14008 | 25 | 25 | |
| 188 | 40 | 58148 | 82 | 103 | |
| 357 | 40 | 46753 | 101 | 83 | |
| 431 | 40 | 33139 | 51 | 59 | |
| 475 | 40 | 24201 | 38 | 43 | |
| 307 | 39 | 17133 | 28 | 30 | |
| 483 | 39 | 97391 | 147 | 173 | |
| 185 | 39 | 9837 | 30 | 17 | |
| 32 | 38 | 3437 | 9 | 6 | |
| 428 | 37 | 69214 | 118 | 123 | |
| 223 | 34 | 47677 | 83 | 85 | |
| 300 | 33 | 63500 | 121 | 113 | |
| 323 | 33 | 23633 | 41 | 42 | |

continued

| ZONE | Total Employment | Agg Tonnage prediction | INCOGS truck count | Predicted | R-square |
|---|---|---|---|---|---|
| 386 | 29 | 76873 | 102 | 137 | |
| 444 | 26 | 54059 | 81 | 96 | |
| 115 | 24 | 23772 | 39 | 42 | |
| 435 | 24 | 41437 | 65 | 74 | |
| 118 | 23 | 52228 | 91 | 93 | |
| 416 | 23 | 40466 | 64 | 72 | |
| 440 | 23 | 70093 | 105 | 125 | |
| 339 | 22 | 1973 | 3 | 4 | |
| 288 | 20 | 8391 | 14 | 15 | |
| 347 | 20 | 16923 | 25 | 30 | |
| 382 | 20 | 12816 | 24 | 23 | |
| 402 | 20 | 41232 | 57 | 73 | |
| 10 | 19 | 1365 | 4 | 2 | |
| 83 | 18 | 1289 | 5 | 2 | |
| 385 | 18 | 66151 | 111 | 118 | |
| 396 | 17 | 18382 | 31 | 33 | |
| 361 | 16 | 18640 | 21 | 33 | |
| 439 | 16 | 62375 | 79 | 111 | |
| 484 | 16 | 31729 | 49 | 56 | |
| 1 | 15 | 4056 | 11 | 7 | |
| 308 | 15 | 7263 | 12 | 13 | |
| 330 | 15 | 22528 | 36 | 40 | |
| 369 | 15 | 7416 | 12 | 13 | |
| 379 | 15 | 14695 | 22 | 26 | |
| 417 | 15 | 15744 | 22 | 28 | |
| 442 | 15 | 4420 | 9 | 8 | **0.9487** |
| 217 | 13 | 1500 | 11 | 3 | |
| 412 | 13 | 19749 | 31 | 35 | |
| 418 | 12 | 21250 | 36 | 38 | |
| 353 | 12 | 31679 | 56 | 56 | |
| 238 | 11 | 58169 | 96 | 103 | |
| 264 | 11 | 38609 | 81 | 69 | |
| 370 | 10 | 14735 | 21 | 26 | |
| 387 | 9 | 4067 | 9 | 7 | |
| 135 | 7 | 10370 | 18 | 18 | |
| 426 | 7 | 29597 | 43 | 53 | |
| 478 | 7 | 75142 | 98 | 133 | |
| 36 | 6 | 24456 | 37 | 43 | |
| 429 | 6 | 45515 | 64 | 81 | |
| 451 | 6 | 881 | 2 | 2 | |
| 37 | 6 | 34365 | 52 | 61 | |
| 414 | 6 | 14025 | 19 | 25 | |
| 240 | 5 | 16007 | 21 | 28 | |
| 424 | 5 | 19442 | 29 | 35 | |
| 41 | 4 | 15114 | 23 | 27 | |
| 117 | 3 | 23151 | 38 | 41 | |
| 242 | 3 | 10390 | 15 | 18 | |
| 285 | 3 | 2681 | 5 | 5 | |
| 459 | 3 | 23660 | 36 | 42 | |
| 348 | 2 | 10374 | 16 | 18 | |
| 481 | 2 | 37013 | 52 | 66 | |
| 427 | 1 | 37490 | 55 | 67 | |

**Regression output for TAZ's with employment >2000**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.9443561 |
| R Square | 0.891808443 |
| Adjusted R Square | 0.864781416 |
| Standard Error | 389.4143486 |
| Observations | 38 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 46249158.21 | 46249158.21 | 304.986 | 3.697E-19 |
| Residual | 37 | 5610810.792 | 151643.5349 | | |
| Total | 38 | 51859969 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|
| Intercept | 0 | #N/A | #N/A | #N/A | #N/A | #N/A |
| Agg freight tonnage | 0.003235492 | 0.000185268 | 17.46384895 | 1.87E-19 | 0.002860104 | 0.003611 |

Figure 5.7.1: Group 1: Regression Output

**Regression output for TAZ's with employment: 1000 - 2000**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.96579955 |
| R Square | 0.932768771 |
| Adjusted R Square | 0.917143771 |
| Standard Error | 152.7104878 |
| Observations | 65 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 20707165.44 | 20707165 | 887.9386 | 7.62751E-39 |
| Residual | 64 | 1492511.558 | 23320.49 | | |
| Total | 65 | 22199677 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|
| Intercept | 0 | #N/A | #N/A | #N/A | #N/A | #N/A |
| Agg freight tonnage | 0.003380233 | 0.000113437 | 29.7983 | 3.12E-39 | 0.003153617 | 0.003607 |

Figure 5.7.2: Group 2: Regression output

**Regression output for TAZ's with employment: 500 - 1000**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.974951161 |
| R Square | 0.950529766 |
| Adjusted R Square | 0.938334644 |
| Standard Error | 83.94923111 |
| Observations | 83 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 11103734.18 | 11103734 | 1575.562 | 7.45937E-55 |
| Residual | 82 | 577892.8191 | 7047.4734 | | |
| Total | 83 | 11681627 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|
| Intercept | 0 | #N/A | #N/A | #N/A | #N/A | #N/A |
| Agg freight tonnage | 0.002712551 | 6.83377E-05 | 39.693355 | 2.65E-55 | 0.002576605 | 0.002848 |

Figure 5.7.3: Group 3: Regression output

**Regression output for TAZ's with employment: 250 - 500**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.959232017 |
| R Square | 0.920126062 |
| Adjusted R Square | 0.907139049 |
| Standard Error | 55.52132403 |
| Observations | 78 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 2734340.459 | 2734340 | 887.0191 | 1.17563E-43 |
| Residual | 77 | 237361.5415 | 3082.617 | | |
| Total | 78 | 2971702 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|
| Intercept | 0 | #N/A | #N/A | #N/A | #N/A | #N/A |
| Agg freight tonnage | 0.002157915 | 7.24549E-05 | 29.78287 | 5.22E-44 | 0.002013639 | 0.002302 |

Figure 5.7.4: Group 4: Regression output

**Regression output for TAZ's with employment: < 250**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.97403022 |
| R Square | 0.94873487 |
| Adjusted R Square | 0.944061973 |
| Standard Error | 21.97706867 |
| Observations | 215 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 1912828.809 | 1912829 | 3960.377 | 1.3772E-139 |
| Residual | 214 | 103360.1911 | 482.9915 | | |
| Total | 215 | 2016189 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|
| Intercept | 0 | #N/A | #N/A | #N/A | #N/A | #N/A |
| Agg freight tonnage | 0.00177662 | 2.8231E-05 | 62.93153 | 5E-140 | 0.001720974 | 0.001832 |

Figure 5.7.5: Group 5: Regression output

Figure 5.7.6: Predicted count vs. INCOG count for Group 1

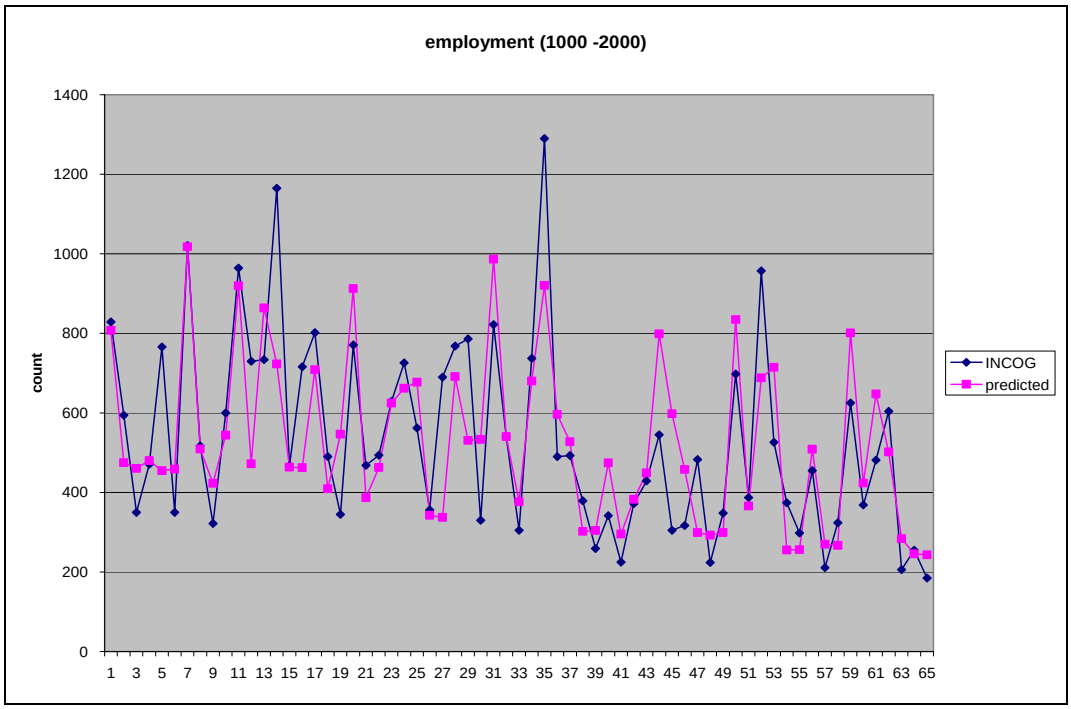



Figure 5.7.7: Predicted count vs. INCOG count for Group 2

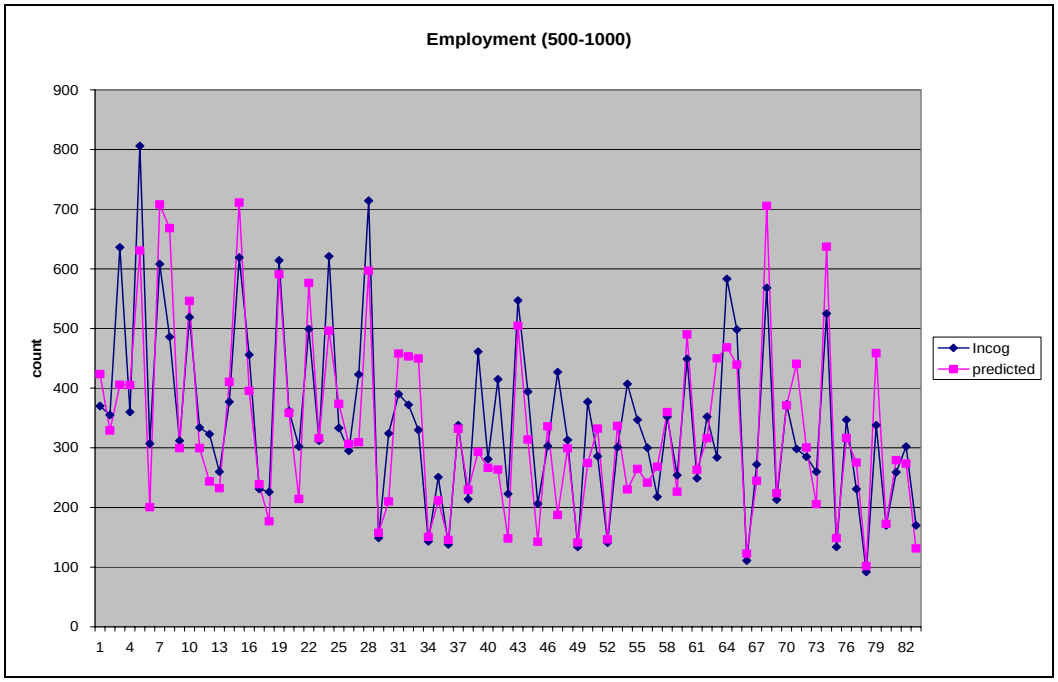



Figure 5.7.8: Predicted count vs. INCOG count for Group 3

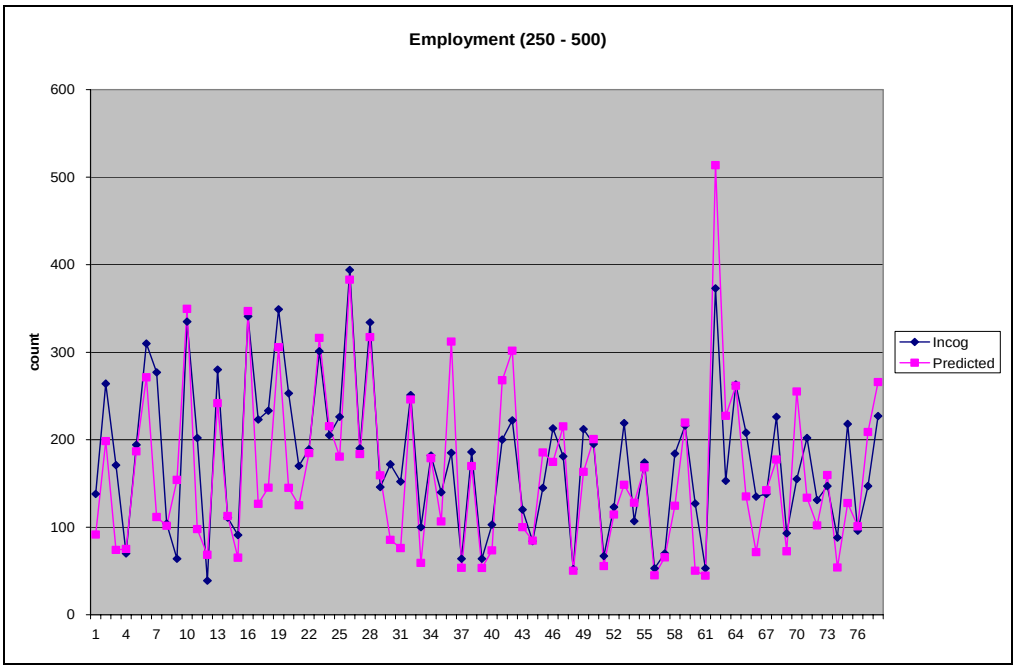



Figure 5.7.9: Predicted count vs. INCOG count for Group 4

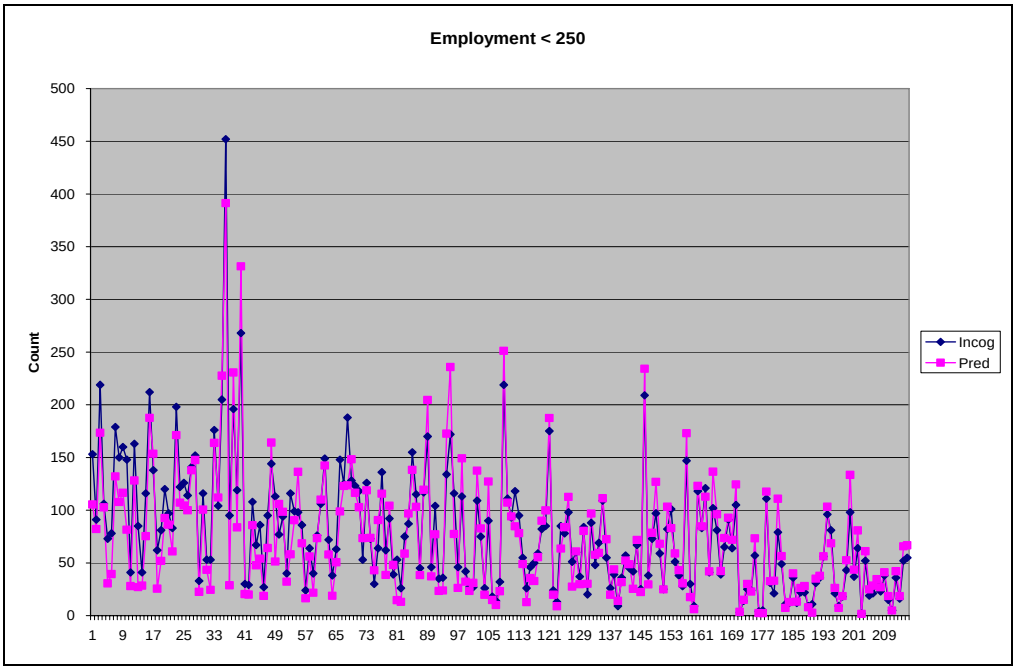



Figure 5.7.10: Predicted count vs. INCOG count for Group 5

# 6.0 FREIGHT DISTRIBUTION USING DOUBLY CONSTRAINED GRAVITY MODEL IN TRANSCAD

Regional freight distribution concerns distribution of freight generation (production and attraction) of a state to all other states. The regional freight flow distribution was modeled using the doubly-constrained gravity model in TransCAD. A doubly constrained gravity model ensures that the flow conservation of productions and attractions for each state. The distribution outcome is an O-D flow matrix for all states.

## 6.1 Databases

The input data needed to run the gravity model in TransCAD include:

- A state-to-state friction factor matrix or an impedance table. This study uses a distance-based friction factor matrix
- A USA state zone layer with estimated production and attraction from freight generation step

A layer of state population-weighted centroids. Figure 6.1.1, represents the network of interconnected state centroids.

The friction factor matrix is based on a state-to-state centroid distance matrix, which is commonly calculated in a mathematical function, such as gamma, exponential, or inverse power. The distance matrix itself can also be used as the input friction factor matrix. An inverse function of distance was used to calculate the friction factor matrix. The distances between 52 origins and 52 destinations (including the DC area and Tulsa separated from OK) have been tabulated in Table 6.1.1.

Since the regression study estimated production and attraction including within state production and attraction, each state's estimated production and attraction figures were multiplied by an "instate factor". The instate factor ensures that a state distributes its relevant production to all other states and attracts from other states the relevant freight that is distributed to the state. Using the instate factor, the total instate production and attraction values were computed as an average of the instate production and attraction.

Such distribution relevant productions and attractions must be stored in table fields that are either contained in a map zone layer or in a table that is joined to a zone layer. The totals of the productions and attractions must be equal; otherwise, a balance procedure is needed. Given that a state's estimated attribution is more reliable, in the balance procedure, attraction was held constant to balance the production.

The summary tables that we have created in order to illustrate the structure of the distribution is based on the outflow of the states. We subtracted the instate portion of each state portion from the production and attraction values so that we could see the distribution from each state to all other states.

SCTG commodity “Total Flows” was used as a prototype for freight distribution. Table 6.1.2 is a sample input table for “Total Flow” for the middle level results. The notations used in the aforementioned tables are presented in Table 6.1.3.

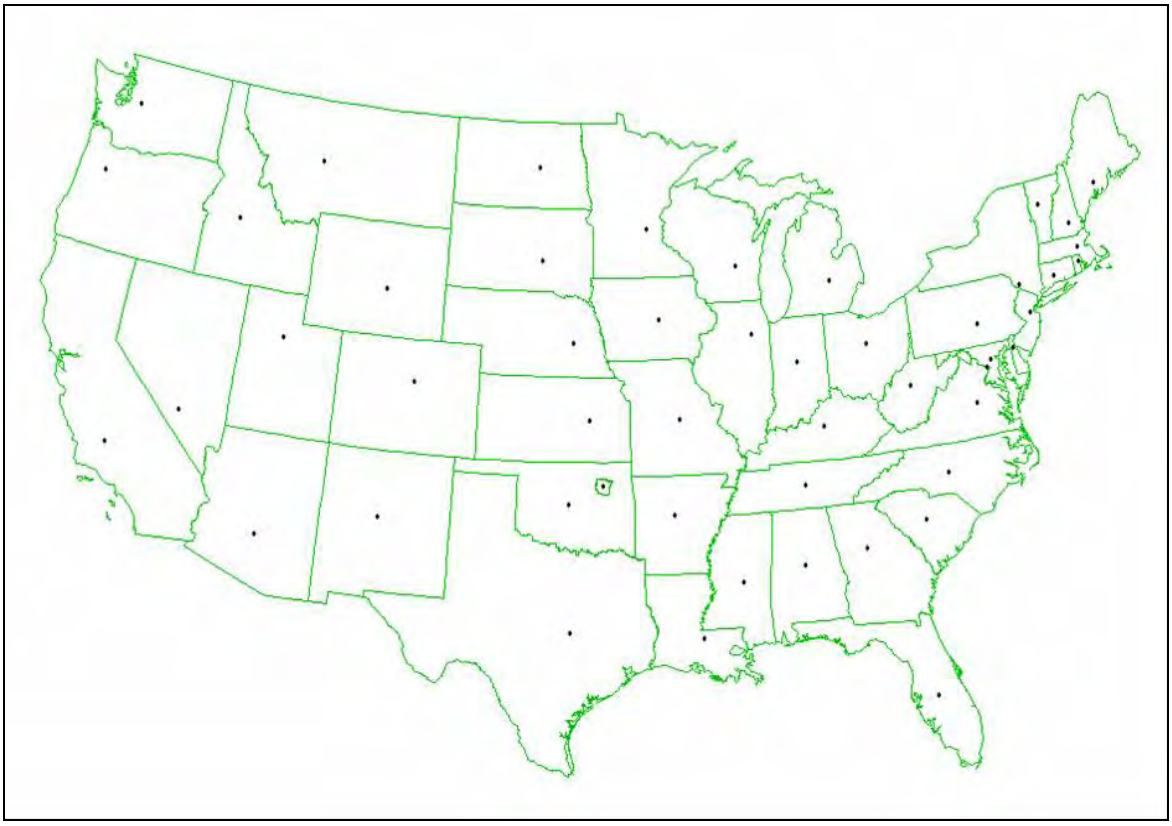


Figure 6.1.1: State Centroids

Table 6.1.1: USA 52x52 Distance Matrix Based on State Centroids, including Tulsa, DC, Hawaii, and Alaska

| ORIGIN/DEST | AK | AL | AR | AZ | CA | CO | CT | DC | DE | FL | GA | HI | IA | ID | IL | IN | KS | KY | LA | MA | MD | ME | MI | MN | MO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AK | 0 | 3347.19 | 3039.03 | 2545.58 | 2216.99 | 2386.32 | 3334.22 | 3340.01 | 3360.76 | 3815.85 | 3423.96 | 2806.05 | 2646.33 | 1818.56 | 2836.89 | 2966.66 | 2721.65 | 3128.59 | 3326.16 | 3340.92 | 3334.03 | 3283.95 | 2892.12 | 2460.13 | 2865.89 |
| AL | 3347.19 | 0 | 362.27 | 1445.9 | 1860.96 | 1118.41 | 961.33 | 680.34 | 764.23 | 471.95 | 169.12 | 4354.1 | 707.9 | 1705.05 | 578.7 | 495.67 | 664.38 | 343.01 | 317.9 | 1055.73 | 699.36 | 1202.61 | 696.02 | 918.49 | 481.89 |
| AR | 3039.03 | 362.27 | 0 | 1104.38 | 1506.16 | 757.4 | 1153.41 | 897.15 | 980.52 | 817.23 | 511.84 | 4006.87 | 476.05 | 1350.25 | 484.96 | 492.5 | 319.88 | 448.96 | 309.58 | 1243.1 | 912.24 | 1365.89 | 701.58 | 701.95 | 233.16 |
| AZ | 2545.58 | 1445.9 | 1104.38 | 0 | 452.39 | 560.75 | 2189.67 | 1967.38 | 2045.45 | 1830.05 | 1608.74 | 2908.41 | 1182.31 | 771.58 | 1393.64 | 1484.68 | 923.48 | 1519.47 | 1205.41 | 2269.27 | 1979.24 | 2359.42 | 1630.56 | 1267.82 | 1152.68 |
| CA | 2216.99 | 1860.96 | 1506.16 | 452.39 | 0 | 823.55 | 2517.82 | 2321.96 | 2394.68 | 2266.9 | 2017.67 | 2506.12 | 1480.9 | 646.67 | 1715.64 | 1824.59 | 1273.39 | 1887.89 | 1642.5 | 2589.51 | 2331.42 | 2659.34 | 1937.69 | 1506.4 | 1510.47 |
| CO | 2386.32 | 1118.41 | 757.4 | 560.75 | 823.55 | 0 | 1694.27 | 1503.58 | 1574.27 | 1571.22 | 1256.75 | 3317.13 | 658.04 | 606.25 | 892.37 | 1004.17 | 470.94 | 1081.16 | 984.75 | 1766.27 | 1512.16 | 1839.8 | 1115.02 | 711.42 | 704.23 |
| CT | 3334.22 | 961.33 | 1153.41 | 2189.67 | 2517.82 | 1694.27 | 0 | 282.4 | 202.4 | 1068.08 | 824.63 | 4996.47 | 1038.41 | 2124.67 | 802.86 | 705.17 | 1266.22 | 704.7 | 1273.22 | 94.45 | 262.73 | 251.79 | 585.62 | 1068.36 | 1040.23 |
| DC | 3340.01 | 680.34 | 897.15 | 1967.38 | 2321.96 | 1503.58 | 282.4 | 0 | 85 | 812.22 | 542.4 | 4820.51 | 867.8 | 1985.99 | 622.14 | 500.05 | 1051.32 | 451.92 | 994.36 | 376.76 | 20.34 | 530.34 | 462.96 | 952.54 | 816.3 |
| DE | 3360.76 | 764.23 | 980.52 | 2045.45 | 2394.68 | 1574.27 | 202.4 | 85 | 0 | 873.87 | 623.34 | 4889.88 | 931.53 | 2044.65 | 686.81 | 570.24 | 1126.74 | 533.79 | 1078.88 | 295.93 | 68.33 | 453.38 | 507.75 | 1001.82 | 893.14 |
| FL | 3815.85 | 471.95 | 817.23 | 1830.05 | 2266.9 | 1571.22 | 1068.08 | 812.22 | 873.87 | 0 | 404.93 | 4723.48 | 1170.76 | 2167.47 | 1006.71 | 894.35 | 1131.22 | 722.63 | 624.93 | 1154.67 | 831.91 | 1317.91 | 1050.9 | 1370.62 | 953.13 |
| GA | 3423.96 | 169.12 | 511.84 | 1608.74 | 2017.67 | 1256.75 | 824.63 | 542.4 | 623.34 | 404.93 | 0 | 4515.68 | 778.52 | 1830.34 | 602.17 | 490.2 | 791.45 | 318.73 | 480.17 | 918.82 | 562.33 | 1072.09 | 658.95 | 969.74 | 582.26 |
| HI | 2806.05 | 4354.1 | 4006.87 | 2908.41 | 2506.12 | 3317.13 | 4996.47 | 4820.51 | 4889.88 | 4723.48 | 4515.68 | 0 | 3961.58 | 2891.03 | 4204.05 | 4320.65 | 3777.93 | 4392.97 | 4104.7 | 5059.73 | 4828.71 | 5106.12 | 4410.84 | 3939.49 | 4015 |
| IA | 2646.33 | 707.9 | 476.05 | 1182.31 | 1480.9 | 658.04 | 1038.41 | 867.8 | 931.53 | 1170.76 | 778.52 | 3961.58 | 0 | 1121.72 | 245.69 | 374.63 | 304.14 | 503.29 | 783.05 | 1108.63 | 873.61 | 1183.32 | 456.98 | 226.16 | 247.93 |
| ID | 1818.56 | 1705.05 | 1350.25 | 771.58 | 646.67 | 606.25 | 2124.67 | 1985.99 | 2044.65 | 2167.47 | 1830.34 | 2891.03 | 1121.72 | 0 | 1366.28 | 1496.25 | 1041.25 | 1610.26 | 1590.76 | 2180.46 | 1990.32 | 2217.02 | 1544.1 | 1056.83 | 1252.78 |
| IL | 2836.89 | 578.7 | 484.96 | 1393.64 | 1715.64 | 892.37 | 802.86 | 622.14 | 686.81 | 1006.71 | 602.17 | 4204.05 | 245.69 | 1366.28 | 0 | 135.04 | 474.23 | 292.26 | 750.75 | 878.03 | 628.13 | 966.75 | 242.14 | 377.19 | 280.26 |
| IN | 2966.66 | 495.67 | 492.5 | 1484.68 | 1824.59 | 1004.17 | 705.17 | 500.05 | 570.24 | 894.35 | 490.2 | 4320.65 | 374.63 | 1496.25 | 135.04 | 0 | 561.49 | 171.73 | 716.02 | 786.78 | 508.08 | 891.54 | 215.77 | 509.37 | 336.77 |
| KS | 2721.65 | 664.38 | 319.88 | 923.48 | 1273.39 | 470.94 | 1266.22 | 1051.32 | 1126.74 | 1131.22 | 791.45 | 3777.93 | 304.14 | 1041.25 | 474.23 | 561.49 | 0 | 615.06 | 608.49 | 1346.02 | 1061.84 | 1440.57 | 715.27 | 490.86 | 237.12 |
| KY | 3128.59 | 343.01 | 448.96 | 1519.47 | 1887.89 | 1081.16 | 704.7 | 451.92 | 533.79 | 722.63 | 318.73 | 4392.97 | 503.29 | 1610.26 | 292.26 | 171.73 | 615.06 | 0 | 605.65 | 795.05 | 465.83 | 922.99 | 354 | 668.46 | 378.11 |
| LA | 3326.16 | 317.9 | 309.58 | 1205.41 | 1642.5 | 984.75 | 1273.22 | 994.36 | 1078.88 | 624.93 | 480.17 | 4104.7 | 783.05 | 1590.76 | 750.75 | 716.02 | 608.49 | 605.65 | 0 | 1367.3 | 1012.9 | 1509.77 | 931.44 | 1009.21 | 536.13 |
| MA | 3340.92 | 1055.73 | 1243.1 | 2269.27 | 2589.51 | 1766.27 | 94.45 | 376.76 | 295.93 | 1154.67 | 918.82 | 5059.73 | 1108.63 | 2180.46 | 878.03 | 786.78 | 1346.02 | 795.05 | 1367.3 | 0 | 357.15 | 163.5 | 652.34 | 1123.83 | 1123.15 |
| MD | 3334.03 | 699.36 | 912.24 | 1979.24 | 2331.42 | 1512.16 | 262.73 | 20.34 | 68.33 | 831.91 | 562.33 | 4828.71 | 873.61 | 1990.32 | 628.13 | 508.08 | 1061.84 | 465.83 | 1012.9 | 357.15 | 0 | 510.2 | 462.21 | 953.68 | 827.44 |
| ME | 3283.95 | 1202.61 | 1365.89 | 2359.42 | 2659.34 | 1839.8 | 251.79 | 530.34 | 453.38 | 1317.91 | 1072.09 | 5106.12 | 1183.32 | 2217.02 | 966.75 | 891.54 | 1440.57 | 922.99 | 1509.77 | 163.5 | 510.2 | 0 | 729.07 | 1168.06 | 1227.25 |
| MI | 2892.12 | 696.02 | 701.58 | 1630.56 | 1937.69 | 1115.02 | 585.62 | 462.96 | 507.75 | 1050.9 | 658.95 | 4410.84 | 456.98 | 1544.1 | 242.14 | 215.77 | 715.27 | 354 | 931.44 | 652.34 | 462.21 | 729.07 | 0 | 494.41 | 518.02 |
| MN | 2460.13 | 918.49 | 701.95 | 1267.82 | 1506.4 | 711.42 | 1068.36 | 952.54 | 1001.82 | 1370.62 | 969.74 | 3939.49 | 226.16 | 1056.83 | 377.19 | 509.37 | 490.86 | 668.46 | 1009.21 | 1123.83 | 953.68 | 1168.06 | 494.41 | 0 | 473.7 |
| MO | 2865.89 | 481.89 | 233.16 | 1152.68 | 1510.47 | 704.23 | 1040.23 | 816.3 | 893.14 | 953.13 | 582.26 | 4015 | 247.93 | 1252.78 | 280.26 | 336.77 | 237.12 | 378.11 | 536.13 | 1123.15 | 827.44 | 1227.25 | 518.02 | 473.7 | 0 |
| MS | 3279.28 | 166.93 | 243.09 | 1207.67 | 1709.72 | 993.11 | 1106.39 | 829.1 | 913.91 | 578.13 | 336.04 | 4195.89 | 676.14 | 1591.1 | 605.62 | 556.58 | 563.54 | 437.52 | 169.3 | 1200.25 | 847.29 | 1341.35 | 770.46 | 899.29 | 430.42 |
| MT | 1803.54 | 1597.87 | 1260.3 | 929.16 | 890.55 | 588.58 | 1915.75 | 1799.71 | 1852.15 | 2068.71 | 1706 | 3128 | 954.64 | 259.97 | 1191.49 | 1325.44 | 940.75 | 1456.42 | 1531.6 | 1965.52 | 1802.04 | 1990.98 | 1345.42 | 851.21 | 1124.06 |
| NC | 3437.96 | 441.82 | 728 | 1830.18 | 2216.74 | 1420.56 | 550.41 | 273.67 | 348.08 | 548.28 | 284.31 | 4722.75 | 844.55 | 1956.11 | 615 | 480.22 | 950.63 | 345.85 | 759.42 | 643.41 | 294 | 801.34 | 559.63 | 988.17 | 716.6 |
| ND | 2162.12 | 1190.95 | 918.33 | 1166.55 | 1317.65 | 618.2 | 1359.59 | 1262.02 | 1307.89 | 1655.56 | 1261.87 | 3680.08 | 484.81 | 789.49 | 684.92 | 818.97 | 632.31 | 972.32 | 1225.72 | 1407.02 | 1262.28 | 1432.12 | 800.54 | 312.56 | 715.79 |
| NE | 2544.58 | 813.25 | 496.45 | 957.19 | 1249.9 | 426.72 | 1268.39 | 1087.27 | 1154.66 | 1285.13 | 919.23 | 3735.47 | 231.37 | 922.55 | 468.72 | 587.71 | 194.12 | 688.38 | 796.61 | 1339.64 | 1094.49 | 1414.26 | 688.33 | 338.22 | 337.01 |
| NH | 3290.45 | 1085.34 | 1256.98 | 2267.26 | 2578.84 | 1756.64 | 135.35 | 412 | 335.52 | 1203.4 | 953.81 | 5040.59 | 1098.63 | 2156.78 | 873.76 | 790.13 | 1345.36 | 811.44 | 1393.73 | 61.1 | 391.86 | 118.34 | 641.71 | 1101.66 | 1126.86 |
| NJ | 3341.05 | 853.56 | 1055.82 | 2106.53 | 2445.37 | 1622.65 | 109.07 | 173.66 | 93.73 | 965.01 | 715.62 | 4933.39 | 971.81 | 2073.88 | 730.61 | 623.38 | 1184.38 | 606.99 | 1166.57 | 203.21 | 154.27 | 359.65 | 529.84 | 1022.22 | 954.26 |
| NM | 2630.98 | 1127.58 | 780.51 | 325.87 | 737.86 | 342.8 | 1868.88 | 1642.63 | 1721.27 | 1529.7 | 1288.04 | 3227.64 | 879.61 | 812.47 | 1078.47 | 1163.78 | 604.86 | 1193.94 | 906.24 | 1950.03 | 1654.76 | 2045.18 | 1318.2 | 993.73 | 829.6 |
| NV | 2193.41 | 1687.67 | 1328.58 | 363.79 | 206.77 | 622.43 | 2315.75 | 2124.91 | 2196.36 | 2108.43 | 1840.18 | 2697.58 | 1277.81 | 492.77 | 1514.62 | 1626.13 | 1080.69 | 1695.71 | 1487.77 | 2386.33 | 2133.84 | 2454.15 | 1734.14 | 1299.69 | 1317.62 |
| NY | 3276.2 | 887.08 | 1066.26 | 2098.17 | 2426.53 | 1603 | 91.64 | 219.02 | 153.57 | 1026.38 | 757.52 | 4906.79 | 947.6 | 2037.92 | 711.36 | 613.81 | 1174.71 | 618.34 | 1195.61 | 176.84 | 198.69 | 315.67 | 496.33 | 982.58 | 949.23 |
| OH | 3065.73 | 562.43 | 652.98 | 1670.82 | 2009.09 | 1187.35 | 519.48 | 323.61 | 387.93 | 878.74 | 497.77 | 4502.06 | 544.6 | 1662.55 | 299.22 | 186.29 | 747.76 | 227.88 | 833.37 | 602.64 | 329.01 | 714.61 | 180.4 | 637.94 | 520.87 |
| OKCO | 2857.46 | 636.74 | 279.73 | 827.83 | 1226.61 | 505.1 | 1390.69 | 1150.42 | 1231.31 | 1072.02 | 791.07 | 3727.36 | 508.94 | 1110.35 | 636.54 | 693.89 | 213.33 | 698.77 | 480.9 | 1476.28 | 1163.77 | 1585.42 | 877.05 | 704.09 | 360.05 |
| OR | 1577 | 2069.29 | 1711.94 | 972.13 | 662.87 | 958.69 | 2477.86 | 2349.08 | 2405.68 | 2528.42 | 2197.27 | 2567.91 | 1487.78 | 368.46 | 1731.43 | 1862.41 | 1406.85 | 1978.49 | 1940.61 | 2529.71 | 2352.78 | 2556.91 | 1901.93 | 1410.09 | 1620.9 |
| PA | 3253.27 | 743.24 | 922.99 | 1967.49 | 2306.73 | 1484.33 | 230.42 | 107.72 | 108.91 | 912.89 | 618.96 | 4796.66 | 835.42 | 1943.03 | 592.87 | 484.16 | 1045.18 | 474.29 | 1050.25 | 321.39 | 92.25 | 459.79 | 401.9 | 896.31 | 815.46 |
| RI | 3366.15 | 1033.24 | 1229.12 | 2263.79 | 2589.03 | 1765.52 | 75.76 | 353.02 | 270.3 | 1122.42 | 893.6 | 5063.97 | 1108.72 | 2188.08 | 875.14 | 779.65 | 1340.31 | 780.36 | 1346.27 | 36.09 | 333.88 | 197.26 | 653.92 | 1131.25 | 1115.16 |
| SC | 3478.07 | 337.86 | 660.49 | 1764.04 | 2164.22 | 1385.36 | 680.69 | 403.69 | 478.42 | 432.52 | 170.14 | 4667.09 | 851.73 | 1941.83 | 641.37 | 512.01 | 914.9 | 351.28 | 650.15 | 773.48 | 424.03 | 931.73 | 633.28 | 1018.52 | 689.77 |
| SD | 2339.58 | 1009.11 | 708.33 | 1007.09 | 1226.59 | 446.34 | 1333.24 | 1190.19 | 1248.1 | 1480.11 | 1100.28 | 3666.03 | 335.36 | 796.55 | 574.07 | 707.08 | 407.76 | 837.98 | 1010.87 | 1393.87 | 1194.13 | 1445.31 | 749.36 | 280.22 | 527.22 |
| TN | 3201.84 | 194.21 | 351.27 | 1452.14 | 1842.21 | 1057.99 | 827.87 | 557.93 | 642.72 | 619.26 | 222.87 | 4347.41 | 555.87 | 1618.38 | 393.62 | 301.89 | 587.56 | 153.03 | 457.52 | 920.71 | 574.68 | 1057.15 | 502.76 | 751.36 | 365.8 |
| Tulsa TMA | 2871.51 | 563.36 | 201.09 | 922.01 | 1311.21 | 557.54 | 1290.34 | 1051.45 | 1131.95 | 1014.2 | 710.31 | 3815.26 | 431.29 | 1154.9 | 539.76 | 593.66 | 164.31 | 600.26 | 454.65 | 1375.83 | 1064.56 | 1485.17 | 779.12 | 639.29 | 261.23 |
| TX | 3122.49 | 638.32 | 399.18 | 860.41 | 1304.71 | 737 | 1541.07 | 1274.64 | 1359.37 | 972.27 | 807.39 | 3753.14 | 798.2 | 1331.72 | 872.23 | 891.38 | 521.22 | 838.36 | 352.31 | 1632.55 | 1291.24 | 1760.65 | 1098.15 | 1006.97 | 596.87 |
| UT | 2128.18 | 1477.56 | 1115.77 | 488.19 | 531.99 | 360.38 | 2019.92 | 1846.16 | 1913.32 | 1925.85 | 1617.11 | 2977.96 | 983.61 | 310.31 | 1226.69 | 1346.37 | 830.03 | 1434.92 | 1326.66 | 2086.26 | 1853.42 | 2145.58 | 1434.77 | 982.4 | 1060.46 |
| VA | 3376.47 | 600.2 | 839.16 | 1923.66 | 2289.48 | 1476.52 | 369.55 | 91.33 | 167.42 | 722.13 | 456.12 | 4792.67 | 856.3 | 1977.98 | 612.08 | 482.19 | 1016.15 | 404.35 | 916.6 | 463.32 | 111.59 | 619.52 | 485.88 | 961.84 | 779.22 |
| VT | 3197.95 | 1071.58 | 1217.72 | 2205.33 | 2507.31 | 1686.93 | 178.72 | 418.4 | 353.22 | 1226.84 | 950.44 | 4960.52 | 1029.93 | 2073.87 | 812.67 | 739.28 | 1286.57 | 778.73 | 1373.19 | 144.8 | 398.15 | 154.11 | 575.09 | 1021.08 | 1074.31 |
| WA | 1457.81 | 2066.08 | 1716.72 | 1092.23 | 829.32 | 983.09 | 2399.24 | 2290.24 | 2341.63 | 2532.9 | 2183.4 | 2694.49 | 1443.94 | 378.81 | 1682.23 | 1815.93 | 1402.13 | 1944 | 1966.01 | 2445.24 | 2292.31 | 2461.15 | 1834.27 | 1339.88 | 1601.6 |
| WI | 2687.65 | 750.91 | 627.12 | 1418.95 | 1702.74 | 884.7 | 833.03 | 704.64 | 755.32 | 1174.53 | 769.6 | 4164.77 | 238.67 | 1294.11 | 172.23 | 283.64 | 535.07 | 453.77 | 910.2 | 895.19 | 706.02 | 956.6 | 250.05 | 248 | 400.66 |
| WV | 3222.27 | 518.86 | 696.89 | 1762.47 | 2119.79 | 1303.79 | 459.88 | 204.96 | 285.32 | 759.49 | 412.26 | 4620.8 | 679.82 | 1801.51 | 435.81 | 305.8 | 847.72 | 248.75 | 820.8 | 552.14 | 217.7 | 689.26 | 332.97 | 790.85 | 612 |
| WY | 2154.78 | 1286.02 | 934.95 | 693.88 | 827.59 | 238.65 | 1740.29 | 1581.87 | 1644.83 | 1751.37 | 1409.13 | 3256.69 | 714.08 | 421.39 | 959.75 | 1086.03 | 621.65 | 1192.42 | 1190.94 | 1803.14 | 1587.59 | 1856.3 | 1154.84 | 689.59 | 831.57 |

| ORIGIN/DEST | MS | MT | NC | ND | NE | NH | NJ | NM | NV | NY | OH | OKCO | OR | PA | RI | SC | SD | TN | Tulsa TMA | TX | UT | VA | VT | WA | WI | WV | WY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AK | 3279.28 | 1803.54 | 3437.96 | 2162.12 | 2544.58 | 3290.45 | 3341.05 | 2630.98 | 2193.41 | 3276.2 | 3065.73 | 2857.46 | 1577 | 3253.27 | 3366.15 | 3478.07 | 2339.58 | 3201.84 | 2871.51 | 3122.49 | 2128.18 | 3376.47 | 3197.95 | 1457.81 | 2687.65 | 3222.27 | 2154.78 |
| AL | 166.93 | 1597.87 | 441.82 | 1190.95 | 813.25 | 1085.34 | 853.56 | 1127.58 | 1687.67 | 887.08 | 562.43 | 636.74 | 2069.29 | 743.24 | 1033.24 | 337.86 | 1009.11 | 194.21 | 563.36 | 638.32 | 1477.56 | 600.2 | 1071.58 | 2066.08 | 750.91 | 518.86 | 1286.02 |
| AR | 243.89 | 1260.3 | 728 | 918.33 | 496.45 | 1256.98 | 1055.82 | 780.51 | 1328.58 | 1066.26 | 652.98 | 279.73 | 1711.94 | 922.99 | 1229.12 | 660.49 | 708.33 | 351.27 | 201.09 | 399.18 | 1115.77 | 839.16 | 1217.72 | 1716.72 | 627.12 | 696.89 | 934.95 |
| AZ | 1287.67 | 929.16 | 1830.18 | 1166.55 | 957.19 | 2267.26 | 2106.53 | 325.87 | 363.79 | 2098.17 | 1670.82 | 827.83 | 972.13 | 1967.49 | 2263.79 | 1764.04 | 1007.09 | 1452.14 | 922.01 | 860.41 | 488.19 | 1923.66 | 2205.33 | 1092.23 | 1418.95 | 1762.47 | 693.88 |
| CA | 1709.72 | 890.55 | 2216.74 | 1317.65 | 1249.9 | 2578.84 | 2445.37 | 737.86 | 206.77 | 2426.53 | 2009.09 | 1226.61 | 662.87 | 2306.73 | 2589.03 | 2164.22 | 1226.59 | 1842.21 | 1311.21 | 1304.71 | 531.99 | 2289.48 | 2507.31 | 829.32 | 1702.74 | 2119.79 | 827.59 |
| CO | 993.11 | 588.58 | 1420.56 | 618.2 | 426.72 | 1756.64 | 1622.65 | 342.8 | 622.43 | 1603 | 1187.35 | 505.1 | 958.69 | 1484.33 | 1765.52 | 1385.36 | 446.34 | 1057.99 | 557.54 | 737 | 360.38 | 1476.52 | 1686.93 | 983.09 | 884.7 | 1303.79 | 238.65 |
| CT | 1106.39 | 1915.75 | 550.41 | 1359.59 | 1268.39 | 135.35 | 109.07 | 1868.88 | 2315.75 | 91.64 | 519.48 | 1390.69 | 2477.86 | 230.42 | 75.76 | 680.69 | 1333.24 | 827.87 | 1290.34 | 1541.07 | 2019.92 | 369.55 | 178.72 | 2399.24 | 833.03 | 459.88 | 1740.29 |
| DC | 829.1 | 1799.71 | 273.67 | 1262.02 | 1087.27 | 412 | 173.66 | 1642.63 | 2124.91 | 219.02 | 323.61 | 1150.42 | 2349.08 | 107.72 | 353.02 | 403.69 | 1190.19 | 557.93 | 1051.45 | 1274.64 | 1846.16 | 91.33 | 418.4 | 2290.24 | 704.64 | 204.96 | 1581.87 |
| DE | 913.91 | 1852.15 | 348.08 | 1307.89 | 1154.66 | 335.52 | 93.73 | 1721.27 | 2196.36 | 153.57 | 387.93 | 1231.31 | 2405.68 | 108.91 | 270.3 | 478.42 | 1248.1 | 642.72 | 1131.95 | 1359.37 | 1913.32 | 167.42 | 353.22 | 2341.63 | 755.32 | 285.32 | 1644.83 |
| FL | 578.13 | 2068.71 | 548.28 | 1655.56 | 1285.13 | 1203.4 | 965.01 | 1529.7 | 2108.43 | 1026.38 | 878.74 | 1072.02 | 2528.42 | 912.89 | 1122.42 | 432.52 | 1480.11 | 619.26 | 1014.2 | 972.27 | 1925.85 | 722.13 | 1226.84 | 2532.9 | 1174.53 | 759.49 | 1751.37 |
| GA | 336.04 | 1706 | 284.31 | 1261.87 | 919.23 | 953.81 | 715.62 | 1288.04 | 1840.18 | 757.52 | 497.77 | 791.07 | 2197.27 | 618.96 | 893.6 | 170.14 | 1100.28 | 222.87 | 710.31 | 807.39 | 1617.11 | 456.12 | 950.44 | 2183.4 | 769.6 | 412.26 | 1409.13 |
| HI | 4195.89 | 3128 | 4722.75 | 3680.08 | 3735.47 | 5040.59 | 4933.39 | 3227.64 | 2697.58 | 4906.79 | 4502.06 | 3727.36 | 2567.91 | 4796.66 | 5063.97 | 4667.09 | 3666.03 | 4347.41 | 3815.26 | 3753.14 | 2977.96 | 4792.67 | 4960.52 | 2694.49 | 4164.77 | 4620.8 | 3256.69 |
| IA | 676.14 | 954.64 | 844.55 | 484.81 | 231.37 | 1098.63 | 971.81 | 879.61 | 1277.81 | 947.6 | 544.6 | 508.94 | 1487.78 | 835.42 | 1108.72 | 851.73 | 335.36 | 555.87 | 431.29 | 798.2 | 983.61 | 856.3 | 1029.93 | 1443.94 | 238.67 | 679.82 | 714.08 |
| ID | 1591.1 | 259.97 | 1956.11 | 789.49 | 922.55 | 2156.78 | 2073.88 | 812.47 | 492.77 | 2037.92 | 1662.55 | 1110.35 | 368.46 | 1943.03 | 2188.08 | 1941.83 | 796.55 | 1618.38 | 1154.9 | 1331.72 | 310.31 | 1977.98 | 2073.87 | 378.81 | 1294.11 | 1801.51 | 421.39 |
| IL | 605.62 | 1191.49 | 615 | 684.92 | 468.72 | 873.76 | 730.61 | 1078.47 | 1514.62 | 711.36 | 299.22 | 636.54 | 1731.43 | 592.87 | 875.14 | 641.37 | 574.07 | 393.62 | 539.76 | 872.23 | 1226.69 | 612.08 | 812.67 | 1682.23 | 172.23 | 435.81 | 959.75 |
| IN | 556.58 | 1325.44 | 480.22 | 818.97 | 587.71 | 790.13 | 623.38 | 1163.78 | 1626.13 | 613.81 | 186.29 | 693.89 | 1862.41 | 484.16 | 779.65 | 512.01 | 707.08 | 301.89 | 593.66 | 891.38 | 1346.37 | 482.19 | 739.28 | 1815.93 | 283.64 | 305.8 | 1086.03 |
| KS | 563.54 | 940.75 | 950.63 | 632.31 | 194.12 | 1345.36 | 1184.38 | 604.86 | 1080.69 | 1174.71 | 747.76 | 213.33 | 1406.85 | 1045.18 | 1340.31 | 914.9 | 407.76 | 587.56 | 164.31 | 521.22 | 830.03 | 1016.15 | 1286.57 | 1402.13 | 535.07 | 847.72 | 621.65 |
| KY | 437.52 | 1456.42 | 345.85 | 972.32 | 688.38 | 811.44 | 606.99 | 1193.94 | 1695.71 | 618.34 | 227.88 | 698.77 | 1978.49 | 474.29 | 780.36 | 351.28 | 837.98 | 153.03 | 600.26 | 838.36 | 1434.92 | 404.35 | 778.73 | 1944 | 453.77 | 248.75 | 1192.42 |
| LA | 169.3 | 1531.6 | 759.42 | 1225.72 | 796.61 | 1393.73 | 1166.57 | 906.24 | 1487.77 | 1195.61 | 833.37 | 480.9 | 1940.61 | 1050.25 | 1346.27 | 650.15 | 1010.87 | 457.52 | 454.65 | 352.31 | 1326.66 | 916.6 | 1373.19 | 1966.01 | 910.2 | 820.8 | 1190.94 |
| MA | 1200.25 | 1965.52 | 643.41 | 1407.02 | 1339.64 | 61.1 | 203.21 | 1950.03 | 2386.33 | 176.84 | 602.64 | 1476.28 | 2529.71 | 321.39 | 36.09 | 773.48 | 1393.87 | 920.71 | 1375.83 | 1632.55 | 2086.26 | 463.32 | 144.8 | 2445.24 | 895.19 | 552.14 | 1803.14 |
| MD | 847.29 | 1802.04 | 294 | 1262.28 | 1094.49 | 391.86 | 154.27 | 1654.76 | 2133.84 | 198.69 | 329.01 | 1163.77 | 2352.78 | 92.25 | 333.88 | 424.03 | 1194.13 | 574.68 | 1064.56 | 1291.24 | 1853.42 | 111.59 | 398.15 | 2292.31 | 706.02 | 217.7 | 1587.59 |
| ME | 1341.35 | 1990.98 | 801.34 | 1432.12 | 1414.26 | 118.34 | 359.65 | 2045.18 | 2454.15 | 315.67 | 714.61 | 1585.42 | 2556.91 | 459.79 | 197.26 | 931.73 | 1445.31 | 1057.15 | 1485.17 | 1760.65 | 2145.58 | 619.52 | 154.11 | 2461.15 | 956.6 | 689.26 | 1856.3 |
| MI | 770.46 | 1345.42 | 559.63 | 800.54 | 688.33 | 641.71 | 529.84 | 1318.2 | 1734.14 | 496.33 | 180.4 | 877.05 | 1901.93 | 401.9 | 653.92 | 633.28 | 749.36 | 502.76 | 779.12 | 1098.15 | 1434.77 | 485.88 | 575.09 | 1834.27 | 250.05 | 332.97 | 1154.84 |
| MN | 899.29 | 851.21 | 988.17 | 312.56 | 338.22 | 1101.66 | 1022.22 | 993.73 | 1299.69 | 982.58 | 637.94 | 704.09 | 1410.09 | 896.31 | 1131.25 | 1018.52 | 280.22 | 751.36 | 639.29 | 1006.97 | 982.4 | 961.84 | 1021.08 | 1339.88 | 248 | 790.85 | 689.59 |
| MO | 430.42 | 1124.06 | 716.6 | 715.79 | 337.01 | 1126.86 | 954.26 | 829.6 | 1317.62 | 949.23 | 520.87 | 360.05 | 1620.9 | 815.46 | 1115.16 | 689.77 | 527.22 | 365.8 | 261.23 | 596.87 | 1060.46 | 779.22 | 1074.31 | 1601.6 | 400.66 | 612 | 831.57 |
| MS | 0 | 1504.16 | 604.11 | 1143.72 | 734.72 | 1225.64 | 1000.4 | 973.2 | 1541.84 | 1027.7 | 665.4 | 495.7 | 1950.71 | 882.13 | 1179.92 | 504.5 | 942.89 | 288.31 | 436.5 | 471.39 | 1340.13 | 753.73 | 1204.09 | 1959.39 | 771.89 | 652.15 | 1177.74 |
| MT | 1504.16 | 0 | 1799.17 | 559.38 | 787.15 | 1937.79 | 1873.22 | 879.53 | 715.68 | 1831.74 | 1479.32 | 1056.37 | 565.93 | 1747.28 | 1975.74 | 1800.26 | 619.32 | 1486.47 | 1078.98 | 1320.4 | 441.77 | 1801.03 | 1852.05 | 491.04 | 1096.83 | 1625.85 | 352.34 |
| NC | 604.11 | 1799.17 | 0 | 1298.95 | 1034.15 | 683.27 | 441.76 | 1504.85 | 2028.9 | 492.67 | 379.47 | 1002.35 | 2324.31 | 367.38 | 616.01 | 130.41 | 1179.91 | 378.04 | 909.92 | 1070.58 | 1776.93 | 182.62 | 691.83 | 2287.97 | 751.1 | 230.94 | 1538.12 |
| ND | 1143.72 | 559.38 | 1298.95 | 0 | 438.28 | 1378.56 | 1322.16 | 952.87 | 1113.96 | 1277.25 | 950.08 | 828.09 | 1125.08 | 1200.9 | 1418.05 | 1323.57 | 230.35 | 1039.76 | 796.62 | 1140.02 | 786.36 | 1273.9 | 1292.67 | 1039.68 | 559.26 | 1103.39 | 495.43 |
| NE | 734.72 | 787.15 | 1034.15 | 438.28 | 0 | 1330 | 1199.12 | 664.85 | 1047.36 | 1177.3 | 766.73 | 395.03 | 1290.99 | 1061.58 | 1339.23 | 1020.8 | 214.7 | 701.2 | 358.41 | 707.56 | 758.93 | 1067.89 | 1261.03 | 1265.51 | 462.75 | 892.35 | 504.07 |
| NH | 1225.64 | 1937.79 | 683.27 | 1378.56 | 1330 | 0 | 241.83 | 1950.16 | 2374.74 | 198.32 | 609.21 | 1482.95 | 2502.95 | 343.51 | 96.71 | 813.68 | 1374.92 | 942.72 | 1382.51 | 1649.78 | 2071.07 | 501.28 | 93.16 | 2414.64 | 879.07 | 574.08 | 1785.33 |
| NJ | 1000.4 | 1873.22 | 441.76 | 1322.16 | 1199.12 | 241.83 | 0 | 1783.86 | 2245.05 | 74.73 | 437.3 | 1299.58 | 2431.48 | 139.22 | 179.75 | 572.13 | 1278.5 | 724.57 | 1199.57 | 1439.85 | 1955.42 | 260.51 | 264.85 | 2360.39 | 779.89 | 359.24 | 1681.1 |
| NM | 973.2 | 879.53 | 1504.85 | 952.87 | 664.85 | 1950.16 | 1783.86 | 0 | 584.31 | 1777.58 | 1349.47 | 502.61 | 1107.01 | 1645.06 | 1943.43 | 1440.9 | 758.3 | 1126.87 | 596.16 | 578.59 | 503.96 | 1598 | 1891.12 | 1182.15 | 1118.22 | 1437.68 | 557.55 |
| NV | 1541.84 | 715.68 | 2028.9 | 1113.96 | 1047.36 | 2374.74 | 2245.05 | 584.31 | 0 | 2224.64 | 1809.71 | 1050.95 | 616.42 | 2106.76 | 2386.48 | 1981.93 | 1019.83 | 1657.29 | 1130.31 | 1162.44 | 327.61 | 2095.17 | 2302.42 | 753.41 | 1497.62 | 1923.92 | 621.9 |
| NY | 1027.7 | 1831.74 | 492.67 | 1277.25 | 1177.3 | 198.32 | 74.73 | 1777.58 | 2224.64 | 0 | 428.37 | 1300.69 | 2392.63 | 145.85 | 165.93 | 622.7 | 1245.07 | 745.9 | 1200.27 | 1456.16 | 1929.73 | 310.14 | 200.57 | 2316.78 | 744.85 | 377 | 1651.16 |
| OH | 665.4 | 1479.32 | 379.47 | 950.08 | 766.73 | 609.21 | 437.3 | 1349.47 | 1809.71 | 428.37 | 0 | 874.15 | 2026.13 | 298.15 | 594.3 | 455.26 | 867.18 | 379.5 | 773.68 | 1050.49 | 1525.41 | 323.91 | 565 | 1970.27 | 391.04 | 156.71 | 1258.6 |
| OKCO | 495.7 | 1056.37 | 1002.35 | 828.09 | 395.03 | 1482.95 | 1299.58 | 502.61 | 1050.95 | 1300.69 | 874.15 | 0 | 1463.24 | 1162.48 | 1466.2 | 939.76 | 598.36 | 624.33 | 100.47 | 312.66 | 854.4 | 1100.65 | 1433.03 | 1485.13 | 728 | 946.08 | 711.5 |
| OR | 1950.71 | 565.93 | 2324.31 | 1125.08 | 1290.99 | 2502.95 | 2431.48 | 1107.01 | 616.42 | 2392.63 | 2026.13 | 1463.24 | 0 | 2302.68 | 2539.14 | 2310.16 | 1158.95 | 1986.33 | 1514.28 | 1661.28 | 618.27 | 2343.49 | 2417.64 | 186.02 | 1652.02 | 2167.12 | 789.33 |
| PA | 882.13 | 1747.28 | 367.38 | 1200.9 | 1061.58 | 343.51 | 139.22 | 1645.06 | 2106.76 | 145.85 | 298.15 | 1162.48 | 2302.68 | 0 | 306.13 | 494.49 | 1146.71 | 600.06 | 1062.29 | 1311.21 | 1818.85 | 191.84 | 331.48 | 2236.14 | 650.94 | 231.17 | 1546.68 |
| RI | 1179.92 | 1975.74 | 616.01 | 1418.05 | 1339.23 | 96.71 | 179.75 | 1943.43 | 2386.48 | 165.93 | 594.3 | 1466.2 | 2539.14 | 306.13 | 0 | 745.7 | 1399.02 | 902.59 | 1365.82 | 1616.4 | 2088.69 | 437.51 | 175.04 | 2457.13 | 899.31 | 535.08 | 1807.31 |
| SC | 504.5 | 1800.26 | 130.41 | 1323.57 | 1020.8 | 813.68 | 572.13 | 1440.9 | 1981.93 | 622.7 | 455.26 | 939.76 | 2310.16 | 494.49 | 745.7 | 0 | 1184.37 | 327.38 | 853.03 | 975.71 | 1744.93 | 312.88 | 821.36 | 2284.8 | 794.29 | 327.21 | 1520.96 |
| SD | 942.89 | 619.32 | 1179.91 | 230.35 | 214.7 | 1374.92 | 1278.5 | 758.3 | 1019.83 | 1245.07 | 867.18 | 598.36 | 1158.95 | 1146.71 | 1399.02 | 1184.37 | 0 | 878.02 | 571.49 | 909.9 | 702.34 | 1185.75 | 1296.68 | 1109.1 | 500.26 | 1009.72 | 411 |
| TN | 288.31 | 1486.47 | 378.04 | 1039.76 | 701.2 | 942.72 | 724.57 | 1126.87 | 1657.29 | 745.9 | 379.5 | 624.33 | 1986.33 | 600.06 | 902.59 | 327.38 | 878.02 | 0 | 532.62 | 716.73 | 1417.56 | 492.51 | 917.45 | 1966.68 | 565.18 | 368.89 | 1197.06 |
| Tulsa TMA | 436.5 | 1078.98 | 909.92 | 796.62 | 358.41 | 1382.51 | 1199.57 | 596.16 | 1130.31 | 1200.27 | 773.68 | 100.47 | 1514.28 | 1062.29 | 1365.82 | 853.03 | 571.49 | 532.62 | 0 | 368.1 | 915.03 | 1003.19 | 1332.9 | 1524.8 | 639.82 | 846.87 | 744.17 |
| TX | 471.39 | 1320.4 | 1070.58 | 1140.02 | 707.56 | 1649.78 | 1439.85 | 578.59 | 1162.44 | 1456.16 | 1050.49 | 312.66 | 1661.28 | 1311.21 | 1616.4 | 975.71 | 909.9 | 716.73 | 368.1 | 0 | 1043.31 | 1207.46 | 1614.14 | 1710.49 | 995.04 | 1081.34 | 968.22 |
| UT | 1348.13 | 441.77 | 1776.93 | 786.36 | 758.93 | 2071.07 | 1955.42 | 503.96 | 327.61 | 1929.73 | 1525.41 | 854.4 | 618.27 | 1818.85 | 2088.69 | 1744.93 | 702.34 | 1417.56 | 915.03 | 1043.31 | 0 | 1824.71 | 1995.5 | 678.66 | 1192.01 | 1650.02 | 296.3 |
| VA | 753.73 | 1801.03 | 182.62 | 1273.9 | 1067.89 | 501.28 | 260.51 | 1598 | 2095.17 | 310.14 | 323.91 | 1100.65 | 2343.49 | 191.84 | 437.51 | 312.88 | 1185.75 | 492.51 | 1003.19 | 1207.46 | 1824.71 | 0 | 509.73 | 2292.06 | 714.7 | 176.49 | 1568.1 |
| VT | 1204.09 | 1852.05 | 691.83 | 1292.67 | 1261.03 | 93.16 | 264.85 | 1891.12 | 2302.42 | 200.57 | 565 | 1433.03 | 2417.64 | 331.48 | 175.04 | 821.36 | 1296.68 | 917.45 | 1332.9 | 1614.14 | 1995.5 | 509.73 | 0 | 2326.86 | 804.86 | 553.45 | 1707.6 |
| WA | 1959.39 | 491.04 | 2287.97 | 1039.68 | 1265.51 | 2414.64 | 2360.39 | 1182.15 | 753.41 | 2316.78 | 1970.27 | 1485.13 | 186.02 | 2236.14 | 2457.13 | 2284.8 | 1109.1 | 1966.68 | 1524.8 | 1710.49 | 678.66 | 2292.06 | 2326.86 | 0 | 1586.57 | 2116.85 | 781.76 |
| WI | 771.89 | 1096.83 | 751.1 | 559.26 | 462.75 | 879.07 | 779.89 | 1118.22 | 1497.62 | 744.85 | 391.04 | 728 | 1652.02 | 650.94 | 899.31 | 794.29 | 500.26 | 565.18 | 639.82 | 995.04 | 1192.01 | 714.7 | 804.86 | 1586.57 | 0 | 545.54 | 908.08 |
| WV | 652.15 | 1625.85 | 230.94 | 1103.39 | 892.35 | 574.08 | 359.24 | 1437.68 | 1923.92 | 377 | 156.71 | 946.08 | 2167.12 | 231.17 | 535.08 | 327.21 | 1009.72 | 368.89 | 846.87 | 1081.34 | 1650.02 | 176.49 | 553.45 | 2116.85 | 545.54 | 0 | 1391.82 |
| WY | 1177.74 | 352.34 | 1538.12 | 495.43 | 504.07 | 1785.33 | 1681.1 | 557.55 | 621.9 | 1651.16 | 1258.6 | 711.5 | 789.33 | 1546.68 | 1807.31 | 1520.96 | 411 | 1197.06 | 744.17 | 968.22 | 296.3 | 1568.1 | 1707.6 | 781.76 | 908.08 | 1391.82 | 0 |

Table 6.1.2: Input Data Bases for Freight Distribution in the Gravity Model (SCTG: Middle Total Level)

| StateAbr | State | Pop97 | Emp97 | Est97 | Pop2030 | CFSOi97 | CFSAj97 | PredOi2030 | PredAj2030 | InstProdPer | InstAtrPer | AdjPredOi | AdjPredAj | AdjInstPredOiDj |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AL | Alabama | 4367935 | 1591179 | 100281 | 5436664 | 256234 | 253122 | 256893 | 251150 | 0.683 | 0.691 | 81559 | 77629 | 174428 |
| AK | Alaska | 612968 | 188923 | 18138 | 812856 | 19673 | 20571 | 87877 | 74227 | 0.887 | 0.848 | 9939 | 11269 | 70448 |
| AZ | Arizona | 4736990 | 1701357 | 108669 | 9634631 | 121647 | 145476 | 319306 | 335602 | 0.858 | 0.718 | 45318 | 94801 | 257395 |
| AR | Arkansas | 2601090 | 925498 | 62326 | 3527083 | 162735 | 159934 | 180599 | 172650 | 0.594 | 0.604 | 73398 | 68373 | 105739 |
| CA | California | 32486010 | 11565015 | 62326 | 46483086 | 778805 | 823934 | 1527754 | 1629673 | 0.912 | 0.862 | 134231 | 224604 | 1399296 |
| CO | Colorado | 4018293 | 1675514 | 127419 | 7184246 | 127429 | 123979 | 290596 | 292768 | 0.696 | 0.715 | 88354 | 83344 | 205833 |
| CT | Connecticut | 3349348 | 1471970 | 92702 | 3877621 | 47158 | 52579 | 211984 | 201603 | 0.592 | 0.531 | 86393 | 94477 | 116359 |
| DE | Delaware | 751487 | 348009 | 22249 | 1123494 | 24149 | 32535 | 108418 | 93799 | 0.441 | 0.632 | 60639 | 34511 | 53533 |
| DC | District of Columbia | 567736 | 396328 | 19554 | 798188 | 49439 | 24999 | 104484 | 88011 | 0.541 | 0.247 | 47991 | 66277 | 39113 |
| FL | Florida | 15186304 | 5550307 | 417522 | 25239051 | 397287 | 465063 | 878321 | 923161 | 0.856 | 0.731 | 126745 | 248338 | 713200 |
| GA | Georgia | 7685099 | 3106872 | 191279 | 13276919 | 373554 | 433317 | 503672 | 517836 | 0.760 | 0.655 | 120817 | 178502 | 361095 |
| HI | Hawaii | 1211640 | 426129 | 29991 | 1482442 | 22290 | 23932 | 113741 | 101009 | 0.990 | 0.922 | 1112 | 7850 | 102894 |
| ID | Idaho | 1228520 | 404670 | 35563 | 2101972 | 47764 | 45566 | 117619 | 109009 | 0.706 | 0.740 | 34588 | 28344 | 81848 |
| IL | Illinois | 12185715 | 5089899 | 302579 | 15094707 | 670949 | 648294 | 604477 | 616141 | 0.685 | 0.709 | 190274 | 179192 | 425576 |
| IN | Indiana | 5955267 | 2487609 | 146241 | 7528995 | 338332 | 375506 | 352328 | 347069 | 0.650 | 0.586 | 123244 | 143745 | 216204 |
| IA | Iowa | 2891119 | 1179660 | 80608 | 3281809 | 218894 | 212460 | 197297 | 184739 | 0.666 | 0.686 | 65864 | 57945 | 129113 |
| KS | Kansas | 2635292 | 1049359 | 73924 | 3232729 | 141428 | 113467 | 186703 | 175498 | 0.505 | 0.629 | 92430 | 65046 | 102362 |
| KY | Kentucky | 3952747 | 1422605 | 89029 | 5009119 | 363393 | 283128 | 236245 | 230591 | 0.542 | 0.695 | 108269 | 70266 | 144150 |
| LA | Louisiana | 4421071 | 1531663 | 100770 | 5056035 | 507887 | 458557 | 218295 | 215930 | 0.611 | 0.677 | 84950 | 69840 | 139717 |
| ME | Maine | 1254774 | 447063 | 37964 | 1458888 | 44607 | 49655 | 116864 | 103442 | 0.748 | 0.672 | 29460 | 33942 | 78452 |
| MD | Maryland | 5157328 | 1906880 | 126001 | 6901460 | 126667 | 151427 | 303070 | 301035 | 0.670 | 0.560 | 99998 | 132308 | 185899 |
| MA | Massachusetts | 6226058 | 2859594 | 166986 | 7358985 | 90866 | 104611 | 372934 | 363007 | 0.728 | 0.632 | 101542 | 133549 | 250425 |
| MI | Michigan | 9809051 | 3844460 | 235308 | 11643943 | 382277 | 388841 | 492480 | 495935 | 0.728 | 0.715 | 134173 | 141205 | 356518 |
| MN | Minnesota | 4763390 | 2195621 | 133002 | 6474220 | 279607 | 226619 | 341740 | 330113 | 0.531 | 0.655 | 160225 | 113776 | 198926 |
| MS | Mississippi | 2777004 | 909746 | 59347 | 3553116 | 121577 | 148086 | 172054 | 165700 | 0.597 | 0.490 | 69372 | 84513 | 91934 |
| MO | Missuuri | 5481193 | 2281643 | 143418 | 6959986 | 187537 | 224096 | 323525 | 318600 | 0.594 | 0.497 | 131362 | 160234 | 175265 |
| MT | Montana | 889865 | 273746 | 30757 | 1156906 | 95778 | 47343 | 93894 | 81902 | 0.407 | 0.823 | 55705 | 14511 | 52790 |
| NE | Nebraska | 1686418 | 701132 | 48588 | 2061852 | 120354 | 107313 | 148107 | 134213 | 0.598 | 0.670 | 59584 | 44246 | 89245 |
| NV | Nevada | 1764104 | 768708 | 42343 | 4434815 | 24727 | 39629 | 185942 | 184089 | 0.702 | 0.438 | 55361 | 103423 | 105623 |
| NH | New Hampshire | 1189425 | 497878 | 36692 | 1681488 | 40586 | 30988 | 127296 | 113880 | 0.467 | 0.612 | 67807 | 44177 | 64596 |
| NJ | New Jersey | 8218808 | 3300923 | 229349 | 10477563 | 223902 | 230991 | 437031 | 440582 | 0.672 | 0.652 | 143177 | 153432 | 290502 |
| NM | New Mexico | 1774839 | 533858 | 42477 | 2604633 | 61653 | 44910 | 129866 | 123116 | 0.559 | 0.767 | 57294 | 28667 | 83511 |
| NY | New York | 18656546 | 6895924 | 478480 | 21606752 | 281014 | 327231 | 745069 | 783775 | 0.775 | 0.665 | 167932 | 262403 | 549254 |
| NC | North Carolina | 7656825 | 3167303 | 197488 | 12192102 | 280915 | 315052 | 474219 | 484862 | 0.746 | 0.665 | 120356 | 162260 | 338232 |
| ND | North Dakota | 649716 | 242047 | 20439 | 629753 | 87831 | 69247 | 90940 | 75384 | 0.624 | 0.792 | 34170 | 15696 | 58229 |
| OH | Ohio | 11277357 | 4709180 | 270540 | 12542671 | 510450 | 528418 | 572932 | 570154 | 0.661 | 0.638 | 194357 | 206225 | 371252 |
| OKCO | Oklahoma City Other | 2651927 | 834523 | 62637 | 3346341 | 89839 | 100351 | 123091 | 124931 | 0.690 | 0.584 | 38129 | 51947 | 78973 |
| OR | Oregon | 3304310 | 1292579 | 98564 | 4999717 | 165754 | 182618 | 224712 | 220868 | 0.754 | 0.684 | 55285 | 69718 | 160288 |
| PA | Pennsylvania | 12227814 | 4840877 | 292118 | 13201629 | 548166 | 553646 | 561577 | 565711 | 0.738 | 0.730 | 147370 | 152585 | 413666 |
| RI | Rhode Island | 1025353 | 390914 | 28164 | 1214879 | 22669 | 20541 | 100525 | 87896 | 0.734 | 0.664 | 26742 | 29503 | 66088 |
| SC | South Carolina | 3859696 | 1473831 | 93926 | 5492738 | 115922 | 139732 | 251594 | 247146 | 0.648 | 0.538 | 88582 | 114302 | 147929 |
| SD | South Dakota | 744223 | 279187 | 23486 | 900930 | 36853 | 33586 | 99856 | 84926 | 0.548 | 0.601 | 45136 | 33861 | 52893 |
| TN | Tennessee | 5499233 | 2247944 | 130952 | 7877606 | 208604 | 267550 | 377518 | 370824 | 0.649 | 0.506 | 132695 | 183325 | 216161 |
| TX | Texas | 19740317 | 7250925 | 459024 | 32670184 | 913505 | 968235 | 968676 | 1055814 | 0.838 | 0.791 | 156678 | 220799 | 823507 |
| Tulsa TMA | Tulsa TMA | 720990 | 293211 | 22008 | 912174 | 31565 | 43091 | 59104 | 54670 | 0.690 | 0.584 | 18308 | 22732 | 36367 |
| UT | Utah | 2119784 | 824120 | 50653 | 3655273 | 96429 | 87709 | 180922 | 173904 | 0.698 | 0.768 | 54559 | 40367 | 129951 |
| VT | Vermont | 597239 | 232476 | 21235 | 733730 | 10455 | 15656 | 91466 | 76622 | 0.626 | 0.418 | 34207 | 44590 | 44645 |
| VA | Virginia | 6829183 | 2626844 | 170654 | 9706474 | 254798 | 263495 | 421693 | 421829 | 0.669 | 0.647 | 139746 | 149100 | 277338 |
| WA | Washington | 5674747 | 2081017 | 159684 | 8642609 | 264047 | 269922 | 348071 | 352056 | 0.775 | 0.758 | 78289 | 85124 | 268357 |
| WV | West Virginia | 1819113 | 542782 | 41625 | 1823142 | 233760 | 110049 | 112810 | 102845 | 0.283 | 0.602 | 80839 | 40933 | 46942 |
| WI | Wisconsin | 5266213 | 2277849 | 138427 | 6620470 | 238700 | 275424 | 335945 | 326387 | 0.729 | 0.631 | 91194 | 120305 | 225417 |
| WY | Wyoming | 489451 | 161772 | 17680 | 594775 | 275466 | 45148 | 77956 | 64251 | 0.135 | 0.827 | 67394 | 11137 | 31838 |

Table 6.1.3: Notations

| | |
|---|---|
| **State** | The name of the states in the USA. |
| **StateAbr** | The short writing form of each state in the USA. |
| **Pop** | The population to the corresponding state. |
| **CFSOi97** | The base year Commodity Flow Survey production amount originated from state i for 1997. |
| **CFSAj97** | The base year Commodity Flow Survey attraction amount destined to state j for 1997. |
| **PredOi2030** | The predicted production amount originated from state I for 2030. |
| **PredAj2030** | The predicted attraction amount destined to state j for 2030. |
| **Emp97** | The base year number of employees. |
| **InstProdPer** | The percentage of instate production. |
| **InstAtrPer** | The percentage of instate attraction. |
| **AdjPredOi** | Adjusted CFS production originated from state i |
| **AdjPredAj** | Adjusted CFS attraction destined to state j. |
| **AdjInstPredOiDj** | Adjusted instate production and attraction amount for prediction. |

## 6.2 Methodology and TransCAD Application

Appendix 3 describes the doubly constrained gravity model that TransCAD uses to distribute the freight produced (attracted) by a state to (from) all other states. Appendix 4 illustrates the distribution methodology using TransCAD. Results are discussed in the next section.

## 6.3 Distribution Results

Table 6.3.1 is an example of state to state O-D flows on the total freight by all modes using middle level distribution results.

Table 6.3.1: State to State O-D Flows by All Modes for All Commodities using Middle Level Results (‘000 tons)

| STATE_ABBR | AK | AL | AR | AZ | CA | CO | CT | DC | DE | FL | GA | HI | IA | ID | IL | IN | KS | KY | LA | MA | MD | ME | MI | MN | MO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AK | | 157.14 | 143.22 | 250.74 | 676.81 | 208.99 | 188.29 | 121.92 | 65.27 | 566.32 | 362.09 | 28.28 | 124.10 | 82.29 | 375.10 | 284.77 | 143.74 | 137.27 | 151.12 | 278.43 | 260.13 | 74.30 | 292.87 | 269.66 | 338.68 |
| AL | 184.40 | | 1436.76 | 1574.68 | 3780.49 | 1390.39 | 1449.23 | 1041.52 | 539.47 | 5519.52 | 4731.41 | 131.39 | 976.89 | 444.63 | 3202.87 | 2581.56 | 1163.00 | 1412.08 | 1619.88 | 2084.89 | 2117.99 | 532.29 | 2379.72 | 1920.67 | 3064.43 |
| AR | 173.91 | 1486.71 | | 1564.16 | 3690.54 | 1431.86 | 1257.15 | 878.23 | 458.65 | 4288.94 | 3109.49 | 123.42 | 1008.14 | 436.89 | 3094.19 | 2369.74 | 1326.75 | 1193.36 | 1495.96 | 1818.78 | 1791.78 | 469.40 | 2175.05 | 1907.51 | 3490.78 |
| AZ | 137.08 | 733.59 | 704.20 | | 3956.87 | 1171.18 | 775.22 | 518.63 | 274.94 | 2516.92 | 1648.31 | 101.55 | 573.53 | 386.23 | 1684.87 | 1272.00 | 721.46 | 618.70 | 743.65 | 1134.80 | 1061.50 | 297.77 | 1262.26 | 1193.98 | 1615.32 |
| CA | 465.73 | 2216.86 | 2091.41 | 4980.62 | | 3401.84 | 2423.25 | 1608.55 | 854.80 | 7693.89 | 5019.92 | 346.14 | 1747.35 | 1327.45 | 5160.02 | 3897.57 | 2135.60 | 1889.57 | 2209.14 | 3555.39 | 3294.21 | 936.40 | 3906.88 | 3695.71 | 4855.17 |
| CO | 254.13 | 1440.74 | 1433.87 | 2605.04 | 6011.36 | | 1522.36 | 1022.25 | 540.78 | 4790.83 | 3227.62 | 177.51 | 1243.28 | 754.98 | 3502.05 | 2600.80 | 1605.55 | 1245.93 | 1436.76 | 2224.55 | 2092.50 | 583.40 | 2572.39 | 2581.95 | 3405.10 |
| CT | 192.80 | 1264.55 | 1060.09 | 1451.99 | 3605.82 | 1281.93 | | 1416.02 | 839.29 | 4511.62 | 3071.93 | 131.67 | 909.42 | 434.68 | 3031.97 | 2425.46 | 1000.91 | 1188.21 | 1115.68 | 4491.90 | 2967.02 | 888.63 | 2617.39 | 1916.91 | 2540.61 |
| DC | 99.59 | 724.94 | 590.74 | 774.87 | 1909.30 | 686.66 | 1129.55 | | 562.70 | 2531.22 | 1800.17 | 68.78 | 495.99 | 229.24 | 1691.50 | 1389.62 | 546.95 | 701.61 | 620.97 | 1532.82 | 3303.74 | 367.27 | 1451.48 | 1025.35 | 1412.02 |
| DE | 127.62 | 898.83 | 738.50 | 983.30 | 2428.76 | 869.53 | 1602.60 | 1346.96 | | 3179.26 | 2216.76 | 87.93 | 623.40 | 291.76 | 2108.21 | 1715.19 | 687.78 | 856.90 | 777.98 | 2115.83 | 2948.75 | 494.24 | 1812.62 | 1296.67 | 1764.60 |
| FL | 326.64 | 2761.69 | 2073.87 | 2703.25 | 6564.93 | 2313.32 | 2587.09 | 1819.59 | 954.75 | | 6708.50 | 236.24 | 1547.69 | 762.30 | 4997.98 | 3984.53 | 1826.55 | 2080.50 | 2436.76 | 3739.40 | 3704.25 | 954.14 | 3874.66 | 3138.28 | 4601.28 |
| GA | 277.48 | 3089.82 | 1962.41 | 2310.59 | 5590.47 | 2034.12 | 2299.10 | 1688.98 | 868.86 | 8755.74 | | 196.91 | 1438.43 | 659.47 | 4795.06 | 3924.29 | 1671.91 | 2187.06 | 2168.63 | 3293.16 | 3425.86 | 834.74 | 3665.13 | 2862.95 | 4386.64 |
| HI | 4.53 | 17.93 | 16.27 | 29.74 | 80.53 | 23.37 | 20.59 | 13.48 | 7.20 | 64.42 | 41.14 | | 13.57 | 8.84 | 41.15 | 31.40 | 16.08 | 15.30 | 17.51 | 30.35 | 27.63 | 8.03 | 31.85 | 28.90 | 37.79 |
| IA | 162.15 | 1087.71 | 1084.79 | 1370.76 | 3317.87 | 1335.95 | 1160.48 | 793.43 | 416.60 | 3444.12 | 2452.53 | 110.77 | | 413.14 | 3393.96 | 2300.94 | 1204.85 | 1031.46 | 1012.93 | 1683.68 | 1623.63 | 438.33 | 2212.53 | 2396.61 | 3065.36 |
| ID | 114.70 | 528.13 | 501.50 | 984.74 | 2688.65 | 865.41 | 591.72 | 391.20 | 207.99 | 1809.62 | 1199.47 | 76.95 | 440.73 | | 1282.08 | 959.93 | 526.43 | 459.92 | 517.60 | 868.73 | 801.60 | 229.49 | 970.54 | 953.84 | 1191.72 |
| IL | 452.28 | 3290.88 | 3072.40 | 3716.06 | 9041.38 | 3472.53 | 3570.29 | 2496.97 | 1300.10 | 10263.46 | 7544.42 | 309.91 | 3131.93 | 1109.05 | | 8900.16 | 3003.32 | 3457.91 | 2921.56 | 5142.67 | 5105.18 | 1326.44 | 7624.03 | 5854.64 | 8415.14 |
| IN | 279.73 | 2160.97 | 1917.00 | 2285.57 | 5563.77 | 2100.99 | 2326.62 | 1671.21 | 861.72 | 6666.04 | 5030.19 | 192.68 | 1729.83 | 676.50 | 7250.86 | | 1789.59 | 2542.42 | 1857.56 | 3331.52 | 3410.38 | 851.91 | 4947.24 | 3953.64 | 4992.09 |
| KS | 232.02 | 1699.73 | 1763.66 | 2130.22 | 5009.54 | 2131.29 | 1577.85 | 1080.89 | 567.81 | 5021.40 | 3521.58 | 162.14 | 1488.44 | 609.63 | 4020.65 | 2940.73 | | 1401.50 | 1576.56 | 2292.19 | 2209.70 | 596.27 | 2791.18 | 2740.98 | 4482.92 |
| KY | 236.83 | 2076.06 | 1695.54 | 1952.56 | 4737.54 | 1767.77 | 2002.06 | 1481.99 | 756.14 | 6113.28 | 4923.79 | 164.93 | 1361.97 | 569.28 | 4947.91 | 4465.43 | 1497.99 | | 1680.27 | 2856.98 | 3011.22 | 725.28 | 3668.48 | 2659.07 | 4147.86 |
| LA | 205.40 | 1876.26 | 1674.52 | 1848.93 | 4363.60 | 1606.00 | 1481.01 | 1033.36 | 540.84 | 5640.92 | 3846.42 | 148.69 | 1053.72 | 504.74 | 3293.47 | 2570.33 | 1327.57 | 1323.77 | | 2144.95 | 2107.13 | 552.77 | 2424.34 | 2075.91 | 3299.74 |
| MA | 240.26 | 1533.09 | 1292.48 | 1791.21 | 4458.43 | 1578.62 | 3785.46 | 1619.36 | 933.81 | 5495.56 | 3708.14 | 163.56 | 1111.93 | 537.81 | 3680.45 | 2926.59 | 1225.37 | 1428.93 | 1361.72 | | 3374.08 | 1261.28 | 3159.71 | 2354.20 | 3095.86 |
| MD | 214.17 | 1545.40 | 1263.45 | 1662.58 | 4099.01 | 1473.45 | 2481.09 | 3463.32 | 1291.36 | 5401.87 | 3827.77 | 147.77 | 1063.99 | 492.42 | 3625.40 | 2972.73 | 1172.15 | 1494.45 | 1327.38 | 3348.03 | | 798.66 | 3121.46 | 2203.19 | 3022.79 |
| ME | 72.81 | 444.49 | 378.81 | 533.75 | 1333.47 | 470.15 | 850.43 | 440.62 | 247.71 | 1592.41 | 1067.40 | 49.18 | 328.74 | 161.34 | 1078.03 | 849.86 | 361.99 | 411.95 | 398.51 | 1432.33 | 914.03 | | 921.36 | 701.59 | 908.87 |
| MI | 317.03 | 2195.22 | 1939.01 | 2499.43 | 6145.99 | 2290.02 | 2767.09 | 1923.68 | 1003.57 | 7143.51 | 5177.25 | 215.37 | 1833.04 | 753.75 | 6844.84 | 5451.92 | 1871.86 | 2301.74 | 1930.78 | 3963.82 | 3946.31 | 1017.81 | | 3805.91 | 4934.44 |
| MN | 430.74 | 2614.42 | 2509.26 | 3488.67 | 8578.85 | 3391.72 | 2990.39 | 2005.23 | 1059.35 | 8537.65 | 5967.50 | 288.37 | 2929.89 | 1093.10 | 7756.19 | 5453.46 | 2712.44 | 2461.90 | 2439.59 | 4357.93 | 4110.13 | 1143.64 | 5616.02 | | 6560.32 |
| MO | 319.11 | 2460.50 | 2708.66 | 2784.03 | 6647.95 | 2638.48 | 2337.84 | 1628.86 | 850.38 | 7383.77 | 5393.41 | 222.38 | 2210.48 | 805.58 | 6576.00 | 4788.40 | 2616.78 | 2265.25 | 2287.39 | 3380.41 | 3326.32 | 873.90 | 4294.97 | 3869.70 | |
| MS | 162.15 | 1789.25 | 1413.88 | 1424.86 | 3388.99 | 1259.21 | 1214.25 | 857.80 | 446.83 | 4538.81 | 3365.20 | 116.11 | 865.57 | 396.72 | 2761.18 | 2179.02 | 1067.84 | 1147.18 | 1710.21 | 1753.26 | 1747.44 | 450.20 | 2017.28 | 1689.22 | 2770.42 |
| MT | 183.26 | 858.27 | 815.99 | 1484.36 | 3893.17 | 1391.58 | 972.82 | 642.18 | 341.48 | 2924.78 | 1952.48 | 119.78 | 737.25 | 645.32 | 2129.02 | 1586.59 | 864.96 | 755.44 | 834.37 | 1428.36 | 1316.24 | 377.75 | 1612.08 | 1622.17 | 1962.14 |
| NC | 270.64 | 2262.01 | 1724.13 | 2170.70 | 5307.23 | 1914.66 | 2534.59 | 2025.02 | 1010.52 | 7806.98 | 5989.94 | 189.71 | 1370.76 | 631.27 | 4652.93 | 3855.85 | 1545.31 | 2084.00 | 1845.60 | 3578.62 | 4063.91 | 889.52 | 3758.86 | 2779.97 | 4024.98 |
| ND | 99.43 | 537.05 | 514.07 | 794.32 | 1983.16 | 785.61 | 617.74 | 409.26 | 217.17 | 1791.50 | 1224.54 | 65.36 | 517.60 | 264.94 | 1440.17 | 1050.24 | 558.28 | 488.58 | 511.07 | 904.66 | 839.10 | 238.90 | 1079.26 | 1255.23 | 1287.15 |
| NE | 154.27 | 981.04 | 1007.24 | 1373.20 | 3282.51 | 1430.45 | 1027.60 | 697.25 | 367.28 | 3149.10 | 2193.92 | 106.01 | 1052.79 | 411.93 | 2629.07 | 1890.13 | 1296.23 | 882.88 | 947.54 | 1495.73 | 1426.82 | 390.69 | 1839.81 | 1997.17 | 2628.70 |
| NH | 157.37 | 991.34 | 839.91 | 1168.21 | 2910.57 | 1030.97 | 2215.63 | 1027.90 | 586.35 | 3539.03 | 2390.81 | 106.77 | 726.97 | 351.81 | 2403.22 | 1905.75 | 799.08 | 926.00 | 882.78 | 4161.80 | 2139.60 | 906.12 | 2070.36 | 1544.18 | 2016.55 |
| NJ | 316.30 | 2151.21 | 1786.96 | 2411.36 | 5971.22 | 2131.80 | 4772.90 | 2689.50 | 1735.65 | 7635.00 | 5261.86 | 216.97 | 1522.85 | 718.76 | 5119.96 | 4131.54 | 1676.32 | 2039.84 | 1880.16 | 5859.50 | 5714.13 | 1310.76 | 4427.58 | 3188.67 | 4279.88 |
| NM | 160.43 | 934.24 | 923.70 | 1992.82 | 4038.55 | 1604.55 | 960.89 | 647.10 | 342.24 | 3139.34 | 2082.65 | 116.34 | 740.79 | 449.50 | 2150.71 | 1617.44 | 968.18 | 786.15 | 957.52 | 1403.73 | 1323.92 | 367.38 | 1590.25 | 1518.25 | 2107.28 |
| NV | 175.42 | 857.08 | 815.33 | 1996.32 | 6124.57 | 1389.12 | 932.92 | 620.21 | 329.36 | 2952.13 | 1937.49 | 127.12 | 685.72 | 540.73 | 2011.11 | 1514.76 | 842.26 | 732.65 | 854.40 | 1367.98 | 1270.10 | 360.14 | 1516.48 | 1450.36 | 1899.10 |
| NY | 390.36 | 2609.07 | 2186.03 | 2962.11 | 7343.31 | 2625.16 | 6170.16 | 3077.94 | 1836.38 | 9195.98 | 6346.69 | 266.64 | 1882.63 | 886.51 | 6332.40 | 5092.70 | 2061.79 | 2488.87 | 2289.88 | 7495.33 | 6498.33 | 1672.38 | 5539.87 | 3958.99 | 5259.46 |
| OH | 445.68 | 3347.78 | 2834.31 | 3549.58 | 8697.43 | 3214.88 | 4103.48 | 3064.10 | 1556.43 | 10782.89 | 8056.78 | 306.23 | 2487.90 | 1054.65 | 9189.71 | 8150.88 | 2642.40 | 3758.05 | 2855.89 | 5807.00 | 6251.64 | 1464.84 | 8399.61 | 5043.87 | 7047.55 |
| OKCO | 95.74 | 678.43 | 768.79 | 921.70 | 2121.26 | 873.86 | 642.34 | 440.52 | 231.51 | 2136.72 | 1474.75 | 68.16 | 534.04 | 250.39 | 1541.22 | 1155.55 | 809.70 | 564.79 | 708.42 | 933.54 | 900.14 | 242.59 | 1099.36 | 1029.97 | 1656.00 |
| OR | 204.65 | 851.94 | 798.45 | 1570.78 | 4562.88 | 1289.47 | 966.00 | 635.94 | 338.66 | 2954.03 | 1941.25 | 136.32 | 692.26 | 623.45 | 2041.51 | 1536.79 | 822.30 | 739.18 | 833.66 | 1420.45 | 1303.34 | 375.90 | 1558.66 | 1496.55 | 1885.84 |
| PA | 324.04 | 2279.04 | 1890.91 | 2601.48 | 6175.99 | 2225.33 | 3875.96 | 3154.53 | 1686.34 | 7890.09 | 5585.80 | 222.38 | 1619.57 | 744.92 | 5540.18 | 4529.80 | 1768.82 | 2232.42 | 1972.05 | 5190.11 | 6776.14 | 1237.53 | 4888.90 | 3371.13 | 4559.83 |
| RI | 59.65 | 383.93 | 322.68 | 446.01 | 1109.39 | 392.84 | 1006.31 | 410.87 | 238.75 | 1379.06 | 930.39 | 40.69 | 276.66 | 133.68 | 916.66 | 730.18 | 305.28 | 357.54 | 340.40 | 1859.87 | 856.67 | 296.64 | 786.62 | 584.61 | 771.95 |
| SC | 197.78 | 1797.82 | 1301.82 | 1609.52 | 3920.05 | 1414.69 | 1743.93 | 1321.55 | 673.61 | 6147.26 | 5124.11 | 139.62 | 1002.67 | 463.95 | 3389.43 | 2773.76 | 1146.32 | 1521.14 | 1418.01 | 2483.28 | 2670.10 | 623.47 | 2656.11 | 2020.22 | 2985.63 |
| SD | 124.06 | 721.08 | 709.96 | 1060.53 | 2588.62 | 1106.69 | 793.85 | 532.12 | 281.36 | 2366.97 | 1630.07 | 83.60 | 738.57 | 337.57 | 1939.97 | 1402.20 | 813.57 | 652.67 | 691.78 | 1159.02 | 1090.00 | 304.37 | 1406.42 | 1657.05 | 1802.38 |
| TN | 303.57 | 3178.25 | 2355.69 | 2554.74 | 6160.03 | 2296.61 | 2462.23 | 1795.67 | 923.09 | 8264.66 | 7075.35 | 213.54 | 1706.31 | 733.69 | 5840.73 | 4866.29 | 1960.22 | 2922.33 | 2359.19 | 3528.80 | 3649.39 | 898.80 | 4262.05 | 3313.87 | 5407.25 |
| Tulsa TMA | 44.43 | 327.11 | 394.50 | 414.75 | 966.35 | 394.28 | 305.32 | 210.34 | 110.35 | 1009.72 | 707.91 | 31.46 | 260.84 | 115.01 | 752.63 | 562.79 | 406.98 | 274.74 | 334.84 | 443.15 | 429.68 | 114.98 | 529.42 | 492.76 | 847.41 |
| TX | 424.33 | 3085.56 | 3145.11 | 4146.80 | 9477.74 | 3551.13 | 2834.95 | 1944.29 | 1022.88 | 10014.42 | 6671.32 | 309.61 | 2123.69 | 1079.16 | 6382.28 | 4878.78 | 2818.97 | 2433.96 | 3539.84 | 4122.67 | 3971.20 | 1069.98 | 4677.39 | 4210.76 | 6476.79 |
| UT | 167.48 | 843.92 | 812.89 | 1729.28 | 4364.23 | 1548.45 | 919.62 | 612.09 | 324.79 | 2870.08 | 1905.61 | 116.76 | 701.77 | 587.75 | 2027.05 | 1516.70 | 862.55 | 728.81 | 836.66 | 1347.56 | 1253.57 | 354.76 | 1518.75 | 1492.44 | 1917.76 |
| VA | 308.01 | 2335.65 | 1870.18 | 2420.68 | 5849.62 | 2142.33 | 3233.27 | 3185.96 | 1424.72 | 8136.31 | 5883.87 | 213.80 | 1545.21 | 712.19 | 5274.40 | 4359.29 | 1714.59 | 2250.95 | 1974.50 | 4470.18 | 6151.66 | 1087.71 | 4439.10 | 3172.38 | 4443.02 |
| VT | 81.03 | 508.05 | 432.90 | 601.39 | 1498.54 | 532.78 | 1040.66 | 522.36 | 294.77 | 1796.37 | 1221.88 | 54.77 | 378.40 | 181.74 | 1253.90 | 992.56 | 413.46 | 478.62 | 452.70 | 1640.11 | 1087.12 | 427.36 | 1092.32 | 806.53 | 1044.37 |
| WA | 300.25 | 1221.34 | 1143.17 | 2173.53 | 6113.32 | 1833.85 | 1397.67 | 918.22 | 489.22 | 4230.69 | 2786.97 | 192.54 | 1000.91 | 885.97 | 2950.77 | 2218.88 | 1179.49 | 1064.80 | 1189.92 | 2056.26 | 1882.25 | 544.84 | 2257.86 | 2176.11 | 2712.02 |
| WI | 225.18 | 1490.95 | 1393.39 | 1810.62 | 4439.24 | 1705.54 | 1729.77 | 1178.37 | 618.98 | 4800.61 | 3433.61 | 152.25 | 1547.68 | 552.22 | 5267.80 | 3489.72 | 1418.95 | 1484.52 | 1350.87 | 2504.72 | 2414.75 | 651.86 | 3699.02 | 3252.55 | 3703.27 |
| WV | 173.02 | 1351.53 | 1095.30 | 1376.53 | 3372.63 | 1231.81 | 1677.24 | 1384.76 | 672.55 | 4439.17 | 3359.56 | 119.73 | 917.29 | 405.71 | 3235.00 | 2768.19 | 1002.80 | 1442.48 | 1130.54 | 2349.21 | 2788.46 | 583.53 | 2754.10 | 1863.52 | 2646.04 |
| WY | 199.15 | 1050.06 | 1023.04 | 1857.30 | 4562.02 | 2091.31 | 1147.75 | 765.19 | 405.63 | 3524.44 | 2370.25 | 135.66 | 922.03 | 639.95 | 2604.12 | 1930.72 | 1122.73 | 919.51 | 1031.42 | 1680.24 | 1567.27 | 442.21 | 1934.58 | 1980.76 | 2462.05 |
| **Total Ajs** | **11268.82** | **77628.66** | **68372.75** | **94800.97** | **224604.75** | **83344.53** | **94476.81** | **66277.29** | **34510.99** | **248338.43** | **178502.27** | **7850.45** | **57945.21** | **28344.59** | **179191.94** | **143744.51** | **65046.00** | **70265.79** | **69840.11** | **133548.68** | **132308.04** | **33941.60** | **141205.26** | **113776.11** | **160234.35** |

| STATE_ABBR | MS | MT | NC | ND | NE | NH | NJ | NM | NV | NY | OH | OKCO | OR | PA | RI | SC | SD | TN | Tulsa TMA | TX | UT | VA | VT | WA | WI | WV | WY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AK | 174.77 | 42.09 | 322.76 | 39.70 | 99.65 | 92.19 | 302.99 | 71.49 | 288.16 | 529.99 | 416.16 | 114.10 | 226.55 | 298.78 | 58.66 | 227.65 | 80.56 | 367.42 | 49.30 | 521.54 | 109.18 | 292.53 | 93.43 | 286.92 | 256.85 | 78.34 | 29.06 |
| AL | 2263.09 | 231.31 | 3166.72 | 251.62 | 743.66 | 681.52 | 2418.18 | 488.56 | 1652.19 | 4156.83 | 3668.35 | 946.81 | 1106.72 | 2465.95 | 443.11 | 2428.38 | 549.47 | 4514.07 | 417.28 | 4450.40 | 645.60 | 2603.10 | 687.44 | 1369.60 | 1995.66 | 718.14 | 179.82 |
| AR | 1850.49 | 227.56 | 2496.83 | 249.23 | 790.06 | 597.49 | 2078.57 | 499.84 | 1626.34 | 3603.91 | 3213.68 | 1112.57 | 1073.30 | 2117.12 | 386.37 | 1819.54 | 559.80 | 3462.10 | 520.75 | 4684.01 | 643.48 | 2156.80 | 606.12 | 1326.51 | 1909.92 | 602.22 | 181.29 |
| AZ | 839.58 | 186.36 | 1415.26 | 173.37 | 484.93 | 374.14 | 1262.78 | 485.49 | 1792.78 | 2198.55 | 1811.96 | 600.51 | 950.61 | 1260.92 | 239.81 | 1012.80 | 376.48 | 1690.38 | 246.48 | 2786.36 | 616.29 | 1256.84 | 379.08 | 1135.49 | 1129.04 | 340.74 | 148.17 |
| CA | 2513.57 | 615.25 | 4355.49 | 544.86 | 1459.08 | 1173.34 | 3936.05 | 1238.43 | 6923.16 | 6860.55 | 5588.49 | 1739.64 | 3475.84 | 3918.58 | 750.83 | 3104.94 | 1156.69 | 5130.43 | 722.88 | 8016.05 | 1957.76 | 3888.33 | 1189.00 | 4020.00 | 3484.35 | 1050.85 | 458.12 |
| CO | 1650.35 | 388.61 | 2776.64 | 381.40 | 1123.58 | 734.43 | 2483.15 | 869.48 | 2774.78 | 4333.92 | 3650.29 | 1266.39 | 1735.76 | 2495.03 | 469.81 | 1980.08 | 873.85 | 3380.00 | 521.18 | 5307.40 | 1227.46 | 2474.11 | 747.00 | 2130.94 | 2365.56 | 678.22 | 371.11 |
| CT | 1340.09 | 228.76 | 3095.15 | 252.54 | 679.68 | 1329.07 | 4681.50 | 438.46 | 1569.20 | 8577.66 | 3923.40 | 783.86 | 1094.97 | 3669.38 | 1013.42 | 2055.40 | 527.83 | 3051.44 | 339.85 | 3567.85 | 613.86 | 3144.28 | 1228.66 | 1367.60 | 2020.25 | 777.63 | 171.50 |
| DC | 755.17 | 120.46 | 1972.60 | 133.46 | 367.87 | 491.86 | 2104.31 | 235.54 | 832.16 | 3413.25 | 2336.94 | 428.82 | 575.01 | 2375.73 | 330.07 | 1242.47 | 282.23 | 1775.16 | 186.76 | 1951.90 | 325.92 | 2471.47 | 491.95 | 716.70 | 1097.83 | 512.14 | 91.21 |
| DE | 941.64 | 153.33 | 2356.32 | 169.52 | 463.87 | 671.61 | 3250.72 | 298.19 | 1057.85 | 4874.72 | 2841.53 | 539.44 | 733.00 | 3040.10 | 459.10 | 1515.96 | 357.22 | 2184.41 | 234.53 | 2458.10 | 413.98 | 2645.60 | 664.53 | 914.06 | 1380.42 | 595.41 | 115.74 |
| FL | 2872.41 | 394.39 | 5466.83 | 419.97 | 1194.39 | 1217.35 | 4294.28 | 821.42 | 2847.40 | 7330.76 | 5911.85 | 1495.19 | 1920.08 | 4271.58 | 796.38 | 4154.58 | 902.45 | 5873.27 | 644.49 | 7227.13 | 1098.57 | 4537.18 | 1216.17 | 2373.80 | 3215.09 | 1180.21 | 301.99 |
| GA | 2779.60 | 343.63 | 5474.48 | 374.66 | 1086.04 | 1073.35 | 3862.68 | 711.24 | 2439.05 | 6803.38 | 5765.23 | 1346.90 | 1646.85 | 3946.93 | 701.24 | 4519.93 | 811.16 | 6562.52 | 589.74 | 6283.76 | 952.00 | 4282.42 | 1079.69 | 2040.96 | 3001.35 | 1165.75 | 265.07 |
| HI | 20.04 | 4.40 | 36.22 | 4.18 | 10.96 | 10.01 | 33.27 | 8.30 | 33.43 | 57.96 | 45.78 | 13.01 | 24.16 | 32.83 | 6.41 | 25.73 | 8.69 | 41.38 | 5.48 | 60.92 | 12.19 | 32.51 | 10.11 | 29.46 | 27.80 | 8.68 | 3.17 |
| IA | 1218.99 | 221.23 | 2136.03 | 270.01 | 888.57 | 556.47 | 1906.04 | 431.34 | 1471.81 | 3339.72 | 3035.39 | 831.60 | 1001.31 | 1951.19 | 355.53 | 1507.98 | 626.64 | 2688.41 | 370.49 | 3410.55 | 597.76 | 1917.52 | 570.09 | 1249.75 | 2306.60 | 542.69 | 175.81 |
| ID | 596.02 | 206.57 | 1049.38 | 147.44 | 370.89 | 287.28 | 959.68 | 279.20 | 1238.10 | 1677.63 | 1372.65 | 415.94 | 961.99 | 957.38 | 183.26 | 744.35 | 305.54 | 1237.74 | 174.26 | 1848.80 | 534.06 | 942.79 | 292.09 | 1180.10 | 877.96 | 256.06 | 130.17 |
| IL | 3588.37 | 589.54 | 6890.80 | 693.29 | 2047.66 | 1697.55 | 5913.53 | 1155.61 | 3983.34 | 10366.16 | 10346.39 | 2214.69 | 2724.94 | 6159.28 | 1087.04 | 4676.28 | 1518.89 | 8523.55 | 986.49 | 9458.33 | 1893.30 | 6039.91 | 1743.25 | 3399.91 | 7244.79 | 1766.16 | 458.21 |
| IN | 2307.04 | 357.92 | 4517.14 | 411.89 | 1199.33 | 1096.70 | 3887.62 | 708.02 | 2444.26 | 6791.88 | 7476.24 | 1352.79 | 1671.13 | 4102.76 | 705.43 | 3136.21 | 894.40 | 5785.53 | 600.97 | 5980.36 | 971.24 | 4066.91 | 1124.21 | 2082.85 | 3910.02 | 1231.24 | 276.77 |
| KS | 1857.83 | 320.64 | 2974.82 | 359.79 | 1351.55 | 755.64 | 2591.97 | 696.43 | 2233.33 | 4518.45 | 3982.72 | 1557.64 | 1469.36 | 2632.59 | 484.65 | 2129.82 | 852.74 | 3829.60 | 714.14 | 5592.72 | 907.64 | 2628.51 | 769.53 | 1819.37 | 2612.50 | 732.93 | 264.47 |
| KY | 2133.25 | 299.32 | 4288.03 | 336.55 | 983.94 | 935.94 | 3371.19 | 604.42 | 2076.43 | 5829.90 | 6054.20 | 1161.30 | 1411.76 | 3551.31 | 606.69 | 3020.80 | 731.19 | 6102.26 | 515.27 | 5161.31 | 819.70 | 3688.33 | 952.14 | 1755.53 | 2921.39 | 1126.87 | 231.51 |
| LA | 2505.48 | 260.45 | 2991.78 | 277.35 | 831.94 | 702.94 | 2448.01 | 579.98 | 1907.71 | 4225.73 | 3624.66 | 1147.57 | 1254.38 | 2471.52 | 455.06 | 2218.51 | 610.58 | 3881.11 | 494.75 | 5913.73 | 741.35 | 2548.90 | 709.49 | 1545.58 | 2084.34 | 695.79 | 204.59 |
| MA | 1630.65 | 283.06 | 3662.81 | 311.67 | 833.72 | 2103.88 | 4843.42 | 539.79 | 1939.12 | 8781.18 | 4678.97 | 960.05 | 1356.88 | 4129.47 | 1578.45 | 2466.51 | 649.43 | 3685.46 | 415.69 | 4372.50 | 758.04 | 3663.48 | 1631.86 | 1895.59 | 2465.28 | 917.89 | 211.59 |
| MD | 1612.69 | 258.83 | 4149.92 | 286.85 | 789.17 | 1073.26 | 4686.78 | 505.17 | 1766.46 | 7554.34 | 4998.34 | 918.55 | 1235.40 | 5349.74 | 721.43 | 2631.58 | 606.04 | 3781.97 | 399.95 | 4179.31 | 699.73 | 5002.58 | 1073.30 | 1540.12 | 2368.37 | 1081.10 | 195.84 |
| ME | 475.50 | 86.01 | 1039.56 | 93.47 | 247.30 | 520.18 | 1230.40 | 160.43 | 579.73 | 2224.99 | 1340.35 | 283.32 | 407.77 | 1118.16 | 286.90 | 703.23 | 193.68 | 1066.00 | 122.48 | 1288.72 | 226.63 | 1012.31 | 482.88 | 510.21 | 728.60 | 258.92 | 63.24 |
| MI | 2353.68 | 400.77 | 4862.73 | 466.45 | 1286.50 | 1312.96 | 4591.19 | 767.14 | 2696.67 | 8141.95 | 8490.33 | 1418.30 | 1867.82 | 4679.73 | 836.42 | 3309.55 | 986.61 | 5584.06 | 623.00 | 6223.31 | 1071.76 | 4563.84 | 1363.42 | 2335.66 | 4567.32 | 1349.93 | 305.61 |
| MN | 2908.28 | 595.08 | 5295.90 | 800.52 | 2060.73 | 1445.02 | 4879.08 | 1080.74 | 3805.71 | 6585.84 | 7523.13 | 1960.74 | 2644.55 | 4965.11 | 918.44 | 3714.42 | 1718.76 | 6406.75 | 855.65 | 8267.00 | 1554.10 | 4812.72 | 1485.48 | 3321.71 | 5926.09 | 1347.84 | 461.72 |
| MO | 2813.51 | 424.58 | 4522.89 | 484.20 | 1599.92 | 1113.11 | 3862.89 | 884.81 | 2939.42 | 6728.09 | 6200.48 | 1859.56 | 1967.02 | 3961.46 | 715.37 | 3238.03 | 1102.75 | 6166.37 | 867.98 | 7500.65 | 1177.96 | 3975.90 | 1134.63 | 2441.89 | 3979.99 | 1128.89 | 338.53 |
| MS | | 205.84 | 2518.79 | 222.58 | 670.01 | 574.27 | 2015.05 | 446.25 | 1483.59 | 3475.92 | 3048.21 | 893.88 | 984.48 | 2047.12 | 372.14 | 1881.74 | 490.08 | 3504.06 | 393.68 | 4259.66 | 579.94 | 2124.68 | 580.13 | 1216.14 | 1729.71 | 586.00 | 161.35 |
| MT | 966.07 | | 1714.97 | 260.57 | 619.95 | 472.81 | 1576.94 | 434.53 | 1764.26 | 2760.73 | 2265.71 | 672.91 | 1348.00 | 1575.24 | 301.15 | 1213.59 | 525.15 | 2023.65 | 283.46 | 2954.14 | 765.60 | 1545.45 | 481.59 | 1739.95 | 1470.46 | 420.85 | 218.91 |
| NC | 2276.37 | 330.25 | | 362.70 | 1023.71 | 1158.46 | 4359.29 | 662.86 | 2313.03 | 7336.63 | 6107.31 | 1225.11 | 1581.28 | 4507.15 | 765.62 | 4780.34 | 775.68 | 5468.94 | 534.66 | 5638.18 | 903.73 | 5503.39 | 1159.72 | 1965.25 | 2952.34 | 1354.53 | 252.14 |
| ND | 600.89 | 149.89 | 1083.43 | | 423.39 | 300.02 | 1003.01 | 243.04 | 885.14 | 1762.37 | 1482.49 | 414.74 | 628.43 | 1009.95 | 190.59 | 762.51 | 404.80 | 1290.63 | 177.88 | 1768.75 | 368.95 | 982.36 | 307.34 | 795.97 | 1031.12 | 270.85 | 113.23 |
| NE | 1117.96 | 220.41 | 1890.04 | 261.69 | | 494.07 | 1682.68 | 441.11 | 1468.98 | 2942.28 | 2575.71 | 843.68 | 982.44 | 1707.41 | 315.88 | 1342.94 | 673.55 | 2366.45 | 368.26 | 3324.94 | 607.53 | 1687.42 | 504.46 | 1222.53 | 1778.10 | 470.29 | 183.51 |
| NH | 1056.55 | 185.35 | 2358.33 | 204.47 | 544.78 | | 2897.38 | 351.94 | 1266.18 | 5531.92 | 3040.86 | 625.12 | 887.53 | 2639.23 | 765.71 | 1583.94 | 425.18 | 2386.01 | 270.64 | 2841.97 | 495.34 | 2332.87 | 1214.54 | 1109.74 | 1616.18 | 591.52 | 138.37 |
| NJ | 2267.30 | 378.07 | 5427.34 | 418.05 | 1134.69 | 1833.12 | | 729.87 | 2600.01 | 14969.21 | 6781.93 | 1313.18 | 1807.68 | 6987.27 | 1283.73 | 3554.59 | 677.43 | 5213.43 | 570.23 | 5977.41 | 1017.54 | 5732.30 | 1792.41 | 2256.01 | 3382.60 | 1374.69 | 284.47 |
| NM | 1079.33 | 223.93 | 1773.98 | 217.75 | 639.40 | 462.67 | 1568.92 | | 1838.24 | 2731.18 | 2283.44 | 824.42 | 1080.66 | 1572.60 | 296.73 | 1272.03 | 484.53 | 2155.94 | 332.05 | 3709.78 | 721.53 | 1570.56 | 469.22 | 1310.65 | 1433.35 | 428.13 | 187.02 |
| NV | 973.43 | 246.65 | 1679.27 | 215.13 | 577.64 | 451.56 | 1516.15 | 498.68 | | 2643.77 | 2165.01 | 684.14 | 1333.75 | 1511.79 | 288.87 | 1196.92 | 459.00 | 1988.30 | 283.76 | 3115.67 | 850.10 | 1499.22 | 457.97 | 1553.39 | 1369.54 | 406.18 | 187.39 |
| NY | 2759.45 | 466.99 | 6444.63 | 518.26 | 1399.88 | 2387.01 | 10561.58 | 896.46 | 3198.79 | | 6372.64 | 1610.77 | 2228.64 | 8454.09 | 1613.31 | 4251.81 | 1085.14 | 6341.11 | 699.52 | 7309.16 | 1253.42 | 6674.72 | 2390.43 | 2783.51 | 4207.85 | 1662.41 | 360.91 |
| OH | 3518.54 | 567.25 | 7800.37 | 633.88 | 1781.84 | 1907.62 | 6957.40 | 1089.76 | 3808.76 | 12173.79 | | 2031.02 | 2621.84 | 7635.11 | 1231.39 | 5227.35 | 1353.67 | 8691.75 | 893.13 | 9022.27 | 1505.33 | 7373.53 | 1960.87 | 3270.42 | 5713.70 | 2421.15 | 426.06 |
| OKCO | 808.41 | 129.67 | 1225.96 | 138.94 | 457.29 | 307.29 | 1055.49 | 308.27 | 942.99 | 1835.00 | 1591.30 | | 608.03 | 1067.69 | 197.54 | 884.65 | 318.25 | 1574.58 | 346.56 | 2729.78 | 376.76 | 1074.54 | 311.96 | 748.77 | 997.38 | 296.95 | 106.34 |
| OR | 958.53 | 279.65 | 1703.56 | 226.65 | 573.27 | 469.69 | 1584.21 | 435.02 | 1979.16 | 2733.29 | 2211.51 | 664.59 | | 1555.44 | 299.62 | 1207.94 | 466.77 | 1989.91 | 274.86 | 2957.85 | 742.46 | 1531.86 | 476.89 | 2497.30 | 1384.94 | 414.15 | 184.35 |
| PA | 2392.99 | 392.35 | 5829.73 | 437.32 | 1196.16 | 1676.87 | 7259.09 | 760.05 | 2693.38 | 12448.34 | 7732.08 | 1380.03 | 1867.46 | | 1112.10 | 3774.23 | 921.35 | 5606.98 | 601.07 | 6248.07 | 1056.87 | 6386.12 | 1703.09 | 2330.38 | 3629.41 | 1694.71 | 296.44 |
| RI | 407.82 | 70.32 | 928.38 | 77.37 | 207.46 | 456.10 | 1250.31 | 134.45 | 482.48 | 2227.06 | 1169.09 | 239.37 | 337.24 | 1042.59 | | 620.48 | 161.41 | 922.49 | 103.66 | 1091.20 | 188.55 | 927.35 | 383.58 | 421.28 | 612.56 | 230.55 | 52.61 |
| SC | 1762.05 | 242.14 | 4952.97 | 264.48 | 753.65 | 806.16 | 2958.18 | 492.47 | 1708.17 | 5015.10 | 4240.57 | 915.96 | 1161.73 | 3023.36 | 530.18 | | 568.19 | 4167.45 | 399.75 | 4251.36 | 666.35 | 3433.84 | 807.78 | 1441.78 | 2129.03 | 894.73 | 185.52 |
| SD | 813.46 | 185.73 | 1424.63 | 248.89 | 670.03 | 383.59 | 1294.37 | 332.52 | 1161.17 | 2268.83 | 1946.55 | 584.10 | 795.74 | 1308.27 | 244.48 | 1007.17 | | 1734.64 | 251.05 | 2417.81 | 487.61 | 1282.31 | 392.28 | 997.37 | 1362.11 | 355.36 | 152.99 |
| TN | 3120.48 | 383.99 | 5388.91 | 425.74 | 1262.99 | 1154.91 | 4126.20 | 793.80 | 2698.62 | 7113.15 | 6705.65 | 1550.45 | 1820.05 | 4271.50 | 749.63 | 3982.36 | 930.65 | | 689.37 | 6982.65 | 1061.89 | 4487.15 | 1169.99 | 2258.06 | 3530.38 | 1292.32 | 298.47 |
| Tulsa TMA | 390.33 | 59.88 | 586.56 | 66.33 | 218.82 | 145.85 | 502.48 | 136.12 | 428.80 | 873.64 | 767.17 | 379.94 | 279.70 | 509.82 | 93.78 | 423.27 | 149.96 | 767.53 | | 1208.06 | 171.54 | 513.49 | 148.17 | 345.26 | 481.85 | 142.67 | 48.76 |
| TX | 3735.42 | 551.98 | 5470.81 | 574.55 | 1747.44 | 1354.59 | 4658.59 | 1345.05 | 4164.13 | 8073.81 | 6854.31 | 2646.90 | 2664.05 | 4687.19 | 873.18 | 3981.38 | 1277.37 | 6875.98 | 1068.47 | | 1615.07 | 4756.74 | 1370.09 | 3266.58 | 4133.32 | 1298.45 | 441.28 |
| UT | 958.86 | 269.71 | 1653.31 | 225.96 | 601.99 | 445.14 | 1495.19 | 493.23 | 2142.13 | 2610.42 | 2156.17 | 688.77 | 1260.78 | 1494.83 | 284.46 | 1176.56 | 485.70 | 1971.50 | 286.05 | 3045.06 | | 1478.53 | 452.31 | 1516.54 | 1377.49 | 402.43 | 221.47 |
| VA | 2411.24 | 373.71 | 6910.75 | 412.96 | 1147.68 | 1439.01 | 5781.65 | 736.93 | 2593.11 | 9541.71 | 7249.45 | 1346.39 | 1785.53 | 6199.92 | 960.34 | 4161.66 | 876.73 | 5718.30 | 587.74 | 6155.89 | 1014.86 | | 1438.73 | 2223.37 | 3992.08 | 1662.08 | 283.76 |
| VT | 542.28 | 95.92 | 1199.52 | 106.42 | 282.61 | 617.08 | 1489.08 | 181.34 | 652.45 | 2814.67 | 1587.95 | 322.44 | 457.85 | 1361.90 | 327.19 | 806.38 | 220.92 | 1228.11 | 139.70 | 1460.46 | 255.72 | 1185.05 | | 572.89 | 847.24 | 305.32 | 71.59 |
| WA | 1371.68 | 418.16 | 2452.66 | 332.56 | 826.39 | 680.32 | 2261.46 | 611.20 | 2670.30 | 3954.67 | 3195.64 | 933.82 | 2892.96 | 2248.53 | 433.58 | 1736.64 | 677.73 | 2869.93 | 392.76 | 4201.46 | 1034.56 | 2209.72 | 691.25 | | 2023.25 | 597.64 | 264.92 |
| WI | 1634.49 | 296.07 | 3086.89 | 360.92 | 1006.97 | 830.09 | 2840.76 | 559.99 | 1957.98 | 5008.57 | 4677.44 | 1042.11 | 1353.83 | 2933.90 | 528.19 | 2148.47 | 775.44 | 3746.09 | 459.23 | 4453.92 | 787.27 | 2824.40 | 856.46 | 1695.06 | | 808.84 | 238.23 |
| WV | 1394.92 | 213.46 | 3667.67 | 238.82 | 670.91 | 765.32 | 2908.24 | 421.35 | 1473.59 | 4984.64 | 4992.90 | 781.58 | 1012.53 | 3247.37 | 500.77 | 2274.47 | 509.62 | 3454.36 | 342.53 | 3524.60 | 579.38 | 3486.21 | 777.51 | 1261.30 | 2037.52 | | 162.90 |
| WY | 1191.74 | 344.50 | 2060.55 | 309.78 | 812.32 | 555.47 | 1867.30 | 571.09 | 2109.41 | 3264.73 | 2726.20 | 868.46 | 1398.43 | 1872.99 | 354.57 | 1463.31 | 680.78 | 2475.42 | 363.24 | 3716.65 | 989.32 | 1846.72 | 565.66 | 1734.80 | 1783.85 | 505.46 | |
| **Total Ajs** | **84512.68** | **14511.02** | **162260.10** | **15695.75** | **44246.26** | **44176.58** | **153431.28** | **28666.90** | **103423.44** | **262402.77** | **206224.80** | **51947.17** | **69717.90** | **152584.89** | **29502.61** | **114301.46** | **33860.76** | **183324.93** | **22731.95** | **220799.46** | **40366.78** | **149099.40** | **44589.98** | **85124.61** | **120304.73** | **40932.90** | **11137.30** |

Table 6.3.2 shows the states in descending flow order and only lists states that are interacting with Tulsa. The third column of each table represents the flow percentages to/from the corresponding state from/to Tulsa in relation to the total flow. The fourth column shows the cumulative flow values. These flow values are extracted from TransCAD results.

Table 6.3.2: Middle Level From and To Tulsa Total Flows for 2030 by All Modes (tons)

| MIDDLE LEVEL TOTAL FLOWS FROM TULSA | | | | | MIDDLE LEVEL TOTAL FLOWS TO TULSA | | | |
|---|---|---|---|---|---|---|---|---|
| **Destination** | **From Tulsa TMA** | **Percentage** | **Cumulative Per.** | | **Origination** | **To Tulsa TMA** | **Percentage** | **Cumulative Per.** |
| **TX** | **1208060** | 5.95% | 5.95% | | **TX** | **1068470** | 4.70% | 4.70% |
| **FL** | **1009720** | 4.97% | 10.91% | | **IL** | **986490** | 4.34% | 9.04% |
| **CA** | **966350** | 4.76% | 15.67% | | **OH** | **893130** | 3.93% | 12.97% |
| **NY** | **873640** | 4.30% | 19.97% | | **MO** | **867980** | 3.82% | 16.79% |
| **MO** | **847410** | 4.17% | 24.14% | | **MN** | **855650** | 3.76% | 20.55% |
| TN | 767530 | 3.78% | 27.92% | | CA | 722880 | 3.18% | 23.73% |
| OH | 767170 | 3.78% | 31.69% | | KS | 714140 | 3.14% | 26.87% |
| IL | 752630 | 3.70% | 35.40% | | NY | 699520 | 3.08% | 29.95% |
| GA | 707910 | 3.48% | 38.88% | | TN | 689370 | 3.03% | 32.98% |
| NC | 586560 | 2.89% | 41.77% | | FL | 644490 | 2.84% | 35.82% |
| IN | 562790 | 2.77% | 44.54% | | MI | 623000 | 2.74% | 38.56% |
| MI | 529420 | 2.61% | 47.14% | | PA | 601070 | 2.64% | 41.20% |
| VA | 513490 | 2.53% | 49.67% | | IN | 600970 | 2.64% | 43.85% |
| PA | 509820 | 2.51% | 52.18% | | GA | 589740 | 2.59% | 46.44% |
| NJ | 502480 | 2.47% | 54.65% | | VA | 587740 | 2.59% | 49.03% |
| MN | 492760 | 2.42% | 57.07% | | NJ | 570230 | 2.51% | 51.53% |
| WI | 481850 | 2.37% | 59.45% | | NC | 534660 | 2.35% | 53.89% |
| MA | 443150 | 2.18% | 61.63% | | CO | 521180 | 2.29% | 56.18% |
| MD | 429680 | 2.11% | 63.74% | | AR | 520750 | 2.29% | 58.47% |
| NV | 428800 | 2.11% | 65.85% | | KY | 515270 | 2.27% | 60.74% |
| SC | 423270 | 2.08% | 67.93% | | LA | 494750 | 2.18% | 62.91% |
| AZ | 414750 | 2.04% | 69.97% | | WI | 459230 | 2.02% | 64.93% |
| KS | 406980 | 2.00% | 71.98% | | AL | 417280 | 1.84% | 66.77% |
| AR | 394500 | 1.94% | 73.92% | | MA | 415690 | 1.83% | 68.60% |
| CO | 394280 | 1.94% | 75.86% | | MD | 399950 | 1.76% | 70.36% |
| MS | 390330 | 1.92% | 77.78% | | SC | 399750 | 1.76% | 72.12% |
| OKCO | 379940 | 1.87% | 79.65% | | MS | 393680 | 1.73% | 73.85% |
| WA | 345260 | 1.70% | 81.35% | | WA | 392760 | 1.73% | 75.58% |
| LA | 334840 | 1.65% | 83.00% | | IA | 370490 | 1.63% | 77.21% |
| AL | 327110 | 1.61% | 84.61% | | NE | 368260 | 1.62% | 78.83% |
| CT | 305320 | 1.50% | 86.11% | | WY | 363240 | 1.60% | 80.42% |
| OR | 279700 | 1.38% | 87.49% | | OKCO | 346560 | 1.52% | 81.95% |
| KY | 274740 | 1.35% | 88.84% | | WV | 342530 | 1.51% | 83.45% |
| IA | 260840 | 1.28% | 90.12% | | CT | 339850 | 1.50% | 84.95% |
| NE | 218820 | 1.08% | 91.20% | | NM | 332050 | 1.46% | 86.41% |
| DC | 210340 | 1.04% | 92.23% | | UT | 286050 | 1.26% | 87.67% |
| UT | 171540 | 0.84% | 93.08% | | NV | 283760 | 1.25% | 88.92% |
| SD | 149960 | 0.74% | 93.82% | | MT | 283460 | 1.25% | 90.16% |
| VT | 148170 | 0.73% | 94.54% | | OR | 274660 | 1.21% | 91.37% |
| NH | 145850 | 0.72% | 95.26% | | NH | 270640 | 1.19% | 92.56% |
| WV | 142670 | 0.70% | 95.96% | | SD | 251050 | 1.10% | 93.67% |
| NM | 136120 | 0.67% | 96.63% | | AZ | 246480 | 1.08% | 94.75% |
| ID | 115010 | 0.57% | 97.20% | | DE | 234530 | 1.03% | 95.78% |
| ME | 114980 | 0.57% | 97.77% | | DC | 186760 | 0.82% | 96.60% |
| DE | 110350 | 0.54% | 98.31% | | ND | 177880 | 0.78% | 97.39% |
| RI | 93780 | 0.46% | 98.77% | | ID | 174260 | 0.77% | 98.15% |
| ND | 65330 | 0.32% | 99.09% | | VT | 139700 | 0.61% | 98.77% |
| MT | 59880 | 0.29% | 99.39% | | ME | 122480 | 0.54% | 99.31% |
| WY | 48760 | 0.24% | 99.63% | | RI | 103660 | 0.46% | 99.76% |
| AK | 44430 | 0.22% | 99.85% | | AK | 48300 | 0.21% | 99.98% |
| HI | 31460 | 0.15% | 100.00% | | HI | 5480 | 0.02% | 100.00% |
| Tulsa TMA | | 0.00% | 100.00% | | Tulsa TMA | | 0.00% | 100.00% |
| **Total Flow from Tulsa** | **20320530** | | | | **Total Flow to Tulsa** | **22731950** | | |

Table 6.3.3 illustrates 1997 and 2030 freight flow from Tulsa to other states by each mode and as a total. Table 6.3.4 illustrates similar flows from all states to Tulsa.

Table 6.3.3: Tulsa to Other States Total Flows by Highway, Rail, Water, and Air (tons)

| FROM TULSA TO OTHER STATES FLOWS BY EACH MODE FOR 1997 and 2030 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2030 FLOWS | | | | | | 1997 FLOWS | | | | |
| State | Highway | Rail | Water | Air | Total Distribution | State | Highway | Rail | Water | Air | Total Distribution |
| AK | 56638 | 11498 | 0 | 2245 | **70380** | AK | 12199 | 1236 | 893 | 488 | **14815** |
| AL | 227342 | 99097 | 7217 | 4 | **333660** | AL | 171132 | 69082 | 5473 | 3 | **245690** |
| AR | 449555 | 82929 | 0 | 6 | **532490** | AR | 311467 | 55209 | 0 | 4 | **366680** |
| AZ | 386244 | 191283 | 0 | 904 | **578430** | AZ | 124145 | 63349 | 0 | 306 | **187800** |
| CA | 500793 | 206137 | 0 | 100 | **707030** | CA | 176868 | 70754 | 0 | 38 | **247660** |
| CO | 142987 | 131014 | 0 | 650 | **274650** | CO | 41937 | 36251 | 0 | 212 | **78400** |
| CT | 245790 | 0 | 0 | 0 | **245790** | CT | 47420 | 0 | 0 | 0 | **47420** |
| DC | 219810 | 0 | 0 | 0 | **219810** | DC | 30000 | 0 | 0 | 0 | **30000** |
| DE | 206480 | 0 | 0 | 0 | **206480** | DE | 56230 | 0 | 0 | 0 | **56230** |
| FL | 366566 | 394487 | 0 | 77 | **761130** | FL | 129331 | 129913 | 0 | 26 | **259270** |
| GA | 235179 | 296677 | 0 | 1953 | **533810** | GA | 143253 | 166702 | 0 | 1255 | **311210** |
| HI | 0 | 0 | 5063 | 15917 | **20980** | HI | 0 | 0 | 954 | 2347 | **3300** |
| IA | 115086 | 42184 | 0 | 0 | **157270** | IA | 89051 | 33259 | 0 | 0 | **122310** |
| ID | 133466 | 22183 | 0 | 31 | **155680** | ID | 41682 | 7188 | 0 | 10 | **48880** |
| IL | 547372 | 551942 | 47699 | 827 | **1147840** | IL | 477928 | 479646 | 36715 | 741 | **995030** |
| IN | 239470 | 153255 | 0 | 124 | **392850** | IN | 180249 | 101938 | 0 | 103 | **282290** |
| KS | 194794 | 53026 | 0 | 0 | **247820** | KS | 88195 | 20405 | 0 | 0 | **108600** |
| KY | 167277 | 28468 | 0 | 215 | **195960** | KY | 138748 | 24077 | 0 | 194 | **163020** |
| LA | 102765 | 62844 | 55586 | 5 | **221200** | LA | 159683 | 90639 | 85529 | 8 | **335860** |
| MA | 332491 | 16895 | 0 | 744 | **350130** | MA | 71721 | 3088 | 0 | 171 | **74980** |
| MD | 460830 | 54665 | 0 | 85 | **515580** | MD | 178570 | 22268 | 0 | 32 | **200870** |
| ME | 244730 | 0 | 0 | 0 | **244730** | ME | 98400 | 0 | 0 | 0 | **98400** |
| MI | 409402 | 53451 | 0 | 137 | **462990** | MI | 225472 | 31771 | 0 | 77 | **257320** |
| MN | 268856 | 68242 | 0 | 2 | **337100** | MN | 128920 | 29889 | 0 | 1 | **158810** |
| MO | 444442 | 137767 | 0 | 722 | **582930** | MO | 208607 | 64386 | 0 | 377 | **273370** |
| MS | 70417 | 217857 | 51294 | 2 | **339570** | MS | 45450 | 139668 | 28310 | 1 | **213430** |
| MT | 70117 | 13594 | 0 | 19 | **83730** | MT | 30229 | 6232 | 0 | 9 | **36470** |
| NC | 294873 | 147478 | 0 | 9 | **442360** | NC | 140065 | 63641 | 0 | 4 | **203710** |
| ND | 52118 | 3342 | 0 | 0 | **55460** | ND | 32848 | 2422 | 0 | 0 | **35270** |
| NE | 86312 | 64118 | 0 | 0 | **150430** | NE | 47814 | 35626 | 0 | 0 | **83440** |
| NH | 346540 | 0 | 0 | 0 | **346540** | NH | 78790 | 0 | 0 | 0 | **78790** |
| NJ | 367078 | 130713 | 0 | 579 | **498370** | NJ | 150099 | 50829 | 0 | 212 | **201140** |
| NM | 96393 | 17112 | 0 | 325 | **113830** | NM | 23965 | 4632 | 0 | 93 | **28690** |
| NV | 316657 | 109847 | 0 | 4476 | **430980** | NV | 52017 | 15471 | 0 | 742 | **68230** |
| NY | 337084 | 297842 | 0 | 444 | **635370** | NY | 109163 | 78512 | 0 | 135 | **187810** |
| OH | 369314 | 183329 | 128713 | 63 | **681420** | OH | 264216 | 112361 | 74668 | 45 | **451290** |
| OKCO | 332645 | 37384 | 0 | 0 | **370030** | OKCO | 187635 | 22785 | 0 | 0 | **210420** |
| OR | 223230 | 36120 | 0 | 10 | **259360** | OR | 140708 | 21026 | 0 | 7 | **161740** |
| PA | 267644 | 159744 | 0 | 162 | **427550** | PA | 206887 | 105210 | 0 | 123 | **312220** |
| RI | 219920 | 0 | 0 | 0 | **219920** | RI | 43800 | 0 | 0 | 0 | **43800** |
| SC | 352867 | 123493 | 0 | 0 | **476360** | SC | 151650 | 48590 | 0 | 0 | **200240** |
| SD | 259771 | 77859 | 0 | 0 | **337630** | SD | 76600 | 23050 | 0 | 0 | **99650** |
| TN | 436032 | 205887 | 1211 | 359 | **643487** | TN | 218506 | 99221 | 585 | 191 | **318502** |
| TX | 629377 | 327312 | 2292 | 370 | **959351** | TX | 405378 | 198276 | 1394 | 259 | **605307** |
| TULSA TMA | 0 | 0 | 0 | 0 | **0** | TULSA TMA | 0 | 0 | 0 | 0 | **0** |
| UT | 193299 | 122053 | 0 | 1458 | **316810** | UT | 74941 | 46799 | 0 | 580 | **122320** |
| VA | 242719 | 143333 | 0 | 38 | **386090** | VA | 104482 | 64451 | 0 | 18 | **168950** |
| VT | 180500 | 0 | 0 | 0 | **180500** | VT | 29610 | 0 | 0 | 0 | **29610** |
| WA | 190042 | 89608 | 0 | 0 | **279650** | WA | 107839 | 51181 | 0 | 0 | **159020** |
| WI | 354328 | 80208 | 0 | 4 | **434540** | WI | 206906 | 49861 | 0 | 3 | **256770** |
| WV | 39084 | 60916 | 0 | 0 | **100000** | WV | 32190 | 41870 | 0 | 0 | **74060** |
| WY | 26659 | 23331 | 0 | 0 | **49990** | WY | 14797 | 11413 | 0 | 0 | **26210** |
| **Total distribution by Mode** | **13053385** | **5330523** | **299075** | **33065** | **18716048** | **Total distribution by Mode** | **6307792** | **2794177** | **234520** | **8814** | **9345304** |

Table 6.3.4: Other States to Tulsa Total Flows by Highway, Rail, Water and Air (tons)

| FROM OTHER STATES TO TULSA FLOWS BY EACH MODE FOR 1997 and 2030 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2030 FLOWS | | | | | | 1997 FLOWS | | | | |
| State | Highway | Rail | Water | Air | Total Distribution | State | Highway | Rail | Water | Air | Total Distribution |
| AK | 12164 | 71523 | 1953 | 6030 | **91670** | AK | 2449 | 18727 | 391 | 1213 | **22780** |
| AL | 307794 | 52062 | 79113 | 0 | **438970** | AL | 329053 | 58483 | 78474 | 0 | **466010** |
| AR | 259830 | 472427 | 9814 | 0 | **742070** | AR | 257927 | 466875 | 9107 | 0 | **733910** |
| AZ | 346375 | 56430 | 0 | 2056 | **404860** | AZ | 146995 | 22776 | 0 | 900 | **170670** |
| CA | 398256 | 170508 | 0 | 386 | **569150** | CA | 212895 | 81566 | 0 | 229 | **294690** |
| CO | 382057 | 71613 | 0 | 0 | **453670** | CO | 170868 | 32592 | 0 | 0 | **203460** |
| CT | 377757 | 0 | 0 | 1193 | **378950** | CT | 94261 | 0 | 0 | 289 | **94550** |
| DC | 167040 | 35021 | 1024 | 3286 | **206370** | DC | 62097 | 695 | 30 | 239 | **63060** |
| DE | 466191 | 99109 | 0 | 0 | **565300** | DE | 121763 | 26127 | 0 | 0 | **147890** |
| FL | 496801 | 116265 | 0 | 34 | **613100** | FL | 230959 | 53653 | 0 | 18 | **284630** |
| GA | 544438 | 7052 | 0 | 0 | **551490** | GA | 414601 | 4969 | 0 | 0 | **419570** |
| HI | 0 | 0 | 3270 | 920 | **4190** | HI | 0 | 0 | 615 | 175 | **790** |
| IA | 166986 | 69917 | 0 | 7 | **236910** | IA | 180310 | 84682 | 0 | 8 | **265000** |
| ID | 204878 | 19907 | 0 | 585 | **225370** | ID | 92595 | 9479 | 0 | 226 | **102300** |
| IL | 881255 | 578825 | 48990 | 850 | **1509920** | IL | 1211311 | 736734 | 64196 | 1190 | **2013430** |
| IN | 345130 | 83145 | 0 | 25 | **428300** | IN | 325206 | 76170 | 0 | 23 | **401400** |
| KS | 289414 | 128656 | 0 | 0 | **418070** | KS | 221193 | 87197 | 0 | 0 | **308390** |
| KY | 304448 | 74786 | 25575 | 152 | **404960** | KY | 433881 | 102991 | 44462 | 246 | **581580** |
| LA | 210364 | 83060 | 208697 | 9 | **502130** | LA | 512309 | 195454 | 505183 | 24 | **1212970** |
| MA | 443767 | 0 | 0 | 23 | **443790** | MA | 122173 | 0 | 0 | 7 | **122180** |
| MD | 587884 | 0 | 0 | 4776 | **592660** | MD | 280817 | 0 | 0 | 2203 | **283020** |
| ME | 185405 | 58285 | 0 | 0 | **243690** | ME | 85088 | 27332 | 0 | 0 | **112420** |
| MI | 500562 | 25081 | 0 | 7 | **525650** | MI | 392159 | 22085 | 0 | 6 | **414250** |
| MN | 454543 | 200663 | 9553 | 11 | **664770** | MN | 368713 | 167940 | 7366 | 11 | **544030** |
| MO | 405208 | 220727 | 0 | 306 | **626240** | MO | 237225 | 121169 | 0 | 196 | **358590** |
| MS | 241811 | 39255 | 45524 | 0 | **326590** | MS | 183002 | 26815 | 31963 | 0 | **241780** |
| MT | 140844 | 166396 | 0 | 0 | **307240** | MT | 154249 | 168091 | 0 | 0 | **322340** |
| NC | 388984 | 0 | 0 | 6 | **388990** | NC | 234956 | 0 | 0 | 4 | **234960** |
| ND | 109839 | 17741 | 0 | 0 | **127580** | ND | 102942 | 18898 | 0 | 0 | **121840** |
| NE | 271837 | 14403 | 0 | 0 | **286240** | NE | 232378 | 12842 | 0 | 0 | **245220** |
| NH | 529270 | 0 | 0 | 0 | **529270** | NH | 199510 | 0 | 0 | 0 | **199510** |
| NJ | 331098 | 295417 | 0 | 1135 | **627650** | NJ | 200041 | 154204 | 0 | 694 | **354940** |
| NM | 158795 | 105543 | 0 | 72 | **264410** | NM | 75874 | 45376 | 0 | 40 | **121290** |
| NV | 48436 | 194812 | 0 | 1052 | **244300** | NV | 7142 | 27778 | 0 | 160 | **35080** |
| NY | 496702 | 38652 | 0 | 26 | **535380** | NY | 186978 | 17061 | 0 | 11 | **204050** |
| OH | 540127 | 248234 | 23806 | 123 | **812290** | OH | 510074 | 221994 | 23273 | 119 | **755460** |
| OKCO | 441943 | 24007 | 0 | 0 | **465950** | OKCO | 342977 | 19463 | 0 | 0 | **362440** |
| OR | 110613 | 150321 | 0 | 147 | **261080** | OR | 95041 | 123510 | 0 | 128 | **218680** |
| PA | 464079 | 96864 | 0 | 217 | **561160** | PA | 488887 | 101642 | 0 | 241 | **590770** |
| RI | 260720 | 0 | 0 | 0 | **260720** | RI | 70270 | 0 | 0 | 0 | **70270** |
| SC | 179286 | 118874 | 0 | 0 | **298160** | SC | 92248 | 49902 | 0 | 0 | **142150** |
| SD | 476904 | 203886 | 7046 | 0 | **687836** | SD | 195205 | 83625 | 2896 | 0 | **281726** |
| TN | 605690 | 26679 | 988 | 2319 | **635676** | TN | 339662 | 16187 | 566 | 1429 | **357844** |
| TX | 753535 | 81854 | 303 | 298 | **835990** | TX | 705282 | 79187 | 269 | 322 | **785059** |
| TULSA TMA | 0 | 0 | 0 | 0 | **0** | TULSA TMA | 0 | 0 | 0 | 0 | **0** |
| UT | 198420 | 368643 | 0 | 1026 | **568090** | UT | 122462 | 219955 | 0 | 633 | **343050** |
| VA | 256136 | 186794 | 0 | 19 | **442950** | VA | 164772 | 100464 | 0 | 14 | **265250** |
| VT | 121250 | 13440 | 0 | 2240 | **136930** | VT | 15589 | 1398 | 0 | 233 | **17220** |
| WA | 225848 | 86766 | 0 | 96 | **312710** | WA | 180769 | 76857 | 0 | 84 | **257710** |
| WI | 258420 | 159580 | 0 | 0 | **418000** | WI | 195218 | 109362 | 0 | 0 | **304580** |
| WV | 258200 | 10000 | 0 | 0 | **268200** | WV | 492507 | 23843 | 0 | 0 | **516350** |
| WY | 9510 | 281880 | 0 | 0 | **291390** | WY | 33341 | 914799 | 0 | 0 | **948140** |
| **Total distribution by Mode** | **16616840** | **5625104** | **465656** | **29432** | **22737032** | **Total distribution by Mode** | **12128223** | **5010951** | **768790** | **11315** | **17919279** |

Tables 6.3.5 through 6.3.9 show flows to (from) Tulsa from (to) each other state for each of the five commodity groups, respectively. The flows are sorted in decreasing order.

The percentage of flow to/from a specific state as well as the cumulative flow values are also shown in the tables. Top five states with the most interaction are listed in bold.

Table 6.3.5: Middle Level From and To Tulsa Food Group Flows
for 2030 by All Modes (tons)

| FOOD MIDDLE LEVEL FLOWS FROM TULSA | | | | | FOOD MIDDLE LEVEL FLOWS TO TULSA | | | |
|---|---|---|---|---|---|---|---|---|
| Destination | From Tulsa TMA | Percentage | Cumulative Per. | | Origination | To Tulsa TMA | Percentage | Cumulative Per. |
| **MO** | **51610** | 5.61% | 5.61% | | **KS** | **117850** | 9.13% | 9.13% |
| **KS** | **47970** | 5.22% | 10.83% | | **MN** | **90280** | 6.99% | 16.12% |
| **CA** | **44850** | 4.88% | 15.70% | | **MO** | **85640** | 6.63% | 22.76% |
| **NY** | **44000** | 4.78% | 20.49% | | **IL** | **83330** | 6.46% | 29.22% |
| **TX** | **41640** | 4.53% | 25.01% | | **NE** | **72300** | 5.60% | 34.82% |
| IL | 41480 | 4.51% | 29.52% | | IA | 65670 | 5.09% | 39.90% |
| MN | 40960 | 4.45% | 33.98% | | OH | 50570 | 3.92% | 43.82% |
| LA | 36070 | 3.92% | 37.90% | | NY | 43250 | 3.35% | 47.17% |
| FL | 29930 | 3.25% | 41.15% | | TX | 38730 | 3.00% | 50.17% |
| WA | 29500 | 3.21% | 44.36% | | CO | 38390 | 2.97% | 53.15% |
| NC | 29340 | 3.19% | 47.55% | | CA | 37340 | 2.89% | 56.04% |
| IA | 27850 | 3.03% | 50.58% | | AR | 33110 | 2.57% | 58.61% |
| TN | 26730 | 2.91% | 53.49% | | WA | 32020 | 2.48% | 61.09% |
| OH | 25660 | 2.79% | 56.28% | | IN | 30650 | 2.37% | 63.46% |
| AR | 25080 | 2.73% | 59.00% | | TN | 29220 | 2.26% | 65.72% |
| NE | 24730 | 2.69% | 61.69% | | WI | 26370 | 2.04% | 67.77% |
| CO | 23850 | 2.59% | 64.29% | | ND | 25990 | 2.01% | 69.78% |
| GA | 23030 | 2.50% | 66.79% | | LA | 25020 | 1.94% | 71.72% |
| MA | 22340 | 2.43% | 69.22% | | NC | 24580 | 1.90% | 73.62% |
| OR | 19940 | 2.17% | 71.39% | | FL | 22510 | 1.74% | 75.37% |
| WI | 18950 | 2.06% | 73.45% | | VA | 19450 | 1.51% | 76.87% |
| NJ | 18850 | 2.05% | 75.50% | | OR | 19190 | 1.49% | 78.36% |
| OKCO | 16560 | 1.80% | 77.30% | | MI | 18740 | 1.45% | 79.81% |
| VA | 15350 | 1.67% | 78.97% | | GA | 18640 | 1.44% | 81.26% |
| IN | 15300 | 1.66% | 80.63% | | NJ | 18510 | 1.43% | 82.69% |
| MD | 14560 | 1.58% | 82.21% | | MD | 16580 | 1.28% | 83.98% |
| PA | 14380 | 1.56% | 83.78% | | PA | 16550 | 1.28% | 85.26% |
| MI | 13760 | 1.50% | 85.27% | | MA | 16110 | 1.25% | 86.51% |
| NV | 13510 | 1.47% | 86.74% | | DE | 15350 | 1.19% | 87.70% |
| SC | 12510 | 1.36% | 88.10% | | ID | 15000 | 1.16% | 88.86% |
| AZ | 11610 | 1.26% | 89.36% | | OKCO | 13460 | 1.04% | 89.90% |
| MS | 11140 | 1.21% | 90.57% | | SD | 12750 | 0.99% | 90.89% |
| CT | 10450 | 1.14% | 91.71% | | MS | 12350 | 0.96% | 91.85% |
| DC | 9800 | 1.07% | 92.78% | | SC | 11160 | 0.86% | 92.71% |
| SD | 9150 | 0.99% | 93.77% | | VT | 11120 | 0.86% | 93.57% |
| AL | 8350 | 0.91% | 94.68% | | KY | 10590 | 0.82% | 94.39% |
| VT | 7860 | 0.85% | 95.53% | | DC | 10240 | 0.79% | 95.19% |
| DE | 6740 | 0.73% | 96.27% | | AL | 9960 | 0.77% | 95.96% |
| ID | 5920 | 0.64% | 96.91% | | NV | 9620 | 0.75% | 96.70% |
| KY | 5520 | 0.60% | 97.51% | | CT | 9300 | 0.72% | 97.42% |
| UT | 3890 | 0.42% | 97.93% | | MT | 6780 | 0.53% | 97.95% |
| NM | 3610 | 0.39% | 98.33% | | AZ | 6330 | 0.49% | 98.44% |
| ND | 3360 | 0.37% | 98.69% | | NH | 5210 | 0.40% | 98.84% |
| NH | 3280 | 0.36% | 99.05% | | UT | 4550 | 0.35% | 99.19% |
| RI | 2090 | 0.23% | 99.27% | | RI | 4130 | 0.32% | 99.51% |
| ME | 2010 | 0.22% | 99.49% | | NM | 3100 | 0.24% | 99.75% |
| WV | 1530 | 0.17% | 99.66% | | ME | 1610 | 0.12% | 99.88% |
| HI | 1090 | 0.12% | 99.78% | | WV | 620 | 0.05% | 99.93% |
| MT | 1080 | 0.12% | 99.90% | | AK | 510 | 0.04% | 99.97% |
| AK | 670 | 0.07% | 99.97% | | WY | 260 | 0.02% | 99.99% |
| WY | 290 | 0.03% | 100.00% | | HI | 170 | 0.01% | 100.00% |
| TULSA TMA | 0 | 0.00% | 100.00% | | TULSA TMA | 0 | 0.00% | 100.00% |
| **Total Food Flow from Tulsa** | **919730** | | | | **Total Food Flow to Tulsa** | **1290760** | | |

Table 6.3.6: Middle Level From and To Tulsa Chemicals Group Flows for 2030 by All Modes (tons)

| CHEMICALS MIDDLE LEVEL FLOWS FROM TULSA | | | | CHEMICALS MIDDLE LEVEL FLOWS TO TULSA | | | |
|---|---|---|---|---|---|---|---|
| **Destination** | **From Tulsa TMA** | **Percentage** | **Cumulative Per.** | **Origination** | **To Tulsa TMA** | **Percentage** | **Cumulative Per.** |
| **FL** | **111780** | 15.02% | 15.02% | **TX** | **59120** | 12.72% | 12.72% |
| **TX** | **95570** | 12.85% | 27.87% | **FL** | **51550** | 11.09% | 23.82% |
| **MO** | **31740** | 4.27% | 32.14% | **LA** | **31190** | 6.71% | 30.53% |
| **CA** | **30250** | 4.07% | 36.20% | **KS** | **25150** | 5.41% | 35.94% |
| **NC** | **25880** | 3.48% | 39.68% | **MO** | **23460** | 5.05% | 40.99% |
| SC | 24280 | 3.26% | 42.95% | NM | 20480 | 4.41% | 45.40% |
| IL | 23770 | 3.20% | 46.14% | IL | 15640 | 3.37% | 48.77% |
| TN | 21900 | 2.94% | 49.08% | OH | 15220 | 3.28% | 52.04% |
| LA | 20680 | 2.78% | 51.86% | DE | 13970 | 3.01% | 55.05% |
| NY | 20200 | 2.72% | 54.58% | NJ | 11140 | 2.40% | 57.45% |
| MI | 20170 | 2.71% | 57.29% | SC | 10910 | 2.35% | 59.80% |
| NJ | 18190 | 2.44% | 59.73% | NC | 10750 | 2.31% | 62.11% |
| OH | 17850 | 2.40% | 62.13% | IN | 9640 | 2.07% | 64.18% |
| IN | 17690 | 2.38% | 64.51% | GA | 9530 | 2.05% | 66.24% |
| GA | 17080 | 2.30% | 66.81% | NY | 9270 | 2.00% | 68.23% |
| KS | 16740 | 2.25% | 69.06% | TN | 9160 | 1.97% | 70.20% |
| AZ | 15620 | 2.10% | 71.16% | MS | 8210 | 1.77% | 71.97% |
| MS | 14340 | 1.93% | 73.08% | AL | 7900 | 1.70% | 73.67% |
| NV | 13050 | 1.75% | 74.84% | WY | 7370 | 1.59% | 75.26% |
| VA | 12550 | 1.69% | 76.53% | OKCO | 7170 | 1.54% | 76.80% |
| AR | 11970 | 1.61% | 78.13% | AR | 7110 | 1.53% | 78.33% |
| WI | 11260 | 1.51% | 79.65% | MI | 6990 | 1.50% | 79.83% |
| OR | 10170 | 1.37% | 81.02% | NE | 5870 | 1.26% | 81.10% |
| NM | 10150 | 1.36% | 82.38% | CA | 5710 | 1.23% | 82.33% |
| MN | 9770 | 1.31% | 83.69% | WA | 5630 | 1.21% | 83.54% |
| OKCO | 8470 | 1.14% | 84.83% | MN | 5620 | 1.21% | 84.75% |
| PA | 8320 | 1.12% | 85.95% | VA | 5440 | 1.17% | 85.92% |
| AL | 8310 | 1.12% | 87.07% | ID | 5430 | 1.17% | 87.09% |
| MA | 8210 | 1.10% | 88.17% | WI | 5400 | 1.16% | 88.25% |
| WA | 8060 | 1.08% | 89.25% | AZ | 4990 | 1.07% | 89.32% |
| NE | 7660 | 1.03% | 90.28% | NV | 4590 | 0.99% | 90.31% |
| MD | 7380 | 0.99% | 91.28% | IA | 4440 | 0.96% | 91.27% |
| CO | 7080 | 0.95% | 92.23% | PA | 4240 | 0.91% | 92.18% |
| IA | 6980 | 0.94% | 93.17% | UT | 4170 | 0.90% | 93.08% |
| DC | 6680 | 0.90% | 94.06% | WV | 4140 | 0.89% | 93.97% |
| ID | 5810 | 0.78% | 94.84% | MD | 4000 | 0.86% | 94.83% |
| WV | 5530 | 0.74% | 95.59% | CT | 3970 | 0.85% | 95.68% |
| CT | 5040 | 0.68% | 96.26% | MA | 3610 | 0.78% | 96.46% |
| UT | 5000 | 0.67% | 96.94% | DC | 3520 | 0.76% | 97.22% |
| KY | 4850 | 0.65% | 97.59% | KY | 3370 | 0.73% | 97.94% |
| SD | 4380 | 0.59% | 98.18% | CO | 2280 | 0.49% | 98.43% |
| DE | 3750 | 0.50% | 98.68% | MT | 1700 | 0.37% | 98.80% |
| NH | 1520 | 0.20% | 98.89% | VT | 1650 | 0.36% | 99.15% |
| WY | 1500 | 0.20% | 99.09% | OR | 1390 | 0.30% | 99.45% |
| VT | 1480 | 0.20% | 99.29% | ME | 1040 | 0.22% | 99.68% |
| ME | 1410 | 0.19% | 99.48% | RI | 580 | 0.12% | 99.80% |
| MT | 1350 | 0.18% | 99.66% | ND | 450 | 0.10% | 99.90% |
| RI | 1320 | 0.18% | 99.83% | SD | 260 | 0.06% | 99.95% |
| ND | 650 | 0.09% | 99.92% | NH | 180 | 0.04% | 99.99% |
| AK | 370 | 0.05% | 99.97% | AK | 20 | 0.00% | 100.00% |
| HI | 210 | 0.03% | 100.00% | HI | 10 | 0.00% | 100.00% |
| TULSA TMA | 0 | 0.00% | 100.00% | TULSA TMA | 0 | 0.00% | 100.00% |
| **Total Chemicals Flow from Tulsa** | **743970** | | | **Total Chemicals Flow to Tulsa** | **464630** | | |

Table 6.3.7: Middle Level From and To Tulsa Mining Group Flows
for 2030 by All Modes (tons)

| MINING MIDDLE LEVEL FLOWS FROM TULSA | | | | | MINING MIDDLE LEVEL FLOWS TO TULSA | | | |
|---|---|---|---|---|---|---|---|---|
| Destination | From Tulsa TMA | Percentage | Cumulative Per. | | Origination | To Tulsa TMA | Percentage | Cumulative Per. |
| **TX** | **369240** | 6.71% | 6.71% | | **TX** | **430500** | 5.67% | 5.67% |
| **CA** | **290820** | 5.29% | 12.00% | | **KY** | **305230** | 4.02% | 9.70% |
| **NY** | **286810** | 5.21% | 17.21% | | **MN** | **300120** | 3.95% | 13.65% |
| **FL** | **278850** | 5.07% | 22.28% | | **CA** | **295650** | 3.90% | 17.55% |
| **MO** | **253580** | 4.61% | 26.89% | | **OH** | **294080** | 3.88% | 21.42% |
| TN | 236280 | 4.30% | 31.19% | | NY | 287310 | 3.79% | 25.21% |
| OH | 234330 | 4.26% | 35.45% | | VA | 269910 | 3.56% | 28.76% |
| GA | 217990 | 3.96% | 39.41% | | MO | 260510 | 3.43% | 32.20% |
| IN | 213060 | 3.87% | 43.29% | | PA | 259590 | 3.42% | 35.62% |
| PA | 178010 | 3.24% | 46.52% | | IL | 259550 | 3.42% | 39.04% |
| VA | 174660 | 3.18% | 49.70% | | WY | 258480 | 3.41% | 42.45% |
| IL | 153640 | 2.79% | 52.49% | | IN | 243970 | 3.22% | 45.66% |
| NC | 149220 | 2.71% | 55.20% | | GA | 229650 | 3.03% | 48.69% |
| MI | 148090 | 2.69% | 57.90% | | TN | 226650 | 2.99% | 51.67% |
| NJ | 144720 | 2.63% | 60.53% | | MI | 223450 | 2.94% | 54.62% |
| WI | 139860 | 2.54% | 63.07% | | WV | 218240 | 2.88% | 57.49% |
| MN | 136580 | 2.48% | 65.55% | | NJ | 213330 | 2.81% | 60.31% |
| MA | 115970 | 2.11% | 67.66% | | CO | 204030 | 2.69% | 62.99% |
| CO | 115650 | 2.10% | 69.76% | | FL | 192630 | 2.54% | 65.53% |
| KY | 115630 | 2.10% | 71.87% | | LA | 190000 | 2.50% | 68.04% |
| OKCO | 113560 | 2.06% | 73.93% | | KS | 180290 | 2.38% | 70.41% |
| MD | 103070 | 1.87% | 75.80% | | NC | 171980 | 2.27% | 72.68% |
| CT | 95140 | 1.73% | 77.53% | | NM | 170900 | 2.25% | 74.93% |
| MS | 93530 | 1.70% | 79.23% | | MT | 157200 | 2.07% | 77.00% |
| KS | 90500 | 1.65% | 80.88% | | WI | 143210 | 1.89% | 78.89% |
| AZ | 87480 | 1.59% | 82.47% | | MA | 141670 | 1.87% | 80.76% |
| NV | 85340 | 1.55% | 84.02% | | CT | 121990 | 1.61% | 82.36% |
| LA | 81770 | 1.49% | 85.51% | | AL | 111330 | 1.47% | 83.83% |
| AL | 80650 | 1.47% | 86.97% | | OKCO | 108290 | 1.43% | 85.26% |
| SC | 74970 | 1.36% | 88.34% | | SC | 103750 | 1.37% | 86.63% |
| IA | 68260 | 1.24% | 89.58% | | MD | 89950 | 1.19% | 87.81% |
| AR | 61940 | 1.13% | 90.70% | | IA | 87130 | 1.15% | 88.96% |
| WV | 60360 | 1.10% | 91.80% | | WA | 86830 | 1.14% | 90.10% |
| WA | 54800 | 1.00% | 92.80% | | MS | 84530 | 1.11% | 91.22% |
| DC | 53600 | 0.97% | 93.77% | | AR | 82190 | 1.08% | 92.30% |
| NE | 48330 | 0.88% | 94.65% | | UT | 73620 | 0.97% | 93.27% |
| NM | 42690 | 0.78% | 95.43% | | ND | 68480 | 0.90% | 94.17% |
| OR | 37860 | 0.69% | 96.12% | | NV | 62240 | 0.82% | 94.99% |
| VT | 28000 | 0.51% | 96.62% | | AZ | 61520 | 0.81% | 95.80% |
| UT | 27920 | 0.51% | 97.13% | | NE | 59680 | 0.79% | 96.59% |
| ND | 24320 | 0.44% | 97.57% | | DC | 58670 | 0.77% | 97.36% |
| WY | 21290 | 0.39% | 97.96% | | VT | 44800 | 0.59% | 97.95% |
| ID | 20930 | 0.38% | 98.34% | | OR | 39720 | 0.52% | 98.48% |
| MT | 17300 | 0.31% | 98.66% | | ID | 34250 | 0.45% | 98.93% |
| DE | 13170 | 0.24% | 98.90% | | NH | 20730 | 0.27% | 99.20% |
| HI | 13040 | 0.24% | 99.13% | | AK | 19530 | 0.26% | 99.46% |
| AK | 12500 | 0.23% | 99.36% | | ME | 14540 | 0.19% | 99.65% |
| NH | 11020 | 0.20% | 99.56% | | RI | 12100 | 0.16% | 99.81% |
| ME | 10980 | 0.20% | 99.76% | | SD | 9680 | 0.13% | 99.94% |
| RI | 7200 | 0.13% | 99.89% | | HI | 3190 | 0.04% | 99.98% |
| SD | 6010 | 0.11% | 100.00% | | DE | 1530 | 0.02% | 100.00% |
| TULSA TMA | 0 | 0.00% | 100.00% | | TULSA TMA | 0 | 0.00% | 100.00% |
| **Total Mining Flow from Tulsa** | **5500520** | | | | **Total Mining Flow to Tulsa** | **7588400** | | |

Table 6.3.8: Middle Level From and To Tulsa Manufactured Products Group Flows for 2030 by All Modes (tons)

| MANUFACTURED PRODUCTS MIDDLE LEVEL FLOWS FROM TULSA | | | | MANUFACTURED PRODUCTS MIDDLE LEVEL FLOWS TO TULSA | | | |
|---|---|---|---|---|---|---|---|
| Destination | From Tulsa TMA | Percentage | Cumulative Per. | Origination | To Tulsa TMA | Percentage | Cumulative Per. |
| **FL** | **321760** | 5.22% | 5.22% | **OH** | **205050** | 4.59% | 4.59% |
| **CA** | **320750** | 5.20% | 10.42% | **TN** | **183580** | 4.11% | 8.70% |
| **TX** | **316490** | 5.13% | 15.55% | **MI** | **183010** | 4.10% | 12.80% |
| **GA** | **258990** | 4.20% | 19.75% | **TX** | **182070** | 4.08% | 16.87% |
| **NY** | **242700** | 3.94% | 23.68% | **MO** | **169160** | 3.79% | 20.66% |
| TN | 236720 | 3.84% | 27.52% | MS | 167360 | 3.75% | 24.41% |
| OH | 234160 | 3.80% | 31.32% | NC | 164920 | 3.69% | 28.10% |
| MO | 229500 | 3.72% | 35.04% | CA | 157310 | 3.52% | 31.62% |
| NC | 225650 | 3.66% | 38.70% | SC | 156710 | 3.51% | 35.13% |
| NV | 219920 | 3.57% | 42.27% | AR | 137530 | 3.08% | 38.21% |
| MI | 208570 | 3.38% | 45.65% | AL | 137500 | 3.08% | 41.28% |
| SC | 193060 | 3.13% | 48.78% | IN | 135160 | 3.03% | 44.31% |
| MS | 186190 | 3.02% | 51.80% | NY | 132450 | 2.97% | 47.27% |
| MA | 180860 | 2.93% | 54.73% | GA | 130310 | 2.92% | 50.19% |
| VA | 162660 | 2.64% | 57.37% | MN | 128920 | 2.89% | 53.08% |
| WA | 159010 | 2.58% | 59.95% | WA | 124760 | 2.79% | 55.87% |
| WI | 151000 | 2.45% | 62.39% | FL | 124610 | 2.79% | 58.66% |
| IN | 140730 | 2.28% | 64.68% | VA | 124270 | 2.78% | 61.44% |
| OR | 139610 | 2.26% | 66.94% | PA | 122280 | 2.74% | 64.18% |
| PA | 139150 | 2.26% | 69.20% | NV | 117240 | 2.62% | 66.80% |
| MD | 137010 | 2.22% | 71.42% | WI | 117240 | 2.62% | 69.43% |
| AL | 136060 | 2.21% | 73.62% | OR | 108110 | 2.42% | 71.85% |
| NJ | 129650 | 2.10% | 75.73% | NJ | 102450 | 2.29% | 74.14% |
| CO | 125770 | 2.04% | 77.76% | IL | 95330 | 2.13% | 76.28% |
| IL | 125510 | 2.04% | 79.80% | MD | 92320 | 2.07% | 78.34% |
| MN | 125110 | 2.03% | 81.83% | MA | 92310 | 2.07% | 80.41% |
| AZ | 121940 | 1.98% | 83.81% | NH | 86570 | 1.94% | 82.35% |
| AR | 115090 | 1.87% | 85.67% | CO | 84150 | 1.88% | 84.23% |
| CT | 107060 | 1.74% | 87.41% | KS | 77970 | 1.75% | 85.98% |
| OKCO | 90260 | 1.46% | 88.87% | CT | 72670 | 1.63% | 87.60% |
| KS | 89190 | 1.45% | 90.32% | OKCO | 55820 | 1.25% | 88.85% |
| DC | 57870 | 0.94% | 91.26% | KY | 49980 | 1.12% | 89.97% |
| KY | 55930 | 0.91% | 92.16% | AZ | 46570 | 1.04% | 91.01% |
| LA | 51360 | 0.83% | 93.00% | IA | 45990 | 1.03% | 92.04% |
| VT | 50980 | 0.83% | 93.82% | NE | 37350 | 0.84% | 92.88% |
| IA | 50940 | 0.83% | 94.65% | DC | 35440 | 0.79% | 93.67% |
| NE | 44950 | 0.73% | 95.38% | LA | 34740 | 0.78% | 94.45% |
| UT | 42400 | 0.69% | 96.06% | UT | 33920 | 0.76% | 95.21% |
| NM | 35930 | 0.58% | 96.65% | NM | 33580 | 0.75% | 95.96% |
| WV | 29430 | 0.48% | 97.12% | ME | 30880 | 0.69% | 96.65% |
| ME | 29320 | 0.48% | 97.60% | WV | 27740 | 0.62% | 97.27% |
| ID | 27920 | 0.45% | 98.05% | ID | 27480 | 0.62% | 97.89% |
| SD | 27370 | 0.44% | 98.50% | VT | 24190 | 0.54% | 98.43% |
| NH | 27090 | 0.44% | 98.94% | SD | 23870 | 0.53% | 98.97% |
| DE | 17440 | 0.28% | 99.22% | MT | 15530 | 0.35% | 99.31% |
| RI | 15670 | 0.25% | 99.47% | DE | 13910 | 0.31% | 99.62% |
| MT | 10440 | 0.17% | 99.64% | RI | 6690 | 0.15% | 99.77% |
| ND | 6930 | 0.11% | 99.75% | ND | 6530 | 0.15% | 99.92% |
| AK | 6150 | 0.10% | 99.85% | WY | 1950 | 0.04% | 99.96% |
| HI | 5810 | 0.09% | 99.95% | AK | 1050 | 0.02% | 99.99% |
| WY | 3220 | 0.05% | 100.00% | HI | 560 | 0.01% | 100.00% |
| TULSA TMA | 0 | 0.00% | 100.00% | TULSA TMA | 0 | 0.00% | 100.00% |
| **Total Manufactured Products Flow from Tulsa** | **6167280** | | | **Total Manufactured Products Flow to Tulsa** | **4467090** | | |

Table 6.3.9: Middle Level From and To Tulsa Other Product Flows for 2030 by All Modes (tons)

| OTHER PRODUCTS MIDDLE LEVEL FLOWS FROM TULSA | | | | OTHER PRODUCTS MIDDLE LEVEL FLOWS TO TULSA | | | |
|---|---|---|---|---|---|---|---|
| Destination | From Tulsa TMA | Percentage | Cumulative Per. | Origination | To Tulsa TMA | Percentage | Cumulative Per. |
| **IL** | **803440** | 14.92% | 14.92% | **IL** | **1056070** | 11.84% | 11.84% |
| **AZ** | **341780** | 6.35% | 21.27% | **SD** | **634230** | 7.11% | 18.95% |
| **AR** | **318410** | 5.91% | 27.18% | **DE** | **520540** | 5.83% | 24.78% |
| **NH** | **303630** | 5.64% | 32.82% | **AR** | **482130** | 5.40% | 30.19% |
| **SD** | **290720** | 5.40% | 38.22% | **UT** | **451830** | 5.06% | 35.25% |
| MD | 253560 | 4.71% | 42.93% | NH | 416580 | 4.67% | 39.92% |
| UT | 237600 | 4.41% | 47.34% | MD | 389810 | 4.37% | 44.29% |
| ME | 201010 | 3.73% | 51.08% | AZ | 285450 | 3.20% | 47.49% |
| RI | 193640 | 3.60% | 54.67% | NJ | 282220 | 3.16% | 50.65% |
| NJ | 186960 | 3.47% | 58.14% | OKCO | 281210 | 3.15% | 53.81% |
| SC | 171540 | 3.19% | 61.33% | OH | 247370 | 2.77% | 56.58% |
| OH | 169420 | 3.15% | 64.48% | RI | 237220 | 2.66% | 59.24% |
| DE | 165380 | 3.07% | 67.55% | FL | 221800 | 2.49% | 61.72% |
| OKCO | 141180 | 2.62% | 70.17% | LA | 221180 | 2.48% | 64.20% |
| TX | 135710 | 2.52% | 72.69% | ME | 195620 | 2.19% | 66.40% |
| TN | 122490 | 2.27% | 74.96% | MA | 190090 | 2.13% | 68.53% |
| WI | 113470 | 2.11% | 77.07% | TN | 188970 | 2.12% | 70.64% |
| AL | 100290 | 1.86% | 78.93% | AL | 172280 | 1.93% | 72.58% |
| NV | 99160 | 1.84% | 80.78% | CT | 171020 | 1.92% | 74.49% |
| ID | 95100 | 1.77% | 82.54% | GA | 163360 | 1.83% | 76.32% |
| VT | 92180 | 1.71% | 84.25% | PA | 158500 | 1.78% | 78.10% |
| DC | 91860 | 1.71% | 85.96% | ID | 143210 | 1.61% | 79.71% |
| PA | 87690 | 1.63% | 87.59% | MN | 139830 | 1.57% | 81.27% |
| MI | 72400 | 1.34% | 88.93% | MT | 126030 | 1.41% | 82.69% |
| MT | 53560 | 0.99% | 89.93% | WI | 125780 | 1.41% | 84.10% |
| OR | 51780 | 0.96% | 90.89% | TX | 125700 | 1.41% | 85.51% |
| AK | 50690 | 0.94% | 91.83% | CO | 124820 | 1.40% | 86.90% |
| NY | 41660 | 0.77% | 92.61% | NE | 111040 | 1.24% | 88.15% |
| MS | 34370 | 0.64% | 93.24% | DC | 98500 | 1.10% | 89.25% |
| LA | 31320 | 0.58% | 93.83% | MI | 93460 | 1.05% | 90.30% |
| WA | 28280 | 0.53% | 94.35% | OR | 92670 | 1.04% | 91.34% |
| CT | 28100 | 0.52% | 94.87% | MO | 87470 | 0.98% | 92.32% |
| NE | 24760 | 0.46% | 95.33% | CA | 73140 | 0.82% | 93.14% |
| MN | 24680 | 0.46% | 95.79% | AK | 70560 | 0.79% | 93.93% |
| WY | 23690 | 0.44% | 96.23% | WA | 63470 | 0.71% | 94.64% |
| MA | 22750 | 0.42% | 96.65% | NY | 63100 | 0.71% | 95.35% |
| NM | 21450 | 0.40% | 97.05% | VT | 55170 | 0.62% | 95.97% |
| VA | 20870 | 0.39% | 97.44% | MS | 54140 | 0.61% | 96.57% |
| CA | 20360 | 0.38% | 97.82% | NV | 50610 | 0.57% | 97.14% |
| ND | 20200 | 0.38% | 98.19% | NM | 36350 | 0.41% | 97.55% |
| FL | 18810 | 0.35% | 98.54% | KY | 35790 | 0.40% | 97.95% |
| GA | 16720 | 0.31% | 98.85% | IA | 33680 | 0.38% | 98.33% |
| MO | 16500 | 0.31% | 99.16% | ND | 26130 | 0.29% | 98.62% |
| KY | 14030 | 0.26% | 99.42% | VA | 23880 | 0.27% | 98.89% |
| NC | 12270 | 0.23% | 99.65% | WY | 23330 | 0.26% | 99.15% |
| IN | 6070 | 0.11% | 99.76% | WV | 17460 | 0.20% | 99.35% |
| KS | 3420 | 0.06% | 99.82% | KS | 16810 | 0.19% | 99.53% |
| IA | 3240 | 0.06% | 99.88% | NC | 16760 | 0.19% | 99.72% |
| WV | 3150 | 0.06% | 99.94% | SC | 15630 | 0.18% | 99.90% |
| CO | 2300 | 0.04% | 99.98% | IN | 8880 | 0.10% | 100.00% |
| HI | 830 | 0.02% | 100.00% | HI | 260 | 0.00% | 100.00% |
| Tulsa TMA | 0 | 0.00% | 100.00% | Tulsa TMA | 0 | 0.00% | 100.00% |
| **Total Others Flow from Tulsa** | **5384480** | | | **Total Others Flow to Tulsa** | **8921140** | | |

## 6.4 Mode Split

### 6.4.1 Rationale

Mode split is the third step of the four step urban travel demand modeling (UTDM). The objective of mode split is to allocate the total flows between states obtained by trip distribution by various modes such as road, rail, water and air.

The data for mode split is obtained from the Bureau of Transportation Statistics (BTS), 1998 database. This database consists of freight flow by four modes (road, rail, air, water). The database required modification to be applicable to the freight movement model. The freight flows were in tons, whereas the freight movement model required the data in percentage format. The data from BTS was classified by Standard Transportation Commodity code (STCC).In order to convert the data, the total flow was calculated by summing up the flows by each mode. The flow by each mode was then divided by the total flow to give us the percentage mode split. The data classification was also mapped according to the two digit Standard Classification of Transported Goods (SCTG) codes. This data was tabulated and the trip distribution values were multiplied with the mode split values to give the distribution by mode.

### 6.4.2 An Example

The commodity grouping and code mapping is the same as that followed in trip production. The tables below give the mode split values for each state. Example of the Origin- Destination table for the commodity groups

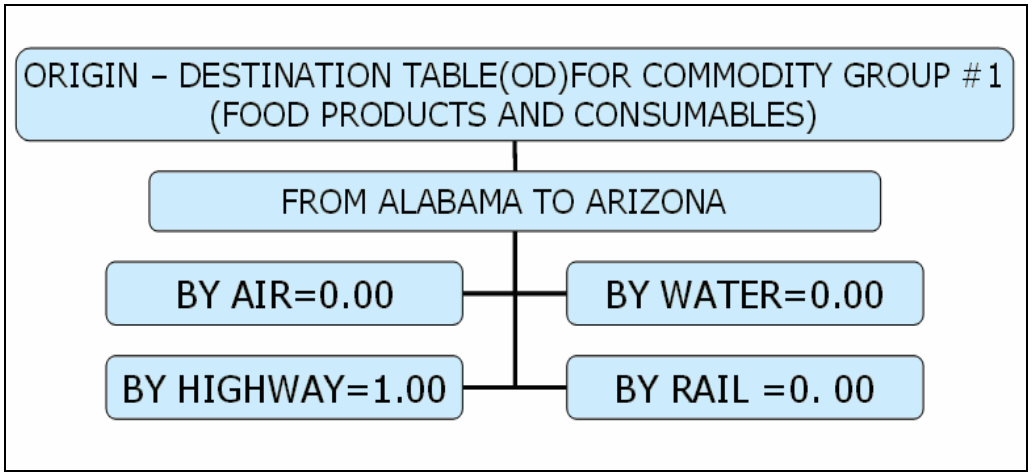



Figure 6.4.1: An Example of Mode Split at the State Level

Table 6.4.1: Mode Split Percentages for Rail for Food Commodity Group

| ORIGINDEST | AK | AL | AR | AZ | CA | CO | CT | DC | DE |
|---|---|---|---|---|---|---|---|---|---|
| AK | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| AL | 0.00 | 0.01 | 0.31 | 0.00 | 0.08 | 0.44 | 0.00 | 0.00 | 0.00 |
| AR | 0.00 | 0.00 | 0.00 | 0.05 | 0.32 | 0.21 | 0.00 | 0.00 | 0.00 |
| AZ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CA | 0.00 | 0.14 | 0.09 | 0.17 | 0.01 | 0.24 | 0.08 | 0.00 | 0.00 |
| CO | 0.00 | 0.14 | 0.07 | 0.10 | 0.28 | 0.02 | 0.00 | 0.00 | 0.00 |
| CT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| DC | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| DE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FL | 0.00 | 0.10 | 0.00 | 0.00 | 0.02 | 0.05 | 0.00 | 0.00 | 0.05 |
| GA | 0.00 | 0.04 | 0.30 | 0.00 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 |
| HI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| IA | 0.00 | 0.13 | 0.62 | 0.08 | 0.31 | 0.35 | 0.00 | 0.00 | 0.00 |
| ID | 0.00 | 0.06 | 0.00 | 0.02 | 0.10 | 0.43 | 0.03 | 0.00 | 0.00 |
| IL | 0.00 | 0.23 | 0.46 | 0.25 | 0.39 | 0.36 | 0.33 | 0.00 | 0.48 |
| IN | 0.00 | 0.59 | 0.09 | 0.24 | 0.09 | 0.00 | 0.48 | 0.00 | 0.71 |
| KS | 0.00 | 0.02 | 0.42 | 0.43 | 0.34 | 0.03 | 0.00 | 0.00 | 0.00 |
| KY | 0.00 | 0.28 | 0.00 | 0.00 | 0.03 | 0.07 | 0.00 | 0.00 | 0.00 |
| LA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MA | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.02 | 0.00 | 0.00 |
| MD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |
| ME | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 |
| MI | 0.00 | 0.66 | 0.21 | 0.00 | 0.12 | 0.13 | 0.70 | 0.00 | 0.73 |
| MN | 0.00 | 0.05 | 0.40 | 0.02 | 0.18 | 0.26 | 0.00 | 0.00 | 0.00 |
| MO | 0.00 | 0.05 | 0.26 | 0.26 | 0.31 | 0.10 | 0.00 | 0.00 | 0.00 |
| MS | 0.00 | 0.00 | 0.01 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 |
| MT | 0.00 | 0.00 | 0.00 | 0.11 | 0.25 | 0.17 | 0.00 | 0.00 | 0.00 |
| NC | 0.00 | 0.04 | 0.26 | 0.52 | 0.13 | 0.00 | 0.40 | 0.00 | 0.00 |
| ND | 0.00 | 0.02 | 0.08 | 0.07 | 0.23 | 0.58 | 0.00 | 0.00 | 0.00 |
| NE | 0.00 | 0.31 | 0.63 | 0.11 | 0.57 | 0.38 | 0.00 | 0.00 | 0.00 |
| NH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NJ | 0.00 | 0.00 | 0.00 | 0.66 | 0.38 | 0.00 | 0.19 | 0.00 | 0.32 |
| NM | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 |
| NV | 0.00 | 0.00 | 0.52 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NY | 0.00 | 0.13 | 0.00 | 0.51 | 0.09 | 0.00 | 0.03 | 0.00 | 0.16 |
| OH | 0.00 | 0.63 | 0.00 | 0.06 | 0.04 | 0.08 | 0.35 | 0.00 | 0.45 |
| OKCO | 0.00 | 0.00 | 0.04 | 0.44 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 |
| OR | 0.00 | 0.08 | 0.28 | 0.08 | 0.12 | 0.51 | 0.00 | 0.00 | 0.00 |
| PA | 0.00 | 0.00 | 0.00 | 0.24 | 0.17 | 0.00 | 0.02 | 0.00 | 0.00 |

Table 6.4.2: Mode Split Percentages for Highway for Food Commodity Group

| ORIGINDEST | AK | AL | AR | AZ | CA | CO | CT | DC | DE |
|---|---|---|---|---|---|---|---|---|---|
| AK | 0.69 | 1.00 | 1.00 | 0.32 | 0.99 | 0.73 | 1.00 | 0.00 | 1.00 |
| AL | 1.00 | 0.98 | 0.69 | 1.00 | 0.92 | 0.56 | 1.00 | 1.00 | 1.00 |
| AR | 1.00 | 1.00 | 0.99 | 0.95 | 0.68 | 0.79 | 1.00 | 1.00 | 1.00 |
| AZ | 1.00 | 1.00 | 0.74 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 |
| CA | 1.00 | 0.86 | 0.91 | 0.83 | 0.99 | 0.74 | 0.92 | 1.00 | 1.00 |
| CO | 1.00 | 0.86 | 0.93 | 0.90 | 0.72 | 0.98 | 1.00 | 1.00 | 1.00 |
| CT | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.74 | 1.00 | 1.00 | 1.00 |
| DC | 1.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 |
| DE | 1.00 | 1.00 | 1.00 | 1.00 | 0.76 | 1.00 | 1.00 | 1.00 | 1.00 |
| FL | 1.00 | 0.90 | 1.00 | 1.00 | 0.97 | 0.94 | 1.00 | 1.00 | 0.95 |
| GA | 1.00 | 0.96 | 0.70 | 1.00 | 0.90 | 1.00 | 1.00 | 1.00 | 1.00 |
| HI | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.03 | 0.00 | 0.00 | 0.00 |
| IA | 1.00 | 0.66 | 0.38 | 0.92 | 0.69 | 0.65 | 1.00 | 1.00 | 1.00 |
| ID | 1.00 | 0.94 | 1.00 | 0.98 | 0.90 | 0.57 | 0.97 | 1.00 | 1.00 |
| IL | 1.00 | 0.49 | 0.51 | 0.75 | 0.61 | 0.64 | 0.67 | 1.00 | 0.52 |
| IN | 1.00 | 0.36 | 0.82 | 0.76 | 0.91 | 0.97 | 0.52 | 1.00 | 0.29 |
| KS | 1.00 | 0.98 | 0.58 | 0.57 | 0.66 | 0.97 | 1.00 | 1.00 | 1.00 |
| KY | 1.00 | 0.38 | 1.00 | 0.99 | 0.97 | 0.93 | 1.00 | 1.00 | 1.00 |
| LA | 1.00 | 0.90 | 0.96 | 0.94 | 0.87 | 0.34 | 1.00 | 1.00 | 1.00 |
| MA | 0.02 | 1.00 | 1.00 | 0.82 | 0.89 | 0.86 | 0.98 | 1.00 | 1.00 |
| MD | 1.00 | 1.00 | 1.00 | 0.98 | 1.00 | 0.98 | 1.00 | 1.00 | 0.98 |
| ME | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.99 | 1.00 | 1.00 | 1.00 |
| MI | 1.00 | 0.34 | 0.79 | 1.00 | 0.87 | 0.87 | 0.30 | 1.00 | 0.27 |
| MN | 1.00 | 0.68 | 0.56 | 0.98 | 0.82 | 0.74 | 1.00 | 1.00 | 1.00 |
| MO | 1.00 | 0.78 | 0.74 | 0.74 | 0.69 | 0.90 | 1.00 | 1.00 | 1.00 |
| MS | 1.00 | 0.95 | 0.99 | 1.00 | 0.94 | 1.00 | 1.00 | 1.00 | 1.00 |
| MT | 1.00 | 1.00 | 1.00 | 0.89 | 0.75 | 0.83 | 1.00 | 0.00 | 1.00 |
| NC | 1.00 | 0.96 | 0.74 | 0.48 | 0.87 | 1.00 | 0.60 | 1.00 | 1.00 |
| ND | 1.00 | 0.98 | 0.92 | 0.93 | 0.77 | 0.42 | 1.00 | 1.00 | 1.00 |
| NE | 1.00 | 0.66 | 0.37 | 0.89 | 0.43 | 0.62 | 1.00 | 1.00 | 1.00 |
| NH | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| NJ | 1.00 | 1.00 | 1.00 | 0.34 | 0.61 | 0.99 | 0.81 | 1.00 | 0.68 |
| NM | 1.00 | 1.00 | 1.00 | 1.00 | 0.96 | 1.00 | 1.00 | 1.00 | 1.00 |
| NV | 1.00 | 1.00 | 0.48 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| NY | 1.00 | 0.87 | 1.00 | 0.49 | 0.90 | 1.00 | 0.97 | 1.00 | 0.84 |
| OH | 1.00 | 0.24 | 1.00 | 0.94 | 0.96 | 0.92 | 0.65 | 1.00 | 0.55 |
| OKCO | 1.00 | 0.75 | 0.96 | 0.56 | 0.60 | 1.00 | 1.00 | 1.00 | 1.00 |
| OR | 1.00 | 0.92 | 0.72 | 0.91 | 0.88 | 0.47 | 1.00 | 1.00 | 1.00 |
| PA | 1.00 | 1.00 | 1.00 | 0.75 | 0.83 | 0.99 | 0.98 | 1.00 | 1.00 |

The mode split rates were obtained for both O-Ds at the state levels. These state-level rates are assumed the same for sub-state regions. For example, the Oklahoma mode split rates are assumed the same for Oklahoma City Others (OKCC) and Tulsa TMA. In some cases, the BTS 1998 data are missing for some states, we used national averages to calculate mode split rates. Tables 6.4.3 shows percentage of freight from Tulsa to other states by each mode for the “food” category. Table 6.4.4 is the distribution of food freight

from Tulsa to other states by each mode using the percentages in Table 6.4.3. Similarly, using the modal split percentages for each commodity group, we split the freight distribution into distribution by mode by commodity group. Tables 6.4.5 and 6.4.6 regroup freight flow for each commodity group into flow from Tulsa to each other state by mode and flow to Tulsa from each state by mode, respectively. Tables 6.4.7 through 6.4.10 give upper and lower bounds on each result.

Table 6.4.3: From Tulsa To Other States Food Group
Mode Split Values by each Mode (units of measure are percentages)

| FOOD SUMMARY TABLE FROM TULSA TO OTHER STATES | | | | | |
|---|---|---|---|---|---|
| | MODESPLIT VALUES | | | | |
| State | Highway | Rail | Water | Air | Total DisTribution |
| AK | 100.00% | 0.00% | 0.00% | 0.00% | 670 |
| AL | 75.29% | 0.00% | 24.71% | 0.00% | 8350 |
| AR | 95.63% | 4.37% | 0.00% | 0.00% | 25080 |
| AZ | 55.95% | 44.04% | 0.00% | 0.01% | 11610 |
| CA | 59.51% | 40.49% | 0.00% | 0.00% | 44850 |
| CO | 99.96% | 0.00% | 0.00% | 0.04% | 23850 |
| CT | 100.00% | 0.00% | 0.00% | 0.00% | 10450 |
| DC | 100.00% | 0.00% | 0.00% | 0.00% | 9800 |
| DE | 100.00% | 0.00% | 0.00% | 0.00% | 6740 |
| FL | 97.79% | 2.21% | 0.00% | 0.00% | 29930 |
| GA | 98.57% | 1.42% | 0.00% | 0.01% | 23030 |
| HI | 0.00% | 0.00% | 0.00% | 100.00% | 1090 |
| IA | 100.00% | 0.00% | 0.00% | 0.00% | 27850 |
| ID | 100.00% | 0.00% | 0.00% | 0.00% | 5920 |
| IL | 77.53% | 22.45% | 0.00% | 0.02% | 41480 |
| IN | 100.00% | 0.00% | 0.00% | 0.00% | 15300 |
| KS | 99.81% | 0.19% | 0.00% | 0.00% | 47970 |
| KY | 83.44% | 16.56% | 0.00% | 0.00% | 5520 |
| LA | 29.67% | 4.50% | 65.83% | 0.00% | 36070 |
| MA | 100.00% | 0.00% | 0.00% | 0.00% | 22340 |
| MD | 100.00% | 0.00% | 0.00% | 0.00% | 14560 |
| ME | 100.00% | 0.00% | 0.00% | 0.00% | 2010 |
| MI | 100.00% | 0.00% | 0.00% | 0.00% | 13760 |
| MN | 100.00% | 0.00% | 0.00% | 0.00% | 40960 |
| MO | 98.92% | 1.07% | 0.00% | 0.00% | 51610 |
| MS | 52.59% | 10.05% | 37.36% | 0.00% | 11140 |
| MT | 100.00% | 0.00% | 0.00% | 0.00% | 1080 |
| NC | 100.00% | 0.00% | 0.00% | 0.00% | 29340 |
| ND | 100.00% | 0.00% | 0.00% | 0.00% | 3360 |
| NE | 100.00% | 0.00% | 0.00% | 0.00% | 24730 |
| NH | 100.00% | 0.00% | 0.00% | 0.00% | 3280 |
| NJ | 97.27% | 2.73% | 0.00% | 0.00% | 18850 |
| NM | 100.00% | 0.00% | 0.00% | 0.00% | 3610 |
| NV | 99.99% | 0.00% | 0.00% | 0.01% | 13510 |
| NY | 97.62% | 2.38% | 0.00% | 0.00% | 44000 |
| OH | 98.08% | 1.92% | 0.00% | 0.00% | 25660 |
| OKCO | 99.80% | 0.20% | 0.00% | 0.00% | 16560 |
| OR | 100.00% | 0.00% | 0.00% | 0.00% | 19940 |
| PA | 98.66% | 1.34% | 0.00% | 0.00% | 14380 |
| RI | 100.00% | 0.00% | 0.00% | 0.00% | 2090 |
| SC | 100.00% | 0.00% | 0.00% | 0.00% | 12510 |
| SD | 100.00% | 0.00% | 0.00% | 0.00% | 9150 |
| TN | 76.28% | 21.19% | 2.53% | 0.00% | 26730 |
| TX | 73.02% | 26.98% | 0.00% | 0.00% | 41640 |
| TULSA TMA | 99.80% | 0.20% | 0.00% | 0.00% | 0 |
| UT | 99.98% | 0.00% | 0.00% | 0.02% | 3890 |
| VA | 98.43% | 1.57% | 0.00% | 0.00% | 15350 |
| VT | 100.00% | 0.00% | 0.00% | 0.00% | 7860 |
| WA | 27.49% | 72.51% | 0.00% | 0.00% | 29500 |
| WI | 100.00% | 0.00% | 0.00% | 0.00% | 18950 |
| WV | 100.00% | 0.00% | 0.00% | 0.00% | 1530 |
| WY | 100.00% | 0.00% | 0.00% | 0.00% | 290 |

Table 6.4.4: From Tulsa To Other States Food Group Flows by each Mode (tons)

| | FLOWS | | | | |
|---|---|---|---|---|---|
| State | Highway | Rail | Water | Air | Total Disribution |
| AK | 670 | 0 | 0 | 0 | 670 |
| AL | 6287 | 0 | 2063 | 0 | 8350 |
| AR | 23984 | 1096 | 0 | 0 | 25080 |
| AZ | 6496 | 5113 | 0 | 1 | 11610 |
| CA | 26689 | 18160 | 0 | 0 | 44850 |
| CO | 23840 | 0 | 0 | 10 | 23850 |
| CT | 10450 | 0 | 0 | 0 | 10450 |
| DC | 9800 | 0 | 0 | 0 | 9800 |
| DE | 6740 | 0 | 0 | 0 | 6740 |
| FL | 29268 | 662 | 0 | 0 | 29930 |
| GA | 22700 | 327 | 0 | 3 | 23030 |
| HI | 0 | 0 | 0 | 1090 | 1090 |
| IA | 27850 | 0 | 0 | 0 | 27850 |
| ID | 5920 | 0 | 0 | 0 | 5920 |
| IL | 32159 | 9313 | 0 | 8 | 41480 |
| IN | 15300 | 0 | 0 | 0 | 15300 |
| KS | 47881 | 89 | 0 | 0 | 47970 |
| KY | 4606 | 914 | 0 | 0 | 5520 |
| LA | 10702 | 1624 | 23745 | 0 | 36070 |
| MA | 22340 | 0 | 0 | 0 | 22340 |
| MD | 14560 | 0 | 0 | 0 | 14560 |
| ME | 2010 | 0 | 0 | 0 | 2010 |
| MI | 13760 | 0 | 0 | 0 | 13760 |
| MN | 40960 | 0 | 0 | 0 | 40960 |
| MO | 51054 | 554 | 0 | 2 | 51610 |
| MS | 5859 | 1119 | 4162 | 0 | 11140 |
| MT | 1080 | 0 | 0 | 0 | 1080 |
| NC | 29340 | 0 | 0 | 0 | 29340 |
| ND | 3360 | 0 | 0 | 0 | 3360 |
| NE | 24730 | 0 | 0 | 0 | 24730 |
| NH | 3280 | 0 | 0 | 0 | 3280 |
| NJ | 18335 | 515 | 0 | 0 | 18850 |
| NM | 3610 | 0 | 0 | 0 | 3610 |
| NV | 13509 | 0 | 0 | 1 | 13510 |
| NY | 42952 | 1048 | 0 | 0 | 44000 |
| OH | 25167 | 493 | 0 | 0 | 25660 |
| OKCO | 16527 | 33 | 0 | 0 | 16560 |
| OR | 19940 | 0 | 0 | 0 | 19940 |
| PA | 14187 | 193 | 0 | 0 | 14380 |
| RI | 2090 | 0 | 0 | 0 | 2090 |
| SC | 12510 | 0 | 0 | 0 | 12510 |
| SD | 9150 | 0 | 0 | 0 | 9150 |
| TN | 20389 | 5665 | 676 | 0 | 26730 |
| TX | 30405 | 11234 | 0 | 0 | 41640 |
| TULSA TMA | 0 | 0 | 0 | 0 | 0 |
| UT | 3889 | 0 | 0 | 1 | 3890 |
| VA | 15109 | 241 | 0 | 0 | 15350 |
| VT | 7860 | 0 | 0 | 0 | 7860 |
| WA | 8108 | 21392 | 0 | 0 | 29500 |
| WI | 18950 | 0 | 0 | 0 | 18950 |
| WV | 1530 | 0 | 0 | 0 | 1530 |
| WY | 290 | 0 | 0 | 0 | 290 |
| **Total distribution by Mode** | **808182** | **79785** | **30646** | **1117** | **919730** |

Table 6.4.5: Middle Level From Tulsa To Other States by each Mode and Commodity Group (tons)

| | HIGHWAY | | | | | RAIL | | | | | WATER | | | | | AIR | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| State | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others |
| AK | 278 | 670 | 5000 | 0 | 50690 | 0 | 0 | 7500 | 3998 | 0 | 0 | 0 | 0 | 0 | 0 | 93 | 0 | 0 | 2153 | 0.00 |
| AL | 4405 | 6287 | 36682 | 123659 | 56310 | 3905 | 0 | 43919 | 12398 | 38874 | 0 | 2063 | 49 | 0 | 5105 | 0 | 0 | 0 | 3 | 0.34 |
| AR | 8238 | 23984 | 41548 | 100279 | 275507 | 3732 | 1096 | 20392 | 14808 | 42901 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1.90 |
| AZ | 6952 | 6496 | 76844 | 83438 | 212515 | 8643 | 5113 | 10632 | 38018 | 128877 | 0 | 0 | 0 | 0 | 0 | 25 | 1 | 4 | 485 | 388.45 |
| CA | 14490 | 26689 | 200165 | 246269 | 13180 | 15742 | 18160 | 90648 | 74410 | 7176 | 0 | 0 | 0 | 0 | 0 | 17 | 0 | 7 | 72 | 3.95 |
| CO | 3860 | 23840 | 43488 | 70661 | 1137 | 3190 | 0 | 72159 | 54505 | 1159 | 0 | 0 | 0 | 0 | 0 | 30 | 10 | 3 | 604 | 3.69 |
| CT | 5040 | 10450 | 95140 | 107060 | 28100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| DC | 6680 | 9800 | 53600 | 57870 | 91860 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| DE | 3750 | 6740 | 13170 | 17440 | 165380 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| FL | 111735 | 29268 | 20245 | 190837 | 14482 | 0 | 662 | 258605 | 130892 | 4327 | 0 | 0 | 0 | 0 | 0 | 45 | 0 | 0 | 31 | 0.96 |
| GA | 9744 | 22700 | 49035 | 142397 | 11303 | 7217 | 327 | 168919 | 114843 | 5371 | 0 | 0 | 0 | 0 | 0 | 119 | 3 | 35 | 1751 | 45.51 |
| HI | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4358 | 706 | 210 | 1090 | 13040 | 1453 | 124.50 |
| IA | 4525 | 27850 | 49812 | 30491 | 2407 | 2455 | 0 | 18448 | 20449 | 833 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| ID | 3916 | 5920 | 20930 | 27900 | 74800 | 1893 | 0 | 0 | 0 | 20290 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 20 | 9.99 |
| IL | 10868 | 32159 | 54073 | 62357 | 387915 | 12885 | 9313 | 74024 | 62957 | 392763 | 0 | 0 | 25538 | 0 | 22160 | 16 | 8 | 5 | 196 | 602.29 |
| IN | 7946 | 15300 | 87685 | 124811 | 3729 | 9739 | 0 | 125375 | 15801 | 2340 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 118 | 1.24 |
| KS | 12149 | 47881 | 44187 | 87954 | 2624 | 4591 | 89 | 46313 | 1236 | 796 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| KY | 2171 | 4606 | 102516 | 46740 | 11244 | 2634 | 914 | 13097 | 9060 | 2764 | 0 | 0 | 0 | 0 | 0 | 45 | 0 | 18 | 130 | 22.69 |
| LA | 2350 | 10702 | 31507 | 47139 | 11067 | 18326 | 1624 | 34218 | 4219 | 4457 | 0 | 23745 | 16045 | 0 | 15796 | 4 | 0 | 0 | 1 | 0.18 |
| MA | 8136 | 22340 | 99861 | 180208 | 21947 | 0 | 0 | 16109 | 0 | 786 | 0 | 0 | 0 | 0 | 0 | 74 | 0 | 0 | 652 | 17.19 |
| MD | 7344 | 14560 | 103070 | 105622 | 230233 | 0 | 0 | 0 | 31372 | 23292 | 0 | 0 | 0 | 0 | 0 | 36 | 0 | 0 | 15 | 34.20 |
| ME | 1410 | 2010 | 10980 | 29320 | 201010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| MI | 13582 | 13760 | 148083 | 168694 | 65284 | 6538 | 0 | 0 | 39817 | 7096 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 7 | 59 | 20.76 |
| MN | 4924 | 40960 | 90435 | 114288 | 18250 | 4845 | 0 | 46145 | 10822 | 6429 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1.02 |
| MO | 21824 | 51054 | 188143 | 169986 | 13435 | 9840 | 554 | 65431 | 58891 | 3052 | 0 | 0 | 0 | 0 | 0 | 77 | 2 | 6 | 623 | 13.32 |
| MS | 3919 | 5859 | 9167 | 39115 | 12357 | 10421 | 1119 | 45116 | 147074 | 14128 | 0 | 4162 | 39247 | 0 | 7884 | 1 | 0 | 0 | 1 | 0.14 |
| MT | 239 | 1080 | 17300 | 10438 | 41060 | 1110 | 0 | 0 | 0 | 12484 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 16.00 |
| NC | 16932 | 29340 | 59939 | 177911 | 10751 | 8945 | 0 | 89281 | 47733 | 1518 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 6 | 0.22 |
| ND | 523 | 3360 | 24320 | 6930 | 16985 | 127 | 0 | 0 | 0 | 3215 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NE | 4308 | 24730 | 23837 | 17354 | 16083 | 3352 | 0 | 24493 | 27596 | 8677 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NH | 1520 | 3280 | 11020 | 27090 | 303630 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NJ | 17690 | 18335 | 87307 | 86693 | 157053 | 0 | 515 | 57413 | 42948 | 29837 | 0 | 0 | 0 | 0 | 0 | 500 | 0 | 0 | 10 | 69.65 |
| NM | 5886 | 3610 | 42690 | 24431 | 19776 | 4263 | 0 | 0 | 11182 | 1667 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 317 | 7.37 |
| NV | 12937 | 13509 | 10394 | 215870 | 63947 | 0 | 0 | 74929 | 0 | 34918 | 0 | 0 | 0 | 0 | 0 | 113 | 1 | 17 | 4050 | 294.68 |
| NY | 19972 | 42952 | 18712 | 218907 | 36541 | 0 | 1048 | 268098 | 23597 | 5100 | 0 | 0 | 0 | 0 | 0 | 228 | 0 | 0 | 197 | 19.39 |
| OH | 16184 | 25167 | 7967 | 205334 | 114662 | 1659 | 493 | 118493 | 28794 | 33891 | 0 | 0 | 107871 | 0 | 20843 | 7 | 0 | 0 | 31 | 24.91 |
| OKCO | 8215 | 16527 | 111107 | 55617 | 141180 | 255 | 33 | 2453 | 34643 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| OR | 4124 | 19940 | 26164 | 134421 | 38580 | 6045 | 0 | 11696 | 5183 | 13197 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 6 | 2.95 |
| PA | 8268 | 14187 | 49397 | 123489 | 72303 | 0 | 193 | 128611 | 15579 | 15361 | 0 | 0 | 0 | 0 | 0 | 52 | 0 | 3 | 82 | 25.04 |
| RI | 1320 | 2090 | 7200 | 15670 | 193640 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| SC | 24280 | 12510 | 12679 | 193060 | 110338 | 0 | 0 | 62291 | 0 | 61202 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| SD | 2982 | 9150 | 6010 | 27370 | 214260 | 1398 | 0 | 0 | 0 | 76460 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| TN | 17631 | 20389 | 135784 | 182388 | 79839 | 4216 | 5665 | 100158 | 54062 | 41785 | 0 | 676 | 336 | 0 | 199 | 52 | 0 | 2 | 270 | 34.18 |
| TX | 67661 | 30405 | 191205 | 253358 | 86747 | 27858 | 11234 | 176663 | 62830 | 48727 | 0 | 0 | 1371 | 0 | 922 | 51 | 0 | 1 | 302 | 15.31 |
| TULSA TMA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| UT | 2097 | 3889 | 14925 | 41572 | 130816 | 2891 | 0 | 12990 | 0 | 106172 | 0 | 0 | 0 | 0 | 0 | 12 | 1 | 5 | 828 | 612.01 |
| VA | 3846 | 15109 | 125935 | 81937 | 15891 | 8688 | 241 | 48725 | 80703 | 4976 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 20 | 2.66 |
| VT | 1480 | 7860 | 28000 | 50980 | 92180 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| WA | 1970 | 8108 | 46211 | 118446 | 15308 | 6090 | 21392 | 8589 | 40564 | 12972 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| WI | 8966 | 18950 | 128949 | 104477 | 92986 | 2294 | 0 | 10911 | 46520 | 20483 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1.23 |
| WV | 5530 | 1530 | 279 | 29430 | 2315 | 0 | 0 | 60081 | 0 | 835 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| WY | 1278 | 290 | 1761 | 3220 | 20110 | 222 | 0 | 19529 | 0 | 3580 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| **TOTAL** | **536074** | **808182** | **2864455** | **4780926** | **4063748** | **206012** | **79785** | **2432456** | **1367502** | **1244768** | **0** | **30646** | **190457** | **4358** | **73615** | **1883** | **1117** | **13153** | **14494** | **2418** |

Table 6.4.6: Middle Level From Other States To Tulsa by each Mode and Commodity Group (tons)

| | HIGHWAY | | | | | RAIL | | | | | WATER | | | | | AIR | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| State | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others |
| AK | 15 | 368 | 11718 | 0 | 63 | 0 | 0 | 0 | 1050 | 70473 | 0 | 0 | 1953 | 0 | 0 | 5 | 142 | 5859 | 0 | 24.18 |
| AL | 6806 | 9960 | 67266 | 105582 | 118180 | 1094 | 0 | 1863 | 31918 | 17187 | 0 | 0 | 42201 | 0 | 36913 | 0 | 0 | 0 | 0 | 0.16 |
| AR | 1211 | 29645 | 17853 | 48073 | 163048 | 1376 | 3465 | 64337 | 89457 | 313792 | 4524 | 0 | 0 | 0 | 5290 | 0 | 0 | 0 | 0 | 0.00 |
| AZ | 4223 | 6330 | 42726 | 45894 | 247201 | 745 | 0 | 18767 | 0 | 36917 | 0 | 0 | 0 | 0 | 0 | 22 | 0 | 27 | 676 | 1331.74 |
| CA | 2208 | 36712 | 158671 | 141263 | 59401 | 3499 | 622 | 136966 | 15729 | 13692 | 0 | 0 | 0 | 0 | 0 | 3 | 6 | 13 | 318 | 46.95 |
| CO | 0 | 31640 | 177378 | 73471 | 99567 | 2280 | 6750 | 26652 | 10679 | 25253 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| CT | 3965 | 9246 | 121489 | 72462 | 170595 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 54 | 501 | 208 | 424.65 |
| DC | 2464 | 7168 | 23468 | 35440 | 98500 | 704 | 2048 | 32269 | 0 | 0 | 0 | 1024 | 0 | 0 | 0 | 352 | 0 | 2934 | 0 | 0.00 |
| DE | 13970 | 15350 | 1530 | 2042 | 433300 | 0 | 0 | 0 | 11868 | 87240 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| FL | 0 | 22510 | 192630 | 104857 | 176804 | 51550 | 0 | 0 | 19734 | 44981 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | 15.51 |
| GA | 9530 | 18640 | 224503 | 129158 | 162606 | 0 | 0 | 5147 | 1152 | 754 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| HI | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 145 | 2552 | 353 | 221 | 10 | 26 | 638 | 207 | 39.00 |
| IA | 2238 | 38571 | 87130 | 19150 | 19896 | 2202 | 27099 | 0 | 26834 | 13783 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0.14 |
| ID | 4870 | 15000 | 34250 | 17674 | 133085 | 0 | 0 | 0 | 9799 | 10108 | 0 | 0 | 0 | 0 | 0 | 560 | 0 | 0 | 8 | 16.38 |
| IL | 14758 | 56637 | 54987 | 86905 | 667968 | 874 | 20937 | 193947 | 8288 | 354779 | 0 | 5727 | 10608 | 0 | 32655 | 8 | 28 | 8 | 137 | 668.19 |
| IN | 8247 | 30637 | 186834 | 112091 | 7322 | 1388 | 0 | 57132 | 23068 | 1558 | 0 | 0 | 0 | 0 | 0 | 5 | 13 | 5 | 1 | 0.65 |
| KS | 25150 | 108760 | 68416 | 75887 | 11200 | 0 | 9090 | 111874 | 2083 | 5610 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| KY | 1506 | 10585 | 237897 | 31075 | 23384 | 1857 | 0 | 67294 | 1040 | 4594 | 0 | 0 | 0 | 17803 | 7772 | 7 | 5 | 39 | 62 | 39.67 |
| LA | 9024 | 17599 | 74270 | 18080 | 91391 | 6914 | 2674 | 39266 | 1056 | 33149 | 15251 | 4747 | 76464 | 15602 | 96634 | 1 | 0 | 0 | 2 | 6.27 |
| MA | 3610 | 16101 | 141670 | 92310 | 190076 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 13.95 |
| MD | 4000 | 16551 | 88544 | 91360 | 387429 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 1406 | 960 | 2380.71 |
| ME | 1040 | 1610 | 14540 | 21243 | 146971 | 0 | 0 | 0 | 9637 | 48649 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| MI | 6989 | 17989 | 223450 | 164311 | 87823 | 0 | 751 | 0 | 18695 | 5635 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 4 | 2.19 |
| MN | 5620 | 32418 | 231674 | 108429 | 76403 | 0 | 56320 | 62128 | 20483 | 61731 | 0 | 1542 | 6318 | 0 | 1693 | 0 | 0 | 0 | 8 | 2.97 |
| MO | 23435 | 51108 | 130525 | 146083 | 54056 | 0 | 34531 | 129984 | 22815 | 33397 | 0 | 0 | 0 | 0 | 0 | 25 | 2 | 1 | 262 | 16.37 |
| MS | 3828 | 7748 | 44620 | 146931 | 38684 | 0 | 3144 | 21898 | 9487 | 4726 | 4382 | 1458 | 18012 | 10942 | 10731 | 0 | 0 | 0 | 0 | 0.00 |
| MT | 1700 | 6780 | 47147 | 9588 | 75630 | 0 | 0 | 110053 | 5942 | 50400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NC | 10750 | 24580 | 171980 | 164914 | 16760 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0.36 |
| ND | 450 | 16870 | 68480 | 6530 | 17509 | 0 | 9120 | 0 | 0 | 8621 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NE | 5870 | 66512 | 59680 | 37350 | 102425 | 0 | 5788 | 0 | 0 | 8615 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NH | 180 | 5210 | 20730 | 86570 | 416580 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NJ | 8695 | 18510 | 21671 | 102450 | 179772 | 2331 | 0 | 191659 | 0 | 101427 | 0 | 0 | 0 | 0 | 0 | 114 | 0 | 0 | 0 | 1020.84 |
| NM | 19194 | 3100 | 73241 | 33510 | 29750 | 1286 | 0 | 97659 | 0 | 6597 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 70 | 2.70 |
| NV | 4590 | 9620 | 307 | 28628 | 5291 | 0 | 0 | 61932 | 87585 | 45296 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1028 | 23.03 |
| NY | 9262 | 38720 | 287310 | 107221 | 54189 | 0 | 4530 | 0 | 25219 | 8903 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 10 | 8.27 |
| OH | 13037 | 50570 | 155149 | 143687 | 177685 | 2167 | 0 | 133991 | 51688 | 60389 | 0 | 0 | 4923 | 9636 | 9246 | 16 | 0 | 17 | 39 | 50.38 |
| OKCO | 6954 | 13433 | 105951 | 34396 | 281210 | 216 | 27 | 2339 | 21424 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| OR | 1390 | 19190 | 56 | 42334 | 47642 | 0 | 0 | 39664 | 65688 | 44969 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 88 | 58.75 |
| PA | 2098 | 16523 | 213530 | 103285 | 128643 | 2139 | 0 | 46013 | 18934 | 29778 | 0 | 0 | 0 | 0 | 0 | 3 | 27 | 47 | 61 | 78.80 |
| RI | 580 | 4130 | 12100 | 6690 | 237220 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| SC | 5606 | 11160 | 5888 | 145209 | 11422 | 5304 | 0 | 97862 | 11501 | 4208 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| SD | 260 | 7498 | 9680 | 23870 | 435596 | 0 | 5252 | 0 | 0 | 198634 | 0 | 0 | 0 | 0 | 7046 | 0 | 0 | 0 | 0 | 0.00 |
| TN | 8897 | 23253 | 226650 | 177077 | 169813 | 195 | 5158 | 0 | 5094 | 16231 | 0 | 793 | 0 | 0 | 196 | 68 | 16 | 0 | 1409 | 825.92 |
| TX | 38915 | 37811 | 407111 | 157688 | 112011 | 19896 | 916 | 23379 | 24130 | 13534 | 303 | 0 | 0 | 0 | 0 | 7 | 4 | 10 | 252 | 24.90 |
| TULSA TMA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| UT | 3046 | 4550 | 4893 | 16384 | 169548 | 1078 | 0 | 68718 | 17486 | 281362 | 0 | 0 | 0 | 0 | 0 | 46 | 0 | 9 | 50 | 920.74 |
| VA | 5439 | 19450 | 84297 | 124254 | 22696 | 0 | 0 | 185613 | 0 | 1181 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 16 | 2.52 |
| VT | 1650 | 11120 | 29120 | 24190 | 55170 | 0 | 0 | 13440 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2240 | 0 | 0.00 |
| WA | 963 | 32017 | 86830 | 65541 | 40497 | 4659 | 0 | 0 | 59161 | 22947 | 0 | 0 | 0 | 0 | 0 | 9 | 3 | 0 | 58 | 25.80 |
| WI | 5400 | 21411 | 47675 | 97635 | 86299 | 0 | 4959 | 95535 | 19605 | 39481 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| WV | 4140 | 620 | 218240 | 19926 | 15273 | 0 | 0 | 0 | 7814 | 2187 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| WY | 1218 | 260 | 5036 | 1950 | 1045 | 6152 | 0 | 253444 | 0 | 22285 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| TOTAL | 318990 | 1071781 | 5020791 | 3650648 | 6554630 | 119905 | 203180 | 2390824 | 756142 | 2155054 | 24459 | 15435 | 163031 | 54336 | 208396 | 1276 | 364 | 13755 | 5964 | 8073 |

Table 6.4.7: Upper Level From Tulsa To Other States by each Mode and Commodity Group (tons)

| | HIGHWAY | | | | | RAIL | | | | | WATER | | | | | AIR | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| State | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others |
| AK | 398 | 960 | 7156 | 0 | 70590 | 0 | 0 | 10734 | 5785 | 0 | 0 | 0 | 0 | 0 | 0 | 133 | 0 | 0 | 3115 | 0.00 |
| AL | 5719 | 8101 | 47393 | 161058 | 70740 | 5070 | 0 | 56744 | 16148 | 48836 | 0 | 2659 | 63 | 0 | 6413 | 0 | 0 | 0 | 4 | 0.43 |
| AR | 10936 | 31606 | 54843 | 133632 | 354133 | 4954 | 1444 | 26917 | 19733 | 55145 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 2.44 |
| AZ | 8972 | 8353 | 98699 | 108454 | 265249 | 11155 | 6576 | 13656 | 49416 | 160856 | 0 | 0 | 0 | 0 | 0 | 33 | 1 | 5 | 630 | 484.84 |
| CA | 18054 | 33021 | 247030 | 307853 | 15906 | 19614 | 22469 | 111872 | 93017 | 8659 | 0 | 0 | 0 | 0 | 0 | 22 | 0 | 8 | 90 | 4.77 |
| CO | 4961 | 30508 | 55517 | 91594 | 1414 | 4101 | 0 | 92119 | 70653 | 1441 | 0 | 0 | 0 | 0 | 0 | 38 | 12 | 4 | 783 | 4.59 |
| CT | 6580 | 13600 | 124360 | 140670 | 35330 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| DC | 9340 | 13670 | 75010 | 81550 | 124430 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| DE | 5270 | 9370 | 18320 | 24440 | 224960 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| FL | 139364 | 36553 | 25322 | 240657 | 17585 | 0 | 827 | 323458 | 165063 | 5254 | 0 | 0 | 0 | 0 | 0 | 56 | 0 | 0 | 40 | 1.16 |
| GA | 12385 | 28644 | 61934 | 181335 | 13886 | 9173 | 413 | 213352 | 146246 | 6598 | 0 | 0 | 0 | 0 | 0 | 151 | 3 | 45 | 2229 | 55.91 |
| HI | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6060 | 935 | 290 | 1500 | 17950 | 2020 | 165.00 |
| IA | 5939 | 36330 | 65013 | 40188 | 3053 | 3221 | 0 | 24077 | 26952 | 1057 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| ID | 5412 | 8140 | 28630 | 38772 | 99922 | 2617 | 0 | 0 | 0 | 27105 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 28 | 13.34 |
| IL | 13676 | 40129 | 67756 | 78922 | 467932 | 16214 | 11621 | 92757 | 79681 | 473780 | 0 | 0 | 32001 | 0 | 26731 | 20 | 10 | 6 | 248 | 726.53 |
| IN | 10147 | 19440 | 111509 | 160153 | 4626 | 12437 | 0 | 159441 | 20275 | 2903 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 152 | 1.54 |
| KS | 16032 | 62763 | 57911 | 116453 | 3345 | 6058 | 117 | 60699 | 1637 | 1015 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| KY | 2834 | 5975 | 133271 | 61256 | 14217 | 3438 | 1185 | 17026 | 11874 | 3494 | 0 | 0 | 0 | 0 | 0 | 59 | 0 | 23 | 170 | 28.68 |
| LA | 3098 | 13962 | 41201 | 62100 | 14064 | 24157 | 2118 | 44746 | 5559 | 5664 | 0 | 30979 | 20982 | 0 | 20073 | 5 | 0 | 0 | 2 | 0.23 |
| MA | 10316 | 28139 | 126288 | 228911 | 26626 | 0 | 0 | 20372 | 0 | 953 | 0 | 0 | 0 | 0 | 0 | 94 | 1 | 0 | 829 | 20.85 |
| MD | 9404 | 18610 | 132300 | 136474 | 284151 | 0 | 0 | 0 | 40536 | 28747 | 0 | 0 | 0 | 0 | 0 | 46 | 0 | 0 | 20 | 42.21 |
| ME | 1950 | 2760 | 15100 | 40610 | 267480 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| MI | 17178 | 17320 | 186481 | 214206 | 80044 | 8269 | 0 | 0 | 50559 | 8700 | 0 | 0 | 0 | 0 | 0 | 63 | 0 | 9 | 75 | 25.45 |
| MN | 6260 | 51570 | 114225 | 146013 | 22420 | 6159 | 0 | 58285 | 13827 | 7898 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1.25 |
| MO | 27930 | 64844 | 239656 | 218531 | 16675 | 12592 | 703 | 83346 | 75708 | 3788 | 0 | 0 | 0 | 0 | 0 | 98 | 3 | 8 | 801 | 16.54 |
| MS | 5238 | 7768 | 12178 | 52485 | 15971 | 13930 | 1484 | 59934 | 197344 | 18259 | 0 | 5519 | 52138 | 0 | 10190 | 1 | 0 | 0 | 1 | 0.18 |
| MT | 339 | 1520 | 24510 | 14937 | 56546 | 1579 | 0 | 0 | 0 | 17192 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 22.03 |
| NC | 21505 | 37050 | 75821 | 226747 | 13214 | 11361 | 0 | 112939 | 60836 | 1866 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 7 | 0.26 |
| ND | 741 | 4780 | 34550 | 9950 | 23400 | 179 | 0 | 0 | 0 | 4430 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NE | 5776 | 33030 | 31768 | 23392 | 20838 | 4494 | 0 | 32642 | 37198 | 11242 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NH | 2070 | 4460 | 15010 | 37230 | 400760 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NJ | 22388 | 23149 | 110630 | 110524 | 191310 | 0 | 651 | 72750 | 54754 | 36345 | 0 | 0 | 0 | 0 | 0 | 632 | 0 | 0 | 12 | 84.84 |
| NM | 8090 | 4910 | 58140 | 33617 | 26174 | 5860 | 0 | 0 | 15387 | 2206 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 437 | 9.76 |
| NV | 17150 | 17839 | 13706 | 288654 | 82010 | 0 | 0 | 98802 | 0 | 44782 | 0 | 0 | 0 | 0 | 0 | 150 | 1 | 22 | 5416 | 377.91 |
| NY | 25104 | 53661 | 23477 | 276569 | 44400 | 0 | 1309 | 336373 | 29812 | 6196 | 0 | 0 | 0 | 0 | 0 | 286 | 0 | 0 | 248 | 23.56 |
| OH | 20291 | 31404 | 9952 | 258790 | 139290 | 2080 | 615 | 148018 | 36290 | 41170 | 0 | 0 | 134750 | 0 | 25319 | 8 | 0 | 0 | 40 | 30.26 |
| OKCO | 10998 | 21936 | 147728 | 74676 | 182660 | 342 | 44 | 3262 | 46514 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.00 |
| OR | 5376 | 25890 | 33904 | 176622 | 48632 | 7882 | 0 | 15156 | 6810 | 16635 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 8 | 3.72 |
| PA | 10384 | 17759 | 61962 | 156085 | 87722 | 0 | 241 | 161325 | 19691 | 18637 | 0 | 0 | 0 | 0 | 0 | 66 | 0 | 3 | 103 | 30.39 |
| RI | 1860 | 2930 | 10140 | 22170 | 264430 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| SC | 31630 | 16180 | 16435 | 252420 | 138845 | 0 | 0 | 80745 | 0 | 77015 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| SD | 4187 | 12780 | 8390 | 38740 | 294607 | 1963 | 0 | 0 | 0 | 105133 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| TN | 22437 | 25775 | 171926 | 232816 | 98376 | 5366 | 7161 | 126817 | 69010 | 51487 | 0 | 854 | 425 | 0 | 246 | 67 | 0 | 3 | 344 | 42.12 |
| TX | 84702 | 38065 | 239250 | 320594 | 105948 | 34874 | 14064 | 221053 | 79503 | 59513 | 0 | 0 | 1715 | 0 | 1126 | 64 | 0 | 1 | 382 | 18.70 |
| TULSA TMA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| UT | 2767 | 5109 | 19570 | 55309 | 167341 | 3817 | 0 | 17033 | 0 | 135816 | 0 | 0 | 0 | 0 | 0 | 16 | 1 | 7 | 1101 | 782.88 |
| VA | 4876 | 19076 | 159203 | 104474 | 19501 | 11014 | 304 | 61597 | 102901 | 6106 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 25 | 3.26 |
| VT | 2120 | 11200 | 40000 | 73200 | 126950 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| WA | 2514 | 10293 | 58616 | 152153 | 18902 | 7776 | 27157 | 10894 | 52107 | 16018 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| WI | 11435 | 24040 | 163772 | 133931 | 115063 | 2925 | 0 | 13858 | 59635 | 25346 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1.52 |
| WV | 7700 | 2110 | 389 | 41220 | 3124 | 0 | 0 | 83841 | 0 | 1126 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| WY | 1892 | 420 | 2594 | 4760 | 28582 | 328 | 0 | 28776 | 0 | 5088 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| TOTAL | 685726 | 1037502 | 3678546 | 6185898 | 5213374 | 265002 | 100503 | 3095415 | 1760459 | 1553503 | 0 | 40011 | 242075 | 6060 | 91033 | 2433 | 1534 | 18094 | 19373 | 3027 |

Table 6.4.8: Upper Level From Other States To Tulsa by each Mode and Commodity Group (tons)

| | HIGHWAY | | | | | RAIL | | | | | WATER | | | | | AIR | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| State | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others |
| AK | 23 | 542 | 17418 | 0 | 91 | 0 | 0 | 0 | 1570 | 101804 | 0 | 0 | 2903 | 0 | 0 | 8 | 208 | 8709 | 0 | 34.94 |
| AL | 8607 | 12490 | 84522 | 133955 | 144528 | 1383 | 0 | 2341 | 40495 | 21019 | 0 | 0 | 53027 | 0 | 45142 | 0 | 0 | 0 | 0 | 0.19 |
| AR | 1590 | 38670 | 23329 | 63429 | 207577 | 1807 | 4520 | 84071 | 118031 | 399488 | 5942 | 0 | 0 | 0 | 6735 | 0 | 0 | 0 | 0 | 0.00 |
| AZ | 5238 | 7780 | 52658 | 57080 | 295498 | 925 | 0 | 23130 | 0 | 44130 | 0 | 0 | 0 | 0 | 0 | 27 | 0 | 33 | 840 | 1591.93 |
| CA | 2560 | 42227 | 182812 | 164252 | 66710 | 4057 | 716 | 157804 | 18289 | 15377 | 0 | 0 | 0 | 0 | 0 | 3 | 7 | 15 | 370 | 52.73 |
| CO | 0 | 39189 | 220091 | 92051 | 120100 | 2850 | 8361 | 33069 | 13379 | 30460 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| CT | 5114 | 11840 | 155837 | 93830 | 211613 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 70 | 643 | 270 | 526.76 |
| DC | 3556 | 10262 | 33628 | 51290 | 137400 | 1016 | 2932 | 46239 | 0 | 0 | 0 | 1466 | 0 | 0 | 0 | 508 | 0 | 4204 | 0 | 0.00 |
| DE | 19960 | 21780 | 2170 | 2928 | 600147 | 0 | 0 | 0 | 17022 | 120833 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| FL | 0 | 26290 | 225370 | 123849 | 201419 | 60420 | 0 | 0 | 23308 | 51243 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 17.67 |
| GA | 11480 | 22280 | 268729 | 156098 | 189601 | 0 | 0 | 6161 | 1392 | 879 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| HI | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 204 | 3584 | 504 | 306 | 20 | 36 | 896 | 296 | 54.00 |
| IA | 2904 | 49760 | 112600 | 24988 | 25048 | 2856 | 34959 | 0 | 35014 | 17352 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0.18 |
| ID | 6834 | 20930 | 47850 | 24928 | 180740 | 0 | 0 | 0 | 13821 | 13728 | 0 | 0 | 0 | 0 | 0 | 786 | 0 | 0 | 11 | 22.25 |
| IL | 17608 | 67037 | 65256 | 104171 | 765228 | 1043 | 24781 | 230165 | 9935 | 406437 | 0 | 6779 | 12589 | 0 | 37410 | 9 | 34 | 10 | 164 | 765.48 |
| IN | 10146 | 37454 | 228677 | 138572 | 8756 | 1707 | 0 | 69927 | 28517 | 1863 | 0 | 0 | 0 | 0 | 0 | 7 | 16 | 6 | 1 | 0.78 |
| KS | 32890 | 141227 | 88980 | 99645 | 14172 | 0 | 11803 | 145500 | 2735 | 7098 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| KY | 1917 | 13394 | 301544 | 39774 | 28885 | 2364 | 0 | 85298 | 1331 | 5675 | 0 | 0 | 0 | 22786 | 9601 | 9 | 6 | 49 | 79 | 49.00 |
| LA | 11604 | 22446 | 94886 | 23315 | 113617 | 8892 | 3410 | 50166 | 1362 | 41211 | 19613 | 6054 | 97688 | 20120 | 120135 | 1 | 0 | 0 | 2 | 7.80 |
| MA | 4430 | 19559 | 172490 | 113380 | 223474 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 16.40 |
| MD | 4970 | 20424 | 109511 | 114121 | 464019 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 | 1739 | 1199 | 2851.35 |
| ME | 1470 | 2240 | 20340 | 30015 | 199473 | 0 | 0 | 0 | 13615 | 66027 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| MI | 8419 | 21531 | 267860 | 198877 | 102595 | 0 | 899 | 0 | 22627 | 6583 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 5 | 2.56 |
| MN | 6930 | 39610 | 283864 | 134165 | 91101 | 0 | 68815 | 76124 | 25345 | 73607 | 0 | 1885 | 7742 | 0 | 2018 | 0 | 0 | 0 | 10 | 3.54 |
| MO | 28999 | 62745 | 160652 | 181551 | 64865 | 0 | 42393 | 159986 | 28354 | 40075 | 0 | 0 | 0 | 0 | 0 | 31 | 2 | 1 | 325 | 19.64 |
| MS | 5068 | 10176 | 58719 | 195349 | 49544 | 0 | 4129 | 28818 | 12613 | 6052 | 5802 | 1915 | 23703 | 14548 | 13743 | 0 | 0 | 0 | 0 | 0.00 |
| MT | 2500 | 9900 | 68974 | 14156 | 107525 | 0 | 0 | 161006 | 8774 | 71655 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NC | 12990 | 29460 | 206530 | 199963 | 19590 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0.42 |
| ND | 660 | 24815 | 100960 | 9720 | 25061 | 0 | 13415 | 0 | 0 | 12339 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NE | 7920 | 89216 | 80170 | 50660 | 133768 | 0 | 7764 | 0 | 0 | 11252 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NH | 250 | 7160 | 28560 | 120440 | 556640 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NJ | 10537 | 22300 | 26149 | 124820 | 209819 | 2825 | 0 | 231261 | 0 | 118379 | 0 | 0 | 0 | 0 | 0 | 138 | 0 | 0 | 0 | 1191.46 |
| NM | 26514 | 4250 | 100583 | 46443 | 39726 | 1776 | 0 | 134117 | 0 | 8810 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 97 | 3.61 |
| NV | 6010 | 12520 | 400 | 37697 | 6692 | 0 | 0 | 80718 | 115330 | 57289 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1353 | 29.13 |
| NY | 10961 | 45417 | 337760 | 127305 | 61884 | 0 | 5313 | 0 | 29943 | 10167 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 12 | 9.44 |
| OH | 15589 | 60050 | 184418 | 172551 | 205698 | 2591 | 0 | 159269 | 62071 | 69910 | 0 | 0 | 5852 | 11572 | 10704 | 20 | 0 | 21 | 47 | 58.32 |
| OKCO | 9126 | 17485 | 138297 | 45314 | 357190 | 284 | 35 | 3053 | 28225 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| OR | 1780 | 24390 | 72 | 54410 | 58855 | 0 | 0 | 50478 | 84427 | 55553 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 113 | 72.58 |
| PA | 2514 | 19638 | 254082 | 124157 | 148723 | 2562 | 0 | 54752 | 22760 | 34426 | 0 | 0 | 0 | 0 | 0 | 4 | 32 | 56 | 74 | 91.09 |
| RI | 840 | 5940 | 17450 | 9740 | 332620 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| SC | 7112 | 14030 | 7416 | 184784 | 13987 | 6728 | 0 | 123254 | 14636 | 5153 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| SD | 370 | 10803 | 13960 | 34800 | 614434 | 0 | 7567 | 0 | 0 | 280186 | 0 | 0 | 0 | 0 | 9939 | 0 | 0 | 0 | 0 | 0.00 |
| TN | 10888 | 28259 | 275900 | 217685 | 201382 | 239 | 6269 | 0 | 6262 | 19249 | 0 | 963 | 0 | 0 | 232 | 84 | 19 | 0 | 1732 | 979.46 |
| TX | 45550 | 44010 | 474632 | 185671 | 127150 | 23288 | 1066 | 27256 | 28412 | 15364 | 354 | 0 | 0 | 0 | 0 | 9 | 4 | 12 | 297 | 28.26 |
| TULSA TMA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| UT | 3996 | 5930 | 6387 | 21586 | 215024 | 1414 | 0 | 89701 | 23038 | 356828 | 0 | 0 | 0 | 0 | 0 | 60 | 0 | 12 | 66 | 1167.70 |
| VA | 6619 | 23470 | 101852 | 151660 | 26688 | 0 | 0 | 224268 | 0 | 1389 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 20 | 2.96 |
| VT | 2440 | 16370 | 42913 | 36010 | 78770 | 0 | 0 | 19806 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3301 | 0 | 0.00 |
| WA | 1183 | 39077 | 106240 | 80923 | 48109 | 5726 | 0 | 0 | 73045 | 27260 | 0 | 0 | 0 | 0 | 0 | 11 | 3 | 0 | 72 | 30.65 |
| WI | 6670 | 26250 | 58538 | 121061 | 103314 | 0 | 6080 | 117302 | 24309 | 47266 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| WV | 5870 | 880 | 308020 | 28381 | 20959 | 0 | 0 | 0 | 11129 | 3001 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| WY | 1873 | 400 | 7707 | 3010 | 1553 | 9457 | 0 | 387873 | 0 | 33117 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| **TOTAL** | **403077** | **1343901** | **6227763** | **4564559** | **8221363** | **146211** | **255228** | **3062913** | **961118** | **2709534** | **31711** | **19265** | **207088** | **69530** | **255964** | **1751** | **486** | **19707** | **7492** | **9682** |

Table 6.4.9: Lower Level From Tulsa To Other States by each Mode and Commodity Group (tons)

| | HIGHWAY | | | | | RAIL | | | | | WATER | | | | | AIR | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| State | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others |
| AK | 158 | 173 | 2872 | 0 | 30810 | 0 | 0 | 4308 | 2249 | 0 | 0 | 0 | 0 | 0 | 0 | 53 | 67 | 0 | 1211 | 0 |
| AL | 3037 | 7400 | 25575 | 84914 | 41560 | 2693 | 0 | 30621 | 8514 | 28692 | 0 | 0 | 34 | 0 | 3768 | 0 | 0 | 0 | 2 | 0 |
| AR | 5485 | 20288 | 27965 | 66271 | 195678 | 2485 | 2372 | 13725 | 9786 | 30471 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 |
| AZ | 4855 | 4880 | 54216 | 57511 | 159035 | 6037 | 0 | 7501 | 26205 | 96444 | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 3 | 334 | 291 |
| CA | 10701 | 31727 | 150602 | 180699 | 10390 | 11626 | 538 | 68203 | 54598 | 5657 | 0 | 0 | 0 | 0 | 0 | 13 | 5 | 5 | 53 | 3 |
| CO | 2715 | 24082 | 31030 | 48935 | 855 | 2244 | 5138 | 51488 | 37747 | 872 | 0 | 0 | 0 | 0 | 0 | 21 | 0 | 2 | 418 | 3 |
| CT | 3440 | 6591 | 65040 | 72470 | 20800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 | 0 | 0 | 0 |
| DC | 4040 | 3864 | 32330 | 34460 | 59180 | 0 | 1104 | 0 | 0 | 0 | 0 | 552 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DE | 2260 | 8470 | 8030 | 10500 | 105620 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FL | 82487 | 18980 | 14866 | 137944 | 11310 | 0 | 0 | 189894 | 94614 | 3379 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 23 | 1 |
| GA | 6966 | 15130 | 35462 | 101370 | 8653 | 5159 | 0 | 122162 | 81754 | 4112 | 0 | 0 | 0 | 0 | 0 | 85 | 0 | 26 | 1246 | 35 |
| HI | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 85 | 0 | 2663 | 468 | 130 | 15 | 8130 | 888 | 83 |
| IA | 3080 | 27048 | 34181 | 20531 | 1746 | 1670 | 19002 | 12659 | 13769 | 604 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ID | 2426 | 8680 | 13200 | 17078 | 49576 | 1173 | 0 | 0 | 0 | 13448 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 7 |
| IL | 7896 | 46735 | 39597 | 44809 | 307511 | 9362 | 17276 | 54208 | 45240 | 311354 | 0 | 4726 | 18702 | 0 | 17567 | 12 | 23 | 4 | 141 | 477 |
| IN | 5633 | 23910 | 62720 | 87766 | 2795 | 6904 | 0 | 89680 | 11111 | 1754 | 0 | 0 | 0 | 0 | 0 | 3 | 10 | 0 | 83 | 1 |
| KS | 8165 | 75195 | 30115 | 58784 | 1887 | 3085 | 6285 | 31565 | 826 | 573 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| KY | 1491 | 7737 | 70749 | 31773 | 8198 | 1809 | 0 | 9038 | 6159 | 2015 | 0 | 0 | 0 | 0 | 0 | 31 | 3 | 12 | 88 | 17 |
| LA | 1582 | 12640 | 21543 | 31775 | 8018 | 12336 | 1920 | 23396 | 2844 | 3229 | 0 | 3409 | 10971 | 0 | 11443 | 3 | 0 | 0 | 1 | 0 |
| MA | 5847 | 12703 | 72065 | 128963 | 17259 | 0 | 0 | 11625 | 0 | 618 | 0 | 0 | 0 | 0 | 0 | 53 | 7 | 0 | 467 | 14 |
| MD | 5195 | 12678 | 72620 | 73499 | 175880 | 0 | 0 | 0 | 21831 | 17794 | 0 | 0 | 0 | 0 | 0 | 25 | 22 | 0 | 11 | 26 |
| ME | 880 | 930 | 6850 | 18060 | 134270 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MI | 9784 | 14562 | 107575 | 120610 | 50072 | 4710 | 608 | 0 | 28468 | 5442 | 0 | 0 | 0 | 0 | 0 | 36 | 0 | 5 | 42 | 16 |
| MN | 3523 | 25297 | 65505 | 80972 | 13998 | 3466 | 43949 | 33425 | 7668 | 4931 | 0 | 1204 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| MO | 15436 | 39536 | 134344 | 119242 | 10113 | 6960 | 26712 | 46721 | 41311 | 2297 | 0 | 0 | 0 | 0 | 0 | 54 | 1 | 4 | 437 | 10 |
| MS | 2577 | 5232 | 6100 | 25535 | 8697 | 6853 | 2123 | 30022 | 96014 | 9943 | 0 | 985 | 26117 | 0 | 5549 | 1 | 0 | 0 | 1 | 0 |
| MT | 140 | 3410 | 10170 | 6009 | 25574 | 650 | 0 | 0 | 0 | 7776 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 10 |
| NC | 12123 | 19850 | 43229 | 126497 | 8219 | 6405 | 0 | 64391 | 33939 | 1161 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 4 | 0 |
| ND | 298 | 8263 | 14200 | 3960 | 10561 | 72 | 4467 | 0 | 0 | 1999 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NE | 2818 | 42658 | 15778 | 11239 | 11283 | 2192 | 3712 | 16212 | 17871 | 6087 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NH | 960 | 3140 | 7000 | 16930 | 205840 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NJ | 12760 | 14830 | 62766 | 61604 | 122494 | 0 | 0 | 41274 | 30519 | 23272 | 0 | 0 | 0 | 0 | 0 | 360 | 0 | 0 | 7 | 54 |
| NM | 3677 | 1880 | 27160 | 15238 | 13331 | 2663 | 0 | 0 | 6974 | 1124 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 198 | 5 |
| NV | 8654 | 6630 | 7013 | 141790 | 45677 | 0 | 0 | 50555 | 0 | 24942 | 0 | 0 | 0 | 0 | 0 | 76 | 0 | 11 | 2660 | 210 |
| NY | 14544 | 32445 | 13675 | 157871 | 28524 | 0 | 3795 | 195935 | 17017 | 3981 | 0 | 0 | 0 | 0 | 0 | 166 | 0 | 0 | 142 | 15 |
| OH | 11814 | 41510 | 5862 | 148520 | 89316 | 1211 | 0 | 87182 | 20827 | 26399 | 0 | 0 | 79367 | 0 | 16235 | 5 | 0 | 0 | 23 | 19 |
| OKCO | 5412 | 9221 | 73986 | 36343 | 99380 | 168 | 19 | 1634 | 22637 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OR | 2834 | 13880 | 18196 | 90998 | 28410 | 4155 | 0 | 8134 | 3508 | 9718 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 4 | 2 |
| PA | 6022 | 13548 | 36096 | 88941 | 56588 | 0 | 0 | 93982 | 11220 | 12023 | 0 | 0 | 0 | 0 | 0 | 38 | 22 | 2 | 59 | 20 |
| RI | 790 | 2170 | 4290 | 9250 | 122750 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SC | 16670 | 8250 | 8793 | 131680 | 81245 | 0 | 0 | 43197 | 0 | 45065 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SD | 1784 | 3934 | 3640 | 16140 | 133890 | 836 | 2756 | 0 | 0 | 47780 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TN | 12567 | 18327 | 97810 | 129348 | 60787 | 3005 | 4066 | 72147 | 38341 | 31814 | 0 | 625 | 242 | 0 | 152 | 37 | 13 | 2 | 191 | 26 |
| TX | 49714 | 32080 | 140628 | 182328 | 67072 | 20469 | 777 | 129933 | 45215 | 37676 | 0 | 0 | 1008 | 0 | 713 | 37 | 3 | 1 | 217 | 12 |
| TULSA TMA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UT | 1409 | 3120 | 10183 | 27551 | 93900 | 1943 | 0 | 8863 | 0 | 76210 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 3 | 549 | 439 |
| VA | 2761 | 15530 | 90950 | 58216 | 12206 | 6238 | 0 | 35190 | 57340 | 3822 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 14 | 2 |
| VT | 850 | 5450 | 16170 | 29160 | 57410 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| WA | 1400 | 25028 | 33284 | 83242 | 11665 | 4330 | 0 | 6186 | 28508 | 9885 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| WI | 6370 | 16620 | 92457 | 73597 | 70295 | 1629 | 3850 | 7823 | 32771 | 15484 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 |
| WV | 3360 | 350 | 169 | 17740 | 1507 | 0 | 0 | 36471 | 0 | 543 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| WY | 690 | 110 | 949 | 1720 | 11655 | 120 | 0 | 10521 | 0 | 2075 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **TOTAL** | **380079** | **796703** | **2019607** | **3320383** | **2903492** | **144657** | **150469** | **1739873** | **957393** | **932463** | **0** | **11585** | **136441** | **2663** | **55895** | **1314** | **234** | **8210** | **9532** | **1801** |

Table 6.4.10: Lower Level From Other States To Tulsa by each Mode and Commodity Group (tons)

| | HIGHWAY | | | | | RAIL | | | | | WATER | | | | | AIR | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| State | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others | Chemicals | Food | Mining | Manufactured | Others |
| AK | 8 | 173 | 2872 | 0 | 32 | 0 | 0 | 4308 | 490 | 35386 | 0 | 0 | 0 | 0 | 0 | 3 | 67 | 0 | 0 | 12.14 |
| AL | 4980 | 7400 | 25575 | 76726 | 92442 | 800 | 0 | 30621 | 23194 | 13444 | 0 | 0 | 34 | 0 | 28874 | 0 | 0 | 0 | 0 | 0.12 |
| AR | 816 | 20288 | 27965 | 32186 | 117309 | 927 | 2372 | 13725 | 59894 | 225765 | 3048 | 0 | 0 | 0 | 3806 | 0 | 0 | 0 | 0 | 0.00 |
| AZ | 3216 | 4880 | 54216 | 34620 | 201866 | 568 | 0 | 7501 | 0 | 30147 | 0 | 0 | 0 | 0 | 0 | 17 | 0 | 3 | 510 | 1087.50 |
| CA | 1879 | 31727 | 150602 | 119550 | 53943 | 2978 | 538 | 68203 | 13311 | 12434 | 0 | 0 | 0 | 0 | 0 | 2 | 5 | 5 | 269 | 42.64 |
| CO | 0 | 24082 | 31030 | 54673 | 79952 | 1710 | 5138 | 51488 | 7947 | 20278 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0.00 |
| CT | 2787 | 6591 | 65040 | 50535 | 129438 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 39 | 0 | 145 | 322.20 |
| DC | 1309 | 3864 | 32330 | 18680 | 55860 | 374 | 1104 | 0 | 0 | 0 | 0 | 552 | 0 | 0 | 0 | 187 | 0 | 0 | 0 | 0.00 |
| DE | 7610 | 8470 | 8030 | 1102 | 251211 | 0 | 0 | 0 | 6408 | 50579 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| FL | 0 | 18980 | 14866 | 86530 | 156939 | 43140 | 0 | 189894 | 16285 | 39927 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 13.77 |
| GA | 7620 | 15130 | 35462 | 102595 | 138846 | 0 | 0 | 122162 | 915 | 644 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26 | 0 | 0.00 |
| HI | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 85 | 0 | 195 | 136 | 10 | 15 | 8130 | 115 | 24.00 |
| IA | 1548 | 27048 | 34181 | 13137 | 14668 | 1522 | 19002 | 12659 | 18409 | 10162 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0.11 |
| ID | 2780 | 8680 | 13200 | 10014 | 81332 | 0 | 0 | 0 | 5552 | 6178 | 0 | 0 | 0 | 0 | 0 | 320 | 0 | 0 | 4 | 10.01 |
| IL | 11993 | 46735 | 39597 | 70003 | 588412 | 711 | 17276 | 54208 | 6676 | 312524 | 0 | 4726 | 18702 | 0 | 28766 | 6 | 23 | 4 | 110 | 588.60 |
| IN | 6348 | 23910 | 62720 | 85561 | 5986 | 1068 | 0 | 89680 | 17608 | 1274 | 0 | 0 | 0 | 0 | 0 | 4 | 10 | 0 | 1 | 0.53 |
| KS | 17140 | 75195 | 30115 | 51331 | 8155 | 0 | 6285 | 31565 | 1409 | 4085 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| KY | 1086 | 7737 | 70749 | 22197 | 17935 | 1339 | 0 | 9038 | 743 | 3524 | 0 | 0 | 0 | 12716 | 5961 | 5 | 3 | 12 | 44 | 30.43 |
| LA | 6376 | 12640 | 21543 | 12714 | 69165 | 4886 | 1920 | 23396 | 743 | 25087 | 10777 | 3409 | 10971 | 10972 | 73133 | 1 | 0 | 0 | 1 | 4.75 |
| MA | 2810 | 12703 | 72065 | 71260 | 159918 | 0 | 0 | 11625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 11.74 |
| MD | 3020 | 12678 | 72620 | 68391 | 315143 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 0 | 719 | 1936.52 |
| ME | 590 | 930 | 6850 | 11984 | 89789 | 0 | 0 | 0 | 5436 | 29721 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| MI | 5579 | 14562 | 107575 | 130194 | 74724 | 0 | 608 | 0 | 14813 | 4794 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 | 3 | 1.87 |
| MN | 4320 | 25297 | 65505 | 82591 | 62688 | 0 | 43949 | 33425 | 15602 | 50650 | 0 | 1204 | 0 | 0 | 1389 | 0 | 0 | 0 | 6 | 2.44 |
| MO | 17851 | 39536 | 134344 | 110400 | 43847 | 0 | 26712 | 46721 | 17242 | 27090 | 0 | 0 | 0 | 0 | 0 | 19 | 1 | 4 | 198 | 13.28 |
| MS | 2541 | 5232 | 6100 | 96784 | 27459 | 0 | 2123 | 30022 | 6249 | 3354 | 2909 | 985 | 26117 | 7207 | 7617 | 0 | 0 | 0 | 0 | 0.00 |
| MT | 840 | 3410 | 10170 | 4711 | 40110 | 0 | 0 | 0 | 2919 | 26730 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NC | 8560 | 19850 | 43229 | 130255 | 14250 | 0 | 0 | 64391 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0.30 |
| ND | 220 | 8263 | 14200 | 3130 | 9066 | 0 | 4467 | 0 | 0 | 4464 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NE | 3710 | 42658 | 15778 | 23440 | 69338 | 0 | 3712 | 16212 | 0 | 5832 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NH | 110 | 3140 | 7000 | 50960 | 265550 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| NJ | 6868 | 14830 | 62766 | 80250 | 153235 | 1841 | 0 | 41274 | 0 | 86455 | 0 | 0 | 0 | 0 | 0 | 90 | 0 | 0 | 0 | 870.15 |
| NM | 11481 | 1880 | 27160 | 19909 | 19061 | 769 | 0 | 0 | 0 | 4227 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 41 | 1.73 |
| NV | 3120 | 6630 | 7013 | 19268 | 3857 | 0 | 0 | 50555 | 58950 | 33016 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 692 | 16.79 |
| NY | 7633 | 32445 | 13675 | 87736 | 47920 | 0 | 3795 | 195935 | 20636 | 7873 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 8 | 7.31 |
| OH | 10553 | 41510 | 5862 | 115384 | 153550 | 1754 | 0 | 87182 | 41506 | 52186 | 0 | 0 | 79367 | 7738 | 7990 | 13 | 0 | 0 | 31 | 43.54 |
| OKCO | 4704 | 9221 | 73986 | 23095 | 203280 | 146 | 19 | 1634 | 14385 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| OR | 990 | 13880 | 18196 | 29964 | 36481 | 0 | 0 | 8134 | 46494 | 34434 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 62 | 44.99 |
| PA | 1697 | 13548 | 36096 | 82802 | 111445 | 1730 | 0 | 93982 | 15179 | 25797 | 0 | 0 | 0 | 0 | 0 | 3 | 22 | 2 | 49 | 68.26 |
| RI | 300 | 2170 | 4290 | 3440 | 131850 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| SC | 4080 | 8250 | 8793 | 104929 | 8908 | 3860 | 0 | 43197 | 8311 | 3282 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| SD | 130 | 3934 | 3640 | 12250 | 239168 | 0 | 2756 | 0 | 0 | 109062 | 0 | 0 | 0 | 0 | 3869 | 0 | 0 | 0 | 0 | 0.00 |
| TN | 6906 | 18327 | 97810 | 136526 | 140752 | 151 | 4066 | 72147 | 3928 | 13454 | 0 | 625 | 242 | 0 | 162 | 53 | 13 | 2 | 1086 | 684.57 |
| TX | 32629 | 32080 | 140628 | 130779 | 100016 | 16682 | 777 | 129933 | 20012 | 12085 | 254 | 0 | 1008 | 0 | 0 | 6 | 3 | 1 | 209 | 22.23 |
| TULSA TMA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| UT | 2060 | 3120 | 10183 | 10993 | 122818 | 729 | 0 | 8863 | 11733 | 203815 | 0 | 0 | 0 | 0 | 0 | 31 | 0 | 3 | 34 | 666.97 |
| VA | 4289 | 15530 | 90950 | 97017 | 19104 | 0 | 0 | 35190 | 0 | 994 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 13 | 2.12 |
| VT | 800 | 5450 | 16170 | 11610 | 28740 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| WA | 742 | 25028 | 33284 | 50112 | 33447 | 3591 | 0 | 6186 | 45234 | 18952 | 0 | 0 | 0 | 0 | 0 | 7 | 2 | 0 | 45 | 21.31 |
| WI | 4130 | 16620 | 92457 | 74109 | 70299 | 0 | 3850 | 7823 | 14881 | 32161 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| WV | 2300 | 350 | 169 | 10997 | 9089 | 0 | 0 | 36471 | 4313 | 1301 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| WY | 509 | 110 | 949 | 810 | 469 | 2571 | 0 | 10521 | 0 | 9991 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| TOTAL | 233568 | 796703 | 2019607 | 2728235 | 4868862 | 93848 | 150469 | 1739873 | 547406 | 1593157 | 16987 | 11585 | 136441 | 38829 | 161702 | 787 | 234 | 8210 | 4420 | 6553 |

The following tables show total freight flows from and to Tulsa TMA, OK Other, and OK, and 1997 and 2030 population and employment values.

Table 6.4.11: Summary Table From and To Tulsa Flows by Each Mode (tons)

| | From TULSA | | | | To TULSA | |
|---|---|---|---|---|---|---|
| | 1997 | 2030 | | | 1997 | 2030 |
| Highway | 6836398 | 14910398 | | Highway | 12156023 | 16937294 |
| Rail | 2500621 | 4972549 | | Rail | 4854659 | 5191502 |
| Water | 392189 | 406819 | | Water | 898311 | 585578 |
| Air | 7292 | 30764 | | Air | 8527 | 17577 |

Table 6.4.12: Population of Oklahoma, Tulsa and Other than Tulsa

| | Population1997 | Population2030 | Population Per. |
|---|---|---|---|
| OKCO | 2651927 | 3346341 | 78.58% |
| TULSA TMA | 720990 | 912174 | 21.42% |
| OK | 3372917 | 4258515 | |

Table 6.4.13: OK Employment Breakdown Table for 1997 and Predicted 2030

| | Emp 1997 | Emp 2030 |
|---|---|---|
| OKCO | 834523 | 1077803 |
| TULSA TMA | 293211 | 517524 |
| OK | 1127734 | 1595327 |

Table 6.4.14: 1997 From Flows from OK, Tulsa and OKC Other for each commodity group

| | PRODUCTION(FROM) FLOWS BREAKDOWN TABLE 1997 | | | | |
|---|---|---|---|---|---|
| | Chemicals | Food | Mining | Manufactured Products | Others |
| OK | 5301000 | 11016000 | 45058930 | 27724000 | 32304070 |
| OKCO | 4262802 | 9502602 | 36914800 | 18657280 | 20501476 |
| Tulsa TMA | 1038198 | 1513398 | 8144130 | 9066720 | 11802594 |

Table 6.4.15: 1997 To Flows to OK, Tulsa and OKC Other for each commodity group

| | ATTRACTION(TO) FLOWS BREAKDOWN TABLE 1997 | | | | |
|---|---|---|---|---|---|
| | Chemicals | Food | Mining | Manufactured Products | Others |
| OK | **4057000** | **16544000** | **65696990** | **29483000** | **27661010** |
| OKCO | 3176256 | 14097240 | 51312330 | 21015104 | 10750039 |
| Tulsa TMA | 880744 | 2446760 | 14384660 | 8467896 | 16910971 |

Table 6.4.16: 2030 Middle Level From Flows from OK,
Tulsa and OKC Other for each commodity group

| | MIDDLE PRODUCTION(FROM) FLOWS BREAKDOWN TABLE 2030 | | | | |
|---|---|---|---|---|---|
| | Chemicals | Food | Mining | Manufactured Products | Others |
| OK | **7784580** | **15853586** | **65827657** | **42539964** | **50189560** |
| OKCO | 5840598 | 13019814 | 50578129 | 25562926 | 28089718 |
| Tulsa TMA | 1943981 | 2833772 | 15249529 | 16977038 | 22099842 |

Table 6.4.17: 2030 Middle Level To Flows to OK, Tulsa and OKC Other for each commodity group

| | MIDDLE ATTRACTION(TO) FLOW BREAKDOWN TABLE 2030 | | | | |
|---|---|---|---|---|---|
| | Chemicals | Food | Mining | Manufactured Products | Others |
| OK | **5071655** | **20654451** | **82130699** | **36905810** | **34838139** |
| OKCO | 3954254 | 17550244 | 63880867 | 26162582 | 13383173 |
| Tulsa TMA | 1117400 | 3104207 | 18249832 | 10743228 | 21454965 |

Table 6.4.18: 1997 Instate From Flows from OK, Tulsa and OKC Other for each commodity group

| | INSTATE MIDDLE PRODUCTION(FROM) FLOWS BREAKDOWN TABLE 1997 | | | | |
|---|---|---|---|---|---|
| | Chemicals | Food | Mining | Manufactured Products | Others |
| OK | **3658967** | **7603693** | **31101514** | **19136237** | **22297589** |
| OKCO | 2942360 | 6559084 | 25480103 | 12878017 | 14150957 |
| Tulsa TMA | 716607 | 1044609 | 5621411 | 6258220 | 8146632 |

Table 6.4.19: 1997 Instate To Flows to OK, Tulsa and OKC Other for each commodity group

| | INSTATE MIDDLE ATTRACTION(TO) FLOW BREAKDOWN TABLE 1997 | | | | |
|---|---|---|---|---|---|
| | Chemicals | Food | Mining | Manufactured Products | Others |
| OK | **2370076** | **9664911** | **38379808** | **17223801** | **16159405** |
| OKCO | 1855551 | 8235527 | 29976371 | 12276904 | 6280112 |
| Tulsa TMA | 514525 | 1429383 | 8403437 | 4946897 | 9879293 |

Table 6.4.20: 2030 Instate Middle Level From Flows from OK, Tulsa and OKC Other for each commodity group

| | INSTATE MIDDLE PRODUCTION(FROM) FLOWS BREAKDOWN TABLE 2030 | | | | |
|---|---|---|---|---|---|
| | **Chemicals** | **Food** | **Mining** | **Manufactured Products** | **Others** |
| **OK** | **2411345** | **4910793** | **20390719** | **13177143** | **15546676** |
| **OKCO** | 1809179 | 4033006 | 15667038 | 7918350 | 8701047 |
| **Tulsa TMA** | 602166 | 877787 | 4723681 | 5258793 | 6845628 |

Table 6.4.21: 2030 Instate Middle Level To Flows to OK, Tulsa and OKC Other for each commodity group

| | INSTATE MIDDLE ATTRACTION(TO) FLOW BREAKDOWN TABLE 2030 | | | | |
|---|---|---|---|---|---|
| | **Chemicals** | **Food** | **Mining** | **Manufactured Products** | **Others** |
| **OK** | **2108823** | **8588238** | **34150412** | **15345646** | **14485896** |
| OKCO | 1644201 | 7297491 | 26562028 | 10878550 | 5564800 |
| Tulsa TMA | 464621 | 1290747 | 7588384 | 4467095 | 8921097 |

# 7.0 THROUGH FLOW

Through flows are freight flows that do not originate or arrive at TULSA TMA. They pass through TULSA TMA. The through flow is calculated using the following methodology:

1) The Distribution matrix obtained is multiplied with the mode split by the 4 modes. This gives the distribution values after the mode split.
2) The shortest path routes that pass through TULSA TMA have been documented and used to identify the through flow paths.
3) The through flow on these routes are identified and assigned to the various streets and routes in TULSA TMA.
4) The sum of these flows through the routes through each street is the through flow through that street.

## 7.1 Shortest Path

The shortest path is the one that minimizes the total distance from point a to point b in a network. The shortest path is used in trip assignment to find the freight flow routes. The shortest path also enables one to calculate the flow through the major highways and streets in the Tulsa TMA region. There are different criteria on which the shortest path can be calculated like based on distance, time, cost attributes, etc. We have considered the distance criteria for calculating the shortest path for this project. The multiple shortest paths are used due its ease in calculating shortest paths to multiple destinations from a single origin. The shortest path is calculated for three modes: Road, Rail and Water. The steps to calculate the shortest path in TRANSCAD is Appendix 5.

The shortest paths that flow through the Tulsa TMA region are identified by TransCAD and tabulated in a table. This table is used during trip assignment to assign tonnages to various paths. Table 7.1.1 is a summary of the notations used in the output tables.

Table 7.1.1: Notations used in the output

| Variable | Description |
|---|---|
| From | Origin Centroid |
| To | Destination Centroid |
| ID | TRASCAD ID's for the various routes |
| Length | Length of the street |
| Street 1 | Name of street in TULSA TMA |
| Street 2 | Name of alternate name of street after some distance |

The following table gives the shortest paths by road from TULSA TMA to the rest of USA. The shortest paths indicate that the majority of flow by road through TULSA TMA flows through I-44.There is also a lot of flow through I -244, U-64, U-412 and U – 75.

Table 7.1.2: Shortest paths by road from TULSA TMA to the rest of USA

| FROM | TO | LENGTH | ROUTE | MAJOR STREETS |
|---|---|---|---|---|
| | | ( IN MILES) | (MAJOR SR1 ROUTES) | IN TULSA TMA |
| TULSA TMA | CALIFORNIA | 1472 | I44,I40,S58 | I44,U75A,I244 |
| TULSA TMA | NEVADA | 1358 | I44,I40,U 95 | I44,U75A,I244 |
| TULSA TMA | ARIZONA | 1053 | I44,I40,U60 | I44,U75A,I244 |
| TULSA TMA | NEW MEXICO | 645 | I44,I40,U54, U60 | I44,U75A,I244 |
| TULSA TMA | COLORADO | 684 | U412,U50, U40,S86 | U64,I244,U412 |
| TULSA TMA | UTAH | 1154 | U412,U50, U6,I70 | U64,I244,U412 |
| TULSA TMA | IDAHO | 1483 | U412,U50,I80,U191 | U64,I244,U412 |
| TULSA TMA | OREGON | 1906 | I80,I84,U20,U50,U412 | U64,I244,U412 |
| TULSA TMA | WASHINGTON | 1929 | I80,I84,I90,U412 | U64,I244,U412 |
| TULSA TMA | MONTANA | 1346 | U212,U12,S96 | U64,I244,U412 |
| TULSA TMA | SOUTH DAKOTA | 696 | U412,U81 | U64,I244,U412 |
| TULSA TMA | WYOMING | 944 | U26,I25,U412,I35 | U64,I244,U412 |
| TULSA TMA | MISSOURI | 290 | I44,U54 | I44,U412 |
| TULSA TMA | WEST VIRGINIA | 963 | I44,U30,U40 | I44,U412 |
| TULSA TMA | VIRGINIA | 1167 | I44,U60,I64 | I44,U412 |
| TULSA TMA | ILLINOIS | 621 | I44,I55 | I44,U412 |
| TULSA TMA | MICHIGAN | 889 | I44,I55,I94 | I44,U412 |
| TULSA TMA | INDIANA | 652 | I44,I70 | I44,U412 |
| TULSA TMA | VERMONT | 1494 | I44,U40,I70,U20,I90 | I44,U412 |
| TULSA TMA | MAINE | 1672 | I44,U40,I70,U20,I90,I95 | I44,U412 |
| TULSA TMA | OHIO | 828 | I44,U40 | I44,U412 |
| TULSA TMA | NEW YORK | 1327 | I44,U40,U22,I80 | I44,U412 |
| TULSA TMA | NEW JERSEY | 1307 | I44,U40,U22,I80 | I44,U412 |

| | | | | |
|---|---|---|---|---|
| TULSA TMA | CONNECTICUT | 1417 | I44,U40,U22,I80 | I44,U412 |
| TULSA TMA | RHODE ISLAND | 1492 | I44,U40,U22,I70 | I44,U412 |
| TULSA TMA | MASSACHUSSETS | 1512 | I44,U40,I70,I76 | I44,U412 |
| TULSA TMA | MARYLAND | 1244 | I44,U40,U22,I70 | I44,U412 |
| TULSA TMA | DIST OF COLUMBIA | 1191 | I44,U40,U22,I70 | I44,U412 |
| TULSA TMA | IOWA | 485 | U169,I35 | I44,U412 |
| TULSA TMA | NORTH CAROLINA | 1055 | I40,U64,S22 | U64,S51 |
| TULSA TMA | SOUTH CAROLINA | 966 | U72,U64,S22 | U64,S51 |
| TULSA TMA | TENNESSEE | 621 | U62,U412 | U64,S51 |
| TULSA TMA | GEORGIA | 809 | U278,U72,S22 | U64,S51 |
| TULSA TMA | FLORIDA | 1186 | U64,U78,I75 | U64,S51 |
| TULSA TMA | ALABAMA | 649 | S22,U64 | U64,S51 |
| TULSA TMA | MISSISSIPPI | 657 | S22,U78 | U64,S51 |
| TULSA TMA | TEXAS | 406 | I35,U75,U69 | U64,S51 |
| TULSA TMA | LOUISIANA | 522 | I49 | U64,S51 |
| TULSA TMA | KANSAS | 2014 | U75 | S11,U75 |
| TULSA TMA | ALASKA | 2903 | U212,I15 | S11,U75 |
| TULSA TMA | MINNESOTA | 687 | I35,U169 | U169,I244 |
| TULSA TMA | WISCONSIN | 764 | I35,U169 | U169,I244 |
| TULSA TMA | NEBRASKA | 450 | U75,U169 | S11,U75 |
| TULSA TMA | ARKANSAS | 207 | S22 | U64,S51 |
| TULSA TMA | NORTH DAKOTA | 924 | U75,I29,U281 | U64,I244,U412 |
| TULSA TMA | KENTUCKY | 696 | I44,U60 | I44,U412 |
| TULSA TMA | DELAWARE | 1249 | I44,U40,I70 | I44,U412 |
| TULSA TMA | PENNSYLVANIA | 1158 | I44,U40,I70 | I44,U412 |
| TULSA TMA | NEW HAMPSHIRE | 1537 | I44,U40,U22,I70 | I44,U412 |

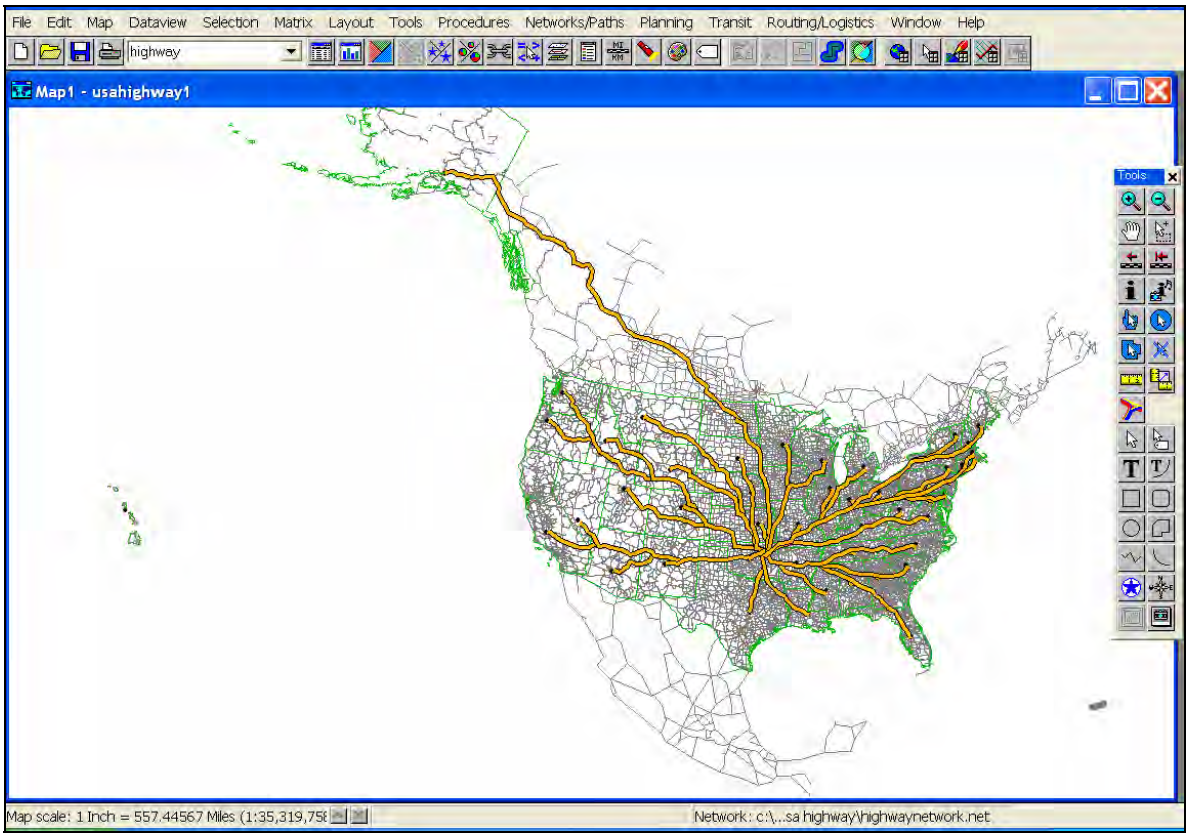



Figure 7.1.1: Shortest paths by road from TULSA TMA to rest of USA

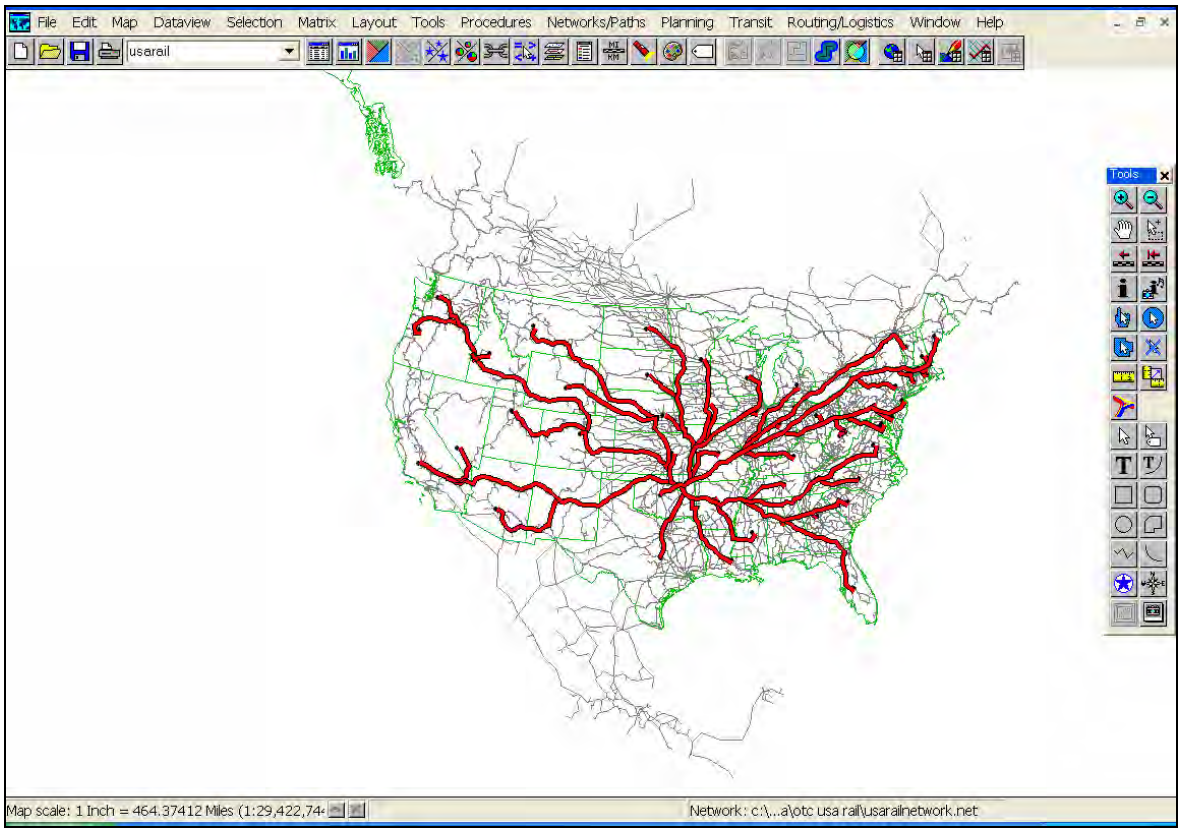



Fig 7.1.2: Shortest paths by rail from TULSA TMA to rest of USA

The following table gives the shortest paths by rail from TULSA TMA to the rest of USA. The shortest paths indicate that the majority of flow by rail through TULSA TMA flows through SLSF route. There is also a lot of flow through SLSF Chrk, SLSF Avar and MKT.

Table 7.1.3: Shortest paths by rail from TULSA TMA to the rest of USA

| FROM | TO | LENGTH ( IN MILES) |
|---|---|---|
| TULSA TMA | ALABAMA | 708 |
| TULSA TMA | ARIZONA | 1269 |
| TULSA TMA | ARKANSAS | 220 |
| TULSA TMA | CALIFORNIA | 1621 |
| TULSA TMA | COLORADO | 734 |
| TULSA TMA | CONNECTICUT | 1575 |
| TULSA TMA | DELAWARE | 1400 |
| TULSA TMA | DIST OF COLUMBIA | 1369 |
| TULSA TMA | FLORIDA | 1314 |
| TULSA TMA | GEORGIA | 887 |
| TULSA TMA | IDAHO | 1823 |
| TULSA TMA | ILLINOIS | 656 |
| TULSA TMA | INDIANA | 709 |
| TULSA TMA | IOWA | 522 |
| TULSA TMA | KANSAS | 262 |
| TULSA TMA | KENTUCKY | 768 |
| TULSA TMA | LOUISIANA | 626 |
| TULSA TMA | MAINE | 1760 |
| TULSA TMA | MARYLAND | 1367 |
| TULSA TMA | MASSACHUSSETS | 1600 |
| TULSA TMA | MICHIGAN | 954 |
| TULSA TMA | MINNESOTA | 763 |
| TULSA TMA | MISSISSIPPI | 601 |
| TULSA TMA | MISSOURI | 371 |
| TULSA TMA | MONTANA | 1475 |
| TULSA TMA | NEBRASKA | 737 |
| TULSA TMA | NEVADA | 1740 |
| TULSA TMA | NEW HAMPSHIRE | 1615 |
| TULSA TMA | NEW JERSEY | 1469 |
| TULSA TMA | NEW MEXICO | 726 |
| TULSA TMA | NEW YORK | 1463 |
| TULSA TMA | NORTH CAROLINA | 1167 |
| TULSA TMA | NORTH DAKOTA | 1047 |
| TULSA TMA | OHIO | 932 |
| TULSA TMA | OREGON | 2231 |
| TULSA TMA | PENNSYLVANIA | 1298 |
| TULSA TMA | RHODE ISLAND | 1607 |
| TULSA TMA | SOUTH CAROLINA | 1088 |
| TULSA TMA | SOUTH DAKOTA | 738 |
| TULSA TMA | TENNESSEE | 706 |
| TULSA TMA | TEXAS | 467 |
| TULSA TMA | UTAH | 1829 |
| TULSA TMA | VERMONT | 1601 |
| TULSA TMA | VIRGINIA | 1318 |
| TULSA TMA | WASHINGTON | 2149 |
| TULSA TMA | WEST VIRGINIA | 1301 |
| TULSA TMA | WISCONSIN | 813 |
| TULSA TMA | WYOMING | 1003 |

The following table gives the shortest paths by water from TULSA TMA to the rest of USA. The shortest paths indicate that all of the flow by water through TULSA TMA flows through the Verdigris River.

Table 7.1.4: Shortest paths by water from TULSA TMA to the rest of USA

| FROM | TO | Mileage | LINK NAME |
|---|---|---|---|
| TULSA | DC | 2487 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER - JACKSONVILLE HBR - POTOMAC RIVER |
| TULSA | ALASKA | 8751 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER - ATCHAFALAYA RIVER - |
| | | | GULF OF MEXICO- PACIFIC SPINE - GULF OF ALASKA |
| TULSA | CALIFORNIA | 6162 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER - ATCHAFALAYA RIVER - |
| | | | GULF OF MEXICO- PACIFIC SPINE |
| TULSA | OREGON | 7345 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER - ATCHAFALAYA RIVER - |
| | | | GULF OF MEXICO- PACIFIC SPINE -COLUMBIA RIVER ENTRANCE - WILLAMETTE RIVER |
| TULSA | WASHINGTON | 7420 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER - ATCHAFALAYA RIVER - |
| | | | GULF OF MEXICO- PACIFIC SPINE- PUGET SOUND SPINE |
| TULSA | LOUISIANA | 862 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER |
| TULSA | MISSISSIPPI | 721 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER |
| TULSA | ALABAMA | 1507 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER - ALABAMA - COOSA RIVER |
| TULSA | FLORIDA | 1759 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER - ATCHAFALAYA RIVER - |
| | | | GULF OF MEXICO- KISSIMMEE RIVER |
| TULSA | GEORGIA | 2043 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- GULF DEEP WATER SPINE |
| | | | JACKSONVILLE HBR- ALTAMAHA RIVER |
| TULSA | NEBRASKA | 1689 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- MISSOURI RIVER |
| TULSA | ARKANSAS | 297 | VERDIGRIS RIVER - ARKANSAS RIVER |
| TULSA | MINNESOTA | 1672 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER |
| TULSA | MISSOURI | 1144 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- MISSOURI RIVER |
| TULSA | ILLINOIS | 1299 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER -ILLINOIS RIVER |
| TULSA | TENNESSEE | 1070 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER - OHIO RIVER -TENNESSEE RIVER- |
| | | | CUMBERLAND RIVER |
| TULSA | KENTUCKY | 1319 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER - OHIO RIVER - KENTUCKY RIVER |
| TULSA | WISCONSIN | 1754 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER -ILLINOIS RIVER- GREEN BAY SPINE- |
| | | | FOX RIVER |
| TULSA | MICHIGAN | 1975 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER -ILLINOIS RIVER- LAKE MICHIGAN SPINE - |
| | | | HURON WESTERN PERIMETER -SAGINAW RIVER |
| TULSA | SOUTH CAROLINA | 2100 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- GULF DEEP WATER SPINE |
| | | | JACKSONVILLE HBR- SANTEE RIVER |
| TULSA | OHIO | 1762 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER - OHIO RIVER -MUSKINGUM RIVER |
| TULSA | WEST VIRGINIA | 1653 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER - OHIO RIVER |
| TULSA | NORTH CAROLINA | 2178 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- GULF DEEP WATER SPINE |
| | | | JACKSONVILLE HBR - CAPE FEAR RIVER |
| TULSA | VIRGINIA | 2495 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- GULF DEEP WATER SPINE |
| | | | JACKSONVILLE HBR-YORK RIVER |
| TULSA | MARYLAND | 2462 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- GULF DEEP WATER SPINE |
| | | | JACKSONVILLE HBR-ATLANTIC DEEP WATER SPINE-SEVERN RIVER |
| TULSA | DELAWARE | 2467 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- GULF DEEP WATER SPINE |
| | | | JACKSONVILLE HBR-ATLANTIC DEEP WATER SPINE-DELAWARE RIVER |
| TULSA | PENNSYLVANIA | 2558 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- GULF DEEP WATER SPINE |
| | | | JACKSONVILLE HBR-ATLANTIC DEEP WATER SPINE-CHESAPEAKE BAY |
| TULSA | NEW YORK | 2664 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- GULF DEEP WATER SPINE |
| | | | JACKSONVILLE HBR-ATLANTIC DEEP WATER SPINE-HUDSON RIVER |
| TULSA | NEW JERSEY | 2554 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- GULF DEEP WATER SPINE |
| | | | JACKSONVILLE HBR-ATLANTIC DEEP WATER SPINE-NEW YORK & NEW NEW JERSEY CH |
| TULSA | CONNECTICUT | 2646 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- GULF DEEP WATER SPINE |
| | | | JACKSONVILLE HBR-ATLANTIC DEEP WATER SPINE-QUINNIPIAC RIVER |
| TULSA | RHODE ISLAND | 2693 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- GULF DEEP WATER SPINE |
| | | | JACKSONVILLE HBR-ATLANTIC DEEP WATER SPINE - NARRAGANSETT BAY |
| TULSA | MASSACHUSSETS | 2793 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- GULF DEEP WATER SPINE |
| | | | JACKSONVILLE HBR-ATLANTIC DEEP WATER SPINE -MASSACHUSSETS BAY |
| TULSA | NEW HAMPSHIRE | 2884 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- GULF DEEP WATER SPINE |
| | | | JACKSONVILLE HBR-ATLANTIC DEEP WATER SPINE-PORTSMOUTH HARBOR |
| TULSA | VERMONT | 2764 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER -ILLINOIS RIVER- LAKE MICHIGAN SPINE - |
| | | | LAKE HURON WEB -NY STATE BARGE CANAL SYSTEM- LAKE CHAMPLAIN |
| TULSA | MAINE | 2901 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- GULF DEEP WATER SPINE |
| | | | JACKSONVILLE HBR-ATLANTIC DEEP WATER SPINE-KENNEBEC RIVER |
| TULSA | HAWAII | 7990 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER - ATCHAFALAYA RIVER - |
| | | | GULF OF MEXICO-HONOLULU, OAHU, HI-CONT. AMERICA |
| TULSA | IDAHO | 7714 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER - ATCHAFALAYA RIVER - |
| | | | GULF OF MEXICO- PACIFIC SPINE-COLUMBIA RIVER - SNAKE RIVER |
| TULSA | TEXAS | 1323 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER - ATCHAFALAYA RIVER - |
| | | | GIW-SABINE RIVER |
| TULSA | KANSAS | 1475 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- MISSOURI RIVER - KANSAS RIVER |
| TULSA | SOUTH DAKOTA | 1903 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER- MISSOURI RIVER |
| TULSA | NORTH DAKOTA | 2698 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER -ILLINOIS RIVER- LAKE MICHIGAN SPINE - |
| | | | LAKE SUPERIOR SPINE |
| TULSA | INDIANA | 1392 | VERDIGRIS RIVER - ARKANSAS RIVER - MISSISSIPPI RIVER - OHIO RIVER |

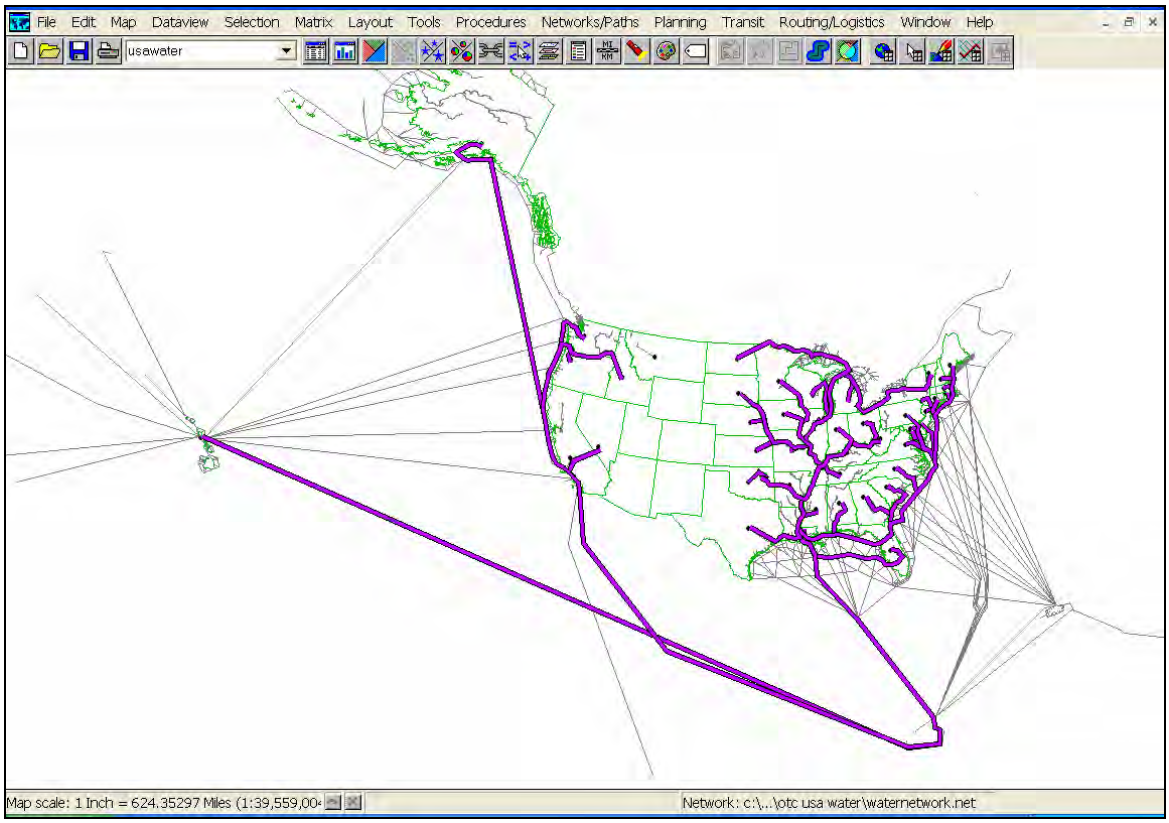



Fig 7.1.3: Shortest paths by water from TULSA TMA to the rest of USA

## 7.2 Through Flow For The Base Year 1997/2000

The through flow for the base year has been split into five commodities and the total sum of theses tonnages. The Five commodity groups are Chemicals Products, Food Products, Mining Products and Manufacturing Products and Other Products.

### 7.2.1 Through Flow By Road For The Base Year

Table 7.2.1.1: Through flow by road for base year for all commodities and total flow

| STREETS | Chemical | Manufacturing | Food | Mining | Other | Total |
|---|---|---|---|---|---|---|
| I - 44 | 702.4 | 6526.3 | 3301.28 | 21075.66 | 3356.76 | 34962.4 |
| U 75 A | 702.4 | 5047.47 | 3301.28 | 21075.66 | 3356.76 | 33483.57 |
| L YALE | 5.57 | 12.15 | 1.22 | 1.64 | 35.74 | 56.32 |
| L-41 ST | 5.57 | 142.97 | 190.83 | 206.39 | 122.18 | 667.94 |
| U 64 | 565.48 | 2032.38 | 3762.91 | 4372.87 | 530.27 | 11263.91 |
| STURNE | 667.86 | 4817.32 | 3249.28 | 19536.17 | 3208.37 | 31479 |
| S66 | 679.11 | 4735.2 | 2876.39 | 20016.75 | 3295.74 | 31603.19 |
| S51 | 65.34 | 1331.86 | 887.69 | 1394.19 | 460.4 | 4139.48 |
| U 412 | 1215.73 | 6443.16 | 6213.19 | 23329.07 | 3729.25 | 40930.4 |
| S ROGER | 679.11 | 4866.02 | 3066 | 20221.5 | 3382.18 | 32214.81 |
| I-244 | 547.37 | 1662.87 | 3671.07 | 4058.87 | 451.47 | 10391.65 |
| I-444 | 19.27 | 859.18 | 632.54 | 510.37 | 264.16 | 2285.52 |
| SMUSKO | 19.27 | 859.18 | 632.54 | 510.37 | 264.16 | 2285.52 |
| U 75 | 519.41 | 1559.7 | 3507.76 | 3489.05 | 334.03 | 9409.95 |
| L-21 ST | 63.79 | 772.8 | 678.82 | 1941.09 | 221.52 | 3678.02 |
| L APACH | 23.29 | 312.27 | 424.89 | 1058.91 | 61.02 | 1880.38 |
| LPORT | 23.29 | 312.27 | 424.89 | 1058.91 | 61.02 | 1880.38 |
| U169 | 23.29 | 312.27 | 424.89 | 1058.91 | 61.02 | 1880.38 |

The above table gives the total tonnage and the tonnage by commodity through the major streets of TULSA TMA for the base year. The comparison of the tonnage by commodity is shown in Figure 7.2.1.1. The major flows are for Mining products and the major streets are on I-44, S 66, U 412 and U 75 A.

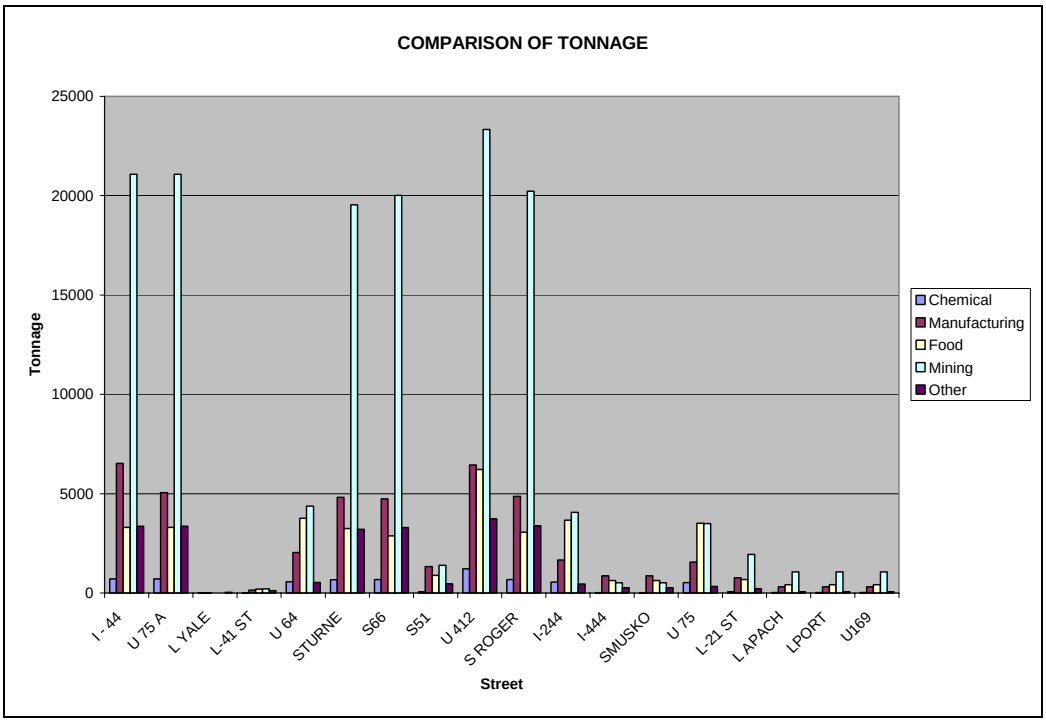



Figure 7.2.1.1: Comparison of through flow tonnage by road for commodity groups

### 7.2.2 Through Flow By Rail For The Base Year

Table 7.2.2.1: Through flow by rail for base year for all commodities and total flow

| ROUTE | Chemical | Food | Manufacturing | Mining | Other | Total |
|---|---|---|---|---|---|---|
| SLSF CHRK | 129.36 | 129.11 | 3040.21 | 710.31 | 301.33 | 4310.32 |
| WBNSFHUP | 129.36 | 18.47 | 3040.21 | 710.31 | 288.48 | 4186.83 |
| SLSF | 129.36 | 129.11 | 3040.21 | 710.31 | 301.33 | 4310.32 |
| WBNSFRUPTSS | 129.36 | 18.47 | 2824.61 | 675.53 | 301.33 | 3949.3 |
| WBNSF | 877.45 | 2696.82 | 7280.9 | 2625.54 | 1187.67 | 14668.38 |
| TSU | 288.96 | 481.87 | 4303.67 | 2005.32 | 904.96 | 7984.78 |
| SLSFAVAR | 825.43 | 2567.71 | 4744.26 | 2099.51 | 917.49 | 11154.4 |
| WTSUTSS | 251.53 | 381.13 | 4179.54 | 1741.46 | 892.3 | 7445.96 |
| MKT | 902.77 | 2567.71 | 4761.87 | 2217.36 | 948.64 | 11398.35 |
| WUPTBNSF | 902.77 | 2567.71 | 4761.87 | 2217.36 | 948.64 | 11398.35 |
| SLWCSOON | 77.34 | 0 | 17.61 | 117.85 | 31.15 | 243.95 |
| WSLWC | 77.34 | 0 | 17.61 | 117.85 | 31.15 | 243.95 |
| WBNSFRUP | 52.02 | 129.11 | 3022.6 | 592.46 | 270.18 | 4066.37 |

The above table gives the total tonnage and the tonnage by commodity through the major routes of TULSA TMA for the base year. The comparison of the tonnage by commodity is shown in Fig 8.2.2.1. The major flows are for Mining products and the major streets are on WBNSF, TSU, SLSFAVAR, MKT and WUPTBNSF.

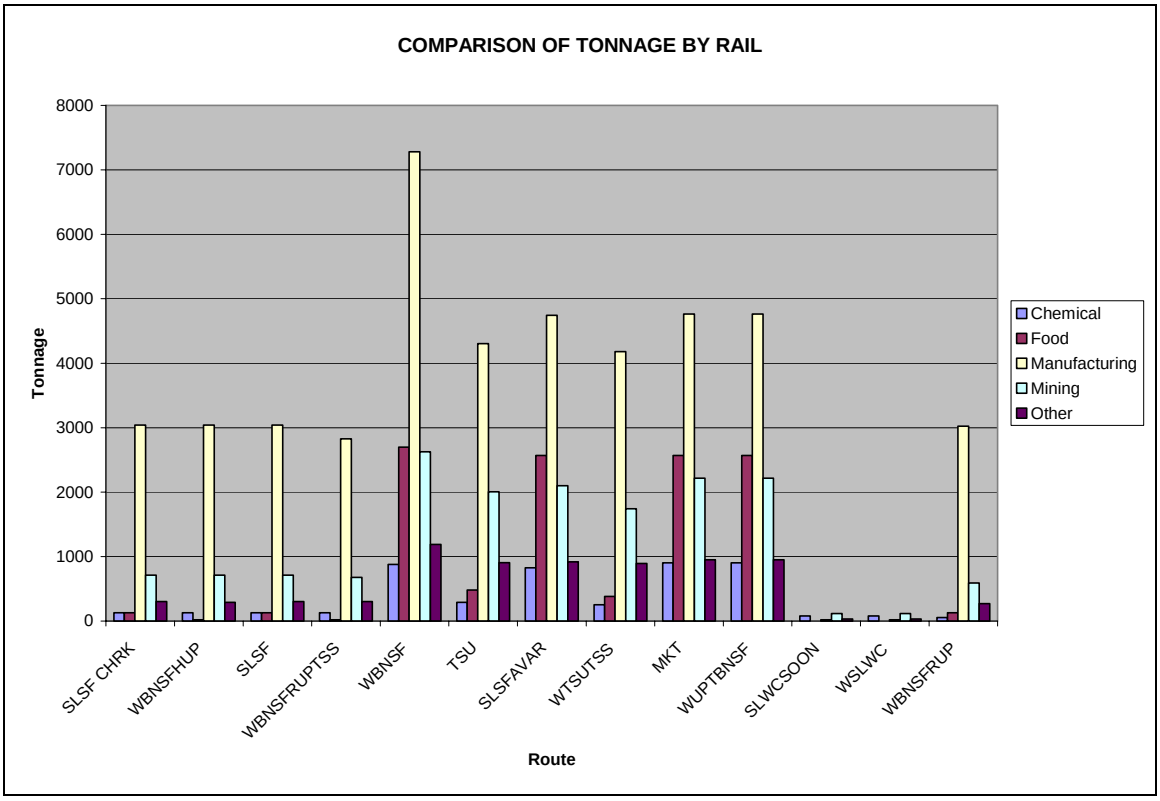



Figure 7.2.2.1: Comparison of through flow tonnage by rail for various commodity groups

## 7.3 Through Flow For The Year 2030

The through flow has been divided into 3 bands, upper, middle and lower bound. This range gives the lowest estimate and the highest estimate of the tonnages for the through flow.

The tables are split by total tonnage and tonnage by commodity. The total flow gives the total tonnage through TULSA TMA while the flow by commodity gives the tonnage by the five commodities Chemical Products, Food Products, Mining Products and Manufacturing Products and Other Products.

The methodology for the through flow is the same as was adopted for the through flow for the base year.

### 7.3.1 Total Through Flow By Road

The table below gives the total flow by road.

Table 7.3.1.1: Total flow for the year 2030 with Lower, Middle, and Upper bound and comparison with base year for Road mode

| STREETS | Lower Bound (in'000 tons) | Middle Bound ( in '000 tons) | Upper Bound ( in'000 tons) | Base Year ( in '000 tons) |
|---|---|---|---|---|
| I - 44 | 28586.95 | 39129.59 | 55087.93 | 34962.4 |
| U 75 A | 28586.95 | 39844.47 | 55087.93 | 33483.57 |
| L YALE | 147.46 | 280.42 | 408.46 | 56.32 |
| L-41 ST | 698.43 | 1014.61 | 1327.67 | 667.94 |
| U 64 | 6912.07 | 9446.23 | 12127.91 | 11263.91 |
| STURNE | 27908.98 | 38675.36 | 52772.43 | 31479 |
| S66 | 27189.15 | 37933.87 | 52660.69 | 31603.19 |
| S51 | 3872.14 | 5176.44 | 6639.62 | 4139.48 |
| U 412 | 32555.96 | 45189.08 | 61952.9 | 40930.4 |
| S ROGER | 27740.12 | 38668.06 | 53579.9 | 32214.81 |
| I-244 | 6318.34 | 8571.16 | 10978.96 | 10391.65 |
| I-444 | 2187.69 | 2787.84 | 3572.95 | 2285.52 |
| SMUSKO | 2187.69 | 2787.84 | 3572.95 | 2285.52 |
| U 75 | 5227.62 | 7057.63 | 9061.24 | 9409.95 |
| L-21 ST | 2934.79 | 4018.78 | 5085.45 | 3678.02 |
| L APACH | 1397.8 | 1910.6 | 2427.24 | 1880.38 |
| LPORT | 1397.8 | 1910.6 | 2427.24 | 1880.38 |
| U169 | 1397.8 | 1910.6 | 2427.24 | 1880.38 |

The above table gives the tonnages for the total flow for the through flow by the major streets of TULSA TMA. The comparison between the 4 ranges is depicted in the column graph below (Fig 8.3.1.1). The graph shows that the lower bound flows are similar or higher than the base year while the middle and upper bound have higher tonnage compared to the base year. The biggest increase in the upper bound compared to the base year is on I-44, S 66, U 412 and U 75 A while the flow is lower on U75.

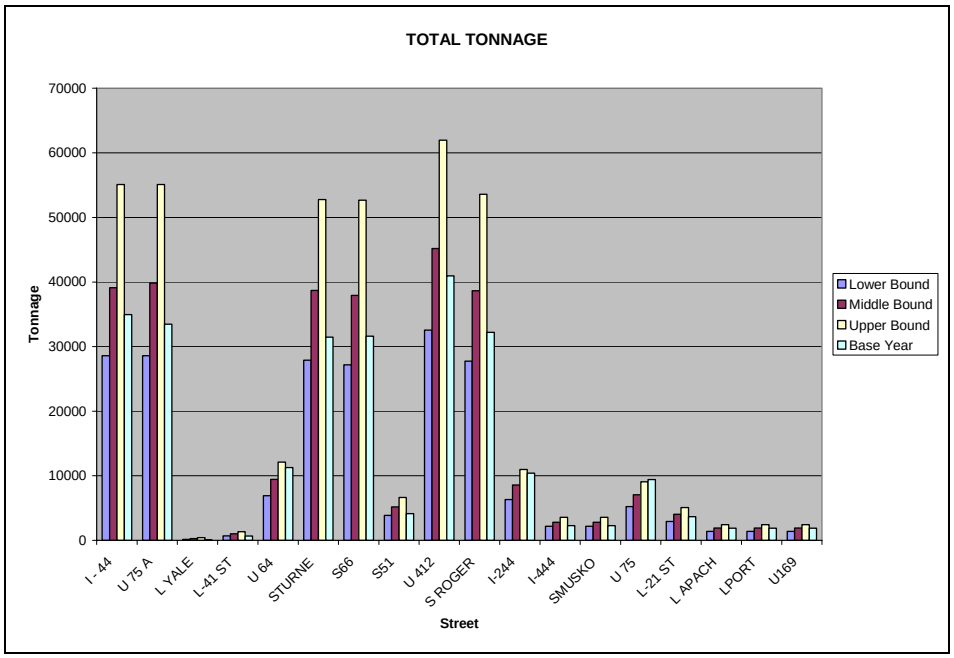



Fig 7.3.1.1 Total lower, middle, upper bound flows for base year by Road

### 7.3.2 Total Through Flow By Rail

The same methodology was adopted for rail mode. The total flow by rail and the comparison with the base year is shown in Table 7.3.2.1: Total flow for the year 2030 with Lower, middle, and upper bounds and comparison with base year for Rail mode

Table 7.3.2.1: Lower, Middle, and Upper Bounds of Rail Through Flows

| ROUTE | Lower Bound (in'000 tons) | Middle Bound (in'000 tons) | Upper Bound (in'000 tons) | Base Year (in'000 tons) |
|---|---|---|---|---|
| SLSF CHRK | 5557.01 | 7551.44 | 9638.12 | 4310.32 |
| WBNSFHUP | 5045.41 | 6869.13 | 8782.5 | 4186.83 |
| SLSF | 5557.01 | 7551.44 | 9638.12 | 4310.32 |
| WBNSFRUPTSS | 5557.01 | 7551.44 | 9638.12 | 3949.3 |
| WBNSF | 17012.21 | 22778.33 | 30362.44 | 14668.38 |
| TSU | 11303.46 | 14886.94 | 20626.69 | 7984.78 |
| SLSFAVAR | 12548.18 | 16691.65 | 22546.73 | 11154.4 |
| WTSUTSS | 10081.38 | 13446.05 | 18618.4 | 7445.96 |
| MKT | 13641.16 | 18156.41 | 24369.14 | 11398.35 |
| WUPTBNSF | 13641.16 | 18156.41 | 24369.14 | 11398.35 |
| SLWCSOON | 1092.98 | 1464.76 | 1822.41 | 243.95 |
| WSLWC | 1092.98 | 1464.76 | 1822.41 | 243.95 |
| WBNSFRUP | 4464.03 | 6086.68 | 9062.78 | 4066.37 |

The above table gives the total flow by rail mode for the year 2030 and the comparison with the base year. This is depicted graphically in the chart below (Figure 7.3.2.1). The lower bound is similar to the base year tonnage while the middle and upper bound values for 2030 are significantly higher than the base year values. The routes with the highest increase are WBNSF, TSU, SLSFAVAR, MKT and WUPTBNSF.

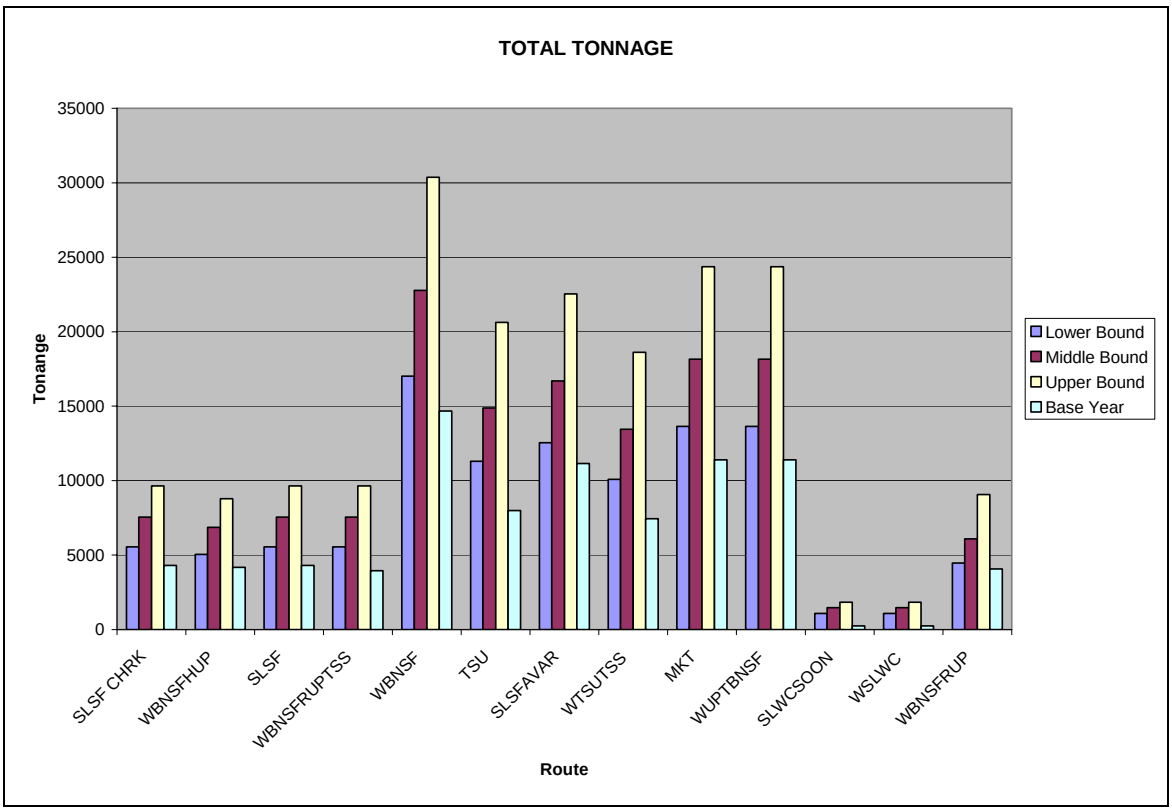



Figure 7.3.2.1: Total Flow comparison between lower, middle, upper bound and the base year by Rail

## 7.4 Through Flow By Commodity For The Year 2030 By Road

### 7.4.1 Chemical Products

Table 7.4.1.1 Flow for 2030 by road for Chemical products

| STREETS | Lower Bound (in'000 tons) | Middle Bound (in ' 000 tons) | Upper Bound ( in '000 tons) | Base Year ( in'000 tons) |
|---|---|---|---|---|
| I - 44 | 797.26 | 1116.29 | 1419.37 | 702.4 |
| U 75 A | 797.26 | 1116.29 | 1419.37 | 702.4 |
| L YALE | 4.51 | 8.74 | 12.83 | 5.57 |
| L-41 ST | 4.51 | 8.74 | 12.83 | 5.57 |
| U 64 | 259.21 | 371.86 | 482.33 | 565.48 |
| STURNE | 793.06 | 1096.08 | 1380.37 | 667.86 |
| S66 | 777.23 | 1088.68 | 1384.15 | 679.11 |
| S51 | 72.2 | 103.58 | 134.01 | 65.34 |
| U 412 | 1011.9 | 1424.19 | 1818.43 | 1215.73 |
| S ROGER | 777.23 | 1088.68 | 1384.15 | 679.11 |
| I-244 | 240.64 | 344.22 | 445.71 | 547.37 |
| I-444 | 24.27 | 34.69 | 44.8 | 19.27 |
| SMUSKO | 24.27 | 34.69 | 44.8 | 19.27 |
| U 75 | 211.28 | 302.97 | 393.12 | 519.41 |
| L-21 ST | 63.45 | 87.76 | 111.6 | 63.79 |
| L APACH | 20.03 | 27.61 | 35.22 | 23.29 |
| LPORT | 20.03 | 27.61 | 35.22 | 23.29 |
| U169 | 20.03 | 27.61 | 35.22 | 23.29 |

The above table gives the through flow for chemical products for the year 2030 and compares these values with the base year values. The comparison is depicted in Table 7.4.1.1 below. The increase in the flow by streets follows the same trend as the total flow.

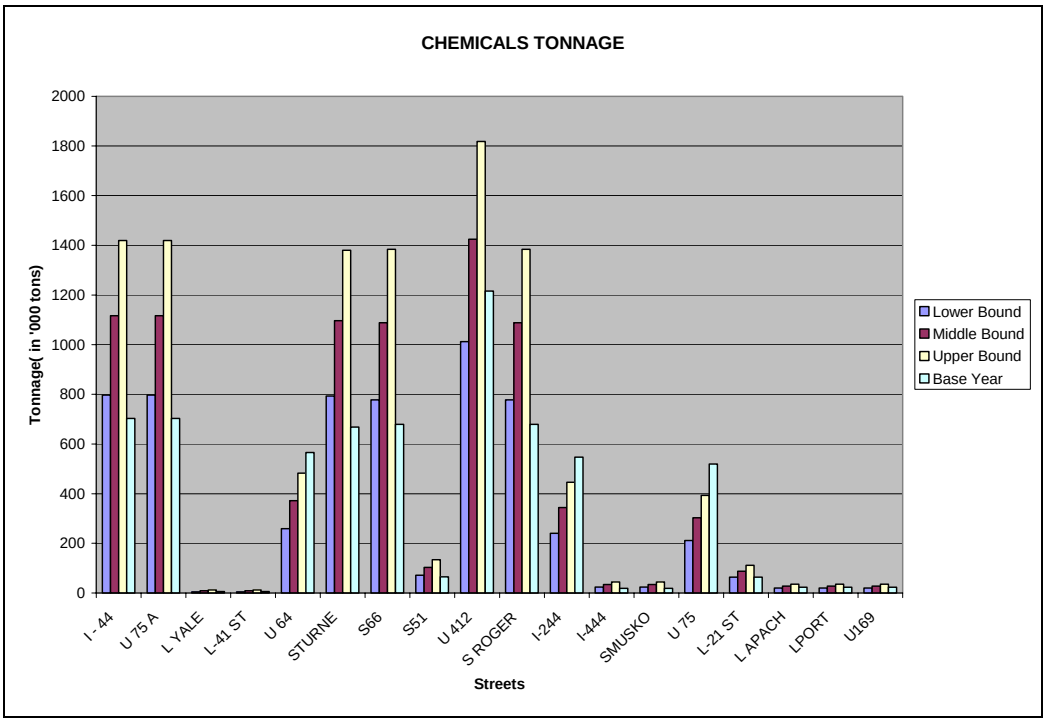



Figure 7.4.1.1: Through Flow for Chemical Products by Road

### 7.4.2 Food Products

Table 7.4.2.1 Flow for 2030 by road for Food products

| STREETS | Lower bound ( in'000 tons) | Middle bound (in '000 tons) | Upper bound ( in'000 tons) | Base Year ( in'000 tons) |
|---|---|---|---|---|
| I - 44 | 3292.08 | 4466.78 | 11942.9 | 3301.28 |
| U 75 A | 3292.08 | 4466.78 | 11942.9 | 3301.28 |
| L YALE | 21.54 | 41.13 | 60 | 1.22 |
| L-41 ST | 287.65 | 397.41 | 506.94 | 190.83 |
| U 64 | 2264.57 | 2911.03 | 3741.74 | 3762.91 |
| STURNE | 3310.98 | 4514.29 | 11818.34 | 3249.28 |
| S66 | 3003.96 | 4065.02 | 11427.27 | 2876.39 |
| S51 | 1189.48 | 1380.57 | 1762.86 | 887.69 |
| U 412 | 4958.87 | 6533.16 | 14593.38 | 6213.19 |
| S ROGER | 3270.07 | 4421.3 | 11874.21 | 3066 |
| I-244 | 2151.47 | 2748.54 | 3530.05 | 3671.07 |
| I-444 | 874.98 | 940.32 | 1200.46 | 632.54 |
| SMUSKO | 874.98 | 940.32 | 1200.46 | 632.54 |
| U 75 | 1950.07 | 2470.78 | 3179.34 | 3507.76 |

| | | | | |
|---|---|---|---|---|
| L-21 ST | 581.08 | 800.88 | 1018.03 | 678.82 |
| L APACH | 288.12 | 401.76 | 515.63 | 424.89 |
| LPORT | 288.12 | 401.76 | 515.63 | 424.89 |
| U169 | 288.12 | 401.76 | 515.63 | 424.89 |

The above table gives the through flow for food products for the year 2030 and compares these values with the base year values. The comparison is depicted in Figure 7.4.2.1 below. The increase in the flow by streets follows the same trend as the total flow.

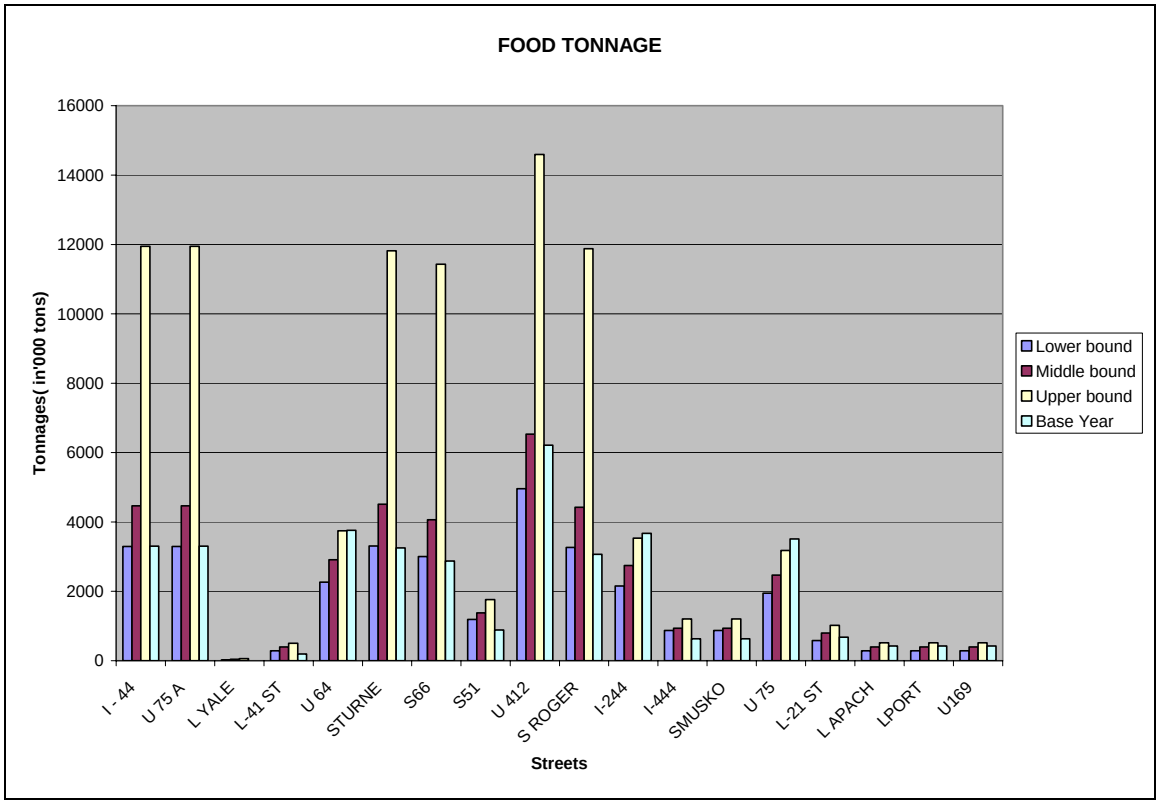



Figure 7.4.2.1: Through Flow for Food Products by Road

### 7.4.3 Manufacturing Products

Table 7.4.3.1: Flow for 2030 by road for Manufactured products

| STREETS | Lower bound ( in'000 tons) | Middle bound ( in '000 tons) | Upper bound (in'000 tons) | Base Year ( in '000 tons) |
|---|---|---|---|---|
| I - 44 | 6237.6 | 8635.13 | 11101.37 | 6526.3 |
| U 75 A | 6237.6 | 8635.13 | 11101.37 | 5047.47 |
| L YALE | 44.31 | 86.48 | 127.61 | 12.15 |
| L-41 ST | 204.21 | 304.99 | 404.65 | 142.97 |
| U 64 | 1541.1 | 2206.07 | 2852.87 | 2032.38 |
| STURNE | 6223.13 | 8578.18 | 10747.16 | 4817.32 |
| S66 | 6011.56 | 8325.37 | 10707.4 | 4735.2 |
| S51 | 1200.45 | 1729.04 | 2240.09 | 1331.86 |
| U 412 | 7282.31 | 10135.2 | 13038.69 | 6443.16 |
| S ROGER | 6171.46 | 8543.88 | 10984.44 | 4866.02 |
| I-244 | 1323 | 1884.1 | 2432.54 | 1662.87 |
| I-444 | 750.81 | 1079.1 | 1399.88 | 859.18 |
| SMUSKO | 750.81 | 1079.1 | 1399.88 | 859.18 |
| U 75 | 1091.46 | 1556.13 | 2012.66 | 1559.7 |
| L-21 ST | 631.37 | 873.22 | 1106.57 | 772.8 |
| L APACH | 226.04 | 309.76 | 393.97 | 312.27 |
| LPORT | 226.04 | 309.76 | 393.97 | 312.27 |
| U169 | 226.04 | 309.76 | 393.97 | 312.27 |

The above table gives the through flow for manufacturing products for the year 2030 and compares these values with the base year values. The comparison is depicted in Figure 7.4.3.1 below. The increase in the flow by streets follows the same trend as the total flow.

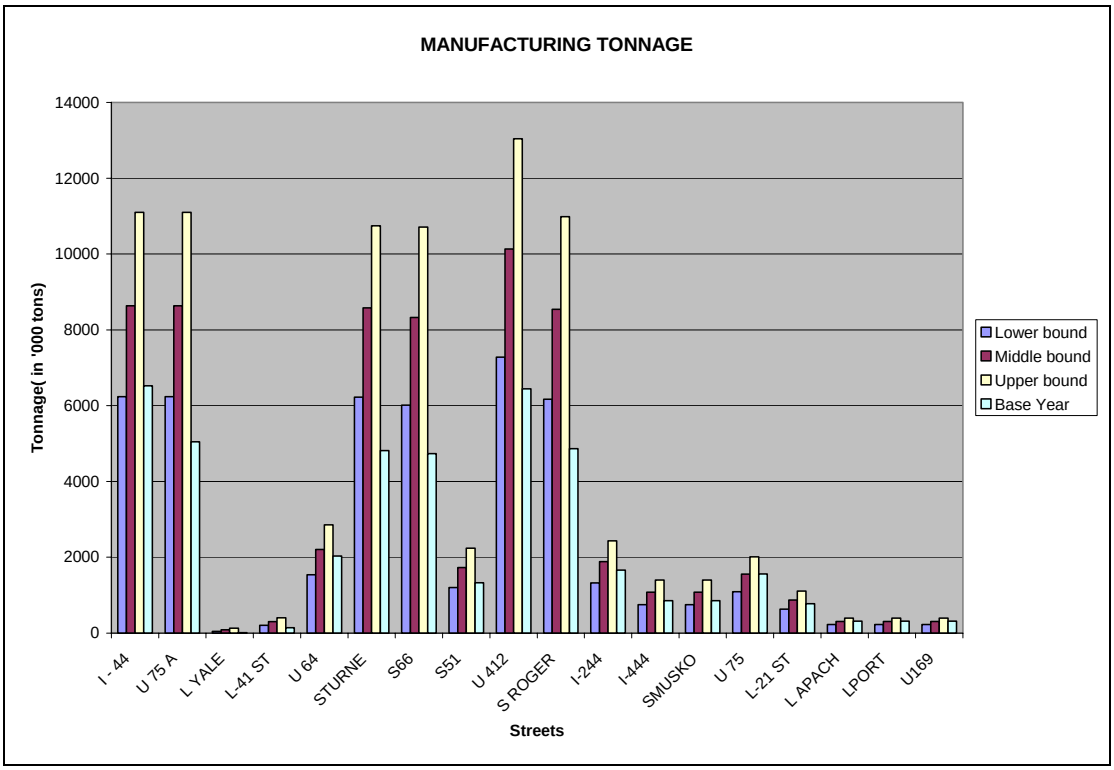



Figure 7.4.3.1: Through Flow for Manufacturing Products by Road

### 7.4.4 Mining Products

Table 7.4.4.1: Flow for 2030 by road for Mining products

| STREETS | Lower bound ( in '00 tons) | Middle bound ( in'000 tons) | Upper bound ( '000 tons) | Base Year ( in'000 tons) |
|---|---|---|---|---|
| I - 44 | 14798 | 20154.98 | 24572.48 | 21075.66 |
| U 75 A | 14798 | 20869.86 | 24572.48 | 21075.66 |
| L YALE | 43.08 | 82.45 | 120.43 | 1.64 |
| L-41 ST | 56.06 | 99.87 | 142.3 | 206.39 |
| U 64 | 2381.55 | 3333.15 | 4268.1 | 4372.87 |
| STURNE | 14274.97 | 19889.56 | 23083.9 | 19536.17 |
| S66 | 13981.23 | 19758.26 | 23163.63 | 20016.75 |
| S51 | 994.08 | 1402.85 | 1798.19 | 1394.19 |
| U 412 | 15502.93 | 21897.36 | 25902.45 | 23329.07 |
| S ROGER | 13994.21 | 19775.68 | 23185.5 | 20221.5 |
| I-244 | 2213.93 | 3085.16 | 3940.47 | 4058.87 |
| I-444 | 301.99 | 425.53 | 545.66 | 510.37 |

| | | | | |
|---|---|---|---|---|
| SMUSKO | 301.99 | 425.53 | 545.66 | 510.37 |
| U 75 | 1689.46 | 2355.83 | 3015.57 | 3489.05 |
| L-21 ST | 1465.78 | 2006.47 | 2540.95 | 1941.09 |
| L APACH | 816.77 | 1111.6 | 1408.85 | 1058.91 |
| LPORT | 816.77 | 1111.6 | 1408.85 | 1058.91 |
| U169 | 816.77 | 1111.6 | 1408.85 | 1058.91 |

The above table gives the through flow for mining products for the year 2030 and compares these values with the base year values. The comparison is depicted in Figure 7.4.4.1 below. The increase in the flow by streets follows the same trend as the total flow.

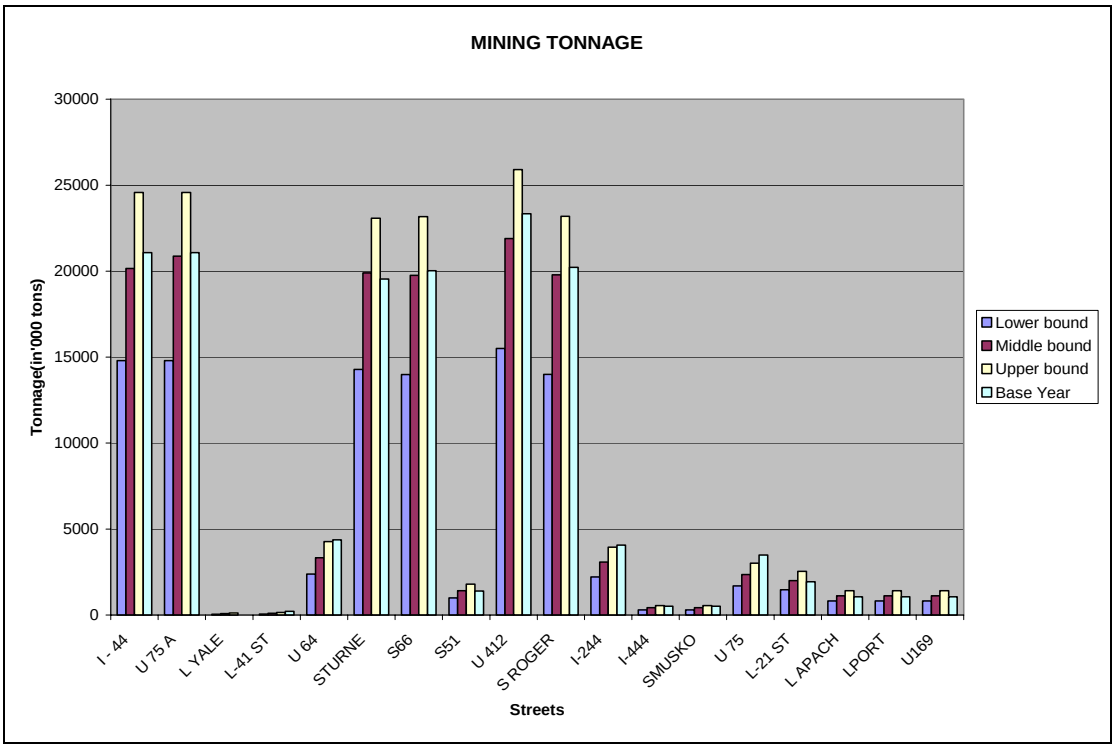



Figure 7.4.4.1: Through Flow for Mining Products by Road

### 7.4.5 Other Products

Table 7.4.5.1: Flow for 2030 by road for Other products

| STREETS | Lower Bound ( in'000 tons) | Middle Bound ( in '000 tons) | Upper Bound ( in '000 tons) | Base Year ( in '000 tons) |
|---|---|---|---|---|
| I - 44 | 3462.01 | 4756.41 | 6051.81 | 3356.76 |
| U 75 A | 3462.01 | 4756.41 | 6051.81 | 3356.76 |
| L YALE | 34.02 | 61.62 | 87.59 | 35.74 |
| L-41 ST | 146 | 203.6 | 260.95 | 122.18 |
| U 64 | 465.64 | 624.12 | 782.87 | 530.27 |
| STURNE | 3306.84 | 4597.25 | 5742.66 | 3208.37 |
| S66 | 3415.17 | 4696.54 | 5978.24 | 3295.74 |
| S51 | 415.93 | 560.4 | 704.47 | 460.4 |
| U 412 | 3799.95 | 5199.17 | 6599.95 | 3729.25 |
| S ROGER | 3527.15 | 4838.52 | 6151.6 | 3382.18 |
| I-244 | 389.3 | 509.14 | 630.19 | 451.47 |
| I-444 | 235.64 | 308.2 | 382.15 | 264.16 |
| SMUSKO | 235.64 | 308.2 | 382.15 | 264.16 |
| U 75 | 285.35 | 371.92 | 460.55 | 334.03 |
| L-21 ST | 193.11 | 250.45 | 308.3 | 221.52 |
| L APACH | 46.84 | 59.87 | 73.57 | 61.02 |
| LPORT | 46.84 | 59.87 | 73.57 | 61.02 |
| U169 | 46.84 | 59.87 | 73.57 | 61.02 |

The above table gives the through flow for other products for the year 2030 and compares these values with the base year values. The comparison is depicted in Figure 7.4.5.1 below. The increase in the flow by streets follows the same trend as the total flow.

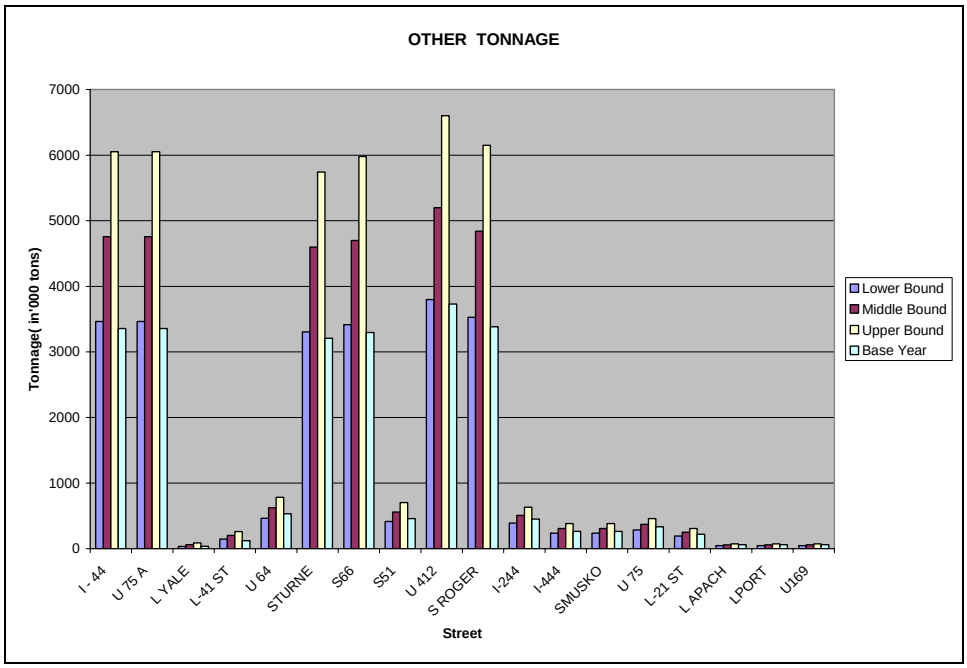



Figure 7.4.5.1: Through Flow for Other Products by Road

## 7.5 Through Flow By Commodity For The Year 2030 By Rail

### 7.5.1 Chemical Products

Table 7.5.1.1: Flow for Chemical Products by rail for 2030

| ROUTE | Lower Bound ( in'000 tons) | Middle Bound ( in'000 tons) | Upper Bound ( in'000 tons) | Base Year ( in'000 tons) |
|---|---|---|---|---|
| SLSF CHRK | 203.41 | 257.88 | 444.5 | 129.36 |
| WBNSFHUP | 203.41 | 257.88 | 444.5 | 129.36 |
| SLSF | 203.41 | 257.88 | 444.5 | 129.36 |
| WBNSFRUPTSS | 203.41 | 257.88 | 444.5 | 129.36 |
| WBNSF | 693.9 | 987.21 | 3265.61 | 877.45 |
| TSU | 446.93 | 630.11 | 2770.04 | 288.96 |
| SLSFAVAR | 643.18 | 917.58 | 3046.5 | 825.43 |
| WTSUTSS | 352.15 | 518.15 | 2640.61 | 251.53 |
| MKT | 795.87 | 1105.83 | 3271.89 | 902.77 |
| WUPTBNSF | 795.87 | 1105.83 | 3271.89 | 902.77 |
| SLWCSOON | 152.69 | 188.25 | 225.39 | 77.34 |
| WSLWC | 152.69 | 188.25 | 225.39 | 77.34 |
| WBNSFRUP | 50.72 | 69.63 | 1466.18 | 52.02 |

The above table gives the through flow for chemical products for the year 2030 and compares these values with the base year values. The comparison is depicted in Figure 7.5.1.1 below. The increase in the flow by streets follows the same trend as the total flow.

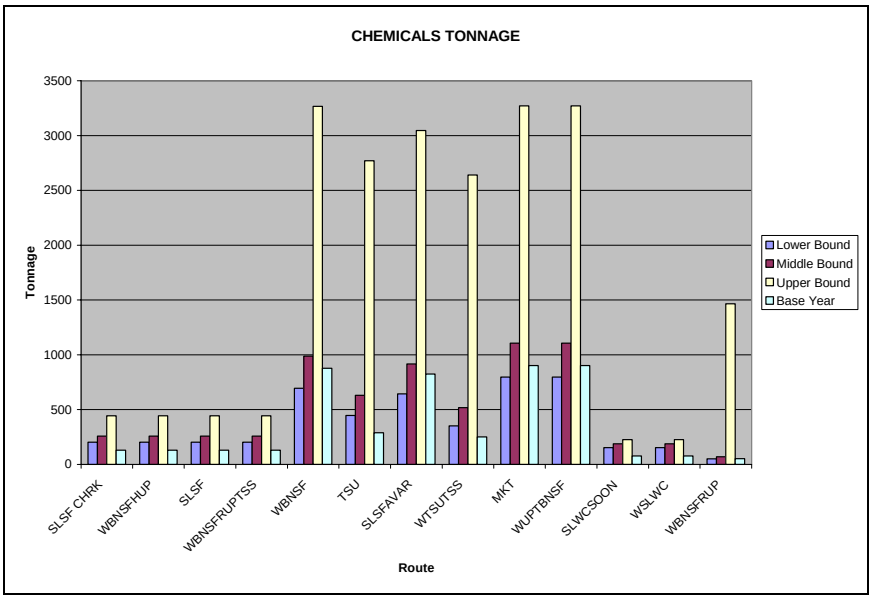



Figure 7.5.1.1: Through Flow for Chemical Products by Rail

### 7.5.2 Food Products

Table 7.5.2.1: Flow for Food Products by rail for 2030

| ROUTE | Lower Bound ( in'000 tons) | Middle Bound ( in'000 tons) | Upper Bound ( in'000 tons) | Base Year ( in'000 tons) |
|---|---|---|---|---|
| SLSF CHRK | 178.01 | 238.58 | 299.7 | 129.11 |
| WBNSFHUP | 39.07 | 53.82 | 68.38 | 18.47 |
| SLSF | 178.01 | 238.58 | 299.7 | 129.11 |
| WBNSFRUPTSS | 178.01 | 238.58 | 299.7 | 18.47 |
| WBNSF | 1788.97 | 2458.73 | 3121.8 | 2696.82 |
| TSU | 787.53 | 1019.33 | 1252.36 | 481.87 |
| SLSFAVAR | 1613.25 | 2223.27 | 2826 | 2567.71 |
| WTSUTSS | 568.7 | 761.23 | 951.68 | 381.13 |
| MKT | 1615.54 | 2226.39 | 2829.9 | 2567.71 |
| WUPTBNSF | 1615.54 | 2226.39 | 2829.9 | 2567.71 |
| SLWCSOON | 2.29 | 3.12 | 3.9 | 0 |
| WSLWC | 2.29 | 3.12 | 3.9 | 0 |
| WBNSFRUP | 175.72 | 235.46 | 295.8 | 129.11 |

The above table gives the through flow for food products for the year 2030 and compares these values with the base year values. The comparison is depicted in Figure 7.5.2.1. below. The increase in the flow by streets follows the same trend as the total flow.

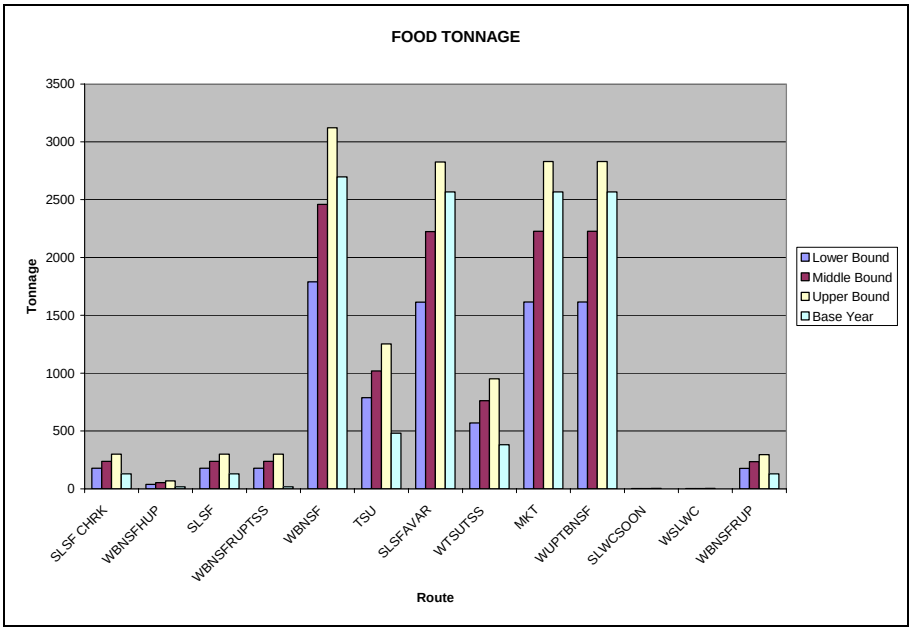



Figure 7.5.2.1: Through Flow for Food Products by Rail

### 7.5.3 Manufacturing Products

Table 7.5.3.1: Flow for Manufactured Products by rail for 2030 (in'000 tons)

| ROUTE | Lower Bound | Middle Bound | Upper Bound | Base Year |
|---|---|---|---|---|
| SLSF CHRK | 752.75 | 1039.86 | 1320.63 | 710.31 |
| WBNSFHUP | 714.58 | 987.91 | 1254.8 | 710.31 |
| SLSF | 752.75 | 1039.86 | 1320.63 | 710.31 |
| WBNSFRUPTSS | 752.75 | 1039.86 | 1320.63 | 675.53 |
| WBNSF | 2924.26 | 3898.08 | 4929.7 | 2625.54 |
| TSU | 2381.91 | 3144.16 | 3967.86 | 2005.32 |
| SLSFAVAR | 2411.37 | 3186.41 | 4022.72 | 2099.51 |
| WTSUTSS | 1849.22 | 2508.8 | 3224.46 | 1741.46 |
| MKT | 2651.23 | 3514.6 | 4436.37 | 2217.36 |
| WUPTBNSF | 2651.23 | 3514.6 | 4436.37 | 2217.36 |
| SLWCSOON | 239.86 | 328.19 | 413.65 | 117.85 |
| WSLWC | 239.86 | 328.19 | 413.65 | 117.85 |
| WBNSFRUP | 512.89 | 711.67 | 906.98 | 592.46 |

The above table gives the through flow for manufacturing products for the year 2030 and compares these values with the base year values. The comparison is depicted in Figure 7.5.3.1 below. The increase in the flow by streets follows the same trend as the total flow.

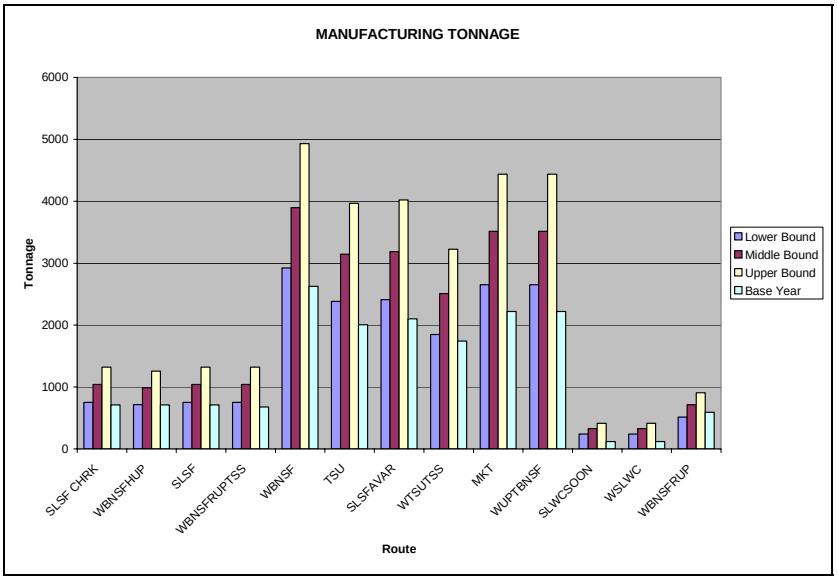



Figure 7.5.3.1: Through Flow for Food Products by Rail

### 7.5.4 Mining Products

Table 7.5.4.1: Flow for Mining Products by rail for 2030

| ROUTE | Lower Bound ( in'000 tons) | Middle Bound ( in'000 tons) | Upper bound ( in'000 tons) | Base Year ( in'000 tons) |
|---|---|---|---|---|
| SLSF CHRK | 4104.68 | 5595.65 | 7051.47 | 3040.21 |
| WBNSFHUP | 3785.58 | 5169.55 | 6516.84 | 3040.21 |
| SLSF | 4104.68 | 5595.65 | 7051.47 | 3040.21 |
| WBNSFRUPTSS | 4104.68 | 5595.65 | 7051.47 | 2824.61 |
| WBNSF | 10390.25 | 13770.99 | 16936.56 | 7280.9 |
| TSU | 6761.62 | 8816.31 | 11011.1 | 4303.67 |
| SLSFAVAR | 6946.39 | 9075.54 | 11011.1 | 4744.26 |
| WTSUTSS | 6402.41 | 8400.33 | 10199.16 | 4179.54 |
| MKT | 7607.21 | 9975.74 | 12137.11 | 4761.87 |
| WUPTBNSF | 7607.21 | 9975.74 | 12137.11 | 4761.87 |
| SLWCSOON | 660.82 | 900.2 | 1126.01 | 17.61 |
| WSLWC | 660.82 | 900.2 | 1126.01 | 17.61 |
| WBNSFRUP | 3443.86 | 4695.45 | 5925.46 | 3022.6 |

The above table gives the through flow for mining products for the year 2030 and compares these values with the base year values. The comparison is depicted in Figure 7.5.4.1 below. The increase in the flow by streets follows the same trend as the total flow.

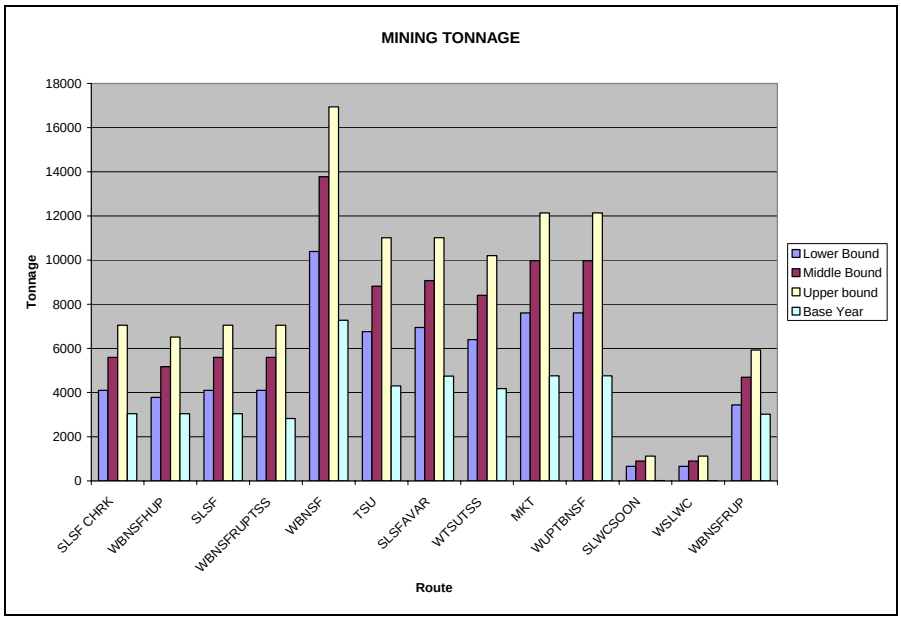



Figure 7.5.4.1: Through Flow for Mining Products by Rail

### 7.5.5 Other Products

Table 7.5.5.1: Flow for Mining Products by rail for 2030 (in ‘000 tons)

| ROUTE | Lower Bound | Middle Bound | Upper Bound | Base Year |
|---|---|---|---|---|
| SLSF CHRK | 318.16 | 419.47 | 521.82 | 301.33 |
| WBNSFHUP | 302.77 | 399.97 | 497.98 | 288.48 |
| SLSF | 318.16 | 419.47 | 521.82 | 301.33 |
| WBNSFRUPTSS | 318.16 | 419.47 | 521.82 | 301.33 |
| WBNSF | 1214.83 | 1663.32 | 2108.77 | 1187.67 |
| TSU | 925.47 | 1277.03 | 1625.33 | 904.96 |
| SLSFAVAR | 933.99 | 1288.85 | 1640.41 | 917.49 |
| WTSUTSS | 908.9 | 1257.54 | 1602.49 | 892.3 |
| MKT | 971.31 | 1333.85 | 1693.87 | 948.64 |
| WUPTBNSF | 971.31 | 1333.85 | 1693.87 | 948.64 |
| SLWCSOON | 37.32 | 45 | 53.46 | 31.15 |
| WSLWC | 37.32 | 45 | 53.46 | 31.15 |
| WBNSFRUP | 280.84 | 374.47 | 468.36 | 270.18 |

The above table gives the through flow for other products for the year 2030 and compares these values with the base year values. The comparison is depicted in Figure 7.5.5.1 below. The increase in the flow by streets follows the same trend as the total flow.

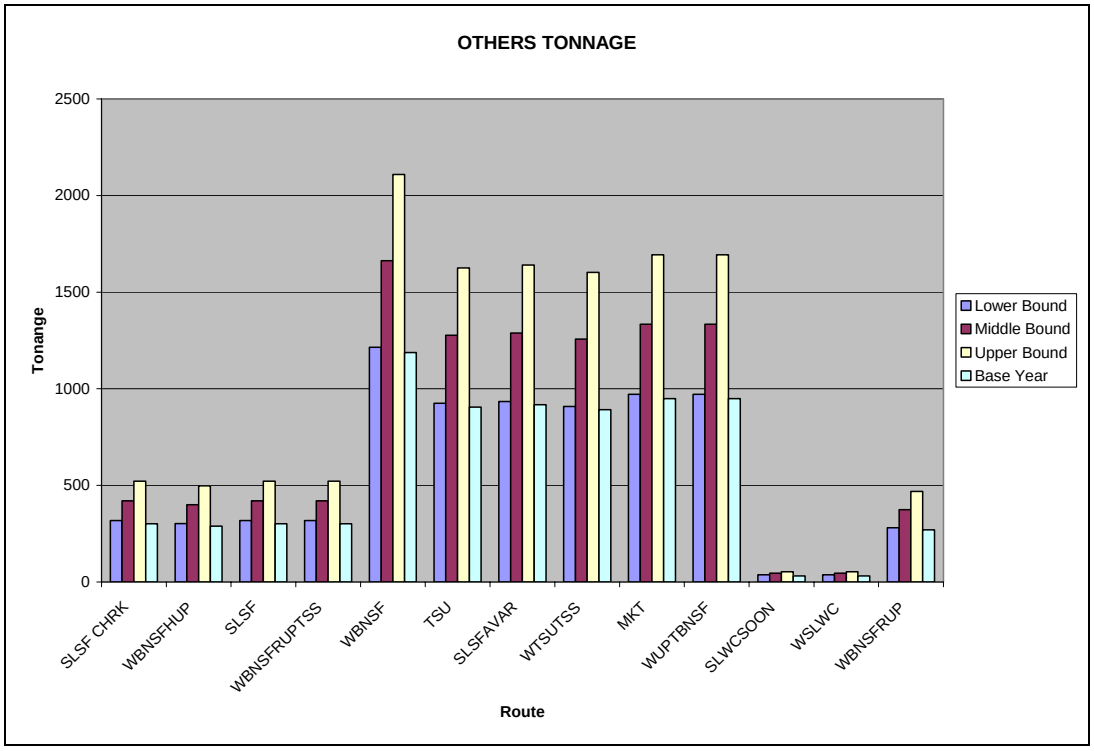



Figure 7.5.5.1: Through Flow for Other Products by Rail

## 8.0 FREIGHT ASSIGNMENT

Freight Assignment is the last step of the four step urban travel demand modeling (UTDM). The objective of freight assignment is to assign freight flows on the various routes. We used TransCAD to assign fright to specific streets. The methodology adopted for the freight assignment is described in Appendix 6.

The freight assignments for the base year and for the year 2030 are displayed below. The tables have been split into highest flow, lowest flow and average flow. TRANSCAD assigns flows on segments inbuilt into the software. Some streets are included in more that one ID. In order to obtain tonnage by street, the highest and lowest flow in the ID's that include the respective street are selected and the flows are chosen.

The trip assignment tables for the base year by road for total show the flows by the major streets of TULSA TMA. The highest flow are through I -44 and U 412 which have flows of about 44 Mn tons. The lowest flows are by L YALE and LCREEK which have flows of about 2 Mn tons. The comparison of flows for base year for total flow is shown in table 8.1.1.1.

The trip assignment tables for the base year by rail for total show the flows by the major routes of TULSA TMA. The highest flows are through the MKT and wUP tBNSF routes which have flows of about 12 million tons. The lowest flows are by SLSF Chrk, wBNSFhUP and wBNSFrUP which have flows of about 7 million tons. The comparison of flows for base year for total flow is shown in table 8.1.1.2.

The base year flows by road for the various commodity groups include Chemical products, Food products, Manufactured products, Mining products and Other products. The trends followed for the street flows are the same for the commodities as they are for the total flows. The highest flows are by Mining products followed by manufacturing products. The lowest flows are for chemical products.

The base year flows by rail for the various commodity groups include Chemical products, Food products, Manufactured products, Mining products and Other products. The trends followed for the route flows are the same for the commodities as they are for the total flows. The highest flows are by Mining products. The lowest flows are for chemical products.

The projected trip assignment tables for the year 2030 by road for total show the flows by the major streets of TULSA TMA. The tables are split in to Lower middle and upper bound. The three bounds show the same trends of flow with an incremental increase in their respective flows. The highest flow are through I -44 and U 412 which have flows of about 37,51 and 65 million tons for the lower, middle and upper bound respectively. The lowest flows are by L YALE and LCREEK which have flows of about 1,2 and 2.5 million

tons for lower, middle and upper bound respectively. The comparison of flows for projected year for total flow is shown in table 8.2.1.

The trip assignment tables for the base year by rail for total show the flows by the major routes of TULSA TMA. The highest flows are through the MKT and wUP tBNSF routes which have flows of about 16,18 and 38 million tones for lower, middle and upper bound respectively. The lowest flows are by SLSF Chrk, wBNSFhUP and wBNSFrUP which have flows of about 8,11 and 16 million tons respectively . The comparison of flows for projected year for total flow is shown in table 8.3.1.

The predicted 2030 year assignment flows by road for the various commodity groups include Chemical products, Food products, Manufactured products, Mining products and Other products. The trends followed for the street flows are the same for the commodities as they are for the total flows. The highest flows are by Mining products followed by manufacturing products. The lowest flows are for chemical products.

The predicted 2030 year assignment flows by rail for the various commodity groups include Chemical products, Food products, Manufactured products, Mining products and Other products. The trends followed for the route flows are the same for the commodities as they are for the total flows. The highest flows are by Mining products. The lowest flows are for chemical products.

## 8.1 Freight Assignment For The Base Year:

The freight assignment tables for the base year by rail and road mode are tabulated below. The highest flows by road are by I-44, SROGER, STURNE, U 412 and U75A. The highest flows by rail are by MKT, WUptBNSF and WBNSF.

### 8.1.1 Freight Assignment For The Base Year For Total Flow By Road

Table 8.1.1.1: Assignment flow for base year for total by road

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 14544.95 | 5070.94 | 9807.94 |
| I44 | 43549.10 | 33343.81 | 38446.45 |
| S11 | 4680.42 | 4680.42 | 4680.42 |
| U169 | 5440.65 | 5440.65 | 5440.65 |
| U64 | 7890.54 | 2256.21 | 5073.37 |
| U75 | 9316.54 | 5805.63 | 7561.08 |

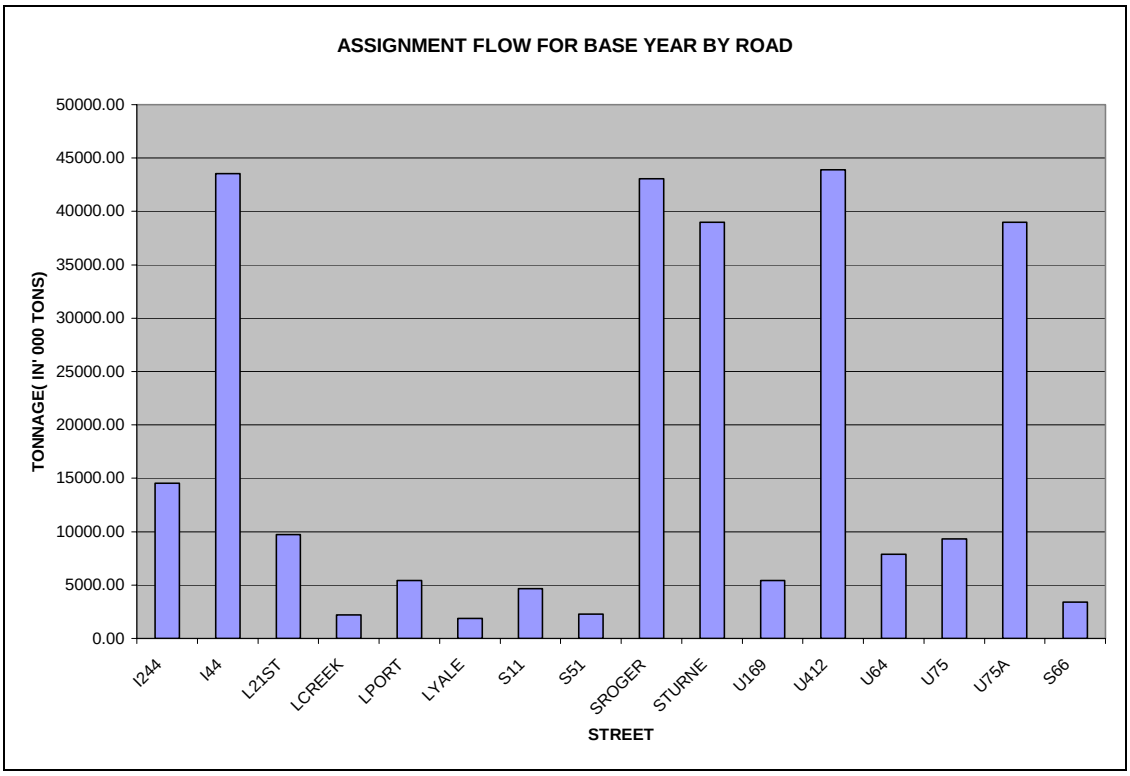



Figure 8.1.1: Comparison of assignment flows by street for base year

### 8.1.2 Freight Assignment For The Base Year For Total Flow By Rail

Table 8.1.2.1: Assignment flow for base year for total by rail

| ROUTE | UPPER FLOW ( IN ' 000 TONS) | LOWER FLOW ( IN ' 000 TONS) | AVERAGE FLOW ( IN ' 000 TONS) |
|---|---|---|---|
| MKT | 12437.8 | 12437.8 | 12437.8 |
| SLSF | 8215.504 | 8215.504 | 8215.504 |
| SLSF Avar | 9209.177 | 9209.177 | 9209.177 |
| SLSF Chrk | 6387.487 | 6387.487 | 6387.487 |
| SLWC Soon | 8215.504 | 7558.637 | 7887.071 |

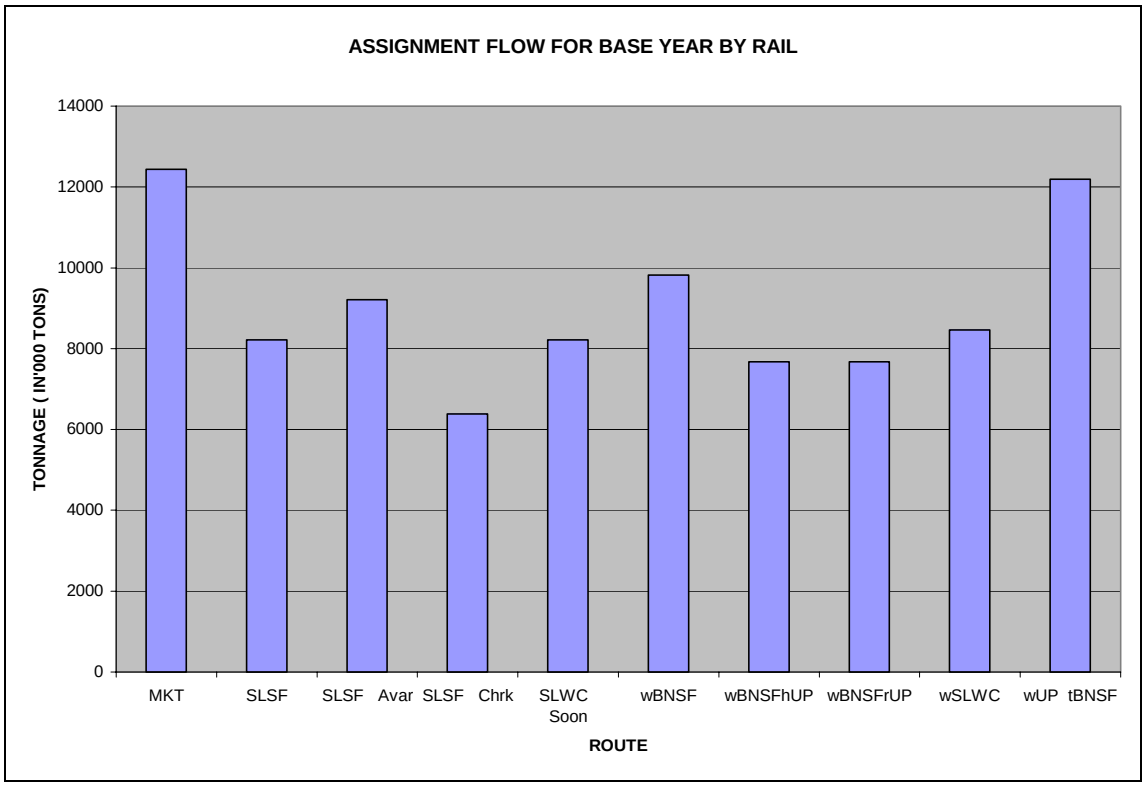



Figure 8.1.2: Comparison of assignment flows by route for base year

### 8.1.3 Freight Assignment For The Base Year For The Commodity Groups By Road

Table 8.1.3.1: Assignment flow for base year for road for chemical products

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 597.62 | 106.72 | 352.17 |
| I44 | 832.60 | 680.61 | 756.60 |
| S11 | 99.91 | 99.91 | 99.91 |
| U169 | 97.11 | 97.11 | 97.11 |
| U64 | 553.76 | 19.28 | 286.52 |
| U75 | 499.85 | 499.85 | 499.85 |

Table 8.1.3.2: Assignment flow for base year for road for food products

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 4104.40 | 900.96 | 2502.68 |
| I44 | 3760.13 | 2859.18 | 3309.65 |
| S11 | 967.18 | 967.18 | 967.18 |
| U169 | 983.38 | 983.38 | 983.38 |
| U64 | 807.94 | 633.45 | 720.70 |

Table 8.1.3.3: Assignment flow for base year for road for mining products

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 5934.38 | 2639.97 | 4287.18 |
| I44 | 23652.81 | 20119.84 | 21886.32 |
| S11 | 2384.72 | 2384.72 | 2384.72 |
| U169 | 2712.56 | 2712.56 | 2712.56 |
| U64 | 4070.26 | 510.37 | 2290.32 |
| U75 | 4070.26 | 2154.00 | 3112.13 |

Table 8.1.3.4: Assignment flow for base year for road for manufacturing products

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 2526.85 | 1189.37 | 1858.11 |
| I44 | 8415.88 | 6263.80 | 7339.84 |
| S11 | 949.41 | 949.41 | 949.41 |
| U169 | 1188.52 | 1188.52 | 1188.52 |
| U64 | 1310.81 | 859.19 | 1085.00 |
| U75 | 1216.04 | 509.87 | 862.95 |

Table 8.1.3.5: Assignment flow for base year for road for other products

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 2915.884 | 316.8444 | 1616.36 |
| I44 | 13746.1 | 6473.872 | 10109.99 |
| S11 | 448.6693 | 448.6693 | 448.67 |
| U169 | 672.0184 | 672.0184 | 672.02 |
| U64 | 2599.04 | 316.8444 | 1457.94 |
| U75 | 316.8444 | 141.4739 | 229.16 |

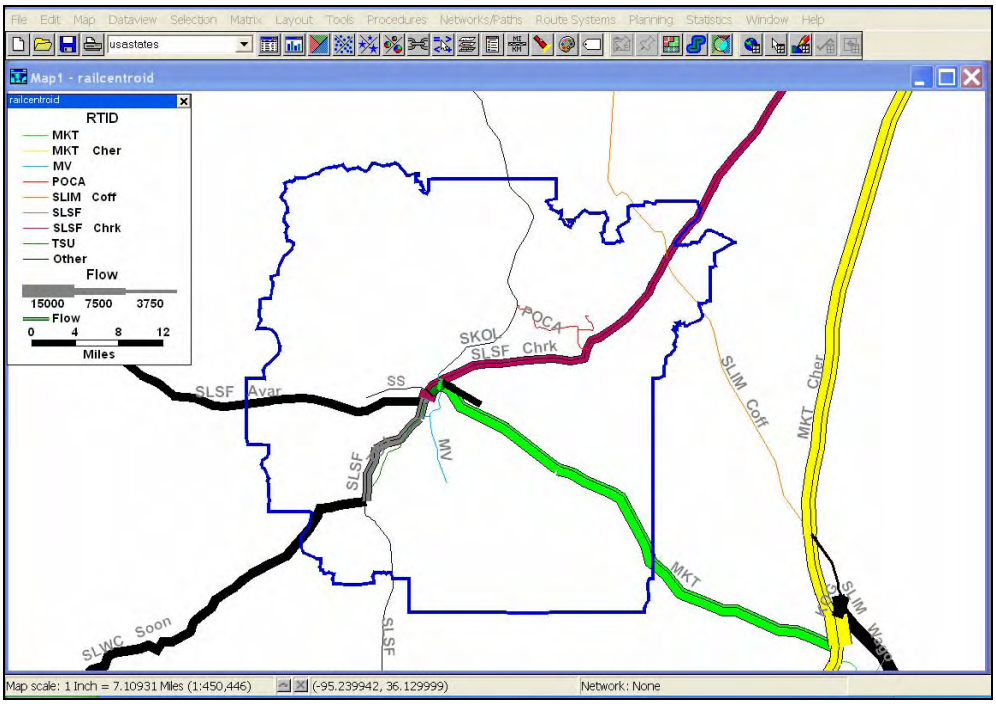



Figure 8.1.3.1: Freight assignment by rail flow intensity for TULSA TMA for other products for base year

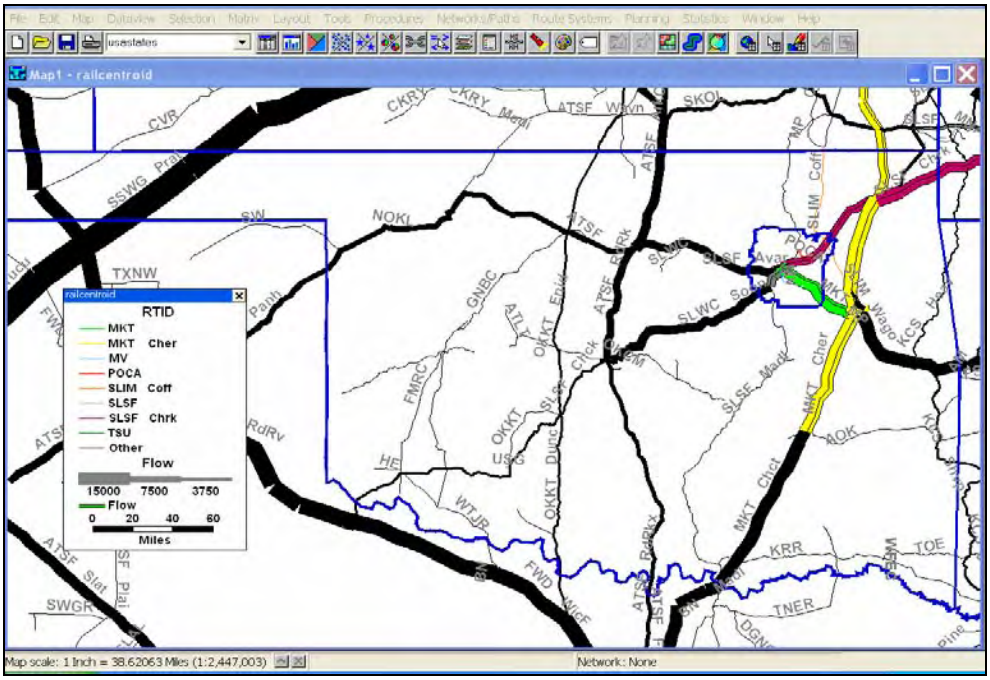



Figure 8.1.3.2: Freight assignment by rail flow intensity for Oklahoma for other products for base year

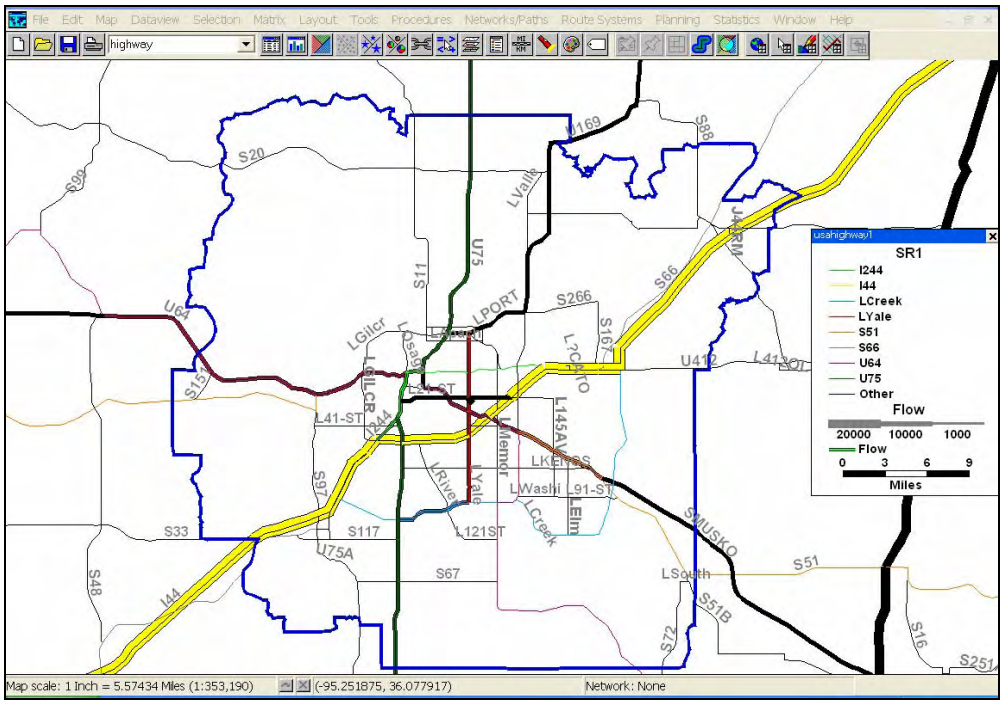



Figure 8.1.3.3: Freight assignment by road flow intensity for TULSA TMA for mining products for 2030 upper bound

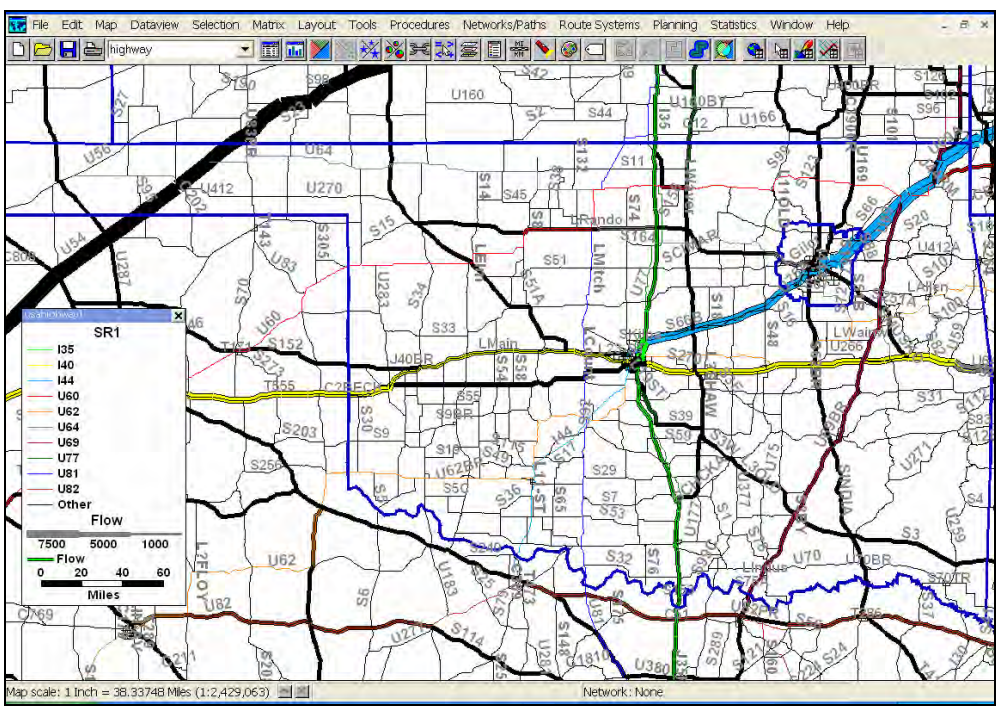



Figure 8.1.3.4: Freight assignment by road flow intensity for Oklahoma for mining products for 2030 upper bound

### 8.1.4 Freight Assignment By Rail For The Base Year By Commodity

Table 8.1.4.1: Assignment flow for base year for rail for chemical products

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 1030.724 | 1030.724 | 1030.724 |
| SLSF | 249.5357 | 249.5357 | 249.5357 |
| SLSF Avar | 789.7037 | 789.7037 | 789.7037 |
| SLSF Chrk | 132.8362 | 132.8362 | 132.8362 |
| SLWC Soon | 249.5357 | 249.5357 | 249.5357 |

Table 8.1.4.2: Assignment flow for base year for rail for food products

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 2586.361 | 2586.361 | 2586.361 |
| SLSF | 193.1573 | 193.1573 | 193.1573 |
| SLSF Avar | 2533.87 | 2533.87 | 2533.87 |
| SLSF Chrk | 288.9326 | 288.9326 | 288.9326 |
| SLWC Soon | 193.1573 | 193.1573 | 193.1573 |

Table 8.1.4.3: Assignment flow for base year for rail for mining products

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 5716.98 | 5716.98 | 5716.98 |
| SLSF | 5459.521 | 5459.521 | 5459.521 |
| SLSF Avar | 4067.285 | 4067.285 | 4067.285 |
| SLSF Chrk | 4555.848 | 4555.848 | 4555.848 |
| SLWC Soon | 5459.521 | 5459.521 | 5459.521 |

Table 8.1.4.4: Assignment flow for base year for rail for manufacturing products

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 2854.196 | 2854.196 | 2854.196 |
| SLSF | 1523.587 | 1523.587 | 1523.587 |
| SLSF Avar | 1685.481 | 1685.481 | 1685.481 |
| SLSF Chrk | 1160.335 | 1160.335 | 1160.335 |
| SLWC Soon | 1523.587 | 1523.587 | 1523.587 |

Table 8.1.4.5: Assignment flow for base year for rail for other products

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 1652.555 | 1652.555 | 1652.555 |
| SLSF | 708.2245 | 708.2245 | 708.2245 |
| SLSF Avar | 1139.045 | 1139.045 | 1139.045 |
| SLSF Chrk | 1735.709 | 1735.709 | 1735.709 |
| SLWC Soon | 708.2245 | 708.2245 | 708.2245 |

## 8.2 Freight Assignment By Road For The Year 2030 For Total Flow

The freight assignment tables for the base year by rail and road mode are tabulated below. The highest flows by road are by I-44, SROGER, STURNE, U 412 and U75A. The highest flows by rail are by MKT, WUptBNSF and WBNSF.

Table 8.2.1: Assignment flow for the year 2030 for total by road and lower bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 9025.236 | 4022.89 | 6524.063 |
| I44 | 37706.15 | 27351.63 | 32528.89 |
| S11 | 3630.66 | 3630.66 | 3630.66 |
| U169 | 4378.016 | 4378.016 | 4378.016 |
| U64 | 6399.679 | 1951.158 | 4175.419 |
| U75 | 4817.8 | 2098.318 | 3458.059 |

Table 8.2.2: Assignment flow for the year 2030 for total by road and middle bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 12863.71 | 5581.423 | 9222.565 |
| I44 | 51661.6 | 37498.74 | 44580.17 |
| S11 | 5084.846 | 5084.846 | 5084.846 |
| U169 | 5988.144 | 5988.144 | 5988.144 |
| U64 | 9170.426 | 2736.879 | 5953.652 |
| U75 | 6729.096 | 3074.138 | 4901.617 |

Table 8.2.3: Assignment flow for the year 2030 for total by road and upper bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 16615.43 | 7096.293 | 11855.86 |
| I44 | 65474.96 | 47565.62 | 56520.29 |
| S11 | 6514.792 | 6514.792 | 6514.792 |
| U169 | 7575.609 | 7575.609 | 7575.609 |
| U64 | 11875.79 | 3507.634 | 7691.714 |
| U75 | 8610.608 | 4026.265 | 6318.436 |

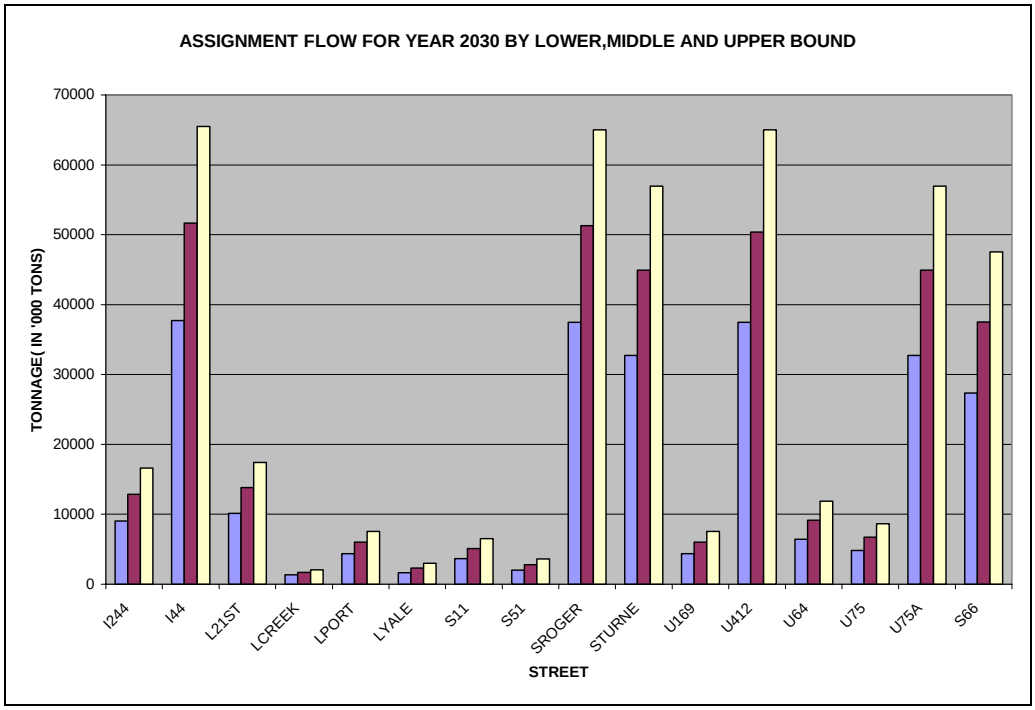



Figure 8.2.1: Comparison of assignment flow by street for the year 2030 by lower, middle and upper bound

## 8.3 Freight Assignment By Rail For The Year 2030 For Total Flow

Table 8.3.1: Assignment flow for the year 2030 by rail for total and lower bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 16142.43 | 16142.43 | 16142.43 |
| SLSF | 9104.234 | 9104.234 | 9104.234 |
| SLSF Avar | 11442.98 | 11442.98 | 11442.98 |
| SLSF Chrk | 8374.861 | 8374.861 | 8374.861 |
| SLWC Soon | 9104.234 | 9104.234 | 9104.234 |

Table 8.3.2: Assignment flow for the year 2030 by rail for total and middle bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 18733.16 | 18733.16 | 18733.16 |
| SLSF | 14813.67 | 14813.67 | 14813.67 |
| SLSF Avar | 12783.46 | 12783.46 | 12783.46 |
| SLSF Chrk | 11483.18 | 11483.18 | 11483.18 |
| SLWC Soon | 14813.67 | 12352.2 | 13582.94 |

Table 8.3.3: Assignment flow for the year 2030 by rail for total and upper bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 38748.97 | 36866.57 | 37807.77 |
| SLSF | 24660.06 | 23764.12 | 24212.09 |
| SLSF Avar | 39499.9 | 36692.61 | 38096.25 |
| SLSF Chrk | 35343.02 | 32990.01 | 34166.51 |
| SLWC Soon | 27758.46 | 27634 | 27696.23 |

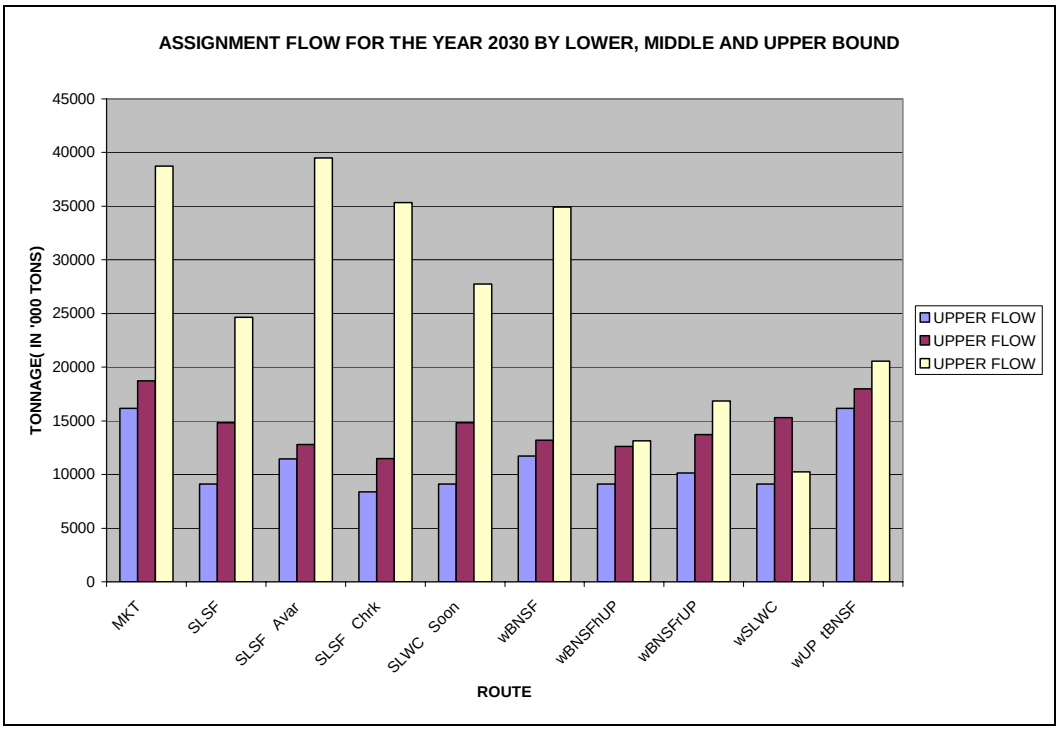



Figure 8.3.1: Comparison of assignment flow by route
for the year 2030 by lower, ,middle and upper bound

## 8.4 Freight Assignment By Road For The Year 2030 By Commodity

Table 8.4.1.1: Assignment flow by road for chemical products for lower bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 291.6878 | 130.1436 | 210.92 |
| I44 | 987.5616 | 776.2852 | 881.92 |
| S11 | 98.4423 | 98.4423 | 98.44 |
| U169 | 95.4259 | 95.4259 | 95.43 |
| U64 | 239.435 | 24.2736 | 131.85 |
| U75 | 239.435 | 192.9699 | 216.20 |

Table 8.4.1.2: Assignment flow by road for chemical products for middle bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 420.4691 | 186.681 | 303.58 |
| I44 | 1381.794 | 1088.17 | 1234.98 |
| S11 | 139.5761 | 139.5761 | 139.58 |
| U169 | 132.6994 | 132.6994 | 132.70 |
| U64 | 341.6979 | 34.6914 | 188.19 |
| U75 | 341.6979 | 279.2295 | 310.46 |

Table 8.4.1.3: Assignment flow by road for chemical products for upper bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 546.5955 | 241.7137 | 394.15 |
| I44 | 1767.877 | 1394.253 | 1581.06 |
| S11 | 179.7583 | 179.7583 | 179.76 |
| U169 | 169.1452 | 169.1452 | 169.15 |
| U64 | 442.1102 | 44.7965 | 243.45 |
| U75 | 442.1102 | 363.8461 | 402.98 |

Table 8.4.2.1: Assignment flow by road for food products for lower bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 2321.51 | 769.4941 | 1545.50 |
| I44 | 3746.967 | 2977.473 | 3362.22 |
| S11 | 786.7385 | 786.7385 | 786.74 |
| U169 | 799.7254 | 799.7254 | 799.73 |
| U64 | 1455.112 | 675.9727 | 1065.54 |
| U75 | 1455.112 | 905.5739 | 1180.34 |

Table 8.4.2.2: Assignment flow by road for food products for middle bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 3277.134 | 1063.764 | 2170.45 |
| I44 | 5094.906 | 4031.141 | 4563.02 |
| S11 | 1105.639 | 1105.639 | 1105.64 |
| U169 | 1107.892 | 1107.892 | 1107.89 |
| U64 | 2056.421 | 940.3259 | 1498.37 |
| U75 | 2056.421 | 1306.608 | 1681.51 |

Table 8.4.2.3 Assignment flow by road for food products for upper bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 4214.855 | 1353.936 | 2784.40 |
| I44 | 6431.416 | 5077.48 | 5754.45 |
| S11 | 1418.695 | 1418.695 | 1418.69 |
| U169 | 1411.151 | 1411.151 | 1411.15 |
| U64 | 2646.859 | 1200.456 | 1923.66 |
| U75 | 2646.859 | 1698.34 | 2172.60 |

Table 8.4.3.1: Assignment flow by road for mining products for lower bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 2881.414 | 2148.88 | 2515.15 |
| I44 | 16555.1 | 13933.33 | 15244.22 |
| S11 | 1710.869 | 1710.869 | 1710.87 |
| U169 | 2047.338 | 2047.338 | 2047.34 |
| U64 | 2148.88 | 301.9977 | 1225.44 |
| U75 | 2148.88 | 704.5764 | 1426.73 |

Table 8.4.3.2: Assignment flow by road for mining products for middle bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 4039.367 | 2988.273 | 3513.82 |
| I44 | 22555.28 | 18996.06 | 20775.67 |
| S11 | 2391.686 | 2391.686 | 2391.69 |
| U169 | 2805.247 | 2805.247 | 2805.25 |
| U64 | 2988.273 | 425.5313 | 1706.90 |
| U75 | 2988.273 | 1040.824 | 2014.55 |

Table 8.4.3.3: Assignment flow by road for mining products for upper bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 5175.724 | 3794.106 | 4484.91 |
| I44 | 28502.88 | 24022.87 | 26262.88 |
| S11 | 3061.017 | 3061.017 | 3061.02 |
| U169 | 3552.059 | 3552.059 | 3552.06 |
| U64 | 3815.101 | 545.6667 | 2180.38 |
| U75 | 3815.101 | 1368.03 | 2591.57 |

Table 8.4.4.1: Assignment flow by road for manufacturing products for middle bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 2026.956 | 776.2636 | 1401.61 |
| I44 | 8507.404 | 5996.538 | 7251.97 |
| S11 | 778.863 | 778.863 | 778.86 |
| U169 | 1006.594 | 1006.594 | 1006.59 |
| U64 | 1250.692 | 750.8052 | 1000.75 |
| U75 | 776.2636 | 231.8167 | 504.04 |

Table 8.4.4.2: Assignment flow by road for manufacturing products for middle bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 2904.11 | 1085.474 | 1994.79 |
| I44 | 11795.47 | 8312.217 | 10053.84 |
| S11 | 1095.502 | 1095.502 | 1095.50 |
| U169 | 1392.675 | 1392.675 | 1392.68 |
| U64 | 1818.636 | 1079.1 | 1448.87 |
| U75 | 1085.474 | 344.5712 | 715.02 |

Table 8.4.4.3: Assignment flow by road for manufacturing products for upper bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 3762.376 | 1389.693 | 2576.03 |
| I44 | 15026.68 | 10597.14 | 12811.91 |
| S11 | 1406.653 | 1406.653 | 1406.65 |
| U169 | 1771.235 | 1771.235 | 1771.24 |
| U64 | 2372.683 | 1399.87 | 1886.28 |
| U75 | 1389.693 | 454.5742 | 922.13 |

Table 8.4.5.1: Assignment flow by road for other products for lower bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 1503.668 | 198.1088 | 850.89 |
| I44 | 7909.118 | 3668.005 | 5788.56 |
| S11 | 255.7473 | 255.7473 | 255.75 |
| U169 | 428.9325 | 428.9325 | 428.93 |
| U64 | 1305.559 | 198.1088 | 751.83 |
| U75 | 198.1088 | 63.3814 | 130.75 |

Table 8.4.5.2: Assignment flow by road for other products for middle bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 2222.628 | 257.2302 | 1239.93 |
| I44 | 10834.16 | 5071.153 | 7952.66 |
| S11 | 352.4434 | 352.4434 | 352.44 |
| U169 | 549.6311 | 549.6311 | 549.63 |
| U64 | 1965.398 | 257.2302 | 1111.31 |
| U75 | 257.2302 | 102.9057 | 180.07 |

Table 8.4.5.3: Assignment flow by road for other products for upper bound

| STREET | HIGHESTFLOW (IN'000 TONS) | LOWEST FLOW ( IN'000 TONS) | AVERAGE FLOW ( IN '000 TONS) |
|---|---|---|---|
| I244 | 2915.884 | 316.8444 | 1616.36 |
| I44 | 13746.1 | 6473.872 | 10109.99 |
| S11 | 448.6693 | 448.6693 | 448.67 |
| U169 | 672.0184 | 672.0184 | 672.02 |
| U64 | 2599.04 | 316.8444 | 1457.94 |
| U75 | 316.8444 | 141.4739 | 229.16 |

## 8.5 Freight Assignment By Rail For The Year 2030 By Commodity

Table 8.5.1.1: Assignment flow by rail for chemical products for lower bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 934.6299 | 934.6299 | 934.6299 |
| SLSF | 322.8491 | 322.8491 | 322.8491 |
| SLSF Avar | 603.2248 | 603.2248 | 603.2248 |
| SLSF Chrk | 127.4369 | 127.4369 | 127.4369 |
| SLWC Soon | 322.8491 | 322.8491 | 322.8491 |

Table 8.5.1.2: Assignment flow by rail for chemical products for middle bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 1289.2734 | 1289.2734 | 1289.2734 |
| SLSF | 427.2315 | 427.2315 | 427.2315 |
| SLSF Avar | 863.2324 | 863.2324 | 863.2324 |
| SLSF Chrk | 177.4015 | 177.4015 | 177.4015 |
| SLWC Soon | 427.2315 | 427.2315 | 427.2315 |

Table 8.5.1.3: Assignment flow by rail for chemical products for upper bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 4284.0347 | 4284.0347 | 4284.0347 |
| SLSF | 2524.5921 | 2524.5921 | 2524.5921 |
| SLSF Avar | 2470.4629 | 2470.4629 | 2470.4629 |
| SLSF Chrk | 1646.5562 | 1646.5562 | 1646.5562 |
| SLWC Soon | 2524.5921 | 2524.5921 | 2524.5921 |

Table 8.5.2.1: Assignment flow by rail for food products for lower bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 1637.845 | 1637.845 | 1637.845 |
| SLSF | 239.2113 | 239.2113 | 239.2113 |
| SLSF Avar | 1596.697 | 1596.697 | 1596.697 |
| SLSF Chrk | 315.3936 | 315.3936 | 315.3936 |
| SLWC Soon | 239.2113 | 239.2113 | 239.2113 |

Table 8.5.2.2: Assignment flow by rail for food products for middle bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 2256.878 | 2256.878 | 2256.878 |
| SLSF | 323.5075 | 323.5075 | 323.5075 |
| SLSF Avar | 2199.624 | 2199.624 | 2199.624 |
| SLSF Chrk | 423.99 | 423.99 | 423.99 |
| SLWC Soon | 323.5075 | 323.5075 | 323.5075 |

Table 8.5.2.3: Assignment flow by rail for food products for upper bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 2868.082 | 2868.082 | 2868.082 |
| SLSF | 408.0191 | 408.0191 | 408.0191 |
| SLSF Avar | 2794.778 | 2794.778 | 2794.778 |
| SLSF Chrk | 532.4818 | 532.4818 | 532.4818 |
| SLWC Soon | 408.0191 | 408.0191 | 408.0191 |

Table 8.5.3.1: Assignment flow by rail for mining products for lower bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 8765.6 | 8765.6 | 8765.6 |
| SLSF | 6584.428 | 6584.428 | 6584.428 |
| SLSF Avar | 5675.905 | 5675.905 | 5675.905 |
| SLSF Chrk | 5303.083 | 5303.083 | 5303.083 |
| SLWC Soon | 6584.428 | 6584.428 | 6584.428 |

Table 8.5.3.2: Assignment flow by rail for mining products for middle bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 11465.76 | 11465.76 | 11465.76 |
| SLSF | 9028.31 | 9028.31 | 9028.31 |
| SLSF Avar | 7375.79 | 7375.79 | 7375.79 |
| SLSF Chrk | 7200.449 | 7200.449 | 7200.449 |
| SLWC Soon | 9028.31 | 9028.31 | 9028.31 |

Table 8.5.3.3: Assignment flow by rail for mining products for upper bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 14143.93 | 14143.93 | 14143.93 |
| SLSF | 11412.82 | 11412.82 | 11412.82 |
| SLSF Avar | 9077.707 | 9077.707 | 9077.707 |
| SLSF Chrk | 9059.807 | ( IN ‘ 000 TONS) | 9059.807 |
| SLWC Soon | 11412.82 | 11412.82 | 11412.82 |

Table 8.5.4.1: Assignment flow by rail for manufacturing products for lower bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 3262.711 | 3262.711 | 3262.711 |
| SLSF | 1319.522 | 1319.522 | 1319.522 |
| SLSF Avar | 2262.664 | 2262.664 | 2262.664 |
| SLSF Chrk | 1043.661 | 1043.661 | 1043.661 |
| SLWC Soon | 1319.522 | 1319.522 | 1319.522 |

Table 8.5.4.2: Assignment flow by rail for manufacturing products for middle bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 4420.252 | 4420.252 | 4420.252 |
| SLSF | 1861.25 | 1861.25 | 1861.25 |
| SLSF Avar | 2999.707 | 2999.707 | 2999.707 |
| SLSF Chrk | 1448.67 | 1448.67 | 1448.67 |
| SLWC Soon | 1861.25 | 1861.25 | 1861.25 |

Table 8.5.4.3: Assignment flow by rail for manufacturing products for upper bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 5551.766 | 5551.766 | 5551.766 |
| SLSF | 2388.346 | 2388.346 | 2388.346 |
| SLSF Avar | 3725.76 | 3725.76 | 3725.76 |
| SLSF Chrk | 1843.356 | 1843.356 | 1843.356 |
| SLWC Soon | 2388.346 | 2388.346 | 2388.346 |

Table 8.5.5.1: Assignment flow by rail for other products for lower bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 1541.646 | 1541.646 | 1541.646 |
| SLSF | 638.2237 | 638.2237 | 638.2237 |
| SLSF Avar | 1304.491 | 1304.491 | 1304.491 |
| SLSF Chrk | 1585.286 | 1585.286 | 1585.286 |
| SLWC Soon | 638.2237 | 638.2237 | 638.2237 |

Table 8.5.5.2: Assignment flow by rail for other products for middle bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 2096.41 | 2096.41 | 2096.41 |
| SLSF | 861.2511 | 861.2511 | 861.2511 |
| SLSF Avar | 1806.575 | 1806.575 | 1806.575 |
| SLSF Chrk | 2083.32 | 2083.32 | 2083.32 |
| SLWC Soon | 861.2511 | 861.2511 | 861.2511 |

Table 8.5.5.3: Assignment flow by rail for other products for upper bound

| ROUTE | UPPER FLOW ( IN ‘ 000 TONS) | LOWER FLOW ( IN ‘ 000 TONS) | AVERAGE FLOW ( IN ‘ 000 TONS) |
|---|---|---|---|
| MKT | 20553.32 | 20553.32 | 20553.32 |
| SLSF | 10261.4 | 10261.4 | 10261.4 |
| SLSF Avar | 20379.36 | 20379.36 | 20379.36 |
| SLSF Chrk | 16849.8 | 16849.8 | 16849.8 |
| SLWC Soon | 10261.4 | 10261.4 | 10261.4 |

## 8.6 Freight Assignment By Water For The Year 2030 By Total and Commodity

The trip assignment flows by water mode for the projected year 2030 for total flows and by the five commodity groups Chemical products, Food products, Manufacturing products, Mining products and Other products are shown below. The flow by water through TULSA TMA is through the Verdigris River and the Arkansas River. The tonnage for the total and for the commodity groups are displayed in table X.1. The highest flow is by the Verdigris River. The highest flow by commodity is for Mining products with 1.5 million tons. The lowest flow by commodity is for chemical products with 111,000 tons. The middle bound is taken into consideration for analysis for the future year.

Table 8.5.5.4: Port of Catoosa total freight flow by year (in tons)
Source: Tulsaport.com( About our waterways)

| YEAR | TOTAL FLOW THROUGH PORT OF CATOOSA ( IN TONS) |
|---|---|
| 1990 | 1,860,459 |
| 1991 | 2,175,448 |
| 1992 | 2,059,903 |
| 1993 | 1,666,979 |
| 1994 | 1,944,263 |
| 1995 | 1,581,424 |
| 1996 | 1,961,197 |
| 1997 | 2,160,948 |
| 1998 | 2,417,537 |
| 1999 | 2,242,850 |
| 2000 | 2,210,061 |
| 2001 | 2,046,692 |
| 2002 | 2,223,103 |
| 2003 | 2,250,139 |
| 2004 | 2,220,871 |

Table 8.5.5.5: Assignment flow for water for the base year and predicted year 2030 for total and commodity groups (middle level prediction)

| FLOW | TOTAL FLOW THRU PORT OF CATOOSA FOR THE BASE YEAR ( IN'000 TONS) | TOTAL FLOW THRU PORT OF CATOOSA FOR THE PROJECTED YEAR 2030 ( IN '000 TONS) |
|---|---|---|
| TOTAL | 1983.31 | 2593 |
| CHEMICAL | 85.94 | 111 |
| FOOD | 225.55 | 270 |
| MANUFACTURING | 107.78 | 178 |
| MINING | 1287.11 | 1540 |
| OTHER | 276.93 | 493 |

## 9.0. TULSA TMA TAZ LEVEL FREIGHT FLOWS

### 9.1 Evaluation of I-I flow

On accomplishing trip production and attraction, a model to predict the production and demand for all the states in United States and Tulsa TMA is established. This model can predict the production and attraction for the Tulsa TMA based on socio-economic and demographic variables in present as well as future years. It should be noted that the production represents the aggregation of Internal to Internal (I-I) and Internal to External (I-E) flow whereas attraction represents the aggregation of I-I and E-I flow as shown in the Figure 9.1.1. I-I represents TAZ to TAZ within Tulsa TMA and I-E represents TAZ to other states.

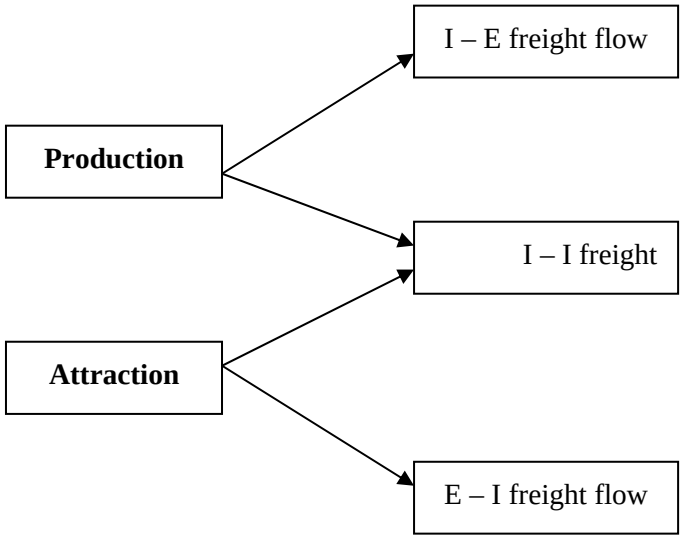



Figure 9.1.1: Schematic evaluation of I-I flow

The I-I production or attraction for Tulsa TMA is a fraction of its total production or attraction. In the base-year (1997/2000), the Tulsa production and attraction were estimated using Tulsa's shares of population and employment with respect to the corresponding total population and the total employment in State of Oklahoma.

The 2030 production or attraction for Tulsa were predicated using Tulsa's forecasted 2030 population and employment multiplied by the coefficients of linear regression, which was based upon the base-year state level CFS production or attraction and state level population and employment:

CFS Production (1997) for State (i) = f(State 1997 Employment (i))
CFS Attraction (1997) for State (j) = f(State 1997 Employment(i), CFS Production)

The above relations were used to predict Tulsa's and other states' 2030 total production and attraction, which were then split for in-state and out-state portions using the rates in Table 9.1.1 and Table 9.1.2. The split rates for commodity groups in Table 9.1.3 were used.

Table 9.1.1: Total Production by State and In-State Rates, including Tulsa TMA in the Base Year (1997 CFS)

| State | ChemOi | FoodOi | MiningOi | ManuOi | OthOi | TotOi97 | InProdPer | InAtrPer |
|---|---|---|---|---|---|---|---|---|
| AL | 11146 | 16164 | 91044 | 109503 | 28377 | 256234 | 0.68 | 0.69 |
| AK | 19 | 560 | 10410 | 559 | 8125 | 19673 | 0.89 | 0.85 |
| AZ | 5537 | 8503 | 39972 | 30173 | 37462 | 121647 | 0.86 | 0.72 |
| AR | 5063 | 27679 | 34243 | 55442 | 40308 | 162735 | 0.59 | 0.60 |
| CA | 13851 | 107991 | 409526 | 223218 | 24219 | 778805 | 0.91 | 0.86 |
| CO | 1262 | 25351 | 65166 | 26624 | 9026 | 127429 | 0.70 | 0.72 |
| CT | 1164 | 3386 | 22407 | 12970 | 7231 | 47158 | 0.59 | 0.53 |
| DE | 3032 | 4061 | 212 | 1856 | 14988 | 24149 | 0.44 | 0.63 |
| DC | 1963 | 6939 | 20780 | 12157 | 7600 | 49439 | 0.54 | 0.25 |
| FL | 63074 | 37134 | 157147 | 100108 | 39824 | 397287 | 0.86 | 0.73 |
| GA | 14040 | 31040 | 192018 | 107183 | 29273 | 373554 | 0.76 | 0.66 |
| HI | 132 | 1890 | 16970 | 2995 | 303 | 22290 | 0.99 | 0.92 |
| ID | 3270 | 11220 | 12216 | 9933 | 11125 | 47764 | 0.71 | 0.74 |
| IL | 23268 | 149638 | 238273 | 84819 | 174951 | 670949 | 0.69 | 0.71 |
| IN | 11841 | 46203 | 180699 | 98099 | 1490 | 338332 | 0.65 | 0.59 |
| IA | 5763 | 104430 | 68004 | 34896 | 5801 | 218894 | 0.67 | 0.69 |
| KS | 11107 | 62288 | 47182 | 19889 | 962 | 141428 | 0.50 | 0.63 |
| KY | 5271 | 19697 | 285554 | 45799 | 7072 | 363393 | 0.54 | 0.70 |
| LA | 73492 | 66317 | 258400 | 46807 | 62871 | 507887 | 0.61 | 0.68 |
| ME | 807 | 1542 | 7022 | 14598 | 20638 | 44607 | 0.75 | 0.67 |
| MD | 2734 | 13657 | 38324 | 37625 | 34327 | 126667 | 0.67 | 0.56 |
| MA | 1679 | 9073 | 40800 | 25648 | 13666 | 90866 | 0.73 | 0.63 |
| MI | 9198 | 30742 | 182823 | 142742 | 16772 | 382277 | 0.73 | 0.72 |
| MN | 4063 | 78503 | 129168 | 54292 | 13581 | 279607 | 0.53 | 0.66 |
| MS | 5827 | 10245 | 34660 | 66203 | 4642 | 121577 | 0.60 | 0.49 |
| MO | 11246 | 49565 | 74110 | 47036 | 5580 | 187537 | 0.59 | 0.50 |
| MT | 1267 | 6279 | 69134 | 6869 | 12229 | 95778 | 0.41 | 0.82 |
| NE | 4243 | 64238 | 25688 | 15699 | 10486 | 120354 | 0.60 | 0.67 |
| NV | 894 | 2292 | 7141 | 13146 | 1254 | 24727 | 0.70 | 0.44 |
| NH | 56 | 2057 | 4141 | 16967 | 17365 | 40586 | 0.47 | 0.61 |
| NJ | 9107 | 19017 | 111837 | 52220 | 31721 | 223902 | 0.67 | 0.65 |
| NM | 8517 | 1561 | 41524 | 8113 | 1938 | 61653 | 0.56 | 0.77 |
| NY | 7999 | 44416 | 151474 | 69129 | 7996 | 281014 | 0.77 | 0.67 |
| NC | 12471 | 33083 | 120747 | 112089 | 2525 | 280915 | 0.75 | 0.67 |
| ND | 483 | 35151 | 44273 | 4170 | 3754 | 87831 | 0.62 | 0.79 |
| OH | 19141 | 76081 | 223948 | 151090 | 40190 | 510450 | 0.66 | 0.64 |
| OKCO | 4263 | 9503 | 36915 | 18657 | 20501 | 89839 | 0.69 | 0.58 |
| OR | 1852 | 31398 | 31396 | 85115 | 15993 | 165754 | 0.75 | 0.68 |
| PA | 8351 | 39666 | 312997 | 144451 | 42701 | 548166 | 0.74 | 0.73 |
| RI | 265 | 2367 | 3524 | 1913 | 14600 | 22669 | 0.73 | 0.66 |
| SC | 7040 | 8470 | 40497 | 58717 | 1198 | 115922 | 0.65 | 0.54 |
| SD | 83 | 5149 | 1881 | 4519 | 25221 | 36853 | 0.55 | 0.60 |
| TN | 6249 | 23385 | 90940 | 72090 | 15940 | 208604 | 0.65 | 0.51 |
| TX | 107672 | 90519 | 481043 | 203126 | 31145 | 913505 | 0.84 | 0.79 |
| Tulsa TMA | 1038 | 1513 | 8144 | 9067 | 11803 | 31565 | 0.69 | 0.58 |
| UT | 3126 | 4190 | 32492 | 15032 | 41589 | 96429 | 0.70 | 0.77 |
| VT | 261 | 2167 | 4446 | 2337 | 1244 | 10455 | 0.63 | 0.42 |
| VA | 5170 | 22059 | 154702 | 69825 | 3042 | 254798 | 0.67 | 0.65 |
| WA | 8446 | 57382 | 76511 | 109238 | 12470 | 264047 | 0.78 | 0.76 |
| WV | 6098 | 1110 | 198594 | 24603 | 3355 | 233760 | 0.28 | 0.60 |
| WI | 6154 | 37193 | 98383 | 77835 | 19135 | 238700 | 0.73 | 0.63 |
| WY | 12358 | 542 | 255519 | 1924 | 5123 | 275466 | 0.14 | 0.83 |

Table 9.1.2: Total Attraction by State and In-State Rates, including Tulsa TMA in the Base Year (1997 CFS)

| State | ChemAj | FoodAj | MiningAj | ManuAj | OthAj | TotalAj97 | InProdPer | InAtrPer |
|---|---|---|---|---|---|---|---|---|
| AL | 9071 | 19823 | 107758 | 94319 | 22151 | 253122 | 0.68 | 0.69 |
| AK | 228 | 977 | 9904 | 2550 | 6912 | 20571 | 0.89 | 0.85 |
| AZ | 7543 | 12765 | 53088 | 37965 | 34115 | 145476 | 0.86 | 0.72 |
| AR | 6908 | 32070 | 43419 | 41271 | 36266 | 159934 | 0.59 | 0.60 |
| CA | 35954 | 119116 | 419265 | 244263 | 5336 | 823934 | 0.91 | 0.86 |
| CO | 3109 | 23582 | 62463 | 34608 | 217 | 123979 | 0.70 | 0.72 |
| CT | 1122 | 5382 | 28037 | 16517 | 1521 | 52579 | 0.59 | 0.53 |
| DE | 1379 | 5801 | 6822 | 4681 | 13852 | 32535 | 0.44 | 0.63 |
| DC | 1030 | 3407 | 10965 | 6202 | 3395 | 24999 | 0.54 | 0.25 |
| FL | 64390 | 42102 | 221676 | 134367 | 2528 | 465063 | 0.86 | 0.73 |
| GA | 14731 | 42832 | 228281 | 144524 | 2949 | 433317 | 0.76 | 0.66 |
| HI | 219 | 2567 | 17010 | 3950 | 186 | 23932 | 0.99 | 0.92 |
| ID | 3025 | 7316 | 14317 | 9824 | 11084 | 45566 | 0.71 | 0.74 |
| IL | 27280 | 110845 | 230285 | 98744 | 181140 | 648294 | 0.69 | 0.71 |
| IN | 15639 | 32040 | 243591 | 83009 | 1227 | 375506 | 0.65 | 0.59 |
| IA | 7618 | 72221 | 95309 | 36524 | 788 | 212460 | 0.67 | 0.69 |
| KS | 6283 | 41568 | 43282 | 22047 | 287 | 113467 | 0.50 | 0.63 |
| KY | 6829 | 17725 | 201630 | 52703 | 4241 | 283128 | 0.54 | 0.70 |
| LA | 38765 | 152011 | 191035 | 64420 | 12326 | 458557 | 0.61 | 0.68 |
| ME | 790 | 2615 | 8126 | 11381 | 26743 | 49655 | 0.75 | 0.67 |
| MD | 3463 | 15190 | 63412 | 43061 | 26301 | 151427 | 0.67 | 0.56 |
| MA | 2513 | 15664 | 46367 | 38308 | 1759 | 104611 | 0.73 | 0.63 |
| MI | 19632 | 31992 | 187048 | 134144 | 16025 | 388841 | 0.73 | 0.72 |
| MN | 6099 | 59154 | 106950 | 50939 | 3477 | 226619 | 0.53 | 0.66 |
| MS | 7807 | 13084 | 61273 | 62103 | 3819 | 148086 | 0.60 | 0.49 |
| MO | 11293 | 43054 | 114855 | 53582 | 1312 | 224096 | 0.59 | 0.50 |
| MT | 1436 | 2727 | 23196 | 7365 | 12619 | 47343 | 0.41 | 0.82 |
| NE | 5083 | 38530 | 40759 | 19333 | 3608 | 107313 | 0.60 | 0.67 |
| NV | 1620 | 3916 | 13678 | 17682 | 2733 | 39629 | 0.70 | 0.44 |
| NH | 421 | 2097 | 4067 | 5106 | 19297 | 30988 | 0.47 | 0.61 |
| NJ | 10822 | 26052 | 113936 | 53636 | 26545 | 230991 | 0.67 | 0.65 |
| NM | 4463 | 3802 | 23998 | 10530 | 2117 | 44910 | 0.56 | 0.77 |
| NY | 9913 | 47904 | 182549 | 81765 | 5100 | 327231 | 0.77 | 0.67 |
| NC | 18822 | 46866 | 139000 | 108406 | 1958 | 315052 | 0.75 | 0.67 |
| ND | 910 | 11342 | 44060 | 6464 | 6471 | 69247 | 0.62 | 0.79 |
| OH | 16168 | 53422 | 281081 | 143346 | 34401 | 528418 | 0.66 | 0.64 |
| OKCO | 3176 | 14097 | 51312 | 21015 | 10750 | 100351 | 0.69 | 0.58 |
| OR | 8947 | 40845 | 42683 | 80151 | 9992 | 182618 | 0.75 | 0.68 |
| PA | 12096 | 47235 | 329179 | 135395 | 29741 | 553646 | 0.74 | 0.73 |
| RI | 370 | 1343 | 2709 | 3118 | 13001 | 20541 | 0.73 | 0.66 |
| SC | 10947 | 12438 | 43019 | 56794 | 16534 | 139732 | 0.65 | 0.54 |
| SD | 1316 | 6782 | 2331 | 5359 | 17798 | 33586 | 0.55 | 0.60 |
| TN | 10568 | 28622 | 142487 | 73537 | 12336 | 267550 | 0.65 | 0.51 |
| TX | 100386 | 106026 | 502405 | 226528 | 32890 | 968235 | 0.84 | 0.79 |
| Tulsa TMA | 881 | 2447 | 14385 | 8468 | 16911 | 43091 | 0.69 | 0.58 |
| UT | 3452 | 6322 | 24733 | 19246 | 33956 | 87709 | 0.70 | 0.77 |
| VT | 201 | 2455 | 5044 | 4863 | 3093 | 15656 | 0.63 | 0.42 |
| VA | 8713 | 23621 | 152606 | 75235 | 3320 | 263495 | 0.67 | 0.65 |
| WA | 8388 | 71563 | 73825 | 109463 | 6683 | 269922 | 0.78 | 0.76 |
| WV | 5656 | 3594 | 79324 | 20756 | 719 | 110049 | 0.28 | 0.60 |
| WI | 8496 | 35078 | 137100 | 75353 | 19397 | 275424 | 0.73 | 0.63 |
| WY | 1856 | 869 | 33072 | 2655 | 6696 | 45148 | 0.14 | 0.83 |

Table 9.1.3: Commodity Group Split Rates: Oklahoma as An Example using 1997 CFS

| Commodity Groups | Production Tons (000) | Production Split Rates | Commodity Groups | Attraction Tons (000) | Attraction Split Rates |
|---|---|---|---|---|---|
| Food | 11016 | 9.07% | Food | 16544 | 11.53% |
| Mining | 45059 | 37.11% | Mining | 65697 | 45.80% |
| Chemicals | 5301 | 4.37% | Chemicals | 4057 | 2.83% |
| Manufactured | 30320 | 24.97% | Manufactured | 29723 | 20.72% |
| Other | 29708 | 24.47% | Other | 27421 | 19.12% |
| Total | 121404 | 100.00% | Total | 143442 | 100.00% |

## 9.2 Evaluation of Internal to Internal flow for Tulsa TMA

Table 9.2.1 shows the In- and Out- production and attraction for Tulsa. However, due to the use of state-level in- and out- ratios, the Tulsa in-production is not equal to in-attraction with small differences for each commodity groups. Because of the nature of the flow the supply and demand should balance for any given TAZ of concern. Therefore, it was decided to take the average of (i.e., 616 as the in-Tulsa production and attraction for Chemicals. 616=(717+515)/2).

Table 9.2.1: 1997 Total and Average Production and Attraction (in '000s) by Commodity Group for Both Inside and Outside Tulsa TMA

| | InChemOi | InFoodOi | InMiningOi | InManuOi | InOthOi | InTotOi |
|---|---|---|---|---|---|---|
| Tulsa TMA | 717 | 1045 | 5621 | 6258 | 8147 | 21787 |
| | | | | | | |
| | InChemAj | InFoodAj | InMiningAj | InManuAj | InOthAj | InTotAj |
| Tulsa TMA | 515 | 1429 | 8403 | 4947 | 9879 | 25174 |
| | | | | | | |
| **Average In Oi&Aj** | InAvg (Oi,Aj) Chem | InAvg (Oi,Aj) Food | InAvg (Oi,Aj) Mining | InAvg (Oi,Aj) Manu | InAvg (Oi,Aj) Others | InAvg (Oi,Aj) Total |
| | 616 | 1237 | 7012 | 5603 | 9013 | 23481 |
| | | | | | | |
| | OutChemSOi | OutFoodOi | OutMiningOi | OutManuOi | OutOthOi | OutTotOi |
| Tulsa TMA | 322 | 469 | 2523 | 2808 | 3656 | 9778 |
| | | | | | | |
| | OutChemAj | OutFoodAj | OutMiningAj | OutManuAj | OutOthAj | OutTotAj |
| Tulsa TMA | 366 | 1017 | 5981 | 3521 | 7032 | 17917 |

The similar notion was applied to 2030 lower, middle, and upper bound forecasts for total and in-Tulsa production and attraction for each commodity group, as shown in Table 9.2.2.

Table 9.2.2: 2030 Total and Average Production and Attraction (in '000s) by Commodity Group for Both Inside and Outside Tulsa TMA

| | | | | | | |
|---|---|---|---|---|---|---|
| | InChemOi | InFoodOi | InMiningOi | InManuOi | InOthOi | InTotOi |
| Tulsa TMA | 836 | 1218 | 6556 | 7298 | 9501 | 25409 |
| | InChemAj | InFoodAj | InMiningAj | InManuAj | InOthAj | InTotAj |
| Tulsa TMA | 485 | 1347 | 7921 | 4663 | 9312 | 23729 |
| **Lower Avg InOi&Aj** | 660 | 1283 | 7238 | 5981 | 9406 | 24569 |
| | InChemOi | InFoodOi | InMiningOi | InManuOi | InOthOi | InTotOi |
| Tulsa TMA | 1342 | 1956 | 10526 | 11718 | 15254 | 40796 |
| | InChemAj | InFoodAj | InMiningAj | InManuAj | InOthAj | InTotAj |
| Tulsa TMA | 653 | 1813 | 10661 | 6276 | 12534 | 31938 |
| **Middle Avg InOi&A** | 997 | 1885 | 10594 | 8997 | 13894 | 36367 |
| | InChemOi | InFoodOi | InMiningOi | InManuOi | InOthOi | InTotOi |
| Tulsa TMA | 1848 | 2694 | 14496 | 16138 | 21008 | 56183 |
| | InChemAj | InFoodAj | InMiningAj | InManuAj | InOthAj | InTotAj |
| Tulsa TMA | 819 | 2274 | 13372 | 7872 | 15720 | 40057 |
| **Uppper Avg InOi&A** | 1333 | 2484 | 13934 | 12005 | 18364 | 48120 |
| | | | | | | |
| **Lower Bound** | OutChemSOi | OutFoodOi | OutMiningOi | OutManuOi | OutOthOi | OutTotOi |
| Tulsa TMA | 375 | 547 | 2942 | 3275 | 4264 | 11403 |
| | OutChemAj | OutFoodAj | OutMiningAj | OutManuAj | OutOthAj | OutTotAj |
| Tulsa TMA | 345 | 959 | 5638 | 3319 | 6628 | 16889 |
| | | | | | | |
| **Middle Bound** | OutChemSOi | OutFoodOi | OutMiningOi | OutManuOi | OutOthOi | OutTotOi |
| Tulsa TMA | 602 | 878 | 4724 | 5259 | 6846 | 18308 |
| | OutChemAj | OutFoodAj | OutMiningAj | OutManuAj | OutOthAj | OutTotAj |
| Tulsa TMA | 465 | 1291 | 7588 | 4467 | 8921 | 22732 |
| | | | | | | |
| **Upper Bound** | OutChemSOi | OutFoodOi | OutMiningOi | OutManuOi | OutOthOi | OutTotOi |
| Tulsa TMA | 829 | 1209 | 6505 | 7242 | 9428 | 25213 |
| | OutChemAj | OutFoodAj | OutMiningAj | OutManuAj | OutOthAj | OutTotAj |
| Tulsa TMA | 583 | 1619 | 9517 | 5603 | 11189 | 28511 |

## 9.3 Allocation at the TAZ level

### 9.3.1: TAZ Partition Ratios

I-I flow evaluated in the previous section represents the total tonnage for Tulsa TMA as a node/zone. In the current project, the geographic granularity of concern is traffic analysis zone or TAZ. Hence the estimated I-I flow is distributed across the TAZ level. For this purpose, the socio-economic and demographic data at a TAZ level were provided by INCOG, Tulsa. The production and attraction were allocated to 514 TAZ's based on employment, population, dwelling units, respectively. Specifically, using the 1995 TAZ data, we established or used the following relationships:

1) Du (1995) = 0.416813*Pop (1995), with R-square = 0.972127

2) Truck (1995) = 1.97*RetEmp (1995) + 0.55*OtherEmp (1995) + 0.33*Du (1995) for all TAZs

3) RetEmp Ratio (1995) = RetEmp (1995)/TotalEmp (1995) for all TAZs

4) OtherEmp Ratio (1995) = OtherEmp (1995)/TotalEmp (1995) for all TAZs

We then calculated the 2030 housing units:

5) Du (2000) = 0.416813*Pop(2000) for all TAZs

6) Du (2030) = 0.416813*Pop(2030) for all TAZs

7) RetEmp (2000) = RetEmp Ratio (1995)*TotalEmp (2000) for all TAZs

8) RetEmp (2030) = RetEmp Ratio (1995)*TotalEmp (2030) for all TAZs

9) OtherEmp Ratio (2000) = OtherEmp (1995)/TotalEmp (2000) for all TAZs

10) OtherEmp Ratio (2030) = OtherEmp (1995)/TotalEmp (2030) for all TAZs

11) Truck (2000) = 1.97*RetEmp (2000) + 0.55*OtherEmp (2000) + 0.33*Du (2000) for all TAZs

12) Truck (2030) = 1.97*RetEmp (2030) + 0.55*OtherEmp (2030) + 0.33*Du (2030) for all TAZs

The total In-State tonnages productions and attractions were partitioned into four commodity groups using CFS 1997 ratios. Assuming commodities were transported was mainly transported in by trucks inside Tulsa, we partitioned each commodity group's total tonnage into TAZs using the following ratio:

Truck (2000) in TAZ(i)/Truck (2000 in all TAZ) * commodity group (i) In-State tonnage (2000)

Truck (2030) in TAZ(i)/Truck (2030 in all TAZ) * commodity group (i) In-State tonnage (2030)

Using INCOG 1995 TAZ data, we established a good regression relation between dwelling units and population. This relation was then used to estimate 2000 TAZ dwelling units. Also, the ratios of retail, other, service employments were calculated with respect to total population in 1995 at the TAZ level and were applied for 2000 and 2030. Some of the 1995 and 2000 data are show in Table 9.3.1

Table 9.3.1: Some 1995 INCOG Employment, Dwelling Unit, and Truck Data

| TAZ | Pop | Du | Autos | RetEMP | SerEMP | OthEMP | TotEMP | Truck | Ret/Total | Ser/Total | Oth/Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 76 | 55 | 77 | 1 | 7 | 8 | 15 | 11 | 0.0436 | 0.4464 | 0.5100 |
| 2 | 28 | 20 | 28 | 15 | 149 | 170 | 333 | 64 | 0.0436 | 0.4464 | 0.5100 |
| 3 | 26 | 19 | 8 | 9 | 94 | 107 | 210 | 41 | 0.0436 | 0.4464 | 0.5100 |
| 4 | 0 | 0 | 0 | 6 | 58 | 66 | 130 | 24 | 0.0436 | 0.4464 | 0.5100 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0000 | 0.0000 | 0.0000 |
| 6 | 1 | 1 | 1 | 6 | 66 | 75 | 147 | 27 | 0.0436 | 0.4464 | 0.5100 |
| 7 | 0 | 0 | 0 | 10 | 99 | 113 | 221 | 41 | 0.0436 | 0.4464 | 0.5100 |
| 8 | 0 | 0 | 0 | 13 | 130 | 149 | 291 | 53 | 0.0436 | 0.4464 | 0.5100 |
| 9 | 0 | 0 | 0 | 7 | 72 | 82 | 162 | 30 | 0.0436 | 0.4464 | 0.5100 |
| 10 | 0 | 0 | 0 | 1 | 9 | 10 | 19 | 4 | 0.0436 | 0.4464 | 0.5100 |
| 11 | 0 | 0 | 0 | 54 | 547 | 625 | 1226 | 225 | 0.0436 | 0.4464 | 0.5100 |
| 12 | 32 | 23 | 8 | 203 | 2081 | 2377 | 4662 | 858 | 0.0436 | 0.4464 | 0.5100 |
| 13 | 11 | 8 | 3 | 247 | 2524 | 2883 | 5654 | 1037 | 0.0436 | 0.4464 | 0.5100 |
| 14 | 1 | 1 | 0 | 13 | 129 | 147 | 288 | 53 | 0.0436 | 0.4464 | 0.5100 |
| 15 | 4 | 3 | 1 | 8 | 78 | 89 | 175 | 33 | 0.0436 | 0.4464 | 0.5100 |
| 16 | 192 | 138 | 44 | 48 | 495 | 566 | 1109 | 224 | 0.0436 | 0.4464 | 0.5100 |
| 17 | 0 | 0 | 0 | 156 | 1593 | 1820 | 3568 | 654 | 0.0436 | 0.4464 | 0.5100 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 497 | 1458 | 534 | 993 | 81 | 200 | 81 | 362 | 182 | 0.2237 | 0.5533 | 0.2230 |
| 498 | 501 | 171 | 351 | 1 | 60 | 43 | 104 | 39 | 0.0128 | 0.5726 | 0.4145 |
| 499 | 751 | 275 | 591 | 15 | 38 | 15 | 68 | 60 | 0.2237 | 0.5533 | 0.2230 |
| 500 | 1865 | 683 | 1038 | 160 | 395 | 159 | 714 | 303 | 0.2237 | 0.5533 | 0.2230 |
| **Total** | **602282** | **247677** | **425596** | **60265** | **134151** | **137515** | **331931** | **134331** | | | |

Table 9.3.2: 2000 and 2030 Employment and Truck Estimates at the TAZ Level Using 1995 TAZ Level Data

| TAZ | BasEMP2000 | SerEmp2000 | TotEMP2000 | Pop2000 | BasEMP2030 | SerEMP2030 | TotEMP2030 | PopP2030 | Truck95 | Du2000 | Du2030 | RetRate95 | SerRate95 | OtRate95 | RetEMP2000 | Ser2000 | Oth2000 | Ret2030 | Ser2030 | Oth2030 | Truck2000 | Truck2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 23 | 24 | 1536 | 4 | 32 | 36 | 1646 | 11 | 640 | 686 | 0.0436 | 0.4464 | 0.5100 | 1 | 11 | 12 | 2 | 16 | 18 | 201 | 219 |
| 2 | 443 | 5060 | 5503 | 105 | 1398 | 5503 | 6901 | 117 | 64 | 44 | 49 | 0.0436 | 0.4464 | 0.5100 | 240 | 2456 | 2807 | 301 | 3080 | 3519 | 2030 | 2544 |
| 3 | 39 | 223 | 262 | 3 | 42 | 312 | 354 | 12 | 41 | 1 | 5 | 0.0436 | 0.4464 | 0.5100 | 11 | 117 | 134 | 15 | 158 | 181 | 96 | 131 |
| 4 | 12 | 94 | 106 | 0 | 19 | 130 | 149 | 8 | 24 | 0 | 3 | 0.0436 | 0.4464 | 0.5100 | 5 | 47 | 54 | 7 | 67 | 76 | 39 | 56 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0000 | 0.0000 | 0.0000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 109 | 161 | 270 | 207 | 79 | 264 | 343 | 213 | 27 | 86 | 89 | 0.0436 | 0.4464 | 0.5100 | 12 | 121 | 138 | 15 | 153 | 175 | 125 | 152 |
| 7 | 11 | 36 | 47 | 0 | 13 | 48 | 61 | 210 | 41 | 0 | 88 | 0.0436 | 0.4464 | 0.5100 | 2 | 21 | 24 | 3 | 27 | 31 | 17 | 49 |
| 8 | 9 | 87 | 96 | 0 | 16 | 126 | 142 | 213 | 53 | 0 | 89 | 0.0436 | 0.4464 | 0.5100 | 4 | 43 | 49 | 6 | 63 | 72 | 35 | 79 |
| 9 | 180 | 428 | 608 | 0 | 176 | 601 | 777 | 116 | 30 | 0 | 48 | 0.0436 | 0.4464 | 0.5100 | 27 | 271 | 310 | 34 | 347 | 396 | 223 | 299 |
| 10 | 8 | 24 | 32 | 0 | 7 | 38 | 45 | 10 | 4 | 0 | 4 | 0.0436 | 0.4464 | 0.5100 | 1 | 14 | 16 | 2 | 20 | 23 | 12 | 18 |
| 11 | 477 | 2177 | 2654 | 0 | 747 | 2546 | 3293 | 110 | 225 | 0 | 46 | 0.0436 | 0.4464 | 0.5100 | 116 | 1185 | 1354 | 144 | 1470 | 1679 | 973 | 1221 |
| 12 | 66 | 212 | 278 | 45 | 87 | 299 | 386 | 53 | 858 | 19 | 22 | 0.0436 | 0.4464 | 0.5100 | 12 | 124 | 142 | 17 | 172 | 197 | 108 | 148 |
| 13 | 3433 | 5382 | 8815 | 1 | 4051 | 8051 | 12102 | 14 | 1037 | 0 | 6 | 0.0436 | 0.4464 | 0.5100 | 385 | 3935 | 4496 | 528 | 5402 | 6172 | 3231 | 4437 |
| 14 | 77 | 193 | 270 | 0 | 62 | 288 | 350 | 5 | 53 | 0 | 2 | 0.0436 | 0.4464 | 0.5100 | 12 | 121 | 138 | 15 | 156 | 178 | 99 | 129 |
| 15 | 37 | 115 | 152 | 9 | 38 | 144 | 182 | 17 | 33 | 4 | 7 | 0.0436 | 0.4464 | 0.5100 | 7 | 68 | 78 | 8 | 81 | 93 | 57 | 69 |
| 16 | 1 | 948 | 949 | 163 | 313 | 740 | 1053 | 170 | 224 | 68 | 71 | 0.0436 | 0.4464 | 0.5100 | 41 | 424 | 484 | 46 | 470 | 537 | 368 | 407 |
| 17 | 43 | 1255 | 1298 | 0 | 320 | 1402 | 1722 | 12 | 654 | 0 | 5 | 0.0436 | 0.4464 | 0.5100 | 57 | 579 | 662 | 75 | 769 | 878 | 476 | 633 |
| 18 | 303 | 812 | 1115 | 152 | 304 | 1244 | 1548 | 157 | 466 | 63 | 65 | 0.0436 | 0.4464 | 0.5100 | 49 | 498 | 569 | 68 | 691 | 789 | 428 | 587 |
| 19 | 759 | 1077 | 1836 | 98 | 1132 | 1573 | 2705 | 108 | 775 | 41 | 45 | 0.0436 | 0.4464 | 0.5100 | 80 | 820 | 936 | 118 | 1207 | 1380 | 685 | 1005 |
| 20 | 364 | 451 | 815 | 67 | 257 | 763 | 1020 | 74 | 134 | 28 | 31 | 0.0436 | 0.4464 | 0.5100 | 36 | 364 | 416 | 45 | 455 | 520 | 307 | 383 |
| 21 | 104 | 486 | 590 | 0 | 92 | 606 | 698 | 9 | 138 | 0 | 4 | 0.0436 | 0.4464 | 0.5100 | 26 | 263 | 301 | 30 | 312 | 356 | 216 | 257 |
| 22 | 12 | 192 | 204 | 53 | 29 | 286 | 315 | 53 | 29 | 22 | 22 | 0.0436 | 0.4464 | 0.5100 | 9 | 91 | 104 | 14 | 141 | 161 | 81 | 122 |
| 23 | 97 | 608 | 705 | 80 | 188 | 918 | 1106 | 87 | 322 | 33 | 36 | 0.0436 | 0.4464 | 0.5100 | 31 | 315 | 360 | 48 | 494 | 564 | 268 | 416 |
| 24 | 38 | 589 | 627 | 0 | 87 | 875 | 962 | 7 | 143 | 0 | 3 | 0.0436 | 0.4464 | 0.5100 | 27 | 280 | 320 | 42 | 429 | 491 | 230 | 353 |
| 25 | 109 | 1654 | 1763 | 70 | 259 | 2404 | 2663 | 77 | 350 | 29 | 32 | 0.0436 | 0.4464 | 0.5100 | 77 | 787 | 899 | 116 | 1189 | 1358 | 655 | 986 |
| 26 | 46 | 794 | 840 | 554 | 113 | 1135 | 1248 | 767 | 231 | 231 | 320 | 0.0436 | 0.4464 | 0.5100 | 37 | 375 | 428 | 54 | 557 | 636 | 377 | 553 |
| 27 | 0 | 12 | 12 | 23 | 3 | 18 | 21 | 31 | 35 | 10 | 13 | 0.0436 | 0.4464 | 0.5100 | 1 | 5 | 6 | 1 | 9 | 11 | 7 | 12 |
| 28 | 18 | 199 | 217 | 0 | 138 | 1206 | 1344 | 10 | 149 | 0 | 4 | 0.0436 | 0.4464 | 0.5100 | 9 | 97 | 111 | 59 | 600 | 685 | 80 | 494 |
| 29 | 220 | 947 | 1167 | 2 | 198 | 1276 | 1474 | 19 | 185 | 1 | 8 | 0.0436 | 0.4464 | 0.5100 | 51 | 521 | 595 | 64 | 658 | 752 | 428 | 543 |
| 30 | 50 | 883 | 933 | 132 | 131 | 1361 | 1492 | 243 | 350 | 55 | 101 | 0.0436 | 0.4464 | 0.5100 | 41 | 416 | 476 | 65 | 666 | 761 | 358 | 577 |
| 31 | 3 | 40 | 43 | 34 | 7 | 61 | 68 | 40 | 64 | 14 | 17 | 0.0436 | 0.4464 | 0.5100 | 2 | 19 | 22 | 3 | 30 | 35 | 20 | 30 |
| 32 | 28 | 48 | 76 | 25 | 23 | 75 | 98 | 31 | 9 | 10 | 13 | 0.0436 | 0.4464 | 0.5100 | 3 | 34 | 39 | 4 | 44 | 50 | 31 | 40 |
| 33 | 26 | 186 | 212 | 147 | 37 | 269 | 306 | 258 | 67 | 61 | 108 | 0.0436 | 0.4464 | 0.5100 | 9 | 95 | 108 | 13 | 137 | 156 | 96 | 144 |
| 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 13 | 0 | 2 | 0.0436 | 0.4464 | 0.5100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 35 | 48 | 142 | 190 | 947 | 595 | 224 | 819 | 1375 | 126 | 395 | 573 | 0.1975 | 0.3560 | 0.4465 | 38 | 68 | 85 | 162 | 292 | 366 | 239 | 692 |
| 36 | 0 | 6 | 6 | 525 | 634 | 12 | 646 | 1713 | 37 | 219 | 714 | 0.1325 | 0.0662 | 0.8013 | 1 | 0 | 5 | 86 | 43 | 518 | 70 | 667 |
| 37 | 2 | 11 | 13 | 846 | 374 | 15 | 389 | 1111 | 52 | 353 | 463 | 0.1674 | 0.5021 | 0.3305 | 2 | 7 | 4 | 65 | 195 | 129 | 112 | 338 |
| 38 | 10 | 162 | 172 | 953 | 35 | 231 | 266 | 1385 | 138 | 397 | 577 | 0.1674 | 0.5021 | 0.3305 | 29 | 86 | 57 | 45 | 134 | 88 | 207 | 309 |
| 39 | 13 | 98 | 111 | 1218 | 84 | 142 | 226 | 1482 | 123 | 508 | 618 | 0.1674 | 0.5021 | 0.3305 | 19 | 56 | 37 | 38 | 113 | 75 | 209 | 301 |
| 40 | 8 | 236 | 244 | 1392 | 50 | 268 | 318 | 1474 | 186 | 580 | 614 | 0.1975 | 0.3560 | 0.4465 | 48 | 87 | 109 | 63 | 113 | 142 | 329 | 386 |
| 41 | 4 | 27 | 31 | 352 | 73 | 40 | 113 | 612 | 23 | 147 | 255 | 0.1975 | 0.3560 | 0.4465 | 6 | 11 | 14 | 22 | 40 | 50 | 64 | 148 |
| 42 | 47 | 57 | 104 | 900 | 314 | 98 | 412 | 2015 | 108 | 375 | 840 | 0.1325 | 0.0662 | 0.8013 | 14 | 7 | 83 | 55 | 27 | 330 | 186 | 541 |
| 43 | 53 | 544 | 597 | 1761 | 186 | 744 | 930 | 2314 | 205 | 734 | 965 | 0.1674 | 0.5021 | 0.3305 | 100 | 300 | 197 | 156 | 467 | 307 | 526 | 765 |
| 44 | 10 | 73 | 83 | 1304 | 136 | 105 | 241 | 1739 | 67 | 544 | 725 | 0.1674 | 0.5021 | 0.3305 | 14 | 42 | 27 | 40 | 121 | 80 | 206 | 341 |
| 45 | 0 | 4 | 4 | 1030 | 261 | 8 | 269 | 1624 | 59 | 429 | 677 | 0.0915 | 0.5394 | 0.3691 | 0 | 2 | 1 | 25 | 145 | 99 | 130 | 306 |
| 46 | 21 | 253 | 274 | 4069 | 581 | 351 | 932 | 7357 | 301 | 1696 | 3067 | 0.1601 | 0.1425 | 0.6974 | 44 | 39 | 191 | 149 | 133 | 650 | 700 | 1571 |
| 47 | 2 | 28 | 30 | 1472 | 303 | 495 | 798 | 3784 | 117 | 614 | 1577 | 0.1601 | 0.1425 | 0.6974 | 5 | 4 | 21 | 128 | 114 | 557 | 205 | 1031 |
| 48 | 18 | 268 | 286 | 1347 | 81 | 408 | 489 | 1603 | 147 | 561 | 668 | 0.0915 | 0.5394 | 0.3691 | 26 | 154 | 106 | 45 | 264 | 180 | 278 | 388 |
| 49 | 2 | 28 | 30 | 352 | 72 | 47 | 119 | 413 | 23 | 147 | 172 | 0.0000 | 0.0000 | 0.0000 | 0 | 0 | 0 | 0 | 0 | 0 | 44 | 52 |
| 50 | 16 | 165 | 181 | 1444 | 750 | 531 | 1281 | 3453 | 75 | 602 | 1439 | 0.2772 | 0.3390 | 0.3838 | 50 | 61 | 69 | 355 | 434 | 492 | 318 | 1402 |
| | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 510 | 66 | 689 | 755 | 3541 | 280 | 1007 | 1287 | 5538 | | 1476 | 2308 | 0.1849 | 0.3773 | 0.3959 | 140 | 285 | 299 | 238 | 486 | 509 | 882 | 1441 |
| 511 | 49 | 1108 | 1157 | 2023 | 79 | 1485 | 1564 | 2159 | | 843 | 900 | 0.1849 | 0.3773 | 0.3959 | 214 | 437 | 458 | 289 | 590 | 619 | 926 | 1180 |
| 512 | 4 | 87 | 91 | 1715 | 51 | 128 | 179 | 1895 | | 715 | 790 | 0.1849 | 0.3773 | 0.3959 | 17 | 34 | 36 | 33 | 68 | 71 | 267 | 341 |
| 513 | 0 | 14 | 14 | 3020 | 553 | 24 | 577 | 4267 | | 1259 | 1779 | 0.1849 | 0.3773 | 0.3959 | 3 | 5 | 6 | 107 | 218 | 228 | 386 | 869 |
| 514 | 394 | 2371 | 2765 | 1677 | 625 | 3142 | 3767 | 2322 | | 699 | 968 | 0.1849 | 0.3773 | 0.3959 | 511 | 1043 | 1095 | 696 | 1421 | 1491 | 1819 | 2482 |
| **Total** | **47306** | **295525** | **342831** | **701580** | **88742** | **428782** | **517524** | **865515** | **134341** | **292433** | **360764** | | | | **63817** | **136077** | **138923** | **94822** | **202737** | **211258** | **289857** | **411221** |

Table 9.3.3: Estimated 2000 Total TAZ Production and Attraction for Tulsa by Commodity Group and Truck

| TAZ | Truck2000 | Chem2000 | Food2000 | Mine2000 | Manu2000 | Oth2000 | Total2000 |
|---|---|---|---|---|---|---|---|
| 1 | 201 | 427 | 857 | 4859 | 3882 | 6246 | 16272 |
| 2 | 2030 | 4311 | 8663 | 49108 | 39235 | 63118 | 164433 |
| 3 | 96 | 205 | 411 | 2332 | 1863 | 2997 | 7808 |
| 4 | 39 | 82 | 166 | 940 | 751 | 1208 | 3147 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 125 | 265 | 533 | 3020 | 2413 | 3882 | 10112 |
| 7 | 17 | 37 | 74 | 417 | 333 | 536 | 1395 |
| 8 | 35 | 75 | 150 | 851 | 680 | 1094 | 2850 |
| 9 | 223 | 473 | 951 | 5391 | 4307 | 6928 | 18050 |
| 10 | 12 | 25 | 50 | 284 | 227 | 365 | 950 |
| 11 | 973 | 2066 | 4151 | 23531 | 18800 | 30244 | 78790 |
| 12 | 108 | 228 | 459 | 2601 | 2078 | 3343 | 8709 |
| 13 | 3231 | 6861 | 13787 | 78158 | 62444 | 100455 | 261705 |
| 14 | 99 | 210 | 422 | 2394 | 1913 | 3077 | 8016 |
| 15 | 57 | 121 | 243 | 1375 | 1098 | 1767 | 4604 |
| 16 | 368 | 782 | 1571 | 8907 | 7116 | 11448 | 29824 |
| 17 | 476 | 1010 | 2030 | 11508 | 9194 | 14791 | 38534 |
| 18 | 428 | 908 | 1825 | 10346 | 8266 | 13297 | 34641 |
| 19 | 685 | 1455 | 2924 | 16575 | 13242 | 21303 | 55499 |
| 20 | 307 | 652 | 1310 | 7429 | 5935 | 9548 | 24874 |
| 21 | 216 | 459 | 923 | 5231 | 4179 | 6723 | 17516 |
| 22 | 81 | 173 | 347 | 1969 | 1573 | 2531 | 6593 |
| 23 | 268 | 570 | 1145 | 6493 | 5187 | 8345 | 21740 |
| 24 | 230 | 488 | 981 | 5559 | 4441 | 7145 | 18614 |
| 25 | 655 | 1391 | 2795 | 15843 | 12657 | 20362 | 53048 |
| 26 | 377 | 801 | 1609 | 9123 | 7289 | 11726 | 30549 |
| 27 | 7 | 15 | 31 | 176 | 141 | 226 | 589 |
| 28 | 80 | 169 | 339 | 1924 | 1537 | 2473 | 6442 |
| 29 | 428 | 909 | 1826 | 10353 | 8271 | 13306 | 34665 |
| 30 | 358 | 761 | 1530 | 8671 | 6928 | 11145 | 29035 |
| 31 | 20 | 42 | 85 | 484 | 387 | 622 | 1621 |
| 32 | 31 | 66 | 132 | 749 | 599 | 963 | 2509 |
| 33 | 96 | 204 | 410 | 2324 | 1857 | 2987 | 7783 |
| 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 239 | 508 | 1020 | 5782 | 4620 | 7432 | 19362 |
| 36 | 70 | 148 | 298 | 1690 | 1350 | 2172 | 5659 |
| 37 | 112 | 239 | 480 | 2720 | 2173 | 3496 | 9108 |
| 38 | 207 | 440 | 884 | 5011 | 4004 | 6441 | 16780 |
| 39 | 209 | 444 | 892 | 5058 | 4041 | 6501 | 16937 |
| 40 | 329 | 699 | 1404 | 7958 | 6358 | 10228 | 26646 |
| 41 | 64 | 135 | 272 | 1541 | 1231 | 1980 | 5160 |
| 42 | 186 | 394 | 792 | 4488 | 3586 | 5768 | 15028 |
| 43 | 526 | 1116 | 2243 | 12715 | 10159 | 16342 | 42575 |
| 44 | 206 | 436 | 877 | 4972 | 3972 | 6390 | 16648 |
| 45 | 130 | 277 | 556 | 3153 | 2519 | 4053 | 10558 |
| 46 | 700 | 1487 | 2989 | 16943 | 13536 | 21776 | 56731 |
| 47 | 205 | 435 | 875 | 4960 | 3963 | 6375 | 16609 |
| 48 | 278 | 590 | 1187 | 6726 | 5374 | 8645 | 22523 |
| 49 | 44 | 93 | 188 | 1065 | 851 | 1369 | 3566 |
| 50 | 318 | 675 | 1355 | 7684 | 6139 | 9876 | 25729 |
| | **...** | **...** | **...** | **...** | **...** | **...** | **...** |
| 510 | 882 | 1873 | 3765 | 21341 | 17050 | 27429 | 71458 |
| 511 | 926 | 1967 | 3953 | 22408 | 17903 | 28800 | 75031 |
| 512 | 267 | 568 | 1141 | 6469 | 5169 | 8315 | 21662 |
| 513 | 386 | 819 | 1646 | 9333 | 7457 | 11996 | 31251 |
| 514 | 1819 | 3862 | 7761 | 43998 | 35152 | 56550 | 147323 |
| **Total** | **289857** | **615566** | **1236996** | **7012424** | **5602559** | **9012963** | **23480508** |

Table 9.3.4: Forecasted 2030 Total TAZ Production and Attraction for Tulsa by Commodity Group and Truck: Lower Bound

| TAZ | Truck2030L | Chem2030L | Food2030L | Mine2030L | Manu2030L | Oth2030L | Total2030L |
|---|---|---|---|---|---|---|---|
| 1 | 150 | 352 | 683 | 3855 | 3185 | 5010 | 13304 |
| 2 | 1747 | 4085 | 7935 | 44775 | 36995 | 58186 | 154519 |
| 3 | 90 | 211 | 409 | 2310 | 1909 | 3002 | 7972 |
| 4 | 38 | 89 | 173 | 979 | 809 | 1272 | 3378 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 105 | 245 | 475 | 2681 | 2216 | 3485 | 9254 |
| 7 | 33 | 78 | 152 | 856 | 707 | 1112 | 2953 |
| 8 | 54 | 126 | 245 | 1385 | 1144 | 1800 | 4779 |
| 9 | 206 | 481 | 934 | 5268 | 4352 | 6845 | 18179 |
| 10 | 12 | 28 | 55 | 312 | 258 | 406 | 1078 |
| 11 | 838 | 1960 | 3808 | 21485 | 17752 | 27920 | 74144 |
| 12 | 102 | 238 | 462 | 2607 | 2154 | 3387 | 8996 |
| 13 | 3048 | 7125 | 13841 | 78099 | 64529 | 101491 | 269522 |
| 14 | 89 | 207 | 402 | 2269 | 1875 | 2948 | 7830 |
| 15 | 47 | 111 | 215 | 1211 | 1001 | 1574 | 4181 |
| 16 | 280 | 654 | 1270 | 7167 | 5922 | 9314 | 24733 |
| 17 | 435 | 1016 | 1973 | 11135 | 9200 | 14470 | 38426 |
| 18 | 403 | 943 | 1831 | 10332 | 8536 | 13426 | 35654 |
| 19 | 690 | 1614 | 3135 | 17687 | 14614 | 22985 | 61039 |
| 20 | 263 | 615 | 1195 | 6743 | 5571 | 8762 | 23269 |
| 21 | 176 | 413 | 801 | 4523 | 3737 | 5877 | 15607 |
| 22 | 84 | 196 | 381 | 2149 | 1775 | 2792 | 7415 |
| 23 | 286 | 668 | 1298 | 7326 | 6053 | 9520 | 25283 |
| 24 | 243 | 568 | 1103 | 6221 | 5140 | 8084 | 21469 |
| 25 | 677 | 1583 | 3074 | 17348 | 14334 | 22544 | 59869 |
| 26 | 380 | 888 | 1726 | 9739 | 8047 | 12656 | 33609 |
| 27 | 8 | 19 | 36 | 204 | 168 | 265 | 703 |
| 28 | 339 | 793 | 1540 | 8692 | 7182 | 11295 | 29996 |
| 29 | 373 | 871 | 1693 | 9550 | 7891 | 12411 | 32959 |
| 30 | 396 | 927 | 1800 | 10160 | 8394 | 13203 | 35061 |
| 31 | 21 | 48 | 93 | 527 | 435 | 684 | 1818 |
| 32 | 27 | 64 | 124 | 700 | 579 | 910 | 2417 |
| 33 | 99 | 232 | 450 | 2542 | 2100 | 3303 | 8772 |
| 34 | 0 | 1 | 2 | 9 | 7 | 11 | 30 |
| 35 | 475 | 1111 | 2158 | 12177 | 10061 | 15824 | 42022 |
| 36 | 458 | 1072 | 2082 | 11749 | 9708 | 15268 | 40546 |
| 37 | 232 | 543 | 1054 | 5948 | 4914 | 7729 | 20526 |
| 38 | 212 | 497 | 965 | 5443 | 4498 | 7074 | 18786 |
| 39 | 207 | 483 | 939 | 5297 | 4376 | 6883 | 18280 |
| 40 | 265 | 620 | 1205 | 6797 | 5616 | 8833 | 23457 |
| 41 | 102 | 238 | 462 | 2610 | 2156 | 3391 | 9006 |
| 42 | 372 | 869 | 1688 | 9524 | 7869 | 12376 | 32866 |
| 43 | 526 | 1229 | 2387 | 13467 | 11127 | 17500 | 46474 |
| 44 | 234 | 547 | 1063 | 5998 | 4955 | 7794 | 20698 |
| 45 | 210 | 492 | 955 | 5389 | 4453 | 7003 | 18598 |
| 46 | 1079 | 2523 | 4902 | 27660 | 22853 | 35944 | 95454 |
| 47 | 708 | 1655 | 3216 | 18146 | 14993 | 23582 | 62624 |
| 48 | 266 | 623 | 1210 | 6827 | 5641 | 8872 | 23560 |
| 49 | 35 | 83 | 161 | 909 | 751 | 1181 | 3137 |
| 50 | 963 | 2251 | 4373 | 24673 | 20386 | 32063 | 85147 |
| | | … | **...** | **...** | **...** | **...** | **...** |
| 510 | 990 | 2315 | 4496 | 25372 | 20963 | 32971 | 87559 |
| 511 | 811 | 1895 | 3681 | 20772 | 17162 | 26993 | 71684 |
| 512 | 234 | 548 | 1064 | 6005 | 4961 | 7803 | 20722 |
| 513 | 597 | 1396 | 2712 | 15302 | 12643 | 19885 | 52808 |
| 514 | 1705 | 3986 | 7744 | 43695 | 36103 | 56783 | 150793 |
| **Total** | **282462** | **660353** | **1282788** | **7238428** | **5980678** | **9406469** | **24979936** |

Table 9.3.5: Forecasted 2030 Total TAZ Production and Attraction for Tulsa by Commodity Group and Truck: Middle Bound

| TAZ | Truck2030M | Chem2030M | Food2030M | Mine2030M | Manu2030M | Oth2030M | Total2030M |
|---|---|---|---|---|---|---|---|
| 1 | 219 | 531 | 1004 | 5642 | 4792 | 7400 | 19369 |
| 2 | 2544 | 6169 | 11658 | 65529 | 55654 | 85945 | 224956 |
| 3 | 131 | 318 | 601 | 3381 | 2871 | 4434 | 11606 |
| 4 | 56 | 135 | 255 | 1432 | 1217 | 1879 | 4918 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 152 | 369 | 698 | 3924 | 3333 | 5147 | 13472 |
| 7 | 49 | 118 | 223 | 1252 | 1064 | 1643 | 4299 |
| 8 | 79 | 191 | 361 | 2027 | 1721 | 2658 | 6958 |
| 9 | 299 | 726 | 1372 | 7709 | 6548 | 10111 | 26465 |
| 10 | 18 | 43 | 81 | 457 | 388 | 599 | 1569 |
| 11 | 1221 | 2960 | 5594 | 31444 | 26705 | 41240 | 107943 |
| 12 | 148 | 359 | 679 | 3815 | 3240 | 5003 | 13096 |
| 13 | 4437 | 10760 | 20335 | 114300 | 97075 | 149910 | 392381 |
| 14 | 129 | 313 | 591 | 3320 | 2820 | 4355 | 11399 |
| 15 | 69 | 167 | 315 | 1773 | 1506 | 2325 | 6087 |
| 16 | 407 | 987 | 1866 | 10489 | 8908 | 13757 | 36008 |
| 17 | 633 | 1534 | 2899 | 16296 | 13840 | 21373 | 55943 |
| 18 | 587 | 1423 | 2690 | 15120 | 12842 | 19831 | 51907 |
| 19 | 1005 | 2437 | 4605 | 25886 | 21985 | 33950 | 88864 |
| 20 | 383 | 929 | 1756 | 9868 | 8381 | 12943 | 33877 |
| 21 | 257 | 623 | 1178 | 6619 | 5621 | 8681 | 22722 |
| 22 | 122 | 296 | 559 | 3145 | 2671 | 4124 | 10795 |
| 23 | 416 | 1009 | 1908 | 10722 | 9106 | 14062 | 36808 |
| 24 | 353 | 857 | 1620 | 9105 | 7733 | 11941 | 31256 |
| 25 | 986 | 2390 | 4517 | 25389 | 21563 | 33299 | 87159 |
| 26 | 553 | 1342 | 2536 | 14253 | 12105 | 18694 | 48930 |
| 27 | 12 | 28 | 53 | 298 | 253 | 391 | 1023 |
| 28 | 494 | 1198 | 2263 | 12721 | 10804 | 16684 | 43670 |
| 29 | 543 | 1316 | 2487 | 13977 | 11871 | 18332 | 47983 |
| 30 | 577 | 1400 | 2645 | 14869 | 12628 | 19501 | 51043 |
| 31 | 30 | 73 | 137 | 771 | 655 | 1011 | 2646 |
| 32 | 40 | 97 | 182 | 1025 | 871 | 1344 | 3519 |
| 33 | 144 | 350 | 662 | 3720 | 3159 | 4879 | 12771 |
| 34 | 1 | 1 | 2 | 13 | 11 | 17 | 44 |
| 35 | 692 | 1678 | 3171 | 17821 | 15135 | 23373 | 61177 |
| 36 | 667 | 1619 | 3059 | 17195 | 14604 | 22552 | 59029 |
| 37 | 338 | 819 | 1549 | 8705 | 7393 | 11417 | 29883 |
| 38 | 309 | 750 | 1417 | 7967 | 6766 | 10449 | 27349 |
| 39 | 301 | 730 | 1379 | 7752 | 6584 | 10167 | 26612 |
| 40 | 386 | 937 | 1770 | 9948 | 8449 | 13047 | 34150 |
| 41 | 148 | 360 | 679 | 3819 | 3244 | 5009 | 13111 |
| 42 | 541 | 1312 | 2480 | 13938 | 11838 | 18281 | 47848 |
| 43 | 765 | 1855 | 3506 | 19709 | 16739 | 25849 | 67659 |
| 44 | 341 | 826 | 1562 | 8778 | 7455 | 11512 | 30133 |
| 45 | 306 | 743 | 1403 | 7887 | 6699 | 10344 | 27076 |
| 46 | 1571 | 3811 | 7202 | 40481 | 34380 | 53092 | 138966 |
| 47 | 1031 | 2500 | 4725 | 26558 | 22556 | 34832 | 91171 |
| 48 | 388 | 941 | 1778 | 9991 | 8486 | 13104 | 34299 |
| 49 | 52 | 125 | 237 | 1330 | 1130 | 1745 | 4567 |
| 50 | 1402 | 3399 | 6424 | 36109 | 30668 | 47359 | 123960 |
| | **...** | **...** | **...** | **...** | **...** | **...** | **...** |
| 510 | 1441 | 3496 | 6606 | 37133 | 31537 | 48701 | 127473 |
| 511 | 1180 | 2862 | 5408 | 30400 | 25819 | 39871 | 104360 |
| 512 | 341 | 827 | 1563 | 8788 | 7463 | 11526 | 30168 |
| 513 | 869 | 2108 | 3984 | 22395 | 19020 | 29372 | 76880 |
| 514 | 2482 | 6020 | 11377 | 63949 | 54312 | 83872 | 219531 |
| **Total** | **411221** | **997297** | **1884723** | **10593648** | **8997189** | **13894041** | **36366898** |

Table 9.3.6: Forecasted 2030 Total TAZ Production and Attraction for Tulsa by Commodity Group and Truck: Upper Bound

| TAZ | Truck2030U | Chem2030U | Food2030U | Mine2030U | Manu2030U | Oth2030U | Total2030U | Total2030U |
|---|---|---|---|---|---|---|---|---|
| 1 | 290 | 710 | 1323 | 7421 | 6394 | 9781 | 25629 | 25629 |
| 2 | 3366 | 8248 | 15366 | 86191 | 74259 | 113594 | 297658 | 297658 |
| 3 | 174 | 426 | 793 | 4447 | 3831 | 5861 | 15357 | 15357 |
| 4 | 74 | 180 | 336 | 1884 | 1623 | 2483 | 6507 | 6507 |
| 5 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 202 | 494 | 920 | 5162 | 4447 | 6803 | 17826 | 17826 |
| 7 | 64 | 158 | 294 | 1647 | 1419 | 2171 | 5689 | 5689 |
| 8 | 104 | 255 | 475 | 2666 | 2297 | 3513 | 9206 | 9206 |
| 9 | 396 | 970 | 1808 | 10140 | 8736 | 13364 | 35019 | 35019 |
| 10 | 23 | 58 | 107 | 601 | 518 | 792 | 2076 | 2076 |
| 11 | 1615 | 3958 | 7373 | 41358 | 35632 | 54507 | 142828 | 142828 |
| 12 | 196 | 480 | 895 | 5018 | 4323 | 6613 | 17329 | 17329 |
| 13 | 5871 | 14386 | 26802 | 150340 | 129527 | 198138 | 519193 | 519193 |
| 14 | 171 | 418 | 779 | 4367 | 3763 | 5756 | 15083 | 15083 |
| 15 | 91 | 223 | 416 | 2332 | 2009 | 3074 | 8054 | 8054 |
| 16 | 539 | 1320 | 2460 | 13796 | 11886 | 18183 | 47645 | 47645 |
| 17 | 837 | 2051 | 3821 | 21434 | 18467 | 28249 | 74023 | 74023 |
| 18 | 777 | 1903 | 3546 | 19888 | 17135 | 26211 | 68682 | 68682 |
| 19 | 1330 | 3258 | 6070 | 34048 | 29334 | 44873 | 117583 | 117583 |
| 20 | 507 | 1242 | 2314 | 12980 | 11183 | 17106 | 44825 | 44825 |
| 21 | 340 | 833 | 1552 | 8706 | 7501 | 11474 | 30065 | 30065 |
| 22 | 162 | 396 | 737 | 4136 | 3564 | 5451 | 14284 | 14284 |
| 23 | 551 | 1349 | 2514 | 14103 | 12150 | 18587 | 48703 | 48703 |
| 24 | 468 | 1146 | 2135 | 11976 | 10318 | 15783 | 41357 | 41357 |
| 25 | 1304 | 3196 | 5954 | 33395 | 28772 | 44012 | 115328 | 115328 |
| 26 | 732 | 1794 | 3342 | 18747 | 16152 | 24708 | 64743 | 64743 |
| 27 | 15 | 38 | 70 | 392 | 338 | 517 | 1354 | 1354 |
| 28 | 653 | 1601 | 2983 | 16732 | 14416 | 22052 | 57783 | 57783 |
| 29 | 718 | 1759 | 3278 | 18384 | 15839 | 24229 | 63490 | 63490 |
| 30 | 764 | 1871 | 3487 | 19557 | 16850 | 25775 | 67539 | 67539 |
| 31 | 40 | 97 | 181 | 1014 | 874 | 1336 | 3501 | 3501 |
| 32 | 53 | 129 | 240 | 1348 | 1162 | 1777 | 4656 | 4656 |
| 33 | 191 | 468 | 872 | 4893 | 4216 | 6449 | 16898 | 16898 |
| 34 | 1 | 2 | 3 | 17 | 15 | 22 | 59 | 59 |
| 35 | 915 | 2243 | 4179 | 23440 | 20195 | 30892 | 80949 | 80949 |
| 36 | 883 | 2164 | 4032 | 22617 | 19486 | 29807 | 78106 | 78106 |
| 37 | 447 | 1096 | 2041 | 11449 | 9864 | 15090 | 39540 | 39540 |
| 38 | 409 | 1003 | 1868 | 10479 | 9028 | 13810 | 36188 | 36188 |
| 39 | 398 | 976 | 1818 | 10196 | 8785 | 13438 | 35213 | 35213 |
| 40 | 511 | 1252 | 2333 | 13085 | 11273 | 17245 | 45187 | 45187 |
| 41 | 196 | 481 | 896 | 5023 | 4328 | 6620 | 17348 | 17348 |
| 42 | 716 | 1754 | 3268 | 18333 | 15795 | 24162 | 63312 | 63312 |
| 43 | 1012 | 2481 | 4622 | 25923 | 22334 | 34165 | 89525 | 89525 |
| 44 | 451 | 1105 | 2058 | 11545 | 9947 | 15216 | 39871 | 39871 |
| 45 | 405 | 993 | 1849 | 10374 | 8938 | 13672 | 35826 | 35826 |
| 46 | 2079 | 5095 | 9492 | 53244 | 45873 | 70173 | 183877 | 183877 |
| 47 | 1364 | 3343 | 6228 | 34932 | 30096 | 46038 | 120635 | 120635 |
| 48 | 513 | 1258 | 2343 | 13142 | 11322 | 17320 | 45384 | 45384 |
| 49 | 68 | 167 | 312 | 1750 | 1508 | 2306 | 6043 | 6043 |
| 50 | 1855 | 4545 | 8467 | 47495 | 40920 | 62595 | 164022 | 164022 |
| | | … | **...** | **...** | **...** | **...** | **...** | **...** |
| 510 | 1907 | 4674 | 8707 | 48841 | 42079 | 64369 | 168670 | 168670 |
| 511 | 1561 | 3826 | 7129 | 39985 | 34450 | 52698 | 138088 | 138088 |
| 512 | 451 | 1106 | 2061 | 11559 | 9958 | 15234 | 39917 | 39917 |
| 513 | 1150 | 2819 | 5251 | 29456 | 25378 | 38822 | 101726 | 101726 |
| 514 | 3285 | 8049 | 14995 | 84113 | 72468 | 110855 | 290480 | 290480 |
| **Total** | **544121** | **1333321** | **2484103** | **13933851** | **12004860** | **18363959** | **48120095** | **48120095** |

Table 9.3.7: Estimated and Forecasted Truck By TAZ
for 1995, 2000, 2030 of Lower, Middle, and Upper Bound

| TAZ | Truck1995 | Truck2000 | Truck2030L | Truck2030 | Truck2030U |
|---|---|---|---|---|---|
| 1 | 11 | 201 | 150 | 219 | 290 |
| 2 | 64 | 2030 | 1747 | 2544 | 3366 |
| 3 | 41 | 96 | 90 | 131 | 174 |
| 4 | 24 | 39 | 38 | 56 | 74 |
| 5 | 0 | 0 | 0 | 0 | |
| 6 | 27 | 125 | 105 | 152 | 202 |
| 7 | 41 | 17 | 33 | 49 | 64 |
| 8 | 53 | 35 | 54 | 79 | 104 |
| 9 | 30 | 223 | 206 | 299 | 396 |
| 10 | 4 | 12 | 12 | 18 | 23 |
| 11 | 225 | 973 | 838 | 1221 | 1615 |
| 12 | 858 | 108 | 102 | 148 | 196 |
| 13 | 1037 | 3231 | 3048 | 4437 | 5871 |
| 14 | 53 | 99 | 89 | 129 | 171 |
| 15 | 33 | 57 | 47 | 69 | 91 |
| 16 | 224 | 368 | 280 | 407 | 539 |
| 17 | 654 | 476 | 435 | 633 | 837 |
| 18 | 466 | 428 | 403 | 587 | 777 |
| 19 | 775 | 685 | 690 | 1005 | 1330 |
| 20 | 134 | 307 | 263 | 383 | 507 |
| 21 | 138 | 216 | 176 | 257 | 340 |
| 22 | 29 | 81 | 84 | 122 | 162 |
| 23 | 322 | 268 | 286 | 416 | 551 |
| 24 | 143 | 230 | 243 | 353 | 468 |
| 25 | 350 | 655 | 677 | 986 | 1304 |
| 26 | 231 | 377 | 380 | 553 | 732 |
| 27 | 35 | 7 | 8 | 12 | 15 |
| 28 | 149 | 80 | 339 | 494 | 653 |
| 29 | 185 | 428 | 373 | 543 | 718 |
| 30 | 350 | 358 | 396 | 577 | 764 |
| 31 | 64 | 20 | 21 | 30 | 40 |
| 32 | 9 | 31 | 27 | 40 | 53 |
| 33 | 67 | 96 | 99 | 144 | 191 |
| 34 | 13 | 0 | 0 | 1 | 1 |
| 35 | 126 | 239 | 475 | 692 | 915 |
| 36 | 37 | 70 | 458 | 667 | 883 |
| 37 | 52 | 112 | 232 | 338 | 447 |
| 38 | 138 | 207 | 212 | 309 | 409 |
| 39 | 123 | 209 | 207 | 301 | 398 |
| 40 | 186 | 329 | 265 | 386 | 511 |
| 41 | 23 | 64 | 102 | 148 | 196 |
| 42 | 108 | 186 | 372 | 541 | 716 |
| 43 | 205 | 526 | 526 | 765 | 1012 |
| 44 | 67 | 206 | 234 | 341 | 451 |
| 45 | 59 | 130 | 210 | 306 | 405 |
| 46 | 301 | 700 | 1079 | 1571 | 2079 |
| 47 | 117 | 205 | 708 | 1031 | 1364 |
| 48 | 147 | 278 | 266 | 388 | 513 |
| 49 | 23 | 44 | 35 | 52 | 68 |
| 50 | 75 | 318 | 963 | 1402 | 1855 |
| | | **...** | | **...** | |
| 510 | | 882 | 990 | 1441 | 1907 |
| 511 | | 926 | 811 | 1180 | 1561 |
| 512 | | 267 | 234 | 341 | 451 |
| 513 | | 386 | 597 | 869 | 1150 |
| 514 | | 1819 | 1705 | 2482 | 3285 |
| **Total** | 134331 | **289857** | **282462** | **411221** | **544121** |

## 9.4 TAZ Flow Distribution and Assignment Results

The TAZs, highways, and urban arterials, and centroids used in distribution and assignment are shown in the following map. There are 514 TAZs, a couple of which had zeros cross-the-board for both base-year and forecast year attributes (i.e., TAZ#5). The centorids were generated using TAZ geometric shape. Since the freight inside Tulsa was assumed primarily carried out by highway mode (inter-state highway, state highway, and urban arterials), the results below are for the highway only and for the middle bound case for 2030.

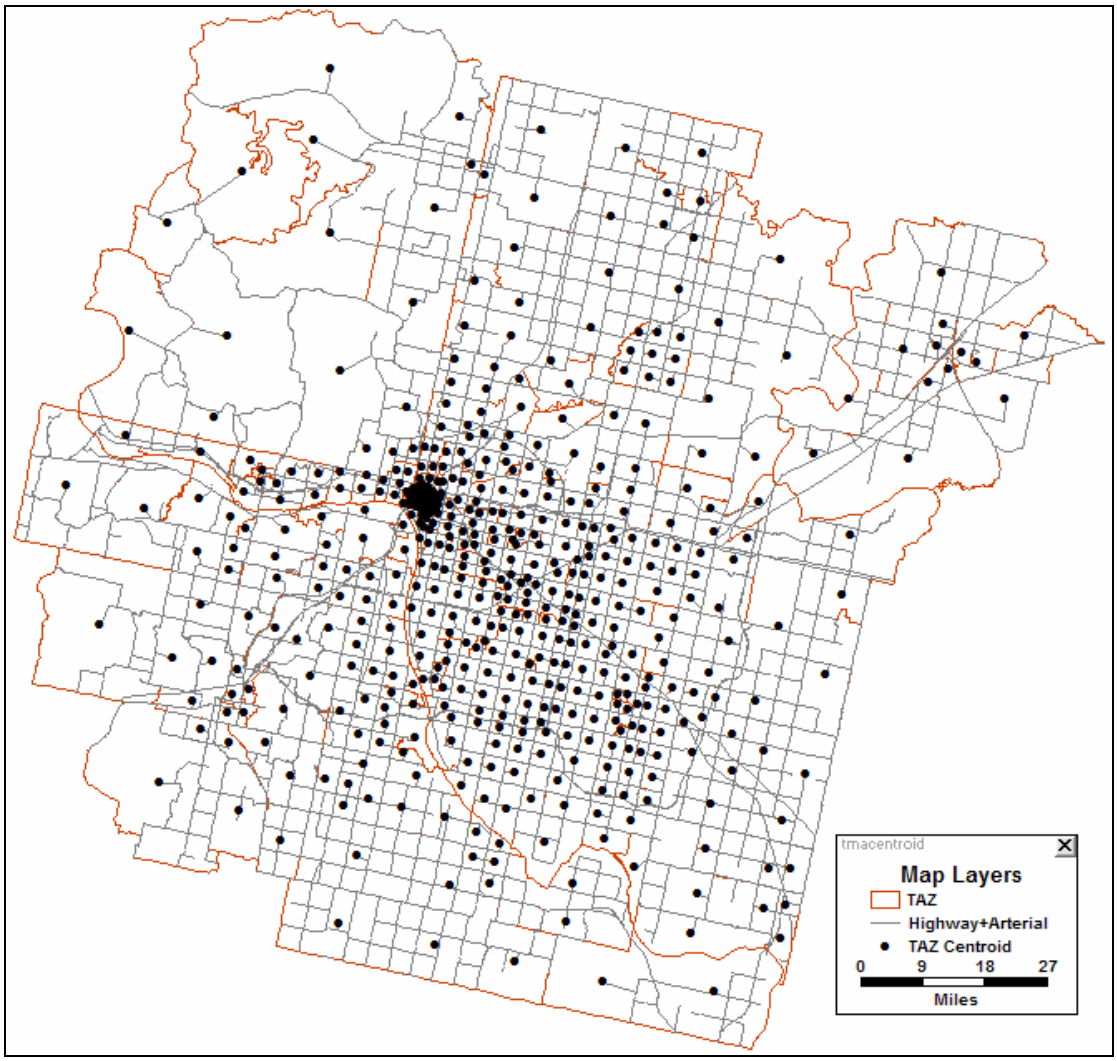
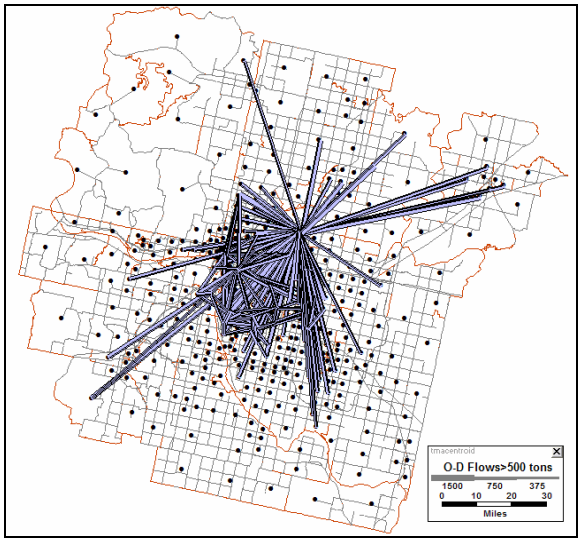



Figure 9.4.1: Tulsa TMA TAZs, Centroids, Highway and Arterials

The top O-D flows and their distributions of the 4 commodity groups are visually shown below:



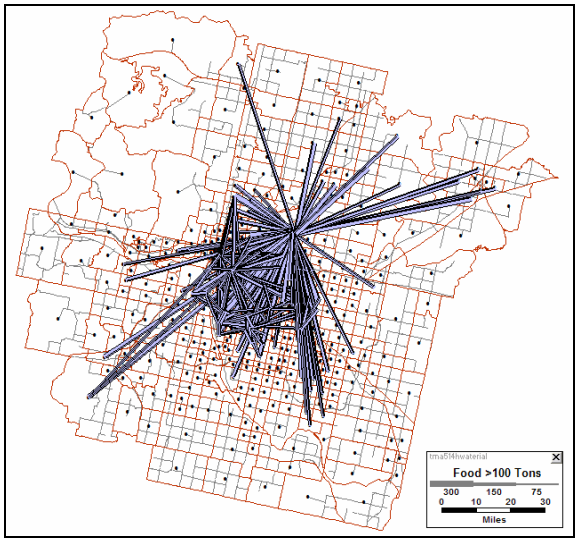
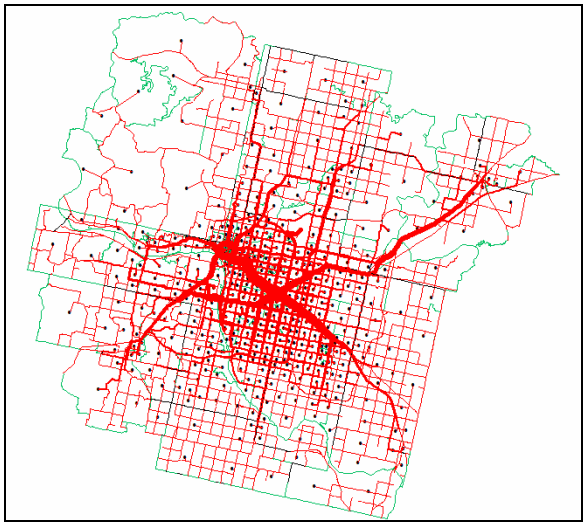




Figure 9.4.2: Manu. Product Flows >500 Tons Figure 9.4.3: Food Flows > 100 tons



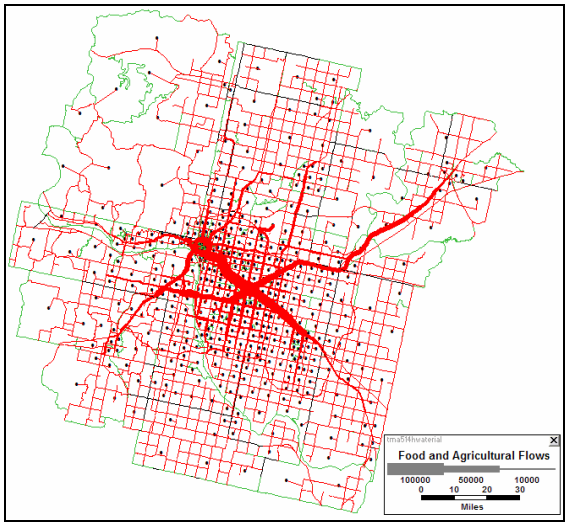
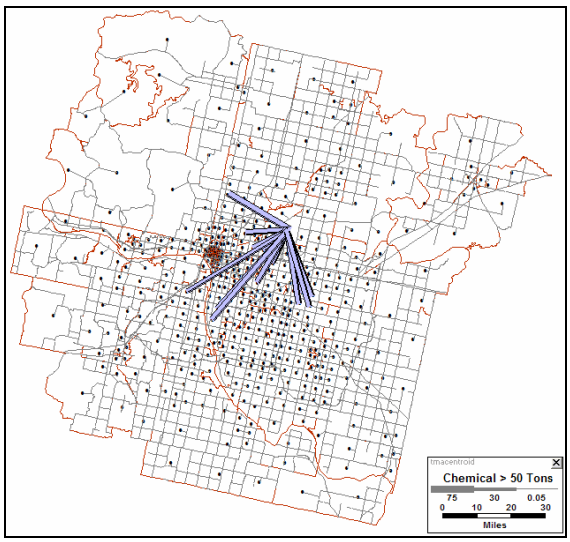



Figure 9.4.4: Manu Product Flows by Street Figure 9.4.5: Food Product Flows by Street



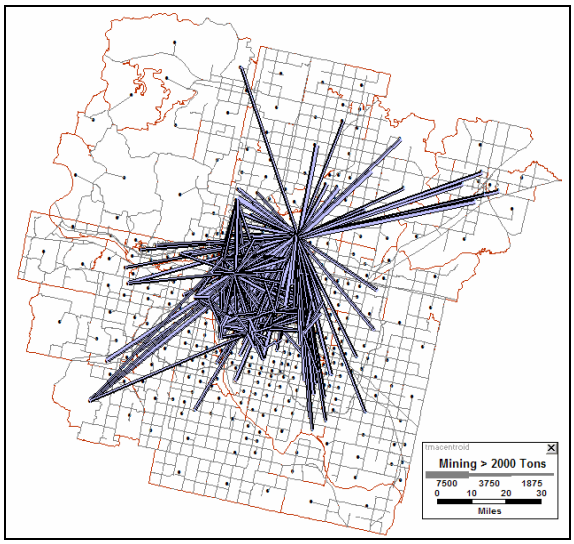
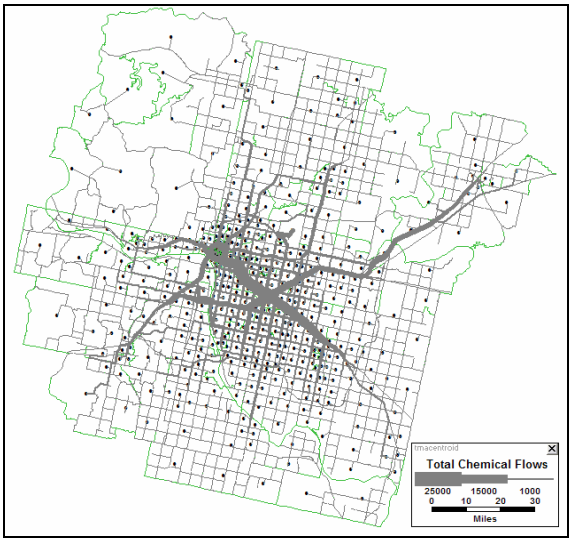




Figure 9.4.6: Chemicals >50 tons

Figure 9.4.7: Mining > 2000 tons



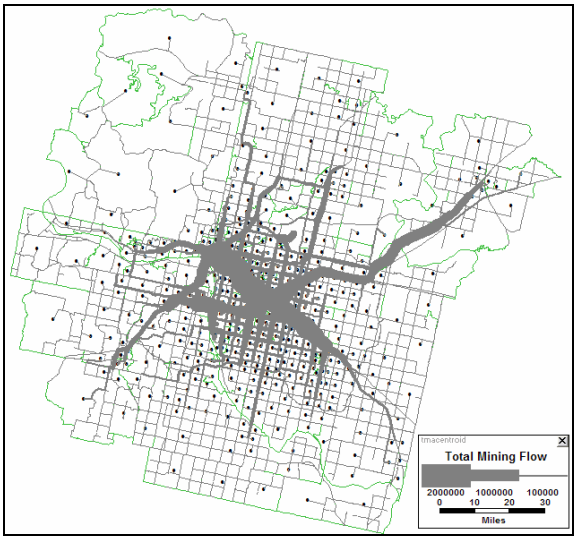




Figure 9.4.8: Chemicals  Flows by Street

Figure 9.4.9: Mining  Flows by Street

The top O-D flows and their distributions on streets of all commodities are visual shown below:

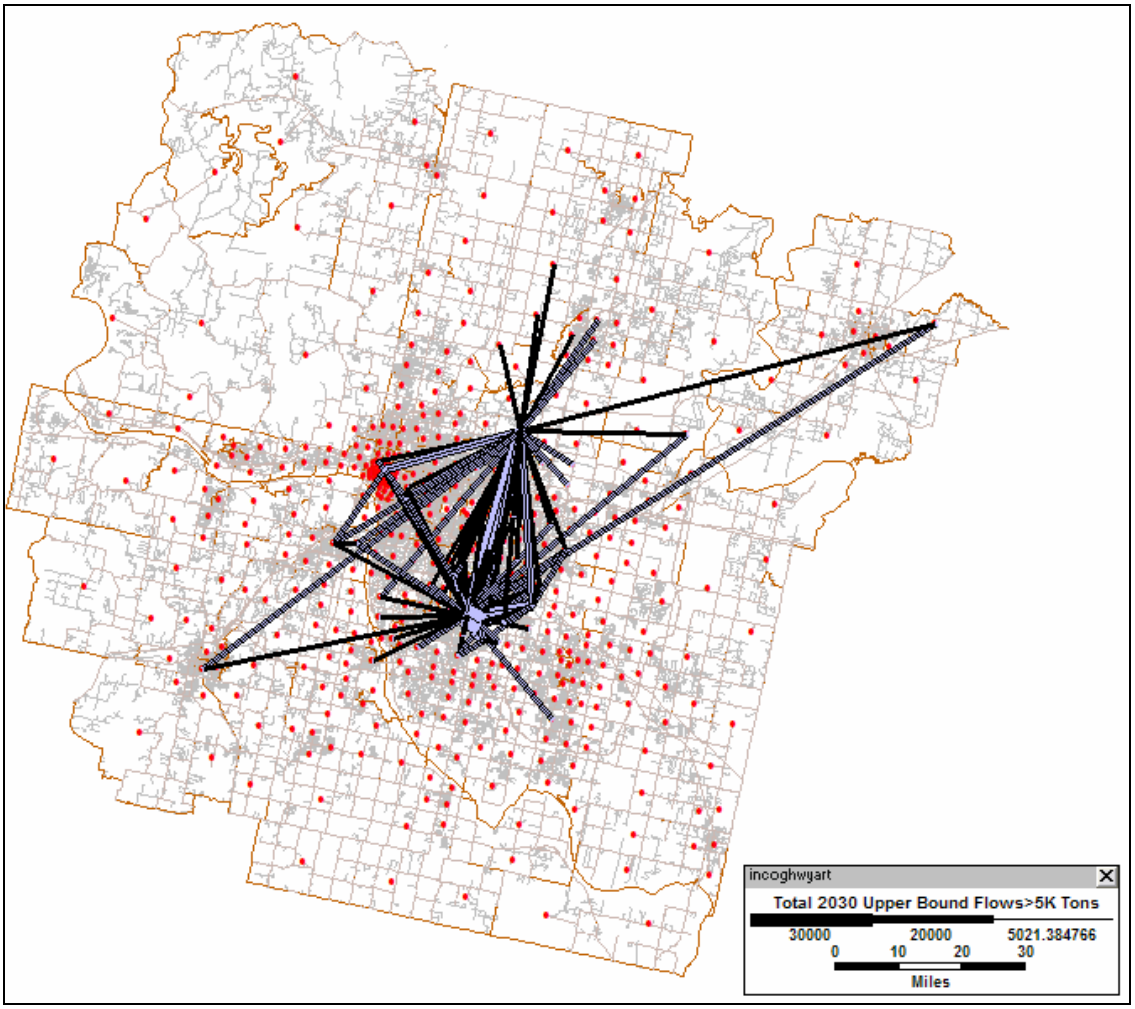
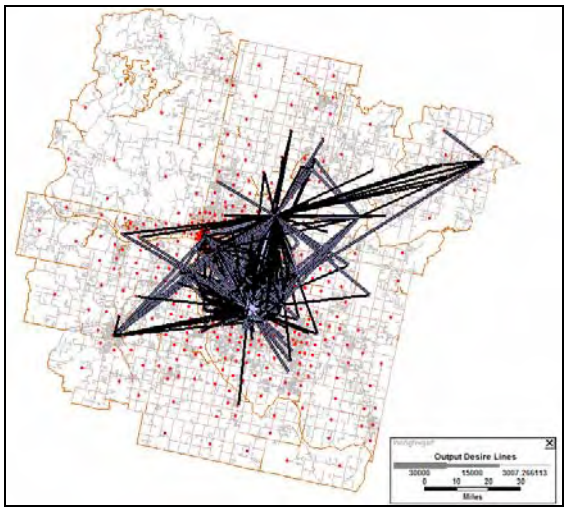



Figure 9.4.10: In-Tulsa Total 2030 Commodity Flows Over 5000 Tons, Middle Bound



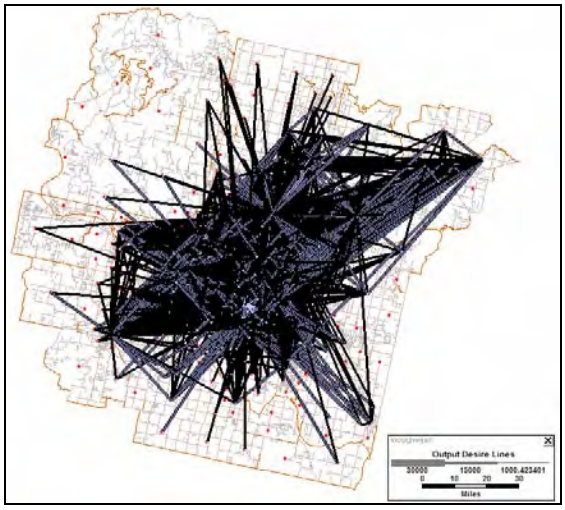




Fig. 9.4.11: In-Tulsa Total Flows > 3K Tons Fig. 9.4.12: In-Tulsa Total Flows > 1K Tons

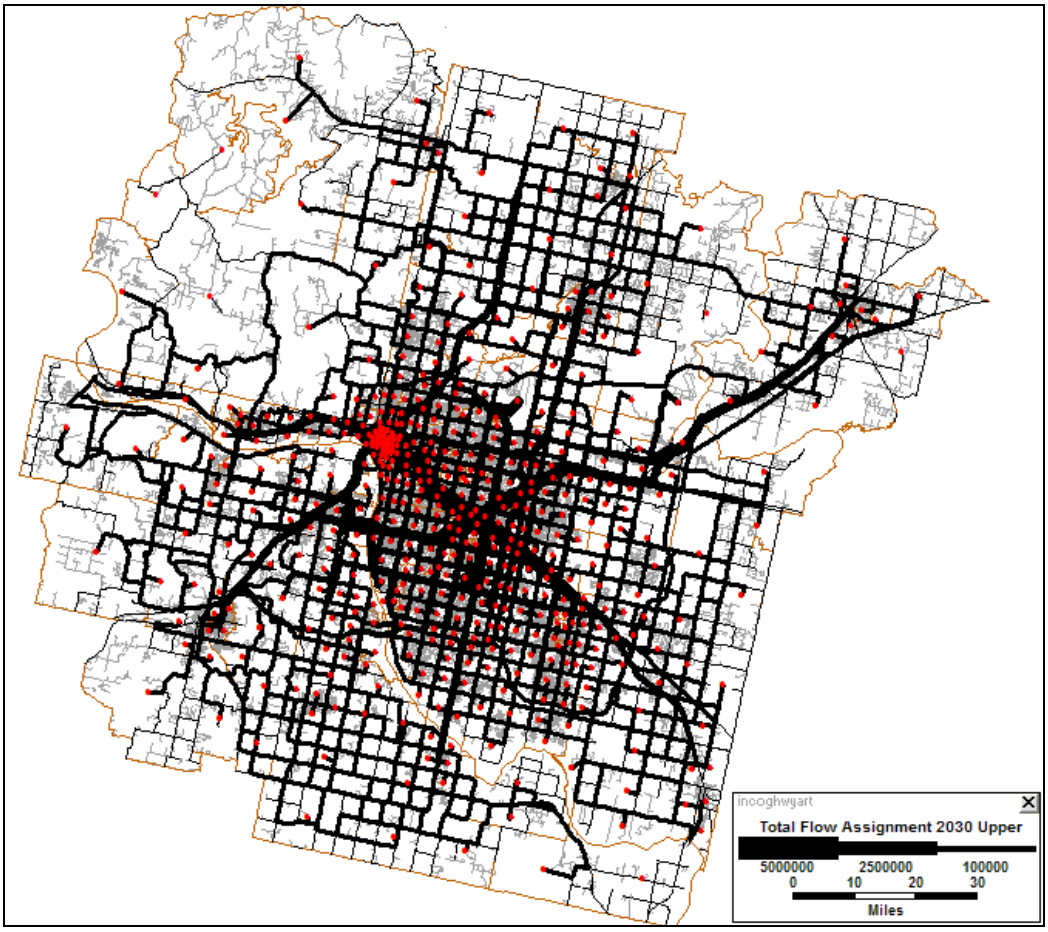



Figure 9.4.13: Total 2030 Commodity Flows by Street in Tulsa TMA, Middle Bound

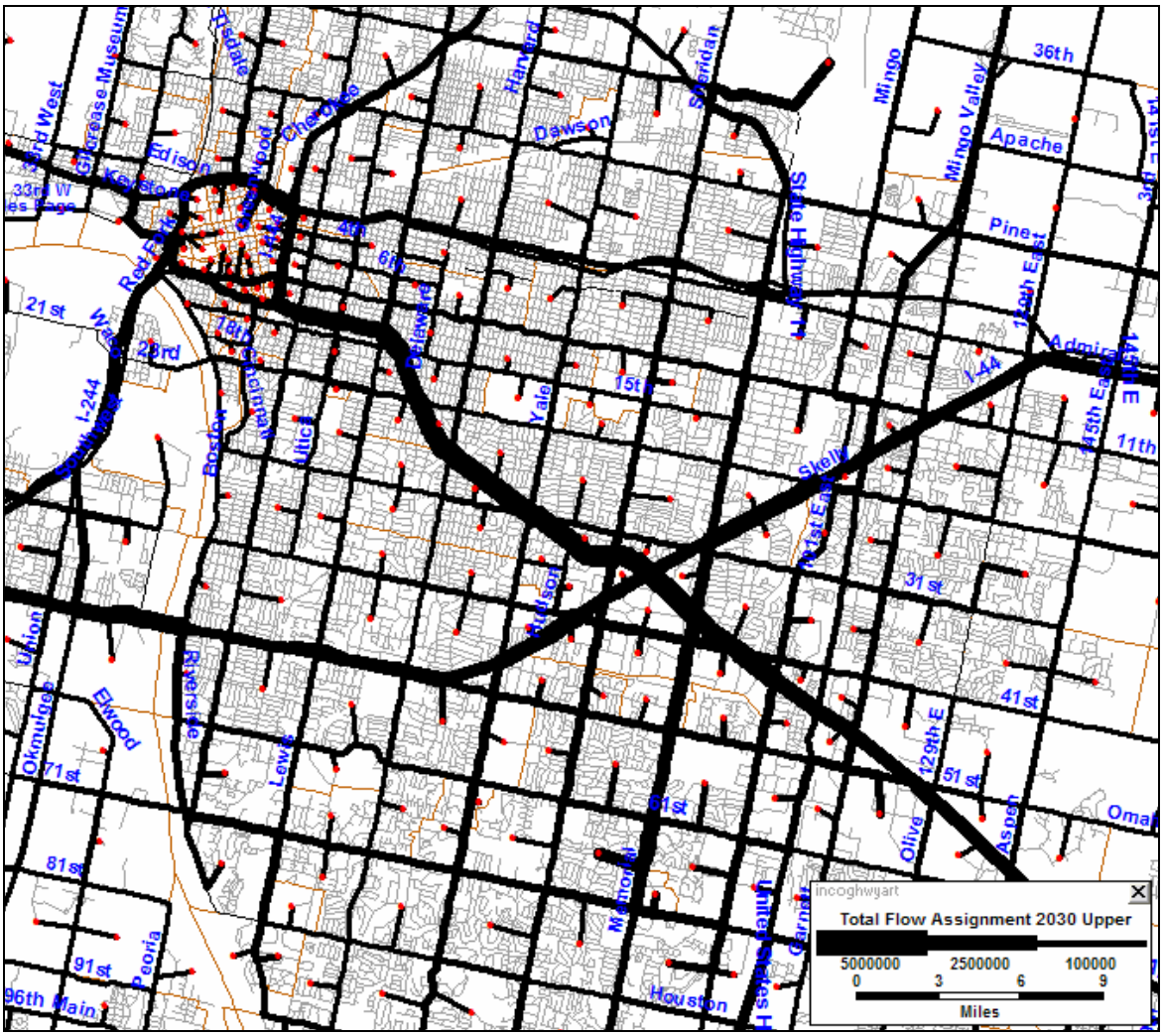



Figure 9.4.14: A Close-Up View of Total 2030 Commodity Flows
by Street in Tulsa TMA, Middle Bound

Table 9.4.1: 2030 Forecasted Total Upper Bound Flows (‘000s) on Top Streets in Tulsa TMA

| Street | Min | Max | Mean |
|---|---|---|---|
| Broken Arrow | 9715 | 4618475 | 434574 |
| I-44 | 21363 | 4018902 | 451040 |
| I-244 | 18690 | 3367338 | 432088 |
| Red Fork | 1185 | 3109425 | 369057 |
| Memorial | 167 | 3041669 | 359692 |
| State Highway 66 | 169158 | 2207120 | 609400 |
| Admiral | 354 | 2591584 | 348729 |
| Cherokee | 54624 | 2103218 | 461908 |
| Apache | 6033 | 2071145 | 358630 |
| Mingo | 581 | 2068569 | 334177 |
| US Highway 64 | 1091 | 1894611 | 340379 |

Table 9.4.2: 2030 Forecasted Total Middle Bound Flows (‘000s) on Top Streets in Tulsa TMA

| Street | Min | Max | Mean |
|---|---|---|---|
| Broken Arrow | 7342 | 3490426 | 328430 |
| I-44 | 16145 | 3037298 | 341365 |
| I-244 | 14125 | 2544875 | 326583 |
| Red Fork | 896 | 2349957 | 278940 |
| Memorial | 127 | 2298750 | 286255 |
| State Highway 66 | 127841 | 1668037 | 460778 |

| | | | |
|---|---|---|---|
| Admiral | 267 | 1958597 | 263576 |
| Cherokee | 41282 | 1589513 | 348829 |
| Apache | 4560 | 1565273 | 275462 |
| Mingo | 439 | 1563326 | 252577 |
| US Highway 64 | 825 | 1431857 | 257242 |

Table 9.4.3: 2030 Forecasted Total Lower Bound Flows (‘000s) on Top Streets in Tulsa TMA

| Street | Min | Max | Mean |
|---|---|---|---|
| Broken Arrow | 5043 | 2397528 | 225594 |
| I-44 | 11090 | 2086280 | 234142 |
| I-244 | 9702 | 1748044 | 224304 |
| Red Fork | 615 | 1614156 | 191584 |
| Memorial | 87 | 1578979 | 186722 |
| State Highway 66 | 87812 | 1145752 | 316350 |
| Admiral | 184 | 1345333 | 181031 |
| Cherokee | 28356 | 1091817 | 239784 |
| Apache | 3132 | 1075165 | 186171 |
| Mingo | 302 | 1073828 | 173477 |
| US Highway 64 | 566 | 983524 | 171110 |

## 10. TULSA PORT OF CATOOSA

### 10.1 Location

Located at the head of navigation for the McClellan-Kerr Arkansas River Navigation System (MKARNS) in Northeast Oklahoma, the Tulsa Port of Catoosa offers year round, ice-free barge service with river flow levels controlled by the U.S. Army Corps of Engineers. And with worldwide access capabilities, commodities can travel easily and efficiently from America's heartland to the rest of the globe. In fact, the Port is just one day’s drive from Chicago, Dallas, Denver, Houston, Memphis, New Orleans, Omaha and St. Louis, and with major highways like the east/west I-44 and I-40 corridors and the north/south I-35 "NAFTA" corridor.

The Tulsa Port of Catoosa is one of the largest, most inland river-ports in the United States. The Port is a 2,000-acre industrial park and multi-modal shipping complex. 50 companies located here employing over 2,500 people in manufacturing, distribution, and

processing of products ranging from agricultural commodities to manufactured consumer goods.

Port of Catoosa offers many shipping options, through its public and private terminals, including grain, dry bulk, break bulk, and bulk liquids. Over the past decade, the port handled around 2.2 million tons of cargo each year by barge, rail, and truck.

## 10.2 Port Facilities

The Tulsa Port of Catoosa has five public terminal areas, each fully equipped and staffed to efficiently transfer inbound and outbound cargos between barges, trucks and rail cars. The assets of these terminals, with the exception of the liquid bulk facilities, are owned by the Tulsa Port of Catoosa but are maintained and operated by independent contractors that have lease agreements with the Port Authority. The liquid bulk companies are private and own their own facilities.

**General Dry Cargo Dock -** The general dry cargo dock primarily loads and unloads commodity iron and steel, project cargo and other break bulk material. Operated by Tuloma Stevedoring, Inc., it is a public dock, 720 feet long, with a 230-foot wide concrete apron, equipped with an assortment of forklifts and cranes, including a 200 ton overhead traveling bridge crane.

**The Roll-on/Roll-off Low Water Wharf** - is a public dock operated by the Port Authority for transferring over-dimensional or over-weight project cargo such as giant processing equipment used in refineries. The wharf is 180 feet long with a 50-foot wide concrete apron and embedded railroad tracks. The dock is connected to a concrete road with a gentle 3.2 percent slope. Loads exceeding 600 tons can be driven directly onto to off of giant ocean-rated flat-deck barges using rail cars, trucks or wheeled transporters. .

**Dry Bulk Terminal –** The Port's dry bulk terminal is a public terminal operated by Catoosa Fertilizer Co. A wide range of dry bulk commodities, from fertilizer to pig iron, can easily be transferred between modes of transportation. Inbound and outbound systems can load or unload up to 400 tons per hour. Covered storage is available for 80,000 tons of material and open storage for 50,000 tons. The terminal is equipped with two pedestal cranes and an outbound loading conveyance system. Unit train transfers are also possible.

**Grain Terminal -** The grain handling facility is a public grain terminal operated by Peavey Company, a division of ConAgra. The facility includes an outbound conveyance system with a 25,000-bushel per hour capacity, an inbound unloading system with a 30,000 bushel per hour capacity, a grain sampler, dust control system, and approximately 4.5 million bushel storage capacity. Grain grading is also available on-site. The major product handled at this terminal is outbound hard red winter wheat, but inbound or outbound

soybeans, oats, milo and millet can also be handled. Grain barges can be loaded in as little as 2.5 hours.

**Bulk Liquids Terminal** - Many types of bulk liquids, including chemicals, asphalt, refined petroleum products and molasses are transferred and stored at seven private terminals at the Port. These terminals should be contacted directly for information regarding the types of materials they handle and quotes for shipping, loading and unloading

The Tulsa Port of Catoosa is an inland multi-modal shipping complex. Each day products are moved through the Port using barge, rail, and truck - often in combination.

**River Barges -** For bulk and break-bulk cargo, barge shipping is best for shipments in excess of 1,500 short tons (30,000 cwt, the capacity of a standard hopper barge) or increments thereof. Both origin and destination points must be barge capable since multiple shifts between modes will erode savings. Freight arrangements are typically made through barge lines that provide the barges and contract with third parties for river towing. Transit times on the U.S. Inland waterway system average 100 miles per day.

## 10.3 Inter-Modality

**Trucking -** The Port is served by most of the nationwide contract carriers and averages over 450 trucks per day. Truck shipments are usually “next-day” requirements and average 20 short tons (400 cwt). Most truck shipments are to or from bulk storage at the Port’s terminals or for plants in the general industrial park.

**Railroads -** Rail shipping is ideal for most bulk and break-bulk cargo in average units of 100 short tons (2,000 cwt). Most of the national rail network is privately owned by the “Class I” operators. The Port is served by both of the remaining Western Class I Carriers, the BN-SF (direct) and the U.P. via a short-line switch on the K.O. line. The K.O. is a Class III with an extensive network in both Kansas and Oklahoma. Rail service is usually booked with the origin carrier who typically provides the cars. The Port is a scheduled service point for all three carriers. Rail transit times for most bulk and break-bulk cargo are roughly equal to barge within 750 miles and are days shorter beyond 1000 miles.

**Airlines -** Adding to the Tulsa Port of Catoosa's accessibility is the Tulsa International Airport. Just seven miles from the Port, this large, modern airport is served by major passenger carriers such as American, Continental, Delta and Southwest, and cargo carriers including FedEx, UPS and Airborne.

**Containers -** World-wide, containerized shipping is the wave of the future. A sealed container can be shipped around the world on a single bill of lading eliminating redundant documentation and pilferage during inspections.

**Foreign Trade Zone 53 -** A Foreign Trade Zone (FTZ) is a secured site within the United States where foreign imports and domestic merchandise are considered to be outside U.S. Customs territory. Goods in the zone remain in international commerce as long as they are held within the zone or until they are exported.

## 10.4 Commodity Flows at the Port

1997 was a record year for tonnage shipped on the MKARNS--12,043,140 tons were shipped on the system. This edged out the previous high of 11,712,885 tons in 1996.

Commodities shipped in 1996 included: 1,178,168 tons of chemical fertilizer; 512,632 tons of farm products; 4,295,994 tons of sand/gravel & rock; 902,831 tons of iron & steel; 399,797 tons of petroleum products; 1,286,500 tons of wheat; and 772,324 tons of soybeans

The 12,043,140 tons shipped on the Waterway in 1997 are equivalent (in tons) to: 8029 barges, 120,435 railroad cars, or 481,740 trucks.

Table 10.1: Port of Catoosa total freight flow by year (in tons) from 1994-2004

| YEAR | TOTAL FLOW THROUGH PORT OF CATOOSA( IN TONS) |
|---|---|
| 1994 | 1,944,263 |
| 1995 | 1,581,424 |
| 1996 | 1,961,197 |
| 1997 | 2,160,948 |
| 1998 | 2,417,537 |
| 1999 | 2,242,850 |
| 2000 | 2,210,061 |
| 2001 | 2,046,692 |
| 2002 | 2,223,103 |
| 2003 | 2,250,139 |
| 2004 | 2,220,871 |

Source: Tulsaport.com

Table 10.2: Total Flows by Commodity Group for The Base Year and Predicted Year 2030

| Commodity Groups | Total Flow Thru Port Of Catoosa For The Base Year ( In'000 Tons) | Total Flow Thru Port Of Catoosa For The Projected Year 2030 ( In '000 Tons) |
|---|---|---|
| Total | 1983.31 | 2593 |
| Chemical | 85.94 | 111 |
| Food | 225.55 | 270 |
| Manufacturing | 107.78 | 178 |
| Mining | 1287.11 | 1540 |
| Other | 276.93 | 493 |

## APPENDIX 1

### Freight Production

We assume that the freight originated (or produced) in a region (i.e., state or MSA) primarily depends on the region's freight related supply capability (business and production). In general, freight flow production = *f*(business and production information), or mathematically it can be rewritten as:

$$o_{in} = a_n^0 + \sum_{l=1} a_n^l x_{in}^l + e_{in} \qquad (1)$$

where: $i$ = 1, 2, …, region index (i.e., Tulsa); $n$ = 1, 2,…, commodity index (i.e., agriculture, construction, electronics); $l$ = 1, 2,…, independent variable index; $a_n^l$ = coefficients of independent variables; $x_{in}^l$ = independent variables (i.e., employment, revenue in industry $n$ in region $i$); $o_{in}$ = freight origins of commodity $n$ in region $i$.

Once intercepts ($a_n^0$) and coefficients ($a_n^l$) are determined by the regression study using the base-year (i.e., 1997, 2000) data, other/future-year (e.g., 2030) business and production information (observed or forecasted) can be plugged into equation (2) to estimate other/future year's freight production.

$$O_{in} = a_n^0 + \sum_{l=1} a_n^l X_{in}^l \qquad (2)$$

Note the difference between $o_{in}$, $x_{in}^l$ and $O_{in}$, $X_{in}^l$. Here, the lower cases represent base-year dependent and independent variables and the upper case for future-year dependent and independent variables.

In this project, we directly used 1997 CFS production flows. Oklahoma data was broken down into productions for Tulsa TMA and Oklahoma Other based on Tulsa's share of total employment of Oklahoma. For the 2030 forecast, we first used the 1997 CFS at the state-level to establish regression relations between production and employment using (1), then (2) was used to predict the 2030 production for all states, including Tulsa TMA.

## APPENDIX 2

### Freight Attraction

We assume that the freight attracted (or destined) to a region depends primarily on the region's level of demand (population and business consumption). In general, freight attraction = *g*(population and business consumption), or mathematically it can be rewritten as:

$$d_{jn} = b_n^0 + \sum_{q=1} b_n^q y_{jn}^q + e_{jn} \qquad (3)$$

where: $j$ = 1, 2,…., region index; $q$ = 1, 2,…., independent variables; $b_n^q$ = coefficients of independent variables; $y_{jn}^q$ = independent variables (i.e., household income, population) in region $j$; $d_{jn}$ = freight origins of commodity $n$ in region $j$.

Once intercepts ($b_n^0$) and coefficients ($b_n^q$) are determined by regression using the base-year data, a future-year's (i.e., 2030) demographic and business information can be plugged into equation (4) to estimate future-year's freight attraction.

$$D_{jn} = b_n^0 + \sum_{q=1} b_n^q Y_{jn}^q \qquad (4)$$

Again, note the difference between $d_{jn}$, $y_{jn}^q$ and $D_{jn}$, $Y_{jn}^q$. Here, the lower cases represent base-year dependent and independent variables and the upper cases represent future-year dependent and independent variables. Note that in (3)-(4), modes are considered altogether. If $n$ = 5 commodity groups based on 2-digit Standard Classification of Transportation Goods (SCTG) codes, then 5 regression runs are needed for freight production and attraction, respectively.

In this project, we directly used 1997 CFS attraction flows. Oklahoma data was broken down into attractions for Tulsa TMA and Oklahoma Other based on Tulsa's share of total Oklahoma employment and total 1997 production. For the 2030 forecast, we first used the 1997 CFS at the state-level to establish regression relations between production and employment using (1) in Appendix 1, then (2) in Appendix was used to predict the 2030 production for all states, including Tulsa TMA. Finally, the projected 2030 production and population were used to forecast the 2030 attraction.

## APPENDIX 3

### Doubly Constrained Gravity Model

The doubly constrained gravity model has been used for distribution purposes and also utilized impedance functions regarding the determination of the relationships between the states.

$$T_{ij} = P_i \cdot \frac{A_j \cdot f(d_{ij})}{\sum_{all.zones.z} A_z \cdot f(d_{iz})}$$ (constrained to productions)

$$T_{ij} = A_j \cdot \frac{P_i \cdot f(d_{ij})}{\sum_{allzones.z} P_z \cdot f(d_{zj})}$$ (constrained to attractions)

with

$$\sum P_i = \sum A_j$$

and

$$f(d_{ij}) = d_{ij}^{-b}, b > 0$$

where:

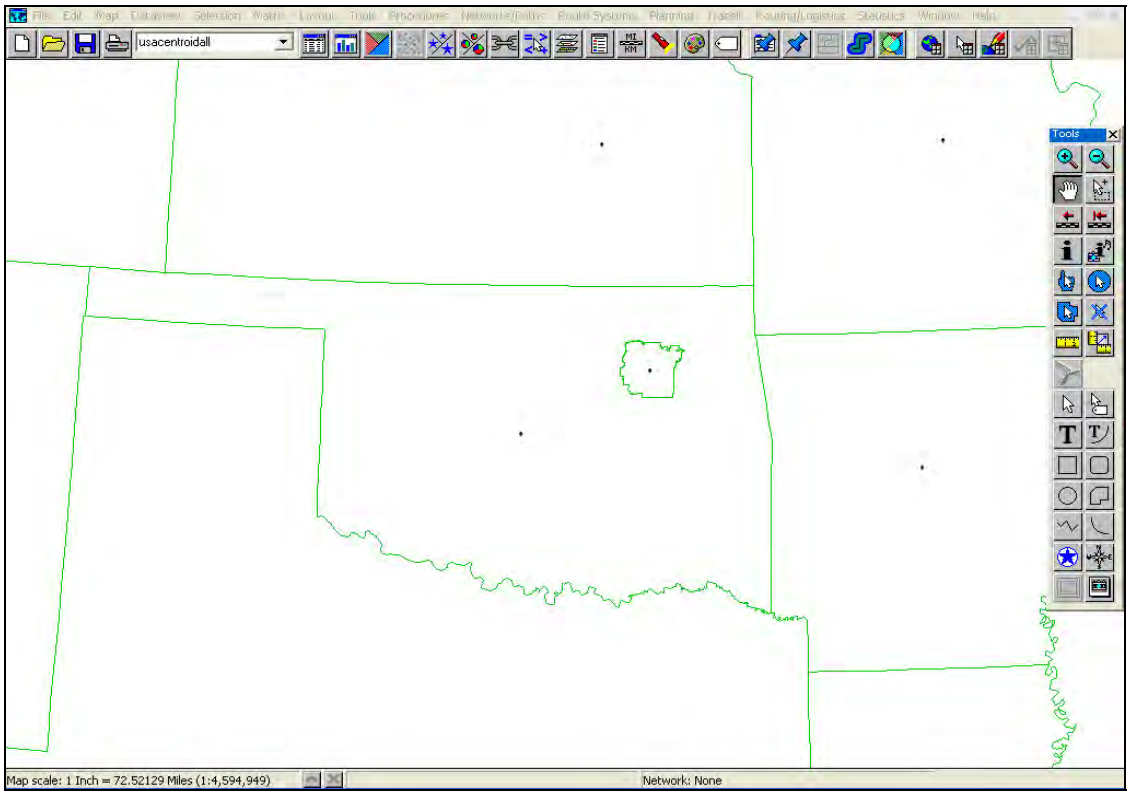
**$T_{ij}$:** the forecast flow produced by i zone and attracted to zone j for middle level total flows.
**Pi:** the number of trips produced by (or originating in) each zone for middle level total flows.
**Aj:** the number of trips attracted to (or terminating in) each zone for middle level total flows.
**dij:** the impedance between each pair of zones as the distance between each states.
**f(dij):** inverse function value as a friction factor between each pair of zones

## APPENDIX 4

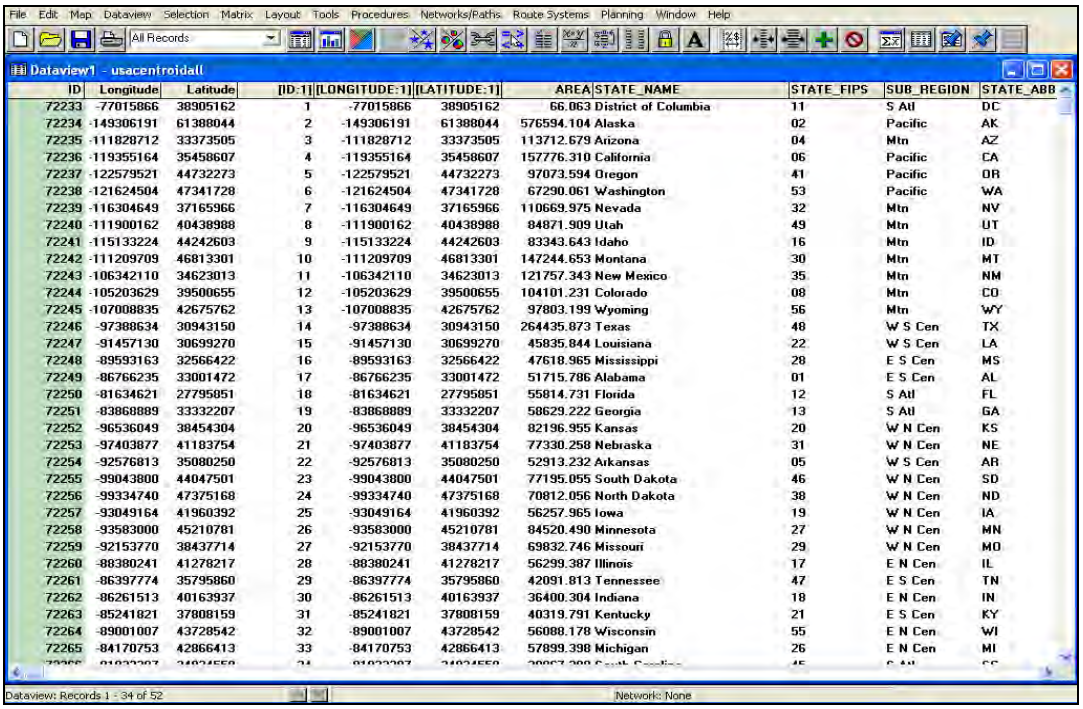
### Illustration Of Gravity Model Application With TransCAD

In this section we illustrate step by step how TransCAD uses the doubly constrained gravity model for freight distribution.

**Step 1:** Open the zone layer which is a map showing all the centroids and linkages between these centroids. The map displayed is as shown in the figure below with Oklahoma zone zoomed format:




**Step 2:** Open the stored database for every state, which is available in TransCAD by clicking new data view button under the toolbar.



File Edit Map Dataview Selection Matrix Layout Tools Procedures Networks/Paths Route Systems Planning Window Help

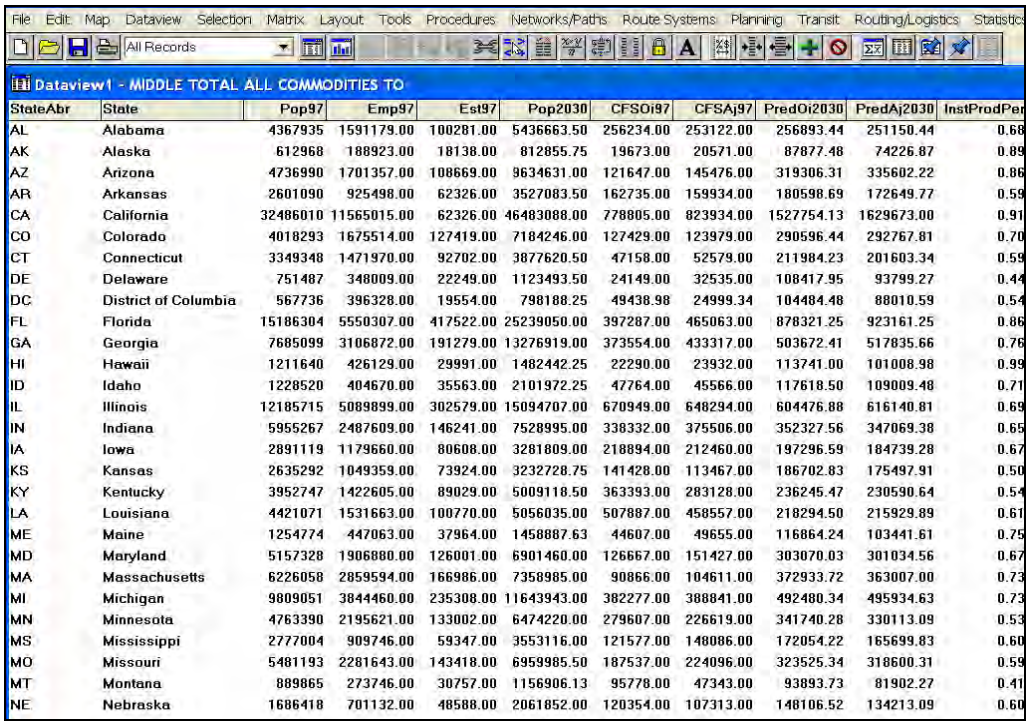
All Records

Dataview1 - usacentroidall

| ID | Longitude | Latitude | [ID:1] | [LONGITUDE:1] | [LATITUDE:1] | AREA | STATE_NAME | STATE_FIPS | SUB_REGION | STATE_ABB |
|---|---|---|---|---|---|---|---|---|---|---|
| 72233 | -77015866 | 38905162 | 1 | -77015866 | 38905162 | 66.063 | District of Columbia | 11 | S Atl | DC |
| 72234 | -149306191 | 61388044 | 2 | -149306191 | 61388044 | 576594.104 | Alaska | 02 | Pacific | AK |
| 72235 | -111828712 | 33373505 | 3 | -111828712 | 33373505 | 113712.679 | Arizona | 04 | Mtn | AZ |
| 72236 | -119355164 | 35458607 | 4 | -119355164 | 35458607 | 157776.310 | California | 06 | Pacific | CA |
| 72237 | -122579521 | 44732273 | 5 | -122579521 | 44732273 | 97073.594 | Oregon | 41 | Pacific | OR |
| 72238 | -121624504 | 47341728 | 6 | -121624504 | 47341728 | 67290.061 | Washington | 53 | Pacific | WA |
| 72239 | -116304649 | 37165966 | 7 | -116304649 | 37165966 | 110669.975 | Nevada | 32 | Mtn | NV |
| 72240 | -111900162 | 40438988 | 8 | -111900162 | 40438988 | 84871.909 | Utah | 49 | Mtn | UT |
| 72241 | -115133224 | 44242603 | 9 | -115133224 | 44242603 | 83343.643 | Idaho | 16 | Mtn | ID |
| 72242 | -111209709 | 46813301 | 10 | -111209709 | 46813301 | 147244.653 | Montana | 30 | Mtn | MT |
| 72243 | -106342110 | 34623013 | 11 | -106342110 | 34623013 | 121757.343 | New Mexico | 35 | Mtn | NM |
| 72244 | -105203629 | 39500655 | 12 | -105203629 | 39500655 | 104101.231 | Colorado | 08 | Mtn | CO |
| 72245 | -107008835 | 42675762 | 13 | -107008835 | 42675762 | 97803.199 | Wyoming | 56 | Mtn | WY |
| 72246 | -97388634 | 30943150 | 14 | -97388634 | 30943150 | 264435.873 | Texas | 48 | W S Cen | TX |
| 72247 | -91457130 | 30699270 | 15 | -91457130 | 30699270 | 45835.844 | Louisiana | 22 | W S Cen | LA |
| 72248 | -89593163 | 32566422 | 16 | -89593163 | 32566422 | 47618.965 | Mississippi | 28 | E S Cen | MS |
| 72249 | -86766235 | 33001472 | 17 | -86766235 | 33001472 | 51715.786 | Alabama | 01 | E S Cen | AL |
| 72250 | -81634621 | 27795851 | 18 | -81634621 | 27795851 | 55814.731 | Florida | 12 | S Atl | FL |
| 72251 | -83868889 | 33332207 | 19 | -83868889 | 33332207 | 58629.222 | Georgia | 13 | S Atl | GA |
| 72252 | -96536049 | 38454304 | 20 | -96536049 | 38454304 | 82196.955 | Kansas | 20 | W N Cen | KS |
| 72253 | -97403877 | 41183754 | 21 | -97403877 | 41183754 | 77330.258 | Nebraska | 31 | W N Cen | NE |
| 72254 | -92576813 | 35080250 | 22 | -92576813 | 35080250 | 52913.232 | Arkansas | 05 | W S Cen | AR |
| 72255 | -99043800 | 44047501 | 23 | -99043800 | 44047501 | 77195.055 | South Dakota | 46 | W N Cen | SD |
| 72256 | -99334740 | 47375168 | 24 | -99334740 | 47375168 | 70812.056 | North Dakota | 38 | W N Cen | ND |
| 72257 | -93049164 | 41960392 | 25 | -93049164 | 41960392 | 56257.965 | Iowa | 19 | W N Cen | IA |
| 72258 | -93583000 | 45210781 | 26 | -93583000 | 45210781 | 84520.490 | Minnesota | 27 | W N Cen | MN |
| 72259 | -92153770 | 38437714 | 27 | -92153770 | 38437714 | 69832.746 | Missouri | 29 | W N Cen | MO |
| 72260 | -88380241 | 41278217 | 28 | -88380241 | 41278217 | 56299.387 | Illinois | 17 | E N Cen | IL |
| 72261 | -86397774 | 35795860 | 29 | -86397774 | 35795860 | 42091.813 | Tennessee | 47 | E S Cen | TN |
| 72262 | -86261513 | 40163937 | 30 | -86261513 | 40163937 | 36400.304 | Indiana | 18 | E N Cen | IN |
| 72263 | -85241821 | 37808159 | 31 | -85241821 | 37808159 | 40319.791 | Kentucky | 21 | E S Cen | KY |
| 72264 | -89001007 | 43728542 | 32 | -89001007 | 43728542 | 56088.178 | Wisconsin | 55 | E N Cen | WI |
| 72265 | -84170753 | 42866413 | 33 | -84170753 | 42866413 | 57899.398 | Michigan | 26 | E N Cen | MI |

Dataview: Records 1 - 34 of 52 Network: None

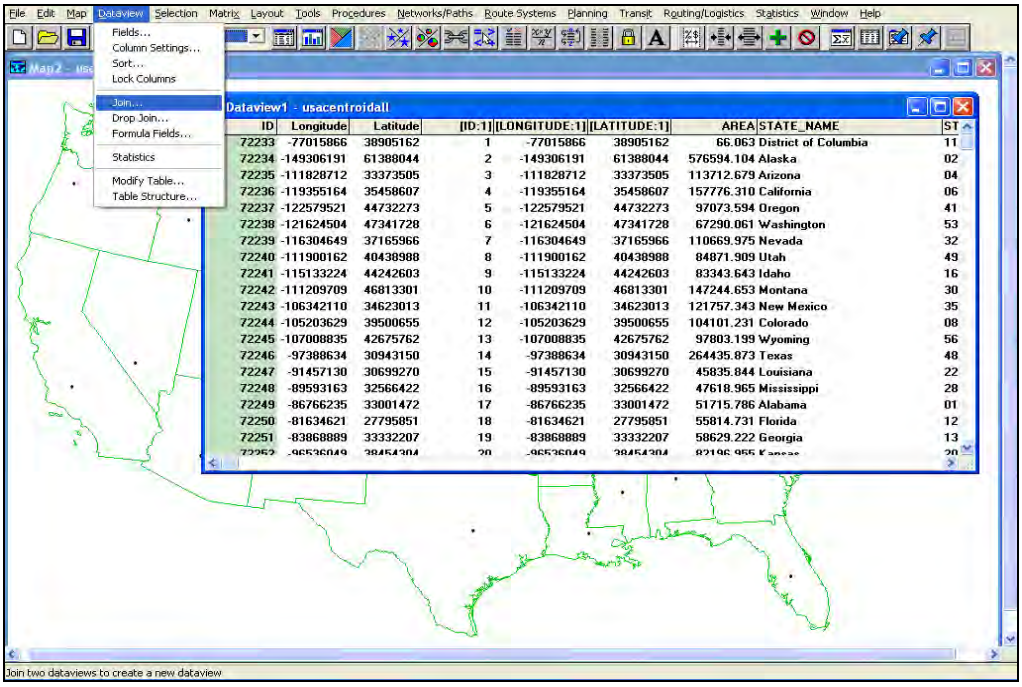
**<u>Step 3</u>**: Open the database for the specific commodity which includes the predicted production and attraction values in the same format by going to **file-open** and then select the appropriate file to transfer to TransCAD.

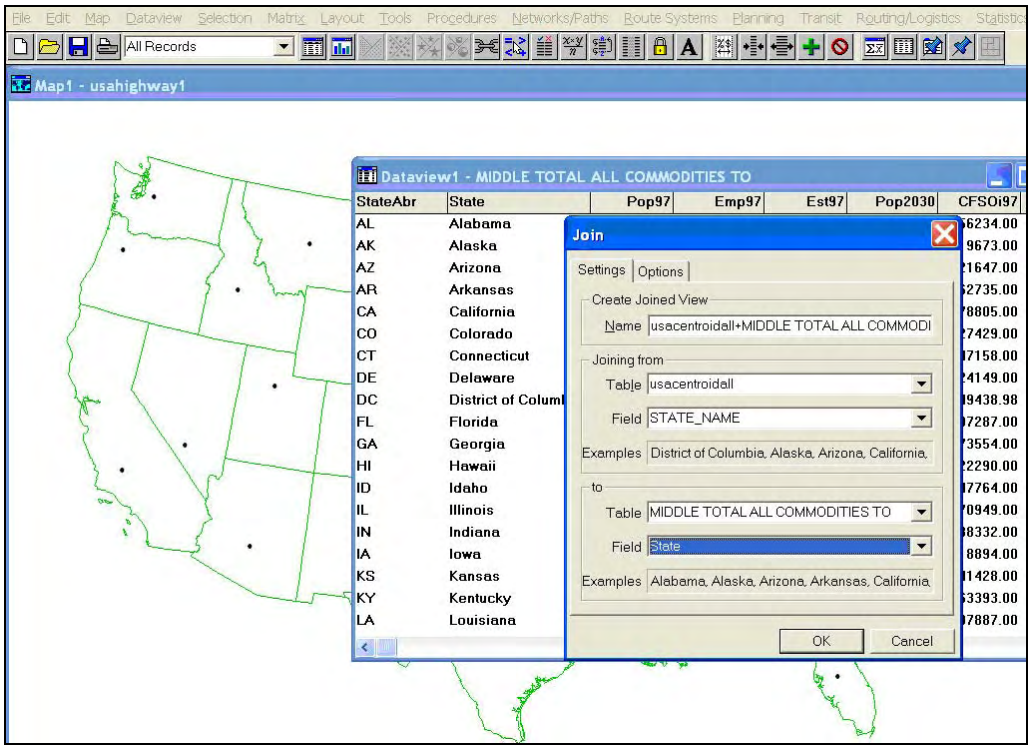


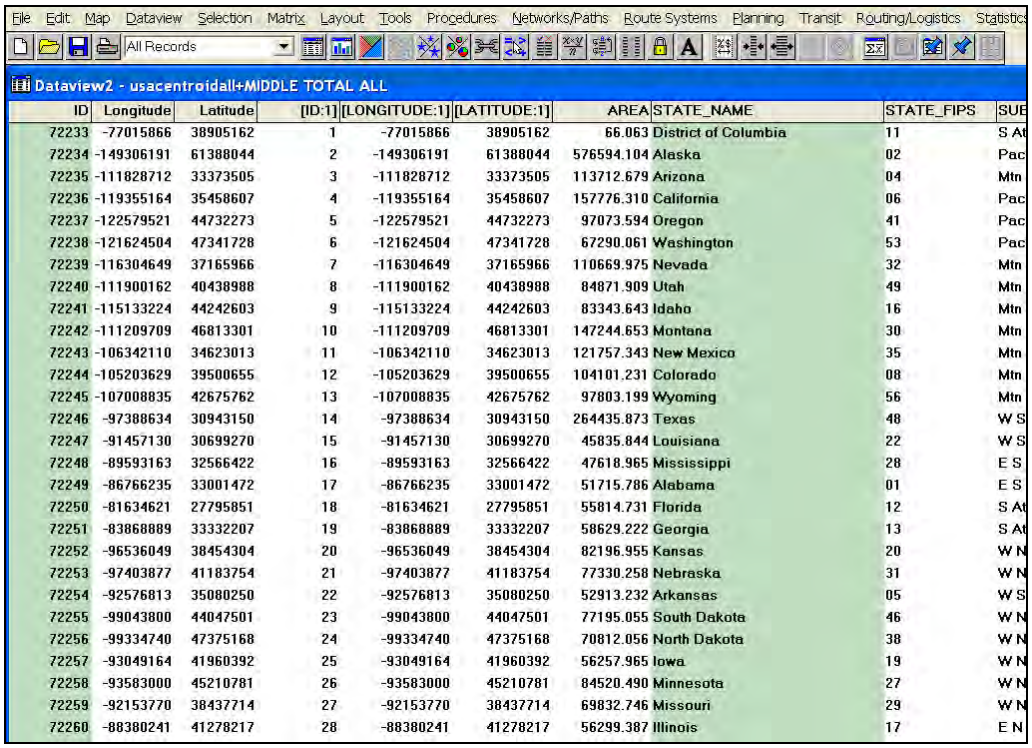
Dataview1 - MIDDLE TOTAL ALL COMMODITIES TO

| StateAbr | State | Pop97 | Emp97 | Est97 | Pop2030 | CFSOi97 | CFSAj97 | PredOi2030 | PredAj2030 | InstProdPer |
|---|---|---|---|---|---|---|---|---|---|---|
| AL | Alabama | 4367935 | 1591179.00 | 100281.00 | 5436663.50 | 256234.00 | 253122.00 | 256893.44 | 251150.44 | 0.68 |
| AK | Alaska | 612968 | 188923.00 | 18138.00 | 812855.75 | 19673.00 | 20571.00 | 87877.48 | 74226.87 | 0.89 |
| AZ | Arizona | 4736990 | 1701357.00 | 108669.00 | 9634631.00 | 121647.00 | 145476.00 | 319306.31 | 335602.22 | 0.86 |
| AR | Arkansas | 2601090 | 925498.00 | 62326.00 | 3527083.50 | 162735.00 | 159934.00 | 180598.69 | 172649.77 | 0.59 |
| CA | California | 32486010 | 11565015.00 | 62326.00 | 46483088.00 | 778805.00 | 823934.00 | 1527754.13 | 1629673.00 | 0.91 |
| CO | Colorado | 4018293 | 1675514.00 | 127419.00 | 7184246.00 | 127429.00 | 123979.00 | 290596.44 | 292767.81 | 0.70 |
| CT | Connecticut | 3349348 | 1471970.00 | 92702.00 | 3877620.50 | 47158.00 | 52579.00 | 211984.23 | 201603.34 | 0.59 |
| DE | Delaware | 751487 | 348009.00 | 22249.00 | 1123493.50 | 24149.00 | 32535.00 | 108417.95 | 93799.27 | 0.44 |
| DC | District of Columbia | 567736 | 396328.00 | 19554.00 | 798188.25 | 49438.98 | 24999.34 | 104484.48 | 88010.59 | 0.54 |
| FL | Florida | 15186304 | 5550307.00 | 417522.00 | 25239050.00 | 397287.00 | 465063.00 | 878321.25 | 923161.25 | 0.86 |
| GA | Georgia | 7685099 | 3106872.00 | 191279.00 | 13276919.00 | 373554.00 | 433317.00 | 503672.41 | 517835.66 | 0.76 |
| HI | Hawaii | 1211640 | 426129.00 | 29991.00 | 1482442.25 | 22290.00 | 23932.00 | 113741.00 | 101008.98 | 0.99 |
| ID | Idaho | 1228520 | 404670.00 | 35563.00 | 2101972.25 | 47764.00 | 45566.00 | 117618.50 | 109009.48 | 0.71 |
| IL | Illinois | 12185715 | 5089899.00 | 302579.00 | 15094707.00 | 670949.00 | 648294.00 | 604476.88 | 616140.81 | 0.69 |
| IN | Indiana | 5955267 | 2487609.00 | 146241.00 | 7528995.00 | 338332.00 | 375506.00 | 352327.56 | 347069.38 | 0.65 |
| IA | Iowa | 2891119 | 1179660.00 | 80608.00 | 3281809.00 | 218894.00 | 212460.00 | 197296.59 | 184739.28 | 0.67 |
| KS | Kansas | 2635292 | 1049359.00 | 73924.00 | 3232728.75 | 141428.00 | 113467.00 | 186702.83 | 175497.91 | 0.50 |
| KY | Kentucky | 3952747 | 1422605.00 | 89029.00 | 5009118.50 | 363393.00 | 283128.00 | 236245.47 | 230590.64 | 0.54 |
| LA | Louisiana | 4421071 | 1531663.00 | 100770.00 | 5056035.00 | 507887.00 | 458557.00 | 218294.50 | 215929.89 | 0.61 |
| ME | Maine | 1254774 | 447063.00 | 37964.00 | 1458887.63 | 44607.00 | 49655.00 | 116864.24 | 103441.61 | 0.75 |
| MD | Maryland | 5157328 | 1906880.00 | 126001.00 | 6901460.00 | 126667.00 | 151427.00 | 303070.03 | 301034.56 | 0.67 |
| MA | Massachusetts | 6226058 | 2859594.00 | 166986.00 | 7358985.00 | 90866.00 | 104611.00 | 372933.72 | 363007.00 | 0.73 |
| MI | Michigan | 9809051 | 3844460.00 | 235308.00 | 11643943.00 | 382277.00 | 388841.00 | 492480.34 | 495934.63 | 0.73 |
| MN | Minnesota | 4763390 | 2195621.00 | 133002.00 | 6474220.00 | 279607.00 | 226619.00 | 341740.28 | 330113.09 | 0.53 |
| MS | Mississippi | 2777004 | 909746.00 | 59347.00 | 3553116.00 | 121577.00 | 148086.00 | 172054.22 | 165699.83 | 0.60 |
| MO | Missouri | 5481193 | 2281643.00 | 143418.00 | 6959985.50 | 187537.00 | 224096.00 | 323525.34 | 318600.31 | 0.59 |
| MT | Montana | 889865 | 273746.00 | 30757.00 | 1156906.13 | 95778.00 | 47343.00 | 93893.73 | 81902.27 | 0.41 |
| NE | Nebraska | 1686418 | 701132.00 | 48588.00 | 2061852.00 | 120354.00 | 107313.00 | 148106.52 | 134213.09 | 0.60 |

**<u>Step 4:</u>** Join the production and attraction data tables with zone layer database table in TransCAD by performing **Dataview-Join** and making the appropriate file name selections.



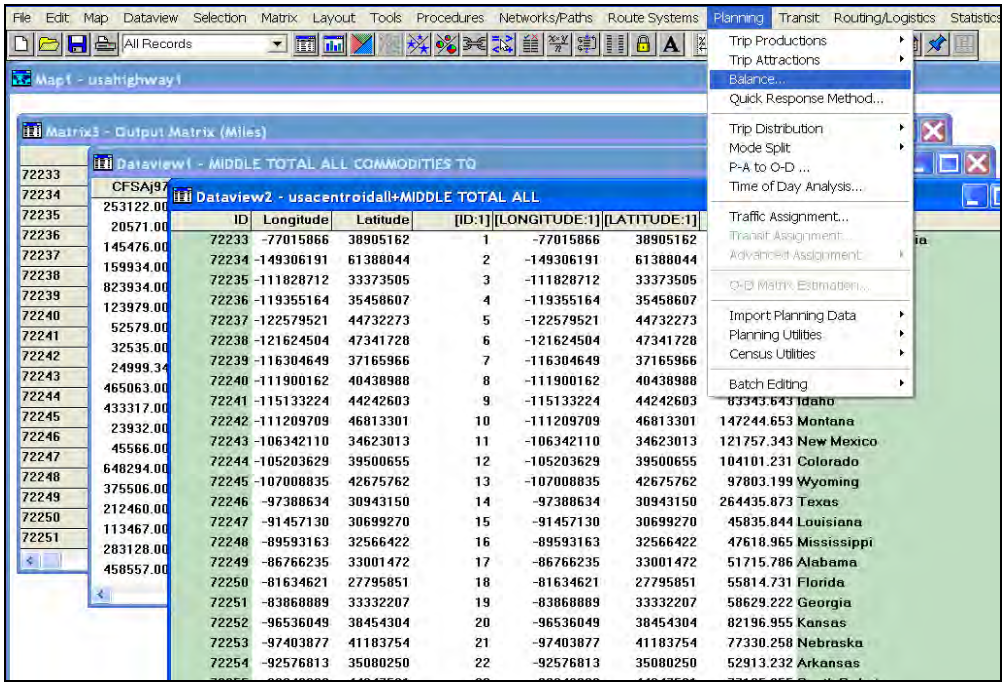


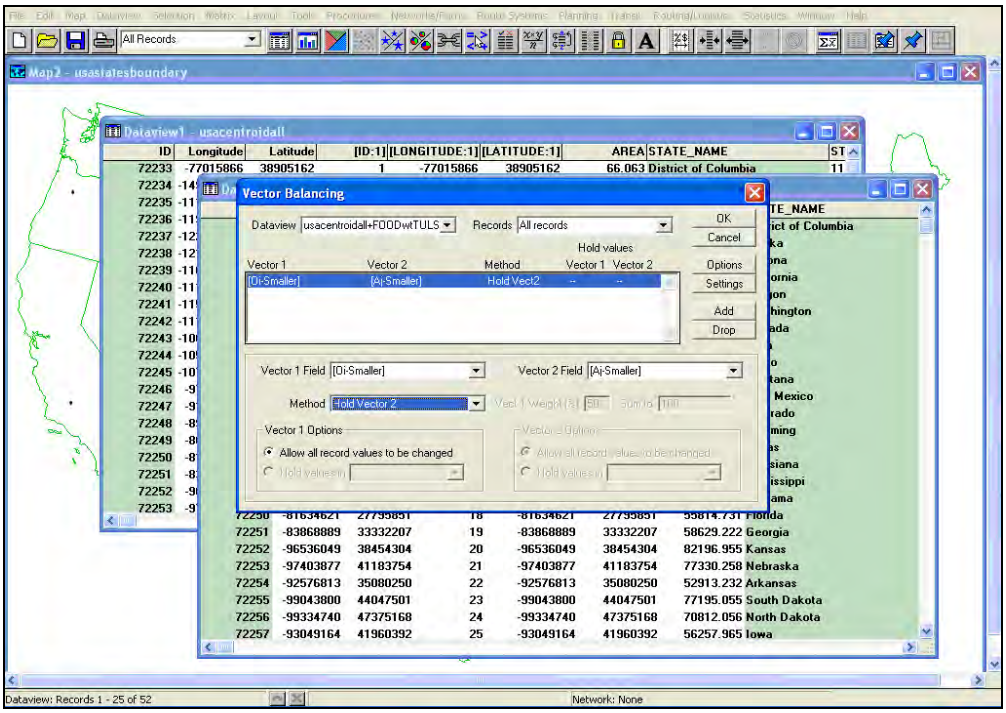



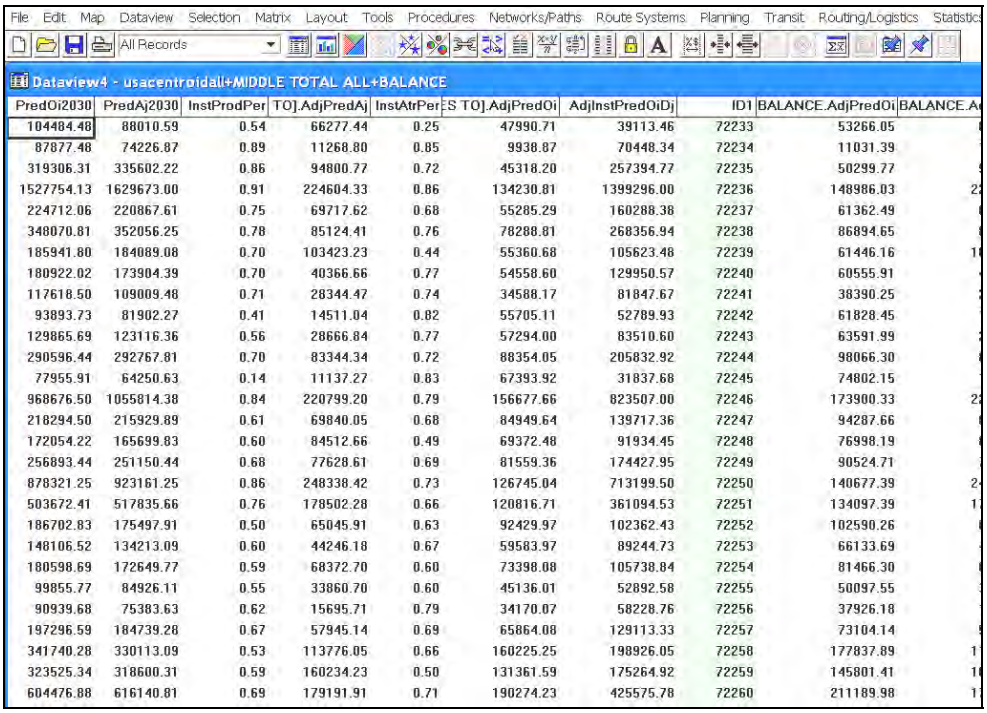

| ID | Longitude | Latitude | [ID:1] | [LONGITUDE:1] | [LATITUDE:1] | AREA | STATE_NAME | STATE_FIPS | SUE |
|---|---|---|---|---|---|---|---|---|---|
| 72233 | -77015866 | 38905162 | 1 | -77015866 | 38905162 | 66.063 | District of Columbia | 11 | S At |
| 72234 | -149306191 | 61388044 | 2 | -149306191 | 61388044 | 576594.104 | Alaska | 02 | Pac |
| 72235 | -111828712 | 33373505 | 3 | -111828712 | 33373505 | 113712.679 | Arizona | 04 | Mtn |
| 72236 | -119355164 | 35458607 | 4 | -119355164 | 35458607 | 157776.310 | California | 06 | Pac |
| 72237 | -122579521 | 44732273 | 5 | -122579521 | 44732273 | 97073.594 | Oregon | 41 | Pac |
| 72238 | -121624504 | 47341728 | 6 | -121624504 | 47341728 | 67290.061 | Washington | 53 | Pac |
| 72239 | -116304649 | 37165966 | 7 | -116304649 | 37165966 | 110669.975 | Nevada | 32 | Mtn |
| 72240 | -111900162 | 40438988 | 8 | -111900162 | 40438988 | 84871.909 | Utah | 49 | Mtn |
| 72241 | -115133224 | 44242603 | 9 | -115133224 | 44242603 | 83343.643 | Idaho | 16 | Mtn |
| 72242 | -111209709 | 46813301 | 10 | -111209709 | 46813301 | 147244.653 | Montana | 30 | Mtn |
| 72243 | -106342110 | 34623013 | 11 | -106342110 | 34623013 | 121757.343 | New Mexico | 35 | Mtn |
| 72244 | -105203629 | 39500655 | 12 | -105203629 | 39500655 | 104101.231 | Colorado | 08 | Mtn |
| 72245 | -107008835 | 42675762 | 13 | -107008835 | 42675762 | 97803.199 | Wyoming | 56 | Mtn |
| 72246 | -97388634 | 30943150 | 14 | -97388634 | 30943150 | 264435.873 | Texas | 48 | W S |
| 72247 | -91457130 | 30699270 | 15 | -91457130 | 30699270 | 45835.844 | Louisiana | 22 | W S |
| 72248 | -89593163 | 32566422 | 16 | -89593163 | 32566422 | 47618.965 | Mississippi | 28 | E S |
| 72249 | -86766235 | 33001472 | 17 | -86766235 | 33001472 | 51715.786 | Alabama | 01 | E S |
| 72250 | -81634621 | 27795851 | 18 | -81634621 | 27795851 | 55814.731 | Florida | 12 | S At |
| 72251 | -83868889 | 33332207 | 19 | -83868889 | 33332207 | 58629.222 | Georgia | 13 | S At |
| 72252 | -96536049 | 38454304 | 20 | -96536049 | 38454304 | 82196.955 | Kansas | 20 | W N |
| 72253 | -97403877 | 41183754 | 21 | -97403877 | 41183754 | 77330.258 | Nebraska | 31 | W N |
| 72254 | -92576813 | 35080250 | 22 | -92576813 | 35080250 | 52913.232 | Arkansas | 05 | W S |
| 72255 | -99043800 | 44047501 | 23 | -99043800 | 44047501 | 77195.055 | South Dakota | 46 | W N |
| 72256 | -99334740 | 47375168 | 24 | -99334740 | 47375168 | 70812.056 | North Dakota | 38 | W N |
| 72257 | -93049164 | 41960392 | 25 | -93049164 | 41960392 | 56257.965 | Iowa | 19 | W N |
| 72258 | -93583000 | 45210781 | 26 | -93583000 | 45210781 | 84520.490 | Minnesota | 27 | W N |
| 72259 | -92153770 | 38437714 | 27 | -92153770 | 38437714 | 69832.746 | Missouri | 29 | W N |
| 72260 | -88380241 | 41278217 | 28 | -88380241 | 41278217 | 56299.387 | Illinois | 17 | E N |

**Step 5:** Balance the predicted production and attraction values.

- Select planning tab on the top menu
- Select “balance” as shown in the figure below



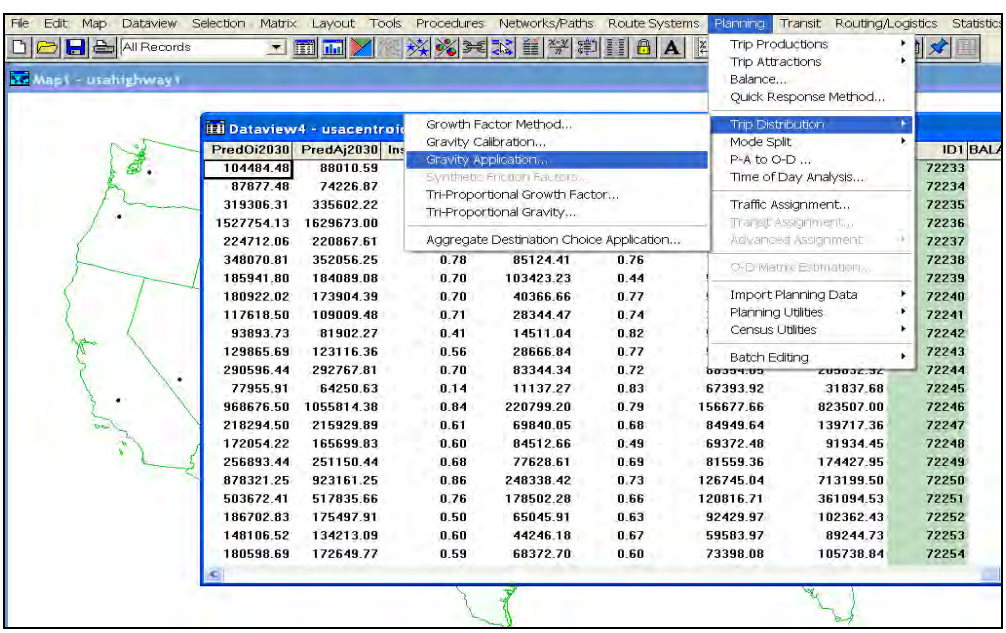


Dataview4 - usacentroidall+MIDDLE TOTAL ALL+BALANCE

| PredOi2030 | PredAj2030 | InstProdPer | TO].AdjPredAj | InstAtrPer | ES TO].AdjPredOi | AdjInstPredOiDj | ID1 | BALANCE.AdjPredOi | BALANCE.A |
|---|---|---|---|---|---|---|---|---|---|
| 104484.48 | 88010.59 | 0.54 | 66277.44 | 0.25 | 47990.71 | 39113.46 | 72233 | 53266.05 | |
| 87877.48 | 74226.87 | 0.89 | 11268.80 | 0.85 | 9938.87 | 70448.34 | 72234 | 11031.39 | |
| 319306.31 | 335602.22 | 0.86 | 94800.77 | 0.72 | 45318.20 | 257394.77 | 72235 | 50299.77 | |
| 1527754.13 | 1629673.00 | 0.91 | 224604.33 | 0.86 | 134230.81 | 1399296.00 | 72236 | 148986.03 | 2 |
| 224712.06 | 220867.61 | 0.75 | 69717.62 | 0.68 | 55285.29 | 160288.38 | 72237 | 61362.49 | |
| 348070.81 | 352056.25 | 0.78 | 85124.41 | 0.76 | 78288.81 | 268356.94 | 72238 | 86894.65 | |
| 185941.80 | 184089.08 | 0.70 | 103423.23 | 0.44 | 55360.68 | 105623.48 | 72239 | 61446.16 | 1 |
| 180922.02 | 173904.39 | 0.70 | 40366.66 | 0.77 | 54558.60 | 129950.57 | 72240 | 60555.91 | |
| 117618.50 | 109009.48 | 0.71 | 28344.47 | 0.74 | 34588.17 | 81847.67 | 72241 | 38390.25 | |
| 93893.73 | 81902.27 | 0.41 | 14511.04 | 0.82 | 55705.11 | 52789.93 | 72242 | 61828.45 | |
| 129865.69 | 123116.36 | 0.56 | 28666.84 | 0.77 | 57294.00 | 83510.60 | 72243 | 63591.99 | |
| 290596.44 | 292767.81 | 0.70 | 83344.34 | 0.72 | 88354.05 | 205832.92 | 72244 | 98066.30 | |
| 77955.91 | 64250.63 | 0.14 | 11137.27 | 0.83 | 67393.92 | 31837.68 | 72245 | 74802.15 | |
| 968676.50 | 1055814.38 | 0.84 | 220799.20 | 0.79 | 156677.66 | 823507.00 | 72246 | 173900.33 | 2 |
| 218294.50 | 215929.89 | 0.61 | 69840.05 | 0.68 | 84949.64 | 139717.36 | 72247 | 94287.66 | |
| 172054.22 | 165699.83 | 0.60 | 84512.66 | 0.49 | 69372.48 | 91934.45 | 72248 | 76998.19 | |
| 256893.44 | 251150.44 | 0.68 | 77628.61 | 0.69 | 81559.36 | 174427.95 | 72249 | 90524.71 | |
| 878321.25 | 923161.25 | 0.86 | 248338.42 | 0.73 | 126745.04 | 713199.50 | 72250 | 140677.39 | 2 |
| 503672.41 | 517835.66 | 0.76 | 178502.28 | 0.66 | 120816.71 | 361094.53 | 72251 | 134097.39 | 1 |
| 186702.83 | 175497.91 | 0.50 | 65045.91 | 0.63 | 92429.97 | 102362.43 | 72252 | 102590.26 | |
| 148106.52 | 134213.09 | 0.60 | 44246.18 | 0.67 | 59583.97 | 89244.73 | 72253 | 66133.69 | |
| 180598.69 | 172649.77 | 0.59 | 68372.70 | 0.60 | 73398.08 | 105738.84 | 72254 | 81466.30 | |
| 99855.77 | 84926.11 | 0.55 | 33860.70 | 0.60 | 45136.01 | 52892.58 | 72255 | 50097.55 | |
| 90939.68 | 75383.63 | 0.62 | 15695.71 | 0.79 | 34170.07 | 58228.76 | 72256 | 37926.18 | |
| 197296.59 | 184739.28 | 0.67 | 57945.14 | 0.69 | 65864.08 | 129113.33 | 72257 | 73104.14 | |
| 341740.28 | 330113.09 | 0.53 | 113776.05 | 0.66 | 160225.25 | 198926.05 | 72258 | 177837.89 | 1 |
| 323525.34 | 318600.31 | 0.59 | 160234.23 | 0.50 | 131361.59 | 175264.92 | 72259 | 145801.41 | 1 |
| 604476.88 | 616140.81 | 0.69 | 179191.91 | 0.71 | 190274.23 | 425575.78 | 72260 | 211189.98 | 1 |

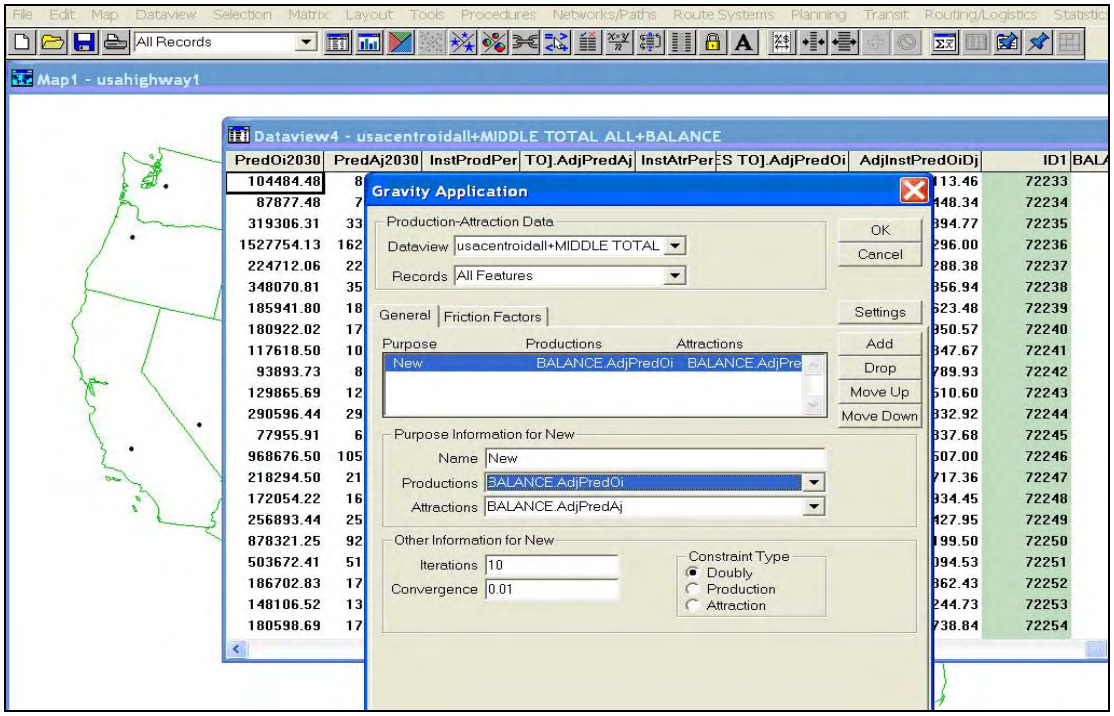
**Step 6:** Run the gravity model:

- Select “Planning” on the top menu
- Go to “Trip distribution”
- Select “Gravity application”



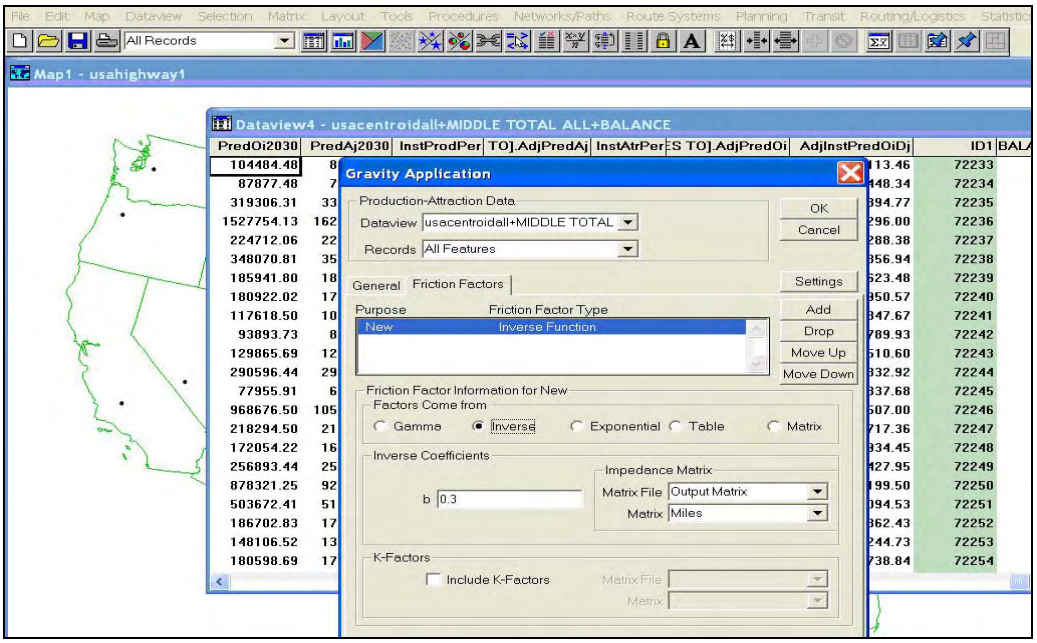
**Step 7:** On the gravity application menu, select the general settings as:

- Production = Balanced Middle Level Total Adjusted Predicted $O_i$ Values
- Attraction = Balanced Middle Level Total Adjusted Predicted $D_j$ Values
- Constraint type = Doubly
- Also select suitable convergence and number of iterations



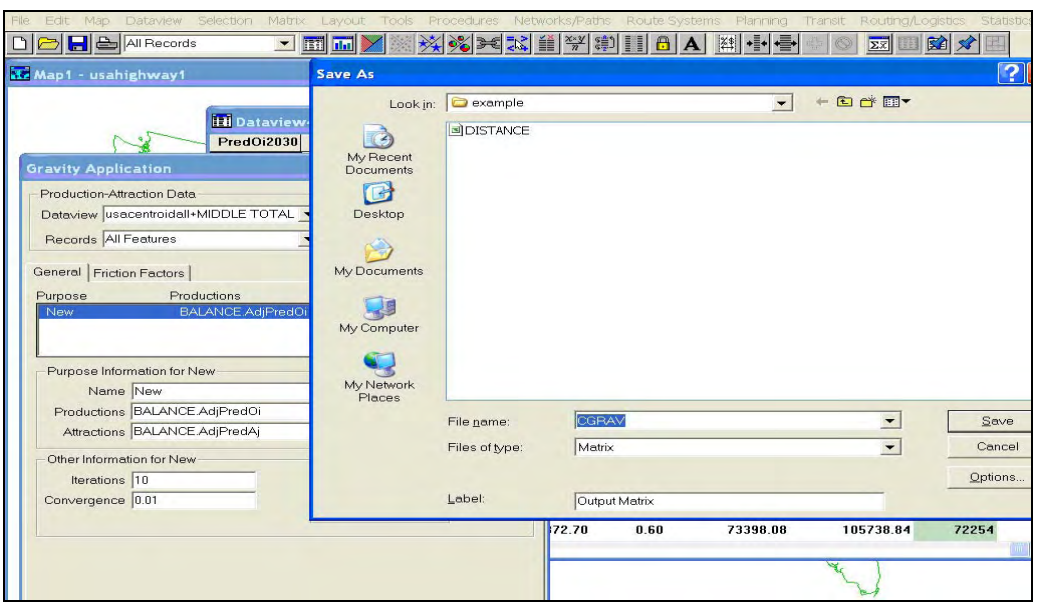

**Step 8:** On the gravity application menu:

- Select the friction factor function from the options (inverse, gamma, exponential etc) available




**Step 9:** Click "OK" on selecting the required parameters/attributes.

This study used the inverse impedance function as a friction factor function. In order to be able to apply this function in TransCAD, we entered inverse function default values and chose the matrix containing the impedances from matrix file drop-down lists. We used state to state distance matrix as an impedance matrix. We selected **b=0.3**. A dialog box "Save As" will appear as shown below:



**Step 10:** Enter the desired file name and click "Save"

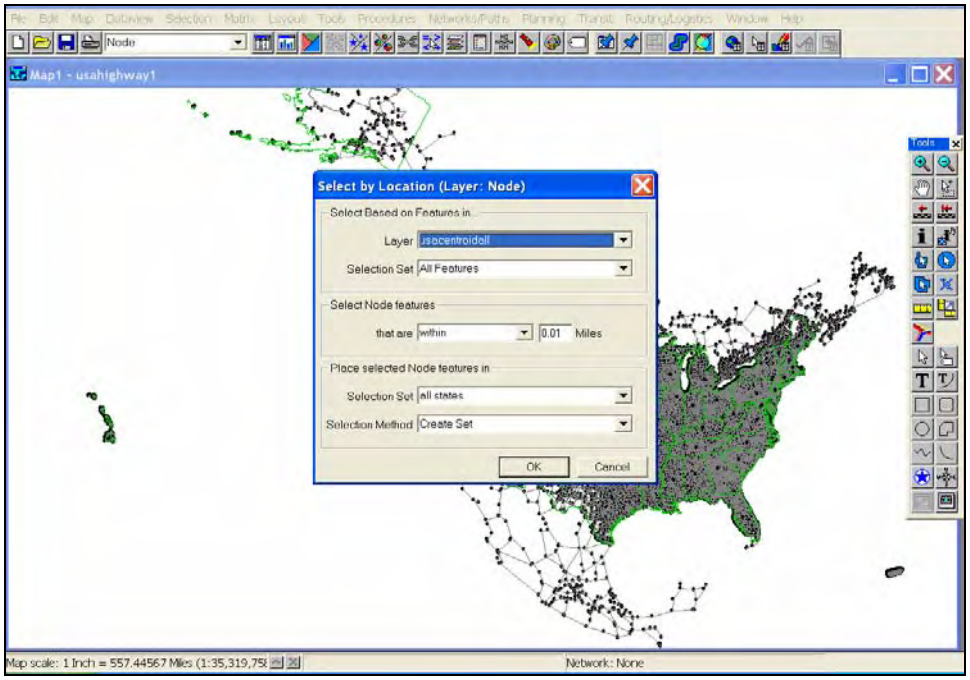
- The production-attraction (P-A) flow matrix is displayed (Result)

| | DC | AK | AZ | CA | OR | WA | NV | UT |
|---|---|---|---|---|---|---|---|---|
| DC | – | 99.59 | 774.87 | 1909.30 | 575.01 | 716.70 | 832.16 | 325.92 |
| AK | 121.92 | – | 250.74 | 676.81 | 226.55 | 286.92 | 288.16 | 109.18 |
| AZ | 518.63 | 137.08 | – | 3956.87 | 950.61 | 1135.49 | 1792.78 | 616.29 |
| CA | 1608.55 | 465.73 | 4980.62 | – | 3475.84 | 4020.00 | 6923.16 | 1957.76 |
| OR | 635.94 | 204.65 | 1570.78 | 4562.88 | – | 2497.30 | 1979.16 | 742.46 |
| WA | 918.22 | 300.25 | 2173.53 | 6113.32 | 2892.96 | – | 2670.30 | 1034.56 |
| NV | 620.21 | 175.42 | 1996.32 | 6124.57 | 1333.75 | 1553.39 | – | 850.10 |
| UT | 612.09 | 167.48 | 1729.28 | 4364.23 | 1260.78 | 1516.54 | 2142.13 | – |
| ID | 391.20 | 114.70 | 984.74 | 2688.85 | 961.99 | 1180.10 | 1238.10 | 534.06 |
| MT | 642.18 | 183.26 | 1484.36 | 3893.17 | 1348.00 | 1739.95 | 1764.26 | 765.60 |
| NM | 647.10 | 160.43 | 1992.82 | 4038.55 | 1080.66 | 1310.65 | 1838.24 | 721.53 |
| CO | 1022.25 | 254.13 | 2605.04 | 6011.36 | 1735.76 | 2130.94 | 2774.78 | 1227.46 |
| WY | 765.19 | 199.15 | 1857.30 | 4562.02 | 1398.43 | 1734.80 | 2109.41 | 989.32 |
| TX | 1944.29 | 424.33 | 4146.80 | 9477.74 | 2664.05 | 3266.58 | 4164.13 | 1615.07 |
| LA | 1033.36 | 205.40 | 1848.93 | 4363.60 | 1254.38 | 1545.58 | 1907.71 | 741.35 |
| MS | 857.80 | 162.15 | 1424.86 | 3388.99 | 984.48 | 1216.14 | 1483.59 | 579.94 |
| AL | 1041.52 | 184.40 | 1574.68 | 3780.49 | 1106.72 | 1369.60 | 1652.19 | 645.60 |
| FL | 1819.59 | 326.64 | 2703.25 | 6564.93 | 1920.08 | 2373.80 | 2847.40 | 1098.57 |
| GA | 1688.98 | 277.48 | 2310.59 | 5590.47 | 1646.85 | 2040.96 | 2439.05 | 952.00 |
| KS | 1080.89 | 232.02 | 2130.22 | 5009.54 | 1469.36 | 1819.37 | 2233.33 | 907.64 |
| NE | 697.25 | 154.27 | 1373.20 | 3282.51 | 982.44 | 1222.53 | 1468.98 | 607.53 |

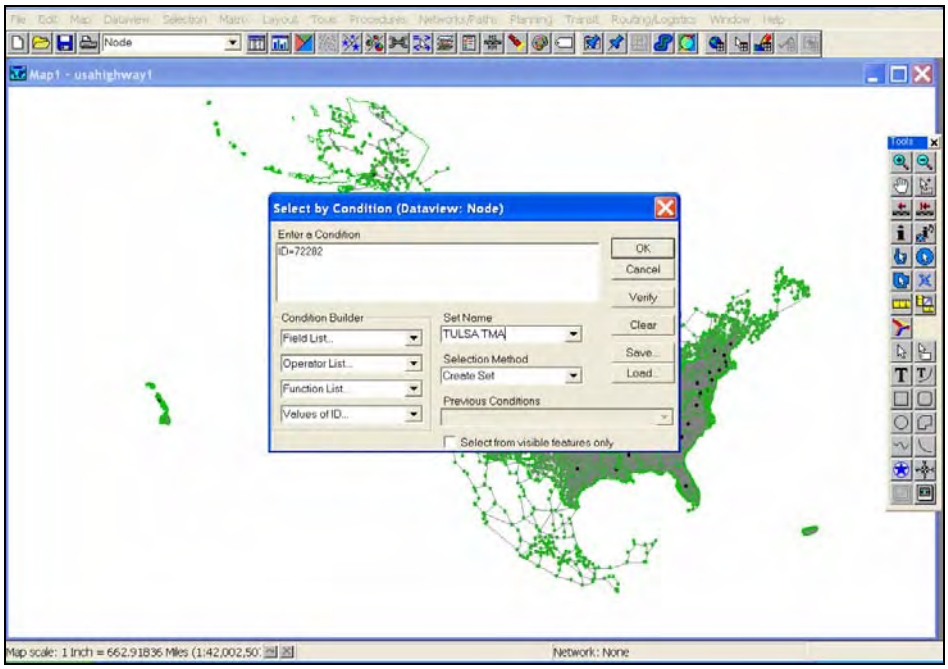
## APPENDIX 5

### Shortest Path Using TransCAD

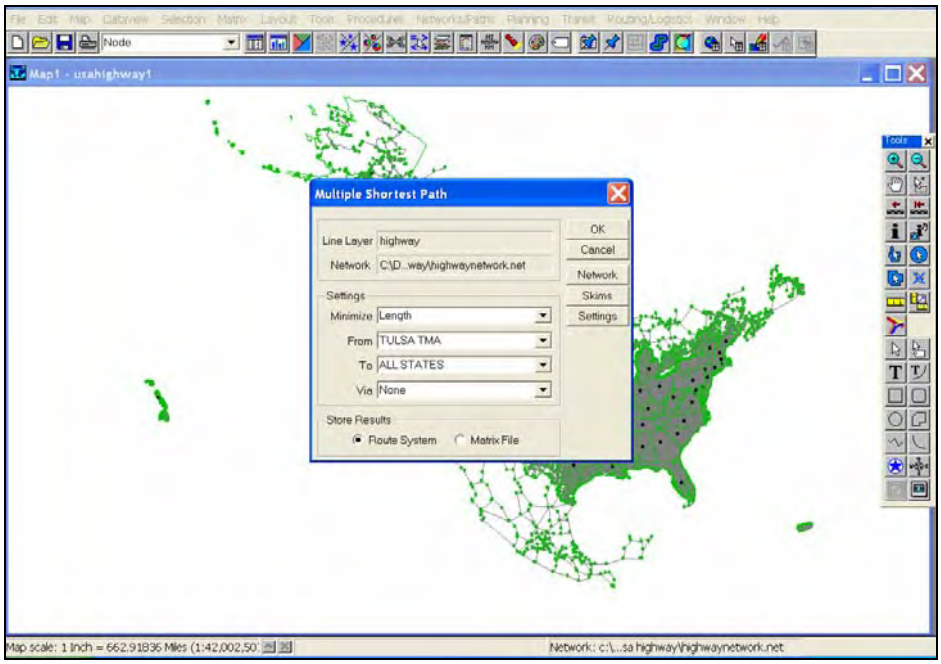
1) Open the map and add the centroid and the state boundary layers.
2) Show the node layer
3) Open Selection – Select by location in the node layer. Select node features as low as possible to minimize error. Name the selection set.



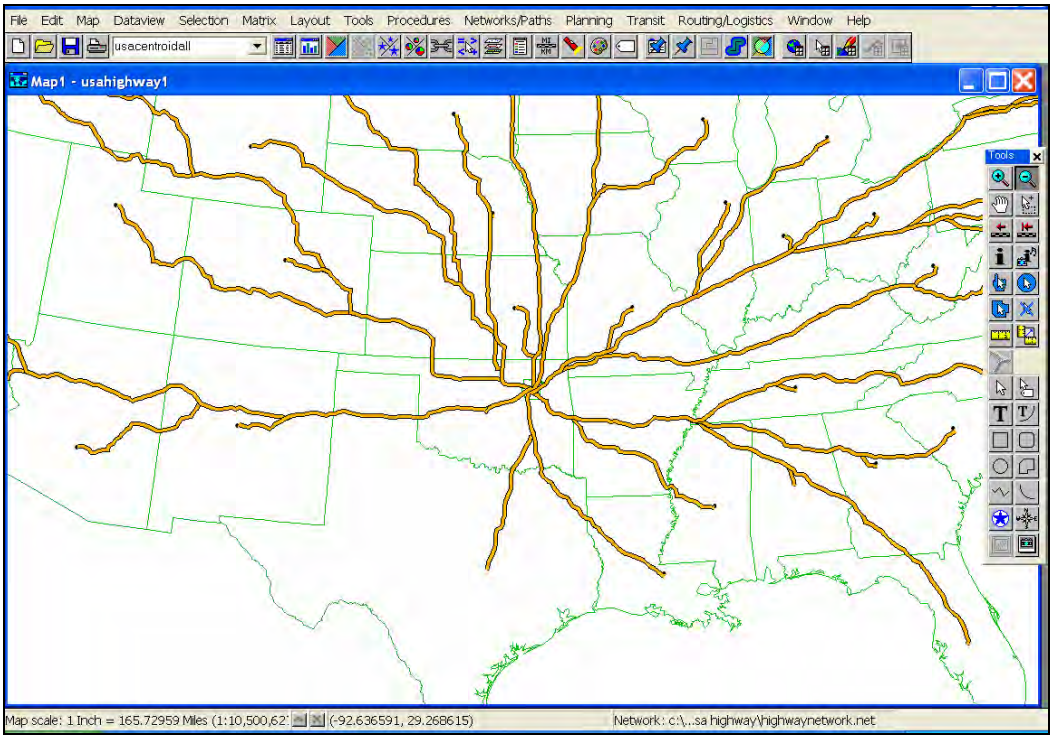

4) Open Selection – Select by condition and type in the TRANCAD ID in the condition box. Name the set.




5) Open Networks/Paths- Multiple Shortest paths and select a network file and settings.
6) In multiple shortest paths enter your origin and destination and also the output format. The route system shows the map layer while the matrix format displays the result in a matrix form.



7) TRANSCAD processes the input data and gives the shortest path from the origin to the destinations. View of the Routes passing from TULSA TMA




8) The shortest paths that flow through the Tulsa TMA region are identified and tabulated in a table. This table is used during trip assignment to assign tonnages to various paths.

## APPENDIX 6

## Freight Assignment Using TransCAD

1) Select the distribution matrix and the geographic file.
2) Open Planning- Select the traffic assignment feature as shown below.

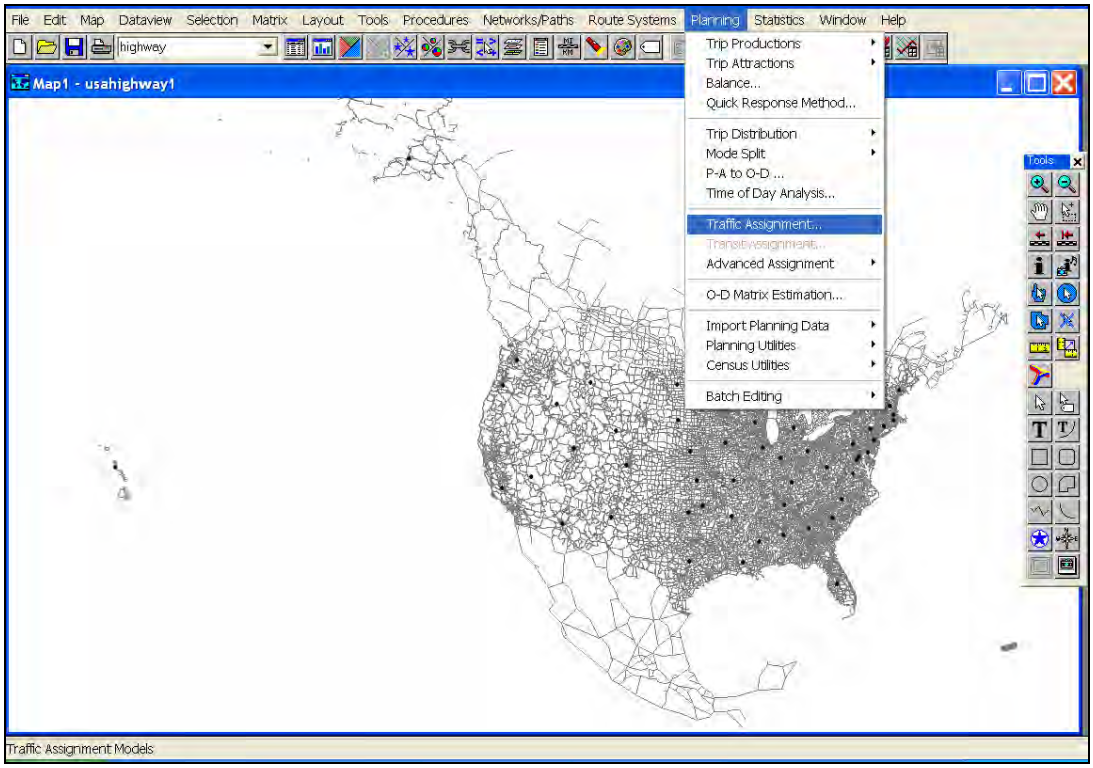



Figure 9.0.1: Trip Assignment methodology

3) Select the respective network file.
4) Complete the network setting. Select the link type as length. Click on OK.

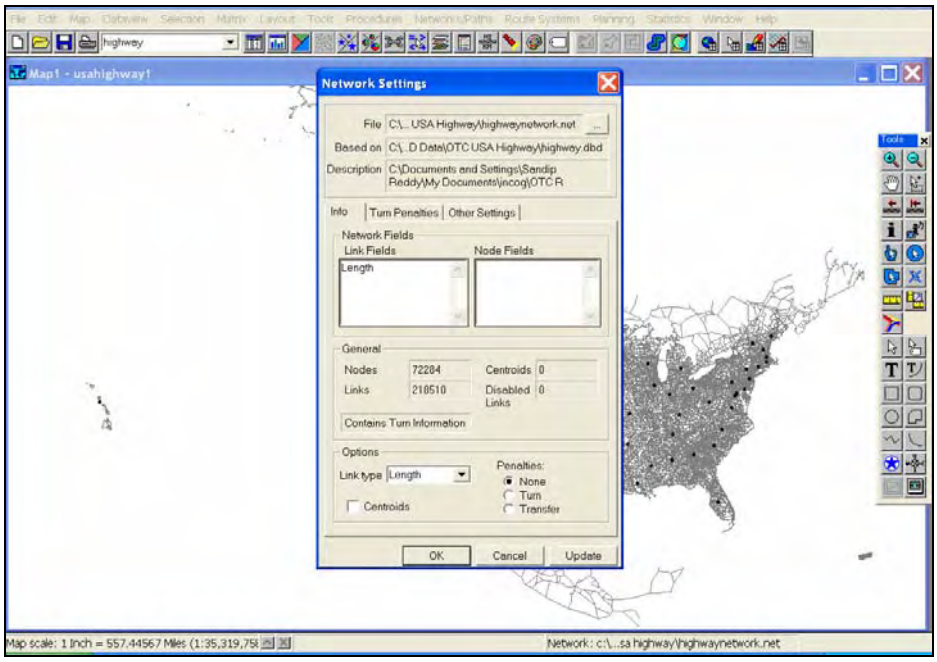



Figure 9.0.2: Trip Assignment methodology

5) Select the All – or – nothing method in traffic assignment. Select the length field. Click OK.

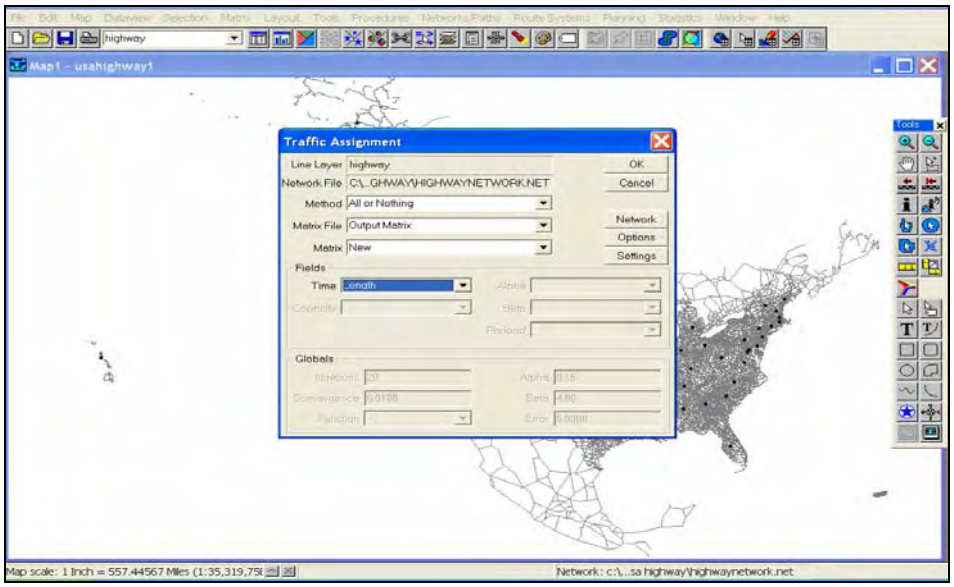



Figure 9.0.3: Trip Assignment methodology

The data view displays the assigned flows by TransSCAD ID. In order to sort the flows for a particular region, select the region before running traffic assignment. TransCAD then displays the assignment for both the entire network and for the selected region.

## REFERENCES


[1] U.S. Census Bureau Homepage, *1997 Economic Census Data*, Retrieved from http://www.census.gov/epcd/www/econ97.html on June 2004.

[2] Sheffi Y., 1986 *Urban Transportation Networks*, Prentice-Hall, Boston.

[3] Oppenheim, N., 1994 *Urban Travel Demand Modeling – From Individual Choices to General Equilibrium*. Wiley-Interscience, New York.

[4] Cambridge Systematics, Inc., Leeper, Cambridge & Campbell, Inc., Sydec, Inc., Corsi, Thomas M., and Grimm, Curitis M., 1997 *NCHRP Report 388: "A Guidebook for Forecasting Freight Transportation Demand*. Transportation Research Board, Washington D.C.

[5] Cambridge Systematics, Inc., Comsis Corporation, and University of Wisconsin, Milwaukee, 1996 *NCHRP report 8-30: Quick Response Freight Manual Final Report*. U.S. Department of Transportation, Washington, D.C.

[6] Bureau of Transportation Statistics, *Commodity Flow Survey*, Retrieved from http://www.bts.gov/ntda/cfs/index.html on July 2004.

[7] Bureau of Transportation Statistics, *National Transportation Atlas Database*, Retrieved from http://transtats.bts.gov/mappingcenter.asp on July 2004.