DALLAS-FORT WORTH REGIONAL TRAVEL MODEL (DFWRTM):
MODEL DESCRIPTION

Transportation Department
North Central Texas Council of Governments
What is NCTCOG?

The North Central Texas Council of Governments is a voluntary association of cities, counties, school districts, and special districts which was established in January 1966 to assist local governments in **planning** for common needs, **cooperating** for mutual benefit, and **coordinating** for sound regional development.

It serves a 16-county metropolitan region centered around the two urban centers of Dallas and Fort Worth. Currently the Council has **236 members**, including 16 counties, 168 cities, 23 independent school districts, and 29 special districts. The area of the region is approximately **12,800 square miles**, which is larger than nine states, and the population of the region is over **6.5 million**, which is larger than 38 states.

**NCTCOG’s** structure is relatively simple; each member government appoints a voting representative from the governing body. These voting representatives make up the **General Assembly** which annually elects a 15-member Executive Board. The **Executive Board** is supported by policy development, technical advisory, and study committees, as well as a professional staff of 312.

**NCTCOG’s** offices are located in Arlington in the Centerpoint Two Building at 616 Six Flags Drive (approximately one-half mile south of the main entrance to Six Flags Over Texas).

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**NCTCOG’s Department of Transportation**

Since 1974 NCTCOG has served as the Metropolitan Planning Organization (MPO) for transportation for the Dallas-Fort Worth area. **NCTCOG’s Department of Transportation** is responsible for the regional planning process for all modes of transportation. The department provides technical support and staff assistance to the Regional Transportation Council and its technical committees, which compose the MPO policy-making structure. In addition, the department provides technical assistance to the local governments of North Central Texas in planning, coordinating, and implementing transportation decisions.

Prepared in cooperation with the Texas Department of Transportation and the U. S. Department of Transportation, Federal Highway Administration, and Federal Transit Administration.

"The contents of this report reflect the views of the authors who are responsible for the opinions, findings, and conclusions presented herein. The contents do not necessarily reflect the views or policies of the Federal Highway Administration, the Federal Transit Administration, or the Texas Department of Transportation."
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The Dallas-Fort Worth Regional Travel Demand Model (DFWRTM) software application is a collection of components that implements a trip-based four-step travel demand model on the TransCAD 4.8 platform. The parameters, coefficients, and models in this application are calibrated based on the following data sources:

- 1994 external stations survey;
- 1994 workplace survey;
- 1999 Texas Department of Transportation (TxDOT) traffic saturation counts;
- 1996 Dallas-Fort Worth household survey;
- 1996 Fort Worth Transportation Authority (FWTA) transit onboard survey;
- 1998 Dallas Area Rapid Transit (DART) transit onboard survey;
- 1999 automatic traffic count stations;
- 1999 SkyComp freeway density, speed and volume study; and
- 2001 Dallas/Fort Worth International Airport survey.

The DFWRTM accepts the following input files: demographic data, roadway network including toll roads and HOV, transit supply system including rail and park-and-ride, airport enplanements, and external stations forecasts. It produces traffic volumes and speeds on roadways and transit usage data on the transit system. In addition to flexible coding tools, a smooth menu system for performing model runs, and extensive reports, the software provides a comprehensive file management system for the organization of input and output data.

The DFWRTM is the North Central Texas Council of Governments' (NCTCOG) official travel demand model. The software is developed and maintained by the Model Development Group in the Transportation Department at NCTCOG.

The core models of the regional travel model for the Dallas Fort Worth metropolitan area were developed by Ken Cervenka, Arash Mirzaei, Francisco Torres, and Sharam Bohluli.
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Introduction

This document describes the logic behind the Dallas-Fort Worth Regional Travel Model (DFWRTM). The DFWRTM is the North Central Texas Council of Governments’ (NCTCOG) official travel demand model. The DFWRTM is a four-step trip-based travel demand model which models a 5,000 square mile area in North Central Texas.

The software application is a collection of components that implements a four-step trip-based travel demand model on the TransCAD 4.8 platform. The software is developed and maintained by the Model Development Group in the Transportation Department at NCTCOG. The parameters, coefficients, and models in this application are calibrated based on the following data sources:

- 1994 external stations survey;
- 1994 workplace survey;
- 1999 Texas Department of Transportation (TxDOT) traffic saturation counts;
- 1996 Dallas-Fort Worth household survey;
- 1996 Fort Worth Transportation Authority (FWTA) transit onboard survey;
- 1998 Dallas Area Rapid Transit (DART) transit onboard survey;
- 1999 automatic traffic count stations;
- 1999 SkyComp freeway density, speed and volume study; and
- 2001 Dallas/Fort Worth International Airport survey.

The DFWRTM accepts the following input files: demographic data, roadway network including toll roads and HOV, transit supply system including rail and park-and-ride, and airport and external stations forecasts. It produces traffic volumes and speeds on roadways and transit usage data on the transit system. In addition to flexible coding tools, a smooth menu system for performing model runs, and extensive reports, the software provides a comprehensive file management system for the organization of input and output data.

In this chapter, we will present a brief summary of each of the four major steps and other intermediate steps of the model. They are presented in the following order:
1. Zone Structure

2. Roadway Network Coding and Preparation

3. Trip Generation (Step 1)

4. Roadway Skim and Trip Distribution (Step 2)

5. Transit Network Coding and Transit Skims

6. Mode Choice (Step 3)

7. Transit and Traffic Assignment (Step 4)

**Zone Structure**

The modeling area of DFWRTM includes the entire counties of Collin, Dallas, Denton, Rockwall and Tarrant, the western portion of Kaufman County, the northern portion of Ellis and Johnson Counties, and the eastern portion of Parker County. Exhibit 1-1 illustrates the modeling areas within the North Central Texas region.

Exhibit 1-1: Modeling Area Within the North Central Texas Region

The modeling area has been divided into 4,874 travel survey zones (TSZ) of which 4,813 are internal zones and 61 are external zones. The process of creating internal TSZs started with the aggregation of 76,336 census blocks into 6,399 zones. The 6,399 zones included zones with no future growth. To improve the speed of the execution of the model while maintaining the model accuracy, the structure of 6,399 zones was aggregated into 4,813 zones. The structure also includes 61 external zones to represent gateway roads to and from the modeling area.
The purpose of having a large number of zones in the area is to avoid splitting the zones for sub-area and corridor analyses. A stable zone structure creates convenience in model runs and consistency in the comparison of different projects.

The TSZ structure remains unchanged during the process of future projections and model analysis. Communication with the model users for zonal data input and output is based on the TSZ structure. Most of the internal model components directly use the TSZ zone structure with the exception of the income and household size distribution component in the trip generation module. The distribution of households among income groups and household sizes are based on the aggregation of the TSZs into 720 regional area analysis (RAA) zones. Exhibit 1-2 shows the TSZs and RAA zones in the modeling area.

**Exhibit 1-2: TSZs and RAA Zones in the Modeling Area**

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**Roadway Network Coding and Preparation**

The transportation network of DFWRTM is a GIS database that represents the actual roadway and rail links for the year of analysis. The network is the underlying database for all other steps in the DFWRTM. The transportation network file is a series of links that are connected through nodes representing railroad tracks, roads, and intersections.

Generally, the roadway network is coordinated with the TSZ layer, so that the number of links inside the TSZ area is minimized. As mentioned in the zone structure description, the zone
structure is designed to stay unchanged for different analyses. This makes roadway coding rules for inclusion of links in the modeling network clear and consistent among roadway networks.

The Roadway Network Coding step includes checks on the integrity of the network and interdependence of the fields; the addition of the roadway network database fields for use later within DFWRTM; creation of centroid connections to link the TSZ layer to the coded roadway network; and the calculation of loaded speeds, loaded travel times, operating costs, walk time, toll values, and cost of link travel. At the end of the roadway coding and preparation, the network is ready for providing initial travel time skim tables to be used in trip distribution.

Trip Generation

The first step in the 4-Step Model is Trip Generation. The function of the Trip Generation module is to convert demographic data into person trips productions and attractions for different purposes. Inputs to the trip generation module have to be predictable and geographically tied to the zone structure. The prediction of the inputs to the trip generation module is the function of the land use model.

The demographic data for the trip generation module includes population, the number of households, median household income, the number of basic, retail and service employments and special generator employments, the household income distribution and the household size distribution for each TSZ.

The outputs of the trip generation program are balanced production and attraction person trips from and to each TSZ for four trip purposes: Home-Based Work (HBW), Home-Based Non-Work (HNW), Non-Home-Based (NHB) and internal truck trips (OTH) to and from each TSZ. In the output, the HBW trip productions and attractions are separated into the four income groups defined in the model. The outputs are used in the trip distribution step along with roadway skims.

The Trip Generation module is described in detail in Chapter 2.

Roadway Skim and Trip Distribution

The second step in the 4-Step Model is Roadway Skim and Trip Distribution.

Roadway Skim

The Roadway Skim module is designed to find the shortest paths from origin centroids to destination centroids for auto modes. The number and types of the travel time skims needed are determined by the number of trip purposes, the number of peak periods, and the traffic assignment vehicle classes, which are dependent on mode choice module. There are a total of four roadway skim matrices produced which represent different time periods of interest (a.m. peak and off-peak) and whether or not HOV facilities are utilized for skimming; the matrices are named Peak HOV, Peak No HOV, Off-Peak HOV, and Off-Peak No HOV.

The output of the roadway skim module consists of four matrices that are built based on the a.m. peak or off-peak loaded travel time with HOV facilities included and excluded from the roadway network. The matrices also include the travel distance along the shortest travel time path for use in the mode choice module.
Trip Distribution

The Trip Distribution module determines the number of trips between each origin and destination zone for which trip production, trip attraction, and skims are known. For internal trips, the DFWRTM adopts a form of the gravity model for trip distribution. Each set of parameters is calibrated for each trip purpose, so there are a total of seven gravity models (four for HBW in each income quartile, HNW, NHB, and OTH trips). There are three types of inputs to feed into the gravity models: a friction factor table, production/attraction totals, and an impedance matrix. The gravity model outputs are trip matrices indicating where trips are generating from and to for each trip purpose. The airport trip sub-module estimates the number of HNW and NHB trips to and from the airports based on the number of enplanements at each airport.

The TSZ productions and attractions are outputs of the trip generation module.

The Roadway Skims and Trip Generation modules are described in detail in Chapter 3.

Transit Network Coding and Transit Skims

The Transit Network represents existing transit service in the year of analysis. It is a GIS database built on the roadway network. Actual transit service is the integration of several routes with different vehicle technologies, boarding and alighting stations, fare structure, transfer policies, and service times.

Transit Network Coding

The DFWRTM models the transit service for the a.m. peak period of 6:30 a.m. to 8:59 a.m. (AM) and the off-peak period of 9:00 a.m. to 2:59 p.m. to represent transit service and transit use in a 24-hour weekday.

Transit lines are grouped into several modes. The modes are created generally based on technology used, fare system, or operating characteristics of the routes. Commonly used modes are local bus, express bus, commuter rail, and light rail.

Transit Skims

Transit skim tables provide the shortest path times through the transit network using the assumptions described in the chapter. The determination of transit paths and travel times is based on the TransCAD Pathfinder algorithm.

The output of the Transit Skims are four matrices describing the network during the peak period with park-and-ride, peak period with no park-and-ride, off-peak period with park-and-ride, and off-peak period with no park-and-ride. Each matrix has tables describing costs and times for travel. These tables are used in the mode choice module, along with other inputs, to calculate the mode shares.

The Transit Network and Transit Skim Modules are described in detail in Chapter 4.
**Mode Choice**

The third step in the 4-Step Model is Mode Choice. The mode choice modules determine the portion of trips that use different modes. The mode choice modules are applied to the trip table outputs of the trip distribution process. The modes considered in the DFWRTM are drive alone, shared-ride with 2 occupants (SR 2), shared-ride with 3 or more occupants (SR 3+), transit with walk access, and transit with drive access.

Trips are segmented based on trip purposes. Models were developed for HBW, HNW, and NHB trips. Nested logit models are used for HBW and HNW trips, and a multinomial logit model is used for NHB trips.

The output of the mode choice module are sets of person trip tables using the modes Drive Alone, SR 2, SR 3+, Transit Walk Access, and Transit Auto Access for the HBW, HNW, and NHB trip purposes.

The Mode Choice modules are described in detail in Chapter 5.

**Roadway Traffic Assignment and Transit Assignment**

The final step in the 4-Step Model is Traffic and Transit Assignment. Traffic assignment is run for the morning peak period and the off-peak period in the initial iteration and the first feedback iteration. For the last iteration, the roadway traffic is assigned for the a.m. peak period, p.m. peak period, and off-peak period, and the transit traffic in the peak and off-peak periods.

**Roadway Traffic Assignment**

The inputs for roadway traffic assignment are vehicle trip tables by time-of-day. There are three time-of-day periods: the a.m. peak period from 6:30 a.m. to 8:59 a.m. (AM); the p.m. peak period from 3:00 p.m. to 6:29 p.m. (PM); and the off-peak period (9:00 a.m. to 2:59 p.m. and 6:30 p.m. to 6:29 a.m.). The DFWRTM considers four vehicle classes: drive-alone vehicles (DA), shared-ride vehicles with access to HOV facilities (SRHOV), shared-ride vehicles with no access to HOV facilities (SRNOHOV), and trucks (TRUCK). The DFWRTM adopts a generalized cost method for multi-modal multi-class roadway assignment. Different vehicle classes have different sets of roadway networks to access and different parameters for value-of-time.

The output of the roadway traffic assignment are total traffic volumes and times stored in the roadway network file, and estimated volumes for each class stored in separate output files.

**Transit Assignment**

The Transit Assignment step uses the TransCAD PathFinder algorithm. Transit assignment is only run after the last feedback is completed in the model run.

Transit assignment includes four separate assignment sub-modules. Two assignment sub-modules assign HBW transit walk-access and drive-access trip tables to the peak transit network with and without park-and-ride included. Two assignment sub-modules assign the total of HNW and NHB transit walk-access and drive-access trip tables to the off-peak transit network with and without park-and-ride included. Transit trip tables are assigned in a 24-hour production-attraction format to the networks.
The Assignment modules are described in detail in Chapter 6.
Trip Generation

The Trip Generation model converts population, household, income, and employment data to the number of person trips. The model includes two modules: trip production and trip attraction. The trip production module estimates the number of trips produced from a zone and the trip attraction module estimates the number of trips attracted to a zone. The module uses the cross-classification model for both trip production and trip attraction models. The trip productions are cross-classified by household size and household income. The trip attractions are determined by employment, area type, and income.

The inputs for trip generation are zonal demographics including population, household, and employment. In the DFWRTM, we use two input sources: the Traffic Survey Zone (TSZ) geographic file and the demographic data file DATA.DBF.

The model outputs are trip productions and attractions for each TSZ in the region, stratified by seven trip purposes:

- Home-based work trips for low income households (HBW1)
- Home-based work trips for low-median income households (HBW2)
- Home-based work trips for high-median income households (HBW3)
- Home-based work trips for high income households (HBW4)
- Home-Based Non-work trips (HNW)
- Non Home-Based trips (NHB)
- Other, mainly service truck trips (OTHER)

This chapter describes the trip generation program including inputs, outputs, and the trip production and trip attraction modules.

Model Inputs and Output

The geographic file TSZ.DBD is saved in folder TCMODEL\TSZGeographic\GEO. The file presents a GIS-generated zone structure at the finest level: Traffic Survey Zones (TSZ). The zoning system provides a platform to aggregate the individual households and premises into manageable chunks of modeling purposes. In the DFWRTM, the trip generation model is performed on a TSZ level. Exhibit 2-1 describes the contents of the TSZ geographic file.
Exhibit 2-1: Field Descriptions for TSZ.DBD

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>Area of the TSZ in square miles</td>
</tr>
<tr>
<td>TSZ</td>
<td>TSZ ID</td>
</tr>
<tr>
<td>RAA</td>
<td>ID of Regional Area Analysis Zone (RAA) which the TSZ belongs to</td>
</tr>
<tr>
<td>County</td>
<td>Name of the county</td>
</tr>
<tr>
<td>JUR57</td>
<td>Jurisdiction ID</td>
</tr>
<tr>
<td>DIST66</td>
<td>District ID</td>
</tr>
<tr>
<td>TAD</td>
<td>Transportation Analysis District (TAD) ID</td>
</tr>
<tr>
<td>City</td>
<td>City of the TSZ</td>
</tr>
<tr>
<td>Land_Area</td>
<td>Land area of the TSZ in square miles</td>
</tr>
<tr>
<td>Water_Area</td>
<td>Water area of the TSZ in square miles</td>
</tr>
<tr>
<td>Total_Area</td>
<td>Total area of the TSZ in square miles</td>
</tr>
<tr>
<td>Model_Area</td>
<td>Model area of the TSZ in square miles</td>
</tr>
<tr>
<td>AREATYPE</td>
<td>Area type</td>
</tr>
<tr>
<td>DART</td>
<td>1 if Dallas Area Rapid Transit has transit lines serving the TSZ, 0 otherwise</td>
</tr>
<tr>
<td>FWT</td>
<td>1 if Fort Worth Transportation Authority has transit lines serving the TSZ, 0 otherwise</td>
</tr>
<tr>
<td>DCTA</td>
<td>1 if Denton County Transportation Authority has transit lines serving the TSZ, 0 otherwise</td>
</tr>
<tr>
<td>Airport</td>
<td>1 if there is an airport in the TSZ, 0 otherwise</td>
</tr>
</tbody>
</table>

The demographic data file DATA.DBF is saved in TCMODEL\TSZGeographic\GEO\ACT.
This file lists a set of socio-economic measures for each TSZ, including population, households, and median income in a table format. These demographic variables, except the income variable, correspond to the study year. The median income is in 1999 dollar value. The field descriptions of the table are presented in Exhibit 2-2.

Exhibit 2-2: Field Descriptions for DATA.DBF

<table>
<thead>
<tr>
<th>Field</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSZ</td>
<td>TSZ ID</td>
</tr>
<tr>
<td>XCOORD</td>
<td>X coordinate of the TSZ centroid</td>
</tr>
<tr>
<td>YCOORD</td>
<td>Y coordinate of the TSZ centroid</td>
</tr>
<tr>
<td>MEDINC</td>
<td>Median household income of TSZ in 1999 dollars</td>
</tr>
<tr>
<td>HHOILD</td>
<td>Number of households in TSZ</td>
</tr>
<tr>
<td>POP</td>
<td>Number of population in TSZ</td>
</tr>
<tr>
<td>BASIC</td>
<td>Number of basic type employment</td>
</tr>
<tr>
<td>RETAIL</td>
<td>Number of retail type employment</td>
</tr>
<tr>
<td>SERVICE</td>
<td>Number of service type employment</td>
</tr>
<tr>
<td>SGBASIC</td>
<td>Number of basic employment of the special generator</td>
</tr>
<tr>
<td>SGRETAIL</td>
<td>Number of retail employment of the special generator</td>
</tr>
<tr>
<td>SGSERVICE</td>
<td>Number of service employment of the special generator</td>
</tr>
<tr>
<td>SGUNIT</td>
<td>Number of units of the special generator</td>
</tr>
<tr>
<td>SGNAME</td>
<td>Name of the special generator</td>
</tr>
<tr>
<td>SGTYPE</td>
<td>Type of the special generator</td>
</tr>
<tr>
<td>SGHBWWRATE</td>
<td>Home-based work trip rate of the special generator</td>
</tr>
<tr>
<td>SGHNWRATE</td>
<td>Home-based non-work trip rate of the special generator</td>
</tr>
<tr>
<td>SGNHBRATE</td>
<td>Non-home-based trip rate of the special generator</td>
</tr>
<tr>
<td>SGTRKRATE</td>
<td>OTHER trip rate of the special generator</td>
</tr>
</tbody>
</table>

The model output file PATRIPS.DBF is saved in TCMODEL\TSZGeographic\GEO\ACT. The outputs include trip productions as well as trip attractions from/to each TSZ. The fields in this table are described in Exhibit 2-3.

Exhibit 2-3: Field Descriptions for PATRIPS.DBF

<table>
<thead>
<tr>
<th>Field</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1WP</td>
<td>Productions of HBW person trips by low income households</td>
</tr>
<tr>
<td>H1WA</td>
<td>Attractions of HBW person trips by low income households</td>
</tr>
<tr>
<td>H2WP</td>
<td>Productions of HBW person trips by low-median income households</td>
</tr>
<tr>
<td>H2WA</td>
<td>Attractions of HBW person trips by low-median income households</td>
</tr>
<tr>
<td>H3WP</td>
<td>Productions of HBW person trips by high-median income households</td>
</tr>
<tr>
<td>H3WA</td>
<td>Attractions of HBW person trips by high-median income households</td>
</tr>
<tr>
<td>H4WP</td>
<td>Productions of HBW person trips by high income households</td>
</tr>
<tr>
<td>H4WA</td>
<td>Attractions of HBW person trips by high income households</td>
</tr>
<tr>
<td>HNWNP</td>
<td>Productions of HNW person trips</td>
</tr>
<tr>
<td>HNWNA</td>
<td>Attractions of HNW person trips</td>
</tr>
<tr>
<td>NHBP</td>
<td>Productions of NHB person trips</td>
</tr>
<tr>
<td>NHBA</td>
<td>Attractions of NHB person trips</td>
</tr>
<tr>
<td>OTHP</td>
<td>Productions of OTHER person trips</td>
</tr>
<tr>
<td>OTAHA</td>
<td>Attractions of OTHER person trips</td>
</tr>
</tbody>
</table>
The process of trip generation can be outlined as follows:

- Create a household income distribution
- Create a household size distribution
- Create a joint household size and income distribution
- Define TSZ area type
- Create a household income distribution for employees by employment type
- Calculate trip productions
- Calculate trip attractions
- Calculate special generators’ trips
- Balance the production and attraction trips

Each task is described in detail in the following sections.

### Household Income Distribution

The trip production model is a cross-classification model by household size and household income. Therefore, it is necessary to estimate the joint distribution of household size and household income for each TSZ. We estimate the joint distribution based on two independent distributions: household income distribution and household size distribution.

The household income distribution reveals how many households exist in each income quartile for the Regional Area Analysis Zones (RAAs). It is based on the ratio of the zonal median income to the regional median income, as illustrated in Exhibit 2-4. For instance, if the zonal median income is 100 percent higher than the regional median income (ratio = 2), then 15 percent of all households would be in income quartile 1 (low income), 16 percent in income quartile 2 (low-median income), 26 percent in income quartile 3 (high-median income), and 43 percent in income quartile 4 (high income) in this RAA. After the income quartile distributions are calculated for all the RAAs, the model then checks whether the total number of households in each quartile for the whole region is 25 percent. It then normalizes the distributions for each zone so that regional income distribution remains 25 percent for each quartile.

### Household Size Distribution

The household size distribution reveals the number of households in each household size category for the RAAs. Households are distributed based on average household size for each TSZ. Exhibit 2-5 shows the distribution of household size based on average household size derived from the 1990 census. The underlying assumption is that the distribution of households relating to any household size in a zone remains unchanged in future years. For instance, if the zonal average household size is 3, 15 percent of households would be in household size 1; 29 percent in household size 2; 21 percent in household size 3; 19 percent in household size 4; 10 percent in household size 5; and 6 percent in household size 6 plus. Unlike the household income distribution, there is no need for normalization, since there is no control total by household size in the region.

### Joint Household Size and Income Distribution

Once the individual distributions have been established, a joint distribution of household size and income quartile is created. Exhibit 2-6 presents the joint household size and income distribution for the whole region. It is used as a starting point in the iterative proportional fitting (IPF) process to estimate the joint household size and income quartile distribution for each RAA. The control totals
in the IPF are the number of households in each household size category and the number of households in each income quartile for each RAA.

All the joint distributions are established at the RAA level and it is assumed that within each RAA, the joint distribution remains constant across TSZs. Therefore, for each TSZ, the joint distribution is obtained as well as the number of households by household size and income quartile.
Exhibit 2-4: Household Income Distribution
Exhibit 2.5: Household Size Distribution
Exhibit 2-6: Joint Distribution of Income and Household Size for the Region

<table>
<thead>
<tr>
<th>Household Size</th>
<th>Income Quartile 1</th>
<th>Income Quartile 2</th>
<th>Income Quartile 3</th>
<th>Income Quartile 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.2006</td>
<td>0.2466</td>
<td>0.2685</td>
<td>0.2843</td>
</tr>
<tr>
<td>2</td>
<td>0.1686</td>
<td>0.2199</td>
<td>0.2841</td>
<td>0.3275</td>
</tr>
<tr>
<td>3</td>
<td>0.1389</td>
<td>0.1987</td>
<td>0.2968</td>
<td>0.3656</td>
</tr>
<tr>
<td>4</td>
<td>0.1664</td>
<td>0.2381</td>
<td>0.2857</td>
<td>0.3097</td>
</tr>
<tr>
<td>5</td>
<td>0.2186</td>
<td>0.2446</td>
<td>0.2871</td>
<td>0.2496</td>
</tr>
<tr>
<td>6+</td>
<td>0.1585</td>
<td>0.216</td>
<td>0.2924</td>
<td>0.3331</td>
</tr>
</tbody>
</table>

Area Type

The trip attraction model is a cross-classification model by area type and employment type. We define area type by the activity density at the RAA level. It is assumed that, within each RAA, the area type remains constant across TSZs. The activity density is defined as follows:

\[
ADEN_i = (POP_i + B \times EMP_i)/AREA_i, \tag{2-1}
\]

where \(ADEN_i\) is the activity density for RAA \(i\), \(POP_i\) is the population of RAA \(i\), \(EMP_i\) is the total employment of RAA \(i\), \(AREA_i\) is the total area of RAA \(i\), and \(B\) is the regional population to employment (P/E) ratio. In the DFWRTM Version 3, \(B\) equals 1.589993, corresponding to year 1999 regional P/E ratio. The area type is then defined in Exhibit 2-7:

Exhibit 2-7: Area Type and Activity Density

<table>
<thead>
<tr>
<th>Area Type</th>
<th>Description</th>
<th>Activity Density Range (Per Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Central Business District</td>
<td>&gt; 125</td>
</tr>
<tr>
<td>2</td>
<td>Outer Business District</td>
<td>30-125</td>
</tr>
<tr>
<td>3</td>
<td>Urban Residential</td>
<td>7.5-30</td>
</tr>
<tr>
<td>4</td>
<td>Suburban Residential</td>
<td>1.8-7.5</td>
</tr>
<tr>
<td>5</td>
<td>Rural</td>
<td>&lt;1.8</td>
</tr>
</tbody>
</table>

It should be noted that there are approximately 100 RAAs whose area types are adjusted after the activity density is calculated. The main reason for this adjustment is to keep a RAA’s area type consistent with the surrounding RAAs. Exhibit 2-8 lists the RAAs that have a pre-defined area type.
Exhibit 2-8: RAAs and Pre-Defined Area Type

<table>
<thead>
<tr>
<th>RAA</th>
<th>Area Type</th>
<th>RAA</th>
<th>Area Type</th>
<th>RAA</th>
<th>Area Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>88</td>
<td>3</td>
<td>266</td>
<td>2</td>
<td>292-305</td>
<td>1</td>
</tr>
<tr>
<td>92</td>
<td>3</td>
<td>268</td>
<td>4</td>
<td>1-49</td>
<td>1</td>
</tr>
<tr>
<td>98</td>
<td>3</td>
<td>285</td>
<td>3</td>
<td>306</td>
<td>1</td>
</tr>
<tr>
<td>116</td>
<td>3</td>
<td>331</td>
<td>3</td>
<td>307</td>
<td>1</td>
</tr>
<tr>
<td>125</td>
<td>3</td>
<td>332</td>
<td>3</td>
<td>308</td>
<td>1</td>
</tr>
<tr>
<td>150</td>
<td>2</td>
<td>333</td>
<td>3</td>
<td>310</td>
<td>1</td>
</tr>
<tr>
<td>155</td>
<td>4</td>
<td>364</td>
<td>4</td>
<td>311</td>
<td>1</td>
</tr>
<tr>
<td>163</td>
<td>2</td>
<td>379</td>
<td>2</td>
<td>313-330</td>
<td>1</td>
</tr>
<tr>
<td>165</td>
<td>3</td>
<td>444</td>
<td>2</td>
<td>359</td>
<td>1</td>
</tr>
<tr>
<td>209</td>
<td>4</td>
<td>460</td>
<td>2</td>
<td>488</td>
<td>1</td>
</tr>
<tr>
<td>226</td>
<td>2</td>
<td>462</td>
<td>2</td>
<td>489</td>
<td>1</td>
</tr>
<tr>
<td>249</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Employment Income Distribution

The trip attraction model for HBW is a cross-classification model by area type and household income quartile at the workplace. This model requires an estimation of household income distribution for employees at their workplace. The DFWRTM first estimates the employment income distribution at the RAA level. It is assumed that within a RAA the employment income distribution remains constant across TSZs and employment income distribution at TSZ level is subsequently obtained.

The employees’ income distribution is estimated on the basis of the income level of households located in and around the zone. First we calculate the employment income quartiles by the following formulas:

\[
PctEmp_{j1} = 0.115 + 0.04486 \times HH670_1 / 0.25 + 0.0352 \times HE75_{1j} \quad (2-2)
\]

\[
PctEmp_{j2} = 0.15892 + 0.07858 \times HH670_2 / 0.25 \quad (2-3)
\]

\[
PctEmp_{j3} = 0.17 + 0.05969 \times HH670_3 / 0.25 \quad (2-4)
\]

\[
PctEmp_{j4} = 0.41 + 0.06893 \times HH670_4 / 0.25 - 0.00629 \times HE50_{j} \quad (2-5)
\]

where subscript \( j \) represents basic, retail, and service employment respectively and subscripts 1 to 4 represent income quartiles. For example, \( PctEmp_{j1} \) is the percentage of employment type \( j \) in income quartile \( i \) in the zone, \( HH670_i \) is the percentage of households in income quartile \( i \) within 6.70 miles; \( HE75_{ij} \) is the ratio of households in income quartile \( i \) to the total employees of employment type \( j \) within 0.75 mile; and \( HE50 \) is the ratio of total households to the total employment within 0.50 mile.

Second, the employment income quartile percentages are normalized so that the sum of income quartile percentages equals 1 for each employment type. Third, an iterative proportional fitting procedure is applied for each employment type respectively to ensure that the regional employment totals and regional employment income distribution over the four income quartile follows the ratio: 0.2019: 0.2588: 0.2670: 0.2723.
Trip production rates for HBW, HNW, and NHB trips are defined as the number of person trips per household and are stratified by income quartile and household size. The production rates for OTHER trips are defined as the number of person trips per employee/household stratified by zonal area type. The estimation of trip productions requires the application of trip rates to the number of households in a zone, stratified by income quartile and household size. Exhibits 2-9 through 2-12 show the trip production rates used in the Trip Generation Model. The "OTHER" trip rates are not stratified by household size and income quartile, but by area type and the employment/household mix with which they are most closely associated.

### Exhibit 2-9: HBW Trip Production Rates

<table>
<thead>
<tr>
<th>Income Quartile</th>
<th>Household Size</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.87</td>
<td>1.347</td>
<td>2.082</td>
<td>2.354</td>
<td>2.003</td>
<td>2.003</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1.288</td>
<td>1.916</td>
<td>2.491</td>
<td>2.583</td>
<td>2.908</td>
<td>3.524</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.288</td>
<td>2.192</td>
<td>2.756</td>
<td>2.771</td>
<td>3.168</td>
<td>3.168</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1.288</td>
<td>2.192</td>
<td>2.866</td>
<td>2.866</td>
<td>3.213</td>
<td>4.458</td>
<td></td>
</tr>
</tbody>
</table>

### Exhibit 2-10: HNW Trip Production Rates

<table>
<thead>
<tr>
<th>Income Quartile</th>
<th>Household Size</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.578</td>
<td>3.44</td>
<td>5.192</td>
<td>7.337</td>
<td>9.067</td>
<td>13.314</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1.308</td>
<td>3.715</td>
<td>5.78</td>
<td>8.467</td>
<td>13.249</td>
<td>13.837</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1.396</td>
<td>3.22</td>
<td>5.746</td>
<td>9.363</td>
<td>12.426</td>
<td>14.903</td>
<td></td>
</tr>
</tbody>
</table>

### Exhibit 2-11: NHB Trip Production Rates

<table>
<thead>
<tr>
<th>Income Quartile</th>
<th>Household Size</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.191</td>
<td>2.054</td>
<td>2.285</td>
<td>2.285</td>
<td>2.285</td>
<td>3.907</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1.847</td>
<td>2.075</td>
<td>2.505</td>
<td>2.765</td>
<td>3.375</td>
<td>3.907</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.691</td>
<td>2.773</td>
<td>3.285</td>
<td>3.859</td>
<td>3.859</td>
<td>4.575</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1.376</td>
<td>2.651</td>
<td>3.585</td>
<td>4.127</td>
<td>4.799</td>
<td>4.799</td>
<td></td>
</tr>
</tbody>
</table>

### Exhibit 2-12: OTHER Trip Production Rates

<table>
<thead>
<tr>
<th>Employment /Household</th>
<th>Area Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>0.128</td>
<td>0.128</td>
<td>0.128</td>
<td>0.128</td>
<td>0.128</td>
<td></td>
</tr>
<tr>
<td>Retail</td>
<td>0.14</td>
<td>0.14</td>
<td>0.14</td>
<td>0.14</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>Household</td>
<td>0.053</td>
<td>0.053</td>
<td>0.053</td>
<td>0.053</td>
<td>0.053</td>
<td></td>
</tr>
</tbody>
</table>
Trip attractions are defined as the number of person trips attracted to a zone. They are stratified by area type, employment type and number of households, and, in the case of the HBW trip purpose, income quartile. Once the area type is defined and the income distribution of employees has been established, person trip attractions are calculated using the rates shown in Exhibits 2-13 through 2-18.

Exhibit 2-13: HBW Trip Attraction Rates for Basic Employment

| Employment Income | Area Type
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td>1</td>
<td>1.378</td>
<td>1.302</td>
<td>1.113</td>
<td>1.252</td>
<td>1.15</td>
</tr>
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<td>2</td>
<td>1.312</td>
<td>1.358</td>
<td>1.219</td>
<td>1.301</td>
<td>1.292</td>
</tr>
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<td>3</td>
<td>1.544</td>
<td>1.408</td>
<td>1.433</td>
<td>1.193</td>
<td>1.197</td>
</tr>
<tr>
<td>4</td>
<td>1.513</td>
<td>1.35</td>
<td>1.505</td>
<td>1.121</td>
<td>1.16</td>
</tr>
</tbody>
</table>

Exhibit 2-14: HBW Trip Attraction Rates for Retail Employment

| Employment Income | Area Type
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td>1</td>
<td>1.04</td>
<td>0.981</td>
<td>0.993</td>
<td>0.993</td>
<td>1.473</td>
</tr>
<tr>
<td>2</td>
<td>0.886</td>
<td>0.95</td>
<td>1.048</td>
<td>0.855</td>
<td>1.652</td>
</tr>
<tr>
<td>3</td>
<td>1.01</td>
<td>1.057</td>
<td>1.187</td>
<td>0.848</td>
<td>1.496</td>
</tr>
<tr>
<td>4</td>
<td>0.955</td>
<td>1.001</td>
<td>1.152</td>
<td>0.848</td>
<td>1.079</td>
</tr>
</tbody>
</table>
### Exhibit 2-15: HBW Trip Attraction Rates for Service Employment

<table>
<thead>
<tr>
<th>Employment Income</th>
<th>Area Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>1.438</td>
<td>1.448</td>
<td>1.166</td>
<td>1.166</td>
<td>1.427</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>1.65</td>
<td>1.383</td>
<td>1.181</td>
<td>1.349</td>
<td>1.676</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>1.705</td>
<td>1.459</td>
<td>1.214</td>
<td>1.599</td>
<td>1.599</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>1.843</td>
<td>1.472</td>
<td>1.326</td>
<td>1.695</td>
<td>1.695</td>
</tr>
</tbody>
</table>

### Exhibit 2-16: HNW Trip Attraction Rates

<table>
<thead>
<tr>
<th>Employment Type</th>
<th>Area Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td></td>
<td>0.215</td>
<td>0.315</td>
<td>0.315</td>
<td>0.222</td>
<td>0.222</td>
</tr>
<tr>
<td>Retail</td>
<td></td>
<td>2.155</td>
<td>2.479</td>
<td>6.682</td>
<td>8.598</td>
<td>11.124</td>
</tr>
<tr>
<td>Service</td>
<td></td>
<td>1.494</td>
<td>1.504</td>
<td>2.525</td>
<td>4.937</td>
<td>5.363</td>
</tr>
<tr>
<td>Households</td>
<td></td>
<td>0.288</td>
<td>0.288</td>
<td>0.288</td>
<td>0.288</td>
<td>0.288</td>
</tr>
</tbody>
</table>

### Exhibit 2-17: NHB Trip Attraction Rates

<table>
<thead>
<tr>
<th>Employment Type</th>
<th>Area Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td></td>
<td>0.575</td>
<td>0.575</td>
<td>0.737</td>
<td>0.737</td>
<td>0.737</td>
</tr>
<tr>
<td>Retail</td>
<td></td>
<td>1.034</td>
<td>1.378</td>
<td>2.271</td>
<td>3.092</td>
<td>4.316</td>
</tr>
<tr>
<td>Service</td>
<td></td>
<td>0.961</td>
<td>1.043</td>
<td>1.693</td>
<td>2.178</td>
<td>2.178</td>
</tr>
<tr>
<td>Households</td>
<td></td>
<td>0.251</td>
<td>0.251</td>
<td>0.251</td>
<td>0.251</td>
<td>0.251</td>
</tr>
</tbody>
</table>

### Exhibit 2-18: OTHER Trip Attraction Rates

<table>
<thead>
<tr>
<th>Employment Type</th>
<th>Area Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td></td>
<td>0.128</td>
<td>0.128</td>
<td>0.128</td>
<td>0.128</td>
<td>0.128</td>
</tr>
<tr>
<td>Retail</td>
<td></td>
<td>0.14</td>
<td>0.14</td>
<td>0.14</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>Service</td>
<td></td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
</tr>
<tr>
<td>Households</td>
<td></td>
<td>0.053</td>
<td>0.053</td>
<td>0.053</td>
<td>0.053</td>
<td>0.053</td>
</tr>
</tbody>
</table>

### Special Generators

Special generators, such as shopping malls and hospitals, attract more trips to the zone than the attraction rates presented in the previous section. In the case of NHB trips, the special generators also produce more trips. It is necessary to consider the impact of special generators to properly capture the travelers’ trip-making behavior.

The DFWRTM considers three types of special generators:
- Regional Shopping Malls with over 500,000 square feet
- Universities and Colleges with over 1,500 enrolled students
- Hospitals with over 300 service employees
The trip generation input data is DATA.DBF, which identifies inputs for special generators. The inputs for special generators are listed in Exhibit 2-19.

The field SGUNIT is defined differently based on different types of special generators. For regional shopping malls, this field is defined as a thousand square feet. For universities and colleges, it is defined as the number of students. For hospitals, this field is defined as the number of service employment which also is equal to field SGSERVICE.

<table>
<thead>
<tr>
<th>Fields</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGBASIC</td>
<td>Number of basic employment of the special generator</td>
</tr>
<tr>
<td>SGRETAIL</td>
<td>Number of retail employment of the special generator</td>
</tr>
<tr>
<td>SGSERVICE</td>
<td>Number of service employment of the special generator</td>
</tr>
<tr>
<td>SGUNIT</td>
<td>Number of units of the special generator</td>
</tr>
<tr>
<td>SGNAME</td>
<td>Name of the special generator</td>
</tr>
<tr>
<td>SGTYPE</td>
<td>Type of the special generator</td>
</tr>
<tr>
<td>SGHBWRATE</td>
<td>HBW trip rate per unit for the special generator</td>
</tr>
<tr>
<td>SGHNWRATE</td>
<td>HNW trip rate per unit for the special generator</td>
</tr>
<tr>
<td>SGNHRATE</td>
<td>NHB trip rate per unit for the special generator</td>
</tr>
<tr>
<td>SGTRKRATE</td>
<td>OTHER trip rate per unit for the special generator</td>
</tr>
</tbody>
</table>

In the DFWRTM, the program first calculates the regular trip attraction totals based on special generators’ employment figures and trip attraction rates previously presented in the trip attraction section. Second, the special generators’ actual trip attractions are obtained by multiplying each special generator’s trip rate by the total number of special generator units in the zone. Subsequently, the differences between the regular trip attractions and the special generators’ trip attractions are calculated for each zone. For HBW, HNW, and OTHER trip purposes, the increments are added to the zonal trip attractions. For NHB trips, half of the increments are added to the trip productions and the other half are added to the trip attractions.

In addition to regional shopping malls, universities, and hospitals, airports and external stations are also special generators requiring extra attention in the modeling process. In the DFWRTM, special treatments for airport trips and external trips are incorporated in the Trip Distribution module.

**Trip Balancing**

Regional trip productions and attractions are balanced for each trip purpose. This step is required because there is no guarantee that the estimated regional production equals the regional attraction totals. For HBW trips, the trip productions for each zone are proportionally adjusted so that the regional productions are equal to the regional attractions. For HNW, NHB, and OTHER trip purposes, the zonal trip attractions are proportionally adjusted so that the regional attractions are equal to the regional productions. Furthermore, NHB trips go through one additional step in which the trip productions of each zone are set equal to the attractions in that zone.
Roadway Network

After a roadway network is coded, it must be brought into the DFWRTM system before it can be used in a model run. The Create Roadway program brings the roadway network into the model system by checking required fields and putting the file into the expected format. The Copy Approach Links program creates zone centroids and approach links which will be used to load the traffic onto the network. The Roadway Preparation program prepares the roadway for skimming by copying loaded speeds and preparing the fields which will be used in later steps of the model run.

This chapter discusses the Create Roadway, Copy Approach Links, and Roadway Preparation programs and how they are used to prepare the roadway network.

Create Roadway

This program imports an E00 file or a TransCAD line geographic file, which is created through the roadway coding process, into a TransCAD link file that will be used for travel demand model runs. The input file contains the coded roadway and rail links for a specific year or scenario. The program creates a TransCAD file with nodes IDs more than 50,000 and checks the reasonableness of the input network. The program also creates a metadata file that is based on user input descriptive information and a report file that is based on the file contents. It also creates a general purpose TransCAD Network file to be used for transit coding.

Inputs

1. E00 file or TransCAD line geographic file (name and address) that contains the coded roadway and rail links.

2. Free speed parameters file that contains traffic control codes and delays associated with them. This file is called FreeSpeedParameters.DBF. This file is located in the folder: TCMODEL\ModelCalibrated\RoadwayNetwork\Data.

3. Roadway network file description for which this network is built. The description should contain the information that singles out this network from other networks. This will be part of the metadata of this file.

4. Name and program area of the person running the program. This will be part of the metadata of this file.
Steps

1. Get the name and location of the input file through browsing.

2. Create a folder under TCMODEL\RoadwayNetwork using the name provided in input 3. Make sure the name ends with the “RDWY” suffix. This is the location of all products of this program. If such a folder exists, the program displays a pop-up warning message to the user stating “Folder name [RDWY folder name] exists, please specify another name or exit the program.”

3. Copy the input file into the new folder and save it as RDWY.DBD.

4. Check the existence of the required fields and their types in the link layer as specified in Exhibit 3-1. If any required field is missing or its type does not match, report the error in an error log file and stop the program.

Exhibit 3-1: Required Fields for Roadway Link Layer

<table>
<thead>
<tr>
<th>No.</th>
<th>Field Name</th>
<th>Type</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LNKNM</td>
<td>INT</td>
<td>LinkName</td>
<td>&gt;= 0</td>
</tr>
<tr>
<td>2</td>
<td>TRDIR</td>
<td>INT</td>
<td>Direction code</td>
<td>1, one-way link and the topological direction is the same as traffic direction 2, two-way link</td>
</tr>
<tr>
<td>3</td>
<td>FUNCL</td>
<td>INT</td>
<td>Functional classification</td>
<td>1, Freeway 2, Principal Arterial 3, Minor Arterial 4, Collectors 6, Freeway Ramp 7, Frontage Road 8, HOV 9, Rail</td>
</tr>
<tr>
<td>4</td>
<td>DIVID</td>
<td>INT</td>
<td>Traffic directional division code</td>
<td>1, directionally divided or one-way road 2, directionally undivided road</td>
</tr>
<tr>
<td>5</td>
<td>INTVN</td>
<td>INT</td>
<td>Number of intervening controls</td>
<td>&gt;= 0</td>
</tr>
<tr>
<td>6</td>
<td>CNTRLA</td>
<td>INT</td>
<td>Traffic control device code at node A</td>
<td>1, No Control 2, Traffic Signal 5, Yield 6, Four-Way Stop 7, Two-Way Stop</td>
</tr>
<tr>
<td>7</td>
<td>CNTRLB</td>
<td>INT</td>
<td>Traffic control device code at node B</td>
<td>1, No Control 2, Traffic Signal 5, Yield 6, Four-Way Stop 7, Two-Way Stop</td>
</tr>
<tr>
<td>8</td>
<td>USER_LENGTH</td>
<td>INT</td>
<td>User specified link in miles times 100, overwriting geographical link length</td>
<td>&gt; 0, null</td>
</tr>
<tr>
<td>9</td>
<td>PKLNA</td>
<td>INT</td>
<td>number of lanes in peak period for AB direction</td>
<td>&gt;= 0</td>
</tr>
<tr>
<td>10</td>
<td>PKLNB</td>
<td>INT</td>
<td>number of lanes in peak period for BA direction</td>
<td>&gt;= 0</td>
</tr>
<tr>
<td>11</td>
<td>OPLNA</td>
<td>INT</td>
<td>number of lanes in off-peak period for AB direction</td>
<td>&gt;= 0</td>
</tr>
<tr>
<td>12</td>
<td>OPLNB</td>
<td>INT</td>
<td>number of lanes in off-peak period for BA direction</td>
<td>&gt;= 0</td>
</tr>
<tr>
<td>13</td>
<td>SPLTA</td>
<td>INT</td>
<td>speed limit in mph for AB direction</td>
<td>&gt;= 0</td>
</tr>
<tr>
<td>14</td>
<td>SPLTB</td>
<td>INT</td>
<td>speed limit in mph for BA direction</td>
<td>&gt;= 0</td>
</tr>
<tr>
<td>15</td>
<td>TOLLA</td>
<td>INT</td>
<td>toll value in cents for AB direction at toll booth</td>
<td>&gt;= 0</td>
</tr>
<tr>
<td>No.</td>
<td>Field Name</td>
<td>Type</td>
<td>Description</td>
<td>Value</td>
</tr>
<tr>
<td>-----</td>
<td>------------</td>
<td>------</td>
<td>-------------</td>
<td>---------</td>
</tr>
<tr>
<td>16</td>
<td>TOLLB</td>
<td>INT</td>
<td>toll value in cents for BA direction at toll booth</td>
<td>&gt;= 0</td>
</tr>
<tr>
<td>17</td>
<td>TOLLMILE</td>
<td>INT</td>
<td>toll value in cents per mile</td>
<td>&gt;= 0</td>
</tr>
</tbody>
</table>
| 18  | TOLLROAD   | INT  | code specifying the type of toll road the link belongs to | 0, link is not part of the toll road  
1, access to or part of toll road with toll booth (TOLLA or TOLLB specifies the toll value)  
2, access or part of toll road without toll booth (TOLLMILE specifies the toll value)  
3, managed lanes (HOV with toll) |
| 19  | CAPACITY   | INT  | saturation capacity in vehicle/lane/hour, overwriting default capacity values | >= 0    |
| 20  | EXC_TRUCK  | INT  | Truck exclusion code | > 0, trucks cannot use the link  
= 0, trucks can use the link |
| 21  | AMLN       | INT  | number of lanes for directional links in AB direction, overwriting PKLNA and makes PKLNB zero for AM period | >= 0    |
| 22  | PMLN       | INT  | number of lanes for directional links in AB direction, overwriting PKLNA and makes PKLNB zero for PM period | >= 0    |

5. Perform the range of value checks specified in Exhibit 3-2. Report the errors and warnings in the error log file. If errors are found, stop the program and refer the user to the error log file. If no errors are encountered, proceed to the next step.
Exhibit 3-2: Range of Values for Roadway Link Required Fields

<table>
<thead>
<tr>
<th>No.</th>
<th>Field Name</th>
<th>Value</th>
<th>Status</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LNKNM</td>
<td>[60000000, 70000000) for HOV [80000000, 90000000) for Rail Unique LNKNM Else</td>
<td>WRN</td>
<td>WRN_L1-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>TRDIR</td>
<td>[1, 2] else</td>
<td>OK</td>
<td>ERR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>FUNCL</td>
<td>[1,4],[6.9] else</td>
<td>OK</td>
<td>ERR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>DIVID</td>
<td>[1,2] else</td>
<td>OK</td>
<td>ERR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>INTVN</td>
<td>[0,2] &gt;2 else</td>
<td>OK</td>
<td>WRN</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>CNTRLA</td>
<td>[1,2] or [5,7] else</td>
<td>OK</td>
<td>ERR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>CNTRLB</td>
<td>[1,2] or [5,7] else</td>
<td>OK</td>
<td>ERR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>USER_LENGTH</td>
<td>&gt;0, null else</td>
<td>OK</td>
<td>ERR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>PKLNA</td>
<td>[0,6] &gt;6 else</td>
<td>OK</td>
<td>WRN</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>PKLB</td>
<td>[0,6] &gt;6 else</td>
<td>OK</td>
<td>WRN</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>OPLNA</td>
<td>[0,6] &gt;6 else</td>
<td>OK</td>
<td>WRN</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>OPLNB</td>
<td>[0,6] &gt;6 else</td>
<td>OK</td>
<td>WRN</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>SPLTA</td>
<td>[0,65] &gt;65 else</td>
<td>OK</td>
<td>WRN</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>SPLTB</td>
<td>[0,65] &gt;65 else</td>
<td>OK</td>
<td>WRN</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>TOLLA</td>
<td>&gt;=0 else</td>
<td>OK</td>
<td>ERR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>TOLLB</td>
<td>&gt;=0 else</td>
<td>OK</td>
<td>ERR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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WRN_L1-1 = Unexpected value for LINKID = LINKID, field name = fieldname
ERR_L1_1 = Value out of range for LINKID = LINKID, field name = fieldname

6. Perform the interdependence value checks as specified in Exhibit 3-3. Report the errors and warnings in the error log file. If errors are found, stop the program and refer the user to the error log file. If no error is encountered, proceed to the next step.
### Exhibit 3-3: Interdependence Field Value Check for Roadway Link Fields

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<td>SPLTb must be =0 for directional links</td>
</tr>
<tr>
<td>39</td>
<td>1</td>
<td>1</td>
<td>2,7</td>
<td>N/C</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>0</td>
<td>&gt;0</td>
<td>0</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>TOLLB must be =0 for directional links</td>
</tr>
<tr>
<td>40</td>
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<td>2,7</td>
<td>N/C</td>
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<td>&gt;0</td>
<td>&gt;0</td>
<td>0</td>
<td>&gt;0</td>
<td>0</td>
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<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>PKLNA must be =0 for AM or PM directional links</td>
</tr>
<tr>
<td>41</td>
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<td>&gt;0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>PKLNB must be =0 for one-way links</td>
</tr>
<tr>
<td>42</td>
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<td>&gt;0</td>
<td>&gt;0</td>
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<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>PKLNB must be =0 for one-way links</td>
</tr>
<tr>
<td>43</td>
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<td>1</td>
<td>2,7</td>
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<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>PKLNB must be =0 for one-way links</td>
</tr>
<tr>
<td>44</td>
<td>1</td>
<td>1</td>
<td>2,7</td>
<td>N/C</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>0</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>PKLNB must be =0 for one-way links</td>
</tr>
<tr>
<td>45</td>
<td>1</td>
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<td>&gt;0</td>
<td>&gt;0</td>
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<td>0</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>SPLTA must be &gt;0 for one-way links</td>
</tr>
<tr>
<td>46</td>
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<td>&gt;0</td>
<td>&gt;0</td>
<td>0</td>
<td>&gt;0</td>
<td>0</td>
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<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>SPLTb must be =0 for one-way links</td>
</tr>
<tr>
<td>47</td>
<td>1</td>
<td>1</td>
<td>2,7</td>
<td>N/C</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>0</td>
<td>&gt;0</td>
<td>0</td>
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<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>TOLLB must be =0 for one-way links</td>
</tr>
<tr>
<td>48</td>
<td>2</td>
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<td>N/C</td>
<td>N/C</td>
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<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>WRN</td>
<td>Two way freeway links</td>
</tr>
<tr>
<td>49</td>
<td>2</td>
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<td>N/C</td>
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<td>N/C</td>
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<td>N/C</td>
<td>N/C</td>
<td>WRN</td>
<td>Two way HOV links</td>
</tr>
<tr>
<td>50</td>
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<td>9</td>
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<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>AMLN must be =0 for rail links</td>
</tr>
<tr>
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<td>9</td>
<td>N/C</td>
<td>&gt;0</td>
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<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>PMLN must be =0 for rail links</td>
</tr>
<tr>
<td>52</td>
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<td>9</td>
<td>N/C</td>
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<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>PKLNA must be =1 for rail links</td>
</tr>
<tr>
<td>53</td>
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<td>N/C</td>
<td>9</td>
<td>N/C</td>
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<td>&lt;=1</td>
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<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>PKLNA must be =1 for rail links</td>
</tr>
<tr>
<td>54</td>
<td>2</td>
<td>N/C</td>
<td>9</td>
<td>N/C</td>
<td>&gt;0</td>
<td>&lt;=1</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>OPLNA must be =1 for rail links</td>
</tr>
<tr>
<td>No</td>
<td>TRDIR</td>
<td>DIVID</td>
<td>FUNCL</td>
<td>INTVN</td>
<td>AMLN</td>
<td>PKLNA</td>
<td>PKLN</td>
<td>OPLNA</td>
<td>OPLNB</td>
<td>SPLTA</td>
<td>SPLTB</td>
<td>TOLLA</td>
<td>TOLLB</td>
<td>Status</td>
<td>Message</td>
</tr>
<tr>
<td>----</td>
<td>--------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>------</td>
<td>-------</td>
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<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>--------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>55</td>
<td>2</td>
<td>N/C</td>
<td>9</td>
<td>N/C</td>
<td>0</td>
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<td>1</td>
<td>1</td>
<td>&gt;1</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>OPLNB must be =1 for rail links</td>
</tr>
<tr>
<td>56</td>
<td>2</td>
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<td>9</td>
<td>N/C</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>SPLTA must be &gt;0 for rail links</td>
</tr>
<tr>
<td>57</td>
<td>2</td>
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<td>9</td>
<td>N/C</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>&gt;0</td>
<td>0</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>SPLTB must be &gt;0 for rail links</td>
</tr>
<tr>
<td>58</td>
<td>2</td>
<td>N/C</td>
<td>[2,7]</td>
<td>N/C</td>
<td>&gt;0</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>WRN</td>
<td>AMLN must be =0 for two-way links</td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>2</td>
<td>N/C</td>
<td>[2,7]</td>
<td>N/C</td>
<td>&gt;0</td>
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<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>WRN</td>
<td>PMLN must be =0 for two-way links</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>2</td>
<td>N/C</td>
<td>[2,7]</td>
<td>N/C</td>
<td>0</td>
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<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>PKLNA must be &gt;0 for two-way links</td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>2</td>
<td>N/C</td>
<td>[2,8]</td>
<td>N/C</td>
<td>0</td>
<td>&gt;0</td>
<td>0</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>PKLN must be &gt;0 for two-way links</td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>2</td>
<td>N/C</td>
<td>[2,7]</td>
<td>N/C</td>
<td>0</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>0</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>WRN</td>
<td>OPLNA must be &gt;0 for two-way links</td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>2</td>
<td>N/C</td>
<td>[2,7]</td>
<td>N/C</td>
<td>0</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>0</td>
<td>N/C</td>
<td>N/C</td>
<td>N/C</td>
<td>WRN</td>
<td>OPLNB must be &gt;0 for two-way links</td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>2</td>
<td>N/C</td>
<td>[2,7]</td>
<td>N/C</td>
<td>0</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>0</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>SPLTA must be &gt;0 for two-way links</td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>2</td>
<td>N/C</td>
<td>[2,7]</td>
<td>N/C</td>
<td>0</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>0</td>
<td>N/C</td>
<td>N/C</td>
<td>ERR</td>
<td>SPLTB must be &gt;0 for two-way links</td>
</tr>
<tr>
<td>66</td>
<td>[8,9]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ERR</td>
<td>User-length value missing for func&gt;=8</td>
<td></td>
</tr>
<tr>
<td>67</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ERR</td>
<td>Tollmile value missing for tollroad=2</td>
<td></td>
</tr>
<tr>
<td>68</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ERR</td>
<td>LENGTH &lt;= 0.00999 and USER-LENGTH = null</td>
<td></td>
</tr>
</tbody>
</table>

N/C = No checks required for the field
N/A = Not applicable
7. Renumber node IDs sequentially starting from 50,000.

8. Add the fields specified in Exhibit 3-4 to the node layer. These fields are not populated in this program.

**Exhibit 3-4: Added Fields to Coded Node Layer**

<table>
<thead>
<tr>
<th>No.</th>
<th>Field Name</th>
<th>Type</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CENTROID</td>
<td>INT</td>
<td>Specifies if a node is a centroid</td>
<td>=1, if node is a centroid</td>
</tr>
<tr>
<td>2</td>
<td>PANDR</td>
<td>INT</td>
<td>Specifies if a node is a park-and-ride node</td>
<td>=1, if node is a park and ride node</td>
</tr>
<tr>
<td>3</td>
<td>TRXFER</td>
<td>INT</td>
<td>Specifies if a node is a transit transfer station</td>
<td>=1, if node is a transfer station</td>
</tr>
</tbody>
</table>

9. Add fields to the link layer and populate them as specified in Exhibit 3-5.

**Exhibit 3-5: Added Fields to Coded Line Layer**

<table>
<thead>
<tr>
<th>No</th>
<th>Field Name</th>
<th>Type</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PKLN_AB</td>
<td>INT</td>
<td>Number of lanes in peak period for AB direction</td>
<td>Look at Calculation Procedure 1</td>
</tr>
<tr>
<td>2</td>
<td>PKLN_BA</td>
<td>INT</td>
<td>Number of lanes in peak period for BA direction</td>
<td>Look at Calculation Procedure 1</td>
</tr>
<tr>
<td>3</td>
<td>OPLN_AB</td>
<td>INT</td>
<td>Number of lanes in OP period for AB direction</td>
<td>Look at Calculation Procedure 1</td>
</tr>
<tr>
<td>4</td>
<td>OPLN_BA</td>
<td>INT</td>
<td>Number of lanes in OP period for BA direction</td>
<td>Look at Calculation Procedure 1</td>
</tr>
<tr>
<td>5</td>
<td>SPLT_AB</td>
<td>INT</td>
<td>Speed limit for AB direction</td>
<td>=SPLTA</td>
</tr>
<tr>
<td>6</td>
<td>SPLT_BA</td>
<td>INT</td>
<td>Speed limit for BA direction</td>
<td>=SPLTB</td>
</tr>
<tr>
<td>7</td>
<td>TOLL_AB</td>
<td>INT</td>
<td>Toll value in cents for AB direction at toll booth</td>
<td>=TOLLA, set null value to 0</td>
</tr>
<tr>
<td>8</td>
<td>TOLL_BA</td>
<td>INT</td>
<td>Toll value in cents for BA direction at toll booth</td>
<td>=TOLLB, set null value to 0</td>
</tr>
<tr>
<td>9</td>
<td>RTSTEMP</td>
<td>INT</td>
<td>Temporary field used for Transit coding</td>
<td>=1</td>
</tr>
<tr>
<td>10</td>
<td>LinkMode</td>
<td>INT</td>
<td>Used in transit modeling</td>
<td>=1</td>
</tr>
<tr>
<td>11</td>
<td>A_PK</td>
<td>REAL</td>
<td>Volume delay function parameter A for a.m. and p.m. periods</td>
<td>=0.015, if FUNCL=1,6,8</td>
</tr>
<tr>
<td>12</td>
<td>B_PK</td>
<td>REAL</td>
<td>Volume delay function parameter B for a.m. and p.m. periods</td>
<td>=6.0, if FUNCL=1,6,8</td>
</tr>
<tr>
<td>13</td>
<td>C_PK</td>
<td>REAL</td>
<td>Volume delay function parameter C for a.m. and p.m. periods</td>
<td>= 4.0, if FUNCL=1,6,8</td>
</tr>
<tr>
<td>14</td>
<td>A_OP</td>
<td>REAL</td>
<td>Volume delay function parameter A for off-peak period</td>
<td>=0.015, if FUNCL=1,6,8</td>
</tr>
<tr>
<td>15</td>
<td>B_OP</td>
<td>REAL</td>
<td>Volume delay function parameter B for off-peak period</td>
<td>=6.0, if FUNCL=1,6,8</td>
</tr>
<tr>
<td>16</td>
<td>C_OP</td>
<td>REAL</td>
<td>Volume delay function parameter C for off-peak period</td>
<td>= 4.0, if FUNCL=1,6,8</td>
</tr>
<tr>
<td>17</td>
<td>MODEL_LENGTH</td>
<td>REAL</td>
<td>Link length in miles</td>
<td>=User_length/100, if User_length&gt;0</td>
</tr>
</tbody>
</table>
10. Build a network from a line layer geographic file with the parameters as described below. The complete Create Network form is shown in Exhibit 3-6.

   a. Create a selection set of FUNCL>0 AND FUNCL<=9; call this selection “FUNCL 1-9”

   b. Create a network file with the following settings:

      i. Create links from: FUNCL 1-9

      ii. Read length from: RTSTEMP

      iii. Other node fields: CENTROID

      iv. Check “drop duplicate link” option

      v. Input network description: “Noapp network”

   c. Press OK and save this network as ALLNET.net.

   Exhibit 3-6: Create Network Form

Examples

Examples of coding the number of lanes for a regular freeway section, a regular HOV section, and a directional HOV section are shown in Exhibits 3-7, 3-8, and 3-9 respectively.
Exhibit 3-7: Number of Lanes Coding Example – Regular Freeway Section

Real World Network

<table>
<thead>
<tr>
<th>AM</th>
<th>OP</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Model Network

Regular Freeway Section
Exhibit 3-8: Number of Lanes Coding Example – Regular HOV Section
### Exhibit 3-9: Example of Coding Number of Lanes for a Directional Freeway – Directional HOV Section

<table>
<thead>
<tr>
<th>Real World Network</th>
<th>Model Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>PMLN, MB=1</td>
</tr>
<tr>
<td></td>
<td>PMLN, MB=0</td>
</tr>
<tr>
<td></td>
<td>CFLN, MB=0</td>
</tr>
<tr>
<td></td>
<td>CFLN, MB=0</td>
</tr>
<tr>
<td></td>
<td>CFLN, MB=0</td>
</tr>
<tr>
<td></td>
<td>CFLN, MB=0</td>
</tr>
<tr>
<td></td>
<td>AMNL, AD=3</td>
</tr>
<tr>
<td></td>
<td>AMNL, AD=0</td>
</tr>
<tr>
<td></td>
<td>OPNL, AD=3</td>
</tr>
<tr>
<td></td>
<td>OPNL, AD=0</td>
</tr>
<tr>
<td></td>
<td>PMLN, AD=2</td>
</tr>
<tr>
<td></td>
<td>PMLN, AD=0</td>
</tr>
<tr>
<td>OP</td>
<td>PMLN, MB=0</td>
</tr>
<tr>
<td></td>
<td>CFLN, MB=0</td>
</tr>
<tr>
<td></td>
<td>CFLN, MB=0</td>
</tr>
<tr>
<td></td>
<td>CFLN, MB=0</td>
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</tr>
<tr>
<td></td>
<td>AMNL, AD=3</td>
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<tr>
<td></td>
<td>AMNL, AD=0</td>
</tr>
<tr>
<td></td>
<td>OPNL, AD=3</td>
</tr>
<tr>
<td></td>
<td>OPNL, AD=0</td>
</tr>
<tr>
<td></td>
<td>PMLN, AD=2</td>
</tr>
<tr>
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<td>PMLN, AD=0</td>
</tr>
<tr>
<td>PM</td>
<td>PMLN, MB=0</td>
</tr>
<tr>
<td></td>
<td>CFLN, MB=0</td>
</tr>
<tr>
<td></td>
<td>CFLN, MB=0</td>
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<tr>
<td></td>
<td>CFLN, MB=0</td>
</tr>
<tr>
<td></td>
<td>CFLN, MB=0</td>
</tr>
<tr>
<td></td>
<td>AMNL, AD=3</td>
</tr>
<tr>
<td></td>
<td>AMNL, AD=0</td>
</tr>
<tr>
<td></td>
<td>OPNL, AD=3</td>
</tr>
<tr>
<td></td>
<td>OPNL, AD=0</td>
</tr>
<tr>
<td></td>
<td>PMLN, AD=2</td>
</tr>
<tr>
<td></td>
<td>PMLN, AD=0</td>
</tr>
</tbody>
</table>

**Directional Freeway - Directional HOV Section**
Copy Approach Links

Approach links are an important component of a roadway network. In four-step travel demand modeling, all the trips originate or end at the centroids and are distributed to the network through the approach links.

Zones in the roadway network are represented as zone centroid points. Centroids are often the center of gravity of the zone, and their coordinates are calculated mathematically. However, if the zone shape is concave, the center of gravity may fall outside of the boundary of the zone; since this placement is undesirable, the centroid is located manually in these cases.

Approach links provide a connection between the zone layer and the roadway and transit network layers. Unlike other links, these links do not match any physical entity in the real world. The number and positions of the approach links determine how the traffic is loaded onto the network. In order to replicate real life traffic conditions, there is generally more than one approach link for each zone. The current implementation of the program only connects the approach links to the nodes in the network; an alternative method would be to allow mid-block connections which connect to the middle of a link.

The approach links of the base year network, 1999, were created with the help of the TransCAD centroid connector generator and edited manually. While zonal boundaries are basically kept constant in DFWRTM, roadway networks change for different analyses. The Copy Approach Link program enables the user to copy centroid connectors from an existing network with centroid connectors to a new roadway network. This process provides consistency among different model runs, since the loading of demand to the network is kept similar. Note that this process does not provide the exact replication of the centroid connectors due to changes to the roadway network. Manual inspection of the output is necessary, particularly where the two roadway networks are different. To help the user check for reasonable connectors, the program generates an approach link text report which provides centroid numbers where problems may have occurred.

Inputs

1. RDWY.DBD – Roadway Network file that contains the demographic and roadway network.

2. TSZ.DBD – Zone Layer file which defines the model zonal boundaries.

3. APPRDWY.DBD – “Copy From” Roadway Network; this file contains centroids and centroid connectors (approach links). The approach links will be copied from this network to the “Copy To” roadway network defined by RDWY.DBD.

Output

1. APPRDWY.DBD – Roadway Network, RDWY.DBD, with centroids and centroid connectors added.

2. APPLINKREP.TXT – Approach Link program report file. It lists the inputs to the program, the number of approach links in the source roadway, the number of
approach links transferred, and a list of centroids that were involved in any approach link transfer errors.

Logic

The steps for the copy approach links process are detailed below. The flow chart in Example 3-10 also summarizes this process.

- First the information in the RDWY.DBD is copied to create the new APPRDWY.DBD.

- Then, the centroid nodes of the “Copy From” network are selected (selection in the node layer: CENTROID>0), and added to the new APPRDWY.DBD. The copied information includes the coordinates and the TSZ id; the TSZ id will become the node’s id. The centroid field of the node is also filled with the value 1 to show that it is a centroid.

- Open the approach link layer of the “Copy From” network. For each approach link in the network, do the following:
  - Get the two end nodes of the approach link. For each approach link, one node is a centroid and the other is a regular node. Find out which one is the centroid and which is not and get their coordinates.
  - Search in the node layer of the new APPRDWY for the nodes that are nearest to the regular node within a certain distance (5 miles). If the nearest one is a centroid, then discard it and try the next nearest node until a non-centroid node is found. If a non-centroid node cannot be found within the distance, then the particular approach link will not be copied.
  - To prevent duplication of approach links, check if the approach link has already been created. If there is no duplication, the approach link is added.
  - Because of network changes or node location changes, there may be some approach links that are not copied; the total number of approach links in the new network is always equal to or less than that the number in the “Copy From” or source network.
  - Repeat the process for the each approach link in the “Copy From”/source network.
Exhibit 3-10: Flow Chart for Copy Approach Links Program

1. Read RDWY.DBD and TSZ.DBD.
2. Create APPRDWY.DBD and copy data from RDWY.DBD.
3. Copy the centroids.
4. Get next approach link to be copied.
5. In “Copy From” network, determine the centroid node and regular node of the approach link to be copied.
6. In “Copy To” network, search within 5 miles of the regular node and find the nearest non-centroid nodes in the node.
7. If the approach link does not already exist in “Copy To” network, add the approach link.
8. Repeat steps for each approach link to be copied.
10. Save APPRDWY.dbd as the output.
The Roadway Preparation program imports a TransCAD roadway file which contains approach links, and prepares the roadway for skimming by creating fields that will be used downstream in the model run and initializing values of some of these fields.

**Inputs**

APPRDWY.DBD – A TransCAD geographic file that contains the approach links.

ACTRDWY.DBD – A TransCAD geographic file from another model run from which initial times will be borrowed.

FreeSpeedParameters.DBF – a Free Speed Parameters file which relates functional class, area type, control A and control B with a value for delay in the AB and BA direction.

CPIFactors.DBF – A CPI Factors file where each row lists a year and the Consumer Price Index for that year.

TSZ.DBD – The zone layer file which will be used to identify the TSZ which each link belongs to; this process is called tagging in TransCAD.

PATRIPS.DBF – A file produced from the Trip Generation module which associates the TSZ with an area type. This PATRIPS.DBF used will correspond to the Zonal Activity folder chosen.

Toll Value Year – A year for which toll values are adjusted to 1999 based on CPI Factors. It should represent the year for which toll values have been coded.

**Steps**

The Roadway Preparation Program proceeds through the following steps.

1. Set up the data arrays.
   a. AMFactor, PMFactor, OPFactor – These factors are used in the conversion of capacity from hourly to time period. Factors are defined by functional class 1-8 and listed in Exhibit 3-11. These factors were changed in July 2005 and documented in “Capacity factors_RE 1999 New Run vs. Run 243 Comparison.”

**Exhibit 3-11: Capacity Conversion of Factors from Hourly to Time Period**

<table>
<thead>
<tr>
<th>TIME PERIOD</th>
<th>Freeway</th>
<th>Principal Arterial</th>
<th>Minor Arterial</th>
<th>Collector</th>
<th>Freeway Ramp</th>
<th>Frontage Road</th>
<th>HOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>2.3</td>
<td>2.1</td>
<td>2.1</td>
<td>2.1</td>
<td>2.3</td>
<td>2.1</td>
<td>2.3</td>
</tr>
<tr>
<td>PM</td>
<td>3.2</td>
<td>2.9</td>
<td>2.9</td>
<td>2.9</td>
<td>3.2</td>
<td>2.9</td>
<td>3.2</td>
</tr>
<tr>
<td>OP</td>
<td>10.0</td>
<td>9.2</td>
<td>9.2</td>
<td>9.2</td>
<td>10.0</td>
<td>9.2</td>
<td>10.0</td>
</tr>
</tbody>
</table>
b. Roadway Approach Link Speeds – The Roadway Approach Link speeds are off-peak and peak speeds for each area type; the speeds are listed in Exhibit 3-12.

Exhibit 3-12: Centroid Speed by Area Type and Time Period

<table>
<thead>
<tr>
<th>Area Type</th>
<th>Off-Peak Speed</th>
<th>Peak Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Business District (CBD)</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td>Outer Business District</td>
<td>23</td>
<td>13</td>
</tr>
<tr>
<td>Urban Residential</td>
<td>27</td>
<td>17</td>
</tr>
<tr>
<td>Suburban Residential</td>
<td>33</td>
<td>21</td>
</tr>
<tr>
<td>Rural</td>
<td>39</td>
<td>23</td>
</tr>
</tbody>
</table>

c. Hourly Capacity Per Lane (Divided or One-Way Roads) – The hourly capacity per lane for divided roads is given by area type and functional class in Exhibit 3-13.

Exhibit 3-13: Hourly Capacity Per Lane – Divided or One-Way Roads

<table>
<thead>
<tr>
<th>Area Type</th>
<th>Functional Class</th>
<th>Freeway</th>
<th>Principal Arterial</th>
<th>Minor Arterial</th>
<th>Collector</th>
<th>Freeway Ramp</th>
<th>Frontage Road</th>
<th>HOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBD</td>
<td>Freeway</td>
<td>2050</td>
<td>725</td>
<td>725</td>
<td>475</td>
<td>1250</td>
<td>725</td>
<td>2050</td>
</tr>
<tr>
<td>Outer Business District</td>
<td>Freeway</td>
<td>2125</td>
<td>775</td>
<td>775</td>
<td>500</td>
<td>1375</td>
<td>775</td>
<td>2125</td>
</tr>
<tr>
<td>Urban Residential</td>
<td>Freeway</td>
<td>2150</td>
<td>850</td>
<td>825</td>
<td>525</td>
<td>1425</td>
<td>850</td>
<td>2150</td>
</tr>
<tr>
<td>Suburban Residential</td>
<td>Freeway</td>
<td>2225</td>
<td>925</td>
<td>900</td>
<td>575</td>
<td>1600</td>
<td>900</td>
<td>2225</td>
</tr>
<tr>
<td>Rural</td>
<td>Freeway</td>
<td>2300</td>
<td>1025</td>
<td>975</td>
<td>600</td>
<td>1725</td>
<td>975</td>
<td>2300</td>
</tr>
</tbody>
</table>

d. Hourly Capacity Per Lane (Undivided Roads) – The hourly capacity per lane for undivided roads is given by area type and functional class in Exhibit 3-14.

1 The values in the body of the table are expressed in passenger cars per hour per lane (pcphpl). They correspond to volumes at level-of-service (LOS) E. The calculation of LOS requires the conversion of the model volume to passenger car equivalents (PCE). These adjustments are treated in an aggregate manner in the travel model based on the actual field data on the freeway network as follows:

<table>
<thead>
<tr>
<th>LOS</th>
<th>AM Volume Adjustment Factor</th>
<th>PM Volume Adjustment Factor</th>
<th>Upper Threshold for Volume to Capacity Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B, C</td>
<td>1.06</td>
<td>1.00</td>
<td>0.65</td>
</tr>
<tr>
<td>D or E</td>
<td>1.18</td>
<td>1.25</td>
<td>1.00</td>
</tr>
</tbody>
</table>

The model volumes are taken from the AMHRVOL_AB / AMHRVOL_BA or PMHRVOL_AB / PMHRVOL_BA fields. The corresponding capacity values are taken from the AMHRCAP_AB / AMHRCAP_BA or PMHRCAP_AB / PMHRCAP_BA fields respectively.
### Exhibit 3-14: Hourly Capacity Per Lane – Undivided Roads

<table>
<thead>
<tr>
<th>Area Type</th>
<th>Freeway</th>
<th>Principal Arterial</th>
<th>Minor Arterial</th>
<th>Collector</th>
<th>Freeway Ramp</th>
<th>Frontage Road</th>
<th>HOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBD</td>
<td>N/A</td>
<td>650</td>
<td>650</td>
<td>425</td>
<td>1250</td>
<td>650</td>
<td>N/A</td>
</tr>
<tr>
<td>Outer Business District</td>
<td>N/A</td>
<td>725</td>
<td>725</td>
<td>450</td>
<td>1375</td>
<td>725</td>
<td>N/A</td>
</tr>
<tr>
<td>Urban Residential</td>
<td>N/A</td>
<td>775</td>
<td>750</td>
<td>475</td>
<td>1425</td>
<td>750</td>
<td>N/A</td>
</tr>
<tr>
<td>Suburban Residential</td>
<td>N/A</td>
<td>875</td>
<td>825</td>
<td>525</td>
<td>1600</td>
<td>825</td>
<td>N/A</td>
</tr>
<tr>
<td>Rural</td>
<td>N/A</td>
<td>925</td>
<td>875</td>
<td>550</td>
<td>1725</td>
<td>875</td>
<td>N/A</td>
</tr>
</tbody>
</table>

e. Peak and off-peak ratios are used for estimating the initial loaded travel times. The peak and off-peak ratios are calculated for each functional class and area type pair.

\[
pkRatio_{fa} = \begin{cases} 
\frac{\sum^{\text{Old PKFRTIME}_{fa}}_{fa}}{\sum^{\text{Old PKTIME}_{fa}}_{fa}}, & \text{if } \sum^{\text{Old PKFRTIME}_{fa}}_{fa} > \sum^{\text{Old PKTIME}_{fa}}_{fa} > 0, \\
0.999, & \text{Otherwise} 
\end{cases}
\]

\[
opRatio_{fa} = \begin{cases} 
\frac{\sum^{\text{Old OPTIME}_{fa}}_{fa}}{\sum^{\text{Old OPFRTIME}_{fa}}_{fa}}, & \text{if } \sum^{\text{Old OPTIME}_{fa}}_{fa} > \sum^{\text{Old OPFRTIME}_{fa}}_{fa} > 0, \\
0.999, & \text{Otherwise} 
\end{cases}
\]

where

\( f \) = functional class between 1 and 8.

\( a \) = area type.

\( \sum^{\text{Old PKFRTIME}_{fa}}_{fa} \) = Sum of peak free travel time from the “Copy From” roadway for functional class \( f \) and area type \( a \). The peak free travel times are taken from the PKFRTIME_AB and PKFRTIME_BA fields from the ACTRDWY.DBD.

\( \sum^{\text{Old PKTIME}_{fa}}_{fa} \) = Sum of peak loaded travel time from the “Copy From” roadway for functional class \( f \) and area type \( a \). The peak loaded travel times are taken from the PKTIME_AB and PKTIME_BA fields from the ACTRDWY.DBD.
\( \sum_{f \in \mathbb{F}} \text{OPFRTIME}_{f, a} \) = Sum of off-peak free travel time from the “Copy From” roadway for functional class \( f \) and area type \( a \). The off-peak free travel times are taken from the \( \text{OPFRTIME\_AB} \) and \( \text{OPFRTIME\_BA} \) fields from the \( \text{ACTRDWY\_DBD} \).

\( \sum_{f \in \mathbb{F}} \text{OPTIME}_{f, a} \) = Sum of off-peak loaded travel time from the “Copy From” roadway for functional class \( f \) and area type \( a \). The off-peak loaded travel times are taken from the \( \text{OPTIME\_AB} \) and \( \text{OPTIME\_BA} \) fields from the \( \text{ACTRDWY\_DBD} \).

2. Create a Zonal Activity folder under TCMODEL\RoadwayNetwork\[RDWY]\[GEO]. If the folder of the specified name already exists, then notify the user that it already exists, and exit the program.

3. Create a copy of the \( \text{APPRDWY\_DBD} \) called \( \text{ACTRDWY\_DBD} \) in the newly created Zonal Activity Folder TCMODEL\RoadwayNetwork\[RDWY]\[GEO]\[ACT].

4. Compute the ratio of free flow travel time to loaded travel time for peak and off-peak periods on the AB and BA direction of all links.
   a. If the ratio is greater than 1, report the error in the error log as “ERR: In old ACTRDWY file, free flow time is more than loaded time” and exit the application.
   b. If the peak or off-peak loaded travel time is 0 or \( \text{OPTIME} = 0 \), report the error in the error log as “ERR: In old ACTRDWY file, loaded time has not been set” and exit the application. This is done so the program does not attempt to divide by 0.

5. Create TSZ and AREATYPE fields in the node and line layers of the \( \text{ACTRDWY\_DBD} \) file. The definitions of the new fields are provided in Exhibit 3-15.

Exhibit 3-15: Added Fields to Coded Node and Line Layers

<table>
<thead>
<tr>
<th>No</th>
<th>Field Name</th>
<th>Type</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TSZ</td>
<td>INT</td>
<td>TSZ of the Node or Link</td>
<td>Value in TSZ_DBD’s TSZ Field</td>
</tr>
<tr>
<td>2</td>
<td>AREATYPE</td>
<td>INT</td>
<td>Area Type of the Node or Link</td>
<td>Range of Value: 1-5</td>
</tr>
</tbody>
</table>

Area Type is taken from \( \text{PATRIPS\_DBF} \); it is the value of the AREATYPE field corresponding the TSZ value of the TSZ of the Link.

6. Calculate the CPI Parameter based on the toll value year. Look up the toll value year specified in the Roadway Prep program inputs in the CPI Factors table to find the corresponding CPI parameter. If there is no CPI value for the specified year, report the error in the error log as “ERR: NO CPI can be found for input year,” and exit the application.

7. Assign a TSZ and an AREATYPE to each node and link.
   a. Assign a TSZ and an AREATYPE to all nodes.
      i. Fill the TSZ field in the node layer by tagging the field with the TSZ field in the TSZ layer. The tagging process in TransCAD will match the node with the TSZ that it lies within.
ii. If a node is not tagged with a TSZ, create a selection set of the closest nodes within a 2 mile radius. Fill the TSZ with the nearest node’s value where the TSZ is not null and is not an external TSZ; external TSZ have a value of 20,000 – 30,000.

iii. If a node has an ID less than 50,000, then it is a centroid. A centroid’s TSZ value is set to their node ID.

iv. If a node is assigned a TSZ that is not found in the TSZ layer, report the error in the error log as “ERR: Node could not be associated with a TSZ,” and exit the application.

v. If a node has a null TSZ, report the error in the error log as “ERR: Null TSZ found for Node id,” and exit the application.

vi. The area type of a node is the same as the area type of the TSZ to which it belongs. If a node is assigned a TSZ found in the PATRIPS.DBF file, set the AREATYPE of the node to the corresponding area type of the TSZ.

b. Assign a TSZ to all links.

i. Fill the TSZ field in the line layer by tagging the field with the TSZ field in the TSZ layer.

ii. For each approach link, overwrite the TSZ assigned with the centroid it is connected to. A centroid is a node whose Node ID is < 50,000.

iii. If a link is not tagged, set the TSZ value to the TSZ of one of its endpoints. If the first endpoint is a centroid, then use the TSZ of the first endpoint; otherwise, use the second endpoint.

iv. If an approach link is assigned a TSZ that is not found in the TSZ layer or an approach link is not assigned a TSZ, report the error in the error log as “ERR: Link could not be associated with a TSZ. Neither endpoint is a centroid,” and exit the application.

v. If a link is assigned a TSZ that is not found in the TSZ layer or a link is not assigned a TSZ, report the error in the error log as “ERR: Link could not be associated with a TSZ,” and exit the application.

c. Assign AREATYPE to Links.

i. Area types of TSZs are found in PATRIPS.DBF. The area type of the link is the same as the area type of the TSZ it corresponds to. If a link is assigned a TSZ found in the PATRIPS.DBF file, set the AREATYPE of the link to the corresponding areatype of the TSZ.

ii. If a link is not assigned an Areatype, report the error in the error log as “ERR: AreaType not found for Line id,” and exit the application.

8. Confirm the existence and population of the CAPACITY field in the line layer of the ACTRDWY.DBD file created in step 3. Prior to DFWRTM version 3, these fields were created and populated in Roadway Preparation, but have since been created and populated in the Create Roadway program.
9. Confirm the existence and population of fields created in the Create RDWY program. These fields were originally created and populated in the Roadway Preparation program, but have since been moved to the Create RDWY program module.

a. MODEL_LENGTH

10. Add Fields to the line layer. If the fields already exist, clear the fields. The list of added fields is given Exhibit 3-16.

Exhibit 3-16: Added Fields to Coded Line Layer

<table>
<thead>
<tr>
<th>No</th>
<th>Field Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MODEL_LENGTH</td>
<td>Real</td>
<td>Link length in miles</td>
</tr>
<tr>
<td>2</td>
<td>AMLN_AB</td>
<td>Integer</td>
<td>Number of lanes in a.m. peak period for AB direction</td>
</tr>
<tr>
<td>3</td>
<td>AMLN_BA</td>
<td>Integer</td>
<td>Number of lanes in a.m. peak period for BA direction</td>
</tr>
<tr>
<td>4</td>
<td>PMLN_AB</td>
<td>Integer</td>
<td>Number of lanes in p.m. peak period for AB direction</td>
</tr>
<tr>
<td>5</td>
<td>PMLN_BA</td>
<td>Integer</td>
<td>Number of lanes in p.m. peak period for BA direction</td>
</tr>
<tr>
<td>6</td>
<td>AMHRCAP_AB</td>
<td>Real</td>
<td>Hourly capacity in a.m. period for AB direction (vehicle/lane/hour)</td>
</tr>
<tr>
<td>7</td>
<td>AMHRCAP_BA</td>
<td>Real</td>
<td>Hourly capacity in a.m. period for BA direction (vehicle/hour)</td>
</tr>
<tr>
<td>8</td>
<td>PMHRCAP_AB</td>
<td>Real</td>
<td>Hourly capacity in p.m. period for AB direction (vehicle/hour)</td>
</tr>
<tr>
<td>9</td>
<td>PMHRCAP_BA</td>
<td>Real</td>
<td>Hourly capacity in p.m. period for BA direction (vehicle/hour)</td>
</tr>
<tr>
<td>10</td>
<td>OPHRCAP_AB</td>
<td>Real</td>
<td>Hourly capacity in off-peak period for AB direction (vehicle/hour)</td>
</tr>
<tr>
<td>11</td>
<td>OPHRCAP_BA</td>
<td>Real</td>
<td>Hourly capacity in off-peak period for BA direction (vehicle/hour)</td>
</tr>
<tr>
<td>12</td>
<td>AMCAP_AB</td>
<td>Real</td>
<td>Capacity in a.m. period for AB direction</td>
</tr>
<tr>
<td>13</td>
<td>AMCAP_BA</td>
<td>Real</td>
<td>Capacity in a.m. period for BA direction</td>
</tr>
<tr>
<td>14</td>
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<td>Capacity in p.m. period for AB direction</td>
</tr>
<tr>
<td>15</td>
<td>PMCAP_BA</td>
<td>Real</td>
<td>Capacity in p.m. period for BA direction</td>
</tr>
<tr>
<td>16</td>
<td>OPCAP_AB</td>
<td>Real</td>
<td>Capacity in off-peak period for AB direction</td>
</tr>
<tr>
<td>17</td>
<td>OPCAP_BA</td>
<td>Real</td>
<td>Capacity in off-peak period for BA direction</td>
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<td>Free flow time in a.m. and p.m. periods for AB direction (minutes)</td>
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<td>Free flow time in a.m. and p.m. periods for BA direction (minutes)</td>
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<td>26</td>
<td>OPSPD_AB</td>
<td>Real</td>
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</tr>
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<td>27</td>
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<td>Real</td>
<td>Loaded link travel speed in off-peak for BA direction (mph)</td>
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<td>Adjusted dollar value for passing through link for drive alone class for AB direction ($)</td>
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<td>Free flow time in a.m. and p.m. periods for BA direction (minutes)</td>
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<td>Free flow time in off-peak periods for AB direction (minutes)</td>
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<td>35</td>
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<td>Real</td>
<td>Free flow time in off-peak periods for BA direction (minutes)</td>
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<td>Type</td>
<td>Description</td>
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<td>PMTIME_BA</td>
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<td>Loaded link travel time in p.m. peak periods for BA direction (minutes)</td>
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<td>OPTIME_AB</td>
<td>Real</td>
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<tr>
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<td>52</td>
<td>RAILTIME_AB</td>
<td>Real</td>
<td>Link travel time on rail for AB direction (minutes)</td>
</tr>
<tr>
<td>53</td>
<td>RAILTIME_BA</td>
<td>Real</td>
<td>Link travel time on rail for BA direction (minutes)</td>
</tr>
<tr>
<td>54</td>
<td>WALKTIME</td>
<td>Real</td>
<td>Walk time on link (minutes)</td>
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<td>Total link volume in a.m. period for AB direction</td>
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<tr>
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<td>AMVOL_BA</td>
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<td>Total link volume in a.m. period for BA direction</td>
</tr>
<tr>
<td>57</td>
<td>PMVOL_AB</td>
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<td>Total link volume in p.m. period for AB direction</td>
</tr>
<tr>
<td>58</td>
<td>PMVOL_BA</td>
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<td>Total link volume in p.m. period for BA direction</td>
</tr>
<tr>
<td>59</td>
<td>OPVOL_AB</td>
<td>Real</td>
<td>Total link volume in off-peak period for AB direction</td>
</tr>
<tr>
<td>60</td>
<td>OPVOL_BA</td>
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<td>Total link volume in off-peak period for BA direction</td>
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</table>

11. For each link in the line layer, fill line layer fields where information is available. Other fields not listed here will be populated during the course of the model run execution. The formulas used for filling fields are provided in Exhibit 3-17.
<table>
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<tr>
<th>FIELD</th>
<th>FUNCL=9</th>
<th>FUNCL=0</th>
<th>FUNCL = {1,4,6,8}</th>
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<td>LENGTH</td>
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<td>See Number of Lanes Calculation Procedure</td>
<td>See Number of Lanes Calculation Procedure</td>
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<td>MODEL_LENGTH*60/SPLT_AB</td>
<td>null</td>
<td>null</td>
</tr>
<tr>
<td>RAILTIME_BA</td>
<td>MODEL_LENGTH*60/SPLT_BA</td>
<td>null</td>
<td>null</td>
</tr>
<tr>
<td>WALKTIME</td>
<td>null</td>
<td>MODEL_LENGTH * 60 / 3</td>
<td>0, FUNCL=8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MODEL_LENGTH * 60 / 3, otherwise</td>
<td></td>
</tr>
</tbody>
</table>
Hourly Capacity Fill Procedure

The general formula for Hourly Capacity is shown in the following equation.

\[
[\text{Hourly Capacity Dir}]_{l,t} = \begin{cases} 
  \text{null}, & f = 9 \\
  1000000, & f = 0 \\
  [\text{cap}]_{l,t} \times [\text{Num Lanes Dir}]_{l,t}, & \text{Otherwise}
\end{cases}
\]  
(3-3)

\[
[\text{cap}]_{l,t} = \begin{cases} 
  \text{CAPACITY}, & \text{CAPACITY} > 0 \\
  \text{dividedCap} [\text{AreaType}] [f], & \text{DIVID} = 1 \\
  \text{undividedCap} [\text{AreaType}] [f], & \text{DIVID} = 2
\end{cases}
\]  
(3-4)

where

\( l \) = a link.

\( t \) = a time period value of AM, PM, OP.

\( f \) = the functional class of the link. For DIVID=1, the functional class must be between 1 and 8. For DIVID=2, the functional class must be between 1 and 7.

\( \text{CAPACITY} \) = Saturation capacity of the link. A field in ACTRDWY.DBD.

\( \text{DIVID} \) = Traffic Directional Division Code of the link. A field in ACTRDWY.DBD.

\( \text{AreaType} \) = The area type of the link.

\([ \text{Num Lanes Dir}]_{l,t} \) = Number of Lanes for Time Period \( t \) and Direction \( \text{Dir} \) field for link \( l \). The ACTRDWY fields used for this variable are shown in Exhibit 3-18.

Exhibit 3-18: Number of Lanes in a Direction

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Direction</th>
<th>Lane Field in ACTRDWY</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>AB</td>
<td>AMLN_AB</td>
</tr>
<tr>
<td>AM</td>
<td>BA</td>
<td>AMLN_BA</td>
</tr>
<tr>
<td>PM</td>
<td>AB</td>
<td>PMLN_AB</td>
</tr>
<tr>
<td>PM</td>
<td>BA</td>
<td>PMLN_BA</td>
</tr>
<tr>
<td>OP</td>
<td>AB</td>
<td>OPLN_AB</td>
</tr>
<tr>
<td>OP</td>
<td>BA</td>
<td>OPLN_BA</td>
</tr>
</tbody>
</table>

The specific formula for calculating hourly capacity in the AM in the AB direction is shown in the following equations.
\[
AMHRCAP_{AB_l} = \begin{cases} 
\text{null}, & f = 9 \\
1000000, & f = 0 \\
[cap_l] * AMLN_{AB_l}, & \text{Otherwise}
\end{cases}
\] (3-5)

\[
[cap_l] = \begin{cases} 
CAPACITY_{l}, & \text{CAPACITY} > 0 \\
\text{dividedCap}[a][f], & \text{DIVID}=1 \\
\text{undividedCap}[a][f], & \text{DIVID}=2
\end{cases}
\] (3-6)

where

\(l\) = a link.
\(t\) = a time period value of AM, PM, OP.
\(f\) = the functional class of the link. For DIVID=1, the functional class must be between 1 and 8. For DIVID=2, the functional class must be between 1 and 7.
\(a\) = The area type of the link.

\(CAPACITY\) = Saturation capacity of the link. A field in ACTRDWY.DBD.

\(DIVID\) = Traffic Directional Division Code of the link. A field in ACTRDWY.DBD.

\(a\) = The area type of the link.

\(\text{dividedCap}[a][f]\) = Hourly capacity per lane for divided or one-way roads for area type \(\text{AreaType}\) and functional class \(f\). A field in ACTRDWY.DBD.

\(\text{undividedCap}[a][f]\) = Hourly capacity per lane for undivided roads for area type \(\text{AreaType}\) and functional class \(f\). A field in ACTRDWY.DBD.

**Number of Lanes Calculation Procedure**

The Number of Lanes Calculation Procedure defines how values of AMLN_{AB}, AMLN_{BA}, PMLN_{AB}, PMLN_{BA}, OPLN_{AB}, and OPLN_{BA} are populated in step 11 of the Roadway Preparation program. The details of the Number of Lanes Calculation Procedure are depicted in Exhibit 3-19.
Exhibit 3-19: Number of Lanes Calculation Procedure – Values of AMLN_AB/BA, PMLN_AB/BA, and OPLN_AB/BA

Regular one-way link for FUNCL $\in [1, 8]$

<table>
<thead>
<tr>
<th>DIR=1</th>
<th>PKLNA&gt;0 &amp; PKLN&lt;0</th>
<th>PKLNB=0</th>
<th>AMLN&gt;0 or PMLN=0</th>
<th>PMLN_AB=PKLNA</th>
<th>PMLN_BA=0</th>
<th>PKLN=0</th>
<th>PKLNB=0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OPLNA&gt;0 &amp; OPLNB=0</td>
<td></td>
<td></td>
<td>OPLN_AB=OPLNA</td>
<td>OPLN_BA=0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Regular two-way link for FUNCL $\in [1, 8]$

<table>
<thead>
<tr>
<th>DIR=2</th>
<th>PKLNA&gt;0 &amp; PKLN&lt;0</th>
<th>PKLNB&gt;0</th>
<th>AMLN&gt;0 or PMLN=0</th>
<th>PMLN_AB=PKLNA</th>
<th>PMLN_BA=PKLNB</th>
<th>PKLN=0</th>
<th>PKLNB=0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OPLNA&gt;0 &amp; OPLNB&gt;0</td>
<td></td>
<td></td>
<td>OPLN_AB=OPLNA</td>
<td>OPLN_BA=OPLNB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Directional one-way link for FUNCL $\in [1, 8]$

<table>
<thead>
<tr>
<th>DIR=1</th>
<th>PKLNA&gt;0 &amp; PKLN&lt;0</th>
<th>PKLNB=0</th>
<th>AMLN&gt;0 or PMLN=0</th>
<th>PMLN_AB=AMLN</th>
<th>PMLN_BA=0</th>
<th>PKLN=0</th>
<th>PKLNB=0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OPLNA&gt;0 &amp; OPLNB=0</td>
<td></td>
<td></td>
<td>OPLN_AB=OPLNA</td>
<td>OPLN_BA=0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FUNCL=9

<table>
<thead>
<tr>
<th>DIR=1</th>
<th>PKLN=0 &amp; PKLN&lt;0</th>
<th>PKLN=0</th>
<th>AMLN=0 or PMLN=0</th>
<th>PMLN_AB=0</th>
<th>PMLN_BA=0</th>
<th>PKLN=0</th>
<th>PKLN=0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OPLNA=0 &amp; OPLNB=0</td>
<td></td>
<td></td>
<td>OPLN_AB=0</td>
<td>OPLN_BA=0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Free Speed Calculation Procedure**

The Free Speed Calculation Procedure defines how values of PKFRSPD_AB, PKFRSPD_BA, OPFRSPD_AB, and OPFRSPD_BA are populated in step 1 of the Roadway Preparation program.

Free Speed is calculated based on the speed limit and traffic controls devices in the middle or at the end of the links. The formulas for total delay conditions for free speed are shown in Exhibit 3-20 where $f(FC,AT)$ represents a function of functional class and area type whose values are represented in Exhibit 3-21.

The constant portion of total delay is stored in the Free Speed Parameters table called FreeSpeedParameters.DBF. This table lists the total delay by functional class, area type,
controlA, and controlB. An example of the Free Speed Parameters file is displayed in Exhibit 3-12. The free speed parameters are the input to step 2.

1. Determine the Free Speed Parameter ID of the link. The Free Speed Parameter ID of the link is a classification of the link type which incorporates the functional class, area type, and the traffic control device codes for the AB and BA direction. Calculation of the Free Speed Parameter ID is specified as follows.

\[
\text{Free Speed Parameter ID} = \begin{cases} 
\text{FUNCL} \times 1000 + \\
\text{AREATYPE} \times 100 + \\
\text{CNTRLA} \times 10 + \\
\text{CNTRLB}
\end{cases}
\]  
\[\text{(3-7)}\]

Where

- \text{FUNCL} = \text{functional class. A field in the line layer.}
- \text{AREATYPE} = \text{area type. A field in the line layer.}
- \text{CNTRLA} = \text{Traffic Control Device Code for the AB direction. A field in the line layer.}
- \text{CNTRLB} = \text{Traffic Control Device Code for the BA direction. A field in the line layer.}

2. In the Free Speed Parameters table, find the AB_DELAY and BA_DELAY values which correspond to the Free Speed Parameter ID calculated in step 1. The AB_DELAY represents the delay in the AB Direction and the BA_DELAY represents the delay in the BA Direction.

3. Use the formulas below for calculating the free speed.

- if \((SPLTA > 0)\)

\[
\text{PKFRSPD} \_\text{AB} = \frac{\text{MODEL} \_\text{LENGTH}}{\text{MODEL} \_\text{LENGTH} + \text{INTVN} \times 0.0033333 + \text{AB} \_\text{DELAY}} \]  
\[\text{(3-8)}\]

\[
\text{OPFRSPD} \_\text{AB} = \frac{\text{MODEL} \_\text{LENGTH}}{\text{MODEL} \_\text{LENGTH} + \text{INTVN} \times 0.0033333 + \text{AB} \_\text{DELAY}} \]  
\[\text{(3-9)}\]

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• If \((\text{SPLTB} > 0)\)

\[
\frac{\text{PKFRSPD}_{BA}}{\text{MODEL}\_\text{LENGTH}} = \frac{\text{MODEL}\_\text{LENGTH}}{\text{SPLTB}} + \text{INTVN} \times 0.00333333 + \text{BA}\_\text{DELAY} \tag{3-10}
\]

\[
\frac{\text{OPFRSPD}_{BA}}{\text{MODEL}\_\text{LENGTH}} = \frac{\text{MODEL}\_\text{LENGTH}}{\text{SPLTB}} + \text{INTVN} \times 0.00333333 + \text{BA}\_\text{DELAY} \tag{3-11}
\]

4. Finally, increase free speed for freeways, principal arterials, and frontage roads by 10 percent up to 75 mph.

• if \((\text{FUNCL} = 1 \text{ or } \text{FUNCL} = 2 \text{ or } \text{FUNCL} = 7)\)

\[
\text{PKFRSPD}\_\text{AB} = \text{Min}(\text{PKFRSPD}\_\text{AB} \times 1.1, 75) \tag{3-12}
\]

\[
\text{OPFRSPD}\_\text{AB} = \text{Min}(\text{OPFRSPD}\_\text{AB} \times 1.1, 75) \tag{3-13}
\]

\[
\text{PKFRSPD}\_\text{BA} = \text{Min}(\text{PKFRSPD}\_\text{BA} \times 1.1, 75) \tag{3-14}
\]

\[
\text{OPFRSPD}\_\text{BA} = \text{Min}(\text{OPFRSPD}\_\text{BA} \times 1.1, 75) \tag{3-15}
\]
### Exhibit 3-20: AB_DELAY and BA_DELAY Calculation for Free Speed in Seconds

<table>
<thead>
<tr>
<th>CNTRLA</th>
<th>CNTRLB</th>
<th>DELAY_AB</th>
<th>DELAY_BA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>3</td>
<td>f(FC,AT)</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>f(FC,AT)</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>6</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>9</td>
<td>7</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>f(FC,AT) + 3</td>
<td>f(FC,AT) + 3</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>f(FC,AT)</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>5</td>
<td>3</td>
<td>f(FC,AT)</td>
</tr>
<tr>
<td>13</td>
<td>6</td>
<td>f(FC,AT) + 6</td>
<td>11</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>11</td>
<td>f(FC,AT) + 6</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>f(FC,AT) + 6</td>
<td>19</td>
</tr>
<tr>
<td>16</td>
<td>7</td>
<td>16</td>
<td>f(FC,AT) + 6</td>
</tr>
<tr>
<td>17</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>18</td>
<td>5</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>19</td>
<td>6</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>20</td>
<td>7</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>21</td>
<td>5</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td>22</td>
<td>6</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>23</td>
<td>7</td>
<td>14</td>
<td>22</td>
</tr>
<tr>
<td>24</td>
<td>6</td>
<td>22</td>
<td>14</td>
</tr>
<tr>
<td>25</td>
<td>7</td>
<td>22</td>
<td>22</td>
</tr>
</tbody>
</table>

### Exhibit 3-21: f(FC,AT) – Traffic Control Delay in Seconds by Functional Class and Area Type

<table>
<thead>
<tr>
<th>Area Type (AT)</th>
<th>Functional Class (FC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1  2  3  4  5  6  7  8</td>
</tr>
<tr>
<td>2</td>
<td>0  9  9  12 12  9 12  0</td>
</tr>
<tr>
<td>3</td>
<td>0  6  7  9  9  6 9  0</td>
</tr>
<tr>
<td>4</td>
<td>0  5  6  8  8  5 8  0</td>
</tr>
<tr>
<td>5</td>
<td>0  4  5  6  6  4 6  0</td>
</tr>
</tbody>
</table>
Exhibit 3-22: Free Speed Parameters Table

### Operating Cost Calculation Procedure

The operating cost is the perceived cost of passing through a link and consists of cost per mile ($0.073/mile) and the toll cost. Tolls are adjusted to the 1999 dollar value, but cost per mile is not adjusted. The adjustment is based on the Consumer Price Index that is stored in CPIFactors.DBF. The operating cost for the drive alone (DA) class is different than share ride classes (SR) for managed lanes. Therefore, there are different fields for DA and SR classes for operating cost.

The DA class pays operating cost and all tolls on managed lanes, toll roads, and other links. The managed lanes (HOV with tolls) charge the toll for DA class only, while the regular toll roads charge all classes the same toll as DAs.

### Initial Times Calculation Procedure

The initial estimated loaded travel times for the a.m. peak period are INIPKTIME_AB, and INIPKTIME_BA. The initial estimated loaded travel times for the off-peak period are INIOPTIME_AB and INIOPTIME_BA. Before the zero feedback run, the loaded link travel time and the loaded link drive time are initialized to the initial estimated loaded travel times, and then are updated based on the assignment at the end of each feedback.

Times are populated using the following steps.
For each functional class and area type pair, calculate the peak ratio of the peak free speed to the peak loaded speed and the off-peak ratio of off-peak free speed to the off-peak loaded speed. If no data is available, the default ratio of 0.999 is assigned.

For a given link, find a link with a matching ID in the “Copy From” roadway network. If a match is found, and the matching link has the same direction code (DIR) and also has a loaded travel speed (Model_Length divided by loaded travel time) defined, use the loaded travel speed of the “Copy From” roadway network to estimate the congested travel time for the link in the new network.

For unmatched links, fill the link’s initial estimated loaded travel times based on the free speed to loaded speed ratios, free flow time, model length, and loaded link travel speed.

The general form of the calculation of the initial estimated loaded travel time is shown in the following equation.

\[
[INITIME]_{tdl} = \begin{cases} 
  null, & f = 9 \\
  \frac{MODEL \_ LENGTH_l \times 60}{[Loaded \ Speed]_{tdl}}, & f = 0 \\
  \frac{MODEL \_ LENGTH_l \times 60}{[Loaded \ Speed]_{tdl}}, & PKSPD \_ AB_l \geq 0 \\
  \frac{[FreeTime]_{tdl}}{{FreeToLoadedRatio}_{taf}}, & Otherwise 
\end{cases}
\]

where

\( l \) = a link.

\( a \) = The area type of the link.

\( f \) = the functional class of the link.

\( MODEL \_ LENGTH_l \) = Length of link \( l \). A field in ACTRDWY.DBD.

\( [INITIME]_{tdl} \) = Initial estimated loaded travel time for Time Period \( t \) and Direction \( d \) for link \( l \). The corresponding field in ACTRDWY.dbd is listed in Exhibit 3-23.

\( [Loaded \ Speed]_{tdl} \) = Loaded link travel speed for Time Period \( t \) and Direction \( d \) for link \( l \). The corresponding field in ACTRDWY.dbd is listed in Exhibit 3-23.
\[ [\text{Free Time}]_{tdl} = \text{Free flow travel time for Time Period } t \text{ and Direction } d \text{ for link } l. \] The corresponding field in ACTRDWY.dbd is listed in Exhibit 3-23.

\[ [\text{FreeToLoad edRatio}]_{taf} = \text{Ratio of free travel time to loaded travel time for area type } a \text{ and functional class } f \text{ for time period } t. \text{ Time period } t \text{ includes peak and off-peak.} \]

Exhibit 3-23: ACTRDWY Fields Used for Initial Estimated Loaded Travel Time by Time and Direction

<table>
<thead>
<tr>
<th>Time</th>
<th>Direction</th>
<th>Initial Estimated Loaded Travel Time Field</th>
<th>Loaded Speed Field</th>
<th>Free Flow Time Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak</td>
<td>AB</td>
<td>INIPKTIME_AB</td>
<td>PKSPD_AB</td>
<td>PKFRTIME_AB</td>
</tr>
<tr>
<td>Peak</td>
<td>BA</td>
<td>INIPKTIME_BA</td>
<td>PKSPD_BA</td>
<td>PKFRTIME_BA</td>
</tr>
<tr>
<td>Off-Peak</td>
<td>AB</td>
<td>INIOPTIME_AB</td>
<td>OPSPD_AB</td>
<td>OPFRTIME_AB</td>
</tr>
<tr>
<td>Off-Peak</td>
<td>BA</td>
<td>INIOPTIME_BA</td>
<td>OPSPD_BA</td>
<td>OPFRTIME_BA</td>
</tr>
</tbody>
</table>

The specific formula for the calculation of the initial estimated loaded travel time for the peak time period in the AB direction is shown in the following equation.

\[
\text{INIPKTIME \_ AB}_l = \begin{cases} 
\text{null} & , f = 9 \\
\frac{\text{MODEL\_LENGTH}_l \times 60}{\text{PKSPD}_l} & , f = 0 \\
\frac{\text{MODEL\_LENGTH}_l \times 60}{\left(\frac{\text{MODEL\_LENGTH}_l}{\text{PKSPD \_ AB}_l}\right)} \cdot \text{PKSPD \_ AB}_l > 0 \\
\frac{\text{PKFRTIME}_l}{\text{pkRatio}_{af}} & , \text{Otherwise}
\end{cases}
\]

where

\( l \) = a link.

\( a \) = The area type of the link.

\( f \) = the functional class of the link.

\( \text{MODEL\_LENGTH}_l \) = Length of link \( l \). A field in ACTRDWY.DBD.
$PKSPD_{AB_l}$ = Loaded link travel speed in the a.m. period in AB direction for link $l$. A field in ACTRDWY.DBD.

$PKFRTIME_{AB_l}$ = Free flow travel speed in a.m. period for link $l$. A field in ACTRDWY.DBD.

$pkRatio_{af}$ = Ratio of free travel time to loaded travel time for area type $a$ and functional class $f$. A field in ACTRDWY.DBD.

**Walking Time Calculation Procedure**

Links of functional class 8 and 9 are not available for walking. All other links are available for walking for access to and from transit stops. The walking speed is assumed to be 3 miles per hour (mph) or 4.4 feet per second, which corresponds to 20 minutes for a mile.

**Outputs**

- A new Zonal Activity directory under the TCMODEL\RoadwayNetwork\[RDWY]\[GEO] directory.
- An ACTRDWY.DBD under the new Zonal Activity directory TCMODEL\RoadwayNetwork\[RDWY]\[GEO]\[New ACT].
- An error log file named ERR_RoadwayPrep.txt located in the new Zonal Activity directory TCMODEL\RoadwayNetwork\[RDWY]\[GEO]\[New ACT].
- A report log file named REP_RoadwayPrep.txt located in the new Zonal Activity directory TCMODEL\RoadwayNetwork\[RDWY]\[GEO]\[New ACT].
Chapter 4

Transit Coding

Transit coding is the process by which a representation of a transit supply system is coded into the travel demand model environment in TransCAD. Transit supply consists of fixed-route services that are operated with predefined headways and operating characteristics. The coded network is used to model the movement of people using the transit system.

This chapter contains the organization and preparation of data for transit coding, and the procedures and programs that are designed to help coders create transit networks, and the underlying assumptions.

Background

Roadway Network

The roadway network contains the set of regular roadway links, rail links, and links on which any transit route can travel. The roadway network is also used by non-transit modes; these modes are auto and truck. A transit coder must make sure that the roadway network matches the needs of the transit to be coded.

Inspecting the Network

A transit network is coded on top of a roadway network. Since the roadway network contains rail links that are only used in transit coding, roadway network coders do not normally check for the accuracy of rail links. Therefore, the transit coders need to inspect the roadway network. Modifications to the roadway network must be completed in the roadway coding environment; so, it is better to inspect the network in that environment and find any problems before the transit coding process begins. When inspecting the roadway network, the coder needs to consider the following limitations:

1. Rail route alignments can only be coded on rail links, which are designated as functional classification 9 (field FUNCL = 9).
2. Stop locations for rail routes are limited to nodes in the roadway network file. If there is no node where a stop is supposed to be coded, the coded roadway file needs to be modified.

When the coded network is ready, it is used to create a Dallas-Fort Worth Regional Travel Model (DFWRTM) network file RDWY.DBD. The conversion of a coded roadway file into a DFWRTM RDWY.DBD file is explained in the Roadway Network chapter. The RDWY.DBD file is used as the basis for transit coding.
Coded Speed

When coding rail links in the roadway coding environment, the user must assign the average speed of the train in the SPLTA field; the speed should be in miles per hour (mph). The coded speed should incorporate dwell times, geometric condition of the rail link, and acceleration and deceleration times. Train travel times on these links are calculated directly based on this coded speed.

Time Periods

For modeling purposes, the only time periods considered are Peak and Off-Peak. They are described in Exhibit 4-1.

Exhibit 4-1: Description of Transit Time Periods

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Hours of Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Service</td>
<td>6:30 a.m. – 8:59 a.m.</td>
</tr>
<tr>
<td>Off-Peak Service</td>
<td>9:00 a.m. – 2:59 p.m.</td>
</tr>
</tbody>
</table>

Transit routes usually have schedules for every day of the week, but transit coding is concerned only with weekday schedules in the peak and off-peak periods. Headway for a transit service in each period is calculated by dividing the time period by the number of bus or train transit vehicles within that time period. The number of transit vehicles in a time period is counted using the schedule of service. Exhibit 4-2 shows an example of calculating peak and off-peak headway; in the example, bus line 29 is providing service to stations A, B, C and D.
Exhibit 4-2: Example Calculation of Peak and Off-Peak Headway

Peak Service for Line 29

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
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<td>6:11</td>
<td>6:17</td>
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<tr>
<td>6:43</td>
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<td>9:11</td>
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Off-Peak Service for Line 29

<table>
<thead>
<tr>
<th>C</th>
<th>B</th>
<th>D</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
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<td>3:36</td>
</tr>
</tbody>
</table>

Peak service covers a time period of 150 minutes; the peak period spans from 6:30 a.m. to 8:59 a.m. The peak times for each station are shown in bold.

For Station A, the number of buses used in the peak service time period is 7. Station A would have headway of 150 / 7, or 21.4 minutes.

For Station B, the number of buses used in the peak service time period is 8. Station B would have headway of 150 / 8, or 18.75 minutes.

Off-peak service covers a time period of 360 minutes; the off-peak period spans from 9 a.m. to 2:59 p.m. The off-peak times for each station are shown in bold.

For Station C, the number of buses used in the off-peak service time period is 10. Station C would have headway of 360 / 10, or 36 minutes.

For Station D, the number of buses used in the off-peak service time period is 9. Station D would have headway of 360 / 9, or 40 minutes.

Organization of Transit Supply Coding

In this section, the organization of lines, route systems, transit agencies, transit folders, and roadway folders is presented.

Scope

The transit supply may include on-demand routes, temporary service routes, and flexible path services. These services cannot be modeled. As a result, the first step is to limit the scope of the coding to fixed-alignment and fixed-schedule services during Peak and Off-peak periods.
Line

The line is the finest level of coded transit service. Line refers to a directional transit service that has its own alignment, headway, and stop locations. In some cases, there are more than two transit lines in a pamphlet and they usually have similar paths. This group of lines, which are part of the same route, is coded in a single route file, but they require their own line numbers, alignments, headways, and stop locations.

Route System Files

For existing and previous services, transit route paths and schedules are provided in pamphlets. The contents of each pamphlet are coded in a single route system file (RTS file) in a folder that reflects the route number or name. A pamphlet contains at least two transit services; one for inbound and one for outbound. Each service is coded separately and has a line number assigned to it in the route system file.

Transit Agencies

Routes and lines are grouped in two different ways: mode and agency. The mode grouping is an operational characteristics grouping and is explained in the next section. The agency grouping is strictly for coding and reporting convenience, and has no effect on the number of riders. The grouping is arbitrary, but is most often the name of the transit agency. Each route should be associated with an agency such as APM, DART, DCTA, FWTA, RAIL, or another arbitrary name. Although the user can define most agency groupings, the RAIL and APM groupings have specific definitions. RAIL includes the Trinity Railway Express (TRE) and the Dallas Area Rapid Transit (DART) red and blue lines. APM includes the airport people movers and the Las Colinas people movers. File folders of the routes belonging to the same agency are stored under that agency’s folder. Since each route is coded separately, this provides a structured organization for the system.

Transit Folder

The agency folders are created as subfolders of a transit folder (TRNT folder). A transit folder is the identification of the transit supply scenario. Therefore, the coder should create a transit folder with a unique and reasonable name that identifies the transit system that is coded; the folder name must end with “TRNT.” Some examples are YR25ALT1TRNT or YR30DARTPRGTRNT.

Roadway Folder

All transit scenarios are built based on a roadway network, and therefore the transit folder is created as a sub-folder of the Roadway folder (RDWY folder). The RDWY folder includes all the necessary files that TransCAD requires to create a geographic file for roadway links. In general, the RDWY folder name should be meaningful for roadway network coders for future updates; the name must end in “RDWY.”

Exhibit 4-3 shows the folder structure of coded files for an example 2025 transit network. The roadway network folder is YR25JUL0703RDWY. In this case, the name of the folder is a key to connect to TRANSX files. The transit sub-folder is named YR25TRNT to state that it is transit for the year 2025.
To summarize, the organization of the transit supply system for coding uses the following rules:

- The finest level of the organization of the transit supply system for coding is a directional service that has an alignment, stop, headway, and is called line.

- A group of lines is coded in a file that is saved with a route name in a TransCAD route file (RTS file).

- Each route file is kept in a separate folder under its respective agency folder.

- All agency folders are located under a transit folder whose name identifies the coding transit supply for a particular scenario.

- The Transit folder is a sub-folder of the Roadway folder that includes the roadway network on which transit lines are coded.
Preliminary Rail Line Check

Before beginning transit coding, the user must check the existence and validity of all rail links in the roadway network. The procedure for this check is provided here, and assumes that an existing roadway network is present.

1. In TransCAD, the coder must open RDWY.DBD, which is a geographic file of nodes and links on a roadway network.

2. The coder must check if rail links exist and are coded properly. To perform this check, he must perform the following steps:
   a. First, the coder needs to select the rail links; these are links which have functional classification 9 (FUNCL=9).
   b. Then the coder needs to open the table of selected links and see if every link has an average speed coded on it (ex. SPLTA = 50 & SPLTB =55).
   c. If there is a problem with the coding, the coder must go back to the roadway coding environment and create the missing links or speeds.

3. All stops that are on a specific rail service must then be checked to see if they are coded as nodes. This is because stops alone cannot be on a rail line; they must have an underlying node.

If coders do not complete this check, they will likely run into many errors, and have to start transit coding over again from the beginning.

Creation of a TRNT Folder

Before beginning the transit coding process, the coder should run the “Update TCModel” program in order to refresh all transit coding programs on the hard drive.

Coding of a transit supply system starts with creation of a Transit folder (TRNT folder) under a Roadway folder (RDWY folder). This is done through the Create TRNT program in the DFWRTM application. The TRNT folder will contain all the information related to the transit supply system being represented in this scenario.

Park & Ride and Transit Transfer Stations

After finishing the rail link check and creating the TRNT folder, the coder must then code Park & Ride and Transit Transfer Stations. Park & Rides are locations where people can park their cars and board a transit line. These locations are coded on roadway nodes, and also must be on either a bus or rail transit line. Transit Transfer Stations are major transit stop locations at which transit passengers transfer from one line to another.

When a new transit scenario is created, the first step of coding is to code Park & Ride and Transfer Transit stations. This step occurs early, so coders can see these locations on the screen when they are coding the transit line alignments. The Park & Ride and Transfer
Point locations are coded by creating PANDR.DBF and TRXFER.DBF files respectively. For each new scenario, the PANDR.DBF and TRXFER.DBF files can be created manually, directly copied from another roadway network, or transferred from another roadway network.

Coding Park & Ride and Transit Transfer Stations

If no existing Park & Ride or Transfer Point files will be used, the coder should create the PANDR.DBF and TRXFER.DBF files manually. This is done using the following steps:

1. Open the RDWY.DBD file in TransCAD.
2. Identify the nodes that are Park & Ride or Transfer Point locations, and record the node IDs.
3. Enter the node IDs of the Park & Ride and Transfer Point locations into the PANDR.DBF and TRXFER.DBF, respectively. The only required field in PANDR.DBF and TRXFER.DBF is the ID field, which contains the node IDs of Park & Ride and Transfer Point locations in the node layer of RDWY.DBD. Another useful field in PANDR.DBF and TRXFER.DBF is the Name field which if defined must be unique among all values listed in these files.

If the coder needs to use previously coded PANDR.DBF and TRXFER.DBF files, they must be either copied or transferred from an existing TRNT folder to a new TRNT folder. This process is discussed in the next section.

Transferring Park & Ride and Transit Transfer Stations

Although it is possible to create the contents of the PANDR.DBF and TRXFER.DBF files, roadway network files and transit scenarios are often very similar and complete manual coding is hardly ever needed. As a result, these two files can be directly copied by the user or can be transferred from one roadway network to another using the Transfer PANDR program.

If RDWY and TRNT folders exist that have similar Park & Ride and Transfer Point locations to the ones the coder wants to create, the coder can transfer information from these folders. For this discussion the selected RDWY and TRNT folder that will be copied from will be referred to as oldRDWY and oldTRNT respectively. The coder must have created a new RDWY folder and new TRNT folder to store the new transit scenario, as described in earlier sections. These new RDWY and TRNT folders will be referred to as newRDWY and newTRNT respectively.

If the oldTRNT and newTRNT are under the same RDWY folder, the coder can simply copy the PANDR.DBF and TRXFER.DBF files into the newTRNT folder. If the newTRNT is under a different RDWY folder, the coder can use the Transfer PANDR program in the DFWRTM application; the execution of this program is described in the DFWRTM Application User Guide.

The program first checks the validity of the oldTRNT’s PANDR.DBF and TRXFER.DBF files. The file checks include the following:

- Find any duplicate records that exist in the oldTRNT’s PANDR.DBF and TRXFER.DBF files,
• Find any records with null IDs. (This assures that there is not any blank record in the oldTRNT's PANDR.DBF and TRXFER.DBF files.), and

• Check whether every ID in the PANDR.DBF and TRXFER.DBF can be found in the node layer of the RDWY.DBD file in the oldRDWY folder.

The program will complete all of these checks regardless of whether any check fails. If any of these checks fail, the program will show the error message and stop; the error message will also be provided in the report file REP_TransferPANDR.txt. If all of the above checks pass successfully, the program will begin the transfer process.

In the transfer process, the program performs the following steps:

1. For each record in the oldTRNT's PANDR.DBF file,
   a. Select a record from the oldTRNT's PANDR.DBF, and note the ID of that record.
   b. Find the node with that ID on the oldRDWY’s RDWY.DBD, and grab the XY coordinate of that node.
   c. Go to the newRDWY’s RDWY.DBD file, and look for the node at that XY coordinate. If there is indeed a node there, store this ID in the newTRNT’s PANDR.DBF file. If no node exists at that XY coordinate, find the node closest to the XY coordinate, and record the ID of the closest node in the newTRNT’s PANDR.DBF file.
   d. Populate the four fields in the newTRNT’s PANDR.DBF file; the fields are XYEQUAL, NAME, FROM, and TO. The XYEQUAL field is filled with either 1 or 0; 1 is assigned if the node had the same coordinates in both files, 0 is assigned otherwise. The NAME field is copied from the old PANDR file; the value in this field should be the station name and it can be left blank. The FROM and TO fields are the file folder addresses of the oldTRNT and newTRNT folders.

2. Repeat Step 1 for every record in the oldTRNT’s TRXFER.DBF file to transfer records to the newTRNT’s TRXFER.DBF.

3. The last step is to call the Fill PAN DR program, which fills the RDWY.DBD files PANDR and TRXFER fields.

After running the Transfer PANDR program, the coder should manually perform checks to verify the correctness of the transfer. Some of the important checks are listed here.

• Spot check the Park & Ride stations and Transit Transfer Stations to see if everything is correct. The user should pay special attention to the records with XYEQUAL equal to 0, because in these cases, the selected node may not be the most suitable node. If there is not an exact XY match, there may be several nodes which are a short distance from the XY coordinate of the oldRDWY node. The program will select the closest node, but this may not be the best replacement. The user needs to make sure that the program has selected the best node, and otherwise needs to manually choose a suitable one to replace it.
• Confirm that the stops and points are coded on roadway nodes that lie on transit lines. To accomplish this step, the coder first needs to compare the number of nodes in oldTRNT’s PANDR.DBF and TRXFER.DBF with the newTRNT’s PANDR.DBF and TRXFER.DBF files. If they are the same, the coder then needs to run the Fill PANDR program to check if the nodes are located on the correct Park & Ride or Transfer Transit locations.

• Review the number of Park & Ride stations and Transit Transfer Stations; this helps avoid a common mistake of transferring from the wrong oldTRNT folder.

Finalizing the Coding of Park & Ride and Transit Transfer Stations

Now the coder is ready to run the Fill PANDR program. This program will fill the PANDR and TRXFER field in the node layer of RDWY.DBD with a value of 1 for node records whose IDs are in PANDR.DBF and TRXFER.DBF respectively.

After the fill is completed, a selection set of Park & Ride Stations and Transit Transfer Stations will be created and displayed in the TransCAD interface. Then the number of Park & Ride stations and Transfer stations will be counted and displayed. The count of Park & Ride stations and Transfer stations are also recorded in the report file REP_FillPANDR.txt.

If the coder discovers that any Park & Ride stations or Transit Transfer Stations are incorrect and has to edit the PANDR.DBF or TRXFER.DBF files, he must re-run the PANDR Fill program, so that the RDWY table will be updated.

Transferring Transit

The Transfer Transit program is the next step for coding transit. The Transfer Transit program transfers bus routes and/or rail routes from one transit folder to another transit folder. The routes will be placed into the corresponding agency folders under the output Transit folder.

Before transferring transit, the coder must identify the existing RDWY and TRNT folders from which files will be transferred. The transfer from RDWY folder (oldRDWY) must contain the RDWY.DBD file, and the transfer from TRNT folder (oldTRNT) must have already been put through the complete transit coding process.

Then, the coder must identify the transfer to RDWY folder (newRDWY) and TRNT folder (newTRNT). In this process, the route folders that will be copied need to be selected individually. For each route to be copied, the program performs the following steps.

1. The program first creates a DBF table for all lines coded in the RTS file based on the oldRDWY line layer for a specific routeID; the name of this file is OLD[ROUTE_ID]NODES.DBF (old node table). The table is made up of six fields: LINE, TRROUTEID, TCNODE, STOPFLAG, SEQ, and AGENCY. For each line in the RTS file, the program performs the following steps.

   a. For the TCNODE and SEQ fields, the program first gets the correct sequence of the first two nodes (in the first link) of the route. To get the correct sequence of the first two nodes of the route, the program needs to first check whether the first link is a one-way or two-way link. If it is a
one-way link, the sequence of node IDs can be assigned according to the direction of the link. For example, if the link direction is from node A to node B, node A will be the first node and node B will be the second node. If it is a two-way link, the node sequence depends on the second link. Regardless of whether the second link is a one-way or a two-way link, the node common in both links is the second node in the sequence. The other node of the first link and second link will be the first node and third node respectively. For example, if the first link’s endpoint IDs are 10 and 20, and the second link’s endpoint IDs are 20 and 30, then node 20 will be the second node since it is common in both links, node 10 will be the first node, and node 30 will be the third node.

b. Based on the correct sequence, the corresponding node IDs of the first link can be identified. Subsequently, the rest of the node IDs of the route can be obtained in sequence by identifying the starting node of the link.

c. The STOPFLAG field is filled with 1 when the node is a stop; otherwise it is set to 0. The LINE field indicates the name of route. The TRROUTEID field is the ID of the route and the AGENCY field is the name of agency.

2. The program then creates a DBF table for all lines coded in the old node table based on the newRDWY’s line layer; the name of this file is NEW[ROUTE_ID]NODES.DBF (new node table). For each record in the old node table, the program performs the following steps.

a. The program selects the next record of the old node table and locates the TCNODE value.

b. In the oldRDWY’s RDWY.DBD file, the program finds the node with the specified TCNODE as the ID, and grabs the XY coordinate of that node.

c. In the newRDWY’s RDWY.DBD file, the program looks for the nearest node based on that XY coordinate.

d. The program creates a new record in the new node table; the newRDWY’s node ID is stored in the TCNODE field of the new record. The values of the other seven fields are populated directly from values in the old node table.

3. To create this, first the newRDWY’s RTSTEMP field is filled with 1; this field is used in shortest path calculations, so that the shortest path between two nodes is calculated as the smallest number of links in the path rather than length or time.

4. Then, the RTS Network and file are created based on the new node table and newRDWY. If the agency folder name is RAIL or APM, the program creates a RTS network only based on functional class 9.

5. The last step of this program is to compare the number of nodes of each line in the RTS file and the new node table. If they are different, it means the node sequence is different in the original and transferred line. The program will record a warning of the node sequence difference in its report. In this case, the coder needs to review this line to determine where nodes were lost.
The program creates a report called TRTransfer.txt. In this report, there is a list of the lines that were transferred, and error and warning message that were encountered during the transfer. The coder should review this file to determine if each route was properly transferred.

## Coding Rail Alignments and Stops

Rail alignments can be coded in two ways: manually or by transfer.

### Coding Rail Alignments Manually

The procedures for coding rail lines manually are detailed here.

1. Open the RDWY.DBD (geographic file of nodes and links on roadway network) and open ALLNET.NET (network file that enables coding of new transit lines; contains traffic direction, flow, and turn prohibitions. This file is needed in order to calculate the shortest path.) Then you’ll need to create three selection sets: Park & Ride nodes (PANDR > 0), rail links (FUNCL =9), and Transit Transfer Stations (TRXFER > 0).

2. Create a new route system file whose name follows the format [Rail Agency][Route Name].RTS. Then, create a RAIL folder, and save it under the TRNT folder with the other agencies. The table structure of the route system files must be modified to include a TRACK field; TRACK is an integer field, and will be populated with the line numbers.

3. Open the route system editing toolbox to code each track. In most cases, the coder will need to code the reverse. Route names should be formatted as [Route] [Route #]; the space in between the route name and line number must be present, or else an error will occur later. The coder must be extremely careful to not select roads, since often the alignments are very close to rail lines. When coding is complete, populate the TRACK field of the table with the line numbers. The route_name field is a TransCAD default, so the DFWRTM programs rely on the TRACK field created in the last step.

4. After preliminary coding is finished, close all files and run the Assign Stops program for the created rail lines.

### Coding Rail Alignments by Transfer

The procedures for coding rail lines by transfer are provided here.

1. To code rail alignment by transfer, the coder must run the Transfer Transit program. This program transfers all rail alignments and stops from one roadway network to another. This is only necessary if the coder wants the rail alignments to be on a different roadway network. If not, the coder can simply copy and paste the TRNT folders. Note that Transfer Transit will only allow the entire contents of the selected TRNT folder to be transferred. This means that if a coder only wants to code part of the roadway network scenario, they will have to code the rail alignments manually. When coding is complete, the coder must enter all the track numbers into the table.
2. After transferring transit from another network, the program creates a report called TRTransfer.txt. In this report, there is a list of the lines that were transferred, and any error and warning message generated during each transfer. The coder should confirm that lines have been properly transferred by reviewing the messages and looking at the shape of the alignment.

3. After preliminary coding is finished, close all files and run the Assign Stops program. Although Transfer Transit does transfer the stops as well, the coder can run Assign Stops in order to reset all the stops, which, in turn, resets the stop allocation.

### Stop Assignment

After running the Transfer Transit program, stops may need to be assigned in the routes. To accomplish this step, the coder needs to run the Assign Stops program. For each route, a DBF table called STOP\[ROUTE_ID\]NODES.DBF will be created with the following eight fields: LINE, TRROUTEID, TCNODE, STOPFLAG, SEQ, AGENCY, FROMFUNCL, and TOFUNCL. The LINE, TRROUTEID, TCNODE, STOPFLAG, SEQ, AGENCY fields are copied directly from the new node table created in the Transfer Transit step.

The FROMFUNCL and TOFUNCL fields are defined as the functional classifications of each link along the coded line in each stop. The reason for adding these two fields is to check if the node in the coded transit line is assigned as a stop. The basic rules for assignment are the following:

- A node in the coded transit line cannot be a stop if the node is one end or two ends of a freeway link (FUNCL=1) or a HOV link (FUNCL=8) along the coded line.
- A node cannot be a stop if the node is one end of a rail link (FUNCL=9), except if the node is two ends of a rail link.
- A node cannot be a stop if it is two ends of a ramp link (FUNCL=6).
- Starting and ending nodes of the coded line must be assigned as stops no matter what kind of links they connect.

All other nodes can be assigned as stops. The detail stop assignment matrix is described in Exhibit 4-4.
Exhibit 4-4: Stop Assignment Matrix

<table>
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<th>FUNCL</th>
<th>1</th>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Integrate

After all line alignments with their stops have been coded properly, the Integrate program needs to be run. In this step, the program creates six major files: TRNT.RTS, NoApp.net, AllRoutes.DBF, UNILINE.DBF, STOPREP.DBF, and Rep_Integrate.TXT. These six files are stored in the TRNT folder.

- The TRNT.rts is a route system file that includes all transit routes based on the separate RTS files.

- The network file NoApp.net is used for importing coded lines.

- AllRoutes.DBF file is a node sequence file for all routes. It contains eight fields: LINE, TTROUTEID, TCNODE, STOPFLAG, SEQ, AGENCY, FROMFUNCL, TOFUNCL. The node sequence file for each route based on each RTS layer is firstly created. Then the program merges all these node sequence files into one AllRoutes.DBF file.

- The UNILINE.DBF file gives the unique number of each line and can be used to create the headway file (HDWY.DBF). It includes eight fields: ROUTE, LINE, AGENCY, PKHDWY, OPHDWY, MODE_ID, PULSETIME, and IN_MOA. The first three fields are created by transferring corresponding fields from the AllRoutes.DBF file. After checking the uniqueness of LINE numbers, the program fills these three fields.

- The STOPREP.DBF file identifies how many nodes are in a line, how many stops are in a line, and how many nodes can be stops if they were assigned through the Assign Stops Program. This file contains six fields: ROUTE, LINE, AGENCY, NODECNT, CANBESTP, and ISSTP. The first three fields are the same as those in the UNILINE.DBF file. The program counts the number of nodes and stops, and fills NODECNT and ISSTP fields. The CANBESTP field is filled by counting the nodes that can be stops according to the rules for stop assignment specified in the last section.

- The Rep_Integrate.TXT is the report file of the Integrate program.
HDWY, MODE and MDXMD DBF Files Preparation

The headway file (HDWY.DBF), mode file (MODE.DBF), and mode to mode file (MDXMD.DBF) are files which can be produced after the Integrate program, and are required by the Transit Files Check program.

Headway File

The headway file describes the headway of each line, and also determines whether the line will appear in the mode of access reports. The HDWY.DBF file can be created and populated by joining the UNILINE.DBF file to an existing HDWY.DBF file, or through direct editing. The HDWY file contains eight fields: ROUTE, LINE, AGENCY, PKHDWY, OPHDWY, MODE_ID, PULSETIME and IN_MOA. The table structure is presented in Exhibit 4-5.

Exhibit 4-5: Field Descriptions for Table HDWY.DBF

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROUTE</td>
<td>TransCAD assigned route ID</td>
</tr>
<tr>
<td>LINE</td>
<td>One-way transit line ID name provided at the time of coding</td>
</tr>
<tr>
<td>AGENCY</td>
<td>Agency name given to the line at the time of coding</td>
</tr>
<tr>
<td>PKHDWY</td>
<td>Headway during peak period</td>
</tr>
<tr>
<td>OPHDWY</td>
<td>Headway during off-peak period</td>
</tr>
<tr>
<td>MODE_ID</td>
<td>Integer number representing mode ID from MODE.DBF file</td>
</tr>
<tr>
<td>PULSETIME</td>
<td>Pulse time used to and from pulsed lines to other lines</td>
</tr>
<tr>
<td>IN_MOA</td>
<td>IN_MOA=1 specifies that the line will appear in the Mode of Access Reports</td>
</tr>
</tbody>
</table>

The PULSETIME field is populated if the user wants to “pulse” a route. Pulsing a route is done to improve operations of a route. It allows the route to receive synchronized feeder service from other routes to limit the transfer wait time.

In order to have a line appear in the Mode of Access Reports which can be created after a model run, the PULSETIME of the line must be greater than 0 or the IN_MOA value must be equal to 1 for the line.

Mode File

Transit routes with similar operating characteristics are grouped into the same category, called modes. The mode file defines these characteristics of a mode. The MODE.DBF file has thirteen fields: MODE_NAME, MODE_ID, MODEGROUP, MODE_USE, MDETIME, INIFARE, ADJINIFARE, PKDWL, OPDWL, ACCESS, EGRESS, PK_WAIT and OP_WAIT. INIFARE and ADJINIFARE give fares of different modes. PKDWL and OPDWL fields indicate the dwell time of peak and off-peak hours for different modes. The detailed table structure can be found in Exhibit 4-6.
Exhibit 4-6: Field Descriptions for Table MODE.DBF

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODE_NAME</td>
<td>Name of the mode</td>
</tr>
<tr>
<td>MODE_ID</td>
<td>Integer number representing the mode</td>
</tr>
<tr>
<td>MODEGROUP</td>
<td>Not used</td>
</tr>
<tr>
<td>MODE_USE</td>
<td>Dummy variable. 1 if the mode is enabled and 0 otherwise</td>
</tr>
<tr>
<td>MODETIME</td>
<td>Link layer field name representing travel time, null if specified in the setup</td>
</tr>
<tr>
<td>INIFARE</td>
<td>Reported fare for the mode (not used in skim and assignment)</td>
</tr>
<tr>
<td>ADJINIFARE</td>
<td>Average fare for the mode</td>
</tr>
<tr>
<td>PKDWL</td>
<td>Dwelling time for peak period</td>
</tr>
<tr>
<td>OPDWL</td>
<td>Dwelling time for off-peak period</td>
</tr>
<tr>
<td>ACCESS</td>
<td>Dummy variable. 1 if the mode is enabled for access from centroid to transit and 0 otherwise</td>
</tr>
<tr>
<td>EGRESS</td>
<td>Dummy variable. 1 if the mode is enabled for egress from transit to transit and 0 otherwise</td>
</tr>
<tr>
<td>PK_WAIT</td>
<td>Weight applied to initial waiting time for peak period</td>
</tr>
<tr>
<td>OP_WAIT</td>
<td>Weight applied to initial waiting time for off-peak period</td>
</tr>
</tbody>
</table>

Mode to Mode File

The mode to mode file or mode transfer table provides transfer cost among various modes. The MDXMD.DBF file includes seven fields: FROM, TO, STOP, COST, TRNFARE, ADJTRANFARE and WAIT. The table structure can be found in Exhibit 4-7.

Exhibit 4-7: Field Descriptions for Table MDXMD.DBF

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM</td>
<td>Mode ID of the line to transfer from</td>
</tr>
<tr>
<td>TO</td>
<td>Mode ID of the line to transfer to</td>
</tr>
<tr>
<td>STOP</td>
<td>Not used</td>
</tr>
<tr>
<td>COST</td>
<td>Not used</td>
</tr>
<tr>
<td>TRNFARE</td>
<td>Reported transfer fare from mode FROM to mode TO (not used in transit skim and assignment)</td>
</tr>
<tr>
<td>ADJTRNFARE</td>
<td>Average transfer fare from mode FROM to mode TO</td>
</tr>
<tr>
<td>WAIT</td>
<td>Not used</td>
</tr>
</tbody>
</table>

Transit Files Check

Transit Files Check is the last step of transit coding. It is run after the HDWY.DBF, MODE.DBF, and MDXMD.DBF files have been built. The purpose of this step is to check the transit files to confirm that the transit coding work is correct. The program steps are listed here.

1. First, the program will check if Fill PANDR has been run since the last time changes had been made to the PANDR.DBF and TRXFER.DBF files. If not, the program will notify the user that the Fill PANDR program must be run before running the Transit Files Check program and stop execution.
2. The program then updates the node layer of RDWY.DBD by adding a new field: STATION_NAME. This field will be filled with the NAME in PANDR.DBF and TRXFER.DBF based on the corresponding node ID. The procedure is as follows:

   a. PANDR.DBF and TRXFER.DBF are integrated into an array set, and checked for validity and consistency. PANDR.DBF and TRXFER.DBF are checked completely in this step, and if any errors are found, the program will report them and then stop execution.

      i. The program checks if there are any nodes which have the same name, but different IDs. This is recorded as an error.

      ii. The program checks if there are any nodes which have the same ID, but different values for NAME. This is recorded as an error.

      iii. The program checks if there are any nodes which have the same ID and same name. This is recorded as a warning.

   b. Once the checks are complete, the program creates a STATION_NAME field in the node table of RDWY.DBD. This field is filled with the NAME field from the PANDR.DBF or TRXFER.DBF record corresponding to the same node ID.

3. The existence of required fields in HDWY.DBF, MODE.DBF, and MDXMD.DBF files is checked in succession. Additional check for field types of HDWY.DBF file is done by comparing them with UNILINE.DBF. If they are different, an error message will appear. During the process of checking MDXMD.DBF file, the field STOP is converted from a character to an integer, since this is a requirement of TransCAD 4.8. It also checks whether the TRACK field in TRNT.RTS file has NULL values or not; if null values are found, an error message will appear.

4. The program checks the referential integrity between the HDWY.DBF, MODE.DBF, and MDXMD.DBF files. This requires that the LINE and MODE_ID fields in HDWY.DBF should refer to TRACK field in TRNT file and MODE_ID field in MODE.DBF respectively. Also, the FROM and TO fields in MDXMD.DBF should refer to MODE_ID field in MODE.DBF.

5. The program adds one record with MODE_ID =1, MODE_NAME = missing mode to the MODE.DBF file. The program also fills all MODE_USE, ACCESS, and EGRESS fields with 1 in the MODE.DBF file. This was a requirement in TransCAD 4.6 build 207.

6. The program completes the TRNT route database by adding and filling fields from the HDWY.DBF and MODE.DBF files. PKHDWY, OPHDWY, MODE_ID, AGENCY, PULSETIME and IN_MOA fields are copied directly from the HDWY file. The TRROUTE field is copied from the ROUTE field in the HDWY file. The MODEGROUP field is copied from MODE file.

7. When the PKHDWY and OPHDWY values in the TRNT file are greater than zero, the program returns one array with two elements. One is the array of ROUTE_IDs with PULSETIME > 0 or IN_MOA > 0, another one is the array of MODE_IDs with PULSETIME > 0 or IN_MOA > 0. These arrays list the routes.
that will be included in the mode of access reports. If there are no routes which have a pulsetime \( > 0 \), then the program will display an error and stop execution.

8. The program creates the OPXFER.DBF and PKXFER.DBF files for use of pulse time in transit assignment. These two tables include four fields: FROM_LINE, TO_LINE, BOARD_STOP and WAIT_TIME. These two tables are used to calculate and show the transfer wait time (WAIT_TIME) between the pulsed line and the non-pulsed line during peak and off peak hours. When the PULSETIME, PKHDWY and OP HDWY are all greater than zero, the line’s transfer wait time will need to be calculated. The FROM_LINE and TO_LINE indicate the ROUTE_IDs of pulsed lines and non-pulsed lines, which are selected from the TRNT file according to the PULSETIME, PKHDWY and OP HDWY. WAIT_TIME is calculated in the following equation.

\[
\text{WAIT \_ TIME} = \begin{cases} 
\frac{\text{PULSE \_ TIME}}{2} & \text{if HDWY of the TO \_ LINE} > \text{PULSE \_ TIME} \\
\frac{\text{HDWY of the TO \_ LINE}}{2} & \text{Default (if no entry in XFER.DBF files)}
\end{cases}
\]

(4-1)

9. The program checks the validity of the PANDR.DBF file by determining if each Park & Ride location is also in the list of transit stops. It does this by checking if each ID in PANDR.DBF also can be found in the TCNODE field of the TRNTS.BIN file.

10. The program creates a bus VMT summary based on the ROUTE and MODE_ID in the ROUTEVMT.DBF and MODEVMT.DBF files respectively. The ROUTEVMT.DBF file contains seven fields: AGENCY, ROUTE, MODE_ID, NLINES, NROUTES, PKVMT, and OPVMT. The MODEVMT.DBF file contains every field in ROUTEVMT, except the ROUTE field. The PKVMT field and OPVMT field are first calculated and added into the TRNT file when PKHDWY and OP HDWY are greater than 0. The formulas for PKVMT and OPVMT are provided here.

\[
PKVMT = \frac{\text{TRNT.Distance} \times 150}{\text{PKHDWY}} \quad (4-2)
\]

where 150 corresponds to the two and half peak hours, from 6:30 a.m. to 9 a.m.

\[
OPVMT = \frac{\text{TRNT.Distance} \times 360}{\text{OPHDWY}} \quad (4-3)
\]

where 360 means six off-peak hours, from 9 a.m. to 3 p.m.

11. In the final step, the program creates a critical stops movement tables. The PKCRTSTOP.BIN and OPCRTSTOP.BIN files are peak and off-peak critical stops movement tables for lines with PULSETIME >0 or IN_MOA >0. Four fields: FROM_LINE, ALIGHT_STOP, BOARD_STOP and TO_LINE are included in these two tables. Based on stops, the FROM_LINE and TO_LINE fields are filled with Route_IDs of selected lines in the peak and off-peak hour. At the same time, the ALIGHT_STOP and BOARD_STOP are filled with the corresponding
STOP_IDS. If a line is found which does not exist in the route file, an error will be displayed and the program will stop.

If any warnings are found during the course of the program, the program will pause to display the warning. If any errors are found during the course of the program, the program will display the error and then stop. Errors are reported in REP_TransitFilesCheck.txt. Model runs which include transit assignment require that the Transit Files Check program is completed successfully within ten minutes of a model run execution attempt.
Roadway Skim

This chapter presents the roadway skim procedure. The roadway skim prepares impedance matrices based on when the trips are made and whether or not the high-occupancy-vehicle (HOV) facilities are accessible. The roadway impedance matrices include level-of-service variables such as travel time and travel distance. They are used in trip distribution and mode choice modules.

Roadway Network and Roadway Skim

The roadway skim module is designed to find the shortest paths from origin centroids to destination centroids by the auto mode. The module output is the skim matrices which are used in the trip distribution and mode choice models. The roadway skim procedure is based on the roadway network ACTRDWY.DBD. The ACTRDWY has two layers: a link layer and a node layer. The link layer contains information such as link length and travel time. The node layer contains the origin and destination nodes. There are a total of four roadway skim matrices representing different time-of-day and whether or not HOV facilities are utilized for skimming. These matrices are: PK_NOHOV, PK_HOV, OP_NOHOV, and OP_HOV. Each of the matrices includes three cores: PKTIME/OPTIME (for peak period or off-peak period respectively), MODEL_LENGTH, and TerminalPKTIME/TerminalOPTIME. PKTIME/OPTIME is the travel time on the shortest path with a consideration of the traffic volume impact for the peak and off-peak period respectively. MODEL_LENGTH is the distance of the shortest path. TerminalPKTIME/TerminalOPTIME is the door-to-door travel time on the shortest path including time spent on accessing to the car, parking, and walking to the destination point, for the peak and off-peak period respectively.

The roadway skim module includes three standard components:

- Create network and define network settings,
- Create skim matrix by using the “Networks/Paths-Multiple Paths” command, and
- Add the terminal time to the link travel time and create a matrix core TerminalPKTIME/TerminalOPTIME.

All these procedures are fully batched in the DFWRTM (see the DFWRTM User Guide for details). The following section describes how to create roadway skim matrices manually, using peak period with HOV facilities accessible as an example.

For the peak period, the steps to create a roadway network and define the network settings are as follows:

1. Load the roadway geographic file ACTRDWY.DBD.
2. Create a selection set “PKHOV” from the link layer. Define the selection set with FUNCL < 9 and AMHRCAP_AB > 0.
3. Create a selection set “Centroids” from the node layer. Define the selection set with CENTROID > 0.
4. Select **Networks/Paths—Create** from the menu to display the Create Network dialogue box with the following settings (as shown in Exhibit 5-1).
   a. Create links from: PKHOV.
   b. Read length from: MODEL_LENGTH.
   c. Other link fields include: PKTIME_*, OPTIME_*, and MODEL_LENGTH
   d. Check Drop Duplicate Links option.
   e. Save the network as PKHOV.net (see Exhibit 5-2).

5. Select **Networks/Paths—Settings** from the menu to display the Network Settings dialogue box. Under the Centroid section, choose "Create from selection set" radio button and select the "Centroids" selection set (as shown in Exhibit 5-3).

6. Click OK.

Exhibit 5-1: Create Roadway Network
Exhibit 5-2: Save Roadway Network

Exhibit 5-3: Network Settings
After creating the network, a multiple shortest path procedure is run to create the skim matrix with the following steps:

1. With the link file ACTRDWY and the network file PKHOV open, select Networks/Paths—Multiple Paths from the menu to display the Multiple Shortest Path dialogue box (see Exhibit 5-4).
2. Select PKTIME_* in the Minimize drop down menu; Select Centroids in the From and To drop down menu.
3. Check the radio button for "Matrix File."
4. Click OK and save the file as TCMODEL\RoadwayNetwork\RDWY\GEO\ACT \PK_HOV.MTX.

Exhibit 5-4: Multiple Shortest Path

[Image of Multiple Shortest Path Dialogue Box]

To resolve the issue of intrazonal travel time and distance, we use a TransCAD built-in function for calculating the intrazonal travel time. Select Planning—Planning Utilities—Intrazonal travel times from the menu; the Intrazonal Impedance Calculation Dialogue box will appear, as shown in Exhibit 5-5. The default settings are adopted to calculate intrazonal travel time and distance. These values automatically replace missing values in the diagonal cells in the matrix PK_HOV.MTX.

Exhibit 5-5: Intrazonal Impedance Calculation

[Image of Intrazonal Impedance Calculation Dialogue Box]
The last step in the roadway skim procedure is to add the terminal time to the travel time. The terminal time is intended to accommodate out-of-vehicle time on both ends of the trips. Therefore, it is defined by the area types of the origin and destination zones. The terminal times by area type are shown in Exhibit 5-6. For example, if you travel from an area type 1 zone to an area type 2 zone, the terminal time would be six minutes.

**Exhibit 5-6: Terminal Time by Area Type in Minutes**

<table>
<thead>
<tr>
<th>Area Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8</td>
<td>6</td>
<td>4.4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>7.3</td>
<td>5.3</td>
<td>3.7</td>
<td>3.3</td>
<td>3.3</td>
</tr>
<tr>
<td>3</td>
<td>7.2</td>
<td>5.2</td>
<td>3.6</td>
<td>3.2</td>
<td>3.2</td>
</tr>
<tr>
<td>4</td>
<td>7.1</td>
<td>5.1</td>
<td>3.5</td>
<td>3.1</td>
<td>3.1</td>
</tr>
<tr>
<td>5</td>
<td>7.1</td>
<td>5.1</td>
<td>3.5</td>
<td>3.1</td>
<td>3.1</td>
</tr>
</tbody>
</table>

The TSZ-to-TSZ terminal time matrix is then created based on zonal area type. This file is saved as TERMTIME.MTX in folder TCMODEL\TSZGeographic\GEOACT. To combine travel time and terminal time, a third core TerminalPKTIME is added to matrix PKHOV. This matrix core is filled by the summation of PKTIME_* and TERMTIME.

The roadway skim procedure is repeatedly performed for the peak period with no access to HOV and off-peak period with or without HOV access. The skim settings for different scenarios are listed in Exhibit 5-7. Note that for the off-peak period, a fourth core TenOPTIME_* is added to matrices OP_HOV and OP_NOHOV. The matrix core is filled by OPTIME_* plus 10 minutes. The variable TenOPTIME is used for the OTHER (truck) trip distribution.

**Exhibit 5-7: Network Settings for Roadway Skim Scenarios**

<table>
<thead>
<tr>
<th></th>
<th>PKHOV</th>
<th>PKNOHOV</th>
<th>OPHOV</th>
<th>OPNOHOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network</td>
<td>PKHOV.net</td>
<td>PKNOHOV.net</td>
<td>OPHOV.net</td>
<td>OPNOHOV.net</td>
</tr>
<tr>
<td>Link selection set to create network</td>
<td>Fundc &lt; 9 and AMHRCAP_AB &gt; 0</td>
<td>Fundc &lt; 8</td>
<td>Fundc &lt; 9 and OPHRCAP_AB &gt; 0</td>
<td>Fundc &lt; 8</td>
</tr>
<tr>
<td>Link Length</td>
<td>MODEL_LENGTH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fields included in network file</td>
<td>PKTIME_*</td>
<td>OPTIME_*</td>
<td>MODEL_LENGTH</td>
<td></td>
</tr>
<tr>
<td>Network settings</td>
<td>Centroids created from selection set where CENTROID &gt; 0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortest path matrix</td>
<td>PK_HOV.MTX</td>
<td>PK_NOHOV.MTX</td>
<td>OP_HOV.MTX</td>
<td>OP_NOHOV.MTX</td>
</tr>
<tr>
<td>Shortest path criterion</td>
<td>PKTIME_ *</td>
<td>OPTIME_ *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intrazonal travel time and distance</td>
<td>Apply Planning Utilities: Intrazonal Travel Times</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminal time</td>
<td>Apply area type to area type terminal time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TenOPTIME</td>
<td>Does not exist</td>
<td>10 + OPTIME_ *</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Chapter 6

Trip Distribution

After the trip generation models estimate the total number of trips produced from each zone and those attracted to each zone, the trip distribution module provides the directional information of trip-making. The trip distribution describes where trips start and end.

The DFWRTM uses the gravity model for trip distribution. Each set of parameters are calibrated for each trip purpose, so there are a total of seven gravity models (four for HBW trips in each income quartile, and one each for HNW, NHB, and TRUCK trips). The gravity model has three types of inputs: a friction factor table, trip production and attraction totals, and an impedance matrix. The gravity model outputs are trip matrices indicating from where trips are coming and to where trips are going for all trip purposes. This chapter describes the gravity model application procedure for seven trip purposes.

Gravity Model

The gravity model in the DFWRTM is shown in the following formula:

\[ T_{ij} = a_i P_i b_j A_j F(t_{ij}) \]  \hspace{1cm} (6-1)

Subject to:

\[ \sum_i T_{ij} = P_j \quad \text{and} \quad \sum_j T_{ij} = A_i \]  \hspace{1cm} (6-2)

where \( T_{ij} \) is the number of trips produced by zone \( i \) and attracted to zone \( j \); \( P_i \) is the total number of trips produced from zone \( i \); \( A_i \) is the total number of trips attracted to zone \( j \); \( t_{ij} \) is travel time between zone \( i \) and zone \( j \); \( F() \) is the impedance function; and \( a_i \) and \( b_j \) are row and column balancing factors. The balancing factors are interdependent as follows:

\[ a_i = \frac{1}{\sum_z b_z A_z F(t_{iz})} \]  \hspace{1cm} (6-3)

\[ b_j = \frac{1}{\sum_z a_z P_z F(t_{zj})} \]  \hspace{1cm} (6-4)

The balancing factors \( a_i \) and \( b_j \) are calculated iteratively starting with \( b_j = 1 \) until they converge with each other.

The TSZ productions/attractions are outputs of the trip generation module and are stored in PATRIPS.DBF under the folder TCMODEL\TSZGeographic\GEO\ACT. The impedance matrix is obtained through the roadway skim. We use matrices PKNOHOV and OPNOHOV for different trip purposes. Among the level-of-service variables, we use roadway travel time for trip distribution. This is partly because in the Dallas-Fort Worth
(DFW) area, driving is the dominant mode over transit. Therefore, roadway travel time is a good indicator of people’s perception of how far it is from an origin to a destination. With the continuous expansion of toll roads and the growing access to transit service, one may argue that both travel time and travel cost in various modes would have an impact on trip distribution patterns. Future model improvement efforts will try to address this issue.

Calibrating the impedance function is a key issue in gravity models. Three parameters of the gamma function, \( a \), \( b \), and \( c \), as shown in the following equation, are estimated for each trip purposes.

\[
F(t_{ij}) = a * t_{ij}^{-b} * e^{-c \cdot t_{ij}}
\]  

(6-5)

The calibration of the impedance function is beyond the scope of this document. The calibration is based on 1996 Household Survey data. Based on these parameters we created a friction factor table for various trip purposes. The friction factors are normalized to the friction factor at five minutes. The table is saved as FrictionFactors.BIN in folder TCMODEL\ModelCalibrated\TripDistribution\Data. The friction factor table field descriptions are presented in Exhibit 6-1. Exhibits 6-2 and 6-3 show the friction factor plots for different trip purposes.

**Exhibit 6-1: Field Description for Table FrictionFactors.BIN**

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Type</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Integer</td>
<td>Travel time in minutes</td>
</tr>
<tr>
<td>F_HBW1</td>
<td>Real</td>
<td>Friction factor for HBW trips made by low income households</td>
</tr>
<tr>
<td>F_HBW2</td>
<td>Real</td>
<td>Friction factor for HBW trips made by low-medium income households</td>
</tr>
<tr>
<td>F_HBW3</td>
<td>Real</td>
<td>Friction factor for HBW trips made by high-medium income households</td>
</tr>
<tr>
<td>F_HBW4</td>
<td>Real</td>
<td>Friction factor for HBW trips made by high income households</td>
</tr>
<tr>
<td>F_HNW</td>
<td>Real</td>
<td>Friction factor for HNW trips</td>
</tr>
<tr>
<td>F_NHB</td>
<td>Real</td>
<td>Friction factor for NHB trips</td>
</tr>
<tr>
<td>F_Truck</td>
<td>Real</td>
<td>Friction factor for OTHER trips</td>
</tr>
</tbody>
</table>
Exhibit 6-2: Friction Factors for HBW Trips by Income Quartiles
Exhibit 6-3: Friction Factors for HNW, NHB, and OTHER Trips

Travel Time in Minutes
Friction Factor

F_HNW
F_NHB
F_OTHER
We use the TransCAD built-in routine to implement the doubly-constrained gravity models. The implementation of the gravity model is described below in Exhibit 6-4:

1. Open table PATRIPS.DBF, roadway skim matrices PK_NOHOV.MTX and OP_NOHOV.MTX, and friction factor table FrictionFactors.BIN.
2. Select **Planning—Trip Distribution—Gravity Application** from the menu.
   a. Choose PATRIPS as a production-attraction dataview.
   b. Add 7 trip purposes and specify productions and attractions for each trip purpose.
   c. Set the number of iterations equal to 100 and convergence equal to 0.001.
   d. Check the radio button “Doubly” for the constraint type (as shown in Exhibit 6-5).
   e. In the “Friction Factors” tab, check the radio button “table”.
   f. Select “FrictionFactors” as the dataview and define F factor and Time as specified in Exhibit 6-6.

**Exhibit 6-4: Settings for Gravity Model Application**

<table>
<thead>
<tr>
<th>Prod.</th>
<th>Attr.</th>
<th>F Factor</th>
<th>Time</th>
<th>Impedance Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>HBW1</td>
<td>H1WP</td>
<td>F_H1W</td>
<td>Time</td>
<td>TerminalPKTIME</td>
</tr>
<tr>
<td>HBW2</td>
<td>H2WP</td>
<td>F_H2W</td>
<td>Time</td>
<td>TerminalPKTIME</td>
</tr>
<tr>
<td>HBW3</td>
<td>H3WP</td>
<td>F_H3W</td>
<td>Time</td>
<td>TerminalPKTIME</td>
</tr>
<tr>
<td>HBW4</td>
<td>H4WP</td>
<td>F_H4W</td>
<td>Time</td>
<td>TerminalPKTIME</td>
</tr>
<tr>
<td>HNW</td>
<td>HNWP</td>
<td>F_HNW</td>
<td>Time</td>
<td>TerminalOPTIME</td>
</tr>
<tr>
<td>NHB</td>
<td>NHBP</td>
<td>F_NHB</td>
<td>Time</td>
<td>TerminalOPTIME</td>
</tr>
<tr>
<td>OTHER</td>
<td>OTHP</td>
<td>F_Truck</td>
<td>Time</td>
<td>TenOPTIME</td>
</tr>
</tbody>
</table>

3. Click OK and save the output file as PADIST.MTX in folder TCMODEL\RoadwayNetwork\RDWY\GEO\ACT\APT.
Exhibit 6-5: Gravity Model Application: General

Exhibit 6-6: Gravity Model Application: Friction Factor
Airport and External Trips

Airport and external trips are specially treated in the DFWRTM partly because they are very different from urban passenger trips. The DFWRTM does not consider airport trips and external trips in the trip generation module. The airport and external trips are modeled in the trip distribution module.

The input data includes the OD surveys which show the directional pattern of airport/external trips, and the forecasted future total trips that are originated from/destined to airports and external stations. The OD matrices for airport and external trips are obtained by expanding the survey OD matrices to fit the future control totals. This chapter describes the airport trip and external trip distribution portions of the trip distribution model.

Airport Trip Distribution

In the DFWRTM, an airport trip distribution module is specially designed for trips going from and to two airports: DFW International Airport (DFWIA) and Love Field (LF). It is assumed that all airport trips are in the HNW and NHB categories. The airport trip distribution uses two input sources: ENPLANE.DBF and AIRPORTDATA.DBF. The ENPLANE data list the total number of HNW trips attracted to DFW and Love Field airports respectively and the total number of NHB trips produced from DFW and Love Field airport respectively. The file is saved in the folder TCMODEL\TSZGeographic\GEO\ACT\APT. AIRPORTDATA.DBF is saved in the folder TCMODEL\ModelCalibrated\TripDistribution\Data. The fields in AIRPORTDATA are listed in Exhibit 7-1.

<table>
<thead>
<tr>
<th>Field Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Descriptions</td>
</tr>
<tr>
<td>----------------------------------------</td>
</tr>
<tr>
<td>RAA RAA ID</td>
</tr>
<tr>
<td>HNWP99 RAA HNW trip productions in year 1999</td>
</tr>
<tr>
<td>NHBA99 RAA NHB trip productions in year 1999</td>
</tr>
<tr>
<td>HNWDFW HNW trips attracted to DFW airport from RAA in year 1999</td>
</tr>
<tr>
<td>NHBDFW NHB trips from DFW to RAA in year 1999</td>
</tr>
<tr>
<td>HNWLF HNW trips attracted to Love Field from RAA in year 1999</td>
</tr>
<tr>
<td>NHBLF NHB trips from Love Field to RAA in year 1999</td>
</tr>
</tbody>
</table>

The airport trip distribution module output is an airport trip matrix AIRPORT.MTX. The file is saved under the folder TCMODEL\TSZGeographic\GEO\ACT\APT. The matrix has two cores: HNW and NHB.

The airport trips are initially distributed at the RAA level and then disaggregated to the TSZ level. The distribution is implemented through a growth factor method with control total constraints. First, the growth of HNW productions and NHB attractions from 1999 to the study year are calculated and applied to the 1999 airport trip distribution pattern at the
RAA level. Second, the RAA trips are proportionally adjusted so that the total DFWIA and Love Field trips equal the control totals in ENPLANE data. Third, the RAA trip distribution is further disaggregated into the TSZ level based on the zonal employment ratio. The detailed procedure is described as follows:

1. Open PATRIPS.DBF and aggregate HNWP and NHBA for RAAs. Save RAA production and attraction totals as HNWP<sub>RAA</sub> and NHBA<sub>RAA</sub>.  

2. Open AIRPORTDATA and Calculate year 99 to study year growth factors.

\[
\text{GrowthHNW}_{RAA} = \frac{\text{HNWP}_{RAA}}{\text{HNWP}_{99}^{RAA}} \quad (7-1)
\]
\[
\text{GrowthNHB}_{RAA} = \frac{\text{NHBA}_{RAA}}{\text{NHBA}_{99}^{RAA}} \quad (7-2)
\]

3. Update HNWDFW, NHBDFW, HNWLF, and NHBLF by growth factors.

\[
\text{HNWDFW}_{RAA} = \text{HNWDFW}_{RAA} \times \text{GrowthHNW}_{RAA} \quad (7-3)
\]
\[
\text{NHBDFW}_{RAA} = \text{NHBDFW}_{RAA} \times \text{GrowthNHB}_{RAA} \quad (7-4)
\]
\[
\text{HNWLF}_{RAA} = \text{HNWLF}_{RAA} \times \text{GrowthHNW}_{RAA} \quad (7-5)
\]
\[
\text{NHBLF}_{RAA} = \text{NHBLF}_{RAA} \times \text{GrowthNHB}_{RAA} \quad (7-6)
\]

4. Open ENPLANE data and read the total number of trips to and from DFWIA, and to and from Love Field as TotalHNWDFW, TotalNHBDFW, TotalHNWLF, and TotalNHBLF respectively.

5. Proportionally adjust HNWDFW, NHBDFW, HNWLF, and NHBLF so that the total airport trips match the totals from ENPLANE data, i.e.

\[
\text{HNWDFW}_{RAA} = \text{HNWDFW}_{RAA} \times \frac{\text{TotalHNWDFW}}{\sum_{\text{allRAAs}} \text{HNWDFW}_{RAA}} \quad (7-7)
\]

6. Calculate TSZ HNW production ratio and TSZ NHB attraction ratio over RAA, i.e.

\[
\text{hnwRatio}_{TSZ} = \frac{\text{HNWP}_{TSZ}}{\text{HNWP}_{RAA}} \quad (7-8)
\]
\[
\text{nhbRatio}_{TSZ} = \frac{\text{NHBA}_{TSZ}}{\text{NHBA}_{RAA}} \quad (7-9)
\]

7. Calculate the airport TSZ employment ratio over RAA, i.e.

\[
\text{EmpRatio}_{\text{AirportTSZ}} = \frac{\text{TotalEmployment}_{\text{AirportTSZ}}}{\text{TotalEmployment}_{\text{AirportRAA}}} \quad (7-10)
\]

8. Disaggregate RAA airport trips into the TSZ level by multiplying hnwRatio (nhbRatio) and EmpRatio, i.e.

\[
\text{hnwDFWTSZ}_{ij} = \text{HNWDFW}_{RAA} \times \text{hnwRatio}_{i} \times \text{EmpRatio}_{j}, \text{ where } i \in \text{RAA} \quad (7-11)
\]
\[
\text{nhbDFWTSZ}_{ij} = \text{NHBDFW}_{RAA} \times \text{nhbRatio}_{i} \times \text{EmpRatio}_{j}, \text{ where } i \in \text{RAA} \quad (7-12)
\]

9. Write HNW and NHB TSZ trips to matrix AIRPORT.MTX and add airport HNW and NHB trips to the trip distribution matrix PADIST.MTX.

---

**External Trip Distribution**

Another trip distribution module in the DFWRTM is the external trip distribution. Similar to airport trips, the external trips are initially distributed at the RAA level and then disaggregated to the TSZ level. The distribution is also implemented through a growth factor method with an additional Fratar process to achieve symmetrical external-external trip sub-matrix. There are two inputs for the external trip distribution. One is an origin-destination (OD) survey data collected in 1995 at the RAA level. The data is in dBase format and saved as EXTERNALDATA.DBF under the folder
TCMODEL\ModelCalibrated\TripDistribution\data. The fields in the file are listed in Exhibit 7-2.

<table>
<thead>
<tr>
<th>Field</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORIGIN RAA</td>
<td>Origin RAA ID (including all RAAs)</td>
</tr>
<tr>
<td>DESTIN RAA</td>
<td>Destination RAA ID (including 61 external RAAs only)</td>
</tr>
<tr>
<td>TRUCKS</td>
<td>Daily trucks from origin RAA to destination RAA</td>
</tr>
<tr>
<td>CARS</td>
<td>Daily passenger vehicle trips from origin RAA to destination RAA</td>
</tr>
</tbody>
</table>

The other input is the total number of vehicles, defined as trucks and cars, across external stations. The file is in dBase format and saved as EXTCOUNT.DBF under the folder TCMODEL\TSZGeographic\GEO\ACT\EXT. The fields in the file are listed in Exhibit 7-3.

<table>
<thead>
<tr>
<th>Field</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAA</td>
<td>RAA ID (including 61 external RAAs only)</td>
</tr>
<tr>
<td>CNTCAR</td>
<td>Total number of passenger vehicle trips from external RAA</td>
</tr>
<tr>
<td>CNTTRK</td>
<td>Total number of truck trips from external RAA</td>
</tr>
</tbody>
</table>

The external trip distribution carries out in three steps. First, the OD survey data is expanded by growth factors. Second, an iterative proportional fitting (IPF, also referred to as Fratar) process is performed on the external-external sub-matrix. Finally, the RAA trip matrix is disaggregated into the TSZ level according to the zonal population and employment ratio. The detailed steps are described as follows:

1. Read total origin trips from EXTCOUNT and save passenger and truck trips as TotalCARRAA and TotalTruckRAA.
2. Read OD survey data from EXTERNALDATA and save passenger and truck trips as CARij and TRUCKij.
3. Calculate the total number of trips from each external RAA from OD survey data, i.e.
   \[ \text{SurveyTotalCar}_{RAA} = \sum_{j \in RAA} \text{CAR}_{ij} \]  
   \[ \text{SurveyTotalTrk}_{RAA} = \sum_{j \in RAA} \text{TRUCK}_{ij} \]  
(7-13) (7-14)
4. Calculate the growth factors by the following formulas:
   \[ \text{GrowthCar}_{RAA} = \frac{\text{TotalCar}_{RAA}}{\text{SurveyTotalCar}_{RAA}} \]  
   \[ \text{GrowthTrk}_{RAA} = \frac{\text{TotalTrk}_{RAA}}{\text{SurveyTotalTrk}_{RAA}} \]  
(7-15) (7-16)
5. Update CARij and TRUCKij by multiplying them by growth factors, i.e.
   \[ \text{CAR}_{ij} = \text{CAR}_{ij} \cdot \text{GrowthCar}_{RAA} \]  
   \[ \text{TRUCK}_{ij} = \text{TRUCK}_{ij} \cdot \text{GrowthTrk}_{RAA}, \text{ where } j \in RAA \]  
(7-17) (7-18)
6. Create matrix EXTRAA.MTX with two cores: car and truck. Save the file in the folder TCMODEL\TSZGeographic\GEO\ACT\EXT. Fill the matrix with the RAA external trips CARij and TRUCKij.
7. Apply the IPF procedure to the external-external sub-matrix. Use the destination subtotals as both row and column control totals so that the external-external sub-matrix is symmetrical.
8. Disaggregate the RAA external matrix to the TSZ level.
   a. Open TSZ demographic DATA.DBF file and calculate the population and employment totals for each TSZ and RAA.
\[ POPEMP_{tsz} = \text{Population}_{tsz} + 1.589993 \times (\text{basic}_{tsz} + \text{service}_{tsz} + \text{retail}_{tsz}) \]  
\[ EMP_{tsz} = \text{basic}_{tsz} + \text{service}_{tsz} + \text{retail}_{tsz} \]  
\[ POPEMP_{RAA} = \sum_{tsz \in RAA} POPEMP_{tsz} \]  
\[ EMP_{RAA} = \sum_{tsz \in RAA} EMP_{tsz} \]  

b. Calculate TSZ population and employment ratio in the RAA level, i.e.,
\[ \text{Ratio}_{POPEMP_{tsz}} = \frac{POPEMP_{tsz}}{POPEMP_{RAA}} \]  
\[ \text{Ratio}_{EMP_{tsz}} = \frac{EMP_{tsz}}{EMP_{RAA}} , \text{where } tsz \in RAA \]  
c. Calculate the TSZ trips by multiplying RAA trips by the population and employment ratio, i.e.
\[ TSZ\text{CAR}_{ij} = CAR_{RA Ai, RAAj} \times \text{Ratio}_{POPEMP_i} \times \text{Ratio}_{POPEMP_j} \]  
\[ TSZ\text{Trk}_{ij} = TRUCK_{RA Ai, RAAj} \times \text{Ratio}_{EMP_i} \times \text{Ratio}_{EMP_j} \]  
where \( i \in RAAi \) and \( j \in RAAj \)
d. Write the TSZ trips to the matrix EXTERNAL.MTX in the folder TCMODEL\TSZGeographic\GEO\ACT\EXT
Transit Skim

The transit skim procedure finds the best transit path between stops or nodes.

The transit network is a significant component in mode choice models. TransCAD creates the transit network from a route system layer. The route system layer and underlying roadway network layer provide information about transit modes (bus or rail, for example), transit routes, and transit stops. After the transit skim procedure is run, the mode choice model predicts which mode the travelers will use.

This chapter describes the procedures of creating the transit route system, creating the transit networks, and transit skims.

Transit Coding

Transit coding creates transit routes and the transit network. The process is started from a roadway network layer. The coder first codes transit routes one by one so each route system file contains one transit line. The stop nodes are also defined during the initial coding. These route system files are saved in agency and route folders in the directory TCMODEL\RoadwayNetwork\RDWY\TRNT. Second, all the transit routes are combined and a table containing information of all transit lines and stops is created (ALLROUTES.DBF). Other input files, such as headway and mode files, are also prepared during transit coding.

Transit Coding is discussed in more detail in Chapter 4.

Transit Route System

The transit route system file ACTTRNT is created from ALLROUTES.DBF in the directory TCMODEL\RoadwayNetwork\RDWY\TRNT. This table contains information about how transit routes should be created. It includes a route ID field and a node ID field that lists all the node IDs visited by the route, as well as a field that indicates whether a route stop should be added at the node location. The table structure of ALLROUTES.DBF is described in Exhibit 8-1.
Besides the table, in order to create a route system the user also needs a roadway line layer on which the route system is based, i.e., ACTRDWY, and a roadway network on which a transit network will be created. In the DFWRTM, a temporary roadway network file is developed for the transit route system creation. Before creating the network file, an integer field RTSTEMP is added to ACTRDWY and the field RTSTEMP is set equal to 1 for all the links. This field is used as a criterion to find a shortest path between two nodes for creation of the route system. It will find a path with the minimum number of links rather than a path with minimum distance. The following steps describe how to create the roadway network.

1. Open the ACTRDWY.DBD file.
2. Make a line layer selection set “NoApp” by condition “FUNCL>0 and FUNCL<=9”
3. Select Networks/Paths—Create from the menu with the following settings (see Exhibit 8-2):
   a. Create links from link set “NoApp.”
   b. Read length from “RTSTEMP.”
   c. Choose “RTSTEMP” in optional link fields and choose “CENTROID” in optional node fields.
   d. Check the box titled “Drop Duplicate Links.”
4. Click OK and save the network file as NoApp.net in the directory TCMODEL\RoadwayNetwork\RDWY\GEO\ACT\APT\TRNT.
Exhibit 8-2: Create Roadway Network

With ACTRDWY open and the network file “NoApp” created, use the following steps to create the route system ACTTRNT from table ALLROUTES.DBF.

1. Open table ALLROUTES.DBF.
2. Select **Route Systems—Utilities—Create from Table** with the following settings (see Exhibit 8-3):
   a. Cost field: TRSTEMP
   b. Layer name: Route System
   c. Table: ALLROUTES
   d. Route number: LINE
   e. Node ID: TCNODE
   f. Check box to “Include Stops in Route System”.
   g. Stop layer: Route Stops
   h. Stop flag: STOPFLAG
   i. User ID: SEQ
3. Click OK and save the route system file as ACTTRNT.rts in folder TCMODEL\RoadwayNetwork\RDWY\GEO\ACT\APT\TRNT.
After the route system is created, transit operating information is added to the route system table. The operating information includes headways for peak and off-peak hours, and the agency which operates the line. The operational and mode information is provided in two input files: HDWY.DBF and MODE.DBF. Both are stored under the folder TCMODEL\RoadwayNetwork\RDWY\TRNT. The table structures for HDWY.DBF and MODE.DBF are presented in Exhibits 8-4 and 8-5 respectively. When creating the transit route system file, seven new fields are added to the transit route system file ACTTRNT. These seven fields are the following: PKHDWY, OPHDWY, MODEGROUP, MODE_ID, AGENCY, PULSETIME, and TRROUTE. These fields are filled with corresponding values from the HDWY and MODE tables, as shown in Exhibit 8-6.

### Exhibit 8-4: Field Descriptions for HDWY.DBF

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROUTE</td>
<td>TransCAD assigned route ID</td>
</tr>
<tr>
<td>LINE</td>
<td>One-way transit line ID name provided at the time of coding</td>
</tr>
<tr>
<td>AGENCY</td>
<td>Agency name given to the line at the time of coding</td>
</tr>
<tr>
<td>PKHDWY</td>
<td>Headway during peak period</td>
</tr>
<tr>
<td>OPHDWY</td>
<td>Headway during off-peak period</td>
</tr>
<tr>
<td>MODE_ID</td>
<td>Integer number representing mode</td>
</tr>
<tr>
<td>PULSETIME</td>
<td>Pulse time used to and from pulsed lines to other lines</td>
</tr>
<tr>
<td>IN_MOA</td>
<td>Any positive integer if the line stops will be in the mode-of-access report, 0 otherwise</td>
</tr>
</tbody>
</table>
Exhibit 8-5: Field Descriptions for MODE.DBF

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODE_NAME</td>
<td>Name of the mode</td>
</tr>
<tr>
<td>MODE_ID</td>
<td>Integer number representing the mode</td>
</tr>
<tr>
<td>MODEGROUP</td>
<td>Not used</td>
</tr>
<tr>
<td>MODE_USE</td>
<td>Dummy variable. 1 if the mode is enabled and 0 otherwise</td>
</tr>
<tr>
<td>MODETIME</td>
<td>Link layer field name representing travel time, null if specified in the setup</td>
</tr>
<tr>
<td>INIFARE</td>
<td>Reported fare for the mode (not used in skim and assignment)</td>
</tr>
<tr>
<td>ADJINIFARE</td>
<td>Average fare for the mode</td>
</tr>
<tr>
<td>PKDWL</td>
<td>Dwelling time for peak period</td>
</tr>
<tr>
<td>OPDWL</td>
<td>Dwelling time for off-peak period</td>
</tr>
<tr>
<td>ACCESS</td>
<td>Dummy variable. 1 if the mode is enabled for access from centroid to transit and 0 otherwise</td>
</tr>
<tr>
<td>EGRESS</td>
<td>Dummy variable. 1 if the mode is enabled for egress from transit to transit and 0 otherwise</td>
</tr>
<tr>
<td>PK_WAIT</td>
<td>Weight applied to initial waiting time for peak period</td>
</tr>
<tr>
<td>OP_WAIT</td>
<td>Weight applied to initial waiting time for off-peak period</td>
</tr>
</tbody>
</table>

Exhibit 8-6: Fields Added to Transit Route System ACTTRNT

<table>
<thead>
<tr>
<th>Added Field Name</th>
<th>Filled from File</th>
<th>Filled by Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>PKHDWY</td>
<td>HDWY</td>
<td>PKHDWY</td>
</tr>
<tr>
<td>OPHDWY</td>
<td>HDWY</td>
<td>OPHDWY</td>
</tr>
<tr>
<td>MODEGROUP</td>
<td>HDWY</td>
<td>MODEGROUP</td>
</tr>
<tr>
<td>MODE_ID</td>
<td>HDWY</td>
<td>MODE_ID</td>
</tr>
<tr>
<td>AGENCY</td>
<td>HDWY</td>
<td>AGENCY</td>
</tr>
<tr>
<td>PULSETIME</td>
<td>HDWY</td>
<td>PULSETIME</td>
</tr>
<tr>
<td>TRROUTE</td>
<td>MODE</td>
<td>ROUTE</td>
</tr>
<tr>
<td>IN_MOA</td>
<td>HDWY</td>
<td>IN_MOA</td>
</tr>
</tbody>
</table>

Transit Network and Transit Skim

The transit skim procedure finds the best transit path and records transit attributes along the best transit path between stops or nodes. These attributes, such as transit fare and travel time, are used for the mode choice model implementation. There are four transit path scenarios in the DFWRTM, based on the time-of-day and whether park-and-ride occurs during the trip. These four scenarios are the following: peak period with park-and-ride, peak period with no park-and-ride, off-peak period with park-and-ride, and off-peak period with no park-and-ride. The transit attributes calculated under different scenarios are used for different trip purposes and different travel modes in the mode choice model. For example, for HBW trips using transit mode with driving access, the path attributes calculated in the peak period with park-and-ride scenario are used in the mode choice model implementation; for HNW trips using transit mode with walking access, off-peak period with no park-and-ride attributes are used. Accordingly, four transit networks are created to find the best path from node to node.

The transit network is characterized by the following assumptions:
- The access to centroids is provided through centroid connectors and non-HOV roadway links. The walking speed is assumed 3 mph.
The travel times for transit lines are provided in the roadway network. The travel time for transit lines is a loaded travel time on roadway links and a fixed travel time on rail links.

The value of time is $2.73 and $1.99 per hour (1999 Dollars) for peak and off-peak period respectively.

The maximum trip cost is $99.00 or 240 minutes.

The maximum number of transfers is 3.

The weight for transfer wait time and walking time is 2.5; the weight for driving time is 10.

The maximum driving time to park-and-ride stations is 20 minutes.

The transfer penalty is 3 minutes.

The transfer wait time is 4 minutes for light rail lines, 7 minutes for commuter rail lines, and half of the headway for all other lines.

The minimum and maximum initial wait times are 2 and 20 minutes respectively.

The minimum and maximum transfer wait times are 2 and 30 minutes respectively.

The maximum walking access, egress, and transfer times are 20 minutes.

The transit network creation is implemented in batch mode. The following section describes an equivalent manual process to create the transit network and define transit network settings, using peak period with park-and-ride as an example. To create a peak hour transit network, use the following steps:

1. Open the transit route system file ACTTRNT.rts.
2. Make a route system selection set “Selection” by condition “PKHDWY > 0.”
3. On line layer ACTRDWY, make a non-transit link selection set by condition “FUNCL < 8.”
4. Select Transit—Create Network from the menu to display the Create Transit Network dialog box and choose options as follows (see Exhibit 8-7):
   a. Routes: Selection
   b. Stops: All Stops
   c. Mode Field: MODE_ID
   d. Walk Mode Field: LinkMode
   e. Line Layer Fields: Length, PKTIME_*, PKDRIVETIME_* , RAILTIME_* , and LinkMode
   f. Route Fields: Route_ID, Mode_ID, PKHDWY
   g. Using Node IDs in: TCNODE
   h. Check radio button for “Use Existing Information”.
   i. Non-transit links in: Selection
   j. Click Attributes to display the Non-Transit Link Options dialogue: for the transit attribute PKTIME_*, change non-transit attribute mapping to WALKTIME and click OK (see Exhibit 8-8).
   k. Check the box of Ignore Link Directions
5. Click OK and save the transit network file as PKTRNT.tnw in folder TCMODEL\RoadwayNetwork\RDWY\GEO\ACT\APT\TRNT.
Unlike the roadway skim which is used to find the shortest path based on travel time, the transit pathfinder process considers the transit fare as well as travel time. The travel time and transit fare are connected by a value-of-time parameter. Users can define the value-of-time in the transit network settings. Meanwhile, many other parameters are also defined in the transit network settings. In the DFWRTM, three input files are used for
transit network settings. These three files are the following: MODE.DBF, MDXMD.DBF, and PKXFER.DBF/OPXFER.DBF. All files are saved in directory TCMODEL\RoadwayNetwork\RDWY\TRNT. File MDXMD provides transfer cost among various modes. PKXFER/OPXFER provides transfer waiting time among different transit lines for the peak/off-peak period. Exhibits 8-9 and 8-10 describe the structure of MDXMD and PKXFER/OPXFER files respectively.

Exhibit 8-9: Field Descriptions for MDXMD.DBF

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM</td>
<td>Mode ID of the line to transfer from</td>
</tr>
<tr>
<td>TO</td>
<td>Mode ID of the line to transfer to</td>
</tr>
<tr>
<td>STOP</td>
<td>Not used</td>
</tr>
<tr>
<td>COST</td>
<td>Not used</td>
</tr>
<tr>
<td>TRNFARE</td>
<td>Reported transfer fare from mode FROM to mode TO (not used in transit skim and assignment)</td>
</tr>
<tr>
<td>ADJTRNFARE</td>
<td>Average transfer fare from mode FROM to mode TO</td>
</tr>
<tr>
<td>WAIT</td>
<td>Not used</td>
</tr>
</tbody>
</table>

Exhibit 8-10: Field Descriptions for PKXFER.DBF

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM_LINE</td>
<td>Route ID of the line to transfer from</td>
</tr>
<tr>
<td>TO_LINE</td>
<td>Route ID of the line to transfer to</td>
</tr>
<tr>
<td>BOARD_STOP</td>
<td>Not used</td>
</tr>
<tr>
<td>WAIT_TIME</td>
<td>Transfer waiting time in minutes</td>
</tr>
</tbody>
</table>

The following steps describe how to define the transit network settings for peak hour with park-and-ride scenario.

1. With the route system and network files open, choose Transit—Transit Network Settings—Pathfinder from the menu to display Pathfinder Network Settings.
2. The network is PKTRNT and the network file is PKTRNT.tnw
3. Click the General tab to display the General page and choose options as follows (see Exhibit 8-11):
   a. Time: PKTIME_*
   b. Time by Mode: MODETIME
   c. Max Trip Cost: 99
   d. Max Xfers: 3
   e. Value of Time: 0.0455 (cents per minute)
   f. Create centroids from selection set: CENTROID > 0
   g. Max # of Walk Access Paths by mode: None; Global: 10
4. Click the Mode tab to display the Mode page and choose options as follows (see Exhibit 8-12):
   a. Mode Table: MODE.DBF
   b. Access: ACCESS
   c. Egress: EGRESS
   d. Mode Use: MODE_USE
   e. Mode-Mode Cost Table: MDXMD.DBF
   f. From-Mode: FROM
   g. To-Mode: TO
   h. At Stop: STOP
   i. Penalty($): COST
   j. Fare: ADJTRNFARE
   k. Wait Time OverRide: WAIT
   l. Select check box to “Only Combine Routes of Same Mode”
5. Click the Fare tab to display the Fare page and choose options as follows (see Exhibit 8-13):
   a. Fare system: Flat Fare
   b. Regular flat fares by mode: ADJINIFARE
   c. Select check box of “Free Transfers within Same Mode”.

Exhibit 8-12: Pathfinder Network Settings: Mode
6. Click the Weights tab to display the Weight page and choose options as follows (see Exhibit 8-14):
   a. For Transit, initial wait time by mode: PK_WAIT
   b. Global variables:
      i. Fare → 1
      ii. Link Time → 1
      iii. Transfer Penalty Time → 1
      iv. Initial Wait Time → 2.5
      v. Transfer Wait Time → 2.5
      vi. Dwell Time → 1
      vii. On Dwelling Proportions → 0.5
   c. For Non-Transit,
      i. Walking Time → 2.5
      ii. Driving Time → 10
   d. For Others,
      i. Interarrival Parameter → 0.5
      ii. Cost Threshold% → 0
Exhibit 8-14: Pathfinder Network Settings: Weights

7. Click the Park & Ride tab to display the Park & Ride page and choose options as follows (see Exhibit 8-15):
   a. Select check box to Enable Park-and-Ride Mode.
   b. Create a selection set PandR from ACTRDWY node layer by condition “PANDR > 0” and create parking nodes from selection set PandR.
   c. Create a selection set from ACTRDWY line layer by condition “FUNCL < 8” and create driving links from this selection set.
   d. Driving Link Time: PKDRIVETIME_ *
   e. Max Driving Time: 20
   f. Global Max Parking-to-Stop Walk Time: 0.01
8. Click the Others tab to display the Others page and choose options as follows (see Exhibit 8-16):
   a. ROUTE Headway: PKHDWY
   b. MODE Dwelling: PKDWL
   c. GLOBAL variables:
      i. Headway → 20
      ii. Transfer Penalty → 3
      iii. Max Init Wait → 20
      iv. Max Xfer Wait → 30
      v. Min Init Wait → 2
      vi. Min Xfer Wait → 2
      vii. Dwelling → 0.5
      viii. Layover → 5
      ix. Max Access Walk → 20
      x. Max Egress Walk → 20
      xi. Max Transfer Walk → 20
      xii. Max Total Time → 240
   d. Xfer Wait Table: PKXFER
9. Click OK

Exhibit 8-16: Pathfinder Network Settings: Others

After defining the network settings, the network is ready for the transit skim procedure. Using the peak hour with park-and-ride scenario as an example, the following steps describe the transit skim procedure.

1. With the transit route system and network files open, set the ACTRDWY node layer as the current view and make a centroid selection set by condition “CENTROID > 0.”
2. Choose **Transit—Skimming—Pathfinder** to display the Transit Skims page (see Exhibit 8-17).
3. Origins and Destinations are the centroid selection set
4. Select check boxes “Create Parking Matrix” and “Skimming on Modes”.
5. Choose the following Skim Variables (a total of 12):
   a. Generalized Cost, Fare
   b. In-Vehicle Time
   c. Initial Wait Time
   d. Transfer Wait Time
e. Transfer Time
g. Egress Time
h. Dwelling Time
i. Drive Time
j. Length
k. RailTime_

6. Choose the following Skim Modes (a total of 2):
   a. 73. Express DART
   b. 80. Light Rail

7. Click OK and save the skim matrix as PK_PR.MTX, the origin parking matrix as PKORpark.MTX, and the parking matrix as PKpark.MTX. All matrices are saved in the folder TCMODEL\RoadwayNetwork\RDWY\GEO\ACT\APT\TRNT

Exhibit 8-17: Transit Skims (Pathfinder)

For the other three transit scenarios, peak period with no park-and-ride, off-peak period with park-and-ride, and off-peak period with no park-and-ride, the procedures are the same, but the settings and some parameters are different. These differences are described in Exhibit 8-18.
<table>
<thead>
<tr>
<th>Transit Network</th>
<th>Peak Period with Park-and-Ride</th>
<th>Peak Period with no Park-and-Ride</th>
<th>Off-Peak Period with Park-and-Ride</th>
<th>Off-Peak Period with no Park-and-Ride</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route system</td>
<td>PKTRNT.tnw</td>
<td>PKTRNT.tnw</td>
<td>OPTRNT.tnw</td>
<td>OPTRNT.tnw</td>
</tr>
<tr>
<td>Line layer fields</td>
<td>Length, LinkMode, PKTIME_*, PKDRIVETIME_, RAILTIME_</td>
<td>Length, LinkMode, OPTIME_*, OPDRIVETIME_, RAILTIME_</td>
<td>Length, LinkMode, OPTIME_*, OPDRIVETIME_, RAILTIME_</td>
<td>Length, LinkMode, OPTIME_*, OPDRIVETIME_, RAILTIME_</td>
</tr>
<tr>
<td>Route fields</td>
<td>Route_ID, Mode_ID, PKHDWY</td>
<td>Route_ID, Mode_ID, PKHDWY</td>
<td>Route_ID, Mode_ID, OPHDWY</td>
<td>Route_ID, Mode_ID, OPHDWY</td>
</tr>
<tr>
<td>Using node IDs in</td>
<td>TCNODE</td>
<td>TCNODE</td>
<td>TCNODE</td>
<td>TCNODE</td>
</tr>
<tr>
<td>Selection of non-transit links</td>
<td>FUNCL &lt; 8</td>
<td>FUNCL &lt; 8</td>
<td>FUNCL &lt; 8</td>
<td>FUNCL &lt; 8</td>
</tr>
<tr>
<td>Non-transit link attributes</td>
<td>Change mapping WALKTIME for PKTIME_*</td>
<td>Change mapping WALKTIME for OPTIME_*</td>
<td>Change mapping WALKTIME for OPTIME_*</td>
<td>Change mapping WALKTIME for OPTIME_*</td>
</tr>
</tbody>
</table>

**Network Settings**

**General**

<table>
<thead>
<tr>
<th>Link time filed</th>
<th>PKTIME_*</th>
<th>PKTIME_*</th>
<th>OPTIME_*</th>
<th>OPTIME_*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of time</td>
<td>0.0455</td>
<td>0.0455</td>
<td>0.0331</td>
<td>0.0331</td>
</tr>
</tbody>
</table>

**Weights**

<table>
<thead>
<tr>
<th>Initial wait time by mode</th>
<th>PK_WAIT</th>
<th>PK_WAIT</th>
<th>OP_WAIT</th>
<th>OP_WAIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global initial wait time</td>
<td>2.5</td>
<td>2.5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Global transfer wait time</td>
<td>2.5</td>
<td>2.5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Global walking time</td>
<td>2.5</td>
<td>2.5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

**Park & Ride**

<table>
<thead>
<tr>
<th>Parking nodes</th>
<th>PANDR &gt; 0</th>
<th>N/A</th>
<th>PANDR &gt; 0</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving link time</td>
<td>PKDRIVETIME_*</td>
<td>N/A</td>
<td>OPDRIVETIME_*</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**Others**

<table>
<thead>
<tr>
<th>Route headway</th>
<th>PKHDWY</th>
<th>PKHDWY</th>
<th>OPHDWY</th>
<th>OPHDWY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode dwelling time</td>
<td>PKDWL</td>
<td>PKDWL</td>
<td>OPDWL</td>
<td>OPDWL</td>
</tr>
<tr>
<td>Transfer wait table</td>
<td>PKXFER.DBF</td>
<td>PKXFER.DBF</td>
<td>OPXFER.DBF</td>
<td>OPXFER.DBF</td>
</tr>
<tr>
<td></td>
<td>Peak Period with Park-and-Ride</td>
<td>Peak Period with no Park-and-Ride</td>
<td>Off-Peak Period with Park-and-Ride</td>
<td>Off-Peak Period with no Park-and-Ride</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------------------</td>
<td>----------------------------------</td>
<td>-----------------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Skim matrix</td>
<td>PK_PR.MTX</td>
<td>PK_NOPR.MTX</td>
<td>OP_PR.MTX</td>
<td>OP_NOPR.MTX</td>
</tr>
<tr>
<td>Origin-to-parking time matrix</td>
<td>PKORpark.MTX</td>
<td>N/A</td>
<td>OPORpark.MTX</td>
<td>N/A</td>
</tr>
<tr>
<td>Parking node matrix</td>
<td>PKPark.MTX</td>
<td>N/A</td>
<td>OPPark.MTX</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Transit Assignment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OD matrix</td>
<td>PKTransit</td>
<td>PKTransit</td>
<td>OPTransit</td>
<td>OPTransit</td>
</tr>
<tr>
<td>Matrix core</td>
<td>HBW Transit Drive</td>
<td>HBW Transit Walk</td>
<td>HNWNHB Transit Drive</td>
<td>HNWNHB Transit Walk</td>
</tr>
<tr>
<td>Movement table</td>
<td>PKCRTSTOP.BIN</td>
<td>PKCRTSTOP.BIN</td>
<td>OPCRTSTOP.BIN</td>
<td>OPCRTSTOP.BIN</td>
</tr>
<tr>
<td>Output</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow table</td>
<td>PKPRFLW.BIN</td>
<td>PKNOPRFLW.BIN</td>
<td>OPPRFLW.BIN</td>
<td>OPNOPRFLW.BIN</td>
</tr>
<tr>
<td>Walk flow table</td>
<td>PKPRWFN.BIN</td>
<td>PKNOPRWFN.BIN</td>
<td>OPPRWFN.BIN</td>
<td>OPNOPRWFN.BIN</td>
</tr>
<tr>
<td>OnOff table</td>
<td>PKPRONO.BIN</td>
<td>PKNOPRONO.BIN</td>
<td>OPPRONO.BIN</td>
<td>OPNOPRONO.BIN</td>
</tr>
<tr>
<td>Movement table</td>
<td>PKPRMOV.BIN</td>
<td>PKNOPRMOV.BIN</td>
<td>OPPRMOV.BIN</td>
<td>OPNOPRMOV.BIN</td>
</tr>
<tr>
<td>Aggregated flow table</td>
<td>PKPRAGR.BIN</td>
<td>PKNOPRAGR.BIN</td>
<td>OPPRAGR.BIN</td>
<td>OPNOPRAGR.BIN</td>
</tr>
</tbody>
</table>
Mode Choice

The mode choice models are applied to the trip matrices, which are outputs of the trip distribution models. Also called mode split models, mode choice models decide the proportion of trips that use different modes. This chapter describes the mode choice module in the DFWRTM.

Mode Choice Nesting Structures

The DFWRTM considers five modes available for trip makers. These five modes are the following: drive alone, share ride with two occupants, share ride with three or more occupants, transit with walking access, and transit with driving access. Three models were developed for HBW, HNW, and NHB trips respectively. Both multinomial logit and nested logit model structures were tested. As a result, nested logit models are used for HBW and HNW trips and a multinomial logit model is used for NHB trips (see “NCTCOG Mode Choice Model Estimation” prepared by Cambridge Systematics for details). The nesting structure for HBW trips is shown in Exhibit 9-1.

Exhibit 9-1: Nesting Structure for HBW Trips

The nesting structure for HNW trips is shown in Exhibit 9-2.
The model structure for NHB trips is shown in Exhibit 9-3.

**Market Segmentation and Input Data Preparation**

One dummy variable used in the models is defined on the basis of whether the number of vehicles owned by a household is less than the number of persons in the household, so the first step is to segment trips by whether the trip makers have fewer household vehicles than household size. Based on the survey data, the percentage of trips made by households with fewer vehicles than their household size is estimated. The percentages
are different by household size and income quartile. For a household size greater than 3, the model assumes that all households have fewer vehicles than the household size. For household sizes from 1 to 3, the percentages by income quartile are shown in Exhibit 9-4.

Exhibit 9-4: Percentage of Households with Fewer Vehicles than Household Size

<table>
<thead>
<tr>
<th>Income Quartile</th>
<th>HH Size 1</th>
<th>HH Size 2</th>
<th>HH Size 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income Quartile 1</td>
<td>24.31%</td>
<td>65.17%</td>
<td>98.86%</td>
</tr>
<tr>
<td>Income Quartile 2 &amp; 3</td>
<td>6.27%</td>
<td>27.37%</td>
<td>69.04%</td>
</tr>
<tr>
<td>Income Quartile 4</td>
<td>0%</td>
<td>4.75%</td>
<td>63.44%</td>
</tr>
</tbody>
</table>

Second, the model aggregates the shares for each income quartile using the household size distribution. For example, the share of HBW trips made by households with fewer vehicles than household size in income quartile 1 is calculated as follows:

\[ HWVLTP = (Hh1Inc1 \times 0.2431 + Hh2Inc1 \times 0.6517 + Hh3Inc1 \times 0.9886 + Hh4Inc1 + Hh5Inc1 + Hh6Inc1) / Inc1 \]  

(9-1)

And the share of HBW trips made by households with equal or more vehicles than household size in income quartile 1 is expressed as follows:

\[ HWVGEP = 1 - HWVLTP \]  

(9-2)

Where Hh1Inc1 is the number of households with size 1 and in income quartile 1, and Inc1 is the number of households in income quartile 1. Similarly, the share of HNW trips made by households with fewer vehicles than household size in income quartile 1 can be expressed as follows:

\[ HNWWLTP = (Hh1Inc1 \times 0.2431 + Hh2Inc1 \times 0.6517 + Hh3Inc1 \times 0.9886 + Hh4Inc1 + Hh5Inc1 + Hh6Inc1) / HhTotal \]  

(9-3)

where HhTotal is the total number of households.

The shares for HBW, HNW, and NHB trips are saved in VehicleAvailability.DBF in the folder TSZGeographic\GEOVACT. The fields in this table are described in Exhibit 9-5.
The trip share for each market segment is then applied to the trip distribution output matrix PADIST.MTX and creates four matrices. These four matrices are the following: HBWMC, HNWMC, NHBMC, and TRUCKMC. Matrix HBWMC and HNWMC have 6 cores which represent the six market segments; the core names are H1WVLTP, H1WVGEP, H23WVLTP, H23WVGEP, H4WVLTP, and H4WVGEP for HBWMC and HNW1VLTP, HNW1VGEP, HNW23VGEP, HNW23VLTP, HNW4VLTP, and HNW4VGEP for HNWMC. The cores in these two matrices are filled by multiplying PADIST by the corresponding columns in the trip share table. For example, core H1WVLTP in HBWMC is filled by multiplying core H1W in PADIST by column H1WVLTP in table Vehicleavailability.DBF.

Since household auto ownership does not have a significant impact on NHB and OTHER trips’ mode choice, these two trip purposes are not segmented by whether the trips are made by households with fewer vehicles. Both matrices NHBMC and TRUCKMC have one core which is copied from matrix PADIST.

Besides household demographic attributes, zonal demographic variables such as TSZ area type are found significant in the models. These relevant variables are prepared in NLMDATA.BIN under the folder TSZGeographic\GEO\ACT folder. The data set includes the fields described in Exhibit 9-6.

<table>
<thead>
<tr>
<th>Fields</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSZ</td>
<td>Id of TSZ</td>
</tr>
<tr>
<td>H1WVLTP</td>
<td>Share of H1W trips made by households with fewer vehicles than household size in income quartile 1</td>
</tr>
<tr>
<td>H1WVGEP</td>
<td>Share of H1W trips made by households with vehicles greater than or equal to household size in income quartile 1</td>
</tr>
<tr>
<td>H23WVLTP</td>
<td>Share of H23W trips made by households with fewer vehicles than household size in income quartile 2 and 3</td>
</tr>
<tr>
<td>H23WVGEP</td>
<td>Share of H23W trips with vehicles greater than or equal to household size in income quartile 2 and 3</td>
</tr>
<tr>
<td>H4WVLTP</td>
<td>Share of H4W trips with fewer vehicles than household size in income quartile 4</td>
</tr>
<tr>
<td>H4WVGEP</td>
<td>Share of H4W trips with vehicles greater than or equal to household size in income quartile 4</td>
</tr>
<tr>
<td>HNW1VLTP</td>
<td>Share of HNW trips made by households with fewer vehicles than household size in income quartile 1</td>
</tr>
<tr>
<td>HNW1VGEP</td>
<td>Share of HNW trips made by households with vehicles greater than or equal to household size in income quartile 1</td>
</tr>
<tr>
<td>HNW23VLTP</td>
<td>Share of HNW trips made by households with fewer vehicles than household size in income quartile 2 and 3</td>
</tr>
<tr>
<td>HNW23VGEP</td>
<td>Share of HNW trips made by households with vehicles greater than or equal to household size in income quartile 2 and 3</td>
</tr>
<tr>
<td>HNW4VLTP</td>
<td>Share of HNW trips made by households with fewer vehicles than household size in income quartile 4</td>
</tr>
<tr>
<td>HNW4VGEP</td>
<td>Share of HNW trips made by households with vehicles greater than or equal to household size</td>
</tr>
</tbody>
</table>
Exhibit 9-6: Field Descriptions for NLMDATA.BIN

<table>
<thead>
<tr>
<th>Fields</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSZ</td>
<td>TSZ ID</td>
</tr>
<tr>
<td>PCOSTHBW</td>
<td>Parking cost for home-based work trips</td>
</tr>
<tr>
<td>PCOSTHNW</td>
<td>Parking cost for home-based nonwork trips</td>
</tr>
<tr>
<td>PCOSTNHB</td>
<td>Parking cost for non-home-based trips</td>
</tr>
<tr>
<td>HHIQ1</td>
<td>Average household size for income quartile 1</td>
</tr>
<tr>
<td>HHIQ23</td>
<td>Average household size for income quartile 2 and 3</td>
</tr>
<tr>
<td>HHIQ4</td>
<td>Average household size for income quartile 4</td>
</tr>
<tr>
<td>ATYPE1</td>
<td>Dummy variable, 1 for area type=1 and 0 otherwise</td>
</tr>
<tr>
<td>ATYPE2</td>
<td>Dummy variable, 1 for area type=2 and 0 otherwise</td>
</tr>
<tr>
<td>VLTP</td>
<td>1</td>
</tr>
<tr>
<td>Airport</td>
<td>0</td>
</tr>
<tr>
<td>FTWORTH</td>
<td>Dummy variable, -1 if in Fort Worth CBD and 0 otherwise</td>
</tr>
<tr>
<td>LINC</td>
<td>1</td>
</tr>
<tr>
<td>MINC</td>
<td>1</td>
</tr>
<tr>
<td>HINC</td>
<td>1</td>
</tr>
</tbody>
</table>

The parking cost is obtained from input file PARKING4874.DBF in directory TCMODEL\ModelCalibrated\ModeChoice\Data. The average household size is calculated based on the joint household size and income quartile distribution obtained in the Trip Generation module. The dummy variables on area type and Fort Worth CBD are defined according to information in the TSZ layer.

The level-of-service variables used in the models include roadway travel time, operating cost, transit in-vehicle travel time, transit fare, etc. These inputs are prepared through the roadway skim and transit skim procedures (see Chapters 4 and 7 respectively for details). The skims are done for different time-of-day (peak hours and off-peak hours) and for various roadway and transit mode of access scenarios (roadway: HOV vs. no HOV; transit: park-and-ride vs. no park-and-ride). Depending on the trip purposes, the models read the level-of-service variables from the corresponding skim matrices.

Model Implementation

As the person trips are segmented by household income quartile, household size, and vehicle ownership status, the models are applied to each segment respectively. Thirteen nested logit models (six for HBW trip segments, six for HNW trip segments, and one for NHB trips as multinomial logit model can be viewed as a special case of nested logit model) are saved in the folder TCMODEL\ModelCalibrated\ModeChoice\Data\Files. The files provide information such as the nested structure and utility functions for all modes. The files also identify the data sources from which to read the independent variables. For example, the model information for HNW1VGEP trips shows that, to calculate the utility function of drive alone mode, the travel time is read from the roadway skim matrix OP_HOV.MTX with a core OPTIME_.*. It also identifies the variables that should be read from NLMDATA and the location of file NLMDATA (see Exhibit 9-7).
Exhibit 9-7: Nested Logit Model for HNW1VGEP Segment

The models are applied at an aggregate level to each trip segment sequentially. Specifically, the models are implemented by calling the Nested Logit Model Application in batch mode. The output matrices are named following trip segments (i.e., H1WVLTP.MTX, H1WVGEP.MTX, etc.). These files are saved in the folder TCMODEL\RoadwayNetwork\RDWY\GEO\ACT\APT\TRNT. The following section demonstrates the procedure of nested logit model implementation from the TransCAD menu, which is equivalent to the DFWRTM application, using H1WVLTP trips as an example:

1. Open matrix “HBWMC.MTX” and other input files including the level-of-service matrices for roadway and transit, and NLMDATA described in the previous section.
2. Select **Planning—Mode Split — Nested Logit Model Application** from the menu to display the Nested Logit Model dialogue window (see Exhibit 9-8).
3. Select TCMODEL\ModelCalibrated\ModeChoice\Data\H1WVLTP.NLM as the model file.
4. In the “Application” tab, check the “Aggregate” radio button and “OD-based” box for model type. Also, check the “Matrix File” radio button and select “HBW” as the matrix file.
5. In the “Model” tab, the nested structure is shown (see Exhibit 9-9).
6. In the “Options” tab, check the “Drop Alternative” radio button. Also, check the box “Apply Probabilities to Total Matrix” and specify “HBW” as the total matrix file and “H1WVLTLP” as the matrix (see Exhibit 9-10).
7. Click Run and save the output file.

Similar processes are applied to other trip segments with different time-of-day skim matrices.
Exhibit 9-9: Nested Logit Model Implementation: Model
Exhibit 9-10: Nested Logit Model Implementation: Options
Time-of-Day and Vehicle Trips Conversion

This chapter describes the post-mode choice matrix manipulation procedure. It applies the time-of-day and vehicle occupancy factors to various trips. After this procedure, the trip matrix is ready for the assignment process.

Time-of-Day and Post-Mode Choice Matrix Manipulation

After the nested logit models are run on all trip segments, a matrix manipulation procedure is applied to the passenger trip categories to convert the daily production-attraction person trip tables to time-of-day origin-destination vehicle trip tables. For auto modes, trips are first added up for drive alone and share ride modes. Meanwhile, the vehicle occupancy factors are applied for shared ride trips. For shared ride 2, the occupancy factor is 2. For shared ride 3+, the occupancy factors are different for different trip purposes. It is 3.32 for HBW, 3.58 for HNW, and 3.75 for NHB.

Second, it is assumed that 80 percent of the share ride trips use HOV lanes for HBW trips, 60 percent for HNW shared ride trips, and 0 percent for NHB shared ride trips. So, the shared ride trips are divided into two categories: shared ride with HOV and shared ride with no HOV. The detailed procedure for these trip purposes is described as follows:

1. Create a matrix HBWAuto.MTX following the same structure of h1wVLTP. The matrix includes 6 cores: H1W Drive Alone, H1W Share Ride, H23W Drive Alone, H23W Share Ride, H4W Drive Alone, and H4W Share Ride.
2. Fill the cores:
   a. H1W Drive Alone = h1wVLTP.drive alone + h1wVGEP.drive alone
   b. H1W Share Ride = h1wVLTP.ShareRide2 * 0.5 + h1wVLTP.ShareRide3 /3.32 + h1wVGEP.ShareRide2 * 0.5 + h1wVGEP.ShareRide3 /3.32
   c. H23W Drive Alone = h23wVLTP.drive alone + h23wVGEP.drive alone
   d. H23W Share Ride = h23wVLTP.ShareRide2 * 0.5 + h23wVLTP.ShareRide3 /3.32 + h23wVGEP.ShareRide2 * 0.5 + h23wVGEP.ShareRide3 /3.32
   e. H4W Drive Alone = h4wVLTP.drive alone + h4wVGEP.drive alone
   f. H4W Share Ride = h4wVLTP.ShareRide2 * 0.5 + h4wVLTP.ShareRide3 /3.32 + h4wVGEP.ShareRide2 * 0.5 + h4wVGEP.ShareRide3 /3.32
3. Add 6 cores to HBWAuto.MTX. These 6 cores are: H1W SRIDE NOHOV, H1W SRIDE HOV, H23W SRIDE NOHOV, H23W SRIDE HOV, H4W SRIDE NOHOV, and H4W SRIDE HOV.
4. Fill the new cores in the matrix:
   a. H1W SRIDE NOHOV = H1W Share Ride * 0.2
   b. H1W SRIDE HOV = H1W Share Ride * 0.8
   c. H23W SRIDE NOHOV = H23W Share Ride * 0.2
d. $H_{23W} \text{ SRIDE HOV} = H_{23W} \text{ Share Ride} \times 0.8$

e. $H_{4W} \text{ SRIDE NOHOV} = H_{23W} \text{ Share Ride} \times 0.2$

f. $H_{4W} \text{ SRIDE HOV} = H_{23W} \text{ Share Ride} \times 0.8$

5. Create a matrix $HNWNHBAuto.MTX$ following the same structure of $HNW1VLTP$. The matrix includes 8 cores: $HNW1\text{Drive Alone}$, $HNW1\text{ShareRide}$, $HNW23\text{Drive Alone}$, $HNW23\text{ShareRide}$, $HNW4\text{Drive Alone}$, $HNW4\text{ShareRide}$, $NHB\text{Drive Alone}$, and $NHB\text{ShareRide}$.

6. Fill the cores in the matrix:

a. $HNW1\text{Drive Alone} = hnw1\text{VLTP}.\text{drive alone} + hnw1\text{VGEP}.\text{drive alone}$

b. $HNW23\text{Drive Alone} = hnw23\text{VLTP}.\text{drive alone} + hnw23\text{VGEP}.\text{drive alone}$

c. $HNW4\text{Drive Alone} = hnw4\text{VLTP}.\text{drive alone} + hnw4\text{VGEP}.\text{drive alone}$

d. $NHB \text{ Drive Alone} = nhb.\text{drive alone}$

e. $HNW1\text{ShareRide} = hnw1\text{VLTP}.\text{ShareRide2} /2 + hnw1\text{VLTP}.\text{ShareRide3} /3.58 + h1w\text{VGEP}.\text{ShareRide2} /2 + h1w\text{VGEP}.\text{ShareRide3} /3.58$

f. $HNW23\text{ShareRide} = hnw23\text{VLTP}.\text{ShareRide2} /2 + hnw23\text{VLTP}.\text{ShareRide3} /3.58 + hnw23\text{VGEP}.\text{ShareRide2} /2 + hnw23\text{VGEP}.\text{ShareRide3} /3.58$

g. $HNW4\text{ShareRide} = hnw4\text{VLTP}.\text{ShareRide2} /2 + hnw4\text{VLTP}.\text{ShareRide3} /3.58 + hnw4\text{VGEP}.\text{ShareRide2} /2 + hnw4\text{VGEP}.\text{ShareRide3} /3.58$

h. $NHB\text{ShareRide} = nhb.\text{ShareRide2} /2 + nhb.\text{ShareRide3} /3.75$

7. Add 8 cores to $HNWNHBAuto.MTX$. These 8 cores are: $HNW1 \text{ SRIDE HOV}$, $HNW1 \text{ SRIDE NOHOV}$, $HNW23 \text{ SRIDE HOV}$, $HNW23 \text{ SRIDE NOHOV}$, $HNW4 \text{ SRIDE HOV}$, $HNW4 \text{ SRIDE NOHOV}$, $NHB \text{ SRIDE HOV}$, and $NHB \text{ SRIDE NOHOV}$.

8. Fill the cores:

a. $HNW1 \text{ SRIDE HOV} = HNW1\text{ShareRide} \times 0.4$

b. $HNW1 \text{ SRIDE NOHOV} = HNW1\text{ShareRide} \times 0.6$

c. $HNW23 \text{ SRIDE HOV} = HNW23\text{ShareRide} \times 0.4$

d. $HNW23 \text{ SRIDE NOHOV} = HNW23\text{ShareRide} \times 0.6$

e. $HNW4 \text{ SRIDE HOV} = HNW4\text{ShareRide} \times 0.4$

f. $HNW4 \text{ SRIDE NOHOV} = HNW4\text{ShareRide} \times 0.6$

g. $NHB \text{ SRIDE NOHOV} = NHB\text{ShareRide} \times 1.0$

h. $NHB \text{ SRIDE HOV} = NHB\text{ShareRide} \times 0$

The time-of-day factors are applied to the daily production-attraction vehicle trip matrices to obtain a.m. peak period (AM), p.m. peak period (PM), and off-peak (OP) origin-destination trip matrices. The time-of-day matrices are calculated as follows:

1. For $H1W$ trips (including $H1W \text{ Drive Alone}$, $H1W \text{ Share Ride HOV}$, and $H1W \text{ Share Ride No HOV}$),

   $H1W \text{ AM} = H1W \times 0.2118 + \text{Transpose} \times H1W \times 0.0351$

   $H1W \text{ PM} = H1W \times 0.0232 + \text{Transpose} \times H1W \times 0.2227$

   $H1W \text{ OP} = H1W \times 0.2650 + \text{Transpose} \times H1W \times 0.2422$

2. For $H23W$ trips (including $H23W \text{ Drive Alone}$, $H23W \text{ Share Ride HOV}$, and $H23W \text{ Share Ride No HOV}$),

   $H23W \text{ AM} = H23W \times 0.2752 + \text{Transpose} \times H23W \times 0.0111$

   $H23W \text{ PM} = H23W \times 0.0170 + \text{Transpose} \times H23W \times 0.2736$

   $H23W \text{ OP} = H23W \times 0.2078 + \text{Transpose} \times H23W \times 0.2153$

3. For $H4W$ trips (including $H4W \text{ Drive Alone}$, $H4W \text{ Share Ride HOV}$, and $H4W \text{ Share Ride No HOV}$),

   $H4W \text{ AM} = H4W \times 0.2899 + \text{Transpose} \times H4W \times 0.0149$

   $H4W \text{ PM} = H4W \times 0.0156 + \text{Transpose} \times H4W \times 0.2658$

   $H4W \text{ OP} = H4W \times 0.1945 + \text{Transpose} \times H4W \times 0.2193$
4. For HNW trips (including HNW1/HNW2/HNW4 Drive Alone, Share Ride HOV, and Share Ride No HOV),
   \[
   \begin{aligned}
   \text{HNW AM} &= \text{HNW} \times 0.1356 + \text{Transpose HNW} \times 0.0412 \\
   \text{HNW PM} &= \text{HNW} \times 0.0993 + \text{Transpose HNW} \times 0.1611 \\
   \text{HNW OP} &= \text{HNW} \times 0.2651 + \text{Transpose HNW} \times 0.2977
   \end{aligned}
   \]

5. For NHB trips (including NHB Drive Alone, Share Ride HOV, and Share Ride No HOV),
   \[
   \begin{aligned}
   \text{NHB AM} &= \text{NHB} \times 0.0257 + \text{Transpose NHB} \times 0.0257 \\
   \text{NHB PM} &= \text{NHB} \times 0.1219 + \text{Transpose NHB} \times 0.1219 \\
   \text{NHB OP} &= \text{NHB} \times 0.3524 + \text{Transpose NHB} \times 0.3524
   \end{aligned}
   \]

The last step before traffic assignment consists of multiplying each time-of-day origin-destination vehicle trip matrix by the K-factor matrix saved under directory TCMODEL\ModelCalibrated\TripAssignment\DataKfact_Apr9D3.MTX.

For the transit mode, two new transit matrices are created following the same structure of h1wVLTP. These two matrices are the following: PKTransit and OPTransit in folder TCMODEL\RoadwayNetwork\RDWY\GEO\ACT\APT\TRNT. It is assumed that HBW trips are made during the peak period. Thus, matrix PKTransit has the following three cores: HBW Transit Walk, HBW Transit Drive, and HBW Transit. The Transit Walk and Transit Drive cores are filled by adding up Transit Walk and Transit Drive cores across all HBW market segments respectively. We also assume that HNW and NHB are made during the off-peak hours. So, matrix OPTransit has the following eight cores: HNW Transit Walk, HNW Transit Drive, NHB Transit Walk, NHB Transit Drive, HNWNHB Transit Walk, HNWNHB Transit Drive, HNW Transit, and NHB Transit. The first four cores in the matrix are filled by adding up the corresponding cores in all market segment matrices. Then, the HNWNHB Transit Walk/Drive cores are filled by adding HNW Transit Walk/Drive to NHB Transit Walk/Drive respectively. The PKTransit and OPTransit matrices are used for transit assignment.
Chapter 11

Trip Assignment

The assignment is the last step in the travel demand model. In the DFWRTM, traffic assignment is run for the morning peak period and off-peak period in the initial iteration and the first feedback iteration. The roadway travel times (PKTIME and OPTIME) are updated based on the a.m. peak period and the off-peak period traffic assignment. During the last iteration, the roadway traffic is assigned for the a.m. peak period, p.m. peak period, and off-peak period, and the transit assignment is run for the peak and off-peak periods.

This chapter describes the roadway traffic assignment and the transit assignment procedures.

Roadway Traffic Assignment

The inputs for roadway traffic assignment are vehicle trip tables by time-of-day. There are three time-of-day periods: AM Peak (6:30 a.m. to 8:59 a.m.), PM Peak (3:00 p.m. to 6:29 p.m.), and Off-Peak (9:00 a.m. to 2:59 p.m. and 6:30 p.m. to 6:29 a.m.) periods. The DFWRTM considers four vehicle classes: drive-alone vehicles (DA), share-ride vehicles with access to HOV facilities (SRHOV), share-ride vehicles with no access to HOV facilities (SRNOHOV), and trucks (TRUCK). Trucks should have a consistent meaning in both air quality and transportation models, using the vehicle type definition by TxDOT, as shown in Exhibit 11-1, vehicle class Drive alone and Shared ride apply to vehicle profile types 1 and 2 in the exhibit, and Truck is defined as types 3-13 in the exhibit. The DFWRTM adopts a generalized cost method for multi-modal multi-class roadway assignment. Different vehicle classes have different sets of roadway networks to access and different parameters for value-of-time. The outputs of the roadway traffic assignment are the following: AMFLOW, OPFLOW, and PMFLOW. These files are binary files that record traffic volumes of different vehicle classes as well as link speed and link volume-capacity ratio.

The DFWRTM chooses the user equilibrium generalized cost method because the user equilibrium is a proven theory and widely adopted in practice around the world. The generalized cost component considers path choice by a combined measure of roadway operating cost, toll cost, and travel time. Furthermore, the congested travel time is sensitive to the capacity and volume of the roadway.

One important component in traffic assignment is the volume-delay function. The DFWRTM uses a customized volume-delay function: NCTCOG.vdf. The function uses a similar form of widely-used Bureau of Public Road (BPR) function with a constraint of a floor speed. The next section describes this function in detail.
TYPICAL VEHICLE PROFILE FOR EACH TXDOT VEHICLE TYPE

<table>
<thead>
<tr>
<th>TYPE 1</th>
<th>TYPE 2</th>
<th>TYPE 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorcycles &amp; Passenger Cars</td>
<td>Two Axle, 4-Tire Single Unit</td>
<td>Buses</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TYPE 4</th>
<th>TYPE 5</th>
<th>TYPE 6</th>
<th>TYPE 7</th>
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</thead>
<tbody>
<tr>
<td>Two Axle, 4-Tire Single Units</td>
<td>Three Axle Single Units</td>
<td>Four or More Axles, Single Units</td>
<td>Three Axles, Single Trailers</td>
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</table>

<table>
<thead>
<tr>
<th>TYPE 8</th>
<th>TYPE 9</th>
<th>TYPE 10</th>
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<tr>
<td>Four Axles, Single Trailers</td>
<td>Five Axle Single Trailers</td>
<td>Six or More Axles, Single Trailers</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>TYPE 11</th>
<th>TYPE 12</th>
<th>TYPE 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Five or Less Axles, Multi-Trailers</td>
<td>Six Axles, Multi-Trailers</td>
<td>Seven or More Axles, Multi-Trailers</td>
</tr>
</tbody>
</table>
Volume Delay Function

The volume-delay function (sometimes referred as the performance function) calculates a congested travel time that reflects the free speed travel time and the delay time due to the impact of traffic volume on the link. The DFWRTM volume-delay function is similar to the BPR functions used in other regional models, in that link speed decreases as the volume-capacity (VC) ratio increases. However, the NCTCOG volume-delay function includes an assumption of maximum minutes of delay per mile that effectively limits the decrease in link speed when the VC ratio exceeds a certain threshold. The introduction of this floor speed is to speed up the assignment procedure and make it converge more quickly. The drawback of the floor speed is that it violates a property of the user equilibrium formulation and might lead to problematic convergence.

The general form of NCTCOG's volume-delay function is as follows:

\[
TravelTime = FreeFlowTime + \text{Min}\{Ae^{B(vol/cap)}, C\} \times Length
\]  

(11-1)

Values for A, B, and C for freeway and arterial links are shown in Exhibit 11-2. Exhibit 11-3 shows the relationship between speed and VC ratio for freeway and arterial links.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Freeway</th>
<th>Arterial</th>
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<tbody>
<tr>
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<td>0.015</td>
<td>0.05</td>
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<tr>
<td>B</td>
<td>6.0</td>
<td>3.90</td>
</tr>
<tr>
<td>C</td>
<td>4.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Exhibit 11-2: Volume-Delay Function Parameters

Exhibit 11-3: Speed vs. VC Ratio for Roadway Links
Link capacity and free flow travel time are stored in the network file under the following fields:
- AMCAP_*: Capacity for AM period
- PMCAP_*: Capacity for PM period
- OPCAP_*: Capacity for OP period
- PKFRTIME_*: Free flow time for AM and PM periods
- OPFRTIME_*: Free flow time for OP period

Roadway Link Operating and Toll Cost

Two types of costs are assigned to each roadway link: vehicle operating cost and toll cost. While vehicle operating costs can include both long-term costs (insurance, car payments, repairs, etc.) and short-term out-of-pocket costs (primarily fuel cost), the DFWRTM mainly considers the short-term costs because the Model Development Group believes that the short-term costs have a significant impact on the travelers’ routing choice in the assignment module. The auto operating cost is assumed to be 7.3 cents per mile, expressed in constant 1999 dollars.

Tolls can be considered within the model by two methods: a fixed dollar value for a link, or a dollar per mile value. When the location of toll plazas and the amount of the toll are known, the fixed value is used. Otherwise, the unit toll cost (toll per mile) is used and toll cost on the link is subsequently calculated. In both cases, the link toll cost is adjusted to constant 1999 dollars. Toll adjustment factors are the Consumer Price Index (CPI) adjustment factors listed in Exhibit 11-4 and displayed in a chart in Exhibit 11-5.

Managed lane facilities are HOV lanes that can be used by the Drive Alone (DA) class by paying a toll, but are free for Shared Ride classes. They have a higher cost for the DA class; this is reflected in the roadway network file in field OPERCOSTDA.

Based on the toll cost and operating cost, the direct dollar cost of traveling through each link is calculated as follows:

\[
\text{AdjustedToll} = \left( \text{FixedToll} + (\text{TollMile})(\text{Length}) \right)\text{AdjustmentFactor}_{yr}
\]

\[
\text{OperatingCost} = (\text{Length})(\text{CostMile}) + \text{AdjustedToll}
\]

where \(\text{AdjustmentFactor}_{yr}\) is the adjustment factor to convert year \(yr\) toll cost to 1999 Dollar; \(\text{CostMile}\) is the operating cost per mile for all links and is set as 0.073 Dollar/Mile across all links.

Link cost attributes are stored in the network file in the following fields:
- TOLL_*: fixed toll cost in cents at the toll booth.
- TOLLMILE: toll cost per mile in cents.
- OPERCOST_*: Adjusted dollar cost for passing through a link for non-Drive Alone classes in Dollars.
- OPERCOSTDA_*: Adjusted dollar cost for passing through a link for Drive Alone class in Dollars.
- TOLLROAD: Code fields used for managed lane facilities.
- MODEL_LENGTH: Length of the link in miles.
Exhibit 11-4: Consumer Price Index (CPI) Adjustment Factor Based on 1999 Dollar for 1984-2030

<table>
<thead>
<tr>
<th>Year</th>
<th>CPI Adjustment Factor</th>
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<tr>
<td>2020</td>
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<tr>
<td>2021</td>
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</tr>
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</table>

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Generalized Cost and Value-of-Time

The value-of-time (VOT) parameter combines the impact of travel time, vehicle operating cost, and toll cost in the traffic assignment. Estimating an appropriate value-of-time is often a difficult task because there are many factors that influence an individual’s perception of the value-of-time. For instance, higher income households generally have a higher value-of-time than lower income households. The VOTs used in the DFWRTM traffic assignment are the following:

<table>
<thead>
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<th>Year</th>
<th>CPI Adjustment Factor</th>
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<td>0.583</td>
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<tr>
<td>2030</td>
<td>0.574</td>
</tr>
</tbody>
</table>

Exhibit 11-5: Toll Adjustment Factor Based on 1999 Dollar
- $10/hour ($0.167/minute) for auto-based vehicle classes (DA, SRHOV, and SRNOHOV).
- $12/hour ($0.2/minute) for trucks

The total travel cost on a roadway link is then calculated as shown in the following equation:

\[
\text{GeneralizedCost} = \text{OperatingCost} + (VOT)(\text{TravelTime})
\]  

(11-4)

Implementing Roadway Traffic Assignment in TransCAD

The traffic assignment module in the DFWRTM is fully batched. This section describes an equivalent process if it is run manually, using the a.m. peak period as an example. The assignment process has two components: create a roadway network, and run a multi-modal multi-class assignment.

For the a.m. peak time period, the following steps are taken to create the AM network:
1. Open the roadway geographic file ACTRDWY.DBD.
2. Create a selection of links with “AMHRCAP_AB > 0”; call this selection “AMLinks.”
3. Create a selection of nodes with “CENTROID > 0”; call this selection “Centroids.”
4. Create a network file with the following settings: (see Exhibit 11-6):
   a. Create links from: AMLinks
   b. Read length from: MODEL_LENGTH
   c. Other Link fields: A_PK, B_PK, C_PK, MODEL_LENGTH, AMCAP_*, OPERCOSTDA_*, OPERCOST_*, PKFRTIME_*
   d. Check “Drop Duplicate Links” option.
   e. Save this network as AM.NET.
5. Open the network setting dialog box, under the Centroids section, choose the “Create from selection set” radio button and select the “Centroids” selection set (see Exhibit 11-7).
6. Click OK.
Exhibit 11-6: Create AM Network File

Exhibit 11-7: Network Settings for AM Network File
After creating the network for the a.m. peak period and defining network settings, run the multi-modal multi-class assignment using the following steps:

1. Load the ACTRDWY.DBD file.
2. Load the AM.NET file.
3. Load the AM.MTX file (contains AM vehicle trip tables for four classes).
4. Create a selection of links with "AMHRCAP_AB > 0"; call this selection “AMLinks.”
5. Create a selection of links with “AMHRCAP_AB > 0 and FUNCL = 8 and TOLLROAD <> 3”; call this selection “ExclusionSetDA.”
6. Create a selection of links with “AMHRCAP_AB > 0 and FUNCL = 8”; call this selection “ExclusionSetSRNOHOV”
7. If the “exc_truck” field exists in the link layer, create a selection of links with “AMHRCAP_AB > 0 and (FUNCL = 8 or exc_truck = 1)”. If the “exc_truck” field does not exist, create a selection of links with “AMHRCAP_AB > 0 and FUNCL = 8”; call this selection “ExclusionSetTruck.”
8. Bring up the Multi-modal Multi-class Assignment dialog box and use the following settings (see Exhibit 11-8):
   a. Press the Network button to bring up the Network Settings Window.
      i. Under Toll tab, choose the Toll Links “In Selection Set” radio button, and select AMLinks (see Exhibit 11-9).
      ii. Press OK.
   b. Delay Function: NCTCOG
   c. Method: User Equilibrium
   d. O-D Matrix: AM
Exhibit 11-8: Multi-Modal Multi-Class Assignment for AM Period

Multi-Modal Multi-Class Assignment

Network File: C:\\CT29GECYR25ACW\TEMPAM.NET
Method: User Equilibrium
Delay Function: NCTCOG
O-D Matrix: AM

Class Information

<table>
<thead>
<tr>
<th>Matrices</th>
<th>PCE</th>
<th>VOT</th>
<th>Fixed Toll</th>
<th>Road Toll</th>
<th>Exclusion Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive Alone</td>
<td>1.0</td>
<td>0.167</td>
<td>OPERCOSTDA</td>
<td>--</td>
<td>ExclusionSetDA</td>
</tr>
<tr>
<td>SRIDE_NO1</td>
<td>1.0</td>
<td>0.167</td>
<td>OPERCOST</td>
<td>--</td>
<td>ExclusionSetSRNO</td>
</tr>
<tr>
<td>SRIDE_HVY</td>
<td>1.0</td>
<td>0.167</td>
<td>OPERCOST</td>
<td>--</td>
<td>None</td>
</tr>
<tr>
<td>Truck</td>
<td>1.0</td>
<td>0.2</td>
<td>OPERCOST</td>
<td>--</td>
<td>ExclusionSetTruck</td>
</tr>
</tbody>
</table>

Use Class: 1.0

Delay Function Parameters

<table>
<thead>
<tr>
<th>Name</th>
<th>Field</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>PKRTIME</td>
<td>N/A</td>
</tr>
<tr>
<td>Capacity</td>
<td>AMCAP</td>
<td>N/A</td>
</tr>
<tr>
<td>Length</td>
<td>MODEL_LENGTH</td>
<td>N/A</td>
</tr>
<tr>
<td>A</td>
<td>A_PK</td>
<td>0.015</td>
</tr>
<tr>
<td>B</td>
<td>B_PK</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Field: PKRTIME

Globals

| Iterations | 30 |
| Convergence | 0.00001 |
| Function | |
| Error | 5.0000 |

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e. Use the table in Exhibit 11-10 for vehicle class information.

**Exhibit 11-10: Vehicle Class Settings for AM Assignment**

<table>
<thead>
<tr>
<th>Matrices</th>
<th>PCE</th>
<th>VOT</th>
<th>Fixed Toll</th>
<th>Exclusion Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive Alone</td>
<td>1.0</td>
<td>0.167</td>
<td>OPERCOSTDA_*</td>
<td>ExclusionSetDA</td>
</tr>
<tr>
<td>ShareRide NO HOV</td>
<td>1.0</td>
<td>0.167</td>
<td>OPERCOST_*</td>
<td>ExclusionSetSRN OHOV</td>
</tr>
<tr>
<td>ShareRide HOV</td>
<td>1.0</td>
<td>0.167</td>
<td>OPERCOST_*</td>
<td>-</td>
</tr>
<tr>
<td>Truck</td>
<td>1.0</td>
<td>0.2</td>
<td>OPERCOST_*</td>
<td>ExclusionSetTruck</td>
</tr>
</tbody>
</table>

f. Use the table in Exhibit 11-11 to define delay function parameters.

**Exhibit 11-11: Settings for Volume-Delay Function for AM Assignment**

<table>
<thead>
<tr>
<th>Name</th>
<th>Field</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>PKFRTIME_*</td>
<td>N/A</td>
</tr>
<tr>
<td>Capacity</td>
<td>AMCAP_*</td>
<td>N/A</td>
</tr>
<tr>
<td>Length</td>
<td>MODEL_LENGTH</td>
<td>N/A</td>
</tr>
<tr>
<td>A</td>
<td>A_PK</td>
<td>0.015</td>
</tr>
<tr>
<td>B</td>
<td>B_PK</td>
<td>6.2</td>
</tr>
<tr>
<td>C</td>
<td>C_PK</td>
<td>60</td>
</tr>
<tr>
<td>Preload</td>
<td>None</td>
<td>N/A</td>
</tr>
</tbody>
</table>
g. Press the Option button to bring up the Options Window.
   i. Under other options, check “Class Flows” (see Exhibit 11-12).
   ii. Press OK
h. Use 30 for the number of iterations and 0.00 for convergence value.
i. Press OK, and specify the output file locations.

Exhibit 11-12: Reporting Volumes for Vehicle Classes in the Output File

Model Outputs

Similar steps, with adjustments according to time periods, are taken for running Off-Peak and PM traffic assignments. After the traffic assignment is done for each time period, estimated volumes for each class are stored in the output files. Total traffic volume for each time period is calculated and stored in the roadway network file. Also, the volumes are used in a post-processed procedure for link travel time estimation, which are also stored in the roadway network file. If a feedback run is needed for a model run, new link estimated times are used for skim matrices. Total volumes and times are stored in the following fields:

- **AMVOL_***: Total link volume for the AM period.
- **PMVOL_***: Total link volume for the PM period.
- **OPVOL_***: Total link volume for the OP period.
- **PKTIME_***: Loaded link travel time in the AM period.
- **PMTIME_***: Loaded link travel time in the PM period.
- **OPTIME_***: Loaded link travel time in the OP period.
TransCAD provides six distinct transit assignment methods. Among the six, there are three core methods: All-or-nothing, Pathfinder, and Stochastic User Equilibrium. DFWRTM uses the Pathfinder method because it is easier to use, faster to compute, and more conventional in terms of application practice.

The DFWRTM transit assignment is based on the transit route system ACTTRNT. For transit assignment of different time periods, two transit networks are built from the route system, PKTRNT.net and OPTRNT.net; complete settings and fare structure information are described in the Transit Network and Transit Skims section of this document. Matrices PKTransit and OPTransit provide node-to-node (centroid-to-centroid) passenger demand for different time-of-day. Each matrix has two cores: one for transit with driving access and the other for transit with walk access. It is assumed that all HBW transit trips are made during the peak period and all HNW and NHB transit trips are made during the off-peak period. Therefore, the HBW Transit Drive trip table is used for the peak period with park-and-ride scenario; HBW Transit Walk table is used for peak period with no park-and-ride scenario; HNWNHB Transit Drive table is used for off-peak period with park-and-ride; and HNWNHB Transit Walk table is used for off-peak period with no park-and-ride.

In order to track transfers from route to route, two movement tables are created; they are PKCRTSTOP and OPCRTSTOP. The files are saved under directory TCMODEL\RoadwayNetwork\TRNT in binary format. PKCRTSTOP is used for the peak period and OPCRTSTOP is used for the off-peak period. The movement table structure is described in Exhibit 11-13.

**Exhibit 11-13: Field Descriptions for PKCRTSTOP/OPCRTSTOP**

<table>
<thead>
<tr>
<th>Field</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>From_Line</td>
<td>Integer</td>
<td>Transit line ID from which the stop is connected</td>
</tr>
<tr>
<td>Alight_Stop</td>
<td>Integer</td>
<td>Alighting stop ID</td>
</tr>
<tr>
<td>Board_Stop</td>
<td>Integer</td>
<td>Boarding stop ID</td>
</tr>
<tr>
<td>To_Line</td>
<td>Integer</td>
<td>Transit line ID to which the stop is connected</td>
</tr>
</tbody>
</table>

The following steps describe how the transit assignment module is implemented through the TransCAD menu, using peak period with park-and-ride scenario as an example. The transit network PKTRNT.twt is created and the network settings are defined as described in the previous Transit Skim section. With the transit route system and network file open, use the following steps to run transit assignment.

1. Choose **Transit—Assignment—Pathfinder** to display the Transit Assignment dialog box (see Exhibit 11-14).
2. If PKTRNT.twt is not the network file, click the Network button and choose PKTRNT.twt as the network file.
3. Select PKTransit as the matrix file and HBW Transit Drive as the matrix.
4. Select the radio button “Based on Node Layer.”
5. Click Options to display the Transit Option Settings dialog box (see Exhibit 11-15)
   a. Select PKCRTSTOP as the movement table.

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b. Check the "Compute Boarding Counts" box and "Aggregate Segment Counts" box.

6. Click OK and save the flow table as PKPRFLW.BIN, walk flow table as PKPRWFN.BIN, on-off table as PKPRONO.BIN, movement table as PKPRMOV.BIN, and aggregated flow table as PKPRAGR.BIN

Exhibit 11-14: Transit Assignment (Pathfinder)

Exhibit 11-15: Transit Option Settings
For the other three transit scenarios, peak hour with no park-and-ride, off-peak hour with park-and-ride, and off-peak hour with no park-and-ride, the procedures are the same with minor adjustments to accommodate the time-of-day and park-and-ride differences. Users can refer to Exhibit 8-18 for assignment details for other scenarios.
Update Times and Feedback

The UpdateTimes program and Feedback process exist to calibrate the output from the assignment process with observed travel time and maintain travel time consistency throughout the model run. This chapter describes the Update Times program and Feedback process.

Update Times

After trip assignment and at the end of each feedback, the post-processing Update Times program is run. This program updates the roadway link geographic file ACTRDWY.DBD.

Output of the traffic assignment step includes traffic volume for each vehicle class and travel time on each link. In Update Times, the assignment output is calibrated with observed traffic volume. However, since link travel time estimates do not compare well to observed travel time, another set of volume delay functions is used to calculate link travel times from the estimated volume. This process considers variation of volume within the time period.

Assigned volumes are stored after each assignment in AMFLOW.BIN, PMFLOW.BIN and OPFLOW.BIN, and the fields PKTIME_AB, PKTIME_BA, OPTIME_AB, and OPTIME_BA are updated with AM and OP post-processed times based on these assigned volumes and free time. Post-processed final weighted speeds PKSPD_AB, PKSPD_BA, OPSPD_AB, and OPSPD_BA are also calculated.

The flowchart of the full process is shown in Exhibit 12-1.
Exhibit 12-1: Update Times program Flow Chart

Volume Delay Function

A volume-delay function is used in the Update Times program which differs from the function used in Trip Assignment. The actual equation remains the same, and is shown in Equation in 11-1.

\[ TravelTime = FreeFlowTime + \min \left\{ A e^{B \left( \frac{\gamma_c}{C} \right)}, C \right\} \times \text{Length} \]  

(12-1)

where \( \gamma_c \) is the volume capacity ratio, and A, B, and C are parameters.

The difference from Trip Assignment is the values of the A, B, and C parameters. Those used in the Update Times program are based on traditional volume speed curves, while the assignment parameters are modified to validate the estimated traffic volumes against
the actual traffic counts. The values of the A, B, and C parameters in the Update Times program and in the Assignment program are displayed in Exhibits 12-2 and 12-3 respectively.

**Exhibit 12-2: Volume Delay Parameters Used in Update Times Program**

<table>
<thead>
<tr>
<th></th>
<th>Freeway (Func1 =1,6,8)</th>
<th>Arterial (Func1=2,3,4,7)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>0.015</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>4.20</td>
<td>3.90</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>5.0</td>
<td>6.00</td>
</tr>
</tbody>
</table>

**Exhibit 12-3: Volume Delay Parameters Used in Assignment**

<table>
<thead>
<tr>
<th></th>
<th>Freeway (Func1 =1,6,8)</th>
<th>Arterial (Func1=2,3,4,7)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>0.015</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>6.0</td>
<td>3.90</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>4.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Exhibit 12-4 shows the relationship between speed and the volume-capacity ratio for freeway and arterial links assumed in the Update Times program.

**Exhibit 12-4: Speed Volume Relationship for Roadway Links in Update Times Program**

![Speed-Volume Relationship in Update Times](image-url)
Exhibit 12-5 shows a comparison of the speed and volume-capacity ratio relationship on freeways in the Update Times program and in Trip Assignment. In this exhibit, the assumed free flow speed is 60 miles per hours (mph).

Exhibit 12-5 demonstrates how the parameter values will affect the speed-volume relationship. For the same free flow speed, the C parameter determines the minimum speed. In the graph, in Assignment, C=4, and the minimum speed is 12 mph and begins from a v/c ratio of 0.95, while in the Update Times program, C=5, and the minimum speed is 10 mph and begins from a v/c ratio of 1.4. B is larger in Trip Assignment than in the Update Times program, which means that the speed drops more quickly in Trip Assignment.

Time of Day Distribution

The Update Times program uses an observed time-of-day distribution for a.m. peak (AM), p.m. peak (PM), and off-peak volumes. The model uses AM and OP time in each feedback for trip distribution and mode choice; as a result, they need to be updated at the end of each feedback.
The time of day distribution for AM, PM, and off-peak is shown in the fractions in Exhibits 12-6, 12-7, and 12-8 respectively. The AM, PM, and off-peak periods are broken down into half-hour periods. Half-hour periods are used because there are two cases where an hour is split over different peak types. The 6:00 – 6:30 a.m. period is off-peak, but 6:30 – 7:00 a.m. period is part of the a.m. peak period. The 6:00 – 6:30 p.m. period is part of the p.m. peak period, and the 6:30 – 7:00 p.m. period is off-peak. Note that the volume factors do not change based on the forecast year.

### Exhibit 12-6: AM Fractions

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>AM Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:30-7:00</td>
<td>0.176</td>
</tr>
<tr>
<td>7:00–7:30</td>
<td>0.222</td>
</tr>
<tr>
<td>7:00-8:00</td>
<td>0.222</td>
</tr>
<tr>
<td>8:00–8:30</td>
<td>0.190</td>
</tr>
<tr>
<td>8:30-9:00</td>
<td>0.190</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1.000</strong></td>
</tr>
</tbody>
</table>

### Exhibit 12-7: PM Fractions

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>PM Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:00-15:30</td>
<td>0.131</td>
</tr>
<tr>
<td>15:30-16:00</td>
<td>0.131</td>
</tr>
<tr>
<td>16:00-16:30</td>
<td>0.150</td>
</tr>
<tr>
<td>16:30-17:00</td>
<td>0.150</td>
</tr>
<tr>
<td>17:00-17:30</td>
<td>0.155</td>
</tr>
<tr>
<td>17:30-18:00</td>
<td>0.155</td>
</tr>
<tr>
<td>18:00-18:30</td>
<td>0.128</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1.000</strong></td>
</tr>
</tbody>
</table>
### Exhibit 12-8: OP Fractions

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>OP Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>18:30-19:00</td>
<td>0.053</td>
</tr>
<tr>
<td>19:00-19:30</td>
<td>0.040</td>
</tr>
<tr>
<td>19:00-20:00</td>
<td>0.040</td>
</tr>
<tr>
<td>20:00-20:30</td>
<td>0.031</td>
</tr>
<tr>
<td>20:30-21:00</td>
<td>0.031</td>
</tr>
<tr>
<td>21:00-21:30</td>
<td>0.026</td>
</tr>
<tr>
<td>21:30-22:00</td>
<td>0.026</td>
</tr>
<tr>
<td>22:00-22:30</td>
<td>0.021</td>
</tr>
<tr>
<td>22:30-23:00</td>
<td>0.021</td>
</tr>
<tr>
<td>23:00-23:30</td>
<td>0.015</td>
</tr>
<tr>
<td>23:30-0:00</td>
<td>0.015</td>
</tr>
<tr>
<td>0:00-0:30</td>
<td>0.009</td>
</tr>
<tr>
<td>0:30-1:00</td>
<td>0.009</td>
</tr>
<tr>
<td>1:00-1:30</td>
<td>0.006</td>
</tr>
<tr>
<td>1:30-2:00</td>
<td>0.006</td>
</tr>
<tr>
<td>2:00-2:30</td>
<td>0.005</td>
</tr>
<tr>
<td>2:30-3:00</td>
<td>0.005</td>
</tr>
<tr>
<td>3:00-3:30</td>
<td>0.005</td>
</tr>
<tr>
<td>3:30-4:00</td>
<td>0.005</td>
</tr>
<tr>
<td>4:00-4:30</td>
<td>0.007</td>
</tr>
<tr>
<td>4:30-5:00</td>
<td>0.007</td>
</tr>
<tr>
<td>5:00-5:30</td>
<td>0.023</td>
</tr>
<tr>
<td>5:30-6:00</td>
<td>0.023</td>
</tr>
<tr>
<td>6:00-6:30</td>
<td>0.051</td>
</tr>
<tr>
<td>9:00-9:30</td>
<td>0.043</td>
</tr>
<tr>
<td>9:30-10:00</td>
<td>0.043</td>
</tr>
<tr>
<td>10:00-10:30</td>
<td>0.040</td>
</tr>
<tr>
<td>10:30-11:00</td>
<td>0.040</td>
</tr>
<tr>
<td>11:00-11:30</td>
<td>0.042</td>
</tr>
<tr>
<td>11:30-12:00</td>
<td>0.042</td>
</tr>
<tr>
<td>12:00-12:30</td>
<td>0.043</td>
</tr>
<tr>
<td>12:30-13:00</td>
<td>0.043</td>
</tr>
<tr>
<td>13:00-13:30</td>
<td>0.044</td>
</tr>
<tr>
<td>13:30-14:00</td>
<td>0.044</td>
</tr>
<tr>
<td>14:00-14:30</td>
<td>0.048</td>
</tr>
<tr>
<td>14:30-15:00</td>
<td>0.048</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1.000</strong></td>
</tr>
</tbody>
</table>

### Calculation Procedure

The Update Times calculation procedure has the following four steps.
1. Calculate volume at time interval $t$ in period $p$ based on the fraction of period volume at $t$ and volume in $p$ period. The fraction of period volume is specified in Exhibits 12-6, 12-7, and 12-8.

$$Vol^p_t = f^p_t \cdot Vol^P$$ (12-2)

2. For links with positive capacity in the $p$ period, calculate the delay of time interval $t$

$$delay_t = length \cdot \min \left\{ A \cdot e^{B \cdot \left( \frac{Vol^p_t}{Cap_t} \right)}, C \right\}$$ (12-3)

where $A$, $B$ and $C$ are specified in Exhibit 12-2, and $Cap_t$ is the fraction of hourly capacity based on $t$.

3. Calculate average loaded time for each period which is the volume-weighted average of travel time at time intervals in that period.

$$t^P = \frac{\sum_{t \in p} Vol^p_t \cdot (t_{free} + delay_t)}{Vol^P}$$ (12-4)

where $t_{free}$ is the free flow time.

4. Calculate loaded speed for each period.

$$s^P = \frac{length \cdot 60}{t^P}$$ (12-5)

Exhibit 12-9 shows the correspondence of these variables to the ACTRDWY.DBD field names.
Exhibit 12-9: Correspondence Between Update Times Variables and ACTRDWY.DBD Fields

<table>
<thead>
<tr>
<th>Variables</th>
<th>Field names</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Vol^p$</td>
<td>AMVOL, PMVOL, OPVOL for AB/BA</td>
</tr>
<tr>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Length</td>
<td>MODEL_LENGTH</td>
</tr>
<tr>
<td>$t^p$</td>
<td>PKTIME, PMTIME, OPTIME for AB/BA</td>
</tr>
<tr>
<td>$t_{free}$</td>
<td>PKFRTIME, OPFRTIME for AB/BA</td>
</tr>
<tr>
<td>$s^p$</td>
<td>PKSPD, PMSPD, OPSPD for AB/BA</td>
</tr>
</tbody>
</table>

For example, consider a freeway link with a free flow speed of 71.5 mpg (PKFRSPD), a number of lanes of 3 (AMLN), and a capacity per hour per lane of 4600 (AMHRCAP). If one assumes that the volume is 30,000 (AMVOL) which corresponds to a v/c ratio of 0.87, the resulting calculations of a.m. peak fractional volume and speed are shown in Exhibit 12-10.

Exhibit 12-10: Fraction Volume and Speed for the AM Period

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>AM Fraction</th>
<th>Volume</th>
<th>Speed</th>
<th>v/c ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:30-7:00</td>
<td>0.176</td>
<td>5280</td>
<td>49.49</td>
<td>0.77</td>
</tr>
<tr>
<td>7:00-7:30</td>
<td>0.222</td>
<td>6660</td>
<td>35.22</td>
<td>0.97</td>
</tr>
<tr>
<td>7:30-8:00</td>
<td>0.222</td>
<td>6660</td>
<td>35.22</td>
<td>0.97</td>
</tr>
<tr>
<td>8:00-8:30</td>
<td>0.19</td>
<td>5700</td>
<td>45.42</td>
<td>0.83</td>
</tr>
<tr>
<td>8:30-9:00</td>
<td>0.19</td>
<td>5700</td>
<td>45.42</td>
<td>0.83</td>
</tr>
</tbody>
</table>

Speed calculated using the volume delay function in the Update Times program and total AMVOL is 42.33 mph. Speed calculated using the average speed weighted by fraction volume is 41.61 mph, which is lower than the speed calculated using the volume delay function. This difference is illustrated in Exhibit 12-11.

The new time is used in the feedback to run trip distribution, mode choice, and traffic assignment.
**Feedback**

The Feedback procedure involves feeding the travel time after assignment back into the trip distribution process to assure travel time consistency. In a well-defined feedback process, the values of the input variables and output variables should converge. The selection of appropriate convergence criteria is necessary to inform modelers when the iterative application of the feedback loop can be ended and the final assignment result can be used. The two most important variables for determining if equilibrium is achieved in the feedback process are volumes on links and average operating speeds on links. Because of the way in which speeds are estimated in traditional travel forecasting models, volume and speed are directly related through a functional relationship, so convergence with respect to volume implies convergence with respect to speed.

Unfortunately, there is no mathematical guarantee that the feedback process for the model from trip distribution to traffic assignment will converge. Therefore, for practical reasons, the number of feedbacks is set to two in DFWRTM.

The final assignment result is used to update the loaded link travel times (PKTIME, PMTIME, and OPTIME), the loaded link travel speeds (PKSPD, PMSPD, and OPSPD), and their corresponding volume fields in ACTRDWY.
Nested Logit Model Files

The mode choice models in the DFWRTM use the nested logit model structure. The nesting structure, model parameters, and model inputs are saved in the model file format in TransCAD. The following files are the model information files and are used for the mode choice implementation for each market segment.

The market segments represented in this section are the following: H1WVGEP, H1WLTP, H23WVGEP, H23WLTP, H4WVGEP, H4WLTP, HNW1VGE, HNWVLTP, HNW23VGE, HNW23VLTP, HNW4VGE, HNW4VLTP, and NHB.

HBW1 Market Segment: H1WVGEP

*****************************************************************************
Nested Logit Model
*****************************************************************************
Stored in: "C:\TCMODEL\ModelCalibrated\ModeChoice\Data\H1WVGEP.NLM"
*****************************************************************************
Model Structure
*****************************************************************************

Modes
  Transit Walk
  Transit Drive
  Auto Nest
    Drive Alone
    Shared Ride 2
    Shared Ride 3

*****************************************************************************
Utility Variables
*****************************************************************************

Utility(Transit Walk)  = -5.4435
  - 0.025 * Matrix([PKSKIMNOR],[In-Vehicle Time])
  - 0.025 * Matrix([PKSKIMNOR],[Dwelling Time])
  - 0.55 * Matrix([PKSKIMNOR],[Fare])
  - 0.064 * Matrix([PKSKIMNOR],[Initial Wait Time])
  - 0.064 * Matrix([PKSKIMNOR],[Transfer Wait Time])
  - 0.064 * Matrix([PKSKIMNOR],[Transfer Time])
Utility(Transit Drive)_ij = -6.0375
- 0.025 * Matrix([PKSKIMPR],[In-Vehicle Time])_ij
- 0.025 * Matrix([PKSKIMPR],[Dwelling Time])_ij
- 0.55 * Matrix([PKSKIMPR],[Fare])_ij
- 0.064 * Matrix([PKSKIMPR],[Initial Wait Time])_ij
- 0.064 * Matrix([PKSKIMPR],[Transfer Wait Time])_ij
- 0.064 * Matrix([PKSKIMPR],[Transfer Time])_ij
- 0.055 * Matrix([PKSKIMPR],[Drive Time])_ij
- 0.064 * Matrix([PKSKIMPR],[Egress Time])_ij
+ 0.257 * Field(NLMDATA.ATYPE1)_j
+ 0.276 * Field(NLMDATA.ATYPE2)_j
+ 3.056 * Field(NLMDATA.LINC)_i
+ 0 * Field(NLMDATA.Airport)_j

Utility(Shared Ride 2)_ij = -3.6645
- 0.055 * Matrix([Shortest Path],[PKTIME_\*])_ij
- 0.02 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_ij
- 0.14 * Field(NLMDATA.PCOSTHBW)_j
+ 0.329 * Field(NLMDATA.LINC)_i
+ 0 * Field(NLMDATA.Airport)_j

Utility(Shared Ride 3)_ij = -4.9239
- 0.055 * Matrix([Shortest Path],[PKTIME_\*])_ij
- 0.012 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_ij
- 0.085 * Field(NLMDATA.PCOSTHBW)_j
+ 0.329 * Field(NLMDATA.LINC)_i
+ 0 * Field(NLMDATA.Airport)_j

Data Sources

*******************************************************************
View "NLMDATA", from file:
"C:\TCMODEL\TSZGeographic\Z4874OCT29GEO\Z4874Y99OCT2903ACT\NLMDATA.BIN"
Fields Used:
ATYPE1
ATYPE2
Airport
FtWorth
LINC
PCOSTHBW

Matrix "PKSKIMNOPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\PK_NOPR.MTX"
Cores Used:
"Access Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "PKSKIMPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\PK_PR.MTX"
Cores Used:
"Drive Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "Shortest Path", from file
"L:\TCMODEL\ROADWAYNETWORK\YR99NOV0503ALIGNEDRDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\PK_HOV.MTX"
Cores Used:
"MODEL_LENGTH (Skim)"

Matrix "Shortest Path", from file
"L:\TCMODEL\ROADWAYNETWORK\YR99NOV0503ALIGNEDRDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\PK_NOHOV.MTX"
Cores Used:
"PKTIME_"

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HBW1 Market Segment: H1WVLTP

*******************************************************************
Nested Logit Model
*******************************************************************
Stored in: "C:\TCMODEL\ModelCalibrated\ModeChoice\Data\H1WVLTP.NLM"

*******************************************************************
Model Structure
*******************************************************************

Modes
- Transit Walk
- Transit Drive
- Auto Nest
  - Drive Alone
  - Shared Ride 2
  - Shared Ride 3

*******************************************************************
Utility Variables
*******************************************************************

Utility(Transit Walk)_{ij} = -3.625
- 0.025 * Matrix([PKSKIMNOPR].[In-Vehicle Time])_{ij}
- 0.025 * Matrix([PKSKIMNOPR].[Dwelling Time])_{ij}
- 0.55 * Matrix([PKSKIMNOPR].[Fare])_{ij}
- 0.064 * Matrix([PKSKIMNOPR].[Initial Wait Time])_{ij}
- 0.064 * Matrix([PKSKIMNOPR].[Transfer Wait Time])_{ij}
- 0.064 * Matrix([PKSKIMNOPR].[Transfer Time])_{ij}
- 0.064 * Matrix([PKSKIMNOPR].[Access Time])_{ij}
+ 0.257 * Field(NLMDATA.ATYPE1)_j
+ 0.276 * Field(NLMDATA.ATYPE2)_j
+ 0.813 * Field(NLMDATA.VLTP)_i
+ 3.056 * Field(NLMDATA.LINC)_i
+ 0 * Field(NLMDATA.Airport)_j

Utility(Transit Drive)_{ij} = -5.6742
- 0.025 * Matrix([PKSKIMPR].[In-Vehicle Time])_{ij}
- 0.025 * Matrix([PKSKIMPR].[Dwelling Time])_{ij}
- 0.55 * Matrix([PKSKIMPR].[Fare])_{ij}
- 0.064 * Matrix([PKSKIMPR].[Initial Wait Time])_{ij}
- 0.064 * Matrix([PKSKIMPR].[Transfer Wait Time])_{ij}
- 0.055 * Matrix([PKSKIMPR].[Drive Time])_{ij}
- 0.064 * Matrix([PKSKIMPR].[Egress Time])_{ij}
+ 0.257 * Field(NLMDATA.ATYPE1)_j
+ 0.276 * Field(NLMDATA.ATYPE2)_j
+ 0.813 \times \text{Field(NLMDATA.VLTP)}_i \\
+ 2.183 \times \text{Field(NLMDATA.LINC)}_i \\
+ 0 \times \text{Field(NLMDATA.Airport)}_j \\
+ 1 \times \text{Field(NLMDATA.FtWorth)}_j \\

\text{Utility(Auto Nest)}_{ij} = 0.725 \times \log(\exp(\text{Utility(Drive Alone)}_{ij}) \\
+ \exp(\text{Utility(Shared Ride 2)}_{ij}) \\
+ \exp(\text{Utility(Shared Ride 3)}_{ij})) \\

\text{Utility(Drive Alone)}_{ij} = -0.055 \times \text{Matrix([Shortest Path].[PKTIME\_*])}_{ij} \\
- 0.041 \times \text{Matrix([Shortest Path].[MODEL\_LENGTH (Skim)])}_{ij} \\
- 0.279 \times \text{Field(NLMDATA.PCOSTHBW)}_j \\

\text{Utility(Shared Ride 2)}_{ij} = -2.6548 \\
- 0.055 \times \text{Matrix([Shortest Path].[PKTIME\_*])}_{ij} \\
- 0.02 \times \text{Matrix([Shortest Path].[MODEL\_LENGTH (Skim)])}_{ij} \\
- 0.14 \times \text{Field(NLMDATA.PCOSTHBW)}_j \\
+ 0.873 \times \text{Field(NLMDATA.VLTP)}_i \\
+ 0.329 \times \text{Field(NLMDATA.LINC)}_i \\
+ 0 \times \text{Field(NLMDATA.Airport)}_j \\

\text{Utility(Shared Ride 3)}_{ij} = -3.7972 \\
- 0.055 \times \text{Matrix([Shortest Path].[PKTIME\_*])}_{ij} \\
- 0.012 \times \text{Matrix([Shortest Path].[MODEL\_LENGTH (Skim)])}_{ij} \\
- 0.085 \times \text{Field(NLMDATA.PCOSTHBW)}_j \\
+ 0.873 \times \text{Field(NLMDATA.VLTP)}_i \\
+ 0.329 \times \text{Field(NLMDATA.LINC)}_i \\
+ 0 \times \text{Field(NLMDATA.Airport)}_j \\

*****************************************************************************

Data Sources
*****************************************************************************

View "NLMDATA", from file:
"C:\TMODEL\TSZGeographic\Z4874OCT29GEO\Z4874Y99OCT2903ACT\NLMDATA.BIN"
Fields Used:
- ATYPE1
- ATYPE2
- Airport
- FtWorth
- LINC
- PCOSTHBW
- VLTP

Matrix "PK_SKIMNOPR", from file
"C:\TMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\PK_NOPR.MTX"
Cores Used:
"Access Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "PKSKIMPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\PK_PR.MTX"
Cores Used:
"Drive Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "Shortest Path", from file
"L:\TCMODEL\ROADWAYNETWORK\YR99NOV0503ALIGNEDRDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\PK_HOV.MTX"
Cores Used:
"MODEL_LENGTH (Skim)"
"PKTIME_*"

HBW23 Market Segment: H23WVGEP

******************************************************
Nested Logit Model
******************************************************

Stored in: "C:\TCMODEL\ModelCalibrated\ModeChoice\Data\H23WVGEP.NLM"

******************************************************
Model Structure
******************************************************

Modes
Transit Walk
Transit Drive
Auto Nest
Drive Alone
Shared Ride 2
Shared Ride 3
Utility Variables

Utility(Transit Walk)\_ij = -2.7994
- 0.025 * Matrix([PKSKIMNOPR],[In-Vehicle Time])\_ij
- 0.025 * Matrix([PKSKIMNOPR],[Dwelling Time])\_ij
- 0.55 * Matrix([PKSKIMNOPR],[Fare])\_ij
- 0.064 * Matrix([PKSKIMNOPR],[Initial Wait Time])\_ij
- 0.064 * Matrix([PKSKIMNOPR],[Transfer Wait Time])\_ij
- 0.064 * Matrix([PKSKIMNOPR],[Transfer Time])\_ij
- 0.064 * Matrix([PKSKIMNOPR],[Access Time])\_ij
- 0.064 * Matrix([PKSKIMNOPR],[Egress Time])\_ij
+ 0.257 * Field(NLMDATA.ATYPE1)\_j
+ 0.276 * Field(NLMDATA.ATYPE2)\_j
+ 0 * Field(NLMDATA.Airport)\_j

Utility(Transit Drive)\_ij = -3.551
- 0.025 * Matrix([PKSKIMPR],[In-Vehicle Time])\_ij
- 0.025 * Matrix([PKSKIMPR],[Dwelling Time])\_ij
- 0.55 * Matrix([PKSKIMPR],[Fare])\_ij
- 0.064 * Matrix([PKSKIMPR],[Initial Wait Time])\_ij
- 0.064 * Matrix([PKSKIMPR],[Transfer Wait Time])\_ij
- 0.064 * Matrix([PKSKIMPR],[Transfer Time])\_ij
- 0.055 * Matrix([PKSKIMPR],[Drive Time])\_ij
- 0.064 * Matrix([PKSKIMPR],[Egress Time])\_ij
+ 0.257 * Field(NLMDATA.ATYPE1)\_j
+ 0.276 * Field(NLMDATA.ATYPE2)\_j
+ 0 * Field(NLMDATA.Airport)\_j
+ 1 * Field(NLMDATA.FtWorth)\_j

Utility(Auto Nest)\_ij = 0.725 * Log(Exp(Utility(Drive Alone)\_ij) + Exp(Utility(Shared Ride 2)\_ij) + Exp(Utility(Shared Ride 3)\_ij))

Utility(Drive Alone)\_ij = -0.055 * Matrix([Shortest Path],[PKTIME\_*])\_ij
- 0.041 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])\_ij
- 0.279 * Field(NLMDATA.PCOSTHBW)\_j

Utility(Shared Ride 2)\_ij = -3.4
- 0.055 * Matrix([Shortest Path],[PKTIME\_*])\_ij
- 0.02 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])\_ij
- 0.14 * Field(NLMDATA.PCOSTHBW)\_j
+ 0 * Field(NLMDATA.Airport)\_j

Utility(Shared Ride 3)\_ij = -5.6842
- 0.055 * Matrix([Shortest Path],[PKTIME\_*])\_ij
- 0.012 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])\_ij
- 0.085 * Field(NLMDATA.PCOSTHBW)\_j
+ 0 * Field(NLMDATA.Airport)\_j
Data Sources

View "NLMDATA", from file:
"C:\TCMODEL\TSZGeographic\Z4874OCT29GEO\Z4874Y99OCT2903ACT\NLMDATA.BIN"
Fields Used:
ATYPE1
ATYPE2
Airport
FtWorth
PCOSTHVBW

Matrix "PKSKIMNOPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\PK_NOPR.MTX"
Cores Used:
"Access Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "PKSKIMPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\PK_PR.MTX"
Cores Used:
"Drive Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "Shortest Path", from file
"L:\TCMODEL\ROADWAYNETWORK\YR99NOV0503ALIGNEDRDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\PK_NOHOV.MTX"
Cores Used:
"MODEL_LENGTH (Skim)"

Matrix "Shortest Path", from file
"L:\TCMODEL\ROADWAYNETWORK\YR99NOV0503ALIGNEDRDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\PK_HOV.MTX"
Cores Used:
"PKTIME_*"

HBW23 Market Segment: H23WVLTP

******************************************************************************
Nested Logit Model
******************************************************************************

Stored in: "C:\TCMODEL\ModelCalibrated\ModeChoice\Data\H23WVLTP.NLM"

******************************************************************************
Model Structure
******************************************************************************

Modes
Transit Walk
Transit Drive
Auto Nest
  Drive Alone
  Shared Ride 2
  Shared Ride 3

******************************************************************************
Utility Variables
******************************************************************************

Utility(Transit Walk)_{ij} = -1.3066
- 0.025 * Matrix ([PKSKIMNOPR]. [In-Vehicle Time])_{ij}
- 0.025 * Matrix ([PKSKIMNOPR]. [Dwelling Time])_{ij}
- 0.55 * Matrix ([PKSKIMNOPR]. [Fare])_{ij}
- 0.064 * Matrix ([PKSKIMNOPR]. [Initial Wait Time])_{ij}
- 0.064 * Matrix ([PKSKIMNOPR]. [Transfer Wait Time])_{ij}
- 0.064 * Matrix ([PKSKIMNOPR]. [Transfer Time])_{ij}
- 0.064 * Matrix ([PKSKIMNOPR]. [Access Time])_{ij}
- 0.064 * Matrix ([PKSKIMNOPR]. [Egress Time])_{ij}
+ 0.257 * Field (NLMDATA.ATYPE1)_{j}
+ 0.276 * Field (NLMDATA.ATYPE2)_{j}
+ 0.813 * Field (NLMDATA.VLTP)_{i}
+ 0 * Field (NLMDATA.Airport)_{j}

Utility(Transit Drive)_{ij} = -3.6889
- 0.025 * Matrix ([PKSKIMPR]. [In-Vehicle Time])_{ij}
- 0.025 * Matrix ([PKSKIMPR]. [Dwelling Time])_{ij}
- 0.55 * Matrix ([PKSKIMPR]. [Fare])_{ij}
- 0.064 * Matrix ([PKSKIMPR]. [Initial Wait Time])_{ij}
- 0.064 * Matrix ([PKSKIMPR]. [Transfer Wait Time])_{ij}
- 0.064 * Matrix ([PKSKIMPR]. [Transfer Time])_{ij}
- 0.055 * Matrix ([PKSKIMPR]. [Drive Time])_{ij}
- 0.064 * Matrix ([PKSKIMPR]. [Egress Time])_{ij}
+ 0.257 * Field (NLMDATA.ATYPE1)_{j}
+ 0.276 * Field (NLMDATA.ATYPE2)_{j}
+ 0.813 * Field (NLMDATA.VLTP)_{i}
Utility(Auto Nest)_ij = 0.725 * Log(Exp(Utility(Drive Alone)_ij) + Exp(Utility(Shared Ride 2)_ij) + Exp(Utility(Shared Ride 3)_ij))

Utility(Drive Alone)_ij = -0.055 * Matrix([Shortest Path],[PKTIME_*])_ij - 0.041 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_ij - 0.279 * Field(NLMDATA.PCOSTHBW)_j

Utility(Shared Ride 2)_ij = -3.1791 - 0.055 * Matrix([Shortest Path],[PKTIME_*])_ij - 0.02 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_ij - 0.14 * Field(NLMDATA.PCOSTHBW)_j + 0.873 * Field(NLMDATA.VLTP)_i + 0 * Field(NLMDATA.Airport)_j

Utility(Shared Ride 3)_ij = -4.0764 - 0.055 * Matrix([Shortest Path],[PKTIME_*])_ij - 0.012 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_ij - 0.085 * Field(NLMDATA.PCOSTHBW)_j + 0.873 * Field(NLMDATA.VLTP)_i + 0 * Field(NLMDATA.Airport)_j

Data Sources

View "NLMDATA", from file:
"C:\TCMODEL\TSZGeographic\Z4874OCT29GEO\Z4874Y99OCT2903ACT\NLMDATA.BIN"
Fields Used:
ATYPE1
ATYPE2
Airport
FtWorth
PCOSTHBW
VLTP

Matrix "PKSKIMNOPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\PK_NOPR.MTX"
Cores Used:
"Access Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "PKSKIMPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\PK_PR.MTX"
Cores Used:
"Drive Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "Shortest Path", from file
"L:\TCMODEL\ROADWAYNETWORK\YR99NOV0503ALIGNEDRDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\PK_HOV.MTX"
Cores Used:
"MODEL_LENGTH (Skim)"

Matrix "Shortest Path", from file
"L:\TCMODEL\ROADWAYNETWORK\YR99NOV0503ALIGNEDRDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\PK_NOHOV.MTX"
Cores Used:
"PKTIME_*"

HBW4 Market Segment: H4WVGE

*******************************************************************
Nested Logit Model
*******************************************************************
Stored in: "C:\TCMODEL\ModelCalibrated\ModeChoice\Data\H4WVGE\H4WVGE.PNLM"

*******************************************************************
Model Structure
*******************************************************************

Modes
Transit Walk
Transit Drive
Auto Nest
Drive Alone
Shared Ride 2
Shared Ride 3
Utility Variables

Utility(Transit Walk)\(_{ij} = 2.4182\)
- 0.025 * Matrix([PKSKIMNOPR].[In-Vehicle Time])\(_{ij}\)
- 0.025 * Matrix([PKSKIMNOPR].[Dwelling Time])\(_{ij}\)
- 0.55 * Matrix([PKSKIMNOPR].[Fare])\(_{ij}\)
- 0.064 * Matrix([PKSKIMNOPR].[Initial Wait Time])\(_{ij}\)
- 0.064 * Matrix([PKSKIMNOPR].[Transfer Wait Time])\(_{ij}\)
- 0.064 * Matrix([PKSKIMNOPR].[Transfer Time])\(_{ij}\)
- 0.064 * Matrix([PKSKIMNOPR].[Access Time])\(_{ij}\)
- 0.064 * Matrix([PKSKIMNOPR].[Egress Time])\(_{ij}\)
+ 0.257 * Field(NLMDATA.ATYPE1)\(_j\)
+ 0.276 * Field(NLMDATA.ATYPE2)\(_j\)
- 5.665 * Field(NLMDATA.HINC)\(_i\)
+ 0 * Field(NLMDATA.Airport)\(_j\)

Utility(Transit Drive)\(_{ij} = 0.0178\)
- 0.025 * Matrix([PKSKIMPR].[In-Vehicle Time])\(_{ij}\)
- 0.025 * Matrix([PKSKIMPR].[Dwelling Time])\(_{ij}\)
- 0.55 * Matrix([PKSKIMPR].[Fare])\(_{ij}\)
- 0.064 * Matrix([PKSKIMPR].[Initial Wait Time])\(_{ij}\)
- 0.064 * Matrix([PKSKIMPR].[Transfer Wait Time])\(_{ij}\)
- 0.055 * Matrix([PKSKIMPR].[Drive Time])\(_{ij}\)
- 0.064 * Matrix([PKSKIMPR].[Egress Time])\(_{ij}\)
+ 0.257 * Field(NLMDATA.ATYPE1)\(_j\)
+ 0.276 * Field(NLMDATA.ATYPE2)\(_j\)
- 3.527 * Field(NLMDATA.HINC)\(_i\)
+ 0 * Field(NLMDATA.Airport)\(_j\)
+ 1 * Field(NLMDATA.FtWorth)\(_j\)

Utility(Auto Nest)\(_{ij} = 0.725 * \log(\exp(\text{Utility(Drive Alone)}\(_{ij}\))
+ \exp(\text{Utility(Shared Ride 2)}\(_{ij}\))
+ \exp(\text{Utility(Shared Ride 3)}\(_{ij}\)))\)

Utility(Drive Alone)\(_{ij} = -0.055 * \text{Matrix([Shortest Path],[PKTIME\_\_*])}\(_{ij}\)
- 0.041 * \text{Matrix([Shortest Path],[MODEL\_LENGTH (Skim)])}\(_{ij}\)
- 0.279 * Field(NLMDATA.PCOSTHBW)\(_j\)

Utility(Shared Ride 2)\(_{ij} = -2.8487\)
- 0.055 * \text{Matrix([Shortest Path],[PKTIME\_\_*])}\(_{ij}\)
- 0.02 * \text{Matrix([Shortest Path],[MODEL\_LENGTH (Skim)])}\(_{ij}\)
- 0.14 * Field(NLMDATA.PCOSTHBW)\(_j\)
- 0.265 * Field(NLMDATA.HINC)\(_i\)
+ 0 * Field(NLMDATA.Airport)\(_j\)

Utility(Shared Ride 3)\(_{ij} = -6.3456\)
- 0.055 * \text{Matrix([Shortest Path],[PKTIME\_\_*])}\(_{ij}\)
- 0.012 * Matrix([Shortest Path].[MODEL_LENGTH (Skim)])_ij
- 0.085 * Field(NLMDATA.PCOSTHBW)_j
- 0.265 * Field(NLMDATA.HINC)_i
+ 0 * Field(NLMDATA.Airport)_j

*******************************************************************
Data Sources
*******************************************************************

View "NLMDATA", from file:
"C:\TCMODEL\TSZGeographic\Z4874OCT29GEO\Z4874Y99OCT2903ACT\NLMDATA.BIN"
Fields Used:
ATYPE1
ATYPE2
Airport
FtWorth
HINC
PCOSTHBW

Matrix "PKSKIMNOPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\PK_NOPR.MTX"
Cores Used:
"Access Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "PKSKIMPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\PK_PR.MTX"
Cores Used:
"Drive Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "Shortest Path", from file
"L:\TCMODEL\ROADWAYNETWORK\YR99NOV0503ALIGNEDRDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\PK_HOV.MTX"
Cores Used:
"MODEL_LENGTH (Skim)"

163
Matrix "Shortest Path", from file
"L:\TCMODEL\ROADWAYNETWORK\YR99NOV0503ALIGNEDRDWY\Z4874OCT2
9GEO\Z4874Y99OCT2903ACT\PK_NOHOV.MTX"
Cores Used:
"PKTIME_"

HBW4 Market Segment: H4WVLTP

*******************************************************************************
Nested Logit Model
*******************************************************************************
Stored in: "C:\TCMODEL\ModelCalibrated\ModeChoice\Data\H4WVLTP.NLM"

*******************************************************************************
Model Structure
*******************************************************************************

Modes
Transit Walk
Transit Drive
Auto Nest
  Drive Alone
  Shared Ride 2
  Shared Ride 3

*******************************************************************************
Utility Variables
*******************************************************************************

Utility(Transit Walk)_ij = 2.9524
- 0.025 * Matrix([PKSKIMNOPR].[In-Vehicle Time])_ij
- 0.025 * Matrix([PKSKIMNOPR].[Dwelling Time])_ij
- 0.55 * Matrix([PKSKIMNOPR].[Fare])_ij
- 0.064 * Matrix([PKSKIMNOPR].[Initial Wait Time])_ij
- 0.064 * Matrix([PKSKIMNOPR].[Transfer Wait Time])_ij
- 0.064 * Matrix([PKSKIMNOPR].[Transfer Time])_ij
- 0.064 * Matrix([PKSKIMNOPR].[Access Time])_ij
- 0.064 * Matrix([PKSKIMNOPR].[Egress Time])_ij
+ 0.257 * Field(NLMDATA.ATYPE1)_j
+ 0.276 * Field(NLMDATA.ATYPE2)_j
+ 0.813 * Field(NLMDATA.VLTP)_i
- 5.665 * Field(NLMDATA.HINC)_i
+ 0 * Field(NLMDATA.Airport)_j

Utility(Transit Drive)_ij = -0.2955
- 0.025 * Matrix([PKSKIMPR].[In-Vehicle Time])_ij
- 0.025 * Matrix([PKSKIMPR].[Dwelling Time])_ij
- 0.55 * Matrix([PKSKIMPR].[Fare])_ij
\[-0.064 \cdot \text{Matrix([PKSKIMPR].\{Initial Wait Time\}))}_{ij} \]
\[-0.064 \cdot \text{Matrix([PKSKIMPR].\{Transfer Wait Time\}))}_{ij} \]
\[-0.064 \cdot \text{Matrix([PKSKIMPR].\{Transfer Time\}))}_{ij} \]
\[-0.055 \cdot \text{Matrix([PKSKIMPR].\{Drive Time\}))}_{ij} \]
\[-0.064 \cdot \text{Matrix([PKSKIMPR].\{Egress Time\}))}_{ij} \]
\[+ 0.257 \cdot \text{Field(NLMDATA.ATYPE1)}_j \]
\[+ 0.276 \cdot \text{Field(NLMDATA.ATYPE2)}_j \]
\[+ 0.813 \cdot \text{Field(NLMDATA.VLTP)}_i \]
\[-3.527 \cdot \text{Field(NLMDATA.HINC)}_i \]
\[+ 0 \cdot \text{Field(NLMDATA.Airport)}_j \]
\[+ 1 \cdot \text{Field(NLMDATA.FtWorth)}_j \]

\[\text{Utility(Auto Nest)}_{ij} = 0.725 \cdot \log(\exp(\text{Utility(Drive Alone)}_{ij}) + \exp(\text{Utility(Shared Ride 2)}_{ij}) + \exp(\text{Utility(Shared Ride 3)}_{ij})) \]

\[\text{Utility(Drive Alone)}_{ij} = -0.055 \cdot \text{Matrix([Shortest Path].\{PKTIME\}} *)_{ij} \]
\[+ 0.041 \cdot \text{Matrix([Shortest Path].\{MODEL_LENGTH (Skim)\}})_i \]
\[+ 0.279 \cdot \text{Field(NLMDATA.PCOSTHBW)}_j \]

\[\text{Utility(Shared Ride 2)}_{ij} = -3.2577 \]
\[-0.055 \cdot \text{Matrix([Shortest Path].\{PKTIME\}} *)_{ij} \]
\[-0.02 \cdot \text{Matrix([Shortest Path].\{MODEL_LENGTH (Skim)\}})_i \]
\[+ 0.14 \cdot \text{Field(NLMDATA.PCOSTHBW)}_j \]
\[+ 0.873 \cdot \text{Field(NLMDATA.VLTP)}_i \]
\[-0.265 \cdot \text{Field(NLMDATA.HINC)}_i \]
\[+ 0 \cdot \text{Field(NLMDATA.Airport)}_j \]

\[\text{Utility(Shared Ride 3)}_{ij} = -4.8799 \]
\[-0.055 \cdot \text{Matrix([Shortest Path].\{PKTIME\}} *)_{ij} \]
\[-0.012 \cdot \text{Matrix([Shortest Path].\{MODEL_LENGTH (Skim)\}})_i \]
\[-0.085 \cdot \text{Field(NLMDATA.PCOSTHBW)}_j \]
\[+ 0.873 \cdot \text{Field(NLMDATA.VLTP)}_i \]
\[-0.265 \cdot \text{Field(NLMDATA.HINC)}_i \]
\[+ 0 \cdot \text{Field(NLMDATA.HINC)}_j \]

*******************************************************************
Data Sources
*******************************************************************

View "NLMDATA", from file:
"C:\TCMODEL\TSZ\Geographic\Z4874OCT29\Z4874Y99OCT2903ACT\NLMDATA.BIN"

Fields Used:
ATYPE1
ATYPE2
Airport
FtWorth
HINC
PCOSTHBW
VLTP

Matrix "PKSKIMNOPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\PK_NOPR.MTX"
Cores Used:
"Access Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "PKSKIMPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\PK_PR.MTX"
Cores Used:
"Drive Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "Shortest Path", from file
"L:\TCMODEL\ROADWAYNETWORK\YR99NOV0503ALIGNEDRDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\PK_HOV.MTX"
Cores Used:
"MODEL_LENGTH (Skim)"
"PKTIME_**"

HNW Market Segment: HNW1VGEP

******************************************************************************
Nested Logit Model
******************************************************************************
Stored in: "C:\TCMODEL\ModelCalibrated\ModeChoice\Data\HNW1VGEP.nlm"
******************************************************************************
Model Structure
******************************************************************************

Alternatives
  Drive Alone
  Shared Ride Nest
Utility Variables

Utility(Drive Alone)\_ij = -0.011 \cdot \text{Matrix([Shortest Path],[OPTIME\_*])\_ij}
- 0.012 \cdot \text{Matrix([Shortest Path],[MODEL\_LENGTH (Skim)])\_ij}
- 0.081 \cdot \text{Field(NLMDATA.PCOSTHNW)\_j}

Utility(Shared Ride Nest)\_ij = 0.666 \cdot \log(\exp(\text{Utility(Shared Ride 2)\_ij})
+ \exp(\text{Utility(Shared Ride 3)\_ij}))

Utility(Shared Ride 2)\_ij = -2.076
- 0.011 \cdot \text{Matrix([Shortest Path],[OPTIME\_*])\_ij}
- 0.0059 \cdot \text{Matrix([Shortest Path],[MODEL\_LENGTH (Skim)])\_ij}
+ 0.212 \cdot \text{Field(NLMDATA.HHIQ1)\_i}
- 0.331 \cdot \text{Field(NLMDATA.ATYPE1)\_j}
- 0.041 \cdot \text{Field(NLMDATA.PCOSTHNW)\_j}
+ 0 \cdot \text{Field(NLMDATA.Airport)\_j}

Utility(Shared Ride 3)\_ij = -5.9413
- 0.011 \cdot \text{Matrix([Shortest Path],[OPTIME\_*])\_ij}
- 0.0033 \cdot \text{Matrix([Shortest Path],[MODEL\_LENGTH (Skim)])\_ij}
- 0.023 \cdot \text{Field(NLMDATA.PCOSTHNW)\_j}
+ 0.916 \cdot \text{Field(NLMDATA.HHIQ1)\_i}
- 0.331 \cdot \text{Field(NLMDATA.ATYPE1)\_j}
+ 0 \cdot \text{Field(NLMDATA.Airport)\_j}

Utility(Transit Nest)\_ij = 0.892 \cdot \log(\exp(\text{Utility(Transit Walk)\_ij})
+ \exp(\text{Utility(Transit Drive)\_ij}))

Utility(Transit Walk)\_ij = -5.688
- 0.217 \cdot \text{Matrix([OPSKIMNOPR],[Fare])\_ij}
- 0.007 \cdot \text{Matrix([OPSKIMNOPR],[In-Vehicle Time])\_ij}
- 0.053 \cdot \text{Matrix([OPSKIMNOPR],[Initial Wait Time])\_ij}
- 0.053 \cdot \text{Matrix([OPSKIMNOPR],[Transfer Wait Time])\_ij}
- 0.053 \cdot \text{Matrix([OPSKIMNOPR],[Transfer Time])\_ij}
- 0.053 \cdot \text{Matrix([OPSKIMNOPR],[Access Time])\_ij}
- 0.053 \cdot \text{Matrix([OPSKIMNOPR],[Egress Time])\_ij}
- 0.007 \cdot \text{Matrix([OPSKIMNOPR],[Dwelling Time])\_ij}
+ 0.527 \cdot \text{Field(NLMDATA.HHIQ1)\_i}
+ 1.581 \cdot \text{Field(NLMDATA.ATYPE1)\_j}
+ 0 \cdot \text{Field(NLMDATA.Airport)\_j}

Utility(Transit Drive)\_ij = -7.2537
- 0.217 \cdot \text{Matrix([OPSKIMPR],[Fare])\_ij}
- 0.007 * Matrix([OPSKIMPR],[In-Vehicle Time])_ij
- 0.053 * Matrix([OPSKIMPR],[Initial Wait Time])_ij
- 0.053 * Matrix([OPSKIMPR],[Transfer Wait Time])_ij
- 0.053 * Matrix([OPSKIMPR],[Transfer Time])_ij
- 0.011 * Matrix([OPSKIMPR],[Drive Time])_ij
- 0.053 * Matrix([OPSKIMPR],[Egress Time])_ij
- 0.007 * Matrix([OPSKIMPR],[Dwelling Time])_ij
+ 0.527 * Field(NLMDATA.HHIQ1)_i
+ 1.581 * Field(NLMDATA.ATYPE1)_j
+ 0 * Field(NLMDATA.Airport)_j
+ 1 * Field(NLMDATA.FtWorth)_j

*******************************************************************

Data Sources
*******************************************************************

View "NLMDATA", from file:
"C:\TCMODEL\TSZGeographic\Z4874OCT29GEO\Z4874Y99OCT2903ACT\NLMDATA.BIN"
Fields Used:
ATYPE1
Airport
FtWorth
HHIQ1
PCOSTHNW

Matrix "OPSKIMNOPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\OP_NOPR.MTX"
Cores Used:
"Access Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "OPSKIMPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\OP_PR.MTX"
Cores Used:
"Drive Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "Shortest Path", from file "C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874OCT2903ACT\OP_HOV.MTX"

Cores Used:
"MODEL_LENGTH (Skim)"
"OPTIME_"

HNW Market Segment: HNW1VLTP

****************************************************************************
Nested Logit Model
****************************************************************************

Stored in: "C:\TCMODEL\ModelCalibrated\ModeChoice\Data\HNW1VLTP.nlm"

****************************************************************************
Model Structure
****************************************************************************

Alternatives
Drive Alone
Shared Ride Nest
  Shared Ride 2
  Shared Ride 3
Transit Nest
  Transit Walk
  Transit Drive

****************************************************************************
Utility Variables
****************************************************************************

Utility(Drive Alone)_ij = -0.011 * Matrix([Shortest Path],[OPTIME_*])_ij
  - 0.012 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_ij
  - 0.081 * Field(NLMDATA.PCOSTHNW)_j

Utility(Shared Ride Nest)_ij = 0.666 * Log(Exp(Utility(Shared Ride 2)_ij)
  + Exp(Utility(Shared Ride 3)_ij))

Utility(Shared Ride 2)_ij = 0.1377
  - 0.011 * Matrix([Shortest Path],[OPTIME_*])_ij
  - 0.0059 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_ij
  + 0.935 * Field(NLMDATA.VLTP)_i
  + 0.212 * Field(NLMDATA.HHIQ1)_i
  - 0.331 * Field(NLMDATA.ATYPE1)_j
  - 0.041 * Field(NLMDATA.PCOSTHNW)_j
  + 0 * Field(NLMDATA.Airport)_j

Utility(Shared Ride 3)_ij = -1.2281
  - 0.011 * Matrix([Shortest Path],[OPTIME_*])_ij
Utility(Transit Nest)_{ij} = 0.892 \times \log(\exp(Utility(Transit Walk)_{ij}) + \exp(Utility(Transit Drive)_{ij}))

Utility(Transit Walk)_{ij} = -1.472
- 0.217 \times \text{Matrix}([\text{OPSKIMNPR}].\text{[Fare]})_{ij}
- 0.007 \times \text{Matrix}([\text{OPSKIMNPR}].\text{[In-Vehicle Time]})_{ij}
- 0.053 \times \text{Matrix}([\text{OPSKIMNPR}].\text{[Initial Wait Time]})_{ij}
- 0.053 \times \text{Matrix}([\text{OPSKIMNPR}].\text{[Transfer Wait Time]})_{ij}
- 0.053 \times \text{Matrix}([\text{OPSKIMNPR}].\text{[Transfer Time]})_{ij}
- 0.053 \times \text{Matrix}([\text{OPSKIMNPR}].\text{[Access Time]})_{ij}
- 0.053 \times \text{Matrix}([\text{OPSKIMNPR}].\text{[Egress Time]})_{ij}
- 0.007 \times \text{Matrix}([\text{OPSKIMNPR}].\text{[Dwelling Time]})_{ij}
+ 0.21 \times \text{Field}(\text{NLMDATA}.\text{VLTP})_i
+ 0.527 \times \text{Field}(\text{NLMDATA}.\text{HHIQ1})_i
+ 1.581 \times \text{Field}(\text{NLMDATA}.\text{ATYPE1})_j
+ 0 \times \text{Field}(\text{NLMDATA}.\text{Airport})_j

Utility(Transit Drive)_{ij} = -4.9013
- 0.217 \times \text{Matrix}([\text{OPSKIMPR}].\text{[Fare]})_{ij}
- 0.007 \times \text{Matrix}([\text{OPSKIMPR}].\text{[In-Vehicle Time]})_{ij}
- 0.053 \times \text{Matrix}([\text{OPSKIMPR}].\text{[Initial Wait Time]})_{ij}
- 0.053 \times \text{Matrix}([\text{OPSKIMPR}].\text{[Transfer Wait Time]})_{ij}
- 0.053 \times \text{Matrix}([\text{OPSKIMPR}].\text{[Transfer Time]})_{ij}
- 0.011 \times \text{Matrix}([\text{OPSKIMPR}].\text{[Drive Time]})_{ij}
- 0.053 \times \text{Matrix}([\text{OPSKIMPR}].\text{[Egress Time]})_{ij}
- 0.007 \times \text{Matrix}([\text{OPSKIMPR}].\text{[Dwelling Time]})_{ij}
+ 0.21 \times \text{Field}(\text{NLMDATA}.\text{VLTP})_i
+ 0.527 \times \text{Field}(\text{NLMDATA}.\text{HHIQ1})_i
+ 1.581 \times \text{Field}(\text{NLMDATA}.\text{ATYPE1})_j
+ 0 \times \text{Field}(\text{NLMDATA}.\text{Airport})_j
+ 1 \times \text{Field}(\text{NLMDATA}.\text{FtWorth})_j

Data Sources

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View "NLMDATA", from file:
"C:\TCMODEL\TSZGeographic\Z4874OCT29GEO\Z4874Y99OCT2903ACT\NLMDATA.BIN"

Fields Used:
ATYPE1
Airport
FtWorth
HHIQ1
PCOSTHNW
VLTP

Matrix "OPSKIMNOPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y9
9OCT2903ACT\YR99APT\YR99TRNT\OP_NOPR.MTX"
Cores Used:
"Access Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "OPSKIMPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y9
9OCT2903ACT\YR99APT\YR99TRNT\OP_PR.MTX"
Cores Used:
"Drive Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "Shortest Path", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y9
9OCT2903ACT\OP_HOV.MTX"
Cores Used:
"MODEL_LENGTH (Skim)"
"OPTIME_"""

HNW Market Segment: HNW23VGEP

********************************************************************************
Nested Logit Model
********************************************************************************
Stored in: "C:\TCMODEL\ModelCalibrated\ModeChoice\Data\HNW23VGEP.nlm"

********************************************************************************
Model Structure
********************************************************************************

Alternatives
Drive Alone  
Shared Ride Nest  
Shared Ride 2  
Shared Ride 3  
Transit Nest  
Transit Walk  
Transit Drive

*******************************************************************
Utility Variables
*******************************************************************

Utility(Drive Alone)_{ij} = -0.011 * Matrix([Shortest Path],[OPTIME_*])_{ij} 
- 0.012 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_{ij} 
- 0.081 * Field(NLMDATA.PCOSTHNW)_{j} 

Utility(Shared Ride Nest)_{ij} = 0.666 * Log(Exp(Utility(Shared Ride 2)_{ij}) 
+ Exp(Utility(Shared Ride 3)_{ij}))

Utility(Shared Ride 2)_{ij} = -1.6085 
- 0.011 * Matrix([Shortest Path],[OPTIME_*])_{ij} 
- 0.0059 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_{ij} 
+ 0.212 * Field(NLMDATA.HHIQ23)_{i} 
- 0.331 * Field(NLMDATA.ATYPE1)_{j} 
- 0.108 * Field(NLMDATA.MINC)_{i} 
+ 0 * Field(NLMDATA.Airport)_{j} 

Utility(Shared Ride 3)_{ij} = -5.1273 
- 0.011 * Matrix([Shortest Path],[OPTIME_*])_{ij} 
- 0.0033 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_{ij} 
+ 0.023 * Field(NLMDATA.PCOSTHNW)_{j} 
+ 0.916 * Field(NLMDATA.HHIQ23)_{i} 
- 0.331 * Field(NLMDATA.ATYPE1)_{j} 
- 0.108 * Field(NLMDATA.MINC)_{i} 
+ 0 * Field(NLMDATA.Airport)_{j} 

Utility(Transit Nest)_{ij} = 0.892 * Log(Exp(Utility(Transit Walk)_{ij}) 
+ Exp(Utility(Transit Drive)_{ij}))

Utility(Transit Walk)_{ij} = -3.5009 
- 0.217 * Matrix([OPSKIMNOPR],[Fare])_{ij} 
- 0.007 * Matrix([OPSKIMNOPR],[In-Vehicle Time])_{ij} 
- 0.053 * Matrix([OPSKIMNOPR],[Initial Wait Time])_{ij} 
- 0.053 * Matrix([OPSKIMNOPR],[Transfer Wait Time])_{ij} 
- 0.053 * Matrix([OPSKIMNOPR],[Transfer Time])_{ij} 
- 0.527 * Field(NLMDATA.HHIQ23)_{i} 
+ 1.581 * Field(NLMDATA.ATYPE1)_{j}
Utility(Transit Drive)\_ij = -5.4264 - 0.217 * Matrix([OPSKIMPR].[Fare])\_ij - 0.007 * Matrix([OPSKIMPR].[In-Vehicle Time])\_ij - 0.053 * Matrix([OPSKIMPR].[Initial Wait Time])\_ij - 0.053 * Matrix([OPSKIMPR].[Transfer Wait Time])\_ij - 0.053 * Matrix([OPSKIMPR].[Transfer Time])\_ij - 0.011 * Matrix([OPSKIMPR].[Drive Time])\_ij - 0.053 * Matrix([OPSKIMPR].[Egress Time])\_ij - 0.007 * Matrix([OPSKIMPR].[Dwelling Time])\_ij + 0.527 * Field(NLMDATA.HHIQ23)_i + 1.581 * Field(NLMDATA.ATYPE1)_j - 2.852 * Field(NLMDATA.MINC)_i + 0 * Field(NLMDATA.Airport)_j + 1 * Field(NLMDATA.FtWorth)_j

Data Sources

View "NLMDATA", from file:
"C:\TCMODEL\TSZGeographic\Z4874OCT29GEO\Z4874Y99OCT2903ACT\NLMDATA.BIN"
Fields Used:
ATYPE1
Airport
FtWorth
HHIQ23
MINC
PCOSTHNVW

Matrix "OPSKIMNOPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\OP_NOPR.MTX"
Cores Used:
"Access Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "OPSKIMPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\OP_PR.MTX"
Cores Used:
"Drive Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "Shortest Path", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GE0\Z4874Y99OCT2903ACT\OP_HOV.MTX"

Cores Used:
"MODEL_LENGTH (Skim)"
"OPTIME_"**

HNW Market Segment: HNW23VLTP

***************************************************************
 Nested Logit Model
***************************************************************
 Stored in: "C:\TCMODEL\ModelCalibrated\ModeChoice\Data\H23WVLTP.NLM"

***************************************************************
 Model Structure
***************************************************************

Modes
Transit Walk
Transit Drive
Auto Nest
   Drive Alone
   Shared Ride 2
   Shared Ride 3

***************************************************************
 Utility Variables
***************************************************************

Utility(Transit Walk)_{ij} = -1.3066
- 0.025 * Matrix([PKSKIMNOPR].[In-Vehicle Time])_{ij}
- 0.025 * Matrix([PKSKIMNOPR].[Dwelling Time])_{ij}
- 0.55  * Matrix([PKSKIMNOPR].[Fare])_{ij}
- 0.064 * Matrix([PKSKIMNOPR].[Initial Wait Time])_{ij}
- 0.064 * Matrix([PKSKIMNOPR].[Transfer Wait Time])_{ij}
- 0.064 * Matrix([PKSKIMNOPR].[Transfer Time])_{ij}
- 0.064 * Matrix([PKSKIMNOPR].[Access Time])_{ij}
- 0.064 * Matrix([PKSKIMNOPR].[Egress Time])_{ij}
+ 0.257 * Field(NLMDATA.ATYPE1)_{j}
Utility(Transit Drive)_{ij} = -3.6889
- 0.025 * Matrix([PKSKIMPR].[In-Vehicle Time])_{ij}
- 0.025 * Matrix([PKSKIMPR].[Dwelling Time])_{ij}
- 0.55 * Matrix([PKSKIMPR].[Fare])_{ij}
- 0.064 * Matrix([PKSKIMPR].[Initial Wait Time])_{ij}
- 0.064 * Matrix([PKSKIMPR].[Transfer Wait Time])_{ij}
- 0.064 * Matrix([PKSKIMPR].[Transfer Time])_{ij}
- 0.055 * Matrix([PKSKIMPR].[Drive Time])_{ij}
- 0.064 * Matrix([PKSKIMPR].[Egress Time])_{ij}
+ 0.257 * Field(NLMDATA.ATYPE1)_j
+ 0.276 * Field(NLMDATA.ATYPE2)_j
+ 0.813 * Field(NLMDATA.VLTP)_i
+ 0 * Field(NLMDATA.Airport)_j
+ 1 * Field(NLMDATA.FtWorth)_j

Utility(Auto Nest)_{ij} = 0.725 * Log(Exp(Utility(Drive Alone)_{ij})
+ Exp(Utility(Shared Ride 2)_{ij})
+ Exp(Utility(Shared Ride 3)_{ij}))

Utility(Drive Alone)_{ij} = -0.055 * Matrix([Shortest Path].[PKTIME_*])_{ij}
- 0.041 * Matrix([Shortest Path].[MODEL_LENGTH (Skim)])_{ij}
- 0.279 * Field(NLMDATA.PCOSTHBW)_j

Utility(Shared Ride 2)_{ij} = -3.1791
- 0.055 * Matrix([Shortest Path].[PKTIME_*])_{ij}
- 0.02 * Matrix([Shortest Path].[MODEL_LENGTH (Skim)])_{ij}
- 0.14 * Field(NLMDATA.PCOSTHBW)_j
+ 0.873 * Field(NLMDATA.VLTP)_i
+ 0 * Field(NLMDATA.Airport)_j

Utility(Shared Ride 3)_{ij} = -4.0764
- 0.055 * Matrix([Shortest Path].[PKTIME_*])_{ij}
- 0.012 * Matrix([Shortest Path].[MODEL_LENGTH (Skim)])_{ij}
- 0.085 * Field(NLMDATA.PCOSTHBW)_j
+ 0.873 * Field(NLMDATA.VLTP)_i
+ 0 * Field(NLMDATA.Airport)_j

Data Sources

View "NLMDATA", from file:
"C:\TCMODEL\TSZGeographic\Z4874OCT29GEO\Z4874Y99OCT2903ACT\NLMDATA.BIN"
Fields Used:
ATYPE1
AType2
Airport
FtWorth
PCOSTHBBW
VLTP

Matrix "PKSKIMNOPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\PK_NOPR.MTX"
Cores Used:
"Access Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "PKSKIMPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\PK_PR.MTX"
Cores Used:
"Drive Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "Shortest Path", from file
"L:\TCMODEL\ROADWAYNETWORK\YR99NOV0503ALIGNEDRDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\PK_HOV.MTX"
Cores Used:
"MODEL_LENGTH (Skim)"

Matrix "Shortest Path", from file
"L:\TCMODEL\ROADWAYNETWORK\YR99NOV0503ALIGNEDRDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\PK_NOHOV.MTX"
Cores Used:
"PKTIME_"

HNW Market Segment: HNW4VGEP

*******************************************************************
Nested Logit Model
*******************************************************************
Stored in: "C:\TCMODEL\ModelCalibrated\ModeChoice\Data\HNW4VGEP.nlm"

*******************************************************************
Model Structure
*******************************************************************

Alternatives
Drive Alone
Shared Ride Nest
    Shared Ride 2
    Shared Ride 3
Transit Nest
    Transit Walk
    Transit Drive

*******************************************************************
Utility Variables
*******************************************************************

Utility(Drive Alone)_ij = -0.011 * Matrix([Shortest Path],[OPTIME_*])_ij
- 0.012 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_ij
- 0.081 * Field(NLMDATA.PCOSTHNW)_j

Utility(Shared Ride Nest)_ij = 0.666 * Log(Exp(Utility(Shared Ride 2)_ij)
+ Exp(Utility(Shared Ride 3)_ij))

Utility(Shared Ride 2)_ij = -1.115
- 0.011 * Matrix([Shortest Path],[OPTIME_*])_ij
- 0.0059 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_ij
+ 0.212 * Field(NLMDATA.HHIQ4)_i
- 0.331 * Field(NLMDATA.ATYPE1)_j
- 0.241 * Field(NLMDATA.HINC)_i
+ 0 * Field(NLMDATA.Airport)_j

Utility(Shared Ride 3)_ij = -4.2688
- 0.011 * Matrix([Shortest Path],[OPTIME_*])_ij
- 0.0033 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_ij
- 0.023 * Field(NLMDATA.PCOSTHNW)_j
+ 0.916 * Field(NLMDATA.HHIQ4)_i
- 0.331 * Field(NLMDATA.ATYPE1)_j
- 0.241 * Field(NLMDATA.HINC)_i
+ 0 * Field(NLMDATA.Airport)_j

Utility(Transit Nest)_ij = 0.892 * Log(Exp(Utility(Transit Walk)_ij)
+ Exp(Utility(Transit Drive)_ij))

Utility(Transit Nest)_ij = -0.9381
- 0.011 * Matrix([OPSKIMNOPR],[Fare])_ij
- 0.007 * Matrix([OPSKIMNOPR],[In-Vehicle Time])_ij
- 0.053 * Matrix([OPSKIMNOPR],[Initial Wait Time])_ij
- 0.053 * Matrix([OPSKIMNOPR],[Transfer Wait Time])_ij
Utility(Transit Drive)\_ij = -0.3022
  - 0.217 * Matrix([OPSKIMPR].[Fare])\_ij
  - 0.007 * Matrix([OPSKIMPR].[In-Vehicle Time])\_ij
  - 0.053 * Matrix([OPSKIMPR].[Initial Wait Time])\_ij
  - 0.053 * Matrix([OPSKIMPR].[Transfer Wait Time])\_ij
  - 0.011 * Matrix([OPSKIMPR].[Drive Time])\_ij
  - 0.053 * Matrix([OPSKIMPR].[Egress Time])\_ij
  - 0.007 * Matrix([OPSKIMPR].[Dwelling Time])\_ij
  + 0.527 * Field(NLMDATA.HHIQ4)\_i
  + 1.581 * Field(NLMDATA.ATYPE1)\_j
  - 7.533 * Field(NLMDATA.HINC)\_i
  + 0 * Field(NLMDATA.Airport)\_j

Data Sources

View "NLMDATA", from file: "C:\TCMODEL\TSZGeographic\Z4874OCT29GEO\Z4874Y99OCT2903ACT\NLMDATA.BIN"
Fields Used:
  ATYPE1
  Airport
  FtWorth
  HHIQ4
  HINC
  PCOSTHNW

Matrix "OPSKIMNOPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\OP_NOPR.MTX"
Cores Used:
  "Access Time"
  "Dwelling Time"
  "Egress Time"
  "Fare"
  "In-Vehicle Time"
  "Initial Wait Time"
  "Transfer Time"
"Transfer Wait Time"

Matrix "OPSKIMPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y9
9OCT2903ACT\YR99APT\YR99TRNT\OP_PR.MTX"
Cores Used:
"Drive Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "Shortest Path", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y9
9OCT2903ACT\OP_HOV.MTX"
Cores Used:
"MODEL_LENGTH (Skim)"
"OPTIME_*"

HNW Market Segment: HNW4VLTP

*****************************************************************************
Nested Logit Model
*****************************************************************************
Stored in: "C:\TCMODEL\ModelCalibrated\ModeChoice\Data\HNW4VLTP.nlm"
*****************************************************************************
Model Structure
*****************************************************************************

Alternatives
Drive Alone
Shared Ride Nest
  Shared Ride 2
  Shared Ride 3
Transit Nest
  Transit Walk
  Transit Drive

*****************************************************************************
Utility Variables
*****************************************************************************

Utility(Drive Alone)_{ij} = -0.011 * Matrix([Shortest Path],[OPTIME_*])_{ij}
- 0.012 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_{ij}
- 0.081 * Field(NLMDATA.PCOSTHNW)_{j}
Utility(Shared Ride Nest)$_{ij}$ = $0.666 \times \log(exp(Utility(Shared Ride 2)$_{ij}$) + exp(Utility(Shared Ride 3)$_{ij}$))

Utility(Shared Ride 2)$_{ij}$ = -0.2855
- 0.011 $\times$ Matrix([Shortest Path],[OPTIME_*])$_{ij}$
- 0.0059 $\times$ Matrix([Shortest Path],[MODEL_LENGTH (Skim)])$_{ij}$
+ 0.935 $\times$ Field(NLMDATA.VLTP)$_i$
+ 0.212 $\times$ Field(NLMDATA.HHIQ4)$_i$
- 0.331 $\times$ Field(NLMDATA.ATYPE1)$_j$
- 0.241 $\times$ Field(NLMDATA.HINC)$_i$
+ 0 $\times$ Field(NLMDATA.Airport)$_j$

Utility(Shared Ride 3)$_{ij}$ = -1.9533
- 0.011 $\times$ Matrix([Shortest Path],[OPTIME_*])$_{ij}$
- 0.0033 $\times$ Matrix([Shortest Path],[MODEL_LENGTH (Skim)])$_{ij}$
- 0.023 $\times$ Field(NLMDATA.PCOSTHNW)$_j$
+ 0.935 $\times$ Field(NLMDATA.VLTP)$_i$
+ 0.916 $\times$ Field(NLMDATA.HHIQ4)$_i$
- 0.331 $\times$ Field(NLMDATA.ATYPE1)$_j$
- 0.241 $\times$ Field(NLMDATA.HINC)$_i$
+ 0 $\times$ Field(NLMDATA.Airport)$_j$

Utility(Transit Nest)$_{ij}$ = 0.892 $\times \log(exp(Utility(Transit Walk)$_{ij}$) + exp(Utility(Transit Drive)$_{ij}$))

Utility(Transit Walk)$_{ij}$ = 2.9995
- 0.217 $\times$ Matrix([OPSKIMNOPR],[Fare])$_{ij}$
- 0.007 $\times$ Matrix([OPSKIMNOPR],[In-Vehicle Time])$_{ij}$
- 0.053 $\times$ Matrix([OPSKIMNOPR],[Initial Wait Time])$_{ij}$
- 0.053 $\times$ Matrix([OPSKIMNOPR],[Transfer Wait Time])$_{ij}$
- 0.053 $\times$ Matrix([OPSKIMNOPR],[Transfer Time])$_{ij}$
- 0.053 $\times$ Matrix([OPSKIMNOPR],[Access Time])$_{ij}$
- 0.053 $\times$ Matrix([OPSKIMNOPR],[Egress Time])$_{ij}$
- 0.007 $\times$ Matrix([OPSKIMNOPR],[Dwelling Time])$_{ij}$
+ 0.21 $\times$ Field(NLMDATA.VLTP)$_i$
+ 0.527 $\times$ Field(NLMDATA.HHIQ4)$_i$
+ 1.581 $\times$ Field(NLMDATA.ATYPE1)$_j$
- 7.533 $\times$ Field(NLMDATA.HINC)$_i$
+ 0 $\times$ Field(NLMDATA.Airport)$_j$

Utility(Transit Drive)$_{ij}$ = 0.7238
- 0.217 $\times$ Matrix([OPSKIMPR],[Fare])$_{ij}$
- 0.007 $\times$ Matrix([OPSKIMPR],[In-Vehicle Time])$_{ij}$
- 0.053 $\times$ Matrix([OPSKIMPR],[Initial Wait Time])$_{ij}$
- 0.053 $\times$ Matrix([OPSKIMPR],[Transfer Wait Time])$_{ij}$
- 0.053 $\times$ Matrix([OPSKIMPR],[Transfer Time])$_{ij}$
- 0.011 $\times$ Matrix([OPSKIMPR],[Drive Time])$_{ij}$
- 0.053 $\times$ Matrix([OPSKIMPR],[Egress Time])$_{ij}$
- 0.007 $\times$ Matrix([OPSKIMPR],[Dwelling Time])$_{ij}$
\[ + 0.21 \times \text{Field(NLMDATA.VLTP)}_i + 0.527 \times \text{Field(NLMDATA.HHIQ4)}_i + 1.581 \times \text{Field(NLMDATA.ATYPE1)}_j - 7.533 \times \text{Field(NLMDATA.HINC)}_i + 0 \times \text{Field(NLMDATA.Airport)}_j + 1 \times \text{Field(NLMDATA.FtWorth)}_j \]

************************************************
Data Sources
************************************************

View "NLMDATA", from file:
"C:\TCMODEL\TSZGeographic\Z4874OCT29GEO\Z4874Y99OCT2903ACT\NLMDATA.BIN"
Fields Used:
  ATYPE1
  Airport
  FtWorth
  HHIQ4
  HINC
  PCOSTHWNW
  VLTP

Matrix "OPSKIMNOPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\OP_NOPR.MTX"
Cores Used:
  "Access Time"
  "Dwelling Time"
  "Egress Time"
  "Fare"
  "In-Vehicle Time"
  "Initial Wait Time"
  "Transfer Time"
  "Transfer Wait Time"

Matrix "OPSKIMPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y99OCT2903ACT\YR99APT\YR99TRNT\OP_PR.MTX"
Cores Used:
  "Drive Time"
  "Dwelling Time"
  "Egress Time"
  "Fare"
  "In-Vehicle Time"
  "Initial Wait Time"
  "Transfer Time"
  "Transfer Wait Time"
Matrix "Shortest Path", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y9
9OCT2903ACT\OP_HOV.MTX"
Cores Used:
"MODEL_LENGTH (Skim)"
"OPTIME_**"

NHB

********************************************************************************
Nested Logit Model
********************************************************************************
Stored in: "C:\TCMODEL\ModelCalibrated\ModeChoice\Data\NHB.nlm"

********************************************************************************
Model Structure
********************************************************************************

Modes
Drive Alone
Shared Ride 2
Shared Ride 3
Transit Walk
Transit Drive

********************************************************************************
Utility Variables
********************************************************************************

Utility(Drive Alone)_ij = -0.011 * Matrix([Shortest Path],[OPTIME_*])_ij
- 0.0146 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_ij
- 0.1 * Field(NLMDATA.PCOSTNHB)_j

Utility(Shared Ride 2)_ij = -0.8291
- 0.011 * Matrix([Shortest Path],[OPTIME_*])_ij
- 0.0074 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_ij
- 0.05 * Field(NLMDATA.PCOSTNHB)_j
- 0.754 * Field(NLMDATA.ATYPE1)_j
+ 0 * Field(NLMDATA.Airport)_j

Utility(Shared Ride 3)_ij = -1.0207
- 0.011 * Matrix([Shortest Path],[OPTIME_*])_ij
- 0.004 * Matrix([Shortest Path],[MODEL_LENGTH (Skim)])_ij
- 0.027 * Field(NLMDATA.PCOSTNHB)_j
- 0.754 * Field(NLMDATA.ATYPE1)_j
+ 0 * Field(NLMDATA.Airport)_j

Utility(Transit Walk)_ij = -3.2599
- 0.007 * Matrix([OPS4KIMNOPR],[In-Vehicle Time])_ij
- 0.007 * Matrix([OPS4KIMNOPR],[Dwelling Time])_ij
- 0.2 * Matrix([OPS4KIMNOPR],[Fare])_ij
- 0.036 * Matrix([OPSKIMNOPR].[Initial Wait Time])_ij
- 0.036 * Matrix([OPSKIMNOPR].[Transfer Wait Time])_ij
- 0.036 * Matrix([OPSKIMNOPR].[Transfer Time])_ij
- 0.036 * Matrix([OPSKIMNOPR].[Access Time])_ij
- 0.036 * Matrix([OPSKIMNOPR].[Egress Time])_ij
+ 1.323 * Field(NLMDATA.ATYPE1)_j
+ 0 * Field(NLMDATA.Airport)_j

Utility(Transit Drive)_ij = -5.1752
- 0.007 * Matrix([OPSKIMPR].[In-Vehicle Time])_ij
- 0.007 * Matrix([OPSKIMPR].[Dwelling Time])_ij
- 0.2 * Matrix([OPSKIMPR].[Fare])_ij
- 0.036 * Matrix([OPSKIMPR].[Initial Wait Time])_ij
- 0.036 * Matrix([OPSKIMPR].[Transfer Wait Time])_ij
- 0.011 * Matrix([OPSKIMPR].[Drive Time])_ij
- 0.036 * Matrix([OPSKIMPR].[Egress Time])_ij
+ 1.323 * Field(NLMDATA.ATYPE1)_j
+ 0 * Field(NLMDATA.Airport)_j
+ 1 * Field(NLMDATA.FtWorth)_j

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Data Sources
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View "NLMDATA", from file:
"C:\TCMODEL\TSZGeographic\Z4874OCT29GEO\Z4874Y99OCT2903ACT\NLMDATA.BIN"

Fields Used:
ATYPE1
Airport
FtWorth
PCOSTNHB

Matrix "OPSKIMNOPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y9
9OCT2903ACT\YR99APT\YR99TRNT\OP_NOPR.MTX"

Cores Used:
"Access Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "OPSKIMPR", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y9
9OCT2903ACT\YR99APT\YR99TRNT\OP_PR.MTX"
Cores Used:
"Drive Time"
"Dwelling Time"
"Egress Time"
"Fare"
"In-Vehicle Time"
"Initial Wait Time"
"Transfer Time"
"Transfer Wait Time"

Matrix "Shortest Path", from file
"C:\TCMODEL\RoadwayNetwork\YR99NOV0503RDWY\Z4874OCT29GEO\Z4874Y90CT2903ACT\OP_HOV.MTX"
Cores Used:
"MODEL_LENGTH (Skim)"
"OPTIME_*"