Compass Version 1.0

DRCOG Travel Model User's Guide

Denver Regional Council of Governments

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Software and Hardware Requirements

Compass 1.0 was designed for TransCAD Version 4.5, build 181. We recommend running it on that specific version of TransCAD, as older or newer versions may affect the model results. Specifically, TransCAD 4.7 includes revisions to the transit Pathfinder algorithm. Those revisions improve processing time, and fix a known problem with the DRCOG drive-to-transit skimming procedure, but also significantly changes the model calibration. Therefore, DRCOG is in the process of developing Compass 1.1, which will be calibrated to work with TransCAD 4.7 and include other improvements as warranted. Compass 1.1 is expected to be released in mid-2004.

The only specific hardware requirements for Compass 1.0 are those necessary to run TransCAD. The full model uses about 6 GB of hard disk space. In addition, we recommend that you have several additional GB of free hard disk space as both the model and TransCAD create temporary files for several procedures.

The model was designed on a machine with a 1.8 GHz processor, 512 MB of RAM, and an 80 GB hard disk. On this machine, one iteration takes about 10-12 hours of processing time. In general, the limiting factor is the number of TAZs. With 2664 zones, a single matrix contains about 7 million elements, which consumes about 28 MB of space if stored as 4 byte floating numbers. These matrices quickly add up, especially when we often deal with 10-20 at a time for various skims and trip tables. For some procedures (setting distance-based fares, and converting drive-access trip matrices to PNR-to-Attraction format) memory errors were encountered when trying to process the entire matrices at once, forcing us to process these steps one row at a time. It may be possible to encounter memory errors in other locations if the model is run on a machine with significantly less memory. Likewise, if we move to machines with more memory, it may be possible to re-optimize the code to process these steps all at once, significantly improving execution time.

Installing the Model

After installing TransCAD, take the following steps to install Compass:

1. Copy the graphics files from the \bmp\ directory into:

    C:\Program Files\TransCAD\bmp\

    These files are icons used in the model dialog box. The model will run without them, but they improve the appearance of the dialog box.

2. Open TransCAD, and select: Tools→Add-Ins Select "GIS Developers Kit" and click OK.

3. A dialog box will appear with five icons. The middle icon is "Compile to UI Database". Select this middle icon.

4. From the files included on the CD, select the source code file: DRCOG_xxxxxxxx.rsc

5. Select the file to store the compiled program. The file to compile to is:

   C:\Program Files\TransCAD\drcog_ui.dbd

   If the file does not exist, create it.

6. In TransCAD, select: Tools→Add-Ins. Click "Setup". Click Add. Fill in the blanks as follows:

Type:	Dialog Box
Description:	DRCOG Model
Name:	DRCOG Model
UI Database:	C:\Program Files\TransCAD\drcog_ui.dbd

   Click "OK", and the model is installed.

Once the model is installed, you can open the model dialog box by going to Tools→Add-Ins and selecting "DRCOG Model". Remember that any changes to the source code will not be reflected in model execution unless you repeat these steps to re-compile.

Working with Scenarios

We recommend copying the model files to a subdirectory of C:\drcog\. We recommend a different sub-directory for each scenario you run. It is not necessary that you run these models from a sub-directory of C:\drcog\, but it is important that the directory exist. When the model is run, a file is created called scenario.arr, and the default directory for this directory is C:\drcog\.

Having copied all of the model files from the CD to an appropriate directory, the next step is to add a scenario telling the model where to find those files.

1. Open the model by going to Tools→Add-Ins, and selecting "DRCOG Model".

2. Click on the "Scenario" button.

3. If the scenario has already been added, select the appropriate scenario, and click "OK". Skip these remaining steps, and run the model.

4. Give the scenario an appropriate name.

5. Click the "Dir" tab, and select the appropriate directory.

6. File names can be changed by selecting a step (Initialization, Trip Generation, etc.) and clicking on "Contents". Doing this will open a dialog box showing the files used in that step. You can switch between input and output files using the radio buttons below the file list. You can change a file by selecting that file, and clicking "File". This will open a standard windows file selection dialog box, and you can change the file used. The "Status" field indicates if the file exists, is missing, or is in-use. Missing or in-use input files could cause problems. Also, both scalar and list parameters are shown at the bottom. These can be changed in the window that displays their value.

7. When you are done adjusting any file names or parameters, click "OK" to exit the scenario dialog box, and you will be returned to the main model dialog box. You will notice that the name of the scenario selected will appear in the Scenarios Window.

Most of the model files and parameters are standard, and their names do not change from one scenario two another. There are some exceptions to this rule, and it is important to change these file names in the scenario manager if they are not set by default. The files and parameters you need to pay close attention to include:

Highway and Transit Network Files:
Found at: Initialization → Input Files
   1. peak hour base database
   2. off-peak hour base database
   3. peak hour transit route system
   4. off-peak hour transit route system
   5. peak hour highway network
   6. off-peak hour highway network
   7. peak hour transit network
   8. off-peak hour transit network
   24. combined peak & off-peak highway geographic file
   25. combined peak & off-peak transit route system

Socioeconomic Zonal Data Set
Found at: Trip Generation → Input Files
   1. zone attribute table

Model Year
Found at: Trip Generation → Parameters
   1. Modeling forecast year (4 digits)

In running the model, there are four key model inputs that will actually be changed. These include:

- combined peak & off-peak highway geographic file
- combined peak & off-peak transit route system
- zone attribute table
- Modeling forecast year

Combined Peak & Off-Peak Highway Geographic File

This combined set of files is what actually gets edited when coding highway networks. It contains only the basic link and node attributes provided by the user, and any auxiliary attributes such as traffic counts that are not used in the modeling process.

When running the model, the "General Preprocess" step of "Initialization" copies this geographic file into separate peak and off-peak highway geographic files. All of the data in this combined file are copied. The "Peak DB Preprocess" and "Off-Peak DB Preprocess" steps process these files to add link attribute fields that include peak and off-peak travel times, capacities, free-flow speeds, and other items necessary for running the remainder of the model. These steps also compile the geographic files into peak and off-peak TransCAD network (.net) files. The .net files are not directly viewable by the user, but are used by the shortest path and highway assignment algorithms. Having this compiled .net file stripped of extraneous information greatly improves the processing time associated with these steps.

Three important points should be taken away from this discussion:

- The combined highway geographic file should be edited when coding highway networks.
- The peak and off-peak highway geographic files will be overwritten when the "General Preprocess" step of "Initialization" is run.
- Changes made to the highway geographic file will not be reflected in the shortest path or highway assignment calculations unless "Peak DB Preprocess" and "Off-Peak DB Preprocess" are run to compile to the .net files.

Combined Peak & Off-Peak Transit Route System

Like the combined highway file, the combined transit route system is the file that actually gets edited when coding transit networks. The "General Preprocess" selects the routes from the combined file that operate in the peak and saves them to the peak route system, and selects the routes that operate in the off-peak and saves them in the off peak route system. The "Peak DB Preprocess" and "Off-Peak DB Preprocess" steps compile these route systems into transit network (.tnw) files. These transit networks are used for calculating transit shortest paths and performing transit assignment.

With respect to transit route systems, remember:

- The combined transit route system should be edited when coding transit networks.
- The peak and off-peak transit route systems will be overwritten when the "General Preprocess" step of "Initialization" is run.
- Changes made to the transit route system file will not be reflected in the shortest path or transit assignment calculations unless "Peak DB Preprocess" and "Off-Peak DB Preprocess" are run to compile to the .tnw files.

Zone Attribute Table

The zone attribute table contains the socioeconomic data by TAZ. In any cases where different development scenarios are evaluated, the population, households, and employment in this file should be changed. Socioeconomic data sets will generally be provided by DRCOG for a specific year and development scenario. They should only be changed when evaluating specific development alternatives.

The following 12 fields are inputs in the zonal attribute table, and need to be complete. The remaining fields in the table are generated within the model. The first five fields below are standard, and will not be changed between different scenarios.

ZONE ID:	TAZ ID
DISTRICT:	district names used in k-factors.
DIATime:	pseudo travel time used for distribution trips to DIA.
TAZ_ID:	TAZ_ID by RSA_ID (The 5 digit-ID used in economic modeling).
ACREAGE:	zonal acreage (units of acres).
HH POP:	total household population, not including population in group quarters.
LOW INC. HH:	number of households low-income (bottom 11%)
MED. INC. HH:	number of households medium-income (middle 64%)
HIGH INC. HH:	number of households high-income (top 25%)
PROD./DIST. EMP:	total employment in production and distribution
RETAIL EMP:	total employment in retail.
SERVICE EMP:	total employment in service.

Modeling Forecast Year

The modeling forecast year is the year for which the model run is performed. The model uses this in two ways:

- External station volumes are factored up from a base year by applying a growth factor for the appropriate number of years. These volumes are used to estimate external-external and internal-external trips.

- The model forecast year is used with a lookup table to determine the number of enplanements at DIA, which is used to forecast the traffic at DIA.

Model Stages and Steps

The model contains seven stages with a total of 27 steps that can be run individually, or together. The stages and steps are summarized as follows:

Initialization

> *Area Type Model*
>
> Calculates the population and employment density within ½ mile of each zone centroid, and uses that to determine the area type (CBD, Fringe, Urban, Suburban, Rural). Fills that area type into the zonal data file.
>
> *Parking Cost Model*
>
> Based on the demand of vehicle trips to the CBD, determines the parking cost by TAZ, and fills it into the zonal data file. Also determines parking cost for select non-CBD TAZs.
>
> *General Preprocess*
>
> Splits combined networks into separate peak and off-peak. Calculates additional fields in zonal data file.
>
> *Transit Access/Egress*
>
> Determines fraction of each TAZ within 1/3 mile of transit, and fills those values into zonal data file.
>
> *Peak DB Preprocess*
>
> Creates additional fields in peak highway geographic file, processes peak transit route system, and compiles them into .net and .tnw files.
>
> *Off-Peak DB Preprocess*
>
> Creates additional fields in off-peak highway geographic file, processes off-peak transit route system, and compiles them into .net and .tnw files.

Trip Generation

Calculate HH

Calculates the households in each TAZ by income group and household size.

Calculate PA

Performs trip generation, and balances attractions to productions.

DB Processing

Peak Highway Skimming

Computes peak (6:30-9:00 AM) highway skim, as well as HOV skim, and HOV time savings.

Off-Peak Highway Skimming

Computes off-peak (9:00 AM – 3:00 PM) highway skim. HOV is not an option in the off-peak.

Peak Transit Skimming

Computes peak walk-access and drive-access transit skims. Post-processes those skims to determine distance-based fare, rail flags, and valid paths.

Off-Peak Transit Skimming

Computes off-peak walk-access and drive-access transit skims. Post-processes those skims to determine distance-based fare, rail flags, and valid paths.

Trip Distribution

HBW Distribution

Trip distribution for home-based work trips, segmented into low-income, middle-income, and high-income, using a gravity model.

HNW Distribution

Trip distribution for home-based non-work trips, non-home-based trips, and internal-external trips, using a gravity model.

COM Distribution

Trip distribution for commercial vehicle trips, and for external-external trips.

Mode Split

Set Market Segments

Creates a matrix with flags indicating which cells are attracted by the CBD, attracted by DIA, attracted by Boulder (excluding Boulder productions), and none of the above.

HBW Modal Split

Mode choice for home-based work trips into Drive Alone, Shared Ride 2, Shared Ride 3+, Walk to Transit, and Drive to Transit. Segmented by low, medium, and high income.

HBNW Modal Split

Mode choice for home-based non-work trips into Auto, Walk to Transit, and Drive to Transit. The auto trips are post-processed into Drive-Alone, Shared Ride 2, and Shared Ride 3+ based on the average household size of the production zone.

NHB Modal Split

Mode choice for non-home-based trips into Auto and Walk to Transit. The auto trips are post-processed into Drive-Alone, Shared Ride 2, and Shared Ride 3+ based on the average household size of the production zone.

Trip Assignment

Transit Assignment

First, for drive to transit trips, separates out the portion driving to the PNR lot from the portion actually using transit from the PNR lot to the destination. Then assigns the walk to transit trips, and the transit portion (from PNR to destination) of the drive to transit trips. Does this for both the peak and the off peak.

Highway Time of Day

Takes the mode choice matrices by trip purpose as input, converts from P-A to O-D format, and uses factors to split into AM (6:30-9:00 AM), PM (3:00 – 7:00 PM), and Off-Peak O-D trip tables by vehicle occupancy.

Highway AM Loading

Preloads heavy trucks, then assigns passenger vehicles for three AM sub-periods (6:30-7:00 AM, 7:00 – 8:00 AM, and 8:00-9:00 AM).

Highway PM Loading

Preloads heavy trucks, then assigns passenger vehicles for three PM sub-periods (3:00-5:00 PM, 5:00-6:00 PM, and 6:00-7:00 PM).

Highway Offpeak Loading

Preloads heavy trucks, then assigns passenger vehicles for four off-peak sub-periods (11:00 PM – 6:30 AM, 9:00 – 11:30 AM, 11:30 AM – 3:00 PM, 7:00 – 11:00 PM). Assigns only a single class of passenger vehicles, with no HOV assignment.

Speed Balancing and Reporting

Combine Time Periods

Combines commercial and passenger vehicle flows, converts from hourly flows to totals for the sub-period, combines sub-periods into AM, PM, Off-Peak, and Mid-Day totals, combines main periods into all day totals.

Speed Balance

Compares the resulting AM and Mid-Day periods speeds to the previous iteration, if not converged, feeds the new speeds back into the peak and off-peak geographic files, and starts the model again.

Report

The reporting procedure is not implemented in Version 1.0.

Running the Model

Running Individual Steps

Each step can be run individually. After setting a scenario, if you click on the icon next to each stage name, a dialog box will open allowing you to choose which steps in that stage you want to run. You can do this for any of the stages, or you can click "Run All Steps" at the top of the main model dialog box. Next to that box, is "Stop After Stages" which will force the model to stop execution at the end of a stage. Clicking on the stage name starts execution at that point.

As an example, say you wanted to run only an Off-Peak Highway Skimming. You would take these steps:

1. Open the model, and set a scenario.

2. Leave "Stop After Stages" checked.

3. Click on the icon next to "DB Processing", and uncheck all of the boxes except for "Off-Peak Highway Skimming".

4. Close that dialog box, and click on the words "DB Processing"

The model will execute the off-peak highway skimming step, and stop when it reaches the end of the stage. If it is successful, it will give a message "Batch Routine Successful", and display some execution information when you click "OK". Of course, in this case, you will run into problems if you have not already run the initialization stage to split the combined geographic file and compile the off-peak geographic file into a .net file.

Running the Entire Model

To run the entire model, take these steps:

1. Open the model and set a scenario.

2. Uncheck "Stop After Stages".

3. If you want to run speed balancing, click on the icon next to "Speed Balancing and Reporting", and check the "Speed Balance" Step. If you do not want to speed balance, leave this box unchecked.

4. Click on "Initialization" to start the model at the beginning.

The entire model stream will execute, and if you are speed balancing, it will continue to iterate until the speeds have converged. Keep in mind that if it takes 12 hours to run one iteration, and it takes 6 iterations to converge, you could be talking about 3 days of execution time. Generally, this will not be the case, as you will be starting from speeds that are almost converged.

The Area Type Model

Note that the area type model and the parking cost model are not run by default. After running the Area Type model, DRCOG staff adjust the results by hand using our planning judgment. In particular, we seek to maintain consistency between model years. We do not want a zone that is urban in 2001 to become suburban or rural in 2010, although it is OK for that zone to move up to fringe. Therefore, **we recommend that you do not run the area type model,** as it will overwrite the adjusted values.

The Parking Cost Model

The parking cost model is also not run by default. You can run the parking cost model, and should run it if you have a scenario that has significantly more development in the CBD, or higher levels of service to the CBD. The parking cost model is an economic model of supply and demand. The demand is the number of vehicles attempting to park in the CBD, which we approximate as the HBW vehicle trip attractions to the CBD. (Non-work trips tend to include shorter-duration activities, so we do not count them.) The number of vehicle trips depends on the total person trip attractions to the CBD, the number of those taking transit, and the average auto occupancy. The parking cost model procedure opens the mode choice output matrix, and determines the CBD vehicle trip attractions from that matrix. If an iteration of the model has not yet been run, and this matrix does not exist, the parking cost model will crash. Therefore, **you need to run a model iteration before running the parking cost model.** If the transit ridership or auto occupancy to the CBD changes between iterations, the parking costs will change to, so it is inherently an iterative process. If you are starting from a scenario that has been iterated and converged by DRCOG, you can assume that the parking costs will not change by very much, and skip that step. You cannot assume this if you make major changes affecting the CBD.

The Dreaded Transit Skimming Bug

Unfortunately, TransCAD 4.5 has a bug that causes an illegal memory reference during the drive to transit skimming procedure. During "Peak DB Preprocess" and "Off-Peak DB Preprocess" the model creates highway skim matrices that store the travel time from each TAZ to each PNR lot. These matrices store all of the information that would be store in explicit drive access links, but in a matrix format instead of a link format. When running the drive to transit skim, these matrices are used in place of explicit drive access links, saving the user tremendous amounts of time that would be spent coding drive

access links. The problem is that when this matrix is created, it is somehow incompatible with the transit network files (.tnw files) that are also created in the DB preprocess step.

The bug has been corrected in TransCAD 4.7, but the model results change significantly in TransCAD 4.7, which will force us to re-calibrate the model. We expect to finish the re-calibration and release Compass 1.1 calibrated for TransCAD 4.7 in summer 2004. While we were unable to fix the problem in TransCAD 4.5, we were able to find a way around this problem. If the drive to transit skims are first run by hand for both the peak and the off-peak, they will then work when run via the model. To run these by hand, take these steps:

1. Run the Initialization stage to create the .tnw files and the origin to PNR skim matrices.

2. Open the peak transit route system.

3. Go to Map → Layers, and show the node layer (not the stop layer).

4. While the node layer is the current layer, select the centroids. Do this by going to Selection → Select By Condition, typing "id <= 2664", and clicking OK. (The centroid IDs are 1 through 2664).

5. Open the peak origin to PNR skim matrix (skim_PNR_pk.mtx), and make "TIME" the current core.

6. Make the map active, with the node layer as the current layer.

7. Go to Transit → Multiple Paths, and select the peak transit network file.

8. A Transit Network Settings dialog box will open. Go to the Park & Ride tab, click "Enable Park & Ride", from the "Matrix File" drop-down, select "PNR Skim", and from the "Matrix" drop down, select "TIME". Click OK.

9. A Transit Skims dialog box will open. Leave the input setting as the defaults, and leave both "Create Parking Matrix" and "Skimming on Modes" checked. From the Skim Variables list select: Fare, In-Vehicle Time, Initial Wait Time, Transfer Wait Time, Transfer Time, Access Time, Egress Time, and Dwelling Time (fare, and all seven of the time variables). From the Skim Modes list, select all of the modes. Click OK.

10. An Output File Settings dialog box will open. Save the files in some temporary location, and overwrite them if they already exist. You will not actually use these files. Click OK.

11. A status bar will open that says "Initializing Matrix" for each matrix in the list in step 9. Let these finish. When the status bar changes to "Computing Matrix

(Row …", click cancel. There may be a delayed response before it processes your request. Because you do not need the outputs of this step, you do not need to wait for it to finish.

12. Repeat with the off-peak files.

Having followed these steps, you have somehow corrected the incompatibility between the origin to PNR skim matrix and the .tnw file. Now when you run the DB processing stage, it will work (or start from Trip Generation if you have not run that yet). After completing these steps, **do not** repeat the initialization step, as it will undo what you have just done.

Speed Balancing

The decisions made throughout the model stream depend on the travel time between TAZs, and are thus a function of link speeds. If the links speeds coming out of highway assignment are significantly different from the link speeds assumed at the beginning of the process, then the trip distribution and mode choice are based on invalid assumptions. When this occurs, we need to speed balance by feeding a revised set of link speed into the skimming process, and iterating the model until the input and output speeds match.

The speed balancing procedure in Compass 1.0 has changed considerably from what was used in the old MinUTP model. The old model would average speeds by facility type and area type, and feed the average speeds back. Thus it assumed that all urban freeways operated at the same speed, which is clearly not true. The new model feeds back the speeds on individual links, properly reflecting that it will take longer to travel inbound on North I-25 during the AM peak than outbound. Because of this change, the speed balancing procedure is much more sensitive, and network changes that may not have required speed balancing in the past will now require it.

The "Speed Balance" procedure is a step under the "Speed Balancing and Reporting" stage. It is not run by default, so you will need to check the box to run it. You may not to run speed balancing by default, so you can examine the results at the end of each iteration. If you do this, you can then re-start the model by running just the speed balancing step.

Speed balancing operates on peak and off-peak speeds separately. The peak speeds used are the average speeds for the entire AM peak period (6:30 – 9:00 AM). The off-peak speeds used are the average speeds for the mid-day period (9:00 AM – 3:00 PM). When speed balancing is run, it first checks for convergence by comparing the input speeds to the output speeds. If no more than 1% of the links change speed by more than 10%, then the speeds are considered converged. If the speeds are not converged, a new speed is calculated for each link as the average of the input and output speed. These new speeds are filled into the "AM_AB_SPEED" and "AM_BA_SPEED" fields of the peak highway geographic file, and the "MD_AB_SPEED" and "MD_AB_SPEED" fields of

the off-peak highway geographic file. The speed balancing procedure then restarts the model at the "Peak DB Preprocess" step.

"Peak DB Preprocess" and "Off-Peak DB Preprocess" need to be run such that the new speeds are properly reflected in the compiles .net and .tnw files. Unfortunately, because these steps are re-run, the memory error in the transit skimming will again be encountered. Therefore, you will need to run the steps above to correct that problem.

Viewing the Results

This section reviews some common model outputs that you may want to inspect after a run. It is not meant to be a comprehensive list, just a starting point. Feel free to take advantage of the capabilities of TransCAD to be creative in the way in which you view and report model results.

Trip Generation

The trip generation results are stored in the file "pa_balan.bin". For each zone, this file shows the number of productions and attractions by trip purpose. You can join this file to the table in the TAZ layer (taz2660.dbd, join to "ID"), and display the results graphically, or inspect the values for specific zones. To get the total trips by purpose:

1. Open pa_balan.bin

2. Go to Dataview → Statistics

3. Select a temporary file in which to save the results. Do not overwrite anything important!

4. The resulting table will show the count, sum, minimum, maximum, mean, and standard deviation of each field.

Trip Distribution

The trip distribution matrices are stored in production-attraction format in the following files:

HBW:	dst_hbw.mtx
HNW, NHB, IE:	dst_nwk.mtx
Commercial:	dst_com.mtx
EE:	dst_ee.mtx

You can open and view these matrices as they are. To make them more understandable, you may want to aggregate the results by area type or district. You can aggregate by area type by taking these steps:

1. Open the trip distribution matrix, for example dst_hbw.mtx.

2. Open the zoneXXX.bin file.

3. Make the matrix active, and go to Matrix → Aggregate

4. Fill in the fields of the resulting dialog box as follows:

	Rows	Columns
Dataview	<name of zone view>	<name of zone view>
Matrix ID Field	[Zone ID]	[Zone ID]
Aggregation Field	[Area Type]	[Area Type]

5. Click OK, and save the output file to a temporary location. Do not overwrite anything important!

The resulting matrix will show the total productions and attractions by area type.

Mode Shares

The results of the mode choice models are stored in production-attraction format in the following files:

HBW:	mod_hbw.mtx
HNW:	modhbnw.mtx
NHB:	mod_nhb.mtx

In the HBW matrix, all of the fields are person trips. The non-work matrices are more complicated.

For HNW, "Auto_Shares", "DriveAccTransit_Shares", and "WalkAccTransit_Shares" are the share of trips in each cell choosing each of those modes. "Auto", "DriveAccTransit", and "WalkAccTransit" are person trips. A post-mode choice procedure is used to split the auto trips into drive-alone, shared ride 2 ("Ride 2"), and shared ride 3+ ("Ride 3+"). These last three matrix cores are converted to vehicle trips by the post-processor.

The NHB matrix follows the same format as the HNW matrix. "Auto_Shares" and "Transit_Shares" are the share of trips in each cell choosing these modes. "Auto" and "Transit" are person trips. "Drive Alone", "Ride 2", and "Ride 3+" are vehicle trips calculated by the post-processor.

The matrices can be aggregated like the trip distribution matrices. Also, you can calculate the total trips using each mode by market segments. The matrix Market_Seg.mtx has four cores with 0/1 flags specifying CBD attractions, DIA attractions, Boulder attractions (excluding intra-Boulder), and all others. As an example, you can calculate the HBW trips by mode to the CBD by multiplying the HBW mode choice matrix by the market segment matrix. Again, be sure not to overwrite the results onto an important file.

Highway Assignment Results

The highway assignment results are indexed by link ID and stored in these files.

AllDay.bin	All day results
AM.bin	6:30-9:00 AM
PM.bin	3:00-7:00 PM
OP.bin	All other times
MD.bin	9:00 AM – 3:00 PM (sub-set of the OP)
Am1.bin	6:30-7:00 AM
Am2.bin	7:00-8:00 AM
Am3.bin	8:00-9:00 AM
Pm1.bin	3:00-5:00 PM
Pm2.bin	5:00-6:00 PM
Pm3.bin	6:00-7:00 PM
Op1.bin	11:00 PM – 6:30AM
Op2.bin	9:00 AM – 11:30 AM
Op3.bin	11:30 AM – 3:00 PM
Op4.bin	7:00-11:00 PM

For each link, the tables show the vehicle flow in both directions and totaled, the travel times and average speeds in each direction, the vehicle-miles traveled in each direction and totaled, and the vehicle-hours traveled in each direction and totaled.

You will most often be interested in the all day totals. To get the total system VMT and VHT, follow these steps:

1. Open AllDay.bin

2. Go to Dataview → Statistics

3. Select a temporary file in which to save the results. Do not overwrite anything important!

4. The resulting table will show the count, sum, minimum, maximum, mean, and standard deviation of each field. The sum of Tot_VMT and Tot_VHT is the total VMT and VHT in the system.

Also, you will often want to display maps of the traffic flows. To do this, take these steps:

1. Open AllDay.bin

2. Open the highway geographic file (combined, peak, or off-peak will all work).

3. Click the "New Dataview" icon to display the table of attributes associated with each link.

4. Go to Dataview → Join, and fill in the resulting dialog box as follows:

> Name: <use the default>
>
> Joining from
> Table: PK_LINKS
> Field: ID
>
> Joining to
> Table: AllDay
> Field: ID1

   Click OK, and a joined dataview will appear.

5. Make the map active, and click on the "Automatic Labels" icon. In the dialog box, select the field "AB_Flow / BA_Flow", and adjust any of the display settings as desired.

The all day traffic flows are now displayed on the links.

Transit Assignment Results

The transit assignment results are stored in the following files:

Tonf_pw.bin	Peak walk transit boardings and alightings
Tonf_pd.bin	Peak drive transit boardings and alightings
Tonf_ow.bin	Off-peak walk transit boardings and alightings
Tonf_od.bin	Off-peak drive transit boardings and alightings
Tasnt_pw.bin	Peak walk transit link flows
Tasnt_pd.bin	Peak drive transit link flows

Tasnt_ow.bin	Off-peak walk transit link flows
Tasnt_od.bin	Off-peak drive transit link flows
Tasnw_pw.bin	Peak walk walk link flows
Tasnw_pd.bin	Peak drive walk link flows
Tasnw_ow.bin	Off-peak walk walk link flows
Tasnw_od.bin	Off-peak drive walk link flows

Generally, you will be most interested in transit boardings. The tables output by the transit assignment procedures report the boardings and alightings for each route at each stop. These results are probably not very useful unless aggregated, normally by route. To do this, take these steps:

1. Open tonf_pw.bin.

2. Open the combined transit route system.

3. Click the "New Dataview" icon to display the table of attributes associated with each route.

6. Go to Dataview → Join, and fill in the resulting dialog box as follows:

> Name: \<use the default\>
>
> Joining from
> Table: Routes
> Field: ID
>
> Joining to
> Table: tonf_pw
> Field: route_id

4. Click on the "Aggregate" tab within the join dataview dialog box. Select "One to Many Join". Aggregate the sum of "ON", and none of the other fields.

5. The result will show the total boardings for each route. You can aggregate further to total the boardings regardless of direction or pattern, but it may be easiest in an external database.

6. Repeat for drive-access or off-peak as warranted.

Working with Socioeconomic Data

To evaluate alternate development scenarios, you may need to modify the input data in the zonal data set. You can change the household population, households by income group, or employment by type to simulate the impacts of different developments.

As there are more TAZs in Compass 1.0 than in the old MinUTP model, you are less likely to need to split TAZs further. If you do need to split TAZs further, keep the following guidelines in mind:

- The [Zone ID] in the zoneXXX.bin file corresponds to the ID in the taz2660.dbd file, and also corresponds to the ID in the node layer of the highway geographic file.

- The zones and centroids are continuously 1 through 2664; 2628 through 2664 are external stations.

- Zones 9000+ in the taz2660 file are not within the transportation modeling area and should be ignored.

- Nodes 5000+ in the node layer of the highway geographic file are regular intersection nodes. Nodes 2665 through 4999 are reserved for centroid IDs.

- External stations are referenced in ee_base.mtx and in ExtStations.asc. If the IDs of external stations are changed, these files need to be updated.

- Several locations in the .rsc file select the centroids using the query "Select * where id <= 2664". These queries will need to be updated.

- The area type model uses the file smooth05mi.bin. This file contains the fraction of each zone within 0.5 miles of every centroid, and will be flawed if the zone system is changed. Therefore, we recommend coding the area types by hand if you split TAZs.

The previous list is not meant to be comprehensive, and we cannot guarantee your results if a mistake is made while splitting TAZs.

Coding Highway Networks

Highway networks are coded using the combined highway geographic file. Link geography should be edited using the map editing toolbox, and following the directions in the TransCAD documentation. Be sure to snap any links to the appropriate intersections to avoid leaving "stub" links. There is also a tool in TransCAD that can be used to check the connectivity of the line layer.

The following link attributes need to be updated when coding highway networks:

DIST   the length of the link unless curvature makes it longer

DIR   -1 B to A
               0 two way
               1 A to B

Facility Type 1 – Freeway
               2 – Expressway
               3 – Principal Arterial
               4 – Minor Arterial
               5 – Collector
               6 – Ramp
               8 – Centroid Connector

LANE   Number of through lanes in each direction

TOLL   0 – no toll
               1 – toll road
               6 – on-ramp to toll road

USE   0 – no HOV restrictions
               1 –
               2 –
               3 –
               4 –
               5 –
               6 –
               7 –
               8 –
               9 –
               10 –
               11 –
               12 –
               13 –
               14 –

In addition, these speed fields may be filled in:

AM_AB_SPEED
AM_BA_SPEED
MD_AB_SPEED
MD_BA_SPEED

These fields provide a starting point for the speed balancing process. If they are left blank, a default speed is used as the starting point. Better starting speeds will allow the model to converge in fewer iterations. Therefore, you can take these speeds from the peak and off-peak highway geographic files from a similar model run.

TransCAD's map editing toolbox allows you to set rules for determining how attributes get allocated when links are split. You should set the rules as follows:

DIST	add
DIR	copy
Facility Type	copy
LANE	copy
TOLL	copy
USE	copy

Finally, note that some changes will need to be made to the highway geographic file when coding transit networks. This includes adding any transit only links, and specifying any Park-n-Ride lots in the node layer.

RTD Transit Coding Manual

Introduction

RTD runs the DRCOG model. We model average weekday service that is determined by fixed routes. Thus, we do not model special services such as RockiesRide, BroncosRide, call-n-Rides, and Access-a-Ride. RTD has some 170+ fixed transit routes that are modeled.

Transit trips are assigned in Production-Attraction format (P-A). This differs from auto trips which are assigned in Origin-Destination (O-D) format. P-A format particularly affects how the peak transit service is modeled.

Transit service that is modeled through the travel demand model is represented by fields for the peak and off-peak time periods and mode in the *.rts file. There is an extra field for early-late service. This field exists only for use in the Operations & Maintenance (O&M) model (to be discussed later).

- The **Peak_Hdwy** field represents the morning peak service, roughly from 6–8 AM. P-A format takes care of the afternoon peak service.

- The **Off_Peak_Hdwy** field generally represents service between 10 AM–2 PM.

- The **Early_Late_Hdwy** field generally represents service after 9 PM and before 6 AM.

- The **Route, Pattern, Direction**, and **Shadow** fields exist to help others better understand how the routes are named and do not play a role in the running of the model. The **Route_ID**, **Route_Name,** and **MODE** fields do play a role in the running of the travel demand model.

- The **Company, Service_Type,** and **Equipment_Type** fields are for use in the O&M model. The **Company** field is leftover from the MINUTP model and was used there as input to the O&M model. It is not clear yet whether RTD will continue using this field in the same way in TransCAD®, so it has been left blank.

Service Changes

RTD Service Planners make service changes to the transit routes three times per year: January, May, and September. We prefer to model service in January or September of any given year because that is when school is in session. In May, service on some routes is cut back to reflect that school is out.

All RTD transit routes and some non-RTD operated routes, e.g. LINK and HOP, are published in a guide created for the bus drivers known as the Trailblazer. The Trailblazer

is printed three times per year in conjunction with the service changes and gives specific directions to bus drivers on how to travel on any particular route. In the back of the Trailblazer you will find diagrams of various park-n-Rides, downtown Denver stops, Union Station, and other RTD facilities. Learn how to read and use the Trailblazer. You will find it along with the route schedules to be an invaluable tool when coding transit routes. All transit schedules can be found on the internet at www.rtd-denver.com.

park-n-Rides, Transit Centers, Bus and Rail Stations

park-n-Rides, transit centers, and bus and rail stations are usually the first items to be determined when coding transit networks. Existing park-n-Ride locations, transit centers, and bus and rail stations should already be included in the route systems layer and are found on the RTD Systems Map. The Systems Map also indicates all the existing routes that go to these facilities. Future facility locations are often determined internally at RTD based on fiscal constraints as outlined in RTD's internal Transit Development Program (TDP) and should already be included in future year networks. Corridor studies determine their own park-n-Ride and station locations.

park-n-Rides are added in TransCAD® through a dummy variable by placing a 1 in the **PARKING** field at the particular node location of the park-n-Ride. Also, be sure to name the park-n-Ride in the appropriate field. There is no method to determine capture areas for park-n-Rides in the TransCAD® model. Rather the approach taken in the calibration of the model was to allow users to go on the highway network to get to park-n-Rides.

Existing rail stations are determined by the Systems Map and the Facilities and Properties book and should already be located in the model. Future rail stations are determined first by the appropriate EIS if one exists, such as with the T-REX project. Otherwise, other corridor studies determine their own rail station locations. When a rail station is added to the model, be sure to put a 1 as a dummy variable in the rail station field and enter the station name in the appropriate field. The dummy variable for the rail station field does not affect the running of the model but was included to make it easier to display rail stations on maps.

Transit (Route Systems) Coding

All transit routes are based on actual schedules and routing. Calibration and validation of the model required going through each route and schedule in the system and inputting this information into the model.

To code routes you must determine their routing, headways, and stops. Many routes have multiple patterns. In the MINUTP version of the DRCOG model some routes had shadows which are determined by fares. Shadows have been eliminated in the TransCAD® version of the model. A spreadsheet of routes has been created that details all headways, patterns, and shadows, if appropriate, of routes.

Know that RTD operates or contributes to almost all the bus service in the Denver metro area. This situation is unusual since in most metro areas many different transit agencies provide service to the entire area.

Be conscious of the RTD and community facilities that the routes were designed to access such as park-n-Rides, rail and bus stations, malls, hospitals, sports facilities, etc. Make your best effort to connect the appropriate routes to the zones containing these facilities. You may even need to add centroid connectors and walk links to zone centroids. If you do feel you need to add centroid connectors and walk links of any kind, it is usually best to check with RTD first.

Routes running along US 36 and North I-25 usually use the North I-25 reversible, barrier-separated HOV lanes. It is important for anyone coding routes on or near this facility be familiar with how this facility works! See below for a description and operation of this facility.

US 36/I-25 Direct Connect and North I-25 HOV lane Description and Operation

The construction of the Direct Connect allows HOV users on US 36 to connect to the reversible, barrier-separated HOV lanes on I-25 without entering the General Purpose lanes on either roadway and vice versa during the peak period in the peak direction and in the off-peak in the NB I-25 to WB US 36 direction. The construction on the Direct Connect was supposed to be complete in December 2000 but instead was not finished until May 2001.

Prior to 2001 US 36 had an all-day HOV lane in the EB direction only from Sheridan Blvd. to just west of I-25. Thus, there was no HOV lane for those going in the WB direction on US 36 any time of day. Because the Direct Connect did not exist, users on the US 36 EB HOV lane in order to get to the I-25 HOV lanes had to leave the EB US 36 HOV lane, exit into the General Purpose lanes on US 36 and I-25, and then get back onto the I-25 HOV lanes at 58th Ave. to go to downtown Denver via HOV. They could do this only in the AM peak period in the peak direction which is SB on the I-25 HOV lanes. The North I-25 HOV lanes still only operate SB in the AM peak.

At about 10 AM CDOT goes through the process of closing and sweeping the HOV lanes so that their direction of operation can be reversed. At about Noon the north I-25 HOV lanes open in the NB direction for carpools and off-peak service on buses bound for Boulder and the north metro area. You can actually see this happening by looking at the bus schedules for routes B and 120X. The North I-25 HOV lanes remain operating in the NB direction until about 2 AM on weekdays that covers the PM peak period operation too. Sometime in the early morning on weekdays the direction is reversed again to allow travelers going SB into downtown in the AM peak to use the HOV lanes again. On weekends the North I-25 HOV lanes remain operating NB through the entire weekend.

In the PM peak and off-peak you could and can still only travel the I-25 HOV lanes in the NB direction. Since there was no WB US 36 HOV lane prior to 2001, there was no PM

peak period or direction to deal with there. For users entering and exiting the I-25 reversible, barrier-separated HOV lanes from I-25, users still must enter or exit at 58th Ave. A user could and can still enter the reversible, barrier-separated HOV lanes from 70th Ave. via a T-ramp, but only from 70th Ave. By the way, the I-25 HOV lanes are two lanes south of 58th Ave. and one lane north of 58th Ave. to 70th Ave. and on through the Direct Connect.

Now that the Direct Connect is complete, a user can travel along the US 36 HOV lanes to the I-25 HOV lanes without getting in the General Purpose lanes. An HOV lane in the WB direction was added to US 36 only as far west as Federal Blvd. The original intent was to build the US 36 WB HOV lane all the way to Sheridan Blvd., but there was not enough money to fix the 80th Ave. bridge so they stopped the WB HOV lane just short of 80th Ave. at Federal Blvd.

In order for a user to travel through the Direct Connect via the US 36 HOV lanes, the user must enter and exit the US 36 HOV lanes west of the Pecos interchange. Users cannot get on and off the US 36 HOV lanes east of the Pecos interchange because the HOV lanes are reversible and barrier-separated at this point. Also, drivers getting on and off US 36 from Pecos cannot get on and off the HOV lanes at this interchange either due to the barrier-separation.

Additionally as part of the Direct Connect construction, the WB I-76 to WB I-270 to WB US 36 connection was built. The EB US 36 to EB I-270 to EB I-76 connection was not completed until later in 2003. The WB I-76/I-270/US 36 connection eliminated the need to have a ramp going directly from WB I-76 to NB I-25, so this movement was removed. Also, CDOT is currently constructing an entrance and exit to the I-25 HOV lanes north of the US 36/I-25 Direct Connect.

Patterns and Headway Determination

Many routes have multiple patterns. Patterns are determined by where trips start and end on a route.

- To determine the headway and, if applicable, patterns of a route, look at where trips start and end on the route. A pattern is a series of trips on a route with the same start and end points.

- For peak service, look at the morning peak period, generally from 6-8 AM, due to P-A format (see above). The peak period for Local routes generally falls between 6-8 AM. The peak period for Express and Regional routes can occur a bit earlier.

- For off-peak service, look at the trips generally between 10 AM-2 PM.

- Count the number of trips within a two hour time period. Use the table below to determine the headway. With many routes you will notice a common headway.

- Generally, we try to use headways that divide into 60 minutes evenly, e.g. 5, 7.5, 10, 15, 20, 30, 60; *not* 3.3, 5.7, 13.4, etc.

- Try to understand the intent of the service planners when determining headways.

Number of Trips	Headway (minutes)
1-2	60
3	40
4	30
5-6	20
7-8	15
8 or more	"actual" (Calculate by dividing 120 minutes by the number of peak period trips)

Shadows

Shadows of routes were created in the MINUTP® version of the DRCOG model to represent segments of routes that charge lower fares. Many Regional and Express routes charge different fares depending on where the rider boards on the route. For example, a rider boarding the route B in Boulder and riding it to Denver pays a Regional fare. A rider boarding the route B in Broomfield and riding it to Denver pays an express fare. These fares are determined by looking at the *paper* schedule of a route.

Because determining the possible shadows of every route would result in an unmanageably large number of shadow routes and relatively small gains in accuracy, only those shadows where 15% of their total fares are collected in the lower fare categories are coded. These shadows have already been predetermined in the model. Refer to the spreadsheet to see what shadow lines have been coded. Headways for shadow routes should be the same as the original route. Make sure to change the **MODE** field when coding shadows.

In the latest version of calibrating the TransCAD® model, shadow routes have been eliminated and replaced with distance-based fares in the model code. This action was taken so that headways were not being overmodeled for routes with shadows using the algorithms provided in TransCAD®.

Stops

RTD has a bus stop database, the Bus Stop Information System (BSIS), that can be used to look up stops on a route, but only RTD internally has access to this database. Regardless, for most routes stops can be accurately placed on routes by using the Trailblazer, following the rules below, and looking at similar routes. Even if BSIS were accessible to those outside RTD, many local streets do not exist in the model to accurately place stops in the correct locations, especially for local routes. Thus, the

guidelines below should be followed when placing stops on a route. If you have any questions, do not hesitate to contact RTD.

Local routes: stop at all centroid connectors and street intersections, except in downtown Denver and other parts of the metro area with a dense street system in the model. Look at similar routes for help.

The stops in downtown Denver for bus routes traveling on 15th and 17th streets are based on an XYZ naming system where a bus stops once every three blocks. This helps manage the flow of buses through downtown. Certain bus routes stop at the "X" stops, certain bus routes stop at the "Y" stops, and certain bus routes stop at the "Z" stops. The Trailblazer details which downtown-oriented routes stop at the X, Y, and Z stops by noting above the map of the route what type of stops are used in the upper right hand corner of the page. Also, all Trailblazers are supposed to have a diagram of downtown Denver in the back of the book with the other diagrams that details the XYZ stops on 15th and 17th streets as well as other downtown Denver transit facilities. A table listing the XYZ stops is also provided below.

Street	X Stops	Y Stops	Z Stops
15th	Tremont	Glenarm	Welton
	California	Stout	Champa
	Curtis	Arapahoe	
17th	Lawrence	Arapahoe	Curtis
	Champa	Stout	California
	Welton	Glenarm	Tremont

Limited routes: stop at intersections with crossing routes and locations specified in Trailblazer

Express and Regional routes: stops are usually specified in the Trailblazer

Usually, RTD does not put stops on a route at highway ramps unless a park-n-Ride exists there and the route stops there. Sometimes a route will stop on the opposite side of an interchange with a park-n-Ride to allow riders to get on and off and walk to the other side, e.g. at the US 36/McCaslin interchange.

Loop routes unlike most routes will stop at the same places twice, but TransCAD® does not allow routes to have two stops at the same node. However, TransCAD® will allow a route to have one stop with multiple passes at the same node. Thus, in the case of Loop routes, allow the stops to have two passes when it serves a location twice, etc.

Try to stack up stops on a route in TransCAD®. Thus, if, for example, ten routes stop at the same park-n-Ride, make all the stop icons stack up so that the number "10" shows on top of them. We want to give riders the best opportunity to transfer as possible.

Roadway Layer Coding

Changes to the roadway network are normally under the purview of DRCOG, except where consultants and others will need to modify the roadway network to model a future alternative. DRCOG maintains the roadway layer. The following table breaks out the function of each type of link.

Type	Purpose	Use
0	Roadway base link for transit	
1	Roadway link	
2	Transit only—no walk or auto	Rail lines
99	Walk only—no transit or auto	e.g. Pedestrian overpasses, connect to zone centroids
98	Transit & Walk only—no auto	e.g. 16th St. Mall, Union Station access
97	Walk Access to park-n-Rides	Not needed—replaced by Walk links
96	Drive Access to park-n-Rides	Not needed—replaced by new Drive Access method

HOV Lane Coding

Rail Coding

Rail lines are coded using a combination of the roadway layer and the route systems layer. Look at how other rail lines are coded to see how it is done. To code rail lines you must:

- Determine locations of rail stations and park-n-Rides.

- Add links in the roadway network between each station.

- Add 2 in the TYPE field. All rail links in the model are TYPE 2 indicating that no one can walk or drive on these links.

- Add distance and speed on each link to be inserted into the DIST and T_SPEED fields respectively. Distances and speeds for rail lines are predetermined by consultants prior to running the model.

- All rail links are bidirectional and so receive a 0 in the DIR field.

- After inserting links in the appropriate places with the appropriate attributes, remember to code the rail routes in the Route Systems layer on these links with the appropriate stops, headways, and mode.

Modes

Transit routes are divided into Modes. Modes are differentiated mostly by their fares but also other characteristics as found in the modes.dbf table. Changes in Mode shall be made in the **MODE** field in the *.rts file. If changes are made in fares to a mode, the modes.dbf and the modexfer.dbf tables both need to be changed. Check out these tables to learn the different characteristics of the modes. Know that the TransCAD® model has been calibrated in 1996 dollars.

> Mode 4—Mall Shuttle and other free transit services.
> Mode 5—Denver Local service and local shadow lines where appropriate
> Mode 6—Limited service
> Mode 7—Express, intra-Boulder County routes (J, M, N, Y) and express shadow lines where appropriate
> Mode 8—Regional service and regional shadow lines where appropriate
> Mode 9—Rail service (light rail and commuter rail)
> Mode 10—skyRide service
> Mode 11—Longmont Local service
> Mode 12—Boulder Local service

Error Checking

When coding transit routes in TransCAD®, get in the habit of Reloading your route system under the Route Systems menu. Reload regularly after coding a few routes at a time. Reload, Reload, RELOAD!!!! Reloading will output some errors in the route system, but you will need to run other processes to get all errors. Errors in the Route System are often outputted in the *s.err and *l.err files. The "s" stands for stops and the "l" stands for links. Look at these files through a text editor. When all errors are corrected in this file, the last few errors to be corrected will often be leftover in the file.

After reloading your route system, Verify your route system through the Route Systems menu to output anymore errors. Check the warnings file for errors that must be corrected in your routes. The Verify function also sometimes outputs messages that tell of links in the roadway network that need attributes added.

Before creating your transit network, be sure to use the Tag Stops To Node function under the Transit menu. This function will make sure that any stops that do not have a node associated with them as found in the Near Node field in the Stops table will have a node indicated with the stop. This function will reveal any duplicate stops at nodes.

Last, create your transit network under the Transit menu. If your transit network is error free, you should be able to run this function without any problems.

Common Errors

Many common errors in TransCAD® come from learning how to use the software and become more obvious as to how to correct them as you get used to using the software. Learn how to switch route editing methods. Errors that may be more difficult to fix that only come with understanding how the transit network interfaces with the roadway network are outlined below.

Problem: When coding a transit route, the route cannot recognize the street that you are trying to put the route on.

Solution: The *.net file that the transit network runs on may not have been updated to reflect the latest roadway network. Go to the Networks/Paths menu, then Create… to create a new or updated *.net file. It is okay to create a new *.net file from scratch.

Problem: Stops at a particular node are being very difficult to delete.

Solution: TransCAD® uses a linear referencing system to track stops on a single route. Depending on how much time you have to code route systems, sometimes after working on a route systems for awhile the stops will be able to be deleted. Alternatively, go to the stops table and select the records with the problem stops. Then go to the Edit menu and the Delete Records function to delete the problem stops. At this point it may be helpful to do a Reload to clear any problems. Then try going back and adding stops again.

Problem: After a Route Systems Reload, an error message appears saying the software is "Out of Memory."

Solution: Reloading allows TransCAD® to reassemble the Route, Stop, and Link layers into a unit that allows the transit network to interface with the roadway network appropriately via the "Chunk" layer. Reloading creates the Chunk layer in TransCAD®. To solve the problem, delete the "Chunk" layer whose files are *c.bin, *c.bx, and *c.dcb as well as the *.rtg file. Open your route system again and you should be forced into an automatic Reload.

Operations & Maintenance Model

RTD contracted with Manuel Padron & Associates in 2001 to create a spreadsheet Operations and Maintenance (O&M) model based on the Cycle 9 2001 DRCOG MINUTP model. The purpose of the O&M model was to eliminate the cumbersome task of entering output data from the MINUTP model into a spreadsheet and equilibrating that data which would be used to calculate reasonable O&M costs in future transit alternatives. Because the O&M model has not been calibrated with the new TransCAD® model, it cannot yet be used with this software.