COMPASS
COMMUNITY PLANNING ASSOCIATION
of Southwest Idaho

TRANSPORTATION MODEL ADVISORY COMMITTEE

March 11, 2014 – 1:30 p.m. – 3:00 p.m.

Community Planning Association

700 NE 2nd Street, 2nd Floor Large Conference Room, Meridian

NOTICE: *This packet contains only the documents listed with an asterisk (*) in the agenda. The entire packet, including all attachments is available at* http://www.compassidaho.org/people/tmacmeetings.htm. *The online document requires Adobe Acrobat to read it; COMPASS' homepage* **http://www.compassidaho.org** *contains a free download link if you need a copy. The online document includes bookmarks at the left of the screen that are named to correspond to agenda items with attachments. Clicking on a bookmark will take you directly to the named document.*

****AGENDA****

I. AGENDA ADDITIONS/CHANGES
1:30

II. OPEN DISCUSSION/ANNOUNCEMENTS
1:35 A. **Introductions**

III. CONSENT AGENDA
1:40 ***A. Approve January 14, 2014 Meeting Minutes** *pages 2-3*

IV. ACTION ITEM
1:45 ***A. Regional Travel Demand Model Inputs** — **MaryAnn Waldinger**
Staff will ask for acceptance on model validation and reasonableness checks. pages 7-9

V. INFORMATION/DISCUSSION ITEMS
2:00 ***A. Regional Travel Demand Model Inputs** — **MaryAnn Waldinger**
Staff will review the mode choice model component.

VI. OTHER
2:20 **A. Next Meeting: May 13, 2014 at 1:30 p.m.**

VII. ADJOURNMENT
2:25

VIII. ***SPECIAL SESSION***
2:30 **A. Travel Demand Model 101 Presentation**

***Enclosures** **Times are approximate. Agenda is subject to change**

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Transportation Model Advisory Committee
January 14, 2014
Community Planning Association

MINUTES

ATTENDEES:	Clair Bowman, City of Nampa, **Chair** Vern Brewer, Holladay Engineering Company Stephen Lewis, Keller Associates David Luft, Department of Environmental Quality Shawn Martin, Ada County Highway District, **Vice Chair** Tricia Nillson, Canyon County Development Services Austin Petersen, City of Meridian Jim Pline, Pline Engineering, Inc. Dave Szplett, Idaho Transportation Department, Dist. 3 Andrea Tuning, City of Boise Jay Witt, URS Energy and Construction
MEMBERS ABSENT:	Rhonda Jalbert, Valley Regional Transit Jeff Madsen, Public Participation Committee Tim Richard, Canyon Highway District #4 Kevin Sablan, Idaho Transportation Department, Dist. 3 Vacant, Ada County Information Technology
OTHERS PRESENT:	MaryAnn Waldinger, COMPASS Jessica Wilson, COMPASS

CALL TO ORDER

Chair Bowman called the meeting to order at 1:30 p.m.

AGENDA ADDITIONS / CHANGES

None.

OPEN DISCUSSION / ANNOUNCEMENTS

None.

CONSENT AGENDA

A. Approve October 1, 2013 Meeting Minutes

Approved as presented.

ACTION ITEMS

A. Chair and Vice Chair Elections

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Andrea Tuning nominated to re-elect Clair Bowman for Chair and Shawn Martin for Vice Chair. There being no other nominations, the nominations were closed. By unanimous consent, Clair Bowman was re-elected as TMAC's Chair and Shawn Martin was re-elected as TMAC's Vice Chair for 2014.

B. Regional Travel Demand Model Inputs

MaryAnn Waldinger asked for acceptance on three model elements:

After discussion, **Jay Witt moved and David Luft seconded to use the mode choice of Auto Occupancy – percent of trips by single occupant vehicle (SOV) and auto occupancy rate for non-SOV, all ayes.**

After discussion, **Jim Pline moved and Stephen Lewis seconded to use the Peak Hour Model input of Regional Peak Hour Person Trip Factors – the 2011/12 household travel survey data for each trip type and have two components – arrival and departure, all ayes.**

After discussion **Jim Pline moved and Andrea Tuning seconded to use the model input for screenlines – no change to the screenlines currently used in the Model, all ayes.**

INFORMATION/DISCUSSION ITEMS

A. TMAC Committee Meeting Dates

Meeting dates for TMAC between January 14, 2014 and January 13, 2015 are as follows:

- March 11, 2014
    - This will be special meeting with "model 101" session starting immediately after the regular TMAC meeting. Please plan on 30 to 45 minutes for this session.
- May 13, 2014
- July 8, 2014
- September 9, 2014
- November 4, 2014
- December 23, 2014
- January 13, 2015

All meetings are on a Tuesday at 1:30 p.m. at COMPASS in the large conference room.

OTHER

Next Meeting: Tuesday, March 11, 2014, 1:00 p.m., in COMPASS' 2nd Floor Large Conference Room.

ADJOURNMENT

Jim Pline moved and Austin Petersen seconded to adjourn the meeting at 2:30 p.m.

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Model Update Progress Report, as of March 5, 2014

Trip Generation		
Household Travel Survey Data Collection and Report	Data were collected in fall 2011 and spring 2012 in downtown Boise. The final report and data were submitted to COMPASS in late April. The report is available on the COMPASS website on the "Reports" page.	100% complete *2012 COMPASS Regional Household Travel Survey Report No. 05-2013*
Demographics	TAZ level demographics: population, households, vehicles* and retail, office, industrial, agriculture jobs. Jobs are provided annually by the Department of Labor. Staff cleans the data, geo-codes, looks up those businesses that do not have addresses and allocates jobs by type to TAZs. Demographics are under the purview of DAC. *Vehicle per household ratio is applied to the number of households per TAZ. The average vehicles per household rates are provided by data collected during the 2011/12 household travel survey.	100% complete Information Item at the August 13, 2013 TMAC meeting. Action Item at the October 1, 2013 TMAC meeting. Person per household rates from the 2010 Census and vehicle per household rates from the 2012 household survey were accepted by TMAC on October 1, 2013.
Roadway Network	Model network includes all functionally classified roads collector to interstate and select local roads for circulation. The characteristics are: type, lanes, speed, planning level capacity (daily and peak), and traffic counts.	100% complete All available traffic count data are entered; lanes and speed (for 2011) have been verified. Staff provided the count-coverage map and speed maps to members on several previous occasions seeking input and review. All additional counts and changes have been made.
Cross-Classification Trip Tables	Person trips rates by trip type by household size and vehicle ownership.	100% complete Cross-classification rates were accepted by TMAC on December 12, 2012
Special Generators	Currently not used in the model.	TBA
School Enrollment	Staff is updating enrollment for all public and private schools in the two-county area.	100% complete Information Item at the August 13, 2013 TMAC meeting. Action Item for the October 1, 2013 TMAC meeting.

Trip Distribution		
External to External Trips	Through-trips for the base year and the forecast year factors.	100% complete Accepted by TMAC on February 5, 2013.
Enrollment Boundaries	Staff will begin to update the school enrollment boundaries which will inform the home-base-school trip "friction factors."	100% complete COMPASS Staff updated the enrollment boundaries for the two-county area. These are undergoing internal review and staff will follow up with districts for clarification, if necessary. Information Item for the October 1, 2013 TMAC meeting.
Terminal Times	TAZ-level time in minutes which are added to travel time. These times typically range from one to five minutes. Staff will summarize terminal times by area (rural, suburban, urban, and central business district).	100% complete Information Item at the August 13, 2013 TMAC meeting. Action Item at the October 1, 2013 TMAC meeting. Terminal times were accepted by TMAC on October 1, 2013.

Mode Choice		
Mode Choice Model Component – Attachment 1 and 2	Fully updated using the on-board transit data collected in 2010 per the FTA guidelines. Attachment 1 summarizes the mode choice model, changes, inputs, and results. Attachment 2 summarizes the original mode choice model structure, transit coefficients and constants, FTA guidelines and recommendations.	100% complete Present as information item to TMAC on March 11, 2014.
Auto Occupancy	These are derived from the 2011/12 household travel survey data for each trip type for each time period – daily, 7 a.m., 4 p.m. and 5 p.m. Each time period has two components – percent of trips by single occupant vehicle (SOV) and auto occupancy rate for non-SOV.	100% Complete Action Item at the January 14, 2014 TMAC meeting. SOV and auto occupancy rates were accepted by TMAC on January 14, 2014.

Daily Assignment		
Cutlines	These are used during validation of link-level model volume estimates compared to actual traffic counts. It provides a way to review how well (or not) the model is performing at key locations. Cutlines extend across a corridor and contain multiple facilities. Screenlines extend completely across the model area. Cordon lines encompass a subarea.	100% complete Information Item for the October 1, 2013 TMAC meeting. Action Item at the January 14, 2014 TMAC meeting. Cutlines were accepted by TMAC on January 14, 2014.
Daily Capacity	Using planning level of service “D” threshold capacity.	TBA Leave unchanged for now. During calibration minor adjustments may be needed.
Volume-Delay Curves	Using BPR.	TBA Leave unchanged for now. During calibration minor adjustments may be needed.

Peak Hour Models: 4pm-5pm, 5pm – 6pm, 7am – 8am		
Regional Peak Hour Person Trip Factors	These are derived from the 2011/12 household travel survey data for each trip type and have two components – arrival and departure. Therefore, two trip factors for each type for each “hour.”	100% complete Information Item at the August 13, 2013 and the October 1, 2013 TMAC meetings. Action Item at the January 14, 2014 TMAC meeting. Regional Peak Hour rates were accepted by TMAC on January 14, 2014.
Volume-Delay Curves	Using Conics.	TBA Leave unchanged for now. During calibration minor adjustments may be needed.
Peak Capacity	Currently using peak hour capacity that is slightly higher than daily to account for “signal optimization” to accommodate dominate flows (i.e. east-west) during the peaks.	TBA Leave unchanged for now. During calibration minor adjustments may be needed.

Validation, Calibration and Reasonableness Checks
100%. Staff will provide list of recommended "checks" for discussion and acceptance at the March 11, 2014 meeting. *The adjustments should reflect transportation supply or traveler behavior rather than simple arithmetic, they should be reproducible; and reasons for adjustments should be clearly documented.* Source: *Travel Model Validation and Reasonableness Checking Manual, September 24, 2010*

Definitions

Estimation is the use of statistical analysis techniques and observed data to develop model parameters or coefficients. While model estimation typically occurs at a disaggregate level without bias or correction factors, model estimation may also use statistical analysis procedures to analyze more aggregate data.

Assertion is the declaration of model forms or parameters without the use of statistical analysis of observed data. Model transfer from one region to another is a form of model assertion.

Calibration is the adjustment of constants and other model parameters in estimated or asserted models in an effort to make the models replicate observed data for a base (calibration) year or otherwise produce more reasonable results. Model calibration is often incorrectly considered to be model validation.

Validation is the application of the calibrated models and comparison of the results against observed data. Ideally, the observed data are data *not* used for the model estimation or calibration but, practically, this is not always feasible. Validation data may include additional data collected for the same year as the estimation or calibration of the model or data collected for an alternative year. Validation should also include sensitivity testing.

Sensitivity Tests and Validation Criteria

Trip Generation

> *Page 5-7*
> *Once these effects have been considered, the balance between productions and attractions can be checked for each trip purpose. Assuming that the production and attraction models have been developed from the same data source, the ratio of region wide productions to attractions by purpose should fall in the range of 0.90 to 1.10 prior to balancing. For the base year, the balance between productions and attractions is, in effect, a validation measure.*

Recommendation:
Staff recommends using the **10%** deviation "goal" for unbalanced person-trips production and attractions rates. If the difference between unbalanced production and attractions is greater than 10% than, staff will investigate the possible causes.

Trip Distribution

Trip length frequency

> *The main trip length checks for base year scenarios involve comparing average trip lengths and trip length frequency distributions between model results and observed data from the household travel survey. For home-based work trips, CTPP data are often a supplementary source for trip length information. Trip length checks should be performed separately for each trip, tour, or activity purpose – essentially for each separately estimated model.*
>
> *A more rigorous way of checking trip length frequency distributions is through the use of coincidence ratios. This is most easily understood as the area under both curves divided by the area under at least one of the curves, when the observed and modeled trip length frequency distributions are plotted. Mathematically, the sum of the lower value of the two distributions at each increment of time or distance is divided by the sum of the higher value of the two distributions at each increment. Generally, the coincidence ratio measures the percent of area that "coincides" for the two curves.*

$$CR = \left\{\frac{\sum_T[min(PM_T, PO_T)]}{\sum_T[max(PM_T, PO_T)]}\right\}$$

CR = Coincidence Ratio
PMT = Proportion of modeled distribution in interval T
POT = Proportion of observed distribution in interval T
T = Histogram interval for time, distance, or other impedance measure (e.g., 0-4.9

Recommendation:
Staff recommends using two trip length checks – time and distance – by trip type. This will be **<u>"goodness of fit" visual</u>** check by plotting the data for modeled versus observed trip length frequency and is the most common. The second is calculating the "coincidence ratio" with a goal near **<u>1.0</u>**. This will be the first time using a coincidence ratio as a validation measure.

Origin-Destination Checks

> *It is therefore necessary to check origin-destination patterns at a more aggregate level. Generally, this is described as a district-level validation.*

Recommendation:
Staff recommends using the following "districts" to evaluate origin-destination patterns of modeled v actual.

- Ada County ⇔ Canyon County (entire county)
- Caldwell, Nampa, rest of Canyon County, Meridian, Boise, downtown Boise, north Ada County, south Ada County

Since the actual data are from the 2011/12 household travel survey the districts must be large enough to encompass a sample size of a minimum of 150 records. A map of the proposed districts and accompanying sample size will be provided at the meeting.

Mode Choice

Per the technical memos (attachments 1 and 2) the mode choice model has been developed based on FTA guidance and the use of available local data. Given the nature of the existing transit system sensitivity testing seems to be the most logical and efficient way to determine the reasonableness of the mode choice model.

Recommendation:

Staff recommends performing two different sensitivity tests based on changes to the transit network. One test will be adding a new transit route and reporting how the model responded and the other test will be improving the frequency on all existing transit routes. The goal on both is a change in overall ridership estimates – riders on the new route and more riders overall when the frequencies are improved. Basically, the purpose is to make sure the model is "responding" in the correct direction.

Assignment

Recommendations:

Staff recommends the following validation measures:

- Time of day – percent of trips modeled versus actual for each model time period
- Travel time/speed – comparison of modeled versus actual (from COMPASS travel time data collection) on key regional facilities for peak hour model
- Traffic Volume Checks – comparison of modeled versus actual for each model for each cutline (screenline).
- %RMSE – volume group within facility type
- R^2 – volume group within facility type

The traffic volume related checks described in this chapter focus on traditional measures that are scalable and easily explained: root mean squared error (RMSE), percent RMSE (%RMSE), correlation (R), and coefficient of determination (R2). There are other measures similar to the measures covered in this section, such as mean absolute error (MAE), which may be used or preferred by some. The key to the measures is that they are scalable. For example, an RMSE of 1000 is one-half as large as an RMSE of 2000 for a given set of links.

RMSE and %RMSE are both measures of accuracy of the traffic assignment measuring the average error between the observed and modeled traffic volumes on links with traffic counts. As such, RMSE and %RMSE should be summarized by facility type (or functional class) or by link volume group.

The R^2 statistics should be calculated for links with similar characteristics such as facility type or volume group.

Staff will continue to research "acceptable" target goals for the above assignment validation measures for TMACs consideration.

Memorandum

TO: MaryAnn Waldinger

FROM: Lawrence Liao and Ron West

DATE: January 17, 2014

RE: Revised Mode Choice Model Update Status

Overview

This memo examines the COMPASS mode choice (MC) model update task. The enhanced MC models were developed to meet future regional transportation planning needs, including meeting Federal Transit Administration (FTA) New/Small Starts modeling requirements. This update effort was developed using the available on-board transit survey data.

Examined here are the following elements:

- Current COMPASS MC models
- Key results from household and transit on-board surveys
- Summary of MC model update results

The MC model updates have been designed to meet FTA's modeling requirements, as specified in the "2010 FTA Technical Guidance Memo." These model updates include:

- Refine transit network coding
  - o Code transit lines headways and availability by peak and off-peak periods
  - o Use congested auto speeds to determine bus speeds
- Refine transit levels-of-service (LOS) skimming
  - o Skim access-mode-specific LOS
  - o Skim transit LOS by peak and off-peak periods
- Mode choice model

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- Add market segmentation, by auto ownership, to the home-based work model
- Include auto operating costs as an independent variable
- Apply peak period transit LOS in mode choice models for home-based work, home-based school; and apply off-peak transit LOS in mode choice models for other trip purposes

Mode Choice Models

This section covers the existing MC models, as well as a summary of the new transit on-board survey data.

Current COMPASS MC Model

The COMPASS MC model uses a nested logit structure with five alternatives. The upper level nest splits motorized from non-motorized travel. The non-motorized nest includes walk and bicycle modes. Under the motorized nest, auto and bus modes are available. Transit is further split with a lower level nest that includes walk and drive access modes to transit. Figure 1 shows the existing MC model nested logit structure.

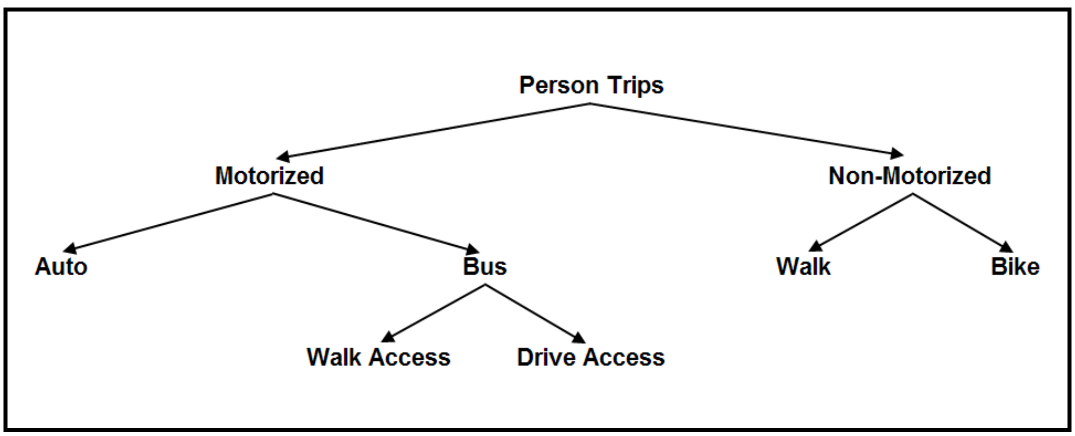


Figure 1: COMPASS Mode Choice Model Nested Logit Structure

There are six unique MC models – one for each trip purpose in the COMPASS MC model structure:

- Home-Based Work (HBW)
- Home-Based School (HBSC)
- Home-Based Shop (HBS)
- Home-Based Social (HBSO)

- Home-Based Other (HBO)
- Non Home-Based (NHB)

All six trip purposes share the same nested logit structure; however, the independent variables, coefficients and constants are calibrated for each trip purpose independently. The coefficients for the HBO trip purpose are used for HBS and HBSO trip purposes.

The independent variables and their coefficients (in parentheses) used in the six unique MC models are shown below:

- In-Vehicle Time (IVT_COEF)
- Initial Wait Time (INITWAIT_COEF)
- Transfer Wait Time (XFERWAIT_COEF)
- Walk Time – Within First Mile (WALK_COEF_1)
- Walk Time – After First Mile (WALK_COEF_GT_1)
- Drive Access Time (DRIVE_COEF)
- Bike Time (BIKE_COEF)
- Bus Fare (COST_COEF)
- Parking Cost (PARKCOST_COEF)
- Number of Transfers (TRANSFERS_COEF)

Household and Transit On-Board Survey Results

The 2012 COMPASS Regional Household Travel Survey was completed in early 2012, and summarized in a May 16, 2012, memorandum from Parsons Brinkerhoff. The household travel survey was comprised of 3,350 household records, 8,773 person records, and 40,891 trip records. Since the previous memorandum summarized the survey results, a full summary of that effort is not included here. The key element for discussion here is a table of trips by mode (Table 18, from the May 16, 2012, memo). As would be generally expected, trips by public bus were very low and the number records collected are not sufficient to re-estimate MC models. Table 1, below shows the number of person trip records by travel mode (raw survey results were not available for the May 16, 2012, memo).

Table 1 – Household Survey Trips by Travel Mode

Mode	Weighted Observations	Percent
Drove Private Vehicle	1,216,367	63%
Passenger	486,095	25%
Bicycle	28,973	1%
School Bus	93,688	5%
Public Bus	4,518	0%
Walked	89,542	5%
Taxi	1,670	0%
Motorcycle	2,927	0%
Other	14,366	1%
Total	1,938,146	100%

The transit on-board survey was developed to augment the household travel survey in order to include sufficient transit ridership surveys to estimate transit modes, including the walk/drive and local/express bus sub-modes. Data from the on-board survey were obtained from a NuStats memoradum, dated April 4, 2011, along with a series of cross tabs documenting survey results. The goal of the on-board survey was to collect roughly 1,500 complete and usable records, which is a sample rate between 25% and 30% of total ridership.

Tables 2 and 3 show the breakdown by access and egress modes for local (Ada County and Canyon County) versus inter-county bus service. Drive access for MC models are comprised of drive alone, drop off/pick up, carpool and taxi. Walk access includes bicycle.

The differences between access/egress modes for local routes versus inter-county routes are of note. The local bus routes were dominated by walk access/egress (range from 84.7% to 90.2%); while inter-county routes had much higher drive access/egress trips (over 26.8% to 41.7%).

Table 2 – On-Board Survey Access Mode Percent of Total, by Service Area

	Service Area			
Access Mode	Ada County	Inter County	Canyon County	Total
Walked/ Wheel Chair	84.7%	54.8%	88.9%	82.1%
Dropped Off	4.4%	13.1%	3.4%	5.2%
Drove Alone	2.1%	26.3%	0.6%	4.4%
Carpooled	0.4%	2.3%	0.0%	0.5%
Bicycled	8.4%	3.5%	7.1%	7.8%
Taxi	0.0%	0.0%	0.0%	0.0%
Total	100.0%	100.0%	100.0%	100.0%

Table 3 – On-Board Survey Egress Mode Percent of Total, by Service Area

Egress Mode	Service Area			
	Ada County	Inter County	Canyon County	Total
Walk/ Wheel Chair	86.7%	66.2%	90.2%	84.9%
Picked Up	0.6%	2.6%	0.0%	0.8%
Drove Alone	1.7%	21.5%	0.6%	3.5%
Carpooled	8.4%	2.7%	6.8%	7.7%
Bicycled	2.6%	6.9%	2.4%	3.0%
Taxi	0.0%	0.0%	0.0%	0.0%
Total	100.0%	100.0%	100.0%	100.0%

Mode Choice Model Development Update

A number of COMPASS MC model improvements have been completed. These improvements are summarized below.

Enhancements to MC Models

The option of splitting the bus mode into two sub-modes, namely, local bus and inter-county bus, was carefully evaluated and deemed unwarranted because the two bus sub-modes could not be clearly distinguished in the model. Consequently, the number of alternatives in the MC models will remain unchanged.

As recommended by the Transportation Model Improvement Program (TMIP) Peer Review Panel, auto ownership has been added as a further market segmentation to the HBW MC model. The new HBW MC model structure has been split into four submodels by auto ownership (0, 1, 2, and 3+). The four HBW submodels use the same constants and coefficients as the original HBW MC model.

When combined, the four new HBW MC results will be consistent with that the original HBW MC model. Since the existing HBW person trips were not classified by auto ownership, HBW person trips were split using the regional auto ownership percentages from the fully expanded 2011/12 household travel survey.

The enhanced HBW MC models split by auto ownership are now ready to be calibrated when the trip generation (TG) model is modified to generate HBW trips by auto ownership level, and when the validation targets are available.

Another enhancement included adding auto operating (AO) costs as an independent variable. AO cost was added to the utility function for the auto mode. The AO cost was calculated as $0.11 x distance. The coefficient was estimated by using the AO value in the North Central Texas Council of Governments (NCTCOG) MC, after correcting for constant dollars to account for the differences between the NCTCOG model using 2005 dollars, and the COMPASS model using 1990 dollars.

One of the guidelines from FTA was to eliminate non-logit decision rules, such as the threshold for walk time. This rule was eliminated by setting WALK_COEF_GT_1=WALK_COEF_1. However, the walk mode share increased significantly after the change. So, an additional test was evaluated that averaged the coefficients ((WALK_COEF_GT_1+WALK_COEF_1)/2). With this test, the mode shares have returned to the previous level. The mode shares summaries before and after those changes are shown in Table 3.

Table 3 Home-Based Work Trip Generation Targets and Mode Shares for Walk Time Threshold

Mode/Mode Shares	Pre Change	Post Change	Average Coefficient
Total_Auto	3,563,513.1	3,540,612.0	3,569,128.61
Total_Bus_Walk	6,485.8	6,405.3	6,092.46
Total_Bus_Auto	1,746.2	1,714.9	1,771.40
Total_Walk	99,509.4	124,373.8	94,011.21
Total_Bike	31,671.9	29,830.4	31,922.69
Total All	3,703,906.9	3,703,906.9	3,703,906.98
MS_Auto	96.20957	95.59128	96.36118
MS_Bus_Walk	0.17511	0.17293	0.16449
MS_Bus_Auto	0.00471	0.04630	0.04783
MS_Walk	2.68661	3.35791	2.53816
MS_Bike	0.85509	0.80538	0.86187

Re-Calibration of Mode Choice Model Constants and Coefficients

FTA staff suggested using asserted coefficients, which meet the FTA guidelines, instead of re-estimating them using the 2011/12 household travel survey data. The existing coefficients were reviewed and found consistent with FTA guidelines. Alternative specific constants were re-calibrated to match the mode shares by access mode derived from the transit on-board survey.

Enhance MC Model Coding

Based on a recommendation from Citilabls, the new XCHOICE command replaced CHOICE command for logit model implementation. The XCHOICE was used in the MC model script. The model result remains the same as that from CHOICE command, with the benefit of reduced run times.

Transit Path Building, Skimming and Assignment

The purpose of this task was to ensure consistency between transit path building, skimming and assignment processes. The transit assignment steps use the same route files used in the skimming steps for path building. Thus, the transit path building assumptions/parameters are guaranteed to be consistent between the transit skimming and assignment processes. In addition, the following enhancements were made to the model:

- Coded transit line headways and availability by peak/off-peak periods
- Added the ability to test rail mode
- Modified the script to use congested auto speeds to determine bus speeds
- Skimmed access-mode-specific LOS.
- Skimmed transit LOS by peak/off-peak periods.
- Evaluated multi-path vs best-path route enumeration methods-best-path route enumeration method was chosen because it allows explicit control of maximum number of transfers allowed
- Added a transit assignment by access mode
- Created post-processing script to summarize transit ridership by access mode.
- Added post-processing module to the transit assignment model to summarize transit ridership by access mode. A b2010 ridership by access mode summary is shown below as an example:

```
SCENARIO b2010 RIDERSHIP

TOTAL  WALK-ACC TRIPS SELECTED:       6,230.36
TOTAL  WALK-ACC RIDERSHIP     :       9,581.00

TOTAL DRIVE-ACC TRIPS SELECTED:       1,235.64
TOTAL DRIVE-ACC RIDERSHIP     :       1,522.34
```

- Completed validation by route and region wide. A re-validation of the MC model against the new on-board survey data was completed. The ridership by access mode was modified to match the result from the transit on-board survey.
- Modified the Cube application to include a cutoff year (default to 2020) to trip distribution (TD) adjustments. The application of TD adjustments will be determined by the TD_Adjust_Cutoff key. The key is default to 2015. So, the TD adjustments will be applied only to scenario years <=2020.

- Added the GPS Adjustment Factors by County to Trip Generation (TG) model. The GPS adjustment factors by county were added to TG model to enable the correction of under-reporting identified in the GPS survey study (conducted as part of the 2011/12 household travel survey). The current values for those factors are set to 1, so no adjustments will be made. Adjustments can be introduced by setting the GPS adjustment factors to appropriate values. For example, the GPS adjustment factor should be set to 1.1 if 10% of under-reporting was determined. The following example below shows how the GPS adjustment as well as the cutoff year was applied.

Keys

Key	Value
Scen. Name	b2012
ClusterToggle	0
Cluster_N	2
WALK_SPEED	2.5
WALK_ACC_CUTOFF	15
DRIVE_ACC_CUTOFF	5
WALK_ACC_COEF_CU	24
BIKE_SPEED	10
WALK_DIST_CUTOFF	3
BIKE_DIST_CUTOFF	6
GPS_Adjust_Ada	1
GPS_Adjust_Canyon	1
Model_Year	2012
TD_Adjust_Cutoff	2020

- Parameters, such as walk speed and bike speed, which were defined as tokens in a pilot step in the beginning of the MC model, were moved to scenario keys. So, the individual transit skimming steps can be executed without worrying about tokens not defined.

Memorandum

TO: MaryAnn Waldinger, COMPASS

FROM: Lawrence Liao, CS; Laurie Hussey, CS

CC: Ken Cervenka, FTA; James Garland, FTA

DATE: July 8, 2010

RE: COMPASS Mode Choice Model Evaluation for FTA Technical Guidance

1.0 Introduction

This technical memorandum transmits a set of enhancements recommended for the COMPASS Mode Choice Model. The public transit mode share in the region is 0.30%, which corresponds to about 5,300 transit trips, based on COMPASS' 2002 Household Travel Survey. These enhancements are targeted to improve the travel forecasting methods and provide a basis for both New Starts and Small Starts funding.

The body of this technical memorandum is organized into the following sections:

- **Section 2.0 –** Overview of the COMPASS Mode Choice Model;
- **Section 3.0 –** FTA Guidelines on Mode Choice Modeling;
- **Section 4.0 –** Assessment and Recommended Enhancements; and
- **Section 5.0 –** Additional FTA Guidelines on Calibration and Validation.

2.0 COMPASS Mode Choice Model Overview

COMPASS' current travel demand forecast model was originally calibrated and validated for automobile travel for 2002 conditions. It was calibrated using data from a household travel characteristics study performed and completed in 2002. This survey obtained information about the number of trips, travel time, and trip purpose by mode and time of day from more than 2,600 Treasure Valley households. It was validated against traffic count data collected in 2002 and 2003. COMPASS' Transportation Model Advisory Committee (TMAC) approved the use of the 2002 calibrated travel demand model on June 29, 2004.

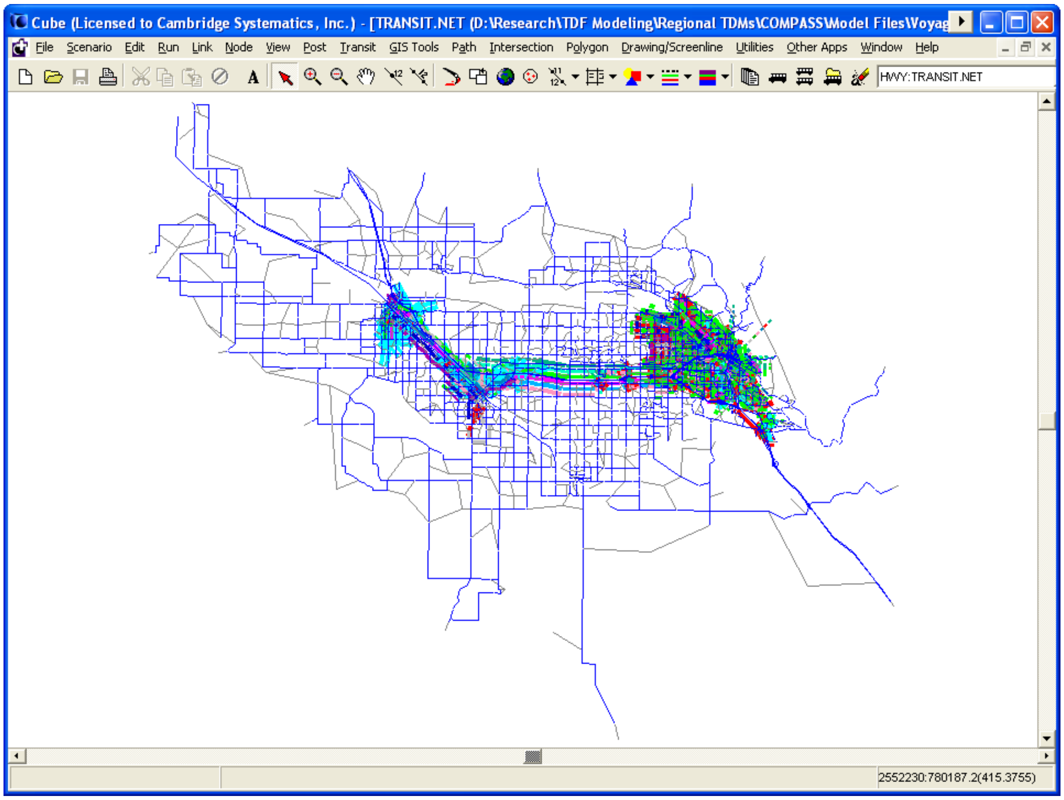
Shortly after the 2002 model was developed, COMPASS began developing a mode choice model for inclusion into the overall four-step travel demand model. The main purpose for the development of this tool was to support the transit-planning component of Communities in Motion, the new long-range transportation plan for a six-county area, including Ada and Canyon Counties. The COMPASS transit network is shown in Figure 2.1. The transit assignment model could not be validated to the same level as highway assignment model for 2002 because there were no up-to-date boarding/alighting counts or on-board survey data available for that timeframe. However, modeled transit mode share was consistent on a regional basis with actual transit mode share data from the 2002 household travel survey. The 2002 model, with the inclusion of the mode choice tool, was approved for use by TMAC in 2006. It is this 2006 version of the COMPASS model that was reviewed in this memorandum.

When the mode choice model was developed in 2005, the objectives were:

1. Adapt a mode choice model from a region of similar size and demographic characteristics. The regions considered included Sacramento, California; Fresno, California; and Salt Lake City, Utah.
2. Match the mode shares in 2002 Survey and the 2000 Census.
3. Maintain validation results in highway assignment.

After reviewing the mode choice models in those regions, it was determined that the Wasatch Front Regional Council (WFRC), the metropolitan planning organization (MPO) for the Salt Lake City region, model was most applicable. The WFRC model was chosen because it had a fully-tested, four-step travel model and its region was most comparable to the COMPASS region, both geographically and demographically.

Figure 2.1   COMPASS Transit Network



The WFRC mode choice model consists of four individual submodels addressing the following trip purposes:

1. Home-Based Work (HBW),
2. Home-Based College (HBC),
3. Home-Based Other (HBO), and
4. Non-Home-Based (NHB).

These four submodels have different model structures and specifications. Due to time and data constraints, it was decided that the COMPASS mode choice model would adapt only the nested logit structure of the HBW submodel in WFRC mode choice model for all trip purposes.

2.1 Mode Specifications

The COMPASS mode choice model has a nested logit structure with five alternatives:

1. Auto;
2. Bus, Walk Access;

3. Bus, Drive Access (Park-and-Ride);
4. Walk; and
5. Bike.

A nested logit model is characterized by grouping (or nesting) subsets of alternatives that are more similar to each other with respect to excluded characteristics than they are to other alternatives. Alternatives in a common nest exhibit a higher degree of similarity and competitiveness than alternatives in different nests. This level of competitiveness, represented by crosselasticities between pairs of alternatives (the impact of a change in one mode on the probability of another mode) is identical for all pairs of alternatives in the nest. The structure of the COMPASS mode choice model is shown in Figure 2.2.

While a nested logit structure implies a top-down decision process, the utilities are calculated in the reverse direction. The utilities of the alternatives at the lowest tier, in this case the Walk and Drive Access for the Bus mode, are calculated first. These utilities are then combined to form the composite, or logsum, utility for their parent mode, the Bus mode, at the next higher tier. When calculating the composite utility, the utilities of the alternatives at the subtier are first factored by their logsum coefficients. The same process is applied until the top tier is reached. Then the probability of choosing an alternative at each tier is calculated, based on the composite utilities, in a top-down fashion.

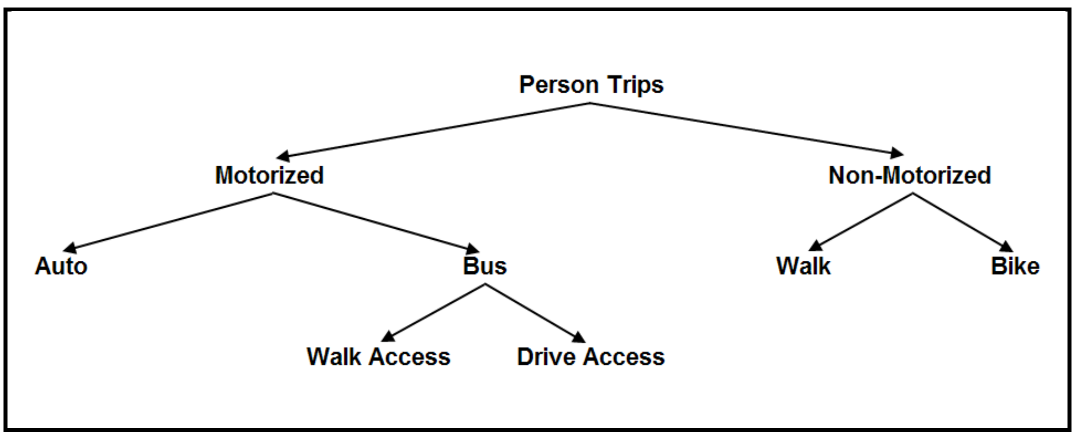


Figure 2.2 COMPASS Mode Choice Model Nested Logit Structure

There are six trip purposes in the COMPASS travel demand model:

1. Home-Based Work (HBW),
2. Home-Based School (HBSC),
3. Home-Based Shop (HBS),
4. Home-Based Social (HBSO),

5. Home-Based Other (HBO), and
6. Non-Home-Based (NHB).

All six trip purposes share the same nested logit structure; however, the independent variables and coefficients have been specified and the constant terms have been calibrated for each trip purpose independently. The coefficients for the WFRC HBO trip purpose have been used for HBS and HBSO trip purposes, which are not available in the WFRC Model. For the other trip purposes, the variables and coefficients from WFRC mode choice models have been used for the comparable COMPASS trip purposes.

The independent variables and their coefficients used in the mode choice model are the following:

- In-Vehicle Time (IVT_COEF),
- Initial Wait Time (INITWAIT_COEF),
- Transfer Wait Time (XFERWAIT_COEF),
- Walk Time – Within First Mile (WALK_COEF_1),
- Walk Time – After First Mile (WALK_COEF_GT_1),
- Drive Access Time (DRIVE_COEF),
- Bike Time (BIKE_COEF),
- Bus Fare (COST_COEF),
- Parking Cost (PARKCOST_COEF), and
- Number of Transfers (TRANSFERS_COEF).

The coefficients for those independent variables are shown in Table 2.1. All time are in minutes are generated by the model. All of the independent variables, except Bus Fare and Parking Cost, are generated by the model; for example, in-vehicle travel time is based on highway network speeds, and transfer wait time is calculated as one-half the transit headway up to a maximum of 15 minutes (thus effectively presuming access to a transit schedule). The local and intercounty bus services use flat fees of $0.50 and $2.00, respectively. These are the fares for initial boarding, and transfers are free of charge.

Table 2.1 Independent Variable Coefficients

	HBW	HBSC	HBS	HBSO	HBO	NHB
IVT_COEF	-0.0221	-0.0221	-0.0107	-0.0107	-0.0107	-0.0233
INITWAIT_COEF	-0.0427	-0.0427	-0.0206	-0.0206	-0.0206	-0.0442
XFERWAIT_COEF	-0.0500	-0.0500	-0.0247	-0.0247	-0.0247	-0.0663
WALK_COEF_1	-0.0462	-0.0462	-0.0268	-0.0268	-0.0268	-0.0425
WALK_COEF_GT_1	-0.0850	-0.0850	-0.0531	-0.0531	-0.0531	-0.0425
DRIVE_COEF	-0.0541	-0.0541	-0.0268	-0.0268	-0.0268	-0.0583
BIKE_COEF	-0.0500	-0.0500	-0.0321	-0.0321	-0.0321	-0.0514
COST_COEF	-0.0061	-0.0099	-0.0054	-0.0054	-0.0054	-0.0049
PARKCOST_COEF	-0.0061	-0.0099	-0.0054	-0.0054	-0.0054	-0.0389
TRANSFERS_COEF	-0.2000	-0.2000	-0.2000	-0.2000	-0.2000	-0.2000

The following parking costs were assumed for the model:

- Downtown Boise – $3.20;
- Boise State University – $2.20; and
- Boise Airport – $9.00.

The parking cost in Downtown Boise was calculated by dividing the monthly Temporary Parking Permit fee of $80.00 (City Code Section 10-11-19) by 25 workdays. The cost of $2.20 for a General Parking Permit was used for the park cost at Boise State University. To be consistent with the other parking costs, the daily parking cost of $9.00 in the Airport Garage was used as the parking cost at the Boise Airport. This assumption for airport parking cost can be changed when better information becomes available.

The alternative specific constants by trip purpose are shown in Table 2.2.

Table 2.2 Alternative specific constants

3.0	HBW	HBSC	HBS	HBSO	HBO	NHB
ASC_MOTOR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ASC_NONMOTOR	-0.5000	0.2008	0.2008	0.2008	-3.0000	-1.4000
ASC_AUTO	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ASC_TRANSIT	-4.0000	-4.0000	-5.0000	-4.0000	-5.0000	-4.0000
ASC_WALKACC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ASC_DRIVEACC	-0.7183	-2.0863	-1.2512	-1.2512	-1.2512	-3.2096
ASC_WALK	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ASC_BIKE	-3.0000	-4.0000	-3.0000	-3.0000	-3.0000	-3.0000

Both the transit level-of-service skimming and transit trip assignment were based on paths built using free-flow highway travel time.

A comparison of mode shares from the model and the 2002 survey is shown in Table 2.3.

Table 2.3 Mode Share Comparison

	Trips		Mode Share (%)	
Mode	Model	Survey*	Model	Survey*
Auto	1,706,766	24,652	94.16%	93.94%
Bus	5,343	74	0.29%	0.28%
Walk	80,464	1,215	4.44%	4.64%
Bike	20,043	300	1.11%	1.14%
Total	*1,812,616*	*26,241*	*100.00%*	*100.00%*
Motor	1,712,109	24,726	94.46%	94.23%
Nonmotorized	100,507	1,515	5.54%	5.77%
Total	*1,812,616*	*26,241*	*100.00%*	*100.00%*
Auto	1,706,766	24,652	99.69%	99.70%
Transit	5,343	74	0.31%	0.30%
Total	*1,712,109*	*24,726*	*100.00%*	*100.00%*
Walk	80,464	1,215	80.06%	80.20%
Bike	20,043	300	19.94%	19.80%
Total	*100,507*	*1,515*	*100.00%*	*100.00%*

*Data from "COMPASS Survey Mode Share Summary.xls," April 4, 2005.

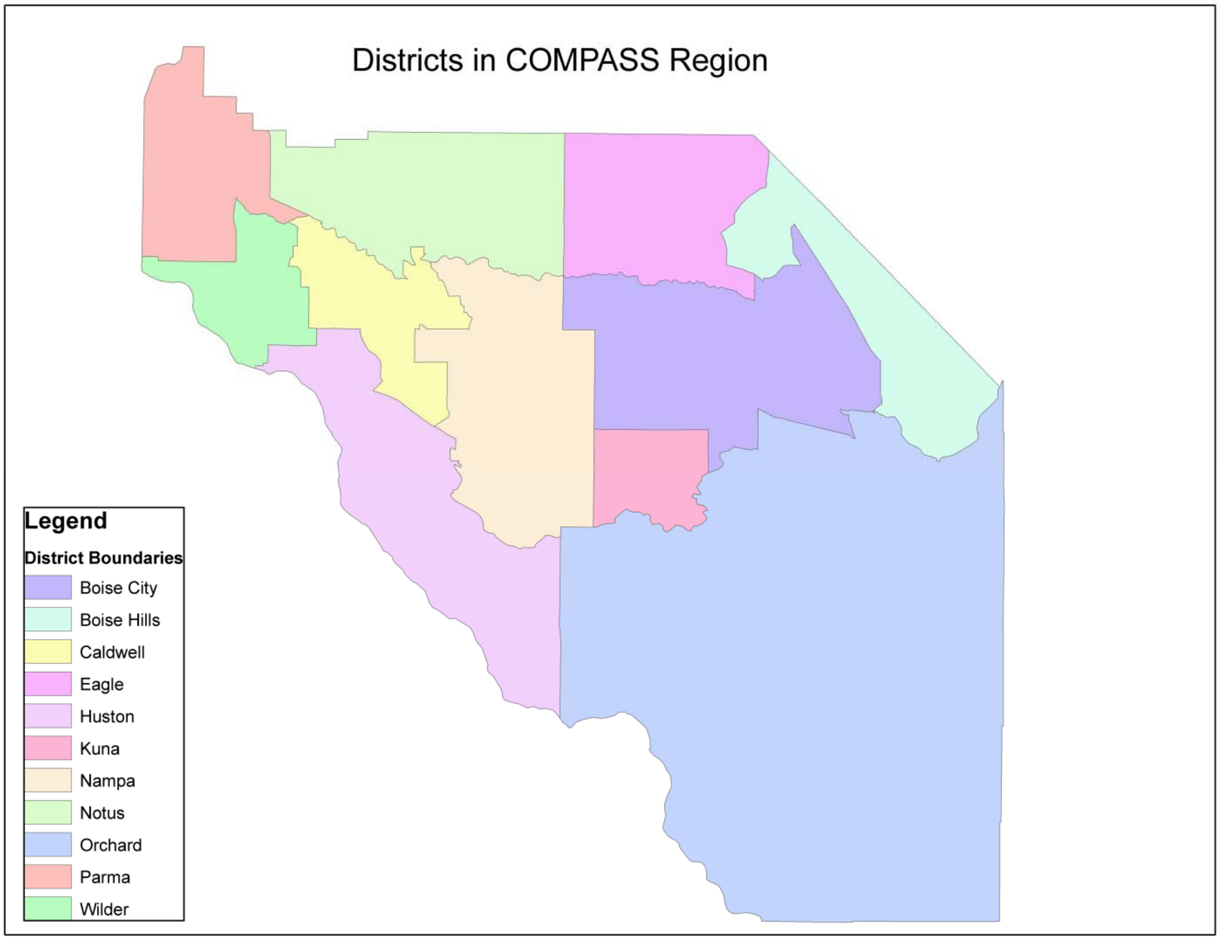
2.2 MODE CHOICE MODEL REASONABLENESS CHECKS

The COMPASS mode choice result was compared to Journey-To-Work flow data from 2000 Census Transportation Planning Package (CTPP), and 2002 COMPASS Household Travel Survey data in this section. The data was aggregated into 11 districts. The definitions of the districts are shown in Table 2.4. The map of the districts is illustrated in Figure 2.3. All comparisons are done at the district-to-district level. These comparisons serve as reasonableness checks for the mode choice results.

Table 2.4 District Definition

District	NAME
1	Parma
2	Eagle
3	Notus
4	Boise Hills
5	Wilder
6	Caldwell
7	Boise City
8	Nampa
9	Huston
10	Orchard
11	Kuna

Figure 2.3 District Map



Work Trip Comparison

The district-to-district peak work trips from 2000 CTPP and total HBW trips from the model are summarized in Tables 2.5 and 2.6. The percentages of total work trips produced by and attracted to districts are very similar between those two tables. Consequently, the overall work trip flow from the mode choice model seems reasonable at district level.

Table 2.5 2000 CTPP Peak Trips

District	1	2	3	4	5	6	7	8	9	10	11	Total	
1	472	0	39	0	84	281	134	325	3	35	3	1376	1%
2	2	1451	11	0	0	180	7059	354	0	700	2	9759	5%
3	50	126	567	4	32	1028	1747	1404	32	381	0	5371	3%
4	0	12	0	28	0	15	677	34	0	121	0	887	0%
5	70	1	16	0	203	392	142	336	53	48	10	1271	1%
6	130	100	207	0	123	4439	2235	3852	149	562	28	11825	6%
7	34	1891	193	151	45	976	95476	4391	94	15608	215	119074	62%
8	112	370	121	47	95	2745	8885	15301	212	2256	155	30299	16%
9	19	4	39	0	8	365	306	666	287	102	20	1816	1%
10	0	66	0	10	0	30	4180	233	16	1720	97	6352	3%
11	8	46	9	16	5	52	2417	374	20	566	343	3856	2%
Total	897	4067	1202	256	595	10503	123258	27270	866	22099	873	191886	100%
	0%	2%	1%	0%	0%	5%	64%	14%	0%	12%	0%	100%	

Table 2.6 Modeled Daily HBW Trips

District	1	2	3	4	5	6	7	8	9	10	11	Total	
1	304	18	72	1	26	617	469	625	45	12	4	2193	1%
2	3	722	9	63	1	65	15855	140	4	960	96	17918	6%
3	175	71	352	5	25	2261	1586	3010	123	101	13	7722	2%
4	0	78	1	19	0	6	2719	16	0	257	13	3109	1%
5	168	22	80	1	38	839	565	873	80	27	6	2699	1%
6	323	119	498	11	67	5996	3911	7227	368	248	34	18802	6%
7	15	3773	44	548	3	444	162976	1212	32	13115	963	183125	57%
8	582	335	1158	36	117	12216	13548	35445	1218	1077	158	65890	20%
9	71	23	84	3	19	1076	1053	2465	222	78	18	5112	2%
10	0	106	1	31	0	13	6430	45	1	939	48	7614	2%
11	1	150	3	20	0	29	6586	93	4	599	142	7627	2%
Total	1642	5417	2302	738	296	23562	215698	51151	2097	17413	1495	321811	100%
	1%	2%	1%	0%	0%	7%	67%	16%	1%	5%	0%	100%	

District-to-district Total Transit Trip Comparison

The district-to-district total transit trips from 2002 HH Survey, and the model are summarized in Tables 2.7, and 2.8. With only 74 transit trips reported in the 2002 HH Survey, many low-volume interchanges are likely not represented. Thus, the district-to-district transit trip table from 2002 HH Survey does not represent a complete picture of the transit trip flows. From Table 2.7, however, we see that most transit trips are generated by District 7 and 8, which are Boise City and Nampa, respectively. Boise City and Nampa are the two most populated cities in the region. Those two cities also generate most transit trips in the model, as seen in Table 2.8.

Table 2.7 2002 HH Survey Transit Trips

District	1	2	3	4	5	6	7	8	9	10	11	Total	
1	--	--	--	--	--	--	--	--	--	--	--	--	--
2	--	--	--	--	--	--	1	--	--	--	--	1	1%
3	--	--	--	--	--	--	--	--	--	--	--	--	--
4	--	--	--	--	--	--	--	--	--	--	--	--	--
5	--	--	--	--	--	--	--	--	--	--	--	--	--
6	--	--	--	--	--	--	1	2	--	--	--	3	4%
7	--	1	--	--	--	1	36	4	--	1	--	43	58%
8	--	--	--	--	--	1	5	20	--	--	--	26	35%
9	--	--	--	--	--	--	--	--	--	--	--	--	--
10	--	--	--	--	--	--	1	--	--	--	--	1	1%
11	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	--	1	--	--	--	2	44	26	--	1	--	74	100%
	--	1%	--	--	--	3%	60%	35%	--	1%	--	100%	

Table 2.8 Total Modeled Transit Trips

District	1	2	3	4	5	6	7	8	9	10	11	Total	
1	--	--	--	--	--	--	--	--	--	--	--	--	--
2	--	--	--	--	--	--	24	--	--	1	--	25	0%
3	--	--	--	--	--	--	--	--	--	--	--	--	--
4	--	--	--	--	--	--	--	--	--	--	--	--	--
5	--	--	--	--	--	--	--	--	--	--	--	--	--
6	--	--	--	--	--	370	55	96	--	2	--	523	10%
7	--	5	--	--	--	7	3548	42	--	102	--	3704	69%
8	--	--	--	--	--	274	173	600	--	5	--	1052	20%
9	--	--	--	--	--	--	--	--	--	--	--	--	--
10	--	--	--	--	--	--	56	--	--	10	--	66	1%
11	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	--	5	--	--	--	651	3856	738	--	120	--	5370	100%
	--	0%	--	--	--	12%	72%	14%	--	2%	--	100%	

District-to-district HBW Transit Trip Comparison

The district-to-district HBW transit trips from 2000 CTPP and the model are summarized in Tables 2.9 and 2.10. Comparing to 2000 CTPP, the model seems to overestimate transit work trips from District 6 and 8; while underestimating trips from District 2 and 3 to District 7.

Table 2.9 2000 CTPP Peak Transit Trips

District	1	2	3	4	5	6	7	8	9	10	11	Total	
1	--	--	--	--	--	--	--	--	--	--	--	--	--
2	--	--	--	--	--	--	27	--	--	--	--	27	3%
3	--	--	--	--	--	--	28	--	--	--	--	28	3%
4	--	--	--	--	--	--	--	--	--	--	--	--	--
5	--	--	--	--	--	--	--	2	--	--	--	2	0%
6	--	--	--	--	--	13	--	7	--	--	--	20	2%
7	--	--	--	--	--	--	771	4	--	52	--	827	86%
8	--	--	--	--	--	--	18	23	--	--	--	41	4%
9	--	--	--	--	--	--	--	--	--	--	--	--	--
10	--	--	--	--	--	--	10	--	--	3	--	13	1%
11	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	--	--	--	--	--	13	854	36	--	55	--	958	100%
	--	--	--	--	--	1%	89%	4%	--	6%	--	100%	

Table 2.10 Modeled HBW Transit Trips

District	1	2	3	4	5	6	7	8	9	10	11	Total	
1	--	--	--	--	--	--	--	--	--	--	--	--	--
2	--	--	--	--	--	--	9	--	--	1	--	10	1%
3	--	--	--	--	--	--	--	--	--	--	--	--	--
4	--	--	--	--	--	--	--	--	--	--	--	--	--
5	--	--	--	--	--	--	--	--	--	--	--	--	--
6	--	--	--	--	--	47	18	20	--	1	--	87	6%
7	--	--	--	--	--	--	891	--	--	61	--	952	69%
8	--	--	--	--	--	95	61	149	--	4	--	309	23%
9	--	--	--	--	--	--	--	--	--	--	--	--	--
10	--	--	--	--	--	--	13	--	--	3	--	15	1%
11	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	--	0	--	--	--	142	992	170	--	69	--	1373	100%
	--	0%	--	--	--	10%	72%	12%	--	5%	--	100%	

Modeled vs. Observed auto and transit travel times

The district-to-district auto and transit travel times from 2002 HH Survey, 2000 CTPP and daily transit trips from the model are summarized in Tables 2.10 to 2.14. These district-to-district travel times are weighted average by trips. So, they represent the average travel time experienced by an average traveler from one district to another. Overall, the model tends to underestimate transit travel times. But, the auto travel times seems more reasonable. The discrepancies between modeled and observed travel times, for both auto and transit, are likely due to the fact that the modeled travel times are extracted based on free-flow conditions.

Table 2.10 2002 HH Survey Transit Travel Time (Minutes)

District	1	2	3	4	5	6	7	8	9	10	11
1	--	--	--	--	--	--	--	--	--	--	--
2	--	--	--	--	--	--	54.0	--	--	--	--
3	--	--	--	--	--	--	--	--	--	--	--
4	--	--	--	--	--	--	--	--	--	--	--
5	--	--	--	--	--	--	--	--	--	--	--
6	--	--	--	--	--	--	45.0	38.5	--	--	--
7	--	55.0	--	--	--	99.0	28.3	46.8	--	15.0	--
8	--	--	--	--	--	20.0	50.6	49.7	--	--	--
9	--	--	--	--	--	--	--	--	--	--	--
10	--	--	--	--	--	--	35.0	--	--	--	--
11	--	--	--	--	--	--	--	--	--	--	--

Table 2.11 CTPP Peak Transit Time (Minutes)

District	1	2	3	4	5	6	7	8	9	10	11
1	--	--	--	--	--	--	--	--	--	--	--
2	--	--	--	--	--	--	37.8	--	--	--	--
3	--	--	--	--	--	--	83.8	--	--	--	--
4	--	--	--	--	--	--	--	--	--	--	--
5	--	--	--	--	--	--	--	5.0	--	--	--
6	--	--	--	--	--	10.0	--	90.0	--	--	--
7	--	--	--	--	--	--	35.6	60.0	--	29.7	--
8	--	--	--	--	--	--	63.9	16.1	--	--	--
9	--	--	--	--	--	--	--	--	--	--	--
10	--	--	--	--	--	--	51.0	--	--	5.0	--
11	--	--	--	--	--	--	--	--	--	--	--

Table 2.12 Modeled Transit Travel Time (Minutes)

District	1	2	3	4	5	6	7	8	9	10	11
1	11.2	48.3	28.1	57.2	16.2	28.0	49.5	36.7	33.7	55.6	51.4
2	48.0	10.6	26.2	22.3	42.3	28.4	18.6	26.3	42.8	29.3	27.6
3	29.9	27.1	13.7	41.2	27.2	17.0	34.6	23.1	33.8	43.0	38.0
4	54.4	17.2	35.9	12.7	46.5	36.5	19.0	32.7	48.9	19.3	31.4
5	20.9	45.0	27.8	55.5	10.6	22.3	46.1	32.2	25.1	50.5	47.2
6	29.4	30.1	17.0	40.8	19.8	9.2	31.6	17.2	22.3	38.5	33.3
7	48.5	17.0	32.4	20.9	43.6	29.7	13.7	24.0	39.8	19.8	22.3
8	39.5	28.6	23.5	36.2	31.7	18.0	26.5	11.2	24.6	32.7	23.3
9	35.9	43.4	34.9	51.2	26.5	27.3	41.4	24.4	18.1	44.9	30.3
10	55.2	28.7	42.2	17.1	49.0	38.3	19.5	31.8	42.9	14.0	24.9
11	53.2	27.5	36.8	33.7	45.4	32.1	23.6	23.0	31.6	28.1	10.6

Table 2.13 CTPP Peak Auto Time (Minutes)

District	1	2	3	4	5	6	7	8	9	10	11
1	11.1	--	15.4	--	14.2	22.1	64.0	35.4	20.0	48.4	45.0
2	--	12.6	11.5	--	--	27.1	22.4	27.3	--	30.2	25.0
3	13.6	25.7	15.8	30.0	22.8	16.8	39.5	23.3	46.1	40.5	--
4	--	10.0	--	26.8	--	35.0	20.1	96.5	--	27.4	--
5	10.8	45.0	11.8	--	10.9	19.5	47.7	27.6	21.3	38.7	35.0
6	27.7	30.8	13.4	--	19.1	11.3	35.3	19.9	17.5	40.5	35.8
7	52.8	21.3	33.3	19.4	41.9	30.6	17.6	26.5	28.2	20.8	22.9
8	26.6	39.9	18.6	31.5	43.3	18.6	30.9	14.0	20.8	32.7	23.7
9	20.0	45.0	20.5	--	25.0	21.0	42.5	25.8	12.0	41.0	30.8
10	--	20.1	--	6.0	--	32.3	19.2	31.0	11.9	12.0	18.3
11	55.0	31.6	25.0	40.0	10.0	30.0	27.0	23.4	25.5	29.4	20.4

Table 2.14 Modeled Auto Travel Time (Minutes)

District	1	2	3	4	5	6	7	8	9	10	11
1	6.6	45.4	24.0	56.7	15.0	25.7	47.7	34.8	32.3	55.4	50.3
2	43.8	6.9	20.6	13.5	40.4	24.4	14.3	22.5	40.0	28.6	24.4
3	25.2	22.4	9.5	36.3	25.3	13.5	32.2	20.2	33.0	41.6	36.0
4	56.3	11.7	34.5	4.6	52.5	34.6	14.6	31.0	49.2	11.5	28.9
5	16.6	42.0	25.4	53.0	6.7	18.9	43.6	29.8	22.1	51.5	45.2
6	25.8	25.6	13.2	36.5	16.1	5.4	28.3	12.8	20.6	37.2	30.0
7	47.0	12.4	30.2	15.4	42.1	26.1	8.7	19.1	36.9	15.0	16.8
8	35.8	23.9	19.9	33.3	29.3	13.0	21.9	7.2	20.0	32.3	18.4
9	32.8	41.1	33.8	49.9	21.0	23.3	38.9	20.7	10.3	44.8	25.8
10	57.4	26.5	43.3	11.4	53.4	37.5	14.2	29.7	38.4	7.4	17.9
11	51.0	24.6	34.9	31.0	45.2	29.2	19.1	18.8	24.1	22.3	5.8

3.0 FTA Model Choice Modeling Guidelines

The FTA's guidance suggests that there must be a reasonable and valid interpretation of the "story told by the model" about traveler behavior. This relates to transit network coding and path-building, as well as the mode choice models. This helps to ensure that the various parameters, constants, network coding conventions, and other decision rules in the models "tell a coherent story" about travel behavior.

In general, the following factors are considered as major contributors to most encountered anomalies and inaccuracies in mode choice models:

- Incorrect representation of travel markets in person-trip tables;
- Inconsistencies between transit path-builder and the mode choice model;
- Inaccurate auto and bus network speeds and travel times;
- Unusual coefficients throughout the model;
- Use of "non-logit decision rules" in the mode choice model;
- Over-specified alternative-specific constants;
- Nature of alternative-specific constants for future modes; and
- Inadequate and non-rigorous calibration and validation procedures.

The following are highlights of the FTA's recommendations with respect to some of the above issues:

- **Network Development –** Transit and highway skims (level-of-service matrices) should be consistent with the actual baseline conditions for bus running times and highway network speeds.
- **Transit Path-Builder and the Mode Choice Model –** It is important to have consistency between the transit path-builder and the mode choice model with respect to modes in model application. Transit path-builder must be checked by comparing model predicted paths against paths from surveys – if existing. While this is not required for model estimation, the settings for model estimation should be close to those used for application, or else the models may need to be re-estimated.
- **Mode Choice Models –** These should be developed in a way that the introduction of a new mode would not require modification of the application code. They should be transparent and not over-specified; too

many nests can result in illogical constants. They should conform to the following guidelines:

- Coefficient of In-Vehicle Time (C_{IVT}) should be -0.03 <C_{IVT} < -0.02 and use the same coefficient for all choices; there should be no variations by mode (e.g. coefficient of transit mode less negative than that for the auto mode; C_{IVT} for commuter rail less negative than that of other transit modes). The FTA has recently allowed C_{IVT} to be slightly lower in absolute value for certain premium modes.
- Coefficient of Out-of-Vehicle Time (C_{OVT}) should be 2.0 < C_{OVT}/ C_{IVT} < 3.0 and use the same coefficient for all alternatives.
- Implicit Value of Time (VOT= C_{IVT} / C_{Cost}), where C_{Cost} is the Coefficient of cost, should be Average wage/4 < VOT < Average wage/3.

- **Use of "Non-Logit Decision Rules" in the Mode Choice Model –** These rules and assumptions established to ensure reasonableness of forecasts by eliminating unlikely transit trips (e.g., requiring that transit IVT be greater than drive access time for auto-access transit choice, assuming a minimum IVT to qualify a transit trip) should be avoided. Such arbitrary rules can result in zero-percent transit mode shares and negative benefits when an alternative exhibits service improvements. Some level of model inaccuracy should be tolerated in lieu of over-defined model specifications.
- **Alternative-Specific Constants** should have no geographic basis with potential exception of CBD bound travel.

The above recommendations are not rules. However, deviations from the above recommendations should have logical explanations and, hopefully, be based on observed behavior.

4.0 Assessment and Recommended Enhancements

After reviewing and testing various aspects of the COMPASS Mode Choice Model, the following enhancements are recommended to prepare the model for New Starts and Small Starts applications.

4.1 Model Nesting Structure

Assessment

The FTA modeling guidelines caution against over specifying the nesting structure in mode choice models. The COMPASS Mode Choice model structure was adapted from the WFRC HBW Mode Choice submodel without market segmentation. The submodels for other trip purposes also share the same nesting structure as HBW trips. The adapted nesting structure does not appear to exhibit over specification problems.

Recommended Enhancements

The FTA guidelines states that models used for New Starts should account for transit markets defined by trip purpose, socioeconomic class, production / attraction locations, and transit access modes. Consequently, it is recommended that the COMPASS HBW Mode Choice Model be expanded to include market segmentation (e.g. by auto ownership), for HBW trips.

4.2 Alternative-Specific Constants

Assessment

The FTA modeling guidelines also caution against overspecifying the alternative-specific constants in mode choice models. The alternative-specific constants in the COMPASS Mode Choice model were calibrated with independent variable coefficients borrowed from the WFRC model. Consequently, some of the alternative-specific constants may be too large and render the model insensitive to variations in level of service.

Recommended Enhancements

The alternative-specific constants should be recalibrated to reflect existing local conditions once the new survey data becomes available.

4.3 MODE SPECIFIC IN-VEHICLE TIME COEFFICIENTS

Assessment

The FTA modeling guidelines caution against mode specific In-Vehicle Time Coefficients. The auto In-Vehicle Time Coefficients in the COMPASS Mode Choice model are about twice the values of the transit In-Vehicle Time Coefficient for all trip purposes, see Table 4.1 below.

Table 4.1 In-Vehicle Time Coefficients

	HBW	HBSC	HBS	HBSO	HBO	NHB
IVT_COEF	-0.0221	-0.0221	-0.0107	-0.0107	-0.0107	-0.0233
DRIVE_COEF	-0.0541	-0.0541	-0.0268	-0.0268	-0.0268	-0.0583

Recommended Enhancements

The auto In-Vehicle Time Coefficients should be set to the same values as the transit In-Vehicle Time Coefficient for all trip purposes.

4.4 COEFFICIENTS OF TRANSIT TRAVEL TIME, AND IMPLICIT VALUE OF TIME

Assessment

The COMPASS Mode Choice model distinguishes between initial and transfer wait times. The Out-of-Vehicle Time coefficient is calculated as the average of the coefficients of the initial and transfer wait times. The ratios of the adapted In-Vehicle Time and Out-of-Vehicle Time coefficients all conform to the FTA guidelines. However, the coefficient of In-Vehicle Time for the HBS, HBSO, and HBO trip purposes are beyond the FTA recommended range.

Also, the coefficient of Cost seems too high, such that, the ratio between the Implicit Value of Time and average hourly wage is slightly too low. As an example, the coefficients of the HBW trips and the FTA recommended ranges are shown in Table 4.2. The coefficients of other trip purposes are shown in Tables 4.3 to 4.5.

Table 4.2 HBW Coefficients

Coefficient	COMPASS	FTA Guidelines	
		Low	High
In-Vehicle Time (C_{IVT})	-0.0221	-0.03	-0.02
Out-of-Vehicle-Time (C_{OVT})	-0.0464		
C_{OVT}/ C_{IVT}	2.1	2	3
Cost	-0.0061		
Implied Value of Time (C_{IVT}/ C_{cost})	$3.62		
Average Hourly Wage	$18.89*		
Value of Time / Average Wage	0.19	0.25	0.33

*: Idaho Occupational Employment & Wage Survey 2009, Boise City-Nampa Metropolitan Statistical Area

Table 4.3 HBSC Coefficients

Coefficient	COMPASS	FTA Guidelines	
		Low	High
In-Vehicle Time (C_{IVT})	-0.0221	-0.03	-0.02
Out-of-Vehicle-Time (C_{OVT})	-0.0464		
C_{OVT}/ C_{IVT}	2.1	2	3

Table 4.4 HBS, HBSO, HBO Coefficients

Coefficient	COMPASS	FTA Guidelines	
		Low	High
In-Vehicle Time (C_{IVT})	-0.0107	-0.03	-0.02
Out-of-Vehicle-Time (C_{OVT})	-0.0227		
C_{OVT}/ C_{IVT}	2.12	2	3

Table 4.5 NHB Coefficients

Coefficient	COMPASS HBW	FTA Guidelines	
		Low	High
In-Vehicle Time (C_{IVT})	-0.0223	-0.03	-0.02
Out-of-Vehicle-Time (C_{OVT})	-0.0553		
C_{OVT}/ C_{IVT}	2.47	2	3

Recommended Enhancements

The coefficients of In-Vehicle Time and Out-of-Vehicle Time for the HBS, HBSO, and HBO trip purposes should be adjusted to be within the FTA recommended range. The HBW coefficients can be used as a reasonable starting point for those trip purposes.

The implied value of time seems too low compared to average hourly wage. The coefficient of Cost should be adjusted such that the ratio between the Implicit Value of Time and average hourly wage is within the FTA recommended range.

4.5 Transit Network Development

Assessment

The transit level of service (LOS) used in the COMPASS Mode Choice model was based on a daily network. The transit service frequencies in the current model represent the average daily condition, hence, not specific to a peak or off-peak period. In addition, the transit paths are based on the best path using either walk or drive access. Therefore, although the overall transit mode share matches 2002 HH Travel Survey, the transit mode share by access mode cannot be distinguished.

Recommended Enhancements

Transit networks by access mode should be constructed separately so that the skimming and assignment of transit trips by access mode will be based on the transit network for the particular access mode. For example, the paths for drive-access trips should all begin with one drive-access link and end with one walk-egress link. Consequently, the transit network for drive-access trip skimming and assignment should not include any walk-access links. In addition, the time of day for the skimmed LOS should be appropriate for the trip purpose. For example, HBW and HBC mode choice models should be based on AM peak auto and transit travel times, and level of transit services. Consequently, an AM peak network and an off-peak network must be developed for this purpose.

4.6 HIGHWAY AND BUS SPEEDS

Assessment

Transit travel times need to account for buses operating in mixed traffic, stops, delays, etc. So, the true comparison should be against scheduled transit times or true O-D transit travel times. The current transit LOS skimming was based on free-flow highway speeds. Since the bus runtime is obtained from the background highway network, the bus speeds were also set to free-flow speeds. Therefore, the transit paths selected may not be consistent with those from the congested peak hours.

Recommended Enhancements

Transit speeds for buses operating in mixed-flow should be based on congested auto speeds.

4.7 SUMMARY OF RECOMMENDED ENHANCEMENTS

In summary, the following are the recommended enhancements to the COMPASS model:

- **Refine Transit Network Coding**:
  - Code transit lines los by time-of-day;
  - Use congested auto speeds to determine bus speeds.
- **Refine Transit LOS skimming:**
  - Skim access-mode-specific LOS; and
  - Skim LOS by time of day.
- **Mode Choice Model:**
  - Add market segmentation, by auto ownership, to HBW model;
  - Include Auto Operating Costs as independent variable; and
  - Use FTA approved coefficients and adjust constants based on new on-board OD survey data.

5.0 Additional FTA Guidelines on Calibration and Validation

The following discussion on model calibration procedures, adopted from *FSUTMS-Cube Framework Phase II: Model Calibration and Validation Standards, Final Report, Florida Department of Transportation Systems Planning Office, 2008*, is applicable to calibration efforts for models used in forecasting transit use, but is especially relevant for the FTA New Starts projects.

5.1 Transit Path-Building

The FTA has noted that certain common practices in transit path-building can have undesired impacts on ridership forecasts. Minimum and maximum values of time and distance used to determine valid transit paths and modal availability can have unexpected effects. It is recommended to use continuous functions, instead of such "either/or" tests. It also is important that transit access coding conventions are consistent among transit modes. Path-building parameters and settings should remain the same for all steps of the model (skimming, assignment).

The FTA recommends evaluating the transit skims by comparing the skim settings to the range of experience in on-board surveys. Settings to check include maximum access distances, travel times, and transfers. Another FTA recommendation is the assignment of "observed" transit trip tables, derived from the expanded transit rider survey, to the coded transit networks. This will provide an opportunity to examine transit network and path-building without the influence of errors in the trip distribution and mode choice models.

5.2 Trip Distribution Model Checks

The FTA recommends a detailed inspection of the person-trip tables that are the outputs of trip distribution. Checking trip length frequency distributions is insufficient. Since information on observed travel patterns is seldom available at a zone level, this must be a district-level summary. The motivation behind this recommendation is that if demand in a corridor is significantly overestimated or underestimated, it will be difficult to produce accurate ridership forecasts for a proposed transit project in the corridor. The implication is that recent household survey data are needed to perform this comparison. In the absence of household survey data, comparisons should at least be made between CTPP/JTW data and model-estimated home-based work trip tables at the planning district or sector level. The FTA has not specified any standards for this check either.

5.3 Mode Choice Estimation Data

The model estimation data will be a combination of the household survey, transit on-board surveys, skim data, and land use data from the model. The survey data for each trip needs to be supplemented by information about the travel time and cost between the origin and destination areas. The travel time and cost data, referred to as level of service data, are obtained by skimming the model system's highway and transit networks for the given origin and destination of each trip. The level of service data for transit modes will include wait, transfer, walk access, auto access, and egress times; number of transfers; in-vehicle times by transit mode; and transit fares. The level of service data for highway modes will include in-vehicle times, out-of-vehicle times, and distances. The survey, zonal, and level of service data will then be merged to provide estimation data sets for each trip purpose. These data sets will consist of the survey trip records, extended to include household and person variables from the surveys; zonal data for the zones of trip origin, destination, production, and attraction (as appropriate); and level of service data for all modes available between the trip end zones.

5.4 Mode Choice Model Calibration Procedures

After the mode choice model is applied, the results by market segment are compared to a calibration target matrix. Aggregate model calibration and validation ensure agreement between the estimated and observed data at the aggregate level through the adjustment of mode-specific constants. The primary role of the constants is to capture the effects of those variables affecting mode choice that cannot be modeled, such as safety, security, and reliability. Constants are included to "explain" which existing specifications of the model (i.e., model structure, variables, and coefficients) cannot be addressed adequately. The concerns with the use of constant terms, in lieu of explanatory variables, lie in the application of the model in the forecasting mode, since changes in variables affecting modal use, but not included in the model, are held constant over time. The ideal situation is a robust model with a strong explanatory power and constants that are of relatively small magnitude. It is not acceptable simply to adjust constants without consideration to the reasons for the differences between model results and observed data. When large adjustments are needed, this usually indicates problems with the model that need to be corrected before validation can continue.

It is important to recognize the relationship between the magnitudes of alternative-specific constants and the other model parameters. For example, if the difference between the constants for two modes is 3.0, and the in-vehicle time coefficient is -0.02, this implies that (all other things being equal) a traveler would be indifferent between spending 30 minutes on the mode with the lower constant and spending three hours on the higher-constant mode. This may be reasonable if the higher-constant mode is an auto mode and the lower constant mode is a transit or nonmotorized mode, when issues such as vehicle availability, parking availability, and transit/nonmotorized mode captivity are not explicitly considered in the model. (Then again, this may indicate that the ways in which these issues are treated in the model need to be reconsidered.) However, if the two modes are either transit modes or both auto modes, it is likely there are other issues in the model that need to be corrected. In the case of two transit modes, it is likely that the FTA would deem this difference to be a case of "bizarre" alternative-specific constants.

One of the most significant problems that may occur in traditional model development is a calibration effort that results in adjustments necessary to match current data that are no more than correction factors for errors made elsewhere in the model set. The "calibration" of alternative-specific constants is meaningful only when the person-trip tables, highway and transit networks, and observed patterns are sufficiently accurate.

To summarize, the initial response to the identification of discrepancies between the model results and the calibration targets is to examine the potential reasons for the discrepancies in the model itself, and to correct any model problems that are identified. After all such issues have been addressed, it would be acceptable to make relatively small adjustments to modal constants to provide a better fit between modeled and observed mode shares.

The FTA has noted that simply matching regional targets by mode is insufficient. Besides segmentation by trip purpose, socioeconomic class (such as auto ownership level), and transit access mode/submode, checks for individual geographic markets must also be performed. The FTA asks, "Do our models grasp adequately the characteristics of our key transit ridership markets?" The FTA contends that a model is not sufficiently validated unless it accurately represents transit demand in key markets. (This requires good validation of both trip distribution and mode choice.)

5.5 Transit Assignment Checks

The transit assignment process is often overlooked during the process of regional model and Long-Range Transportation Plan (LRTP) development. The FTA has recommended specific checks on the transit assignment process for projects requiring New Starts funding. The first of these is to assign a trip table from an expanded on-board survey, and compare the results against a model estimated transit assignment. Checks should be conducted on individual transit lines (or groups of lines in the case of local buses), guideway facilities, stations, and park-and-ride lots, and between station pairs, if the data are available.

The FTA specifically recommends performing modeling for future baseline ("Transportation System Management (TSM)" in the case of New Starts projects) and build alternatives. Future baseline results should be compared to base year results, and future build results should be compared to future baseline results. This is a reasonableness check.

The FTA developed a software tool, known as Summit, for analyzing travel demand forecasts. Summit also computes and reports transportation system user benefits, which can be used in mobility and cost-effectiveness measures for New Starts reporting. Summit requires software changes to regional travel forecasting models to export files required by Summit for the calculation of user benefits. The FTA recommends using the Summit program as a diagnostic check for unusual or anomalous transit assignment results. Summit analyses are performed based on comparisons between future baseline and future build results.

Since the New Starts program focuses on project evaluation, it is also necessary to demonstrate that future changes in the transportation (especially transit) system produce reasonable model results. Tests of the sensitivity to changes must be done through model application in full production mode. Simple elasticity tests are insufficient because they do not exercise the full range of model components, particularly network coding conventions and transit path-building parameters that are central to the transit-related properties of a model set.

5.6 Ridership Forecast Checks

Starting in 2008, New Starts applications will require the following standard ridership forecasts, analyses, and summary reports. These analyses are intended to provide detailed information regarding the sensitivity of the travel models and the sources for forecast changes in transit ridership.

- Future No-Build alternative versus “today”;
- Future TSM alternative versus No-Build alternative;
- Future Build alternative versus TSM alternative;
- Opening year Build alternative versus today; and
- Detailed analysis of transit user benefits accruing from changes in in-vehicle travel times resulting from a proposed project.