New York Best Practice Model 2012

Base Year Model Validation Report

prepared for

New York Metropolitan Transportation Council

prepared by

Cambridge Systematics, Inc.

with

EA Harper Consulting
Florida International University
Gallop Corporation
CDM Smith

June, 2021

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Cambridge Systematics, Inc.
101 Station Landing, Suite 410
Medford, MA 02155

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date

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1.0 Summary of Model Validation Process

This report summarizes the validation of the activity-based model developed for the New York metropolitan region. This model was developed for the New York Metropolitan Transportation Council (NYMTC) by a team led by Cambridge Systematics, Inc. (CS). Also assisting with model validation were EA Harper Consulting, Florida International University, Gallop Corporation, and CDM Smith.

The model structure is documented in a model design plan[1]. A model validation plan[2] was developed prior to model development. This plan laid out the process for the model validation and specified the tests that were performed. A few tests changed slightly or were more specifically defined for the final model validation, but generally the plan was followed. The tests in the plan included checks of the results of all model components compared to the observed data, checks of the highway and transit assignment, and tests of the sensitivity of the model to changes in input data. The remainder of this report focuses on the checks of the activity and travel data from the model components and the assignment results; the sensitivity tests will be documented in a subsequent report.

1.1 Model Component Validation

The activity-based demand model components are included in two major parts:

- **CEMSELTS**, the socioeconomic modeling system; and
- **CEMDAP**, the activity-based modeling engine.

Demand model component validation is discussed in Chapter 2.0. Details of the model structure can be found in the model design report. The CEMSELTS components are shown in Table 1-1. The CEMDAP components are further subdivided into segments based on travel type:

- Generation-allocation (GA)
- Worker (WSCH)
- Non-worker (NWSCH)
- Child (CSCH)
- Joint (JASCH)

[1] Cambridge Systematics, Inc., University of Texas, Austin, and Arizona State University. *New York Best Practice Model – Model Design Plan*. Prepared for the New York Metropolitan Transportation Council, July 2017.

[2] Cambridge Systematics, Inc. and EA Harper Consulting. *New York Best Practice Model – Model Validation Plan*. Prepared for the New York Metropolitan Transportation Council, August 2017.

Table 1-1. CEMSELTS Components

Component	Description	Model Unit	Model Type	Data Source
Student status[1]	Student status - Grade level/college status for each person based on age	Person	Lookup tables	RHTS/PUMS
Education attainment	Less than high school/high school/some college/college graduate/any grad school	Person	MNL (5 alts)	RHTS/PUMS
School location	School location - TAZ for each K-12 student	Student	MNL (TAZ alts)	RHTS
College location	College location - TAZ for each college student	Student	MNL (TAZ alts)	RHTS
Labor force participation	Labor force participation - binary choice	Person	Binary logit	RHTS
Employer type	Employer type	Worker	MNL (5 alts)	RHTS
Occupation industry	Occupation industry	Worker	MNL (6 alts)	RHTS
Household income	Household income level	Household	ORL (8 alts)	RHTS
Residential tenure	Residential tenure - own/rent	Household	Binary logit	PUMS
Housing type	Housing unit type	Household	MNL (3/4 alts)	RHTS/PUMS
Employment location	Work location - Regular workplace TAZ for each worker	Worker	MNL (TAZ alts)	RHTS
Weekly work duration	Work duration - <35 hours, 35-45 hours, or >45 hours per week	Worker	MNL (3 alts)	RHTS
Work flexibility	Work flexibility - none, low, medium, and high	Worker	ORL (4 alts)	RHTS
Driver's license	Person holding of driver's license	Person	Binary logit	RHTS
Parking pass	Worker holding of parking pass	Worker	Binary logit	RHTS
Vehicle ownership[2]	Number of vehicles owned by the household	Household	MNL (5 alts)	RHTS
Annual mileage	Household mileage (annual)	Household	Log-linear regression	NHTS
Vehicle fleet composition	Vehicle fleet - number of household vehicles by type/vintage category	Household	MDCEV	NHTS
Primary driver allocation	Primary driver - which person in the household is the primary driver of each vehicle	Household	MNL (2-8 alts)	NHTS

Model structure abbreviations: MNL – multinomial logit, ORL - ordered response logit, MDCEV – multiple discrete-continuous extreme value.

Data source abbreviations: RHTS – NYMTC Regional Household Travel Survey, PUMS – Public Use Microdata Sample from the U.S. Census Bureau's American Community Survey (ACS), NHTS – National Household Travel Survey.

Notes:

1. Lookup table obtained directly from RHTS/PUMS – no validation required
2. New component added after model design plan was completed

Descriptions of the CEMDAP components in each of these five segments are provided in Table 1-2 through Table 1-6.

Table 1-2. CEMDAP Components – GA Series

Code	Component	What's Modeled	Unit	Model Type
GA1	Child's decision to go to school	Yes/no	Tour	Binary logit
GA2	Child's school start time	Continuous	Person	Hazard-duration
GA3	Child's school end time	Continuous	Person	Hazard-duration
GA4	Adult's decision to go to work	Yes/no	Person	Binary logit
GA5	Adult's work start and end times	32 periods (see list)	Tour	Multinomial logit
GA6	Adult's decision to go to school	Yes/no	Person	Binary logit
GA7	Adult's school start time	Continuous	Person	Log-linear regression
GA8	Adult's school end time	Continuous	Person	Log-linear regression
GA9	Child's travel mode to school	Modes (see list)	Trip	Multinomial logit
GA10	Child's travel mode from school	Modes (see list)	Trip	Multinomial logit
GA11	Allocation of drop off episode to parent	Mother/father	Household	Binary logit
GA12	Allocation of pick up episode to parent	Mother/father	Household	Binary logit
GA13	Determination of households with non-zero out-of-home duration	Out-of-home activities: yes/no	Household	Binary logit
GA14	Determination of total OH time of a household	% time in-home/% out-of-home/% travel	Household	Fractional split
GA15	Independent and joint activity participation for households of size ≤ 5	Activity purpose (see list)/# of participants	Household	MDCEV
GA16	Independent activity participation for households of size > 5	Activity purpose (see list)/# of participants	Household	MDCEV
GA17	Decision of adult to undertake other serve-passenger activities	Yes/no	Person	Binary logit

Table 1-3. CEMDAP Components – WSCH Series

Code	Component	What's Modeled	Unit	Model Type
WSCH1	Worker commute mode	Modes	Tour	Nested logit
WSCH2	Number of before-work tours	0, 1, or 2+ tours	Person	Multinomial logit
WSCH3	Number of work-based tours	0, 1, or 2+ tours	Person	Multinomial logit
WSCH4	Number of after-work tours	0, 1, or 2+ tours	Person	Multinomial logit
WSCH5	Before-work tour mode	Modes	Tour	Multinomial logit
WSCH6	Work-based tour mode	Modes	Tour	Multinomial logit
WSCH7	After-work tour mode	Modes	Tour	Multinomial logit
WSCH8a	Worker number of stops on commute tour	0, 1, or 2 stops	Tour	Ordered probit
WSCH8b	Worker number of stops on before work/after work/at-work tour	1, 2, 3, 4, or 5 stops	Tour	Ordered probit
WSCH9	Worker home or work stay duration before tour	Minutes	Tour	Log-linear regression
WSCH10	Worker activity type at stop	Activity purpose	Trip	Multinomial logit
WSCH11	Worker activity duration at stop	Minutes	Trip	Log-linear regression
WSCH12	Worker travel distance to a stop	Miles	Trip	Log-linear regression
WSCH13	Worker location of a stop	Restricted set of 50 TAZs	Trip	Multinomial logit
WSCH14	Worker Commute Trip Mode Choice	Modes	Trip	Multinomial logit

Table 1-4. CEMDAP Components – NWSCH Series

Code	Component	What's Modeled	Unit	Model Type
NWSCH1	Non-worker number of independent tours	1, 2, 3, or 4 tours	Person	Ordered probit
NWSCH2	Non-worker decision to undertake independent tour before pick-up/joint discretionary tour	Performs tour: yes/no	Tour	Binary logit
NWSCH3	Non-worker decision to undertake an independent tour after pick-up/joint discretionary tour	Performs tour: yes/no	Tour	Binary logit
NWSCH5	Non-worker number of stops in a tour	1, 2, 3, 4, 5, or 6 stops	Tour	Ordered probit
NWSCH6	Non-worker number of stops following pick-up/drop-off	0, 1, 2, or 3 stops	Tour	Ordered probit
NWSCH7	Non-worker home stay duration before tour	Minutes	Tour	Log-linear regression
NWSCH8	Non-worker activity type at stop	Activity purpose	Trip	Multinomial logit
NWSCH9	Non-worker activity duration at stop	Minutes	Trip	Log-linear regression
NWSCH10	Non-worker travel distance to a stop	Miles	Trip	Log-linear regression
NWSCH11	Non-worker stop location	Restricted set of 50 TAZs	Trip	Multinomial logit
NWSCH4	Non-worker trip mode	Modes	Trip	Nested logit

Table 1-5. CEMDAP Components – JASCH Series

Code	Component	What's Modeled	Unit	Model Type
JASCH2	Joint activity start time	Minutes from 3:00 a.m.	Trip	Log-linear regression
JASCH3	Joint activity distance to stop	Miles	Trip	Log-linear regression
JASCH4	Joint Activity location	Restricted set of 50 TAZs	Trip	Multinomial logit
JASCH6	Joint discretionary trip mode choice	Modes	Trip	Nested logit
JASCH5	Vehicle Used for Joint Home-Based Tour	Household vehicles (up to 7)	Tour	Multinomial logit

Table 1-6. CEMDAP Components – CSCH Series

Code	Component	What's Modeled	Unit	Model Type
CSCH4	Child departure time from home for independent discretionary tour	Minutes from 3:00 a.m.	Trip	Log-linear regression
CSCH5	Child activity duration at independent discretionary stop	Minutes	Trip	Log-linear regression
CSCH6	Child travel distance to independent discretionary stop	Miles	Trip	Log-linear regression
CSCH7	Child location of independent discretionary stop	Restricted set of 50 TAZs	Trip	Multinomial logit
CSCH3	Child mode for independent discretionary trip	Modes (see list)	Trip	Nested logit

1.2 Highway and Transit Assignment

Trip assignment checks consist of comparisons of model results to observed data, i.e., traffic and transit ridership counts. Highway assignment checks include:

- Vehicle-miles traveled (VMT) by facility type
- Volume/VMT by subregion
- Volume/VMT by time period
- Percentage root mean square error by facility type and volume level
- Volume ratio on major routes and major water crossings
- Sum of volumes on screenlines

Transit assignment checks include:

- Shares by major mode (commuter rail/bus, subway/other rail, local bus)
- Total regional boardings
- Linked transit trips by time period and subregion
- Boardings by station group (for commuter rail and PATH)
- Hub-bound transit report

The highway and transit assignment testing is summarized in Chapter 3.0.

2.0 Model Component Validation

This chapter summarizes the activity-based demand model component validation. The tests consisted of comparisons of model results for various market segments to the observed data. These comparisons were done using Excel spreadsheet files. R scripts were used to export data from the model application software that could be imported into databases and processed to be imported into Excel spreadsheets, which were populated in advance with the observed data summaries. The model results presented in this chapter are based on model application with feedback.

The comparisons described in this chapter reflect model calibration adjustments that were made following model estimation, in response to the validation results. In some cases, model parameters were adjusted to produce more reasonable results although there was not a universal attempt to match all results from the observed for all market segments by adjusting model constants or other parameters. This type of adjustment was only made when the uncalibrated model results did not appear reasonable and the survey data results were based on a substantial number of observations. The specific calibration adjustments are documented in the Excel files.

Because of the extensive number of comparisons, the spreadsheet files themselves are incorporated as appendices to this report. The remainder of this chapter summarizes the validation results as presented in these spreadsheet files.

The Excel files document the comparisons of the base year model results to the observed data. Each file includes a tab showing the comparison for the entire NYBPM model region for the entire population, followed by tabs representing comparisons for market segments of interest, which, depending on the model may include subregions, households' characteristics such as income, and personal characteristics such as age and gender.

The validation/calibration process was performed as follows:

1. Importing the model estimation results (as documented in the model estimation report) into the "Calibration" tab.
2. Summarizing the observed data (from the expanded RHTS or other appropriate source) by segment in the "Observed data" tab.
3. Running the model and importing the results into the "Model output" tab.
4. Examining the comparison of model results and observed data to determine where the model may not accurately be representing the way that residents of the region travel.
5. Adjusting parameters as appropriate to improve the model results. If no (further) adjustments are needed, finalize the model.

6. If adjustments have been made, rerunning the model and importing the results, and returning to step 4.

The purpose of these comparisons is to verify, to the extent possible, that the model produces reasonable estimates of travel behavior. This does not necessarily mean that a model's forecasts are expected to be exact predictions of future traffic conditions. While it is desirable for a model's base year scenario to reasonably reflect the observed data, the primary objective is for the model to react correctly when run for scenarios representing transportation system, policy, or land use changes that planners wish to study. It is usually possible to improve the match between model results and observed data by adding or making changes to the values of parameters pertaining to various travel market segments; while such parameters are added for better prediction of variables that obviously need correction, increasing the effects of such parameters—such as constants—can make the model less sensitive to factors that affect travel in these scenarios.

An example of this is the average home-school distance between the observed data from NYMTC's Regional Household Travel Survey (RHTS) and the results of the CEMSELTS school location model for the Rockland-Orange subregion (discussed in Section 2.1 and documented in Table 2-1). The modeled average distance for the entire model region is within 0.16 miles (3.6 percent) of the observed distance from the RHTS. Due to the smaller sample sizes for individual subregions in the RHTS, we expect that the differences for subregions would be larger. Eight of the 11 subregions have modeled distances within 15 percent of the observed, within about half a mile. The exceptions are Connecticut at about 0.8 mile difference, Hunterdon-Sussex-Warren at about 1.5 mile difference, and Rockland-Orange with a nearly four mile difference between the modeled and observed home-school distance.

To address this anomaly, the distance variable for New York State could have been changed, as the model has a distance variable specific to New York State, but not to the Rockland-Orange subregion. However, doing so would also affect subregions where the modeled home-school distance is much closer to the observed. As such, changing the value of this parameter would adversely affect the model in other New York counties. It would also be possible to add a distance variable to the model only for the Rockland-Orange subregion, but this would reduce the model's sensitivity to other variables used for the Rockland-Orange subregion.

Given that these changes would not improve results for the entire model area and would therefore have an unnoticeable impact on planning analyses that use these results, no changes were made to the geographic specific distance variables in the school location model.

2.1 CEMSELTS Components

The CEMSELTS validation results can be found in a series of Excel files included in the zip file *CEMSELTS.zip*. There are 17 files representing comparisons between the model results and observed data, which in most cases come from NYMTC's Regional Household Travel Survey (RHTS). For some models, where RHTS data did not provide the necessary data items for comparison, other sources were used, including local data from the National Household Travel Survey (NHTS) and the U.S. Census American Community Survey (ACS).

The validation process consisted of the six steps shown above for each component, starting from the first CEMSELTS component to be validated (education attainment[3]) and continuing through the sequence, as indicated in Table 1-1.

The following is a summary of the base year model comparisons as shown in the Excel files within *CEMSELTS.zip*.

- Education attainment – Regional model results are within one or two percentage points of the observed, and comparisons for all segments are close.
- School location – Average modeled home-school distances are within four percent of observed; the coincidence ratio for the distance frequency distribution is 89 percent. Average modeled home-school distance comparisons by subregion are shown in Table 2-1.
- College location – Average modeled home-college distances are within two percent of observed; the coincidence ratio for the distance frequency distribution is 85 percent.
- Labor force participation – Regional model results are essentially the same as observed; results by subregion, age group, and gender are all within five percent.
- Employer type – Regional model results are essentially the same as observed; results by subregion, age group, and gender are all within 10 percent (all but a few within five percent).
- Occupation industry – Regional model results are with five percent of observed; results by subregion, age group, and gender are all within 10 percent (most within five percent).
- Household income – Regional model results for all income groups are very close to observed (there is a slight shift from $150K-$200K to $100K-$150K in the model). Results by subregion and other segments are all close.

[3] Education attainment is the first CEMSELTS component that requires validation. As shown in Table 1.1, that component is preceded by student status, which does not require validation because it directly uses the observed data rather than modeling student status.

- Residential tenure – Regional model results are essentially the same as observed; results by subregion and other segments are all close.
- Housing type – Regional model results are within a few percent of observed; results by subregion, household size, and income level are also close.
- Employment location – Regional results show that the modeled average home-work distance is very close to the observed. The modeled averages for subregions are mostly close to the observed (shown in Table 2-2) but are farther off for a few of the more remote subregions. The coincidence ratio for the distance frequency distribution is 84 percent. An additional comparison was performed by comparing the modeled subregion to subregion home-work distribution to the distribution from the ACS. This check showed a very close match between the two, as shown in Table 2-3.
- Weekly work duration – Regional model results are within three percent of observed; results by subregion, age group, and gender are mostly within five percent.
- Work flexibility – Regional model results are within two percent of observed; results by subregion, age group, and gender are mostly within five percent.
- Driver's license – Regional model results are within three percent of observed; results by subregion, age group, and gender are mostly within five percent (though license holding for Manhattan is somewhat overestimated).
- Parking pass – Regional model results are within one percent of observed; results by subregion, age group, and gender are mostly within five percent.
- Vehicle ownership – The regional modeled percentages of households by number of vehicles match the observed shares. Results by subregion, age group, and gender are mostly within two percent, with a few segments as much as five percent different.
- Annual mileage – The modeled average regional household mileage is within one percent of the observed from the NHTS data. The modeled percentages of households by mileage segment (generally 5,000 miles) are all within six percent of observed.
- Vehicle fleet composition – The model results match the observed regional distribution of vehicle types and ages closely.
- Primary driver allocation – The model matches well the observed distributions of vehicle types allocated to primary drivers across age and gender distributions.

Table 2-1. Average Modeled and Observed Home-School Distances (miles)

Subregion	Expanded RHTS data	Model	Difference (Model – Survey)
Manhattan	3.0	2.9	-0.1
Other NYC	4.2	4.3	0.1
Long Island	5.0	5.0	0.0
Westchester-Putnam-Dutchess	5.3	5.4	0.1
Rockland-Orange	8.8	5.0	-3.9
Bergen-Passaic	4.5	3.8	-0.7
Essex-Hudson-Union	3.1	3.5	0.4
Middlesex-Morris-Somerset-Mercer	4.1	3.9	-0.2
Monmouth-Ocean	4.4	3.7	-0.7
Hunterdon-Sussex-Warren	6.5	4.5	-2.0
Connecticut	4.6	3.8	-0.8
Region	4.5	4.2	-0.3

Table 2-2. Average Modeled and Observed Home-Work Distances (miles)

Subregion	Expanded RHTS data	Model	Percent Difference (Model - Survey)
Manhattan	5.1	5.1	0.0
Other NYC	8.3	9.2	0.9
Long Island	15.4	13.8	-1.6
Westchester-Putnam-Dutchess	15.2	16.0	0.8
Rockland-Orange	20.9	18.7	-2.2
Bergen-Passaic	11.9	10.4	-1.5
Essex-Hudson-Union	9.8	9.8	0.0
Middlesex-Morris-Somerset-Mercer	14.0	14.4	0.5
Monmouth-Ocean	18.0	19.8	1.8
Hunterdon-Sussex-Warren	21.2	23.1	1.9
Connecticut	12.0	12.7	0.8
Region	11.7	11.8	0.1
New York	10.7	10.8	0.0
New Jersey	13.4	13.7	0.2

Table 2-3. Modeled Subregion Level Home-Work Flows Compared to ACS

		ACS Journey to Work 2009 - 2013										
		1	2	3	4	5	6	7	8	9	10	11
1	Manhattan	85%	9%	1%	1%	0%	1%	1%	1%	0%	0%	1%
2	Other NYC	36%	57%	4%	2%	0%	0%	1%	0%	0%	0%	0%
3	Long Island	10%	11%	78%	0%	0%	0%	0%	0%	0%	0%	0%
4	Westchester-Putnam-Dutchess	15%	8%	1%	70%	2%	1%	0%	0%	0%	0%	4%
5	Rockland-Orange	8%	6%	0%	8%	68%	7%	1%	1%	0%	0%	1%
6	Bergen-Passaic	11%	3%	0%	1%	1%	64%	12%	6%	0%	0%	0%
7	Essex-Hudson-Union	15%	2%	0%	0%	0%	8%	61%	12%	1%	0%	0%
8	Middlesex-Morris-Somerset-Mercer	6%	1%	0%	0%	0%	4%	12%	71%	3%	2%	0%
9	Monmouth-Ocean	5%	2%	0%	0%	0%	1%	6%	12%	74%	0%	0%
10	Hunterdon-Sussex-Warren	2%	1%	0%	0%	1%	6%	8%	32%	0%	51%	0%
11	Connecticut	4%	1%	0%	3%	0%	0%	0%	0%	0%	0%	92%
	Total	23%	20%	12%	6%	2%	6%	9%	10%	4%	1%	8%

		Model 2012										
		1	2	3	4	5	6	7	8	9	10	11
1	Manhattan	86%	9%	1%	1%	0%	1%	1%	1%	0%	0%	0%
2	Other NYC	35%	56%	4%	2%	0%	1%	1%	0%	0%	0%	0%
3	Long Island	10%	10%	80%	0%	0%	0%	0%	0%	0%	0%	0%
4	Westchester-Putnam-Dutchess	15%	7%	0%	70%	3%	1%	0%	0%	0%	0%	3%
5	Rockland-Orange	9%	6%	0%	9%	65%	6%	1%	1%	0%	0%	1%
6	Bergen-Passaic	12%	3%	0%	1%	1%	66%	12%	5%	0%	0%	0%
7	Essex-Hudson-Union	15%	2%	0%	0%	0%	8%	61%	12%	1%	1%	0%
8	Middlesex-Morris-Somerset-Mercer	6%	1%	0%	0%	0%	4%	12%	73%	3%	1%	0%
9	Monmouth-Ocean	5%	2%	0%	0%	0%	2%	6%	12%	73%	0%	0%
10	Hunterdon-Sussex-Warren	2%	1%	0%	0%	1%	5%	7%	31%	1%	52%	1%
11	Connecticut	4%	1%	0%	3%	0%	0%	0%	0%	0%	0%	91%
	Total	23%	20%	12%	6%	2%	6%	8%	10%	4%	1%	8%

2.2 CEMDAP COMPONENTS

The CEMDAP validation results can be found in a series of Excel files included in five zip files corresponding to the five travel segments:

- *GA.zip* (13 files)
- *WSCH.zip* (18 files)
- *NWSCH.zip* (10 files)
- *JASCH.zip* (3 files)
- *CSCH.zip* (3 files)

The observed data for the CEMDAP comparisons come from NYMTC's RHTS. The validation process consisted of the six steps shown at the beginning of this chapter for each component. The GA series was validated first, and the four remaining series were validated in parallel.

The following is a summary of the base year model comparisons as shown in the Excel files within the five zip files.

GA Series

- GA1 – Child's decision to go to school – Regional model results are within one or two percentage points of the observed, and comparisons for grade levels are close. The RHTS data shows some variation by subregion which is not captured by the model (though it is unclear why attendance rates among subregion should vary much).
- GA2/GA3 – Child's school start and end times – The modeled average school activity duration is 6.9 hours, compared to 7.0 hours in the expanded RHTS data set. The coincidence ratios between the modeled and RHTS diurnal distributions at the hourly level are 71 percent for start times and 63 percent for end times. The modeled and RHTS percentages of a.m. and p.m. peak period start and end times are shown in Table 2-4.
- GA4 – Adult's decision to go to work – Regional model results essentially the same as the observed, and comparisons for subregions, age levels, and work durations are close.
- GA5 – Adult's work start and end times – The modeled average work activity duration is 7.1 hours, compared to 7.5 hours in the expanded RHTS data set. The coincidence ratios between the modeled and RHTS diurnal distributions at the hourly level are 56 percent for start times and 58 percent for end times. The modeled and RHTS percentages of a.m. and p.m. peak period start and end times are shown in Table 2-5. The modeled percentage of work arrivals in the a.m. peak periods is low, with more peak spreading than in the RHTS data. The model's functional form made it difficult to produce a better match.
- GA6 – Adult's decision to go to school – Regional model results essentially the same as the observed, and comparisons by subregions and gender are mostly within five percentage points.
- GA7/GA8 – Adult's school start and end times – The modeled average school activity duration is 7.0 hours, compared to 7.0 hours in the expanded RHTS data set. The coincidence ratios between the modeled and RHTS diurnal distributions at the hourly level are 49 percent for start times and 60 percent for end times. The model underestimates the percentage of adult school start times in the p.m. peak period.
- GA9/GA10 – Child's travel mode to school and from school – At the regional level, the modeled shares for all modes are within one percentage

point of the observed, as shown in Table 2-6. Observed trends of mode shares by income level and household size are reflected in the model results. In the subregional summaries, there are some differences between modeled and observed mode shares. The largest of these are in the splits between school bus and walk mode shares in Connecticut and most of New Jersey. These mode shifts do not affect trip assignment since neither walk nor school bus person trips are assigned.

- GA11/GA12 – Allocation of drop off and pickup episodes to parent – Regional model results are within six percent of observed.
- GA13 – Determination of households with non-zero out-of-home duration – The regional percentage of households with non-zero out-of-home activities is within one percent of observed. Comparisons by subregion, income level, and household size are mostly within five percent.
- GA14 – Determination of total OH time of a household – It was noted that the aggregate percentage of time spent inside the home as reported in the RHTS was likely too high to match observed regional travel counts. Calibration was performed to produce a lower percentage of time inside the home (61 percent) than observed (68 percent).
- GA15/GA16 – Independent and joint activity participation for households – The model tended to underestimate joint activity participate somewhat and to overestimate individual participation in work related and other activities. The model reflected observed trends by subregion, income level, household size, and auto ownership level.
- GA17 – Decision of adult to undertake other serve-passenger activities – Regional model results were essentially the same as observed in the expanded RHTS data set, as were model results by gender and employment status. The model reflected that serve-passenger activity participation was lower in Manhattan (though not quite as low as in the observed data).

Table 2-4. Modeled and Observed Percentages of Child School Start and End Times in Peak Periods

Peak Period	Expanded RHTS data		Model Results	
	Start	End	Start	End
AM (6:00-9:00)	81.5%	0.2%	85.6%	0.5%
PM (3:00-6:00)	1.0%	2.2%	3.8%	8.6%

Table 2-5. Modeled and Observed Percentages of Work Start and End Times in Peak Periods

Peak Period	Expanded RHTS data		Model Results	
	Start	End	Start	End
AM (6:00-10:00)	74.7%	1.8%	52.4%	0.1%
PM (3:00-7:00)	5.5%	69.6%	9.4%	64.2%

Table 2-6. Modeled and Observed Regional Child School Mode Shares

Tour Mode	Expanded RHTS data		Model Results	
	To School	From School	To School	From School
HOV - parent chauffeur	30.6%	24.4%	30.0%	24.3%
HOV - other chauffeur	6.9%	8.8%	6.9%	8.7%
Commuter rail/bus – walk access	0.5%	0.5%	0.5%	0.5%
Subway/ferry – walk access	3.6%	3.5%	4.0%	3.7%
Local bus – walk access	4.2%	4.0%	4.8%	4.1%
Walk	17.8%	21.1%	17.7%	20.7%
Bike	0.3%	0.4%	0.3%	0.4%
School bus	36.1%	37.3%	35.8%	37.6%

WSCH Series

- WSCH1 – Worker commute mode – As one of the key components of the entire model, significant attention was paid to the validation and calibration of this component. This included revisiting the validation after the initial highway and transit assignment results to better reflect observed travel conditions, including observations from transit rider surveys. As a result, some new "targets" for mode shares were established that differed from those observed in the RHTS data set. One of the most significant changes was revising the auto access and walk access split for the commuter rail/bus mode to match observed shares from commuter rail survey data.

  Table 2-7 compares the regional model results to the targets. The close match indicates that in the aggregate, the model is producing about the correct number of trips by mode. Because it was not possible to create new targets for the observed mode shares for all of the segments that are consistent with the revised regional targets, a direct comparison of modeled shares to observed is difficult. However, the trends in the model results track those in the RHTS data. For example:

- o For Manhattan residents, auto mode shares are very low (less than 10 percent) while transit shares exceed 60 percent, and non-motorized mode shares are around 20 percent.
- o The transit shares are slightly lower for residents of the other New York City boroughs while the auto shares are around 20 percent, and non-motorized mode shares are under 10 percent.
- o In the rest of the region, auto shares are in the 80 to 90 percent range, except in Essex/Hudson/Union Counties in New Jersey, where the auto share is under 70 percent. The highest auto shares are in the subregions farthest from New York City. Transit shares are in the 15 to 25 percent range in the nearest subregions to the city and are under 10 percent in the rest of the region. The non-motorized shares are under five percent outside New York City and are lower the farther from the city.
- o Travelers from households with annual incomes below $30,000 have auto mode shares of around 40 percent, transit mode shares around 30 percent, and non-motorized mode shares around 25 percent.
- o Travelers from households who own zero vehicles have transit shares around 55 percent range and non-motorized mode shares around 30 percent.

- WSCH2 – Number of before-work tours – The model closely matches the observed percentages of workers with zero, one, and two or more before-work tours.
- WSCH3 – Number of work-based subtours – The model closely matches the observed percentages of workers with zero, one, and two or more work-based subtours.
- WSCH4 – Number of after-work tours – The model closely matches the observed percentages of workers with zero, one, and two or more after-work tours.
- WSCH5/WSCH6/WSCH7 – Before-work/work-based/after-work tour mode – The models closely match the observed regional mode shares for these tours made by workers. Modeled mode shares for the various geographic and demographic segments are generally consistent with observed mode shares, for segments with large enough sample sizes to make worthwhile comparisons.

- WSCH8 – Worker number of stops on commute/before work/after work/at-work tours – The models closely match the observed regional mode shares for these tours. Modeled mode shares for the various demographic segments also match observed mode shares, for segments with large enough sample sizes to make worthwhile comparisons.
- WSCH9 – Worker home or work stay duration before tour – The model results match the observed average durations for all tour types (before-work/after-work/at-work).
- WSCH10 – Worker activity type at stop – The model overestimates the percentage of work-related activities and underestimates the percentages of maintenance, shopping, and social activities. This model is largely determined by the upstream models (GA15/GA16/GA17) which predict activity budgets.
- WSCH11 – Worker activity duration at stop – The model estimates the average activity duration at a stop at 48 minutes, compared to 49 minutes in the RHTS data. The modeled average duration is within a few minutes of the observed for most activity purposes (12 to 15 minutes different for the activities with the longest durations, recreation and social).
- WSCH12 – Worker travel distance to a stop – This is an interim model whose validation is effectively included in the WSCH13 model results described below.
- WSCH13 – Worker location of a stop – The modeled average trip distance is 5.2 miles, compared to the observed average of 5.4 miles. The modeled averages for subregions are all close to the observed (shown in Table 1-1Table 2-8). The coincidence ratio for the distance frequency distribution is 76 percent. The modeled percentage of intrazonal stops is 18 percent, compared to 15 percent observed.
- WSCH14 – Worker commute trip mode choice – The worker commute trip mode choice is closely related to the mode choice for the commute tour (model WSCH1, discussed above). Table 2-9 shows the regional modeled and observed trip mode shares, which are similar to those shown for model WSCH1 in Table 2-7. The model results show that, as is observed, trips on commute tours tend to use the same modes as the tour mode. Model results for geographic and demographic segments also match the observed mode shares well.

Table 2-7. Modeled and Observed Regional Worker Commute Mode Shares

Tour Mode	Commute to Work		Commute from Work	
	Observed*	Model	Observed*	Model
SOV	54.4%	54.1%	54.4%	53.6%
HOV 2	5.4%	5.4%	5.4%	6.3%
HOV 3+	1.0%	1.0%	1.0%	0.9%
Taxi	1.4%	2.0%	1.4%	1.7%
Commuter rail/bus – auto access	5.7%	5.0%	5.7%	5.0%
Commuter rail/bus – walk access	4.4%	4.5%	4.4%	4.6%
Subway/ferry – auto access	0.9%	0.6%	0.9%	0.7%
Subway/ferry – walk access	14.9%	15.8%	14.9%	16.0%
Local bus – walk access	4.4%	4.3%	4.4%	3.9%
Walk	5.4%	5.2%	5.4%	5.2%
Bike	0.7%	0.6%	0.7%	0.6%
School bus	1.6%	1.6%	1.6%	1.5%

* - Adjusted targets from RHTS

Table 2-8. Average Modeled and Observed Home-Work Distances (miles)

Subregion	Expanded RHTS data	Model	Difference (Model - Survey)
Manhattan	5.1	5.1	0.0
Other NYC	8.3	9.2	0.9
Long Island	15.4	13.8	-1.6
Westchester-Putnam-Dutchess	15.2	16.0	0.8
Rockland-Orange	20.9	18.7	-2.2
Bergen-Passaic	11.9	10.4	-1.5
Essex-Hudson-Union	9.8	9.8	0.0
Middlesex-Morris-Somerset-Mercer	14.0	14.4	0.5
Monmouth-Ocean	18.0	19.8	1.8
Hunterdon-Sussex-Warren	21.2	23.1	1.9
Connecticut	12.0	12.7	0.8
Region	11.7	11.8	0.1

Table 2-9. Modeled and Observed Regional Trip Mode Shares on Work Commute

	Observed*	Model
SOV	55.5%	54.1%
HOV 2	5.5%	6.7%
HOV 3+	1.0%	1.1%
Taxi	1.5%	1.9%
Commuter rail/bus – auto access	4.8%	4.0%
Commuter rail/bus – walk access	3.7%	4.0%
Subway/ferry – auto access	0.8%	0.5%
Subway/ferry – walk access	15.2%	16.1%
Local bus – auto access	0.0%	0.0%
Local bus – walk access	4.4%	4.5%
Walk	5.5%	5.3%
Bike	0.7%	0.6%
School bus	1.6%	1.6%

* - Adjusted targets from RHTS

NWSCH Series

- NWSCH1 – Non-worker number of independent tours – The model closely matches the observed percentages of non-workers with zero, one, and two or more independent tours.
- NWSCH2/NWSCH3 – Non-worker decision to undertake independent tour before/after pick-up or joint discretionary tour – The model closely matches the observed percentages of non-workers who choose to undertake an independent tour before a pick-up or joint discretionary tour and after a pick-up or joint discretionary tour.
- NWSCH5 – Non-worker number of stops in a tour – The model closely matches the observed percentages of non-workers with one, two, three, four, five, and six stops on tours.
- NWSCH6 – Non-worker number of stops following pick-up/drop-off – The model matches the observed percentage of non-workers (95 percent) who do not make any stops following pick-up/drop-off activities. Among the five percent of workers who make at least one stop, the model somewhat overestimates the percentage who make one stop and underestimates the percentage who make two or three stops.
- NWSCH7 – Non-worker home stay duration before tour – The model overestimates the home stay duration before the first tour made, and to a lesser extent, the home stay duration before the second tour. The model slightly underestimates the home stay duration before the third and fourth tours.
- NWSCH8 – Non-worker activity type at stop – The model matches the observed percentages for all activity types within five percentage points,

except for the percentage of work-related activities, which is underestimated by about ten percentage points. Since work-related stops are special cases for non-workers, it was difficult to simulate many of these types of stops (the observed percentage of 15 percent seems a bit high in any case).

- NWSCH9 – Non-worker activity duration at stop – The model underestimates the average activity duration at a stop by a little over 25 minutes.
- NWSCH10 – Non-worker travel distance to a stop – This is an interim model whose validation is effectively included in the NWSCH11 model results described below.
- NWSCH11 – Non-worker stop location – The modeled average trip distance is 5.2 miles, compared to the observed average of 5.4 miles. The modeled averages for subregions are all close to the observed (shown in Table 2-10). The coincidence ratio for the distance frequency distribution is 88 percent. The modeled percentage of intrazonal stops is 16 percent, compared to 15 percent observed.
- NWSCH4 – Non-worker trip mode – Table 2-11 shows the regional modeled and observed non-worker trip mode shares, which match well. Model results for geographic and demographic segments also match the observed mode shares well.

Table 2-10. Average Modeled and Observed Non-Worker Trip Distances (miles)

Subregion	Expanded RHTS data	Model	Percent Difference (Model - Survey)
Manhattan	2.6	2.6	0.0
Other NYC	3.9	3.9	0.0
Long Island	7.1	6.9	-0.1
Westchester-Putnam-Dutchess	5.4	5.4	-0.1
Rockland-Orange	8.5	8.5	0.0
Bergen-Passaic	5.6	5.5	-0.1
Essex-Hudson-Union	4.7	4.6	-0.1
Middlesex-Morris-Somerset-Mercer	6.5	6.4	-0.1
Monmouth-Ocean	7.4	7.4	0.0
Hunterdon-Sussex-Warren	11.3	11.3	0.0
Connecticut	5.1	5.0	0.0
Region	5.4	5.2	-0.2

Table 2-11. Modeled and Observed Regional Non-Worker Trip Mode Shares

	Observed*	Model
SOV	57.8%	57.3%
HOV 2	6.6%	7.2%
HOV 3+	1.5%	1.3%
Taxi	1.4%	2.1%
Commuter rail/bus – auto access	3.1%	2.9%
Commuter rail/bus – walk access	2.3%	1.9%
Subway/ferry – auto access	0.7%	0.7%
Subway/ferry – walk access	11.5%	12.0%
Local bus – auto access	0.1%	0.0%
Local bus – walk access	3.4%	3.3%
Walk	11.1%	10.3%
Bike	0.6%	1.0%
School bus	57.8%	57.3%

* - Adjusted targets from RHTS

JASCH Series

JASCH2 – Joint activity start time – The overall coincidence ratio between the modeled and observed temporal distributions of joint activity start times is 55%. The main difference is that the model form tends to overestimate start times in the final period of the day (8:00 p.m. to 3:00 a.m.). Even considering that issue, the model tends to underestimate peak period activity start times. Of the joint activities that begin before 8:00 p.m., the modeled percentage of start times between 6:00 and 9:00 a.m. is 2.4 percent, compared to 5.7 percent observed, and the modeled percentage between 3:00 and 6:00 p.m. is 25.3 percent, compared to 30.9 percent observed.

JASCH3 – Joint activity distance to stop – This is an interim model whose validation is effectively included in the JASCH4 model results described below.

JASCH4 – Joint activity location – The modeled average trip distance is 4.3 miles, compared to the observed average of 4.5 miles. The modeled averages for subregions are all very close to the observed. The coincidence ratio for the distance frequency distribution is 77 percent.

JASCH6 – Joint discretionary trip mode choice – Table 2-12 shows the regional modeled and observed joint trip mode shares, which match very closely. Model results for geographic and demographic segments also match the observed mode shares well.

JASCH5 – Vehicle used for joint home-based tour – Since in the final overall model structure this component's results are not used downstream, its results were not validated.

Table 2-12. Modeled and Observed Regional Joint Trip Mode Shares

	Observed*	Model
HOV 2	45.0%	44.9%
HOV 3+	31.0%	30.9%
Taxi	1.0%	1.1%
Commuter rail/bus – auto access	0.3%	0.3%
Commuter rail/bus – walk access	0.4%	0.2%
Subway/ferry – auto access	0.1%	0.1%
Subway/ferry – walk access	3.0%	3.2%
Local bus – auto access	0.0%	0.0%
Local bus – walk access	2.7%	2.8%
Walk	16.3%	16.1%
Bike	0.3%	0.3%
School bus	45.0%	44.9%

* - Adjusted targets from RHTS

CSCH Series

CSCH4 – Child departure time from home for independent discretionary tour – The overall coincidence ratio between the modeled and observed temporal distributions of child (non-school) activity start times is 61 percent. The model tends to underestimate a.m. peak period activity start times and overestimate p.m. peak period activity start times. The modeled percentage of start times between 6:00 and 9:00 a.m. is 11.4 percent, compared to 19.5 percent observed, and the modeled percentage between 3:00 and 6:00 p.m. is 53.5 percent, compared to 34.2 percent observed.

CSCH5 – Child activity duration at independent discretionary stop – The model underestimates the average activity duration at a stop by about 45 minutes.

CSCH6 – Child travel distance to independent discretionary stop – This is an interim model whose validation is effectively included in the CSCH7 model results described below.

CSCH7 – Child location of independent discretionary stop – The modeled average trip distance is 2.8 miles, compared to the observed average of 3.1 miles. The modeled averages for subregions are all very close to the observed. The coincidence ratio for the distance frequency distribution is 53 percent.

CSCH3 – Child mode for independent discretionary trip – Table 2-13 shows the regional modeled and observed joint trip mode shares, which match very closely except for underestimating walk trips and a corresponding overestimation of HOV 2 trips. Model results for geographic and demographic segments also match the observed mode shares well although the underestimation of walk trips and overestimation of HOV 2 trips is most noticeable in Manhattan.

Table 2-13. Modeled and Observed Regional Child Trip Mode Shares

	Observed*	Model
HOV 2	30.2%	46.7%
HOV 3+	50.6%	50.9%
Taxi	0.3%	0.3%
Subway/ferry – walk access	2.0%	0.1%
Local bus – walk access	1.3%	0.1%
Walk	15.3%	1.1%
Bike	0.4%	0.7%

* - Adjusted targets from RHTS

3.0 Trip Assignment Validation

3.1 Highway Assignment

The highway validation focused on three main classes of measures:

- Vehicle-miles of travel (VMT);
- Individual link traffic volumes; and
- Intra-regional traffic flows as defined by screenlines.

All of these measures are based on comparisons of assigned volumes from the model to observed traffic counts. Due to the large number of jurisdictions that maintain the roads in the network and the variety of roadway types, the counts are assembled from several sources. Generally, the highway assignment results match observed data reasonably well, with no major high or low biases compared to traffic counts.

It should be noted that during the validation process, some gaps and errors in the traffic count database were identified and corrected to the degree possible. Additionally, there appear to be some instances where traffic counts were performed at locations where the traffic loading points from TAZ centroid connectors would not well represent traffic on those links. These instances were also identified, and corrected to the degree possible. While corrections to the traffic count database and centroid connector locations improved the validation, neither of these issues has a major impact on model results though they do affect some of the comparisons between modeled volumes and counts—especially percentage root mean square error (%RMSE).

VMT Checks

For the region, the modeled VMT on links with traffic counts is about half a percent lower than the observed VMT computed from the counts. Table 3-1 shows the modeled and observed VMT by facility type, with the percentage difference compared to the targets from the model validation plan. All targets are met. There are no targets for the (generally low volume) local streets and ramp facility types, which comprise less than one percent of the VMT.

Table 3-1. Modeled and Observed Daily VMT by Facility Type

	Model VMT	Count VMT	Total	Target
Interstate/Freeway/Tollway	18,247,437	17,507,599	4.2%	7%
Principal Arterial	6,758,944	7,397,019	-8.6%	10%
Minor Arterial	3,422,622	3,743,737	-8.6%	10%
Major Collector	800,005	743,276	7.6%	15%
Minor Collector	188,273	198,300	-5.1%	15%
Local Street	29,682	55,979	-47.0%	
Ramp	173,104	126,806	36.5%	
Total	**29,620,067**	**29,772,716**	**-0.5%**	**1%**

The percentage differences between modeled and observed VMT for the four time periods used in highway assignment are:

- AM peak (6:00 AM - 10:00 AM): -4.0%
- Mid-day (10:00 AM – 3:00 PM): -1.8%
- PM peak (3:00 PM – 7:00 PM): -3.1%
- Night (7:00 PM – 6:00 AM): -3.2%

Note that this summary does not include all links included in the summary shown in Table 3-1; there are some links with daily counts but not counts by time of day.

Table 3-2 shows the modeled and count VMT for a set of districts that comprise the entire region. The VMT is within 5.5 percent for all subregions except Mercer County and Connecticut.

Table 3-2. Modeled and Observed Daily VMT by Subregion

	Model VMT	Count VMT	% Difference
Manhattan CBD	578,948	612,561	-5.5%
Upper Manhattan	727,844	718,358	1.3%
Other NYC	4,491,255	4,689,221	-4.2%
Long Island	3,052,757	3,013,531	1.3%
Mid-Hudson	6,057,722	6,285,356	-3.6%
NJTPA Core	3,789,973	3,979,602	-4.8%
NJTPA Other	8,245,810	8,128,133	1.4%
Connecticut	1,899,235	1,682,758	12.9%
Mercer County, NJ	776,522	663,196	17.1%
Total	29,620,066	29,772,716	-0.5%

Link Volume Checks

The overall fit between individual modeled and observed link volumes was examined using the percentage root mean square error (%RMSE) measure. Table

3-3 and Table 3-4 show the %RMSE grouped by facility type and volume group, respectively.

The %RMSE error for each segment, and for the entire set of all links with counts, does not meet most of the targets from the validation plan. This may be due to the issues with some count locations and network loading points discussed at the beginning of this section. For example, the modeled volumes on roadways where zone centroid connectors meet the highway network may be high if actual network loading points for the zone are more dispersed; conversely, modeled volumes on roads where trips from a zone are actually loading may be low if the zone's centroid connectors are not nearby.

Table 3-3. %RMSE by Facility Type

Facility Type	Total	Target
Interstate/Freeway/Tollway	25%	20%-30%
Principal Arterial	54%	30%
Minor Arterial	77%	40%
Major Collector	131%	70%
Minor Collector	207%	70%
Local Street	64%	
Ramp	66%	
Total	**46%**	**40%**

Table 3-4. %RMSE by Volume Group

Volume Group	Links	% RMSE	Target
0 - 1,000	37	552%	100%-200%
1,000 - 5,000	321	150%	45%-100%
5,000 - 10,000	448	78%	36%-45%
10,000 - 20,000	655	54%	28%-34%
20,000 - 30,000	265	44%	24%-26%
30,000 - 50,000	239	38%	21%-24%
50,000 - 100,000	205	26%	12%-21%
100,000 and up	35	21%	12%
All Links	**2,205**	**46%**	**40%**

Table 3-5 shows the VMT, as estimated by the model and observed through traffic counts on 30 major routes that have at least 100,000 VMT on links with counts. Twenty-two of these 30 routes had modeled VMT within 25 percent of observed, and 18 routes had modeled VMT within 20 percent of observed. The model most notably overestimates volumes on the Long Island Expressway, the Taconic State Parkway, and the Palisades Interstate Parkway and underestimates volumes on Shore Parkway, Sunrise Highway, and Meadowbrook State Parkway.

Table 3-6 shows a comparison of volumes on the major crossings into and within New York City, grouped by waterway and location. With one exception, each group's modeled volume is within 15 percent of the traffic counts. The exception is the Kill Van Kull segment, which consists of only the Bayonne Bridge. The Modeled volume on the Bayonne Bridge is 23,000, compared to a count of 19,000.

Table 3-5. Modeled and Observed VMT on Major Routes

	Model VMT	Count VMT	% Diff.	No. of Counts
Garden State Pkwy	2,984,229	2,615,942	14%	81
NJ Turnpike	2,208,268	2,415,491	-9%	26
NYS Thruway	901,986	1,080,273	-17%	12
Southern Pkwy	621,345	603,541	3%	11
Long Island Expy	646,219	492,386	31%	11
I-84 in NY	333,044	373,683	-11%	5
I-84 in CT	460,893	370,743	24%	4
Shore Pkwy	218,822	312,825	-30%	7
Palisades Interstate Pkwy	391,391	309,329	27%	8
I-95 in CT	282,166	304,976	-7%	4
Northern State Pkwy	301,357	300,403	0%	8
I-87	225,942	278,489	-19%	14
Brooklyn Queens Expy	274,494	274,715	0%	10
I-684	300,627	246,085	22%	6
Cross Island Pkwy	198,472	245,611	-19%	9
FDR Drive	287,449	242,997	18%	15
Belt Pkwy	199,454	207,590	-4%	7
I-84	252,045	201,720	25%	10
Henry Hudson Pkwy	191,178	185,151	3%	7
State Hwy 440	148,866	182,235	-18%	11
Sunrise Hwy	126,221	182,235	-31%	5
I-95 In NY	129,302	162,316	-20%	11
State Hwy 17	117,256	149,002	-21%	4
Meadowbrook State Pkwy	80,060	143,504	-44%	6
Hutchinson River Pkwy	147,193	138,502	6%	4
Taconic State Pkwy	218,269	133,205	64%	11
US Hwy 9	97,222	130,592	-26%	15
Saw Mill River Pkwy	102,483	117,414	-13%	4
Gowanus Expy	139,305	104,992	33%	5
I-278	97,058	101,563	-4%	1

Table 3-6. Modeled and Observed Volumes on Major Crossings

	Links	Model	Count	% Diff.
1: Outerbridge Crossing	2	79,414	71,816	11%
2: Goethals Bridge	2	86,141	73,136	18%
Arthur Kill Subtotal	**4**	**165,555**	**144,952**	**14%**
3: Bayonne Bridge	2	23,304	18,755	24%
Kill Van Kull Subtotal	**2**	**23,304**	**18,755**	**24%**
4: Holland Tunnel	2	114,448	92,743	23%
5: Lincoln Tunnel	2	130,278	113,166	15%
6, 7: G Washington Bridge	4	304,266	276,647	10%
8: Tappan Zee Bridge	2	135,531	133,352	2%
9: Mountain Bridge Rd	1	38,003	19,999	90%
10: Newburgh Beacon Bridge	2	90,399	74,500	21%
Hudson River Subtotal	**13**	**812,925**	**710,407**	**14%**
11: Verrazano Bridge	4	218,419	193,100	13%
The Narrows Subtotal	**4**	**218,419**	**193,100**	**13%**
12: Hugh L Carey Tunnel	4	49,551	54,299	-9%
13: Brooklyn Bridge	2	86,723	100,288	-14%
14: Manhattan Bridge	5	103,692	89,087	16%
15: Williamsburg Bridge	2	131,825	112,696	17%
16: Queens Midtown Tunnel	2	72,950	87,938	-17%
17: Ed Koch Queensboro Bridge	5	194,104	178,188	9%
18: R.F. Kennedy Bridge (Queens/Bronx)	2	95,222	85,805	11%
19: R.F. Kennedy (Queens /Manhattan)	2	56,529	66,622	-15%
20: R.F. Kennedy (Bronx / Manhattan)	2	27,876	24,334	15%
21: Bronx Whitestone Bridge	2	128,176	105,719	21%
22: Throgs Neck Bridge	2	127,278	108,859	17%
East River Subtotal	**30**	**1,073,928**	**1,013,835**	**6%**
23: Willis Avenue Bridge - Nb	1	62,564	62,061	1%
24: 3rd Ave Bridge - Sb	1	54,638	59,054	-8%
25: Madison Avenue Bridge	1	43,577	41,782	4%
26: 145th St Bridge	1	24,520	27,918	-12%
27: Macombs Dam Bridge	1	48,108	39,020	23%
28: Cross Bronx Exp Bridge	2	147,857	185,308	-20%
29: Washington Bridge	2	65,124	57,011	14%
30: W 207th St Bridge	1	48,326	39,640	22%
31: Broadway Ave Bridge	1	47,535	35,410	34%
32: Henry Hudson Pkwy Bridge	2	28,466	63,435	-55%
Harlem River Subtotal	**13**	**570,716**	**610,639**	**-7%**

Screenlines

To examine how well the model reflects intra-regional traffic flows, a set of 29 screenlines was defined. The validation plan defined target percentages for the difference between the summed volumes and traffic counts based on the daily traffic across the screenline. Table 3-7 shows the modeled volumes and counts for both directions for these screenlines. The volume difference meets the targets for 25 of the 29 screenlines. Two of the four for which the targets are not met are single link screenlines with average daily volumes of around 10,000 per day per direction.

Some of the major regional trip movements were examined by summing volumes for multiple screenlines. This summary is shown in Table 3-8.

Table 3-7. Modeled and Observed Volumes on Screenlines

	Links	Model NB/EB	Count NB/EB	% Diff NB/EB	Model SB/WB	Count SB/WB	Diff SB/WB	Model Total	Count Total	% Diff Total	Target
Border betw Manhattan & Brooklyn	13	184,143	178,925	2.9%	187,648	177,445	5.7%	371,791	356,370	4.3%	20%
Border betw Manhattan & Queens	9	157,119	160,044	-1.8%	166,464	172,704	-3.6%	323,583	332,748	-2.8%	20%
Border betw Manhattan & Bronx	15	296,737	315,811	-6.0%	301,854	319,162	-5.4%	598,591	634,973	-5.7%	20%
Border betw NJ & Manhattan	8	259,588	238,204	9.0%	289,403	244,352	18.4%	548,991	482,556	13.8%	20%
Border betw CBD & upper Manhattan	17	282,263	325,315	-13.2%	330,648	311,941	6.0%	612,911	637,256	-3.8%	20%
Border betw Brooklyn & Queens	35	480,884	437,680	9.9%	423,593	385,655	9.8%	904,477	823,335	9.9%	20%
Border betw Staten Island & Brooklyn	4	112,639	100,991	11.5%	105,780	92,109	14.8%	218,419	193,100	13.1%	20%
Cross Bay Blvd betw Queens & Rockaway	1	16,164	11,140	45.1%	16,639	10,456	59.1%	32,803	21,596	51.9%	25%
Border betw Queens & Bronx	6	182,099	146,890	24.0%	168,577	153,493	9.8%	350,676	300,383	16.7%	20%
Border betw NJ & Staten Island	6	99,402	84,416	17.8%	89,456	79,291	12.8%	188,858	163,707	15.4%	20%
US202 Bridge betw Westchester & Orange	1	18,858	9,999	88.6%	19,146	10,000	91.5%	38,004	19,999	90.0%	25%
I-84 Bridge betw Dutchess & Orange	2	44,686	37,000	20.8%	45,713	37,500	21.9%	90,399	74,500	21.3%	22%
Border betw Westchester & Rockland (Cuomo Br.)	2	67,944	66,676	1.9%	67,587	66,676	1.4%	135,531	133,352	1.6%	20%
Border betw Bronx & Westchester	24	309,283	311,236	-0.6%	312,118	326,317	-4.4%	621,401	637,553	-2.5%	20%
Border betw Nassau & Suffolk	24	349,420	342,628	2.0%	338,712	343,032	-1.3%	688,132	685,660	0.4%	20%
Border betw Nassau & Long Beach/Jones Beach	8	35,278	66,950	-47.3%	33,527	67,446	-50.3%	68,805	134,396	-48.8%	20%
Border betw Putnam & Dutchess	12	70,752	76,922	-8.0%	72,794	74,973	-2.9%	143,546	151,895	-5.5%	20%
EW Border Betw Queens & Nassau	29	493,597	489,136	0.9%	473,552	468,320	1.1%	967,149	957,456	1.0%	20%
NS Border Betw Rockland & Orange	12	101,306	104,541	-3.1%	100,442	101,530	-1.1%	201,748	206,071	-2.1%	20%
EW Border betw Westchester & Putnam	18	94,189	73,398	28.3%	90,638	69,634	30.2%	184,827	143,032	29.2%	20%
NS Border betw Sussex NJ & Orange NY	8	28,005	24,895	12.5%	27,989	26,285	6.5%	55,994	51,180	9.4%	22%
NS Border betw Bergen NJ & Rockland NY	22	132,521	131,942	0.4%	131,194	131,787	-0.4%	263,715	263,729	0.0%	20%
EW Border betw Putnam & Fairfield CT	7	53,865	49,758	8.3%	54,299	53,863	0.8%	108,164	103,621	4.4%	20%
EW Border betw Westchester & Fairfield CT	21	131,058	121,588	7.8%	134,365	122,045	10.1%	265,423	243,633	8.9%	20%
EW Border of Dutchess & Litchfield CT	10	8,572	8,743	-2.0%	8,635	8,865	-2.6%	17,207	17,608	-2.3%	30%
NS Border of Dutchess & Columbia	14	16,755	16,455	1.8%	15,299	15,410	-0.7%	32,054	31,865	0.6%	25%
EW Border betw Ulster & Dutchess	4	30,871	30,999	-0.4%	30,936	31,000	-0.2%	61,807	61,999	-0.3%	22%
NS Border betw Orange & Sullivan/Ulster	15	75,819	74,044	2.4%	71,413	71,438	0.0%	147,232	145,482	1.2%	20%

Table 3-8. Aggregate Screenline Summary

	Links	Model NB/EB*	Count NB/EB*	% Diff NB/EB*	Model SB/WB*	Count SB/WB*	Diff SB/WB*	Model Total	Count Total	% Diff Total
From/to Manhattan	45	927,402	899,132	3.1%	915,554	907,515	0.9%	1,842,956	1,806,647	**2.0%**
Intra-Manhattan	8	282,263	325,315	-13.2%	330,648	311,941	6.0%	612,911	637,256	**-3.8%**
Other Intra-NYC	46	791,786	696,701	13.6%	714,589	641,713	11.4%	1,506,375	1,338,414	**12.5%**
Other Cross-Hudson	11	230,890	198,091	16.6%	221,902	193,467	14.7%	452,792	391,558	**15.6%**
Other Intra-NYS	127	1,453,825	1,464,811	-0.7%	1,421,783	1,451,252	-2.0%	2,875,608	2,916,063	**-1.4%**
Other NY-NJ	30	160,526	156,837	2.4%	159,183	158,072	0.7%	319,709	314,909	**1.5%**
NY-CT	28	184,923	171,346	7.9%	188,664	175,908	7.3%	373,587	347,254	**7.6%**
Regional cordon	43	132,017	130,241	1.4%	126,283	126,713	-0.3%	258,300	256,954	**0.5%**

* - For “From/to Manhattan,” regardless of orientation, “NB/EB” represents to Manhattan and “SB/WB” represents to Manhattan.

3.2 TRANSIT ASSIGNMENT

The transit assignment validation was less straightforward because of gaps in and inconsistencies among observed data sources. Because of these, it was sometimes necessary to choose which measures to prioritize. In general, the goal was to make sure that total transit demand is reasonable and is consistent with areas of highest ridership. The specific checks discussed below provide some information on the results of some of these choices.

It should also be noted that some summaries reflect linked trips, which include transfers (and sometimes multiple modes) between the trip origin and destination, and some reflect boardings (unlinked trips).

Table 3-9 shows an overall summary of mode choice results from CEMDAP (reflecting linked trips), summarized by aggregate transit mode to show the overall mode shares. The mode share for subway is higher than the observed (from the RHTS) while the commuter rail share is lower. Overall, the transit share is 1.8 percentage points, or about 10 percent higher than the observed share. However, the total modeled linked trips (excluding subway/ferry, where there is not a good estimate of observed linked trips) is about 4.2 million daily and 1.3 million for the a.m. peak, compared to observed estimates of 3.8 million daily and 1.3 million for the a.m. peak, and the overall modeled (a.m. peak) subway boardings match the observed counts well (about 2.7 million in both cases) while modeled commuter rail boardings (about 500,000) are higher than observed (about 400,000). These discrepancies represent examples of the data inconsistencies mentioned above, which are not unusual for large metropolitan areas like New York.

Table 3-9. Mode Shares (trips)

Trip Mode	Expanded RHTS Data	Model Results
Commuter rail/bus	4.4%	3.4%
Subway/ferry	9.9%	12.5%
Local bus	3.5%	3.8%
TOTAL TRANSIT	17.7%	19.5%
Auto	65.0%	62.5%

Non-motorized/other	17.2%	18.1%

Linked Transit Trips

Table 3-10 shows that a.m. peak period linked transit trips are within three percent of observed trips. Note that these comparisons represent only local bus and commuter rail/bus. Other rail is not included because the observed data is not comparable with the observed data for local bus and commuter rail/bus (observed data for "other rail" is unlinked trips, not linked). The differences are small within New York City and modeled trips are lower than observed in New Jersey and northern suburbs.

Modeled trips are high in other time periods compared to observed, especially in the night periods. However, as noted above, the overall (daily) transit share is only about 10 percent higher than the observed. Because of this inconsistency and the sequencing of time of day and mode choice in CEMDAP, these differences could not be addressed without adversely affecting comparisons of a.m. boardings and auto trips in other time periods.

Station Groups

Four sets of station groups have been defined for rail transit assignment validation. The groups correspond to modes: commuter rail, PATH, subway, and light rail. Nine major commuter rail terminals are defined as individual station groups of one station only. Other commuter rail groups are aggregations of established branches or lines. Subway station groups represent the four New York City boroughs that have subway service.

Table 3-11 shows the comparison of modeled and observed a.m. peak period boardings by station group; observed data are available for the three commuter rail operators (MNR, LIRR, and NJT) and for PATH. While overall commuter rail boardings beyond the stations in or near New York City are reasonably consistent with counts (lower for the Long Island Railroad, higher for the others), the model overestimates boardings for nearby stations such as Jamaica, City Terminal, Secaucus, and Hoboken, as well as for the Hoboken light rail and outbound commuter rail ridership. Estimates for PATH are fairly close to observed.

Table 3-10. Linked Transit Trip Summary by Time Period and Subregion

Linked Transit Trips by Origin District - Model

	AM	PM	MD	NT	Daily
Manhattan CBD	77,657	365,430	137,077	192,777	**772,941**
Upper Manhattan	103,846	216,914	102,368	95,935	**519,064**
Bronx	122,012	111,623	114,512	52,602	**400,749**
Queens/Brooklyn	345,696	398,730	363,858	213,641	**1,321,925**
Staten Island	51,525	33,612	50,139	15,236	**150,512**
Long Island	120,279	101,005	146,112	115,605	**483,001**
Mid-Hudson East	102,326	84,722	115,294	78,434	**380,776**
Mid-Hudson West	103,257	81,161	101,266	56,573	**342,257**
NJ Essex/Hudson	129,206	128,900	130,089	81,484	**469,680**
NJ Northwest	80,312	73,685	95,850	53,313	**303,161**
NJ South Shore	23,201	19,002	26,193	9,996	**78,392**
Total	**1,259,316**	**1,614,785**	**1,382,760**	**965,597**	**5,222,458**

Linked Transit Trips by Origin District - Observed

	AM	PM	MD	NT	Daily
Manhattan CBD	74,787	420,393	91,844	66,487	**653,511**
Upper Manhattan	110,967	147,799	91,667	38,001	**388,434**
Bronx	143,516	123,187	120,011	58,731	**445,445**
Queens/Brooklyn	338,507	274,188	322,243	92,123	**1,027,061**
Staten Island	32,303	13,782	25,569	10,363	**82,017**
Long Island	125,104	23,053	31,793	19,141	**199,092**
Mid-Hudson East	121,736	48,587	63,438	15,832	**249,592**
Mid-Hudson West	94,549	36,608	37,631	8,034	**176,821**
NJ Essex/Hudson	144,687	103,622	83,824	27,480	**359,613**
NJ Northwest	93,774	33,353	25,643	10,099	**162,869**
NJ South Shore	23,167	3,613	7,052	2,369	**36,200**
Total	**1,303,098**	**1,228,183**	**900,714**	**348,659**	**3,780,655**

Table 3.10. Linked Transit Trip Summary by Time Period and Subregion (continued)

Linked Transit Trips by Destination District - Model

	AM	PM	MD	NT	Daily
Manhattan CBD	311,028	136,503	296,309	67,258	**811,098**
Upper Manhattan	197,703	133,201	180,011	49,200	**560,115**
Bronx	74,997	155,625	86,091	67,785	**384,498**
Queens/Brooklyn	258,102	468,636	306,098	257,786	**1,290,622**
Staten Island	25,414	50,945	32,936	28,756	**138,051**
Long Island	84,243	146,536	101,732	140,654	**473,165**
Mid-Hudson East	64,157	127,642	87,902	98,789	**378,491**
Mid-Hudson West	67,129	117,866	80,223	76,650	**341,867**
NJ Essex/Hudson	105,663	153,381	120,737	90,920	**470,701**
NJ Northwest	56,909	97,598	72,155	71,855	**298,517**
NJ South Shore	13,972	26,852	18,566	15,944	**75,334**
Total	**1,259,316**	**1,614,785**	**1,382,760**	**965,597**	**5,222,458**

Linked Transit Trips by Destination District - Observed

	AM	PM	MD	NT	Daily
Manhattan CBD	455,685	75,510	98,961	41,903	**672,060**
Upper Manhattan	115,563	136,743	95,639	37,781	**385,726**
Bronx	116,221	141,628	119,329	65,166	**442,343**
Queens/Brooklyn	312,551	308,126	312,906	103,080	**1,036,663**
Staten Island	13,202	28,000	28,400	8,297	**77,899**
Long Island	35,269	111,238	34,712	13,165	**194,384**
Mid-Hudson East	56,880	111,710	57,417	23,468	**249,476**
Mid-Hudson West	37,844	79,939	33,153	8,919	**159,855**
NJ Essex/Hudson	118,118	122,531	88,336	31,927	**360,913**
NJ Northwest	37,659	90,179	25,471	12,826	**166,135**
NJ South Shore	4,104	22,579	6,391	2,128	**35,202**
Total	**1,303,098**	**1,228,183**	**900,714**	**348,659**	**3,780,655**

Table 3-11. Station Group Transit Assignment Summary

ONS	Model	Observed	Difference	% Difference
1 - NJCL – CR	11,761	8,565	3,196	37%
2 - NEC/NJCL – CR	12,557	6,228	6,329	102%
3 - NEC – CR	12,855	28,750	-15,895	-55%
4 - Raritan Valley – CR	10,828	7,750	3,078	40%
5 - NJ CRT West – CR	26,986	24,854	2,132	9%
6 - Main Bergen – CR	22,544	11,611	10,933	94%
7 - Pascack Valley – CR	16,972	3,884	13,088	337%
8 - Hudson – CR	28,244	20,628	7,616	37%
9 - Harlem – CR	25,759	31,010	-5,251	-17%
10 - New Haven – CR	44,880	44,749	131	0%
11 - Harlem New Haven - CR	32,159	4,419	27,740	628%
13 - Port Jefferson – CR	10,651	27,430	-16,779	-61%
14 - Ronkokoma – CR	11,884	15,158	-3,274	-22%
15 - Montauk – CR	11,879	3,374	8,505	252%
16 - Oyster Bay – CR	2,625	3,343	-718	-22%
17 - Babylon – CR	17,516	29,883	-12,367	-41%
18 - West Hempstead - CR	1,453	1,824	-371	-20%
19 - Long Beach – CR	2,682	5,680	-2,998	-53%
20 - Far Rockaway – CR	17,732	9,794	7,938	81%
21 - Hempstead – CR	5,541	7,657	-2,116	-28%
22 - Port Washington - CR	25,757	17,363	8,394	48%
23 - Jamaica & Queens - CR	29,798	1,935	27,863	1440%
24 - City Terminal – CR	21,727	2,945	18,782	638%
50 - New York Penn Station - CR	12,519	21,945	-9,426	-43%
51 - Grand Central – CR	10,074	9,793	281	3%
52 - 125th St – CR	6,122	1,919	4,203	219%
53 - Jamaica – CR	11,294	3,397	7,897	233%
54 - Newark Penn Station - CR/LR/PH	25,753	21,476	4,277	20%
55 - Newark Broad Street - CR/LR/PH	2,808	1,409	1,399	99%
56 - Secaucus – CR	9,355	1,977	7,378	373%
57 - Hoboken - CR/LR/PH	29,590	17,226	12,364	72%
101 - Manhattan – SB	1,048,117	n/a	n/a	n/a
102 - Brooklyn – SB	788,703	n/a	n/a	n/a
103 - Queens – SB	475,150	n/a	n/a	n/a
104 - Bronx – SB	230,007	n/a	n/a	n/a
25 - NJ PATH - LR/PH	38,280	39,765	-1,485	-4%
26 - 33rd St PATH - LR/PH	9,499	11,496	-1,997	-17%
27 - WTC Path - LR/PH	6,069	6,930	-861	-12%
28 - HB LRT – LR	58,100	12,388	45,712	369%
	624,253	468,555	155,698	33%
NJT	114,503	91,642	22,861	25%
MNR	131,042	100,806	30,236	30%
LIRR	107,720	121,506	-13,786	-11%
Penn Station/GCT	22,593	31,738	-9,145	-29%
Jamaica/City Term/Newark/Secaucus	136,447	52,284	84,163	161%
PATH	111,948	70,579	41,369	59%
All commuter rail except NYC	353,265	313,954	39,311	13%

Table 3.11. Station Group Transit Assignment Summary (continued)

OFFS	Model	Observed	Difference	% Difference
1 - NJCL – CR	6,741	1,582	5,159	326%
2 - NEC/NJCL – CR	6,231	2,364	3,867	164%
3 - NEC – CR	6,447	8,398	-1,951	-23%
4 - Raritan Valley – CR	8,305	1,555	6,750	434%
5 - NJ CRT West – CR	19,286	5,238	14,048	268%
6 - Main Bergen – CR	14,928	1,677	13,251	790%
7 - Pascack Valley – CR	11,807	227	11,580	5101%
8 - Hudson – CR	17,730	3,948	13,782	349%
9 - Harlem – CR	14,328	7,642	6,686	88%
10 - New Haven – CR	24,197	15,414	8,783	57%
11 - Harlem New Haven - CR	20,022	1,167	18,855	1616%
13 - Port Jefferson – CR	3,950	6,346	-2,396	-38%
14 - Ronkokoma – CR	6,423	2,880	3,543	123%
15 - Montauk – CR	5,465	850	4,615	543%
16 - Oyster Bay – CR	2,022	431	1,591	369%
17 - Babylon – CR	10,949	5,685	5,264	93%
18 - West Hempstead - CR	503	101	402	398%
19 - Long Beach – CR	1,125	779	346	44%
20 - Far Rockaway – CR	10,162	1,890	8,272	438%
21 - Hempstead – CR	5,948	1,438	4,510	314%
22 - Port Washington - CR	7,405	2,681	4,724	176%
23 - Jamaica & Queens - CR	18,130	6,125	12,005	196%
24 - City Terminal – CR	32,229	13,093	19,136	146%
50 - New York Penn Station - CR	94,584	149,281	-54,697	-37%
51 - Grand Central – CR	49,111	81,377	-32,266	-40%
52 - 125th St – CR	22,946	2,970	19,976	673%
53 - Jamaica – CR	13,542	4,965	8,577	173%
54 - Newark Penn Station - CR/LR/PH	21,377	24,662	-3,285	-13%
55 - Newark Broad Street - CR/LR/PH	5,109	1,177	3,932	334%
56 - Secaucus – CR	10,582	443	10,139	2289%
57 - Hoboken - CR/LR/PH	22,909	23,035	-126	-1%
101 - Manhattan – SB	1,285,996	n/a	n/a	n/a
102 - Brooklyn – SB	697,062	n/a	n/a	n/a
103 - Queens – SB	415,327	n/a	n/a	n/a
104 - Bronx – SB	180,665	n/a	n/a	n/a
25 - NJ PATH - LR/PH	22,507	22,000	507	2%
26 - 33rd St PATH - LR/PH	28,366	30,208	-1,842	-6%
27 - WTC Path - LR/PH	24,274	28,699	-4,425	-15%
28 - HB LRT – LR	43,273	9,470	33,803	357%
	612,913	469,798	143,115	30%
NJT	114,503	91,642	22,861	25%
MNR	131,042	100,806	30,236	30%
LIRR	107,720	121,506	-13,786	-11%
Penn Station/GCT	22,593	31,738	-9,145	-29%
Jamaica/City Term/Newark/Secaucus	136,447	52,284	84,163	161%
PATH	111,948	70,579	41,369	59%
All commuter rail except NYC	353,265	313,954	39,311	13%

Table 3.11. Station Group Transit Assignment Summary (continued)

TOTAL ONS AND OFFS	Model	Observed	Difference	% Difference
1 - NJCL – CR	18,502	10,147	8,355	82%
2 - NEC/NJCL – CR	18,788	8,592	10,196	119%
3 - NEC – CR	19,302	37,148	-17,846	-48%
4 - Raritan Valley – CR	19,133	9,305	9,828	106%
5 - NJ CRT West – CR	46,272	30,092	16,180	54%
6 - Main Bergen – CR	37,472	13,288	24,184	182%
7 - Pascack Valley – CR	28,779	4,111	24,668	600%
8 - Hudson – CR	45,974	24,576	21,398	87%
9 - Harlem – CR	40,087	38,652	1,435	4%
10 - New Haven – CR	69,077	60,163	8,914	15%
11 - Harlem New Haven - CR	52,181	5,586	46,595	834%
13 - Port Jefferson – CR	14,601	33,776	-19,175	-57%
14 - Ronkokoma – CR	18,307	18,038	269	1%
15 - Montauk – CR	17,344	4,224	13,120	311%
16 - Oyster Bay – CR	4,647	3,774	873	23%
17 - Babylon – CR	28,465	35,568	-7,103	-20%
18 - West Hempstead - CR	1,956	1,925	31	2%
19 - Long Beach – CR	3,807	6,459	-2,652	-41%
20 - Far Rockaway – CR	27,894	11,684	16,210	139%
21 - Hempstead – CR	11,489	9,095	2,394	26%
22 - Port Washington - CR	33,162	20,044	13,118	65%
23 - Jamaica & Queens - CR	47,928	8,060	39,868	495%
24 - City Terminal – CR	53,956	16,038	37,918	236%
50 - New York Penn Station - CR	107,103	171,226	-64,123	-37%
51 - Grand Central – CR	59,185	91,170	-31,985	-35%
52 - 125th St – CR	29,068	4,889	24,179	495%
53 - Jamaica – CR	24,836	8,362	16,474	197%
54 - Newark Penn Station - CR/LR/PH	47,130	46,138	992	2%
55 - Newark Broad Street - CR/LR/PH	7,917	2,586	5,331	206%
56 - Secaucus – CR	19,937	2,420	17,517	724%
57 - Hoboken - CR/LR/PH	52,499	40,261	12,238	30%
101 - Manhattan – SB	2,334,113	n/a	n/a	n/a
102 - Brooklyn – SB	1,485,765	n/a	n/a	n/a
103 - Queens – SB	890,477	n/a	n/a	n/a
104 - Bronx – SB	410,672	n/a	n/a	n/a
25 - NJ PATH - LR/PH	60,787	61,765	-978	-2%
26 - 33rd St PATH - LR/PH	37,865	41,704	-3,839	-9%
27 - WTC Path - LR/PH	30,343	35,629	-5,286	-15%
28 - HB LRT – LR	101,373	21,858	79,515	364%
	1,237,166	938,353	298,813	32%
NJT	114,503	91,642	22,861	25%
MNR	131,042	100,806	30,236	30%
LIRR	107,720	121,506	-13,786	-11%
Penn Station/GCT	22,593	31,738	-9,145	-29%
Jamaica/City Term/Newark/Secaucus	136,447	52,284	84,163	161%
PATH	111,948	70,579	41,369	59%
All commuter rail except NYC	353,265	313,954	39,311	13%

Hub-Bound Summary

The hub-bound summary (for a.m. peak boardings to the Manhattan CBD) is summarized in Table 3-12. The modeled results show fewer trips than observed inbound except for local bus. The outbound model results (where overall numbers are lower) are generally higher than observed. While there are some consistencies with other summaries (e.g., high outbound commuter rail summaries from the station group report), there are also inconsistencies. For example, overall a.m. subway boardings match counts well, as do modeled a.m. peak linked trips. Additionally, the work location model summary (see Table 2-3) shows a good fit between modeled and ACS commute patterns to Manhattan. It was felt that increasing work trips to Manhattan would result in a worse fit for other model measures including transit boarding totals and highway screenlines.

Table 3-12. Hub-Bound Transit Summary

Modeled INBOUND Hub-Bound Transit Flows

	Bus	Ferry	Rail	Subway/PATH	Tram	Total
60th St	38,690	0	49,111	189,591	0	**277,392**
Queens	33,970	435	62,196	117,022	0	**213,623**
Brooklyn	44,299	281	0	210,080	0	**254,660**
Staten Island	0	29,048	0	0	0	**29,048**
New Jersey	91,400	2,539	32,388	46,569	0	**172,897**
Total	**208,359**	**32,303**	**143,695**	**563,262**	**0**	**947,619**

Observed INBOUND Hub-Bound Transit Flows

	Bus	Ferry	Rail	Subway/PATH	Tram	Total
60th St	17,395	0	72,541	307,695	0	**397,631**
Queens	10,699	50	81,094	233,817	1,535	**327,195**
Brooklyn	18,028	454	0	382,237	0	**400,719**
Staten Island	0	16,373	0	0	0	**16,373**
New Jersey	110,502	11,128	49,696	67,700	0	**239,026**
Total	**156,624**	**28,005**	**203,331**	**991,449**	**1,535**	**1,380,944**

Modeled OUTBOUND Hub-Bound Transit Flows

	Bus	Ferry	Rail	Subway/PATH	Tram	Total
60th St	22,574	0	10,074	175,947	0	**208,596**
Queens	4,318	50	7,261	74,111	0	**85,741**
Brooklyn	1,369	102	0	101,527	0	**102,998**
Staten Island	0	8,735	0	0	0	**8,735**
New Jersey	42,976	269	5,257	9,496	0	**57,999**
Total	**71,238**	**9,156**	**22,592**	**361,082**	**0**	**464,069**

Observed OUTBOUND Hub-Bound Transit Flows

	Bus	Ferry	Rail	Subway/PATH	Tram	Total
60th St	5,777	0	7,474	153,059	0	**166,310**
Queens	191	68	4,975	53,932	294	**59,460**
Brooklyn	192	18	0	80,280	0	**80,490**
Staten Island	0	2,329	0	0	0	**2,329**
New Jersey	31,120	1,126	7,370	15,253	0	**54,869**
Total	**37,280**	**3,541**	**19,819**	**302,524**	**294**	**363,458**

4.0 Conclusions

The main objective of the validation process is to ensure that the model produces useful outputs for planning analyses. Comparison of base year model results to observed data, as documented in this report, is an important part of this process, but it is also critical that the model's sensitivity to the variables that affect travel demand is reasonable, especially those variables that are related to possible policy decisions (transportation system improvements, pricing, land use, etc.) and those related to inputs that are likely to be different for forecast scenarios (e.g., demographics).

The model validation effort documented in this report included checking results at every model step as well as the results of the overall model. The checks included a large number of travel market segments for many of the components as well as the regional market as a whole. It is important to recognize that the observed data used for comparisons is imperfect. The source of observed data for the CEMSELTS and CEMDAP component comparisons is survey data, which represents a small sample of behavior in the region and has sampling errors, which can be quite large on a percentage basis for relatively small travel segments. Most traffic count data represent samples as well, since they reflect counts taken for short periods whose volumes can vary from the true averages, and the different timeframes of the various counts can lead to inconsistencies. It proved to be difficult to get a comprehensive set of consistent transit demand data, and the data used for the transit assignment comparisons was put together from a variety of differing sources.

It is important to recall the guidelines laid out in the model validation plan:

- "Matching specified standards is neither necessary nor sufficient to prove model validity."
- "It must be remembered that the observed data being used for the validation might be a source of some of the error" (as there is always some error associated with observed data).

The overall conclusion is that the model is validated sufficiently for use in regional planning analyses. The overall amount of travel estimated for the base year is correct, as shown by measures such as VMT per person, modeled VMT on links with counts compared to observed VMT, screenline summaries showing flows between different parts of the region, amount of travel by time of day, and overall transit ridership. Travel is well estimated for various travel segments as well, as the validated model meets the majority of the targets in the validation plan.