SOUTH JERSEY

TRANSPORTATION PLANNING ORGANIZATION

Model Validation Analysis

January 16, 2013

Acknowledgements

The preparation of this report has been financed in part by the U.S. Department of Transportation, Federal Transit Administration, and the Federal Highway Administration. This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or its use.

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Background

The South Jersey Travel Demand Model (SJTDM) is a computer model designed to estimate traffic volumes on all major roads in the SJTPO planning area. Different scenarios may be modeled, such as changes to regional demographics, changes to the roadway network, changes to transit, or even predictive future-year scenarios. The accuracy of these scenarios is dependent on the accuracy of the baseline year 2010 scenario. This scenario must match real-world traffic conditions as closely as possible. All model outputs in this report represent 2010 conditions.

The SJTDM was recently updated to run in Cube 6 by the contractor URS. Cube, developed by Citilabs, is a software environment used for travel demand modeling. During the update, all of the model's inputs, including the demographics and road network, were updated as well. Because of these substantial changes, a validation effort was needed to ensure the accuracy of the baseline scenario. If the baseline is found to accurately model present conditions, then modified scenarios gain credibility in their results.

The model delivery included the Model Development and Validation Report, a separate document completed by URS, which reviewed each step of the model and compared its results to real-world calibration data, such as traffic counts. Also included in the delivery were model run summaries, which similarly compiled model outputs and validation data. In addition, a great deal of model testing has been conducted by SJTPO following the v3.2 and v3.3 model deliveries. A number of different scenarios were developed to test the sensitivity of the model to various changes to network attributes. Other tests conducted include road closure tests, used to determine if the model's traffic assignment scripts produces credible results. In this report, all model reports and tests were reviewed and analyzed to determine the present state of model validation, and what improvements may be made to validation in the future.

For more background on the model and how it works, please visit www.sjtpo.org/SJTDM.html.

Summary

After review of the Model Development and Validation Report, the 2001 Travel Survey, and the outputs produced by the updated Cube Model, the following conclusions were reached regarding the current state of model validation:

1. **Trip generation and distribution** – Both appear to be well-calibrated, as they match the trip rates reported by the travel survey very well. One minor exception is the distribution of certain types of recreational trips, which appears inconsistent with trip generation; however, the effect on overall validation is minor. The only potential issue of concern is the accuracy of the 2001 travel survey data. If travel behavior has changed considerably since 2001, the model may be calibrated to data that no longer represents present conditions.

2. **Mode choice** – For most trip purposes, mode choice proportions match those reported in the travel survey very well. External trip mode choice is also reasonably well accounted for. Mode choice validation may be worth revisiting in the future when the results of the NJ Transit Rail survey are published.

3. **Highway assignment** – Regionally, the model appears to be well validated, with only a 2% difference between total modeled and total observed volumes. This indicates that the model should be suitable for estimating regional emissions for air quality conformity. On smaller scales, validation varies, but in general the model should be considered unsuitable for small-scale analysis if accuracy on individual roads is needed.

4. **Transit assignment** – It appears that the model somewhat overestimates NJ Transit bus trips, while underestimating Atlantic City jitney trips, each of which account for almost half of all regional transit trips. In total, there are 12% fewer transit trips in the model than reported by the validation data. Future improvements may be made by obtaining newer Atlantic City Rail Line ridership data and jitney ridership data.

Analysis and Discussion

Trip Generation and Distribution

After model initialization, the first step in the SJTDM is trip generation. For this step, the spatial distribution of trip origins is determined. The Model Development and Validation (MDV) Report goes into great detail in how this step works in section 5 (MDV p.34). Validation of intermediate steps within trip generation, such as the statistical model used to predict household size and income distribution are detailed in section 5.1 (MDV p.34). Of interest to us for validation is how well the trip generation statistical models match the real-world trip generation rates. Trip rates are validated against the 2001 household travel survey in section 5.2 (MDV p.39), and this is our primary interest. The current Cube model uses the same trip rates that were developed for prior model builds. Trip rates are predicted with a regression model that uses the TAZ-level socioeconomic demographic inputs as regressors, and trip rates by purpose as regressands. Using regression can ensure that the average daily person-trips per household predicted by the model is equal to the trip rate from the household survey. According to the validation table in section 5.4 (MDV p.61), both are equal to 8.2 person-trips for non-recreational trips.

While the mean trip generation rate is a match, what is unknown is the goodness of fit for the entire distribution. That is, the predictive power (typically measured by adjusted R^2) of the trip generation equations is unknown. Ideally, we would know the trip rate and socioeconomic variable values for each household from the household survey. We could then use the trip generation equations to predict trip rates for each household. The predicted vs. observed values could then be plotted against one another, and the accuracy of the model for all households could be seen. However, due to the limited data available from SJTPO's 2001 Household Survey, this level of validation was not conducted. Individual household trip rates, along with the socioeconomic factors needed for the model equations, were not provided in the survey delivery.

Travel survey data was expanded to better match the demographic distribution of regional households. After expansion, the proportions of three main trip purposes were reported: home-based work trips, home-based other trips, and non-home based trips. Survey figures were reported in Table 4-7: Total Trips by Mode in the travel survey final report, while model figures were obtained from the trip generation report generated by Cube. Table 1, below, compares these results.

Table 1: Survey and Model Trips by Purpose

	Expanded survey trips	Survey %	Model %
Home-based work	241,674	18%	18%
Home-based other	740,162	55%	57%
Non-home based	362,639	27%	25%

To tabulate the model figures in the above table, the following trip purpose classifications were used.

Table 2: Model Trip Purposes

Category	Model trip purposes
Home-based work	HBW (Home-based work) and JTW (Journey to work)
Home-based other	SCH (School), HBS (Home-based shopping), HBO (Home-based other), COLL (College)
Non-home based	NWK (Non-home based work) and COM1(Commercial vehicles, no heavy trucks)

The survey results and the model trip generation match very well. Only a 2% difference is present for the home-based other trip purposes and the non-home based trip purposes. Although there are no specific criteria guidelines associated with trip generation checks,[1] this difference was deemed small enough by the modeling team to be acceptable.

Total regional productions and attractions may also be checked as validation. The trip generation model run summary provided with the v3.2 model delivery details productions and attractions, for both recreation and non-recreational trips, and by trip purpose. Ideally, the total number of trip productions and attractions for each trip purpose should be equal. The summary tables found in the trip generation model run summary are copied below for convenience.

Table 3: Non-recreational Trip Generation Summary

Trip Purpose	Productions	Attractions
Home-Based Work	447,834	447,998
Home-Based School	224,260	224,074
Home-Based Shopping	321,613	321,849
Home-Based Other	996,153	995,944
Non-Home-Based Work	171,636	171,641
Non-Home-Based Non-Work	402,963	402,975
Home-Based College	49,158	49,149
Commercial	230,686	230,686
Trucks	76,720	76,720
Total - All Purposes	**2,921,023**	**2,921,036**
Person Trips /HH - Model	8.2	
Person Trips /HH - NJ HH Survey	8.2	

[1] Travel Model Improvement Program. "Travel Model Validation and Reasonability Checking Manual—Second Edition." FHWA. 2010, pg. 5-8.

Table 4: Recreational Trip Generation Summary

Trip Purpose	Productions	Attractions
Overnight Beach Access	52,949	52,961
Daytime Beach Access	20,482	20,489
Seasonal Work	17,046	17,046
Shore Visit	611,769	573,091
Casino Access	205,233	208,469
Event Access	9,613	9,613
Casino Bus	4,404	4,404
Casino Visit	19,280	19,280
Event Visit	10,322	10,322
Total - All Purposes	**951,098**	**915,675**

For non-recreational trips, we see that productions and attractions are within 0.1% of one another, with only negligible discrepancies. For recreational trips, the differences are larger. Two trip types in particular stand out: shore visit and casino access. For shore visits, there are 38,678 more trip productions than attractions, and for casino visits there are 3,236 more attracted trips than produced trips. This discrepancy is not addressed in the model development report. These trip purposes are highly specialized in the model. Section 5.3.1 (MDV p.47) details the shore trip generation algorithm, and section 5.3.2 (MDV p.59) details the casino access trip generation algorithm. One possible explanation for the discrepancy is the stepwise nature of the shore and casino trip models. Trips are initially generated and then re-distributed among the shore towns several times based on factors such as the presence of boardwalks, hotels, or casinos. It is possible that during the stepwise trip distribution process, attraction-side zones cannot be located for many of the produced trips.

It should be noted that much of the recreational trip generation and distribution is based on the 1996 beach access survey. As the region has grown and developed significantly since then, this survey may no longer accurately represent shore access. Additionally, Atlantic City was not a part of this survey. Only Margate City, Cape May City, Ocean City and Wildwood were surveyed.

The model development report does a thorough validation of trip length distribution. Modeled and observed trip lengths are plotted against one another for each trip purpose. Section 6.2 (MDV p.65) of the report contains the trip length validation plots. Trip distribution validation can be more generally summarized with the following two tables, provided with the v3.2 model delivery run summaries. The first, Table 5, compares mean trip length in minutes produced by the model with those reported in the travel survey. Table 6 does the same for trip distance.

Table 5: Trip Length (minutes)

Trip Purpose	Model	Observed
Home-Based Work	21.3	20.8
Home-Based School	12.4	11.3
Home-Based Shopping	15.6	15.2
Home-Based Other	16.9	16.7
Non-Home-Based Work	18.9	19.3
Non-Home-Based Non-Work	14.5	14.8
Home-Based College	30.5	29.2

Table 6: Trip Length (miles)

Trip Purpose	Model	Observed
Home-Based Work	10.9	10.1
Home-Based School	5.2	5.2
Home-Based Shopping	6.0	6.1
Home-Based Other	6.9	6.4
Non-Home-Based Work	9.4	8.0
Non-Home-Based Non-Work	5.5	6.3

For both home-based and non home-based trips, the model outputs are well validated. The largest relative difference occurs for the trip distance of non home-based work trips, for which the model differs from the survey by 20%. While the mean trip length does not properly account for the entire distribution, the distribution plots in Section 6.2 of the model development report show a good match between the modeled and observed trip lengths.

While the overall validation of the trip generation and distribution was quite good (that is, it matched the travel survey results well), there are several areas with room for improvement. First, the travel survey data may be out of date, having been gathered in 2001, nine years prior to the model base year. The South Jersey region has grown somewhat since then. This growth in population and corresponding growth in travel is accounted for in the model because the trip generation was validated based on household trip rates rather than total trips. As demographics are adjusted, the trip generation should remain well-validated unless trip rates change. An updated travel survey could serve to ensure that household trip rates for each trip purpose have remained roughly the same. If they have changed since 2001, then the new trip rates could be used as a baseline for updated model validation. As travel surveys are prohibitively expensive, a new one should only be conducted if regional travel behavior is likely to have changed enough to significantly impact model validation. At this time, it is unknown if a new travel survey is warranted.

The beach access survey used for recreational trip calibration was conducted in 1996. One major shortcoming of this survey was that it did not include Atlantic City. Additionally, there has been new development of many shore areas since the survey was conducted. Prior to the Cube update, the old model developers used the results from the beach survey to determine recreational trip rates, which were then used in all model releases since. While the model trip generation and distribution appears to be well-validated to the beach survey, it is unclear if the beach survey still remains accurate to current conditions. If resources become available with which to conduct a new survey, these resources may be better dedicated toward a more general travel survey that includes a recreational trip component. If a new beach/shore access survey is conducted, more shore towns should be included, specifically Atlantic City.

If a new travel survey were to be conducted, new methodologies should be considered. Many travel surveys now include a GPS component, for which a number of households are loaned GPS units that record the route used for each trip. This would mean that the trip length and duration could be very accurately known for a subset of survey trips, which could then be statistically expanded to all survey trips. The use of GPS would greatly assist in model validation in another way, as the mean speed reported for each road by the GPS units could be compared to the mean speed of the modeled links. Current trends seem to suggest that future travel surveys may be entirely GPS based. As receivers fall in price, paper-and-pen travel diaries may be replaced, and more detailed travel data may become available for model calibration and validation efforts.

Mode Choice

Following trip generation and distribution, the model then selects a travel mode for each trip. Many factors are accounted for in this selection, and they are detailed in Section 7.1 of the model development report. Validation was based on travel modes reported during the 2001 travel survey. Table 7 below summarizes the survey results, with the mode classification used by the survey.

Table 7: Distribution of Travel Modes

Travel Mode	Frequency	Percent
Auto driver	6644	65.2%
Auto passenger	2018	19.8%
Walk	735	7.2%
School Bus	419	4.1%
Bus	141	1.4%
Bicycle	92	0.9%
Subway/elevated rail	2	0.0%
Commuter rail	5	0.0%
Shared ride	42	0.4%
Amtrak, other railroad	10	0.1%
Commuter van/shuttle	10	0.1%
Charter bus	14	0.1%
Other	61	0.6%
Total	**10193**	**100.0%**

Note that more types of travel modes were used in the survey than are used by the model. Section 7.1.4 of the model development report reviews mode choice validation for non-recreational trips. No validation for recreational trips was done due to the lack of available data from the 1996 beach access survey. Table 8, below, is reproduced from the model development report.

Table 8: Mode Choice Validation for Non-recreational Trips

Purpose	Mode	Model	Observed
HBW	Drive-Alone	86.6%	85.9%
	CarPool	5.4%	7.3%
	School Bus	0.0%	0.1%
	Bike-Walk	6.1%	5.1%
	Bus	1.6%	1.6%
	Rail	0.3%	0.2%
	Total	100.0%	100.2%

Purpose	Mode	Model	Observed
HBO	Drive-Alone	41.3%	46.0%
	CarPool	51.6%	47.2%
	School Bus	0.0%	0.2%
	Bike-Walk	5.6%	5.9%
	Bus	1.4%	0.7%
	Rail	0.1%	0.0%
	Total	100.0%	100.0%

Table 8: Mode Choice Validation for Non-recreational Trips (Continued)

Purpose	Mode	Model	Observed
SCH	Drive-Alone	4.3%	4.9%
	CarPool	28.1%	31.6%
	School Bus	52.0%	48.5%
	Bike-Walk	15.5%	14.6%
	Bus	0.0%	0.4%
	Rail	0.0%	0.0%
	Total	100.0%	100.0%
HBS	Drive-Alone	54.4%	55.6%
	CarPool	39.9%	40.4%
	School Bus	0.0%	0.0%
	Bike-Walk	3.4%	3.7%
	Bus	2.0%	0.3%
	Rail	0.2%	0.0%
	Total	100.0%	100.0%

Purpose	Mode	Model	Observed
NHBW	Drive-Alone	80.8%	79.6%
	CarPool	13.2%	15.5%
	School Bus	0.0%	0.1%
	Bike-Walk	3.7%	3.6%
	Bus	2.0%	1.2%
	Rail	0.3%	0.0%
	Total	100.0%	100.0%
NHBNW	Drive-Alone	41.4%	39.0%
	CarPool	52.3%	53.9%
	School Bus	0.0%	2.1%
	Bike-Walk	4.8%	4.1%
	Bus	1.4%	0.7%
	Rail	0.1%	0.2%
	Total	100.0%	100.0%

The above table compares mode choice in the model to that reported by the travel survey. In general, the validation appears very good, as the difference between modeled and predicted mode choice is small. The largest differences are for school trips, for which school bus use is slightly overrepresented, and carpooling is underrepresented. For home-based other trips, driving alone is underrepresented, while carpooling is overrepresented. However, these differences are minor.

Better mode choice validation for rail trips may be possible in the future upon the completion of NJ Transit's rail survey. At present, rail trips are calibrated based on the travel survey, as are all other modes. The rail survey will allow us to check to see if the model is producing the correct number of rail trips.

Separate validation was conducted for external-internal (EI) trip mode choice. Section 7.2.2 (MDV p.85) details the EI methodology. Section 7.2.3 (MDV p.86) reviews the validation. EI trips appear well validated to the data available, which included bus and rail ridership estimates. No vehicle trip data was available for validation. The EI trip validation table from the model development report is copied below for convenience.

Table 9: EI Mode Choice Validation

Region	Observed		Model			
	Rail	Bus	Rail	Bus	Auto	Transit Share
Philadelphia Center	2,400	550	2,295	514	10,230	**22%**
Philadelphia Other	800	200	815	468	13,123	**9%**
Camden	100	600	143	873	9,476	**10%**
Total	**3,300**	**1,350**	**3,253**	**1,855**	**32,829**	**13%**

Table 10, below, was taken from the model run summaries provided with the v3.2 model delivery. It tabulates the total number of trips from a single model analysis day.

Table 10: Mode Choice Total Trips

Mode	Trips	% Share
Drive-Alone	996,624	34.8%
CarPool	1,262,933	44.2%
School Bus	101,818	3.6%
Bike-Walk	464,648	16.2%
Drive-Bus	1,510	0.0528%
Walk-Bus	29,035	1.0%
Drive-Rail	2,172	0.1%
Walk-Rail	1,729	0.0604%
Total	**2,860,469**	**100.0%**

The above table contains the bottom-line for mode choice. Its validity is difficult to check due to the age of the travel survey. Section 4.2 of the travel survey final report contains a statistical expansion of the survey results. The survey data is scaled up from the 1,460 households that participated to the 193,000 households estimated (at the time) to be in the SJTPO planning area. As of 2010, the area now has 220,000 households. Because trip rates may have changed in the past eleven years, we cannot simply further inflate the survey results to 2010 household numbers. Additionally, even the expanded survey data does not account for all households in the region. According to table 4-5 in section 4.2 of the travel survey final report, only 74% of households could be accounted for after expansion.

Highway Assignment

The final step in the travel model, highway assignment, takes the trips generated and distributed in prior steps and determines a network path to assign to each trip. Trips will not necessarily take the shortest path from their origin to their destination, and as network links become congested, an iterative process is used to re-assign trips realistically. The main output of highway assignment is a loaded highway network (along with transit outputs) that shows the number of vehicles travelling on each link during each hour of the analysis day. The model also determines the expected speed of traffic on the link. The accuracy of the loaded highway network is of great importance for air quality modeling and a number of other planning purposes.

The validity of the model highway assignment will be checked in two ways. First, the summary tables included in the v3.2 delivery of the travel model will be analyzed and discussed. Second, individual links for which real-world traffic counts have been conducted will be compared to the corresponding links in the Cube model. Many such counts were initially used to calibrate the travel model, and the accuracy of the calibration may now be determined.

Table 11: Highway Assignment Summary

Volume Group	Count Range (AADT)	Model RMSE(%)	Max. Recommended RMSE Range	Volume	Count	Volume/Count	No of Links
1	1- 5,000	38%	45 - 55%	1,288,118	1,246,964	1.03	491
2	5,000- 10,000	36%	35 - 45%	1,762,279	1,913,130	0.92	282
3	10,000- 20,000	29%	27 - 35%	1,477,826	1,536,806	0.96	109
4	20,000- 30,000	28%	24 - 27%	940,155	859,435	1.09	37
5	30,000- 40,000	11%	22 - 24%	113,285	123,446	0.92	4
6	40,000- 50,000	11%	20 - 22%	88,770	96,400	0.92	2
ALL	**1-50,000**	**39%**	**32 - 39%**	**5,670,433**	**5,776,181**	**0.98**	**925**

The above table is reproduced from the highway assignment summary tables. It gives a regional-scale impression of assignment validation by comparing the modeled volumes to count volumes. Volume Group 1 represents low-volume local roads, while Volume Groups 5 and 6 represent the high-volume freeways. RMSE (root mean square error) is a measure of the difference between modeled and observed volumes for each volume group. Low-volume roads can be expected to have higher errors due to the greater variability in their traffic, and due to the greater difficulty in modeling many small roads (note that Volume Group 1, which has the greatest RSME, contains more than half of all model links). For planning purposes, it is important to have low RSME so that individual links are accurately modeled. As with the Trip Generation validation and calibration above, while there are no “fixed” standards that RMSE values must meet, there are criteria guidelines, which these represent.[2]

[2] See page 9-18, Travel Model Validation and Reasonability Checking Manual—2nd Edition for a more thorough explanation of RMSE.

For air quality conformity purposes, volume/count ratio is perhaps the more important measure. A volume/count ratio of 1.0 would indicate that total modeled volumes are equal to total observed volumes, which would indicate that total regional emissions are being accurately represented. The bottom-line figure is the regional volume/count ratio, which is 0.98. Therefore, for all roads for which counts were obtained, the difference between total modeled and observed volume is only 2%, indicating that the model should predict regional emissions very accurately. However, due to the high RMSE for low- and medium-volume roads, individual links may be inaccurate. The model may not be suitable for small-scale planning purposes in areas where modeled link volumes differ significantly from counts. This is to be expected from a regional model, the primary function of which is air quality conformity. However, highway assignment validation may be examined at a smaller scale to see what other utility the model may have.

Prior to the collection of the traffic counts used for model calibration, nine screenlines were identified in the SJTPO region. Section 10.1.1 of the model development report (MDV p.99) describes the screenlines and their locations. Each screenline crosses a number of roads that are all carrying traffic to the same subregion. For example, one screenline crosses several major routes going into Egg Harbor and Atlantic City (including US 30, the Atlantic City Expressway, and US 40/322) while another screenline captures shore traffic (including the bridges going into Ocean City, Sea Isle City, and Wildwood). Table 12 lists the locations of the screenlines.

Table 12: Screenline Locations

Screen Line#	Direction	Location	Major Routes Crossed	Count Locations
1	N-S	East of GSP & US 9	All roads into Atlantic City, Ocean City, Sea Isle City, Wildwoods, etc.	13
2	N-S	West of GSP & US 9	US 30, Atlantic City Expressway, US 40/322	13
3	N-S	West of NJ 50	US 30, Atlantic City Expressway, US 40/322, NJ 49, NJ 47	17
4	N-S	West of NJ 55 & NJ47	Landis Ave, Sherman Ave, NJ 49	8
5	N-S	West of NJ 77	US 40, NJ 49	10
6	E-W	North of ACE & US 30	US 9, Garden State Parkway, NJ 50	14
7	E-W	South of ACE & Creek	US 40, NJ 50, Garden State Parkway, US 9	9
8	E-W	North of CR 540	NJ 55, Mill Rd, NE/NW Boulevards, Main Rd	9
9	E-W	Crossing US130, I295 & I 95	US 130, I-295, NJ Turnpike, NJ 45	11
Total 1-9				104

Table 13, below, is reproduced from the model run summaries and shows validation for each screenline.

Table 13 – Screenline Validation

Screenline	Volume	Count	Vol/Count
1	156,111	165,368	0.94
2	132,583	119,664	1.11
3	63,662	53,802	1.18
4	66,857	93,377	0.72
5	26,399	38,342	0.69
6	53,995	49,393	1.09
7	18,919	16,806	1.13
8	59,627	55,684	1.07
9	58,543	55,717	1.05
Total	**636,696**	**648,153**	**0.98**

The volume/count ratio for all nine screenlines is 0.98, which again shows accuracy on the regional level. However, validation on individual screenlines varies. Screenlines 1, 2, and 3 capture east-west traffic in Atlantic and Cape May counties, with Screenline 1 running down the coast just a few miles inland. Modeled volumes on these screenlines are fairly accurate, with the highest-volume showing the least error. Screenlines 4 and 5 have the greatest error, with volume/count ratios of 0.72 and 0.69, respectively. These two lines capture east-west traffic just west of Vineland in Cumberland and Salem counties. The model is underestimating traffic on these roads by about 30%. Validation on the remaining screenlines (6 through 9) is very good, with each only slightly overestimating volumes. Screenlines 6 and 7 capture north-south traffic in Atlantic County, Screenline 8 captures north-south traffic in Cumberland County, and Screenline 9 captures north-south traffic in Salem County. Routes crossing these lines appear to be well validated in the model. If the travel model is to be used to model a transportation project that impacts a route crossing one of the screenlines, the above table should be consulted. If the model significantly under- or over-estimated volumes crossing the line, this should be accounted for when interpreting the results of the model scenario.

Section 10.3 of the model development report contains more details on validation by facility type (FT) and by area type (AT). FT refers to the roadway classification, while AT refers to whether the road is in an urban or rural area. FT classification is described in detail in Table 3.2 of the model development report (MDV p.20), and area type is described in Table 3.3 (MDV p.21). The classifications from those two tables have been combined with Table 10.8 (MDV p.112), which shows volume/count ratios for roads in each of these classifications. The result is tabulated in Table 14, below.

Table 14 – Volume/Count Ratios by FT and AT

	AT	1	2	3	4	
FT		CBD	Urban	Suburban	Rural	Total
1	Freeway Class 1	---	0.99	1.06	1.08	1.08
2	Freeway Class 2	---	---	---	0.97	0.97
3	Arterial Class 1	0.93	0.97	1.01	1	0.99
4	Arterial Class 2	---	---	---	1.17	1.17
5	Arterial Class 3	0.77	1.02	0.82	0.88	0.86
6	Collector Class 1	0.91	1.2	0.97	0.95	0.97
7	Collector Class 2	---	0.71	0.97	1.16	1.08
8	Collector Class 3	0.44	1.21	0.81	0.92	0.92
9	Local Class 1	0.45	0.66	0.8	0.69	0.66
10	Local Class 2	1.29	0.89	---	0.86	1.12
11	Ramp Class 1	---	1.11	0.74	1	0.91
	Total	0.85	1	0.95	1	0.98

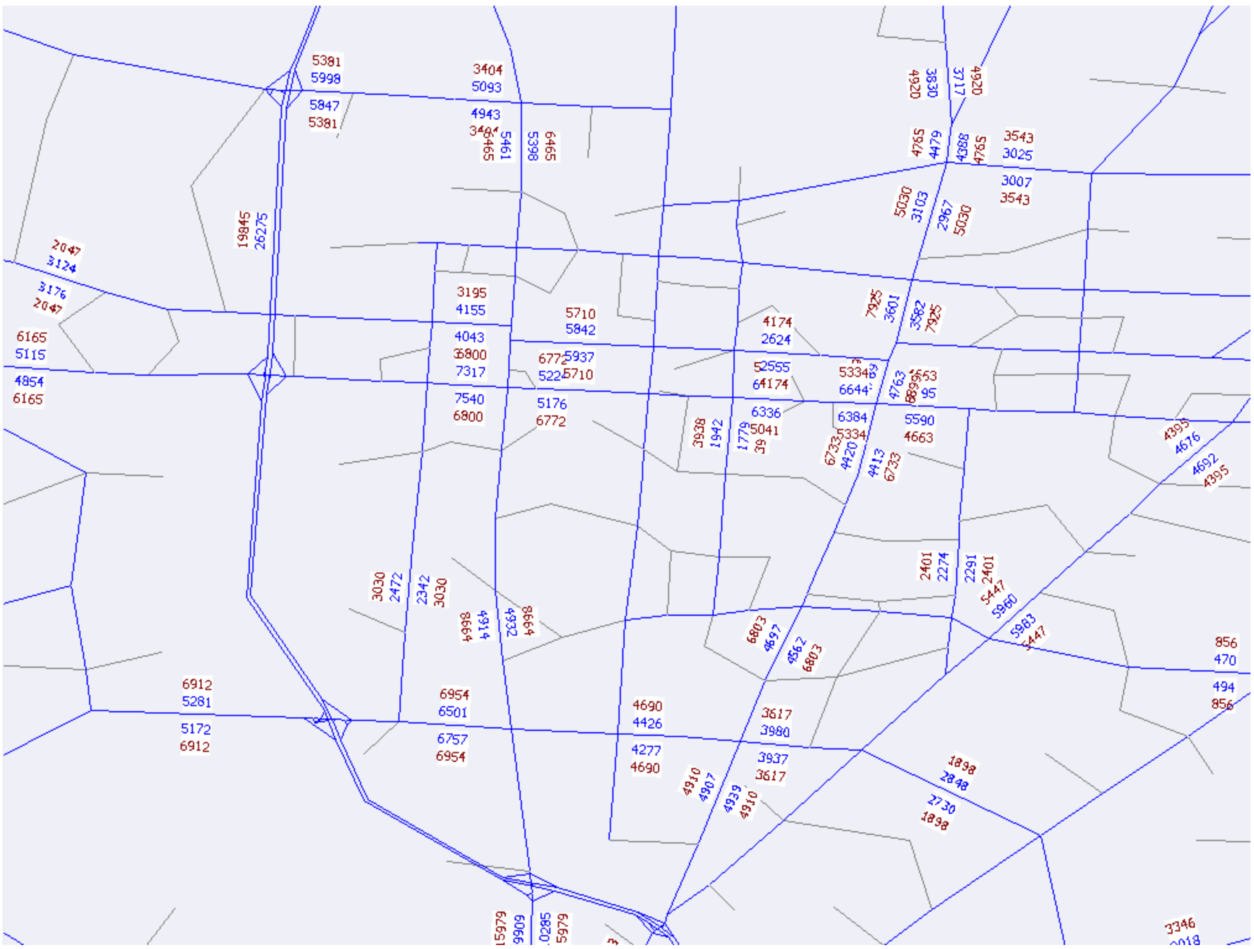
As before, a ratio of 1 indicates a perfect match between modeled and observed volumes. Cells highlighted in red indicate that there are fewer than 10 links in that FT/AT category. For example, Arterial Class 2 is used on only six links in the model. With so few links, validation of these links will likely be inaccurate to due small sample size. Five facility types make up a majority of the links in the model: Freeway Class 1, Arterial Class 1, and Arterial Class 3, Collector Class 1, and Collector Class 3. These classes account for 90% of model links for which traffic counts were obtained, so validation should be focused on these.

Freeway Class 1 represents the largest regional roads, most of which are in Area Type 4, Rural. The model slightly overestimates volumes on these roads by 8%. The two largest facility types are Arterial Class 1 and 3, which combined account for 61% of all model links. The model is very accurate for Arterial Class 1 (with a ratio of 0.99) and underestimates volumes on Arterial Class 3 (with a ratio of 0.86). Collector Class 1 and 3 are fairly accurate, underestimating slightly (with ratios of 0.97 and 0.92). In general, validation is very good for the most common facility types in the model. The only notable exception is for Arterial Class 3, for which volumes are significantly underestimated in three of the four Area Types. Not enough counts were taken on Local Class 1 and 2 roads to properly assess their validation; however, local roads are unlikely to become congested. Freeway Class 2 and Arterial Class 2 are rarely used in the model, and similarly did not have enough counts taken to properly assess their validation.

On a smaller scale, volume/count ratios for corridors can be examined using Cube. As discussed before, the model's regional-scale validation is quite good, allowing it to accurately model emissions as needed for air quality conformity. The model may be used for planning purposes as well, such as evaluating the effects of various project scenarios. Before the model is used in support of any planning effort, however, its validity in the relevant area must be assessed. Several subregions and major corridors were examined, and the general condition of their validation was assessed.

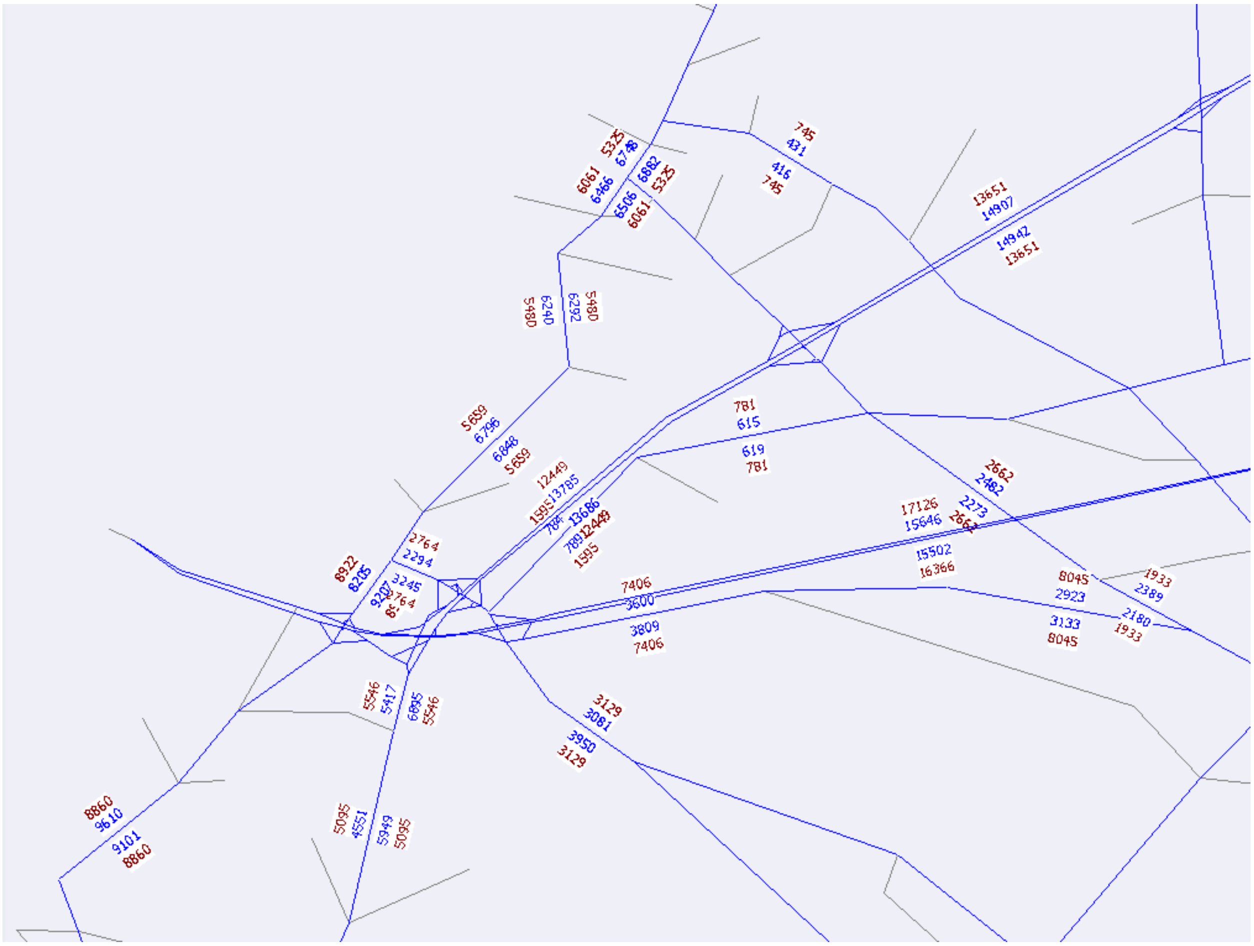
The figures that follow depict link volumes from a Cube model run using a May weekday as the analysis period. Each link is labeled with its 24-hour volume in blue, and spring traffic count in red (the spring counts were also taken in May). Links for which no counts were available were not labeled, and links for which two-way counts were taken will be labeled on each side.

Figure 1: Vineland, Modeled and Observed Volumes



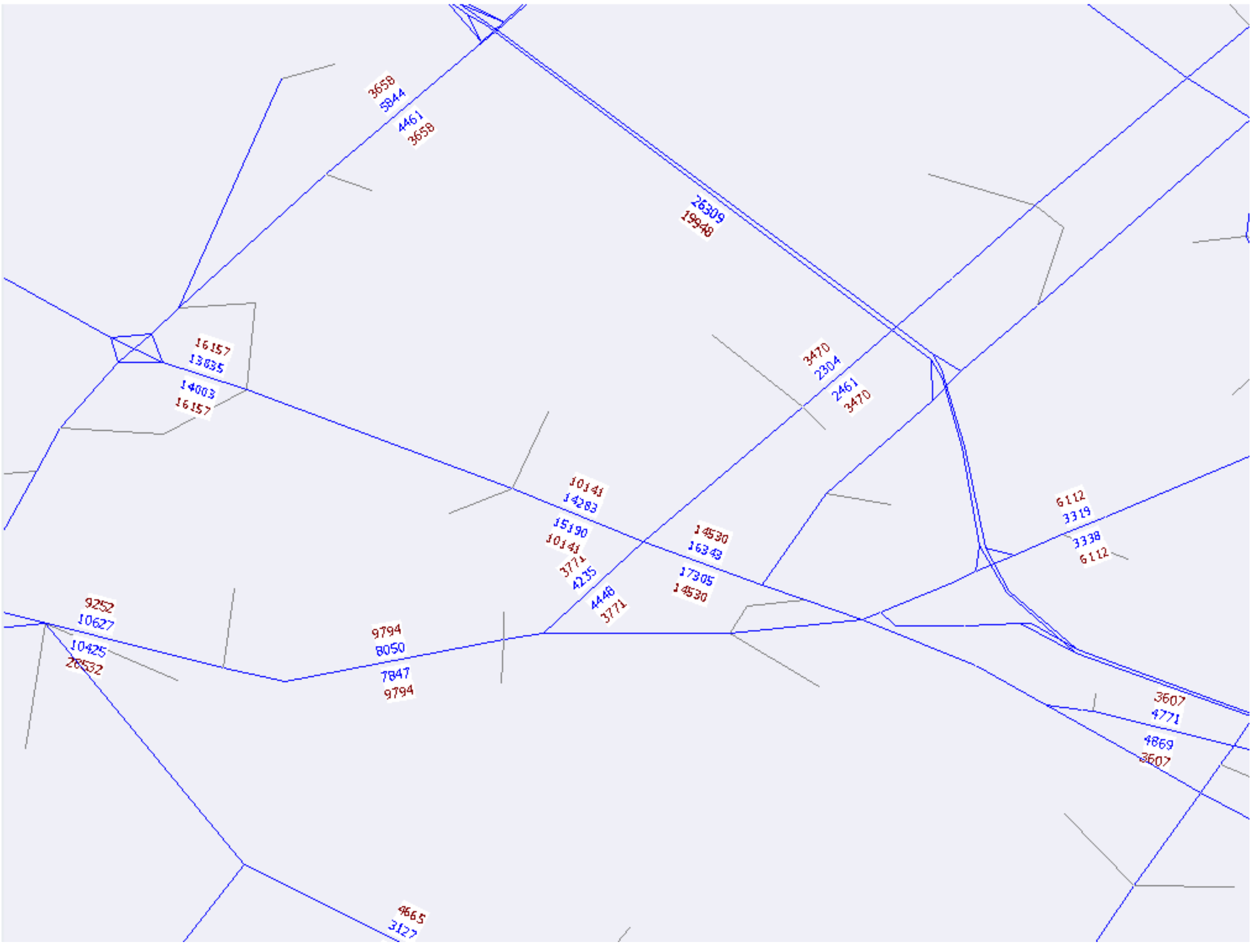
Volume/count ratios for several major roads in Vineland are close to 1.0, including Sherman Ave. between Main Rd and NJ-55 and much of Landis Ave. However, several other major roads have volumes underestimated by the model. In particular, the volume/count ratio for Delsea Dr. is about 0.6, and for Main Rd. the ratio is about 0.67. NJ-55 is somewhat overestimated with a ratio of 1.3, which helps to balance out the north-south volume through Screenline 8, which lies just north of Vineland.

Figure 2: Delaware Memorial Bridge Approaches, Modeled and Observed Volumes



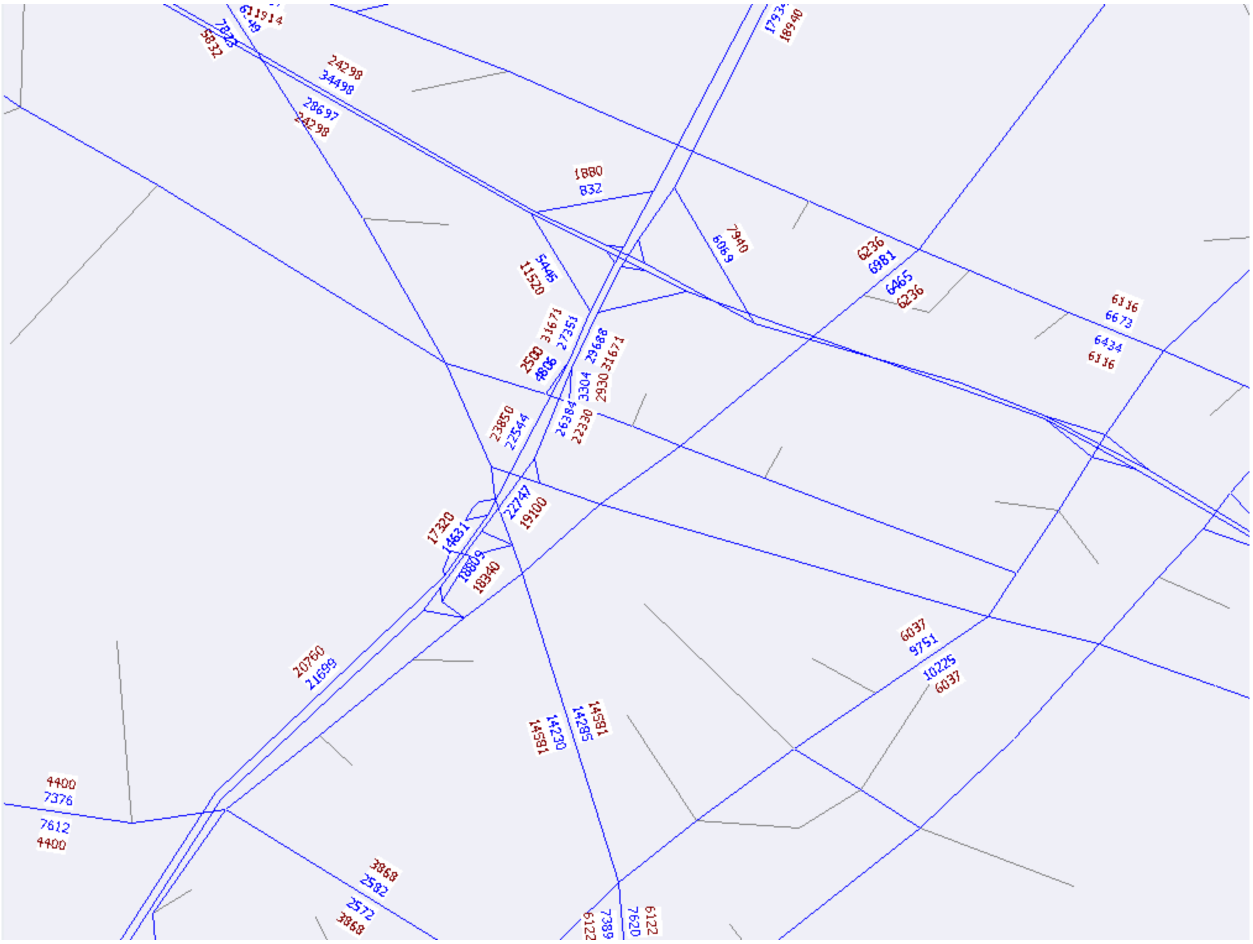
I-295 just before the Delaware Memorial Bridge has a volume/count ratio of 1.10, while the NJ Turnpike has a ratio of 0.91. The remaining approaches are similarly well calibrated, with the exception of US 40, which underestimates with a ratio of 0.50. In total, the bridge approach volumes are close to the counts, and the 10% overestimate from I-295 should cancel out the 10% underestimate for NJ Turnpike, leaving the bridge itself with the correct volume. The good validation on these approaches matches the good validation we expect for Class 1 Freeways (see Table 13) and for Screenline 9, which cuts through these roads just northeast of the bridge.

Figure 3: Convergence of U S40 and US 322, Modeled and Observed Volumes



This corridor is notable for its congestion, and is a location of interest for congestion relief measures. Just before they converge, US 322 shows an overestimate of volume (with a ratio of 1.2) while US 40 shows an underestimate (with a ratio of 0.8). We can expect these errors to cancel out, leaving the 40/322 corridor fairly well calibrated. Some of the traffic counts in this area may be outliers, as they do not match the counts on upstream or downstream links. For example, US 40 has a count of 28,000 vehicles per day in the eastbound direction, while the next link has a far more reasonable count of 9,700 vehicles per day.

Figure 4: Egg Harbor and Pleasantville, Modeled and Observed Volumes



This region contains several major interchanges, including the junction of the Garden State Parkway and the Atlantic City Expressway. Validation on the Parkway itself appears to be very good, with only slight differences from the counts. The model is overestimating volumes on the Atlantic City Expressway, with a volume/count ratio of about 1.2 west of the junction, and a higher ratio of 1.55 east of the junction. 40/322 is similarly overestimated as it heads into Atlantic City. Tilton Rd is very accurately modeled, with ratios close to 1.0.

To conclude, volume/count ratios vary greatly on a small scale. This is to be expected given the model RMSE values in Table 11, which show that although the mean volume/count ratio is about 1.0, individual roadways will commonly be significantly greater or less than 1.0. Because of this, the model is unsuitable for estimating volumes on individual roads, as might be needed when preparing a microsimulation model. The model should also be considered unsuitable for small-scale preliminary traffic impact analysis.

Transit Assignment

Transit validation is reviewed very well in the model development report in Section 11.2 (MDV p.117). Each transit route is listed with both its modeled and observed ridership for ease of comparison. The table is reproduced on the following page with two additional columns – one showing the difference between the modeled and observed ridership, and another showing the percent difference.

In total, the model underestimates transit trips by 12%. However, when Jitney trips are excluded, the model overestimates transit trips by 28%. Jitney trips account for roughly half of all regional transit trips, according to the observed data. NJ Transit bus routes account for most of the remainder. For individual bus routes, validation varies, with most routes being significantly overestimated or underestimated. In total, the model overestimates NJ Transit bus ridership by 21%. The Atlantic City Rail Line is very well validated, with the model estimate differing from the surveyed ridership by only 8%.

Regionally, the total transit validation is good for air quality modeling purposes. However, individual bus routes may differ greatly from the observed ridership. This is similar to the highway assignment validation, which worked well regionally but not at the level of individual roads. This is to be expected from a regional travel demand model, which is not intended to be accurate at small scales.

There are several possible improvements that may be made to transit validation. While the bus ridership data is fairly recent, rail and jitney validation data is not. The results of the Atlantic City Rail survey, which was conducted during the summer of 2012, are one potential source of new validation data. Rail ridership is presently very well validated. Unless the rail survey results differ significantly from the 2006 survey, rail can probably be left as-is. Updated Jitney ridership data was unavailable. The figures from the old model used for calibration may be the best estimates available. It is unclear if better jitney ridership data could be obtained through survey or any other method. At present, the model underestimates jitney ridership considerably, and adjusting mode choice to route more trips onto jitneys 1 and 2 may close the regional 12% gap between observed and modeled transit trips. Because jitneys account for half of all transit trips, future validation effort should be focused on more accurately modeling them. Even though jitney trips are quite short (within Atlantic City only), they should still be considered regionally significant.

Table 15: Transit Validation

Route	Ridership		Diff.	% Diff.	Source (Observed)
	Model	Observed			
313	538	83	455	548%	NJT Ridership and Zone Profile - 11/2010
315	290	62	228	368%	NJT Ridership and Zone Profile - 11/2010
316	99	135	-36	-27%	NJT SJ Bus Survey - 10/2011
319	182	143	39	27%	NJT Ridership and Zone Profile - 11/2010
401	66	108	-42	-39%	NJT Ridership and Zone Profile - 11/2010
402	329	155	174	112%	NJT Ridership and Zone Profile - 11/2010
408	1,669	491	1,178	240%	NJT Ridership and Zone Profile - 11/2010
410	55	145	-90	-62%	NJT Ridership and Zone Profile - 11/2010
468	616	414	202	49%	NJT SJ Bus Survey - 10/2011
501	1,154	406	748	184%	NJT Ridership and Zone Profile - 11/2010
502	1,550	1,331	219	16%	NJT Ridership and Zone Profile - 11/2010
504	171	603	-432	-72%	NJT Ridership and Zone Profile - 11/2010
505	3,005	4,429	-1,424	-32%	NJT Ridership and Zone Profile - 11/2010
507	2,344	1,149	1,195	104%	NJT Ridership and Zone Profile - 11/2010
508	878	869	9	1%	NJT Ridership and Zone Profile - 11/2010
509	1,011	651	360	55%	NJT Ridership and Zone Profile - 11/2010
551	476	939	-463	-49%	NJT Ridership and Zone Profile - 11/2010
552	2,214	927	1,287	139%	NJT Ridership and Zone Profile - 11/2010
553	2,935	1,681	1,254	75%	NJT Ridership and Zone Profile - 11/2010
554	1,962	1,062	900	85%	NJT Ridership and Zone Profile - 11/2010
559	415	1,137	-722	-64%	NJT Ridership and Zone Profile - 11/2010
ACRL	3,768	3,498	270	8%	AC Rail Survey - 06/2006
Jitney #1	3,359	10,960	-7,601	-69%	CENTRAL Model Development Report
Jitney #2	2,138	5,480	-3,342	-61%	CENTRAL Model Development Report
Jitney #3	4,535	5,480	-945	-17%	CENTRAL Model Development Report
Jitney #4	784	-	-	-	Not Available
ACRL Shuttle#1	894	332	562	169%	NJ Transit - 07/2011
ACRL Shuttle#2	11	220	-209	-95%	NJ Transit - 07/2011
ACRL Shuttle#3	457	287	170	59%	NJ Transit - 07/2011
ACRL Shuttle#4	488	249	239	96%	NJ Transit - 07/2011
Total	**38,393**	**43,426**	-5,033	-12%	
Excluding Jitney	27,577	21,506	6,071	28%	