SOUTH JERSEY TRAVEL DEMAND MODEL (SJTDM) IMPROVEMENTS

FY 2011-2012

SJTPO

MODEL DEVELOPMENT AND VALIDATION REPORT

October 2012

URS *in association with*

RESOURCE SYSTEMS GROUP, WHITEHOUSE GROUP, AND TECHNIQUEST

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1 Introduction

As part of the South Jersey Model Improvement Project (SJMIP), SJTPO retained the URS Team to migrate the regional travel demand model to Cube/Voyager and implement several enhancements to develop a model that is more state-of-the-practice. The Team comprised of URS Corporation, Resource Systems Group, Whitehouse Group and TechniQuest. The URS Team developed a model that is now more user-friendly as well as transparent and utilizes only the Cube/Voyager suite unlike the previous version of the model which utilized several software components such as CENTRAL, FORTRAN, CLIPPER, MINUTP and TP+. The URS Team reviewed the CENTRAL version of the model, identified several enhancements and implemented the recommendations after obtaining approval from SJTPO and the peer reviewer.

The base year model was calibrated and validated to 2010 conditions. This document presents the details of the enhancements that were implemented along with the base year 2010 validation statistics. Several elements of the model were not altered; either they were deemed appropriate or more recent data were not available to update it. As agreed with SJTPO staff, in order to develop a comprehensive document for the new model, the descriptions of those components presented in this document have been taken from the previous model documentation. Guidelines on how to operate the new model including performing typical analysis tasks can be found in the SJTDM User's Guide.

The South Jersey Travel Demand Model (SJTDM) is expected to be continued to be used by SJTPO primarily for performing the annual air quality conformity analysis and long range transportation planning for the region. The model is also a very useful tool for highway and transit corridor studies and "what if" scenario analysis related to transportation system changes and/or different land use forecasts such as smart growth scenarios.

This report is organized into twelve chapters. Chapter 2 describes the updates to the TAZ system and base year demographic data. Chapter 3 contains a description of the highway network and associated enhancements. Chapter 4 provides information pertaining to the transit network updates. Chapter 5 presents the trip generation process and results. Chapter 6 describes the trip distribution process and results. Chapter 7 provides details on the mode choice model updates and validation results. Chapter 8 describes the temporal model and Chapter 9 presents the peak hour model. Chapter 10 describes the highway assignment step and validation results and Chapter 11 presents the transit assignment process and validation results.

2 TAZ System and Demographics

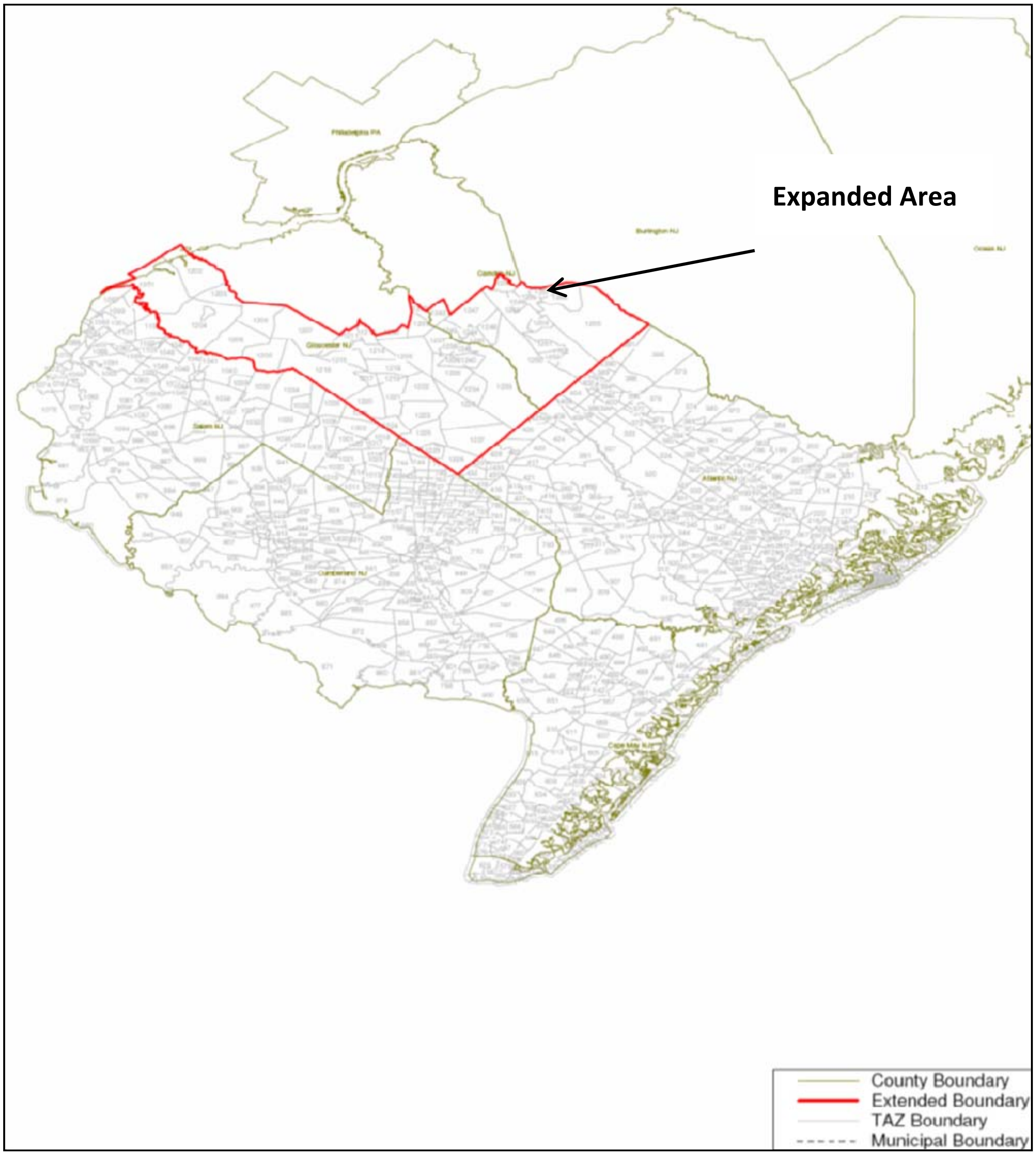
Traffic Analysis Zones (TAZ) are geographic units in which socioeconomic data is summarized for use in travel demand models. Prior to discussions about the TAZ system and demographics, the geographic coverage of the revised SJTDM will be presented here.

2.1 Revised Geographic Coverage

A significant portion of travel within the SJTPO 4-county area comprise of traffic from the Delaware Valley Regional Planning Commission (DVRPC) region. Therefore, during the previous model development, it was necessary to incorporate the 13-county DVRPC area into the SJTPO model. However, due to differences in the modeling methodologies and software platform between the two models, only limited elements of the DVRPC model had been included in the SJTPO model. Specifically, only the networks, zonal system and the trip tables from the DVRPC model had been integrated into the SJTPO model. The networks from the DVRPC and SJTPO regions were stitched together in the model chain. The trip table integration process, however, was a more involved one. In the previous SJTPO model, the trip generation and distribution processes for the recreational trip purposes were performed for the DVRPC and SJTPO regions. For the non-recreational trip purposes, the DVRPC trip tables were combined with those in the SJTPO model (both in production-attraction format) via a process known as 'weaving', implemented as a FORTRAN program. The combined trip tables were then used as input to the mode choice process.

After reviewing the model integration process in the previous SJTPO model and understanding SJTPO's needs, the URS team had developed some options for the proposed geographic coverage of the SJTPO model. The project team and SJTPO/peer reviewer agreed on the option in which the weaving process could be eliminated and in which the geographic coverage would include the 4-county SJTPO region and portions of Camden and Gloucester Counties which would provide a buffer of one township, for continuity of several roadways such as US 40 which crosses the 4-county region several times. The major transit projects crossing the SJTPO region would be treated via a new External-Internal (EI) mode choice process, which will be described in detail in Chapter 7. The major benefit of this revised geographic coverage and approach is the reduced burden on SJTPO to maintain and update the socioeconomic and network data outside the 4-county region. Moreover, SJTPO rarely requires analyzing projects outside the 4-county region. If an agency such as NJ Transit needs to perform an analysis of a transit project just outside this new coverage, it could be done using the DVRPC model which is currently being expanded to encompass the SJTPO region. Finally, the approach reduces unnecessary model complexity. Figure 2.1 shows the revised geographic coverage in the updated SJTDM.

Figure 2.1: Revised Geographic Coverage in New SJTDM



2.2 TAZ System

Once the geographic coverage of the SJTDM was finalized, the TAZ system required modifications. The zonal system in the previous version of the model was based on the 1990 Census geographies. As the 2010 census geographies had been released recently, the project team agreed to update the TAZ layer in the SJTDM so that it conforms to 2010 census geographies. For the most part block groups and blocks were used to define the TAZ polygons, which depended on the density of the area.

Although the 2010 census geography was used to provide general guidelines of the zonal polygons, there were several additional considerations for defining the TAZ boundaries. The peer reviewer had identified several issues with the definition of TAZs in the model and had provided comments via several technical memorandums over the past few years. The URS Team reviewed those issues and determined that several TAZs needed to be combined or split to address those comments. One major modification was the reduction of zones in the Atlantic City area which seemed to be too detailed for an MPO model (the SJTPO model was originally developed based on the Atlantic City model for which this level of zonal detail was warranted). These applied to only the 4-county SJTPO area; in the expanded geographic area (portion of Camden and Gloucester counties), the zonal system was adopted from the DVRPC model Travel Improvement Model (TIM) 2.0 to facilitate seamless transfer of network and socioeconomic data.

Once the TAZ boundaries were updated, a zonal numbering system was developed that was more continuous spatially compared to the previous zonal system and continuing to maintain the provision of spare zones for future use such as zonal splits. There are a total of 240 spare zones. The revised system has a total of 1400 internal zones (including spare zones) and 34 external zones resulting in a total of 1434 zones. Table 2.1 shows the revised TAZ numbering system. The new TAZ layer was created under the Latitude-Longitude coordinate system using GIS software. The TAZ polygons are shown in Figure 2.2.

Table 2.1: Revised TAZ Numbering System

Region	# Zones	Zone Range
Atlantic City	155	1-155
Atlantic City spare zones	20	156-175
Atlantic County Recreational Zones	27	176-202
Atlantic County Recreational spare zones	18	203-220
Rest of Atlantic County	257	221-477
Atlantic County spare zones	23	478-500
Cape May County Recreational Zones	132	501-632
Cape May County Recreational spare zone	18	633-650
Rest of Cape May County	71	651-721
Cape May County spare zones	29	722-750
Cumberland County	253	751-1003
Cumberland County spare zones	22	1004-1025
Salem County	130	1026-1155
Salem County spare zones	20	1156-1175
Gloucester County	97	1176-1272
Gloucester County spare zones	28	1273-1300
Camden County	38	1301-1338
Camden County spare zones	12	1338-1350
Additional reserve for all counties zones	50	1351-1400
SJ External	34	1401-1434
Total spare zones	240	

Note that in Atlantic City, each casino and its associated parking garage were assigned a separate zone. Other special traffic generators such as the Convention Center also have its own TAZ. As can be seen in Table 2.1, separate zones were allocated to the recreational portion of the model following the system setup in the old model, which are comprised of shore communities in Atlantic and Cape May counties and include Atlantic City, Brigantine, Ventnor, Margate, Longport, Ocean City, Strathmere (a portion of Upper Township located on the barrier island), Sea Isle City, Avalon, Stone Harbor, North Wildwood, Wildwood, West Wildwood, Wildwood Crest, Cape May City, West Cape May and Cape May Point.

Figure 2.2: Revised TAZ System

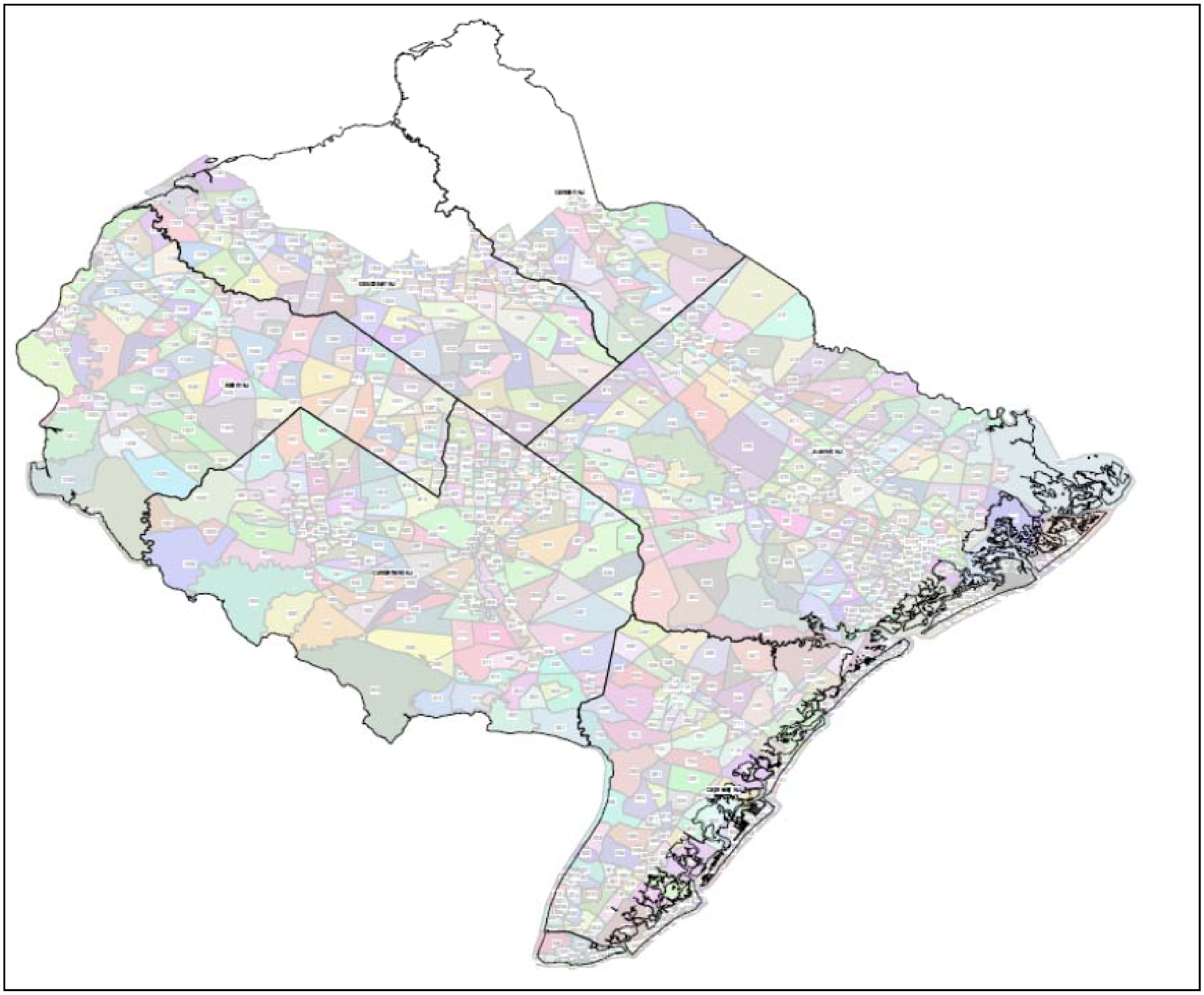


Figure 2.3 shows the revised TAZ system in Atlantic City along with the old TAZ boundaries. As can be seen in the figure, there was a reduction in detail of the TAZs.

Figure 2.3: Revised TAZ System in Atlantic City

2.3 Socioeconomic Data

The previous SJTPO model was validated to the base year of 2002. The project team decided that the updated model should be validated to the year 2010. Demographic data for the 4-county SJTPO region for the year 2010 was developed by the demographic consultant based on census 2010 data at the township level. SJTPO staff then developed demographic data for the new TAZs using census 2010 block level data using the township level numbers as control total. The household-related data required and compiled for the SJTDM included household population, group quarter population, total population and households. Census SF3 data was used to develop household related data.

To develop employment data, the Census Bureau’s Longitudinal Employer-Household Dynamics (LEHD) Workplace Area Characteristics (WAC) dataset was used. This dataset lists the estimated number of workers in each census block, tabulated by 19 different job classifications. These classifications were combined to produce the four employment types required by the model: retail, office, industrial, and other. See the Table 2.2 below for the classification scheme used and the corresponding NAICS sectors.

Table 2.2: Employment Classification Scheme

Category	WAC Variable	Description
Total	C000	Total number of jobs
Industrial	CNS05	NAICS sectors 31-33 (Manufacturing)
Office	CNS09 through CNS13	NAICS sectors 51-55 (Information, Finance and Insurance, Real Estate, Professional Scientific and Technical Services, Management)
Retail	CNS06, CNS07, CNS18	NAICS sectors 43, 44, 45, 72 (Wholesale, Retail, Accommodation and Food services)
Other	---	Total minus Industrial, Office, and Retail

The block-level data was then aggregated to the TAZ level to serve as a model input. As the LEHD WAC data only includes jobs covered by unemployment insurance, it was found to be an underestimate of the total number of workers as reported in the initial demographics report. Thus, the TAZ-level numbers were inflated by a factor of 9.3% so that the total number of employees would be brought into parity with that estimated by the demographer while maintaining the spatial distribution of employment.

Extensive visual quality control checks were performed by the team to ensure that the data appeared reasonable and did not differ significantly from the 2010 (estimated) data in the previous model. The data for Camden and Gloucester counties were taken directly from DVRPC's TIM 1.0 model. Table 2.3 summarizes the key demographic variables by county for the year 2010. Another key variable updated in the model is the median zonal income data, which was also derived from the 2010 census.

Table 2.3: Summary of 2010 Demographic Data in SJTDM

County	Total Population	Households	Total Employment
Atlantic	274,361	102,779	139,066
Cape May	97,238	40,803	34,902
Cumberland	156,662	51,826	62,324
Salem	65,726	25,151	23,865
4-County Total	**593,987**	**220,559**	**260,157**
Gloucester	136,425	45,944	44,273
Camden	61,999	20,711	15,465
Total	**792,411**	**287,214**	**319,895**

School Enrollment data was updated to 2010 conditions based on data from NJ Department of Education. This data was derived at the zonal level at the school end of the trip, not the home location of students. Note that unlike the previous version of the model, school enrollment data pertains to students in K-12 grades and excludes college students which now has been separated out as a separate category as described later in this document.

The model includes four colleges, which are Atlantic Cape May Community College (Mays Landing and Atlantic City campuses), Cumberland County College, Salem Community College and Stockton State College. The enrollment data for these colleges was updated based on data provided by the colleges. The number of college students per household in each TAZ is estimated based on Census data, as described in the Trip Generation chapter.

As with the previous version of the SJTPO model, households (HHs) are stratified into three life-cycle categories for the purpose of trip generation modeling. These household life cycle categories are:

- HHs with retired people;
- HHs with kids under 18 and no retirees;
- HHs with no kids or retired people.

The zonal input data file includes data fields with the percentage of households in each category, for each TAZ. The life cycle percentage data in each TAZ was updated based on census 2010 American Community Survey (ACS) data. The data were developed at the Census Tract geography and related to TAZs based on which TAZ the Census Tract is within.

The recreational data in the model was also outdated; a few casinos have been shut down over the past few years. Data such as square footage of the remaining casinos, number of hotel rooms and number of employees was also updated in the model based on the latest available data. Casino TAZs were updated for the new TAZ system, and the new casino Revel, which opened in 2012, was added to the year 2040 scenario. Casino employees were reallocated according to the new TAZ system as well. Although the model has several other variables as part of the recreational database (such as percentage of employees and visitors parking in the various parking facilities, observed visitor peak hour trips, casino bus trips, etc), only those variables for which data was easily available were updated. The remaining data items could be updated at a later time when a comprehensive survey is conducted.

Other miscellaneous zonal data such as daily and hourly auto parking cost, bus and rail park-n-ride costs were also updated based on the latest available data.

Tables 2-4 through 2-15 present the household and employment related data for 2010 by county and by municipality.

Table 2.4: Atlantic County Household-Related Data by Township

Municipality	Population	Group Quarter Population	Total Population	Household	School Enrollment	College Enrollment
Atlantic City city	38,739	802	39,541	15,500	5,951	0
Brigantine city	9,446	4	9,450	4,294	796	0
Ventnor City city	10,644	6	10,650	4,592	1,170	0
Margate City city	6,354	0	6,354	3,156	514	0
Longport Borough	761	0	761	394	0	0
Galloway Township	34,507	2,818	37,325	13,059	4,995	8,065
Port Republic city	1,081	7	1,088	402	115	0
Absecon city	8,261	150	8,411	3,179	2,585	0
Pleasantville city	19,940	309	20,249	6,661	3,584	0
Northfield city	8,441	183	8,624	3,152	1,092	0
Linwood city	6,957	135	7,092	2,653	2,684	0
Somers Point city	10,785	10	10,795	4,655	2,255	0
Egg Harbor Township	43,417	19	43,436	15,316	8,455	0
Corbin City city	456	0	456	171	0	0
Estell Manor city	1,787	8	1,795	634	194	0
Weymouth Township	2,616	7	2,623	1,127	212	0
Hamilton Township	25,383	1,120	26,503	9,490	5,263	7,559
Egg Harbor City city	4,210	33	4,243	1,593	650	0
Mullica Township	7,628	111	7,739	2,725	698	0
Hammonton Town	12,906	282	13,188	4,835	3,653	0
Folsom Borough	1,864	5	1,869	683	398	0
Buena Vista Township	7,552	18	7,570	2,786	2,315	0
Buena Borough	4,580	19	4,599	1,722	162	0
Total	**268,315**	**6,046**	**274,361**	**102,779**	**47,741**	**15,624**

Table 2.5: Atlantic County Employment-Related Data by Township

Municipality	Industrial Employment	Retail Employment	Office Employment	Other Employment	Total Employment	Seasonal Employment
Atlantic City city	392	24,042	6,013	24,639	55,087	1,511
Brigantine city	40	470	140	1,257	1,907	185
Ventnor City city	58	508	109	890	1,565	165
Margate City city	31	563	158	976	1,728	186
Longport Borough	3	14	5	77	99	0
Galloway Township	295	3,366	1,175	6,095	10,931	0
Port Republic city	5	11	9	33	58	16
Absecon city	111	3,033	694	2,855	6,693	75
Pleasantville city	344	3,605	575	3,833	8,357	161
Northfield city	75	1,262	475	2,722	4,534	148
Linwood city	50	928	378	1,868	3,224	165
Somers Point city	167	2,581	864	3,444	7,056	360
Egg Harbor Township	508	4,388	1,273	6,094	12,263	323
Corbin City city	7	6	0	21	34	0
Estell Manor city	30	31	11	183	255	5
Weymouth Township	19	76	16	163	274	24
Hamilton Township	231	4,012	616	6,072	10,931	0
Egg Harbor City city	44	699	129	768	1,640	268
Mullica Township	136	420	49	666	1,271	231
Hammonton Town	454	2,243	655	3,893	7,245	2,116
Folsom Borough	143	199	53	466	861	11
Buena Vista Township	387	385	58	1,054	1,884	90
Buena Borough	142	278	51	696	1,167	138
Total	**3,672**	**53,120**	**13,506**	**68,767**	**139,066**	**6,179**

Table 2.6: Cape May County Household-Related Data by Township

Municipality	Population	Group Quarter Population	Total Population	Household	School Enrollment	College Enrollment
Ocean City city	11,637	64	11,701	5,890	2,046	0
Upper Township	12,363	10	12,373	4,566	1,432	0
Sea Isle City city	2,114	0	2,114	1,041	49	0
Avalon Borough	1,333	1	1,334	692	75	0
Stone Harbor Borough	865	1	866	441	74	0
North Wildwood city	4,041	0	4,041	2,047	648	0
West Wildwood Borough	592	11	603	276	0	0
Wildwood city	5,100	225	5,325	2,251	860	0
Wildwood Crest Borough	3,270	0	3,270	1,532	283	0
Cape May city	2,844	763	3,607	1,457	154	0
West Cape May Borough	1,026	0	1,026	494	39	0
Lower Township	22,732	105	22,837	9,569	3,446	0
Cape May Point Borough	291	0	291	164	0	0
Middle Township	18,079	832	18,911	7,256	3,587	0
Dennis Township	6,347	120	6,467	2,370	1,015	0
Woodbine Borough	1,976	496	2,472	757	207	0
Total	**94,610**	**2,628**	**97,238**	**40,803**	**13,915**	**0**

Table 2.7: Cape May County Employment-Related Data by Township

Municipality	Industrial Employment	Retail Employment	Office Employment	Other Employment	Total Employment	Seasonal Employment
Ocean City city	157	1,507	460	2,845	4,969	1,578
Upper Township	190	1,071	228	1,392	2,881	641
Sea Isle City city	69	206	62	441	778	508
Avalon Borough	24	279	93	562	958	724
Stone Harbor Borough	30	262	49	354	695	407
North Wildwood city	28	192	36	430	686	479
West Wildwood Borough	0	1	1	32	34	7
Wildwood city	37	834	251	1,205	2,327	1,712
Wildwood Crest Borough	16	162	56	281	515	612
Cape May city	23	594	206	785	1,608	1,302
West Cape May Borough	7	71	16	114	208	28
Lower Township	309	1,628	325	2,663	4,925	391
Cape May Point Borough	1	7	4	35	47	61
Middle Township	215	3,306	924	6,325	10,770	703
Dennis Township	114	413	157	881	1,565	223
Woodbine Borough	117	299	58	1,461	1,935	51
Total	**1,337**	**10,832**	**2,926**	**19,807**	**34,902**	**9,427**

Table 2.8: Cumberland County Household-Related Data by Township

Municipality	Population	Group Quarter Population	Total Population	Household	School Enrollment	College Enrollment
Vineland city	59,233	1,491	60,724	21,450	10,704	4,189
Maurice River Township	3,552	4,405	7,957	1,358	820	0
Millville city	28,162	212	28,374	10,636	6,288	0
Milville city	24	0	24	11	0	0
Commercial Township	5,003	30	5,033	1,817	641	0
Downe Township	1,585	0	1,585	646	165	0
Lawrence Township	3,247	43	3,290	1,102	0	0
Fairfield Township	5,027	1,268	6,295	1,882	609	0
Hopewell Township	3,819	12	3,831	1,477	554	0
Bridgeton city	21,533	4,534	26,067	6,439	4,641	0
Deerfield Township	3,073	46	3,119	1,089	649	0
Upper Deerfield Township	7,590	70	7,660	2,866	2,208	0
Shiloh Borough	516	0	516	198	0	0
Stow Creek Township	1,431	0	1,431	543	292	0
Greenwich Township	756	0	756	312	69	0
Total	**144,551**	**12,111**	**156,662**	**51,826**	**27,640**	**4,189**

Table 2.9: Cumberland County Employment-related data by Township

Municipality	Industrial Employment	Retail Employment	Office Employment	Other Employment	Total Employment	Seasonal Employment
Vineland city	3,641	9,628	2,302	19,134	34,705	472
Maurice River Township	46	107	11	398	562	36
Millville city	1,455	3,075	515	4,852	9,897	585
Milville city	0	10	5	12	27	2
Commercial Township	68	115	15	321	519	13
Downe Township	3	36	16	101	156	10
Lawrence Township	227	95	35	563	920	241
Fairfield Township	185	464	28	760	1,437	27
Hopewell Township	71	368	89	620	1,148	0
Bridgeton city	752	1,650	510	5,123	8,035	666
Deerfield Township	262	258	16	791	1,327	85
Upper Deerfield Township	624	1,155	128	1,284	3,191	175
Shiloh Borough	8	42	3	40	93	10
Stow Creek Township	19	45	7	157	228	51
Greenwich Township	2	25	2	49	78	12
Total	**7,363**	**17,073**	**3,682**	**34,206**	**62,324**	**2,382**

Table 2.10: Salem County Household-related data by Township

Municipality	Population	Group Quarter Population	Total Population	Household	School Enrollment	College Enrollment
Lower Alloways Creek Town	1,540	4	1,544	589	202	0
Elsinboro Township	905	0	905	406	94	0
Quinton Township	2,666	0	2,666	1,036	345	0
Alloway Township	3,371	79	3,450	1,186	434	0
Pittsgrove Township	9,257	136	9,393	3,307	1,581	0
Elmer Borough	1,395	0	1,395	536	0	0
Upper Pittsgrove Township	3,407	98	3,505	1,247	505	0
Pilesgrove Township	3,899	117	4,016	1,488	46	0
Woodstown Borough	3,485	20	3,505	1,444	1,603	0
Mannington Township	1,449	374	1,823	547	946	0
Salem city	5,088	58	5,146	2,157	1,253	0
Pennsville Township	13,409	0	13,409	5,491	1,865	0
Carneys Point Township	7,699	350	8,049	3,264	1,344	1,317
Penns Grove Borough	5,139	8	5,147	1,801	863	0
Oldmans Township	1,766	7	1,773	652	191	0
Total	**64,475**	**1,251**	**65,726**	**25,151**	**11,272**	**1,317**

Table 2.11: Salem County Employment-related data by Township

Municipality	Industrial Employment	Retail Employment	Office Employment	Other Employment	Total Employment	Seasonal Employment
Lower Alloways Creek Town	1	1,096	46	1,087	2,230	0
Elsinboro Township	3	13	2	30	48	0
Quinton Township	471	201	22	801	1,495	32
Alloway Township	36	201	43	470	750	34
Pittsgrove Township	304	851	258	1,613	3,026	0
Elmer Borough	16	167	40	189	412	3
Upper Pittsgrove Township	210	293	53	643	1,199	71
Pilesgrove Township	221	368	61	852	1,502	147
Woodstown Borough	29	394	132	1,030	1,585	133
Mannington Township	14	201	141	445	801	49
Salem city	320	315	140	1,291	2,066	127
Pennsville Township	755	991	204	1,989	3,939	146
Carneys Point Township	84	840	148	1,430	2,502	69
Penns Grove Borough	24	492	70	939	1,525	52
Oldmans Township	271	113	12	389	785	65
Total	**2,759**	**6,536**	**1,372**	**13,198**	**23,865**	**927**

Table 2.12: Camden County Household-related data by Township

Municipality	Population	Group Quarter Population	Total Population	Household	School Enrollment	College Enrollment
Logan Township	6,394	36	6,430	2,150	868	0
Woolwich Township	10,393	34	10,427	3,335	3,493	0
Swedesh borough	2,101	5	2,106	797	452	0
Harrison Township	13,044	34	13,078	4,283	4,020	0
South Harrison Township	3,161	75	3,236	1,060	368	0
Glassboro borough	20,422	2,748	23,170	6,757	2,239	11,816
Elk Township	4,428	60	4,488	1,616	388	0
Clyton borough	7,865	20	7,885	2,751	879	0
Franklin Township	17,682	120	17,802	6,053	3,145	0
New field borough	1,667	5	1,672	624	0	0
Washington Township	11,839	60	11,899	3,949	571	0
Monroe Township	34,139	93	34,232	12,569	6,017	0
Total	**133,135**	**3,290**	**136,425**	**45,944**	**22,440**	**11,816**

Table 2.13: Camden County Employment-related data by Township

Municipality	Industrial Employment	Retail Employment	Office Employment	Other Employment	Total Employment	Seasonal Employment
Logan Township	4,295	874	781	1,254	7,204	0
Woolwich Township	1,281	525	300	189	2,295	0
Swedesh borough	1,047	602	417	460	2,526	0
Harrison Township	1,092	516	1,254	419	3,281	0
South Harrison Township	317	25	96	69	507	0
Glassboro borough	1,321	2,007	3,237	2,345	8,910	0
Elk Township	407	42	170	277	896	0
Clyton borough	390	202	514	1,082	2,188	0
Franklin Township	1,481	444	873	749	3,547	0
New field borough	374	33	156	229	792	0
Washington Township	494	1,587	924	445	3,450	0
Monroe Township	2,759	1,596	2,888	1,434	8,677	0
Total	**15,258**	**8,453**	**11,610**	**8,952**	**44,273**	**0**

Table 2.14: Gloucester County Household-related data by Township

Municipality	Population	Group Quarter Population	Total Population	Household	School Enrollment	College Enrollment
Gloucester Township	6,648	5	6,653	1,985	3,116	0
Winslow Township	38,222	99	38,321	12,952	5,624	0
Berlin borough	4,208	22	4,230	1,532	0	0
Waterford Township	10,808	215	11,023	3,667	890	0
Chesilhurst borough	1,739	33	1,772	575	0	0
Total	**61,625**	**374**	**61,999**	**20,711**	**9,630**	**0**

Table 2.15: Gloucester County Employment-related data by Township

Municipality	Industrial Employment	Retail Employment	Office Employment	Other Employment	Total Employment	Seasonal Employment
Gloucester Township	203	24	300	40	567	0
Winslow Township	2,302	1,085	2,573	2,083	8,043	0
Berlin borough	823	727	1,179	672	3,401	0
Waterford Township	747	400	1,225	762	3,134	0
Chesilhurst borough	82	37	64	137	320	0
Total	**4,157**	**2,273**	**5,341**	**3,694**	**15,465**	**0**

3 Highway Network and Skimming

The highway network in a travel demand model is the digital representation of the roadways of the area encompassed by the model. The coverage of the roadways is seldom 100% especially in a planning level model such as SJTDM. The lower level roadways such as local roads and residential streets are not typically represented in models.

3.1 Network Updates

The 2010 highway network in the SJTDM was updated on several aspects. Firstly, the roadways in the expanded geography, i.e., portions of Camden and Gloucester counties, were added to the 4-county highway network. The network links for this area was initially extracted from the 13-county SJTDM network from the previous version of the model, and further refined to match the level of detail in DVRPC's TIM 2.0 model's 2010 network. The highway network provided to URS from the previous SJTDM did not conform to any standard geographic coordinate system. This made mapping challenging especially when other layers such as TAZ needed to be added to the network. Therefore, the coordinates of the network were transformed so that it conforms to the Latitude-Longitude coordinate system. The peer reviewer had identified several issues over the past few years with the placement of centroid connectors and also related to the TAZs. Those issues were addressed by moving centroid connectors or adding or eliminating them based on whether a zone was added or removed. The level of detail of the network in Atlantic City was also reduced so that it conforms to the revised zonal detail in that area. Figure 3.1 depicts the revised highway network coverage. Figures 3.2 and 3.3 show a comparison of the level of network detail in Atlantic City in the previous model vs. the updated model.

Figure 3.1: Revised Highway network coverage

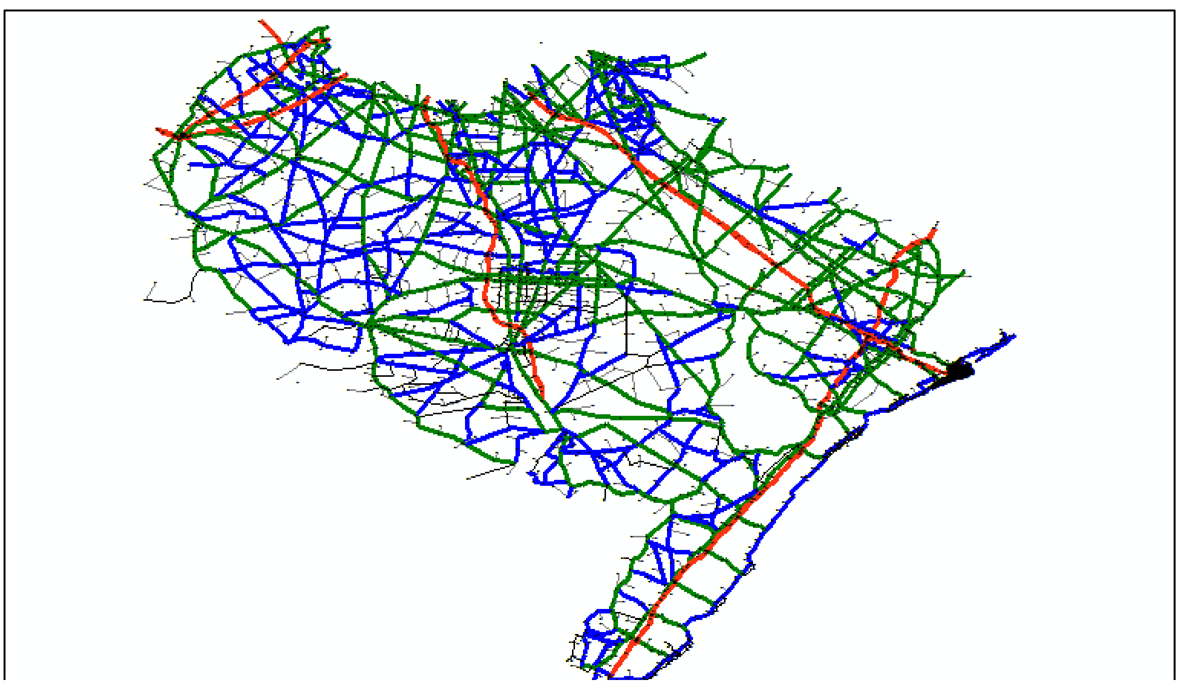


Figure 3.2: Highway network in Atlantic City – previous model

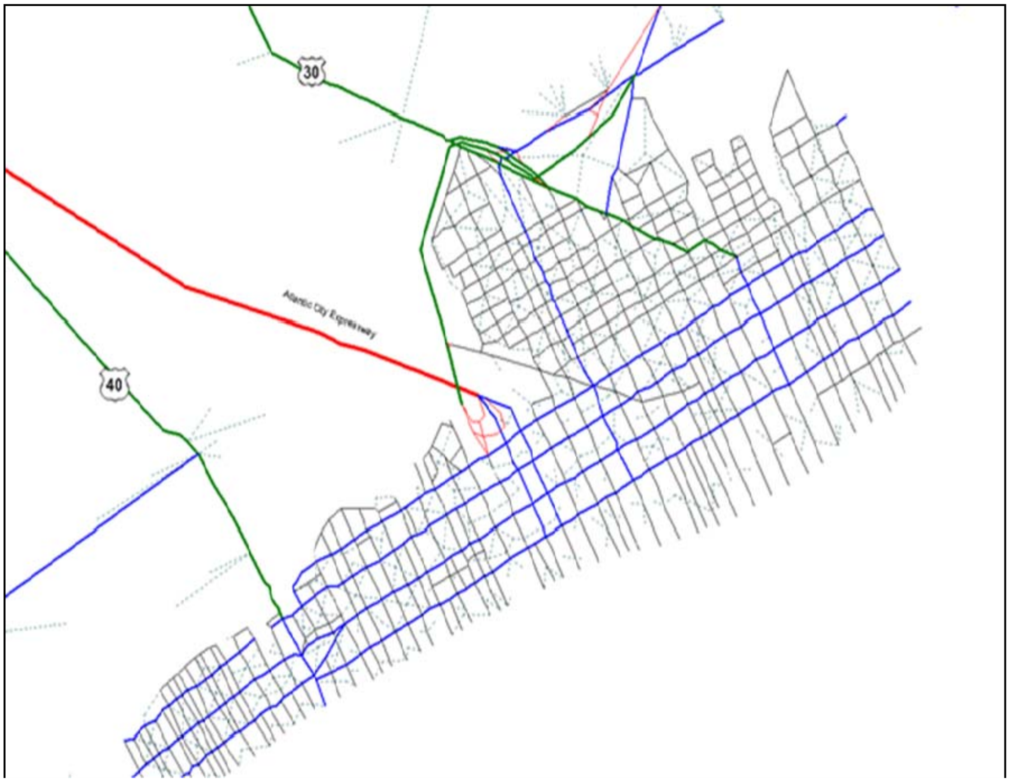
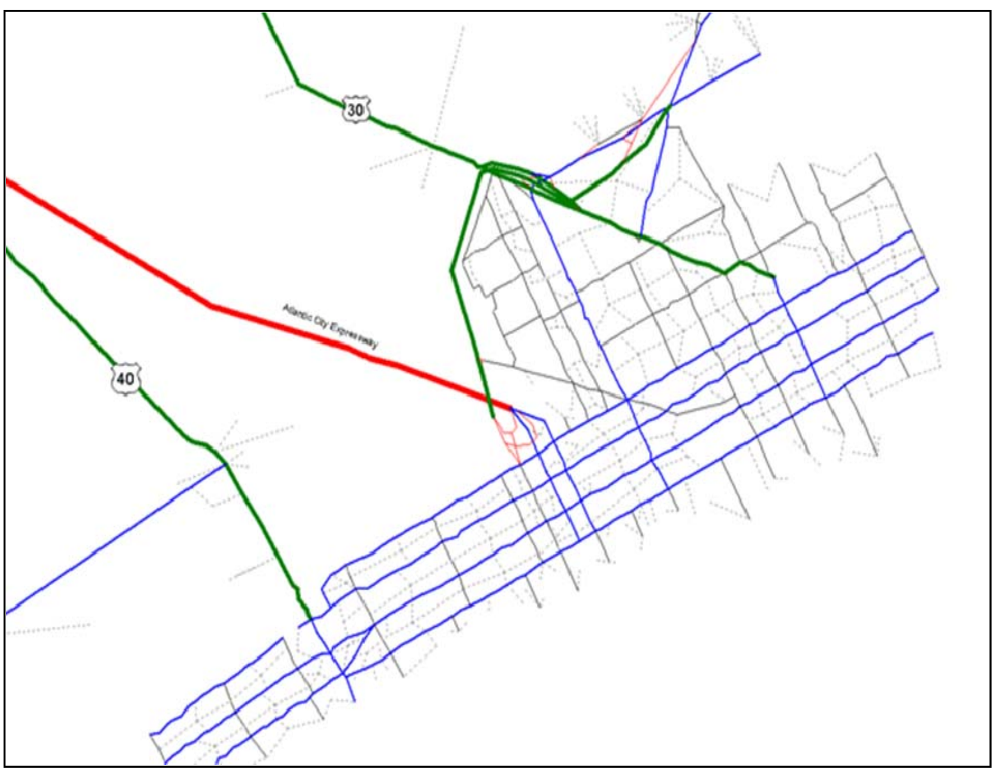


Figure 3.3: Highway network in Atlantic City – updated model



The highway network was also converted to the 'geodatabase' format (from the binary format) in CUBE. A major benefit of this format is the ability to add 'shapes' to links such as ramps or other roadways that have curvature. Also, the network in this format can also be edited in ArcGIS especially by SJTPO staff who do not have CUBE installed on their computers. As part of the effort to add curvature to the roadways via the geodatabase network, all major highways were bifurcated and detailed ramp movements were added. A comparison of the network in binary format vs. geodatabase format is shown in Figures 3.4 and 3.5.

Figure 3.4: Highway network in binary format

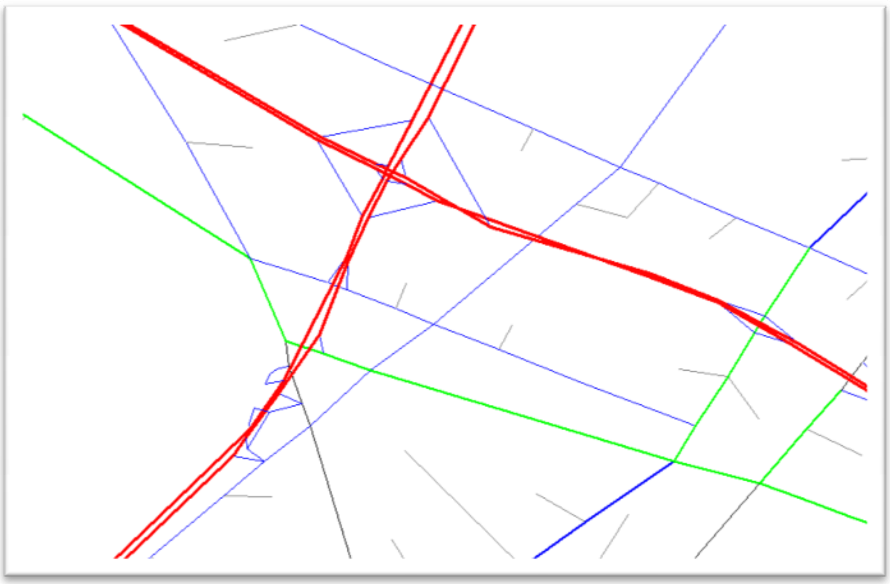
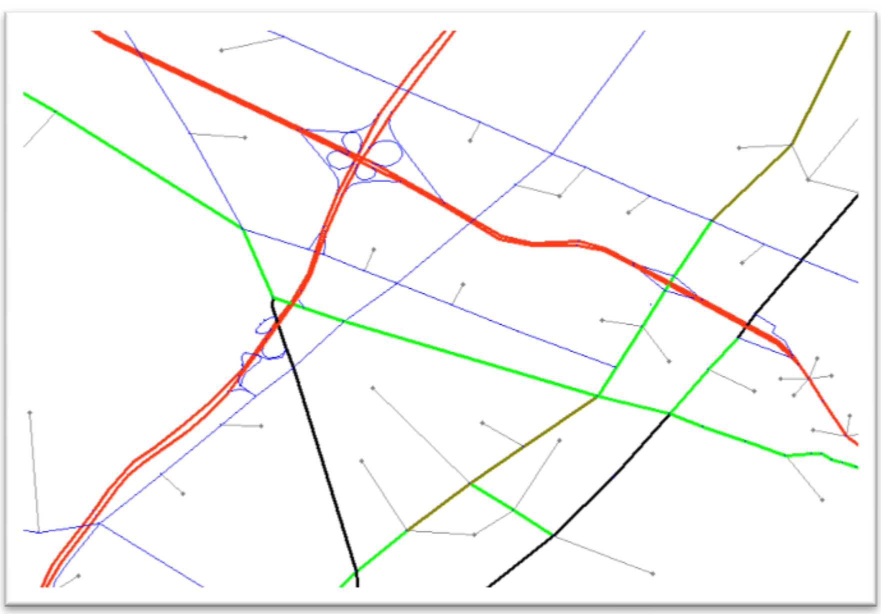


Figure 3.5: Highway network in geodatabase format



The link attributes in the highway network were also cleaned up by removing unused attributes. Note that a few variables related to intersection delay modeling via signals such as green to cycle ratio were retained for future use so that they can be updated when such data is available. The 2010 traffic counts compiled recently were also appended as link attributes. Table 3-1 provides a description of the link attributes. Tables 3-2 and 3-3 provide the definition of the facility types and area types in the model network, which were not changed from the previous model. Table 3-4 shows the zonal population and employment density range matrix used in the determination of area type. The area types in the model network are updated based on the population and employment density of the nearest zone.

Table 3.1: Highway Link Attributes

Field	Description
A	A node - The node number of the upstream end of the link
B	B node - The node number of the downstream end of the link
DISTANCE	Link distance (in hundredths of a mile with an implied decimal)
FC	Functional Class
AT	Area Type
FT	Facility Type
LANES	Number of Lanes
SPDADD	Speed Lookup Adjustment (Additive in %)
SPDSUB	Speed Lookup Adjustment (Subtracted in %)
CAPADD	Capacity Lookup Adjustment (Additive in %)
CAPSUB	Capacity Lookup Adjustment (Subtracted in %)
NSIG	Number of Signals (Not used - for future use)
ARRTYPE	Arrival Type Indicator (Not used - for future use)
GC	Green to Cycle Ratio (Not used - for future use)
CYCLE	Cycle length (Not used - for future use)
NAME	Street Name
COUNTY	County Code
TOLLROAD	Toll Road Indicator (=1 if Toll Road)
TOLL	Toll (cents)
COUNT_SPRING	Spring counts conducted in this study and AADT counts from other sources
COUNT_SUMMER	Summer counts conducted in this study

Table 3.2: Facility Types in highway network

FACILITY TYPE	FT	(Criteria listed in order of decreasing importance, from left to right.)							
		Function of Road	Median	Turn Lanes	Shoulder	Lanes	Control Device	Curb Cuts	Parking
Freeway Class 1	1	full control, limited access facility to serve regional traffic	always exists: raised, guiderail, or grass	none	always greater than 6 feet wide	always has at least two lanes per direction at least 12 feet wide	none	none	none
Freeway Class 2	2	a full control, limited access facility to serve regional traffic, access may occur more than on Class 1	always exists: raised, guiderail, or grass, may not be as wide as on Class 1	none	usually greater than 6 feet wide	always has at least two lanes per direction at least 12 feet wide	none	few or none	none
Arterial Class 1	3	primarily serves regional traffic and provides access to abutting land use as a secondary function	usually has median, especially if no CTL exists	usually has a CTL; if no CTL exists, will have frequent LTL	usually shoulder is approx. 6 feet wide of greater	1-2 lanes per direction; lanes at least 12 feet wide	signals: usually 0-3 per mile	few driveways	usually parking is not permitted
Arterial Class 2	4	primarily serves regional traffic and provides access to abutting land use as a secondary function	usually has median, especially if no CTL exists	usually has a CTL; if no CTL exists, will have frequent LTL	usually shoulder is less than 6 feet wide, road has a narrower cross- section	1-2 lanes per direction lanes usually at least 12 feet wide	signals usually 0-4 per mile	few driveways	possibly parking is permitted during off-peak hours
Arterial Class 3	5	primarily serves regional traffic and provides access to abutting land use as a secondary function	rarely has a median	rarely has a CTL; usually has LTL at major intersections	usually shoulder is less than 6 feet wide	1-2 lanes per direction; usually at least 12 feet wide	signals usually 0-5 per mile	few driveways	possibly parking is permitted during off-peak hours
Collector Class 1	6	primarily provides both land access and traffic circulation service within residential, commercial, & industrial areas	usually has median especially if no CTL exists	sometimes has CTL, if no CTL exists will have frequent LTL	usually greater than or equal to 6 feet wide	usually only 1 lane per direction lanes usually 12 ft wide	signals usually 0-10 per mile	possibly many driveways	possibly parking is permitted

Source: Table 3-5, SJTDM - Model Development and Validation Report, August 1998 – Garmen Associates.

Table 3.2: Facility Types in highway network (Continued)

FACILITY TYPE	FT	(Criteria listed in order of decreasing importance, from left to right.)							
		Function of Road	Median	Turn Lanes	Shoulder	Lanes	Control Device	Curb Cuts	Parking
Collector Class 2	7	primarily provides both land access and traffic circulation service within residential, commercial, and industrial areas	usually has median especially if no CTL exists	sometimes has CTL, if no CTL exists will have frequent LTL	usually shoulder is less than 6 feet wide	usually only 1 lane per direction; usually lanes are 12 ft wide	signals usually 0-10 per mile	possibly many driveways	usually parking is permitted during all hours
Collector Class 3	8	primarily provides both land access and traffic circulation service within residential, commercial, and industrial areas	rarely has a median	rarely has CTL, or frequent turn lanes	usually shoulder is less than 6 feet	usually only 1 lane per direction; lane width varies	signals / stop signs usually 0-10 per mile	possibly many driveways	usually parking is permitted during all hours
Local Class 1	9	serves strictly to provide access to residential or local business areas	rarely has a median	rarely has turn lanes	usually shoulder is less than 6 feet wide	usually only 1 lane per direction, usually about 12 ft wide	stop signs / signals usually 1-10 per mile	usually many driveways	usually parking is permitted during all hours
Local Class 2	10	serves strictly to provide access to residential or local business areas	rarely has a median	rarely has turn lanes	usually shoulder is less than 6 feet wide	usually only 1 lane per direction usually lane width narrow (11 ft wide or less)	stop signs / signals usually 1-10 per mile	usually many driveways	usually parking is permitted during all hours
Ramp Class 1	11	high level ramp providing adequate merge to major facility without a signal or stop sign	usually has raised median or guiderail	none	varies	usually only 1 lane per direction, usually 12 feet wide	usually does not require a stop by the vehicle	none	none
Ramp Class 2	12	lower level ramp with slower speeds, usually requiring a stop at the major facility	usually has raised median or guiderail	sometimes has LTL or RTL at the end of the ramp	varies	usually only 1 lane per direction, about 12 feet wide	signal / stop signs	none	none
Centroid Connector	13	a link used to connect a zone centroid to roadway links, should represent local streets	none	none	none	always only 1 lane per direction; lane width assumed to be normal	none	none	none

Table 3.3: Area Types in highway network

AT	Description
1	CBD
2	Urban
3	Suburban
4	Rural

Table 3.4: Population and Employment Density Range Matrix

Population Density (pop/sq. mi.)	Employment Density (emp/sq. mi.)			
	0-500	501-2,500	2,501-5,000	5,001-1,000,000
0-500	AT4	AT4	AT3	AT2
501-2,500	AT4	AT3	AT2	AT1
2,501-5,000	AT3	AT2	AT1	AT1
5,001-1,000,000	AT2	AT1	AT1	AT1

Source: Table 3-6, SJTDM - Model Development and Validation Report, August 1998 – Garmen Associates.

The link capacities in the model were also updated based on the HCM 2010 Manual. For Freeways (FT 1), the base capacity values were taken from Exhibit 10-5 of the HCM 2010 and were adjusted for assuming 5% truck and level terrain. For FT 2 (other Freeway), the base capacity values from Exhibit 14-2 from the HCM 2010's 'Multilane Highway' Chapter were taken and adjusted for truck percentage and level terrain. For other facilities with interrupted flow (arterials with traffic signals and stop signs), the base capacity of 1900 per hour per lanes was used along with assumptions for green-time to cycle ratio (G/C) and truck factors. However, these initial values were adjusted based on review of the original speed capacity table, and capacity values from other sources such as the North Jersey Model and LOS Tables from Florida DOT. Further adjustments were made as part of the model validation process.

Table 3.5 provides the free-flow speed, initial congested speed (mph) and hourly capacities (vehicles/hour/per lane) based on HCM 2010.

Table 3.5: Speed Capacity Table

FT	AT	LANES	Free-flow Speed	Congested Speed	CAPACITY
1	1	1	50	38	2000
1	1	2-5	55	41	2200
2	1	1	50	38	1650
2	1	2-4	55	41	1850
3	1	1	36	27	1000
3	1	2-4	41	31	1300
4	1	1	35	26	900
4	1	2-4	40	30	1200
5	1	1	30	23	800
5	1	2-4	35	26	1100
6	1	1	27	20	700
6	1	2-5	32	24	900
7	1	1	25	19	600
7	1	2-4	30	23	800
8	1	1	23	17	500
8	1	2-4	25	19	700
9	1	1	18	14	450
9	1	2-4	20	15	550
10	1	1	15	11	400
10	1	2-4	20	15	500
11	1	1	25	19	1100
11	1	2-4	25	19	1100
12	1	1	15	11	700
12	1	2-4	15	11	700
13	1	1	15	11	9999
13	1	2-4	15	11	9999
1	2	1	55	41	2050
1	2	2-5	60	45	2250
2	2	1	55	41	1750
2	2	2-4	60	45	1950
3	2	1	43	33	1100
3	2	2-4	48	36	1400
4	2	1	42	32	1000
4	2	2-4	47	35	1300
5	2	1	35	26	900
5	2	2-4	40	30	1200
6	2	1	32	24	800
6	2	2-4	37	28	1000
7	2	1	30	23	700
7	2	2-4	35	26	900
8	2	1	28	21	600
8	2	2-4	30	23	800
9	2	1	23	17	550
9	2	2-4	25	19	650
10	2	1	20	15	500
10	2	2-4	25	19	600
11	2	1	30	23	1200
11	2	2-4	30	23	1200

FT	AT	LANES	Free-flow Speed	Congested Speed	CAPACITY
12	2	1	20	15	800
12	2	2-4	20	15	800
13	2	1	20	15	9999
13	2	2-4	20	15	9999
1	3	1	60	45	2100
1	3	2-5	65	49	2300
2	3	1	60	45	1850
2	3	2-4	65	49	2050
3	3	1	48	36	1200
3	3	2-4	53	40	1500
4	3	1	47	35	1100
4	3	2-4	52	39	1400
5	3	1	40	30	1000
5	3	2-4	45	34	1300
6	3	1	37	28	900
6	3	2-4	42	32	1100
7	3	1	35	26	800
7	3	2-4	40	30	1000
8	3	1	33	25	700
8	3	2-4	35	26	900
9	3	1	28	21	650
9	3	2-4	30	23	750
10	3	1	25	19	600
10	3	2-4	30	23	700
11	3	1	35	26	1300
11	3	2-4	35	26	1300
12	3	1	25	19	900
12	3	2-4	25	19	900
13	3	1	25	19	9999
13	3	2-4	25	19	9999
1	4	1	62	47	2150
1	4	2-5	67	50	2350
2	4	1	62	47	1950
2	4	2-4	67	50	2150
3	4	1	50	38	1300
3	4	2-4	55	42	1600
4	4	1	49	37	1200
4	4	2-4	54	41	1500
5	4	1	42	32	1100
5	4	2-4	47	35	1400
6	4	1	39	29	1000
6	4	2-4	44	33	1200
7	4	1	37	28	900
7	4	2-4	42	32	1100
8	4	1	35	26	800
8	4	2-4	37	28	1000
9	4	1	30	23	750
9	4	2-4	32	24	850
10	4	1	27	20	700
10	4	2-4	32	24	800
11	4	1	37	28	1400
11	4	2-4	37	28	1400
12	4	1	27	20	1000
12	4	2-4	27	20	1000
13	4	1	27	20	9999
13	4	2-4	27	20	9999

Other updates to the network involved the value of tolls on the toll roads in the model namely Atlantic City Expressway, Garden State Parkway and NJ Turnpike – those were outdated and therefore updated based on the latest available data from the toll agencies. Although the tolls on Garden State Parkway are one-way at some locations, they were divided by 2 and coded in both directions to avoid imbalance in model-estimated volumes. Table 3-6 shows the toll values and locations.

Table 3.6: Toll Values and Locations

TOLL	LOCATION
$1.35	Turnpike 1-2 NB
$1.35	Turnpike 1-2 SB
$1.35	Turnpike 2-3 NB
$1.35	Turnpike 2-3 SB
$0.40	ACE and Berlin Cross Keys (Williamstown)
$0.40	ACE and Berlin Cross Keys (Williamstown)
$0.40	ACE and Williamstown
$0.40	ACE and Williamstown
$0.75	ACE and Winslow/Fleming Pike
$0.75	ACE and Winslow/Fleming Pike
$0.75	ACE and 12th St (Hammonton)
$0.75	ACE and 12th St (Hammonton)
$3.00	ACE and NJ 50 EB
$3.00	ACE and NJ 50 WB
$3.00	ACE and NJ 50 EB ON-Ramp
$0.75	ACE and Access/Wrangleboro
$0.75	ACE and Access/Wrangleboro
$0.75	ACE and Delilah
$0.75	ACE and Delilah
$0.75	ACE and Delilah
$0.75	ACE and US 9
$0.75	ACE and US 9
$0.75	ACE Pleasantville
$0.75	ACE Pleasantville
$0.50	GSP Wildwood
$0.50	GSP Wildwood
$0.75	GSP Cape May NB
$0.75	GSP Cape May NB
$0.75	GSP Great Egg SB
$0.75	GSP Great Egg SB
$0.75	GSP Somers Point SB
$0.75	GSP Somers Point SB
$1.50	Shore, Margate City - Margate Blvd/Jerome Ave Bridge
$1.50	Shore, Margate City - Margate Blvd/Jerome Ave Bridge
$0.75	Shore, Ocean Drive Bridge
$0.75	Shore, Ocean Drive Bridge
$0.75	Shore, Bay Ave Bridge
$0.75	Shore, Bay Ave Bridge
$0.75	Shore, Townsends Inlet Bridge
$0.75	Shore, Townsends Inlet Bridge
$0.75	Shore, Stone Harbor Bridge
$0.75	Shore, Stone Harbor Bridge
$0.75	Shore, Cape May Inlet
$0.75	Shore, Cape May Inlet
$2.00	Delaware Memorial Bridge EB
$2.00	Delaware Memorial Bridge WB
$2.50	Commodore Barry Bridge EB
$2.50	Commodore Barry Bridge WB

3.2 Terminal Times

A key purpose of the computerized highway network is to determine zone-to-zone travel times. This is the time the traveler spends in the vehicle during the trip. Most travel demand models also consider the time that the traveler spends out of the vehicle. This is the time spent walking to and from the vehicle, and the time spent parking and "un-parking" the vehicle, at both ends of the trip. In the South Jersey Travel Demand Model, terminal time is added to the zone-to-zone travel times for the purposes of calculating the split of trips by travel mode.

The definition of this so-called terminal time is often arbitrary, although some recently-developed travel demand models include sub-models which calculate terminal time for each zone. This approach has the advantage of being consistent in that as development increases in a zone, its terminal time also increases to reflect the additional out-of-vehicle time involved.

Terminal time values of 1 minute are usually associated with residential zones, while CBD terminal times in large downtowns are as high as 8 minutes. Terminal times were developed in the previous model by examining zonal development densities and applying knowledge of parking conditions throughout the study area, as well as the area type assigned to each zone. From this, some relationships were hypothesized. The final terminal time in the model is based on area type and reflects a combination of judgment and experience from similar models used in other cities and is shown in Table 3-7. Note that the terminal times for CBD and Urban areas were modified from the previous model as they appeared too high.

Table 3.7: Terminal Times

Area type	Description	Terminal Time (min.)
1	Central Business District (CBD)	4
2	Urban	3
3	Suburban	2
4	Rural	1

3.3 Highway Skimming

One of the most important inputs into subsequent modules of the overall model is highway travel time. This information is determined by identifying the shortest path along the highway networks for each origin-destination pair and then summing (or "skimming") the time and distance associated with that path. The output of this step is a set of matrices that contain the time and distance to travel between all zone-zone pairs in the network. These matrices are also called "impedance tables", "skim trees", or just "skims".

For the highway network, four sets of time and distance skims are created, and since each skim consists of both time and distance tables, this is a total of eight tables. The four sets of skims represent the following conditions:

- single-occupant vehicle (SOV), peak period
- high-occupant vehicle (HOV), peak period
- SOV, off-peak period
- HOV, off-peak period

The HOV skims are created by allowing all links in the network to be used. The SOV skims are created by separately building paths while prohibiting the use of HOV-only links. Although there are currently no HOV links in the SJTPO region, there might be some in the future, and this feature permits the South Jersey Travel Demand Model to estimate the impact of constructing such facilities.

The highway network contains two sets of speeds: one representing average AM peak period conditions and one representing midday (or night) free-flow conditions. The peak speeds are used to create the peak skims and the free-flow speeds are used to create the off-peak skims. The peak skims reflect the presence of congestion on each highway link and are modified during the course of applying the model in a process known as "speed feedback", which is described in more detail later in the document. The initial peak speeds are estimated based on an assumed volume/capacity (V/C) ratio of 0.75 on each link. In subsequent iterations, the speeds are based on the congestion estimated as part of the previous step.

4 Transit Network and Skimming

The transit network in the SJTPO area comprises primarily of public and private buses and rail routes such as the Atlantic City Rail Line. The vast majority of the bus services and the commuter rail service between Atlantic City and Philadelphia are operated by NJ Transit. In addition, several private operators provide circulator-type transit services in Atlantic City, Ocean City, and Wildwood. These services are provided by the independent jitney operators in Atlantic City as well as local carriers such as the Five Mile Beach Electric Railway Company. This chapter discusses the various updates to the SJTDM transit network.

4.1 Transit Network Coverage

There are several routes that run from the 4-county SJTPO region to the DVRPC region such as to Philadelphia. In the previous version of the model, these were represented in its entirety. However, with the revised geographic coverage in the updated model, these routes were truncated at the external boundary. The associated runtimes to the external boundary was also updated based on the available schedules. After consultation with NJ Transit staff, a few buses that no longer are in operation were removed from the transit network and a few that have recently been introduced were coded into the model. The headways were also updated based on the latest schedules from NJ Transit. Figure 4.1 depicts the transit network in the model based on the new geographic coverage.

Table 4-1 depicts the transit network attributes in the SJTDM. Most of these attributes have been carried forward from the previous model with the exception of the introduction of mode 17 for the drive-access connector and the deletion of modes/owners related to routes that are entirely outside the new modeled area such as PATCO. Transit ‘Owners’ were defined in order to facilitate the grouping of ridership estimates. The owner designation was developed to isolate individual transit operators, or to partition operators within the region. In the case of NJ Transit, Company 1 represents the services serving the SJTPO region where the observed ridership data by line was provided by NJ Transit. In contrast, Company 2 contains those NJ Transit lines that exist partially within the DVRPC region. The AM peak period was defined as the time between 6:30 a.m. and 9:00 a.m. and the off-peak period was defined as the time between 9:00 AM and 3:00 PM.

Figure 4.1: Revised Transit Network

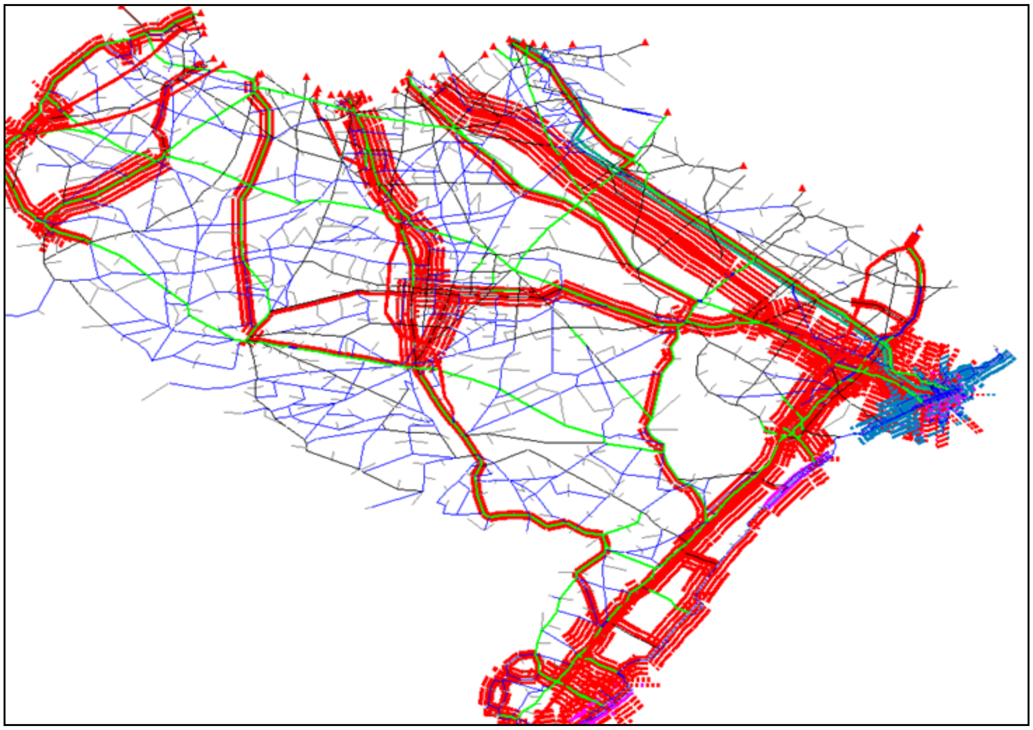


Table 4.1: Transit Network Attributes

Attribute	Value	Description
Mode	1	Casino Shuttle (Atlantic City Rail Station to Casinos)
	2	Local Jitney-Type Service, includes AC and OC Jitneys
	3	NJ Transit Local Bus
	4	NJ Transit Regional Bus
	5	Atlantic City Rail Line
	13	Sidewalk
	16	Walk Access Connector
	17	Drive-Access Connector
Owner	1	NJ Transit (South Jersey Region)
	2	NJ Transit (DVRPC Region)
	3	PATCO
	4	Private Operator Jitney (AC routes)
	6	Salem County
	7	Five-Mile Beach Electric Railway Company
Period	1	Winter AM Peak
	2	Winter Off-Peak
	3	Summer Off-Peak

Table 4-2 lists the transit routes coded in the SJTDM along with their updated operating characteristics, except for a few routes such as the Atlantic City rail shuttles and Jitneys for which data was not available (data from the previous model was therefore carried forward).

Table 4.2: Transit Routes in SJTDM

#	Line No.	Line Code	Point of Origin	Point of Destination	Mode	Owner	Run Time (Mins)	Frequency Winter AM peak	Winter Off peak	Summer Off peak
1	313		Glassboro-Rowan Uni	Cape May						
		313NB	Cape May	Glassboro-Rowan Uni	4	2	179		360	360
		313SB	Glassboro-Rowan Uni	Cape May	4	2	185		180	180
2	315		Turnersville	Cape May						
		315NB	Cape May	Turnersville	4	2	161		180	180
		315SB	Turnersville	Cape May	4	2	161		360	360
3	316		Sickerville	Cape May						
		316NB1	Cape May	Sickerville	4	2	115		180	180
		316SB1	Sickerville	Cape May	4	2	115		120	120
4	319		AC (Bus Terminal)	Cape May						
		319NB2	Wildwood BT	AC (Bus Terminal)	4	1	116		360	360
		319NB3	Wildwood BT	AC (Bus Terminal)	4	1	116		360	360
5	401		Mt. Royal	Woodbury						
		401NB1	Salem (Yorke St.)	Mt. Royal	4	2	46	40	120	120
		401SB1	Mt. Royal	Salem (Yorke St.)	4	2	46	120	120	120
6	402		Gibbstown-Broad st	Pennsville						
		402NB1	Pennsville	Gibbstown-Broad st	4	2	46	120	180	180
		402NB2	Becket/ Gibbstown	Gibbstown-Broad st	4	2	13	40		
		402SB1	Gibbstown-Broad st	Pennsville	4	2	45	120		
		402SB3	Gibbstown-Broad st	Pennsville	4	2	41	120		
7	408		Glass boro, main st	Millville						
		408NB1	Millville (Broad st)	Glass boro, main st	4	2	77	60	60	60
		408NB3	Millville (Broad st)-Exp pitman	Glass boro, main st	4	2	76	120		
		408NB4	Millville (Broad st)-Exp Brooklawn	Glass boro, main st	4	2	72	120		
		408SB	Glass boro, main st	Millville (Broad st)	4	2	78		60	60
		408SB2	Glass boro, main st	Millville (Broad st)	4	2	74	60		
8	410		Mulica Hill	Bridgeton						
		410NB1	Bridgeton(Local)	Mulica Hill	4	2	35		120	120
		410NB3	Bridgeton(Express)	Mulica Hill	4	2	35	40		
		410SB1	Mulica Hill	Bridgeton	4	2	37	120	90	90
9	468		Woodstown	Penns Grove						
		468NB1	Woodstown	Penns Grove	4	6	79	120	120	120
		468NB2	Woodstown	Carney's Point (Ridge/SR-apt.)	4	6	85		180	180
		468SB1	Penns Grove	Woodstown	4	6	78	60	120	120
		468SB2	Carney's Point (Ridge/SR-apt.)	Woodstown	4	6	85		180	180
10	501		Atlantic City	Brigantine						
		501NB1	AC (Bus Terminal)	Brigantine Beach	3	1	37	60	360	360
		501NB	AC (Bus Terminal)	Brigantine Beach via Borgata casino	3	1	41	60	60	60
		501SB	Brigantine Beach via Borgata casino	AC(Bus Terminal)	3	1	48	40	60	60
11	502		Atlantic City	Hamilton TWP						
		502NB1	AC (S. Carolina)	Hamilton (Atlantic. CC)	4	1	58	60	60	60
		502NB2	AC (S. Carolina)	Egg Harbor (Shore Mall)	4	1	30	120	60	60
		502NB3	AC (S. Carolina)	Hamilton (Hamiltom Mall)	4	1	49	120	72	72
		502SB1	Hamilton (Atlantic. CC)	AC (South Carolina)	4	1	60	60	60	60
		502SB2	Egg Harbor (Shore Mall)	AC (South Carolina)	4	1	33		72	72
		502SB3	Hamilton (Hamiltom Mall)	AC (S. Carolina)	4	1	63		360	360
12	504		Atlantic City	Ventnor Plaza						
		504EB	Ventnor Plaza	AC (Maryland)	3	1	40	120	45	45
		504WB	AC (Maryland)	Ventnor Plaza	3	1	39		45	45
		504WB2	AC (Caspian ave)	Ventnor Plaza	3	1	44	60		
13	505		Atlantic City	Longport						
		505NB1	Longport	AC (Melrose)	3	1	44	120	90	90
		505NB2	Margate	AC (Melrose)	3	1	35	60	51	51
		505NB3	Longport	AC (Venice Park)	3	1	56	60	90	90
		505NB4	Margate	AC (Venice Park)	3	1	47	60	51	51
		505SB1	AC (Melrose)	Longport	3	1	41	120	120	120
		505SB2	AC (Melrose)	Margate	3	1	36	40	45	45
		505SB3	AC (Venice Park)	Longport	3	1	54	24	72	72
		505SB4	AC (Venice Park)	Margate	3	1	44	120	60	60
14	507		Atlantic City	Ocean City						
		507NB1	Ocean City	AC (South Carolina)	4	1	71	20	45	45
		507NB2	Northfield	AC (S. Carolina)	4	1	38		180	180
		507SB	AC (South Carolina)	Ocean City	4	1	71	40	60	60

#	Line No.	Line Code	Point of Origin	Point of Destination	Mode	Owner	Run Time (Mins)	Frequency Winter AM peak	Frequency Winter Off peak	Frequency Summer Off peak
15	**508**		**Atlantic City**	**Galloway TWP**						
		508NB	AC (South Carolina)	Galloway/Hamilton TWP	4	1	81	60	72	72
		508NB2	AC (South Carolina)	Egg Harbor (Bellevue commons)	4	1	40	120		
		508SB	Galloway/Hamilton TWP	AC (South Carolina)	4	1	82	40	72	72
16	**509**		**Atlantic City**	**Somers Point**						
		509NB	Somers Point (Mays Land.)	AC (South Carolina)	4	1	46	120	360	360
		509NB2	Ocean City (OCBT)	AC (South Carolina)	4	1	82		90	90
		509SB	AC (South Carolina)	Somers Point (Mays Landing)	4	1	45	40		
		509SB2	AC (South Carolina)	Ocean City (OCBT)	4	1	82		60	60
17	**510**		**CapeMay**	**WildWood**						
		510NB	CapeMay	WildWood	4	2	45		180	180
		510SB	WildWood	CapeMay	4	2	47		180	180
18	**551**		**Sickerviile**	**Ocean City**						
		551EB1	Sickerviile	AC (Bus Terminal)	4	2	50	40	45	45
		551EB3	Sicklerville	AC (Bus Terminal)	4	2	50	120		
		551WB1	AC (Bus Terminal)	Sickerviile	4	2	45	30	40	40
19	**552**		**Cape May**	**Atlantic City**						
		552NB	Cape May	AC (Bus/Rail Terminal)	4	1	124	40	60	60
		552NB2	Wildwood (Bus Terminal)	Middle township	4	1	27		51	51
		552SB	AC (Bus Terminal)	Cape May	4	1	129		72	72
		552SB2	Middle township	Wildwood (Bus Terminal)	4	1	27		51	51
		552SB3	Wildwood (Bus Terminal)	Cape May	4	1	25	120		
20	**553**		**Upper Deerfield**	**Atlantic City**						
		553NB1	AC (Bus Terminal)	Upper Deerfield	4	1	124	120	40	40
		553NB3	AC (Bus Terminal)	Millville(Main St.)	4	1	87		180	180
		553SB1	Upper Deerfield	AC (Bus Terminal)	4	1	118	30	40	40
		553SB3	Millville	AC (Bus Terminal)	4	1	88	60	120	120
21	**554**		**Atlantic City**	**Berlin**						
		554EB	Berlin	AC (Bus Terminal)	4	1	92	40	60	60
		554WB	AC (Bus Terminal)	Berlin	4	1	95	120	51	51
22	**559**		**Lakewood**	**Atlantic City**						
		559NB	AC (Bus Terminal)	Lakewood	4	1	154	60	60	60
		559SB	Lakewood	AC (Bus Terminal)	4	1	152	120	60	60
23	**J1**		**Atlantic City**	**Atlantic City**						
		J1-NB	Jackson ave, Atlantic City	New hampshire ave, Atlantic City	2	4	19	6	6	6
		J1-SB	New hampshire ave, Atlantic City	Jackson ave, Atlantic City	2	4	19	6	6	6
24	**J2**		**Atlantic City**	**Atlantic City**						
		J2-NB	Jackson ave, Atlantic City	Trump Marina, Atlantic City	2	4	25	10	10	10
		J2-SB	Trump Marina, Atlantic City	Jackson ave, Atlantic City	2	4	25	10	10	10
25	**J3**		**Atlantic City**	**Atlantic City**						
		J3-NB	Trump Marina, Atlantic City	Inlet on Pacific ave, Atlantic City	2	4	23	10	10	10
		J3-SB	Inlet on Pacific ave, Atlantic City	Trump Marina, Atlantic City	2	4	23	10	10	10
26	**J4**		**Atlantic City**	**Atlantic City**						
		J4-NB	Jackson ave, Atlantic City	Indiana ave, Atlantic City	2	4	19	6	6	6
		J4-SB	Indiana ave, Atlantic City	Jackson ave, Atlantic City	2	4	19	6	6	6
			Atlantic City	**Atlantic City**						
27	**RS1**	RS1NB	Hilton Casino	Atlantic City Rail sta.	1	4	6	1	1	1
		RS1SB	Atlantic City Rail sta.	Hilton Casino	1	4	6	1	1	1
28	**RS2**	RS2NB	Pacific & MLK Blvd	Atlantic City Rail sta.	1	4	6	1	1	1
		RS2SB	Atlantic City Rail sta.	Pacific & MLK Blvd	1	4	6	1	1	1
29	**RS3**	RS3NB	Pacific & S.virginia ave	Atlantic City Rail sta.	1	4	10	1	1	1
		RS3SB	Atlantic City Rail sta.	Pacific & S.virginia ave	1	4	10	1	1	1
30	**RS4**	RS4NB	Atlantic City Rail sta.	Harrah Casino	1	4	11	1	1	1
		RS4SB	Harrah Casino	Atlantic City Rail sta.	1	4	11	1	1	1
31	**ACRAIL**		**Atco**	**Atlantic City**						
		ACRLEB	Atco	Atlantic City	5	1	52	60	180	180
		ACRLW	Atlantic City	Atco	5	1	45	120	120	120
32	**5MKL**		**Wildwood**	**Wildwood**						
		5MKLN	Raleigh ave, Wildwood	Schellenger Ave,Wildwood	3	7	20			30
		5MKLSB	Schellenger Ave,Wildwood	Raleigh ave, Wildwood	3	7	20			30
33	**5MMO**		**North Wildwood**	**Wildwood Crest**						
		5MMON	Wildwood Crest	North Wildwood	3	7	20	120	60	60
		5MMOSB	North Wildwood	Wildwood Crest	3	7	20	120	60	60
34	**OCJ**		**Ocean City**	**Ocean City**						
		OCJ-NB	59 th Street,Ocean City	Battersea Rd,Ocean City	2	7	30		30	30
		OCJ-SB	Battersea Rd,Ocean City	59 th Street,Ocean City	2	7	30		30	30

For the highway-based transit modes (bus or trolley routes), the highway network is used to represent the links available to the bus service. In contrast, fixed guideway systems, such as rail lines, that operate over exclusive guideways were coded as "transit only" links. In addition to the network links that support the transit services, access links that tie the zonal system to the individual transit services were also coded. These links represent the time and distances of several non-transit or "support" modes that were included in the network. These non-transit modes (modes 13, 16 and 17 in Table 4.1) provide connectivity between transit modes or serve as access connectors to the zonal centroids. In accordance with the mode choice model specifications, only those zones deemed to have complete walk access coverage were provided with access links. In the densely developed section of Atlantic City, the access was extended via a sidewalk network, which provides a means of transferring between transit lines and/or reaching the final destination of a trip. Similarly, walk links were provided to link the rail stations with adjacent bus service.

4.2 Transit Fares

Besides the headways and runtimes for the transit routes, fares are also a critical component of transit operating characteristics. The fares incorporated into the SJTDM reflect the fare policy adopted by NJ Transit. Transit fares that were coded in the previous version of the model were outdated and therefore updated based on the latest fare information from NJ Transit. There are two components of transit fares namely boarding fares and transfer fares that are defined based on transit modes. It should be noted that the shuttle buses (mode 1) operating between the casinos and the rail station in Atlantic City are provided as a free service to patrons of the casinos and therefore have no boarding fares. Table 4-3 presents the boarding and transfer fares by mode.

Table 4.3: Transit Boarding and Transfer Fares

Mode #	Mode	Boarding Fare	Transfer Fares				
			Transfer Modes				
			1	2	3	4	5
1	Shuttle Bus				$0.50	$0.50	
2	Circulator Bus	$2.25		$2.25	$1.50	$1.50	
3	NJT Local Bus	$1.50		$2.25	$0.50	$0.50	
4	NJT Regional Bus	$1.50		$2.25	$0.50	$0.50	
5	NJT Rail			$2.25	$0.50	$0.50	

Note: Shuttle bus is available only for patrons destined for the casinos

For the Atlantic City rail line, station to station fares were also updated based on the latest information from NJ Transit. Table 4-4 shows the station-to-station rail fares.

Table 4.4: Atlantic City Station-to-Station Rail Fares

From Station	To Station	Fare
Atlantic City	Absecon	$1.50
Absecon	Egg Harbor	$1.75
Egg Harbor	Hammonton	$1.50

Besides the boarding and transfer fares, additional fares are assessed by NJ Transit for crossing 'fare zones'. This fare was determined to be $0.50 based on the latest information from NJ Transit.

4.3 Transit Skimming

The previous SJTDM performed transit skimming for bus and rail for the three transit time periods namely winter peak, winter off-peak and summer off-peak. The state of the practice in travel demand models is to have separate skimming steps for walk-transit and drive-transit so that they can also be assigned separately. Therefore, the transit skimming and assignment steps were modified so that they are done separately by walk-bus, walk-rail, drive-bus and drive-rail.

Walk access/egress links can be created manually, and are also automatically generated by the model using the auto-generate feature within the TRNBUILD module. Walk access/egress links are automatically generated using the over-the-network distance if the transit stop is within 1 mile of the TAZ in terms of over-the-network distance. Manual walk links can be used to assert shorter walk distances as appropriate. Drive access links must be specified manually by designating park-and-ride (PNR) nodes and identifying the TAZs that are connected to each PNR lot. Drive links are one-way links, connecting the production TAZ to the transit system, while walk links are two-way links (for access or egress).

The SJTPO model includes an external-internal mode choice process to estimate transit demand to/from external geographies. Transit paths are built between internal TAZs and each external TAZ which is connected to an internal transit line using a walk or drive access link. External mode choice is one circumstance where it is likely that manual access links will be needed to connect the external TAZ with transit routes that serve the external market. More on the external mode choice process is described in Chapter 7.

In the bus skimming step, the bus mode is weighted by 0.5 and the rail mode weighted by 5.0 in order to create "bus-favored" paths. Similarly, during rail skimming, the rail mode is weighted by 0.5 and bus mode weighted by 5.0 to create rail-favored paths. The circulator modes such as jitney and casino shuttles are weighted by 1.0. The initial wait times, transfer wait times and walk times are weighted by 1.5. All time values were calculated in hundredths of a minute and fares in cents.

The transit path-finding weights have been set according to FTA guidance. For path-finding, travelers trade-off components of the transit paths (in and out of vehicle time and transfers) in the same way they do for mode choice. In the SJTPO model, out-of-vehicle time is weighted as twice as onerous as in-vehicle time, and transfers are penalized 10 minutes.

5 Trip Generation

Trip Generation is the first step in the 4-step travel demand modeling process. The SJTDM trip generation process comprises of non-recreational and recreational steps. This chapter describes the processes in detail including the recent updates implemented.

5.1 Socioeconomic Submodels

The non-recreational trip generation rates vary by life cycle, household size or number of workers, and household income categories. However, the basic zonal input socioeconomic data do not include the number of households for each of these stratifications. The standard variables that are known and can be readily forecasted for each zone include the number of households and population in households, as well as the median income.

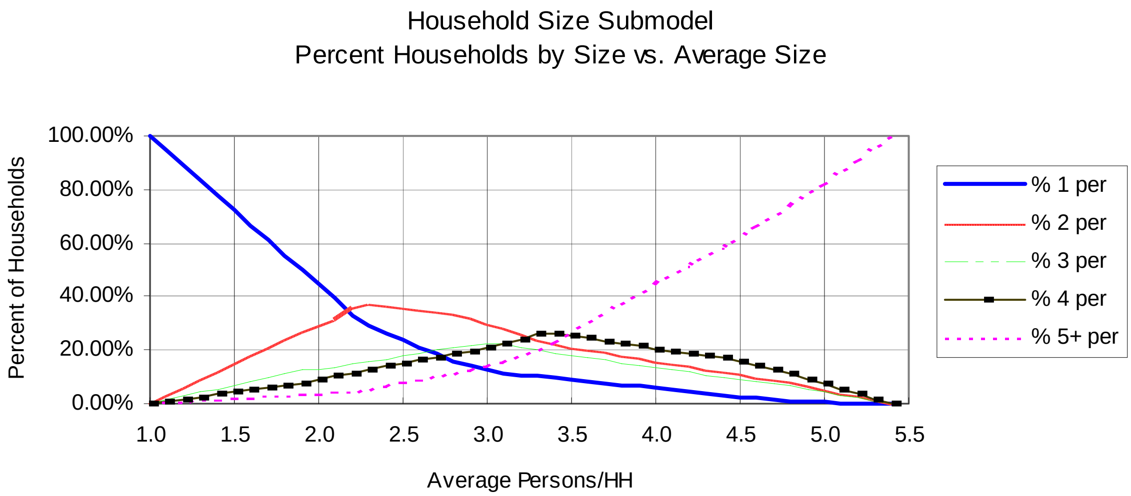
Therefore, it is necessary to develop a procedure to estimate these values, based on the data items that are available. The SJTPO model uses a fairly standard procedure for estimating households by category, which is based on relationships in the Census data as follows:

- Households by size are correlated with the average HH Size per TAZ. As average HH size increases for a TAZ, so does the proportion of larger households.
- Household income quartiles are correlated with the ratio of TAZ median income divided by the regional median income. As a TAZ becomes wealthier on average, compared to the region, the proportion of higher income households increases.
- Workers per household is a function of household size and income, with relationships calibrated from Census data.

For this model update, the household size and income distribution curves were reviewed for the four SJTPO counties. For any normal average value of persons per household, the household size curves provide the percentage of households that would be expected to fall into each size category. A number of other studies have documented that the distribution of households by size class varies in a logical way as a function of the average value. Similarly, the distribution of households by income quartile can be estimated. These relationships can be developed from Census data, based on the ratio of the zone's median income to the county's median income. Unless radical changes in average household size or income are projected, it is reasonable to assume that these relationships will continue to apply in future years.

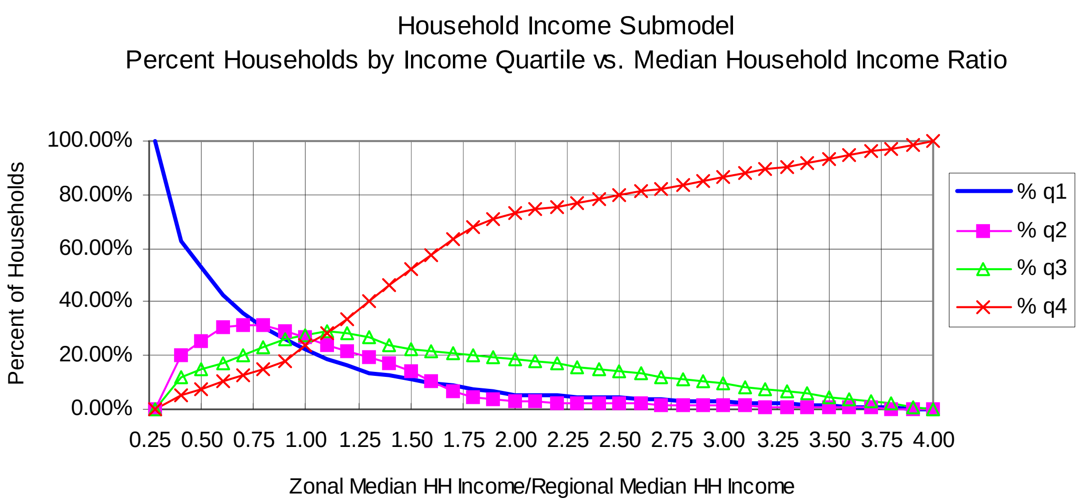
Figure 5-1 shows the household size curve set that is used while Figure 5-2 shows the household income curve set. These curves were taken from the previous model and were developed so that at any point, the percentages all sum to 100%. In the case of the income distribution, the households are summed by income quartile for the county and normalized to insure that for the entire region, approximately 25% of the households are in each quartile.

Figure 5.1: Household Size Model



Source: Figure 5-1, SJTDM - Model Development and Validation Report, August 1998 – Garmen Associates.

Figure 5.2: Household Income Model



Source: Figure 5-2, SJTDM - Model Development and Validation Report, August 1998 – Garmen Associates.

Applying Figure 5-1 and Figure 5-2 produces the individual distributions of households by size and by income. The next step is to combine these so as to estimate the joint distribution by size and income for each zone. This is done by starting with an assumed joint distribution, and then applying a matrix balancing technique to adjust the 20 cell values until the totals by size class match the appropriate size distribution for the zone (as derived from Figure 5-1), and the totals by income group match appropriate income distribution for the zone (as derived from Figure 5-2).

The joint distribution that is initially assumed is the distribution for the whole region, as determined from a weighted tabulation of PUMS data. Once the joint distribution by size and income is known, this is used to estimate the number of households by life cycle. The three-way distribution of households by size, income, and life cycle was established from 2000 Census (PUMS) data, for the whole region. It is assumed that this relationship will continue to be valid into the future, and the data were compared to 2010 as described below. For each cell in the size/income table, the three-way table contains three percentages of households by life cycle. This is applied at the zone level. The resulting total number of households by life cycle is calculated and compared with the desired total from the life cycle input data.

The "life cycle input data" is a separate file which gives the desired percentage of households for each zone in each of the three life cycle categories. This file is determined from 2010 Census data, and specifically the American Community Survey data at the Census Tract geography. ACS data were used to estimate households by Life Cycle, which is the percentage of households with 1) any retired people, 2) any children but no retired people, and 3) no children or retired people. This information serves as the control totals for each zone. The three-way distribution of households by size, income, and life cycle described above is then adjusted until the control totals are met.

Once the number of households by size, income, and life cycle are estimated, this is used to estimate the number of workers. The four-way joint distribution of households by size, income, life cycle, and workers was established from 2000 Census (PUMS) data, for the whole region. It is assumed that this relationship will continue to be valid into the future. For each cell in the size/income/life cycle table, the four-way table contains four percentages of households by workers (0, 1, 2, 3+). This is applied at the zone level. The resulting total number of households by workers is calculated.

In addition, the total number of workers (i.e., resident labor force) will be calculated (this is equal to the number of households by workers times the number of workers per household) and summed for the entire SJTPO region. This is compared to the estimated desired number of workers. That figure is calculated by multiplying the total employment for that forecast year by the ratio of total workers to total employment (equal to the number of workers divided by the number of employees). If this number is greater than one, than the region has a net "export" of workers to jobs in surrounding regions. This ratio will be held for the future as well. Thus, the employment total for any future year is multiplied by the derived ratio to derive the desired total number of workers for that year. This desired total is then used to adjust the initial worker figures (based on the initial number of households by workers in each zone) so that the desired total is met.

At this point, a four-way table exists for each zone showing the number of households stratified jointly by size, income, life cycle, and workers. In this table, each cell is maintained in Real format, so that the entries will consist of values such as 12.5493 households, for example. Although it is understood that fractional households do not exist, maintaining fractional values in this table greatly enhances the precision and sensitivity of the model. In effect, it is implicitly assumed that, in this example, there are fractional values in other zones that make up the remaining 0.4507 household. The four-way table is then "collapsed" to two different three-way tables, by summing along one of its dimensions. One of the three-way tables contains households stratified by life cycle, income, and workers and the other contains households stratified by life cycle, income, and size. The former is used in the work-related production models (HBW, JTW) and the latter is used for the non-work-related purposes.

Validation of the Socioeconomic Segmentation Models

The socioeconomic submodels were not re-estimated as part of this effort because at the time this work was done the new Census data were not readily available at a small area geography. However, towards the end of the model update these models were reviewed and the summaries of households by type compared to the 2010 census data are provided below for HH size, income quartile and number of workers by TAZ. As can be seen from the comparisons, the basic relationships and process developed using older Census data still hold as reasonable predictors for 2010. Generally speaking, there is a very high degree of correlation between the model estimated data and the Census data for 2010, by TAZ. The results for income are a bit more dispersed than the other variables, but this is fairly common for these types of models.

Figure 5.3: Validation of the Household Size Model by TAZ

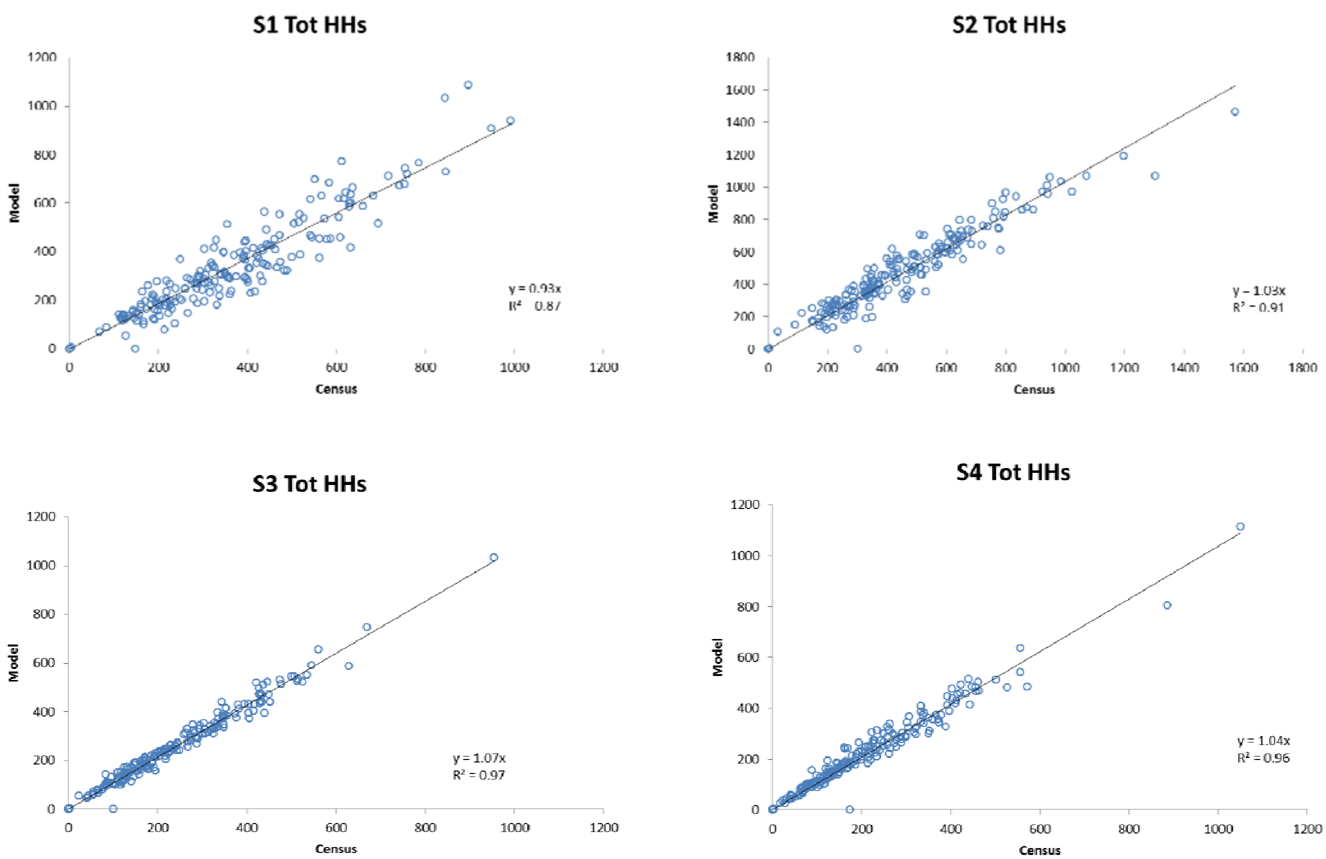


Figure 5.4: Validation of the Income Model by TAZ

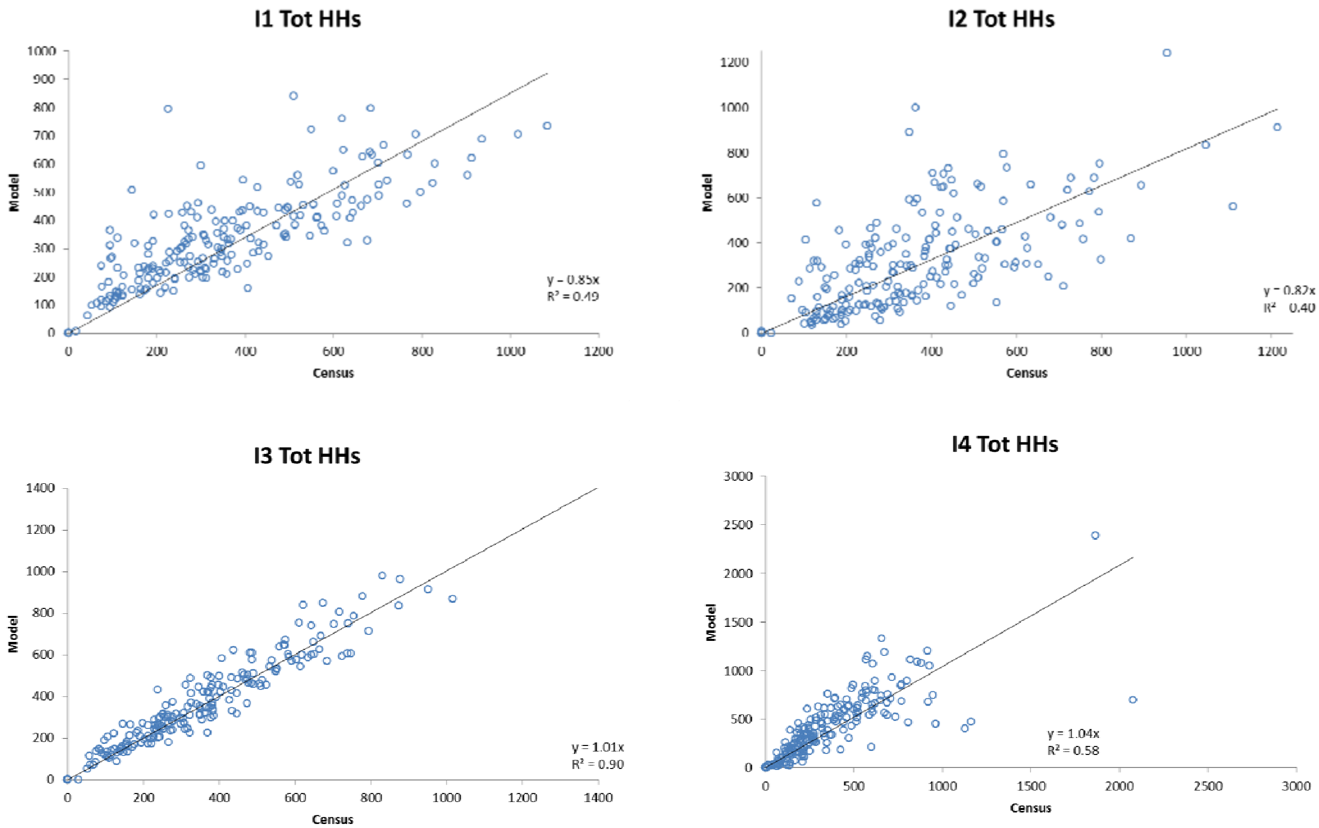
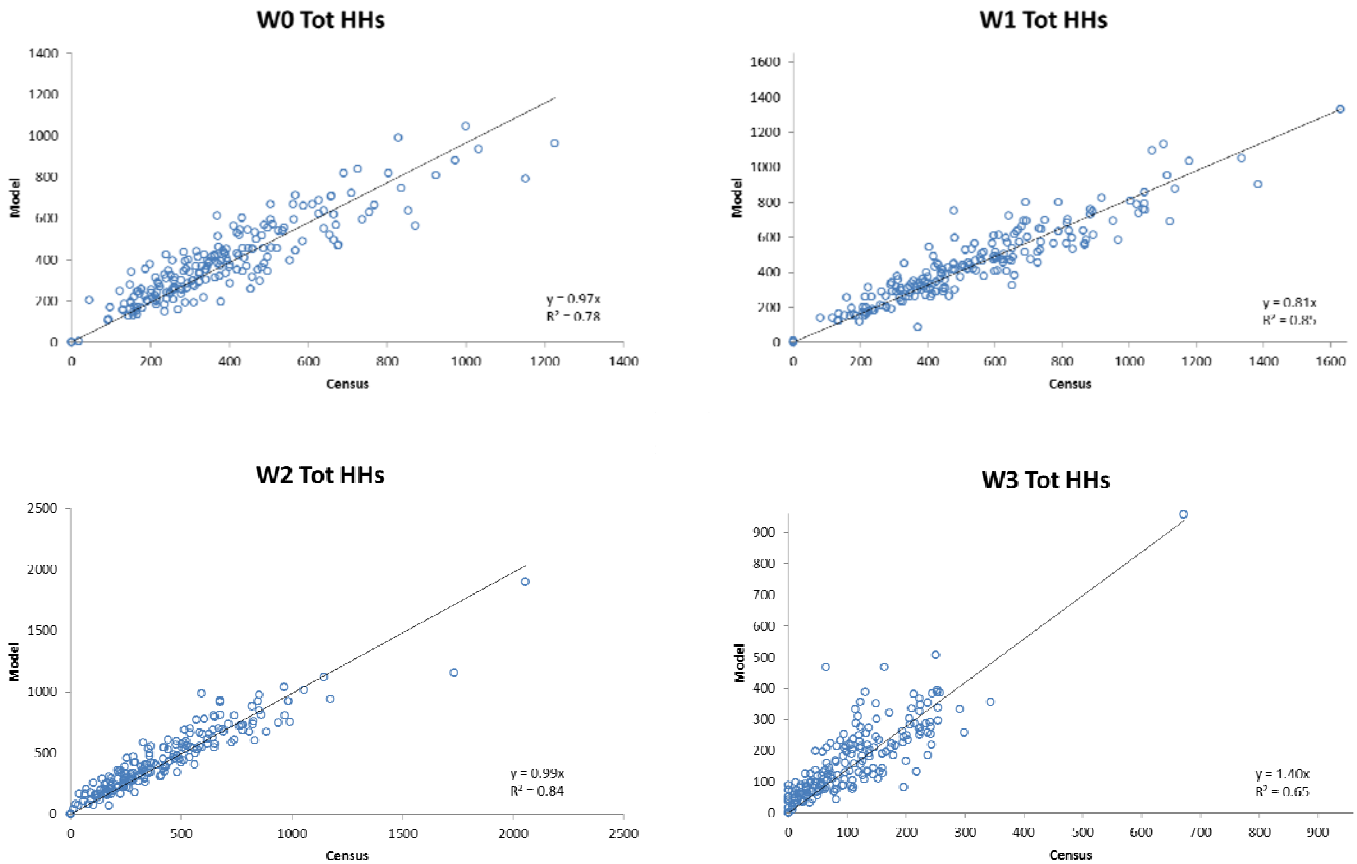


Figure 5.5: Validation of the Worker Model by TAZ



5.2 Non-recreational Trip Generation

This component of the trip generation process estimates the trips produced and attracted by TAZ for the non-recreational trip purposes in the model. The previous version of the model had several non-recreational trip purposes which were reviewed by the URS team and after discussions with SJTPO/peer reviewer, it was decided that a few of them could be either combined or altered. Table 5-1 depicts the final non-recreational trip purposes. The Non-Home-Based Journey to Work and Non-Home-Based Journey at Work purposes were combined together as the Non-Home-Based Work purpose due to similar nature of the trips. The previous model included college trips in the Home-Based School purpose. As college trips tend to have different trip characteristics compared to school (K-12) trips, it was decided to separate out the Hoe-Based College purpose from the Home-Based School purpose.

Table 5.1: Non-recreational trip purposes

#	Purpose	Abbreviation	Description
1	Home-Based Work	HBW	From home to work; work to home
2	Home-Based School	SCH	From home to school; school to home (includes all school trips: primary and secondary)
3	Home-Based College	COLL	From home to college; college to home
4	Home-Based Shop	HBS	From home to shopping; shopping to home (includes eating out and other "quasi-purchasing"-based trips)
5	Home-Based Other	HBO	All other home-based trips not included above (except special recreational trip purposes)
6	Non-Home-Based Work	NHBW	From a non-home location to work; from work to a non-home location (i.e., on the way to or from work)
7	Non-Home-Based Non-Work	NWK	Non-home to non-home segments of a trip chain which both starts and ends at home
8	Commercial	COM	Commercial vehicles (no heavy trucks)
9	Truck	TRK	Heavy trucks

The following data items are required as input to the non-recreational trip generation model:

- Household Population (i.e., excluding students in dormitories)
- Group Quarters Population (i.e., people living in dormitories, nursing homes, prisons, etc.)
- Total Population (the summation of household and group quarters population)
- Households
- Number of Retail Employees
- Number of Office Employees
- Number of Industrial Employees
- Number of Other Employees
- Total Employment (the summation of the previous four employment categories)
- School Enrollment (primary and secondary)
- College Enrollment (university)

The above data items were updated to the year 2010 based on the 2010 census and other data sources as described in Chapter 2.

The non-recreational trip generation rates in the previous model were developed based on a Household survey conducted in 2001. However, there was no detailed documentation regarding the development of those rates from the survey. As no recent household surveys were conducted in the region, the 2001 household survey data was processed to verify the rates used in the model and to derive preliminary rates that could be used as a starting point of the model calibration/validation process. The work-related trip production rates are cross-classified by 3 life-cycle categories, 4 income quartiles and 4 workers/HH categories resulting in a total of 48 different work-related trip generation rates. The non-work trip production rates are cross-classified by 3 life-cycle categories, 4 income quartiles and 5 household size categories resulting in a total of 60 non-work trip generation rates. These categories are defined in Table

5-2. The income categories correspond to income quartiles based on the latest census 2010 data (i.e., 25% households comprise each quartile).

Table 5.2: Cross-classification categories for Non-Work, Non-recreational trip generation rates

Variable	Category #	Description
Life-Cycle	1	Any retired people, no children age 18 or older
	2	Any children age 18 or under, no retired people
	3	No children or retired people
Income	1	Less than $30,000
	2	$30,000 - $60,000
	3	$60,000 - $97,500
	4	Greater than $97,500
Household Size	1	1 person/ Household
	2	2 persons/Household
	3	3 persons/Household
	4	4 persons/Household
	5	5 persons/Household

Tables 5-3 and 5-4 provide the final calibrated trip production rates which are applied to zonal Households stratified by the above categories. The estimation of the trip generation rates was covered in a memo to SJTPO on December 12, 2011.

Table 5.3: Calibrated Non-recreational Trip Production Rates (work-related purposes)

Variable			HBW	JTW	Variable			HBW	JTW
Income=1	Lifecycle=1	Workers=1	0.884	0.238	Income=3	Lifecycle=1	Workers=1	0.884	0.556
		Workers=2	2.053	0.782			Workers=2	2.053	0.976
		Workers=3+	3.660	0.782			Workers=3+	3.660	0.976
	Lifecycle=2	Workers=1	0.916	0.238		Lifecycle=2	Workers=1	0.916	0.556
		Workers=2	1.784	0.782			Workers=2	1.784	0.976
		Workers=3+	2.920	0.782			Workers=3+	2.920	0.976
	Lifecycle=3	Workers=1	0.884	0.238		Lifecycle=3	Workers=1	0.884	0.556
		Workers=2	2.053	0.782			Workers=2	2.053	0.976
		Workers=3+	3.660	0.782			Workers=3+	3.660	0.976
Income=2	Lifecycle=1	Workers=1	0.884	0.493	Income=4	Lifecycle=1	Workers=1	0.884	0.642
		Workers=2	2.053	0.782			Workers=2	2.053	0.976
		Workers=3+	3.660	0.782			Workers=3+	3.660	0.976
	Lifecycle=2	Workers=1	0.916	0.493		Lifecycle=2	Workers=1	0.916	0.642
		Workers=2	1.784	0.782			Workers=2	1.784	0.976
		Workers=3+	2.920	0.782			Workers=3+	2.920	0.976
	Lifecycle=3	Workers=1	0.884	0.493		Lifecycle=3	Workers=1	0.884	0.642
		Workers=2	2.053	0.782			Workers=2	2.053	0.976
		Workers=3+	3.660	0.782			Workers=3+	3.660	0.976

Table 5.4: Calibrated Non-recreational Trip Production Rates (Non-work related purpose)

Variable			SCH	HBS	HBO	NWK	COLL	Variable			SCH	HBS	HBO	NWK	COLL
		HHSize=1	0.000	0.593	1.557	0.502	0.002			HHSize=1	0.000	0.912	1.835	0.502	0.009
		HHSize=2	0.029	0.859	2.504	1.004	0.021			HHSize=2	0.029	1.178	2.782	1.004	0.017
	Lifecycle=1	HHSize=3	0.172	1.125	3.450	1.507	0.174		Lifecycle=1	HHSize=3	0.172	1.444	3.728	1.507	0.126
		HHSize=4	0.832	1.391	4.397	2.009	0.256			HHSize=4	0.832	1.710	4.675	2.009	0.211
		HHSize=5	1.691	1.657	5.344	2.511	0.263			HHSize=5	1.691	1.976	5.622	2.511	0.318
		HHSize=1	0.000	0.000	0.000	0.000	0.000			HHSize=1	0.000	0.000	0.000	0.000	0.000
		HHSize=2	1.209	0.532	2.756	1.004	0.098			HHSize=2	1.209	0.851	3.034	1.004	0.088
Income=1	Lifecycle=2	HHSize=3	1.318	0.798	3.702	1.507	0.144	Income=3	Lifecycle=2	HHSize=3	1.318	1.117	3.980	1.507	0.132
		HHSize=4	2.397	1.064	4.649	2.009	0.156			HHSize=4	2.397	1.383	4.927	2.009	0.185
		HHSize=5	3.353	1.330	5.596	2.511	0.232			HHSize=5	3.353	1.649	5.874	2.511	0.260
		HHSize=1	0.000	0.266	0.947	0.502	0.062			HHSize=1	0.000	0.585	1.225	0.502	0.054
		HHSize=2	0.000	0.532	1.893	1.004	0.255			HHSize=2	0.000	0.851	2.172	1.004	0.139
	Lifecycle=3	HHSize=3	0.000	0.798	2.840	1.507	0.562		Lifecycle=3	HHSize=3	0.000	1.117	3.118	1.507	0.362
		HHSize=4	0.000	1.064	3.787	2.009	0.846			HHSize=4	0.000	1.383	4.065	2.009	0.585
		HHSize=5	0.000	1.330	4.734	2.511	1.605			HHSize=5	0.000	1.649	5.012	2.511	0.592
		HHSize=1	0.000	0.778	1.557	0.502	0.003			HHSize=1	0.000	1.016	2.058	0.502	0.007
		HHSize=2	0.029	1.044	2.504	1.004	0.011			HHSize=2	0.029	1.282	3.005	1.004	0.017
	Lifecycle=1	HHSize=3	0.172	1.310	3.450	1.507	0.099		Lifecycle=1	HHSize=3	0.172	1.548	3.952	1.507	0.121
		HHSize=4	0.832	1.576	4.397	2.009	0.212			HHSize=4	0.832	1.814	4.898	2.009	0.244
		HHSize=5	1.691	1.842	5.344	2.511	0.320			HHSize=5	1.691	2.080	5.845	2.511	0.376
		HHSize=1	0.000	0.000	0.000	0.000	0.000			HHSize=1	0.000	0.000	0.000	0.000	0.000
		HHSize=2	1.209	0.717	2.756	1.004	0.105			HHSize=2	1.209	0.955	3.257	1.004	0.054
Income=2	Lifecycle=2	HHSize=3	1.318	0.983	3.702	1.507	0.141	Income=4	Lifecycle=2	HHSize=3	1.318	1.221	4.204	1.507	0.098
		HHSize=4	2.397	1.249	4.649	2.009	0.175			HHSize=4	2.397	1.487	5.150	2.009	0.160
		HHSize=5	3.353	1.515	5.596	2.511	0.263			HHSize=5	3.353	1.753	6.097	2.511	0.305
		HHSize=1	0.000	0.451	0.947	0.502	0.052			HHSize=1	0.000	0.689	1.448	0.502	0.038
		HHSize=2	0.000	0.717	1.893	1.004	0.187			HHSize=2	0.000	0.955	2.395	1.004	0.097
	Lifecycle=3	HHSize=3	0.000	0.983	2.840	1.507	0.384		Lifecycle=3	HHSize=3	0.000	1.221	3.341	1.507	0.394
		HHSize=4	0.000	1.249	3.787	2.009	0.633			HHSize=4	0.000	1.487	4.288	2.009	0.747
		HHSize=5	0.000	1.515	4.734	2.511	0.497			HHSize=5	0.000	1.753	5.235	2.511	0.722

Non-Recreation Attraction Models

Unlike the production rates, the trip attraction rates are not cross-classified but defined via attraction equations. Those were adopted for the previous version of the SJTDM from the Berks County Travel Model and were modified to include the variables that are more reasonable, after discussions with SJTPO/peer reviewer. The final calibrated attraction equations are presented in Table 5-5. The development and review of the trip attraction rates was covered in a memo to SJTPO from December 12, 2011.

Table 5.5: Non-recreational Trip Attraction Equations

Trip Purpose	Equation
HBW	1.3 * Total Employment
SCH	1.8423 * School Enrollment
HBS	6.25 * Retail Employment
HBO	0.9 * Households + 3.78 * Office Employment + 2.95 * Other Employment
JTW	0.248 * Households + 0.23 * Industrial Employment + 1.26 * Retail Employment + 0.39 * Office Employment + 0.29 * Other Employment
NWK	0.572 * Household Population + 0.56 * Industrial Employment + 3.04 * Retail Employment + 0.95 * Office Employment + 0.71 * Other Employment
COLL	1.45 * College Enrollment
COMM	0.225 * Households + 0.81 * Industrial Employment + 0.81 * Retail Employment + 0.36 * Office Employment + 0.36 * Other Employment
TRK	0.09 * Households + 0.315 * Industrial Employment + 0.297 * Retail Employment + 0.072 * Office Employment + 0.072 * Other Employment

Since the productions for the HBW, HBO, HBS, SCH and COLL purposes are estimated by income category, the attractions for these purposes are also split by the proportion of the productions by income category.

College Trip Generation Model

With this update to the SJTPO model, college trips were modeled as a separate purpose. The previous model had K-12 and College trips as one combined purpose, but the travel characteristics of these two markets vary significantly.

To facilitate this enhancement, zip code level data were obtained from the 4 South Jersey area colleges (Cumberland County College, Stockton State College, Salem County College, Atlantic Cape Community College) to understand enrollment and basic trip distribution patterns. These data were useful in calibrating trip distribution friction factors.

In addition, 2010 Census PUMS data were used to estimate college students by household type, and the 2001 SJTPO HH survey was used to derive an estimate of home-based college trips per student. The trip production rates presented above represent the product of the average trip rate per student, times the average number of college students living in each type of household derived from the PUMS.

Areatype Adjustments

Many travel demand models have a tendency to overestimate trip attractions to central business district (CBD) areas and underestimate them in suburban areas due to natural gravity model selection. Areatype attraction adjustments were deemed necessary for the SJTDM to regulate this tendency, especially with the regional area type makeup of the SJTPO region. Although the previous model had adjustments for all purposes/areatypes, only the CBD area type is now required to have this adjustment. Table 5-6 shows the areatype attraction factors proposed for use in the model.

Table 5.6: Areatype Attraction Adjustment Factors

Purpose	CBD	Urban	Suburban	Rural
HBW	0.75	1	1	1
SCH	0.75	1	1	1
HBS	0.75	1	1	1
HBO	0.75	1	1	1
JTW	0.75	1	1	1
NWK	0.75	1	1	1
COLL	0.75	1	1	1

External Trip Model

The trip generation process as described above estimates the total daily productions and attractions in each zone regardless of where the other end of the trip is. These trips comprise of internal-internal (I-I) trips and internal-external/external-internal (IX/XI) trips. Since the I-I and IX/XI trips tend to have different trip lengths and travel patterns, it is essential that these be separated prior to the trip distribution step. Moreover, an area such as SJTPO has a larger proportion of external trips compared to other larger metropolitan areas. Therefore, the trip generation process comprises of a procedure to perform this split. This process was carried forward from the previous model with updates to the coefficient values to be discussed later in this section.

The internal-external split is done separately for productions (I/I vs. I/X) and attractions (I/I vs. X/I). Other studies have found that this split is related to study area size, each zone's relative location within the study area, and varies by trip purpose. The external share of trip ends is modeled as a function of the over-the-road distance from each zone to the nearest external cordon station (i.e., the SJTPO region border). This distance indicates how close the zone is to the edge of the study area, and one expects the external share to increase as one nears the cordon. This methodology was adopted from the Berks County Travel Model. A series of fitted curves were developed based on an analysis of the observed I/X share of productions vs. distance to the cordon for the Berks County Model development, this is shown in Figure 5-6 for the HBW purpose. The points in the figure represent the observed I/X share of trips as a function of distance to the cordon, while the solid line is a least-squares exponential curve fitted to those points. The fit is very good (r^2 = 0.944. Table 5-7 gives the equation of the fitted curve for each purpose.

Figure 5.6: HBW Observed External Share

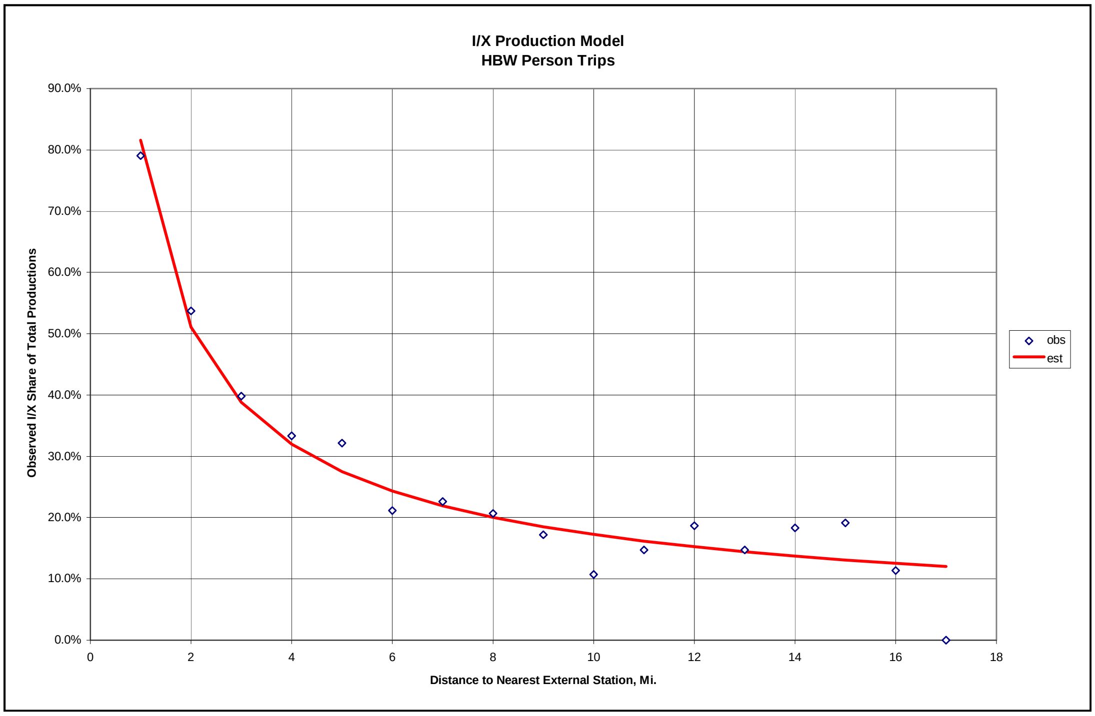


Table 5.7: I/X Production Share Model

Purpose	IX Share
HBW	$1.1 * D^{-0.7}$
SCH	$0.55 * D^{-1.2}$
HBS	$1.1 * D^{-1.1}$
HBO	$1.1 * D^{-1.1}$
JTW	$0.75 * D^{-1.2}$
NWK	$0.5 * D^{-1.1}$
COLL	$1.0 * D^{-1.2}$
COMM	$0.4 * D^{-0.8}$
TRK	$0.8 * D^{-0.7}$

where D = distance from zone to nearest cordon station in miles, via the AM peak highway network.

Table 5-8 presents the X/I model. Following the convention used for the NHB purposes, the X/I model is used to estimate both the I/X share of origins and the X/I share of destinations for JTW, NWK, COM, and TRK trips.

Table 5.8: X/I Attraction Share Model

Purpose	XI Share
HBW	$0.9 * D^{-0.6}$
SCH	$0.3 * D^{-1.25}$
HBS	$0.9 * D^{-1.1}$
HBO	$0.9* D^{-1.1}$
JTW	$0.9 * D^{-1.2}$
NWK	$0.65 * D^{-1.1}$
COLL	$0.8 * D^{-1.2}$
COMM	$0.4 * D^{-0.8}$
TRK	$0.8 * D^{-0.7}$

D = distance from zone to nearest cordon station in miles, via the AM peak highway network. The XI/IX trips by purpose are distributed using a separate gravity model in trip distribution.

5.3 Recreational Trip Generation

The SJTPO area is unique compared to other MPOs in that there is a large recreational area by the shore. To account for the unique travel characteristics of trips destined to this area, the SJTDM has recreational trip purposes for which the trip generation process is performed separately. The process estimates person travel by residents and non-residents for both access trips (those trips from home to some shore community or casino) and activity trips (those trips persons or groups engage in while at the shore or casino).

After reviewing the recreational trip purposes in the previous SJTDM and based on discussions with SJTPO/peer reviewer, the URS Team combined a few trip purposes which had similar characteristics, as shown in Table 5-9. Note that the trip rates for the shore visit purpose were applied by sub-purpose such as shore to ‘beach’, ‘boardwalk’, ‘eat’, ‘shop’ and ‘other’ (to be consistent with the rates derived from the Beach survey) and the productions/attractions totaled for the shore visit purpose for subsequent modeling steps.

Table 5.9: Recreational trip purposes

#	Purpose	Abbreviation	Description
1	Shore Visit	SHV	One trip end at beach, boardwalk, shopping, dining or other and other trip end at home *
2	Overnight Beach Access	BAC	From home to shore town, shore town to home
3	Daytrip Beach Access	DAC	From home to shore town, shore town to home
4	Seasonal Work	SWK	From home to work, work to home
5	Casino Visit	CVT	Travel between Atlantic City casinos
6	Event Visit	EVT	Travel between events and casinos
7	Casino Access Trip	CAC	Non-work, from home to casino, casino to home
8	Event Access	EAC	Non-work, from home to Atlantic City, Atlantic City to home
9	Casino Bus	CBS	Casino access trips via chartered bus

* relates to location at which person/group is staying while at the shore

The recreational trip rates used in the model were derived based on the 1996 Beach Survey. Since no new Beach survey was conducted since then and as that database was not available, the trip rates were left unaltered. Moreover, the process was deemed reasonable and was therefore not modified. The recreational trip generation process comprises of shore and casino trip generation steps as described below.

5.3.1 Shore Trip Generation

This part deals with the recreational trips associated with shore communities, such as trips to the beach, boardwalks, etc. The non-casino and non-event aspects of Atlantic City's recreational trips are dealt with here. Altogether, there are seventeen shore communities that comprise the recreational portion of the South Jersey Travel Model. These communities, listed north to south, are: Brigantine, Atlantic City, Ventnor, Margate, Longport, Ocean City, Strathmere (a shore sub-section of Upper Township), Sea Isle City, Avalon, Stone Harbor, North Wildwood, Wildwood, West Wildwood, Wildwood Crest, Cape May, West Cape May, and Cape May Point.

The trip rates for shore access trips are for home-based trips whereas for the shore visit trips the rates are split into home-based and non-home-based categories. Home-based, for the purposes of the recreational trip generation model, refers to the local shore housing unit from which people base their activities. For instance, for a group vacationing in Wildwood for the week and staying at one of the local hotels, home-based refers to activities begun or completed by accessing their hotel room. For permanent shore residents, home-based is a factual representation. Similarly, non-home-based refers to those trips that are essentially part of a trip chain. For example, a person leaves their hotel room in the afternoon to go to the beach (a home-based shore visit trip), leaves the beach and goes to get something to eat at a local restaurant (a non-home-based shore visit trip), then goes for a walk on the boardwalk (a non-home based shore visit trip), heads back to the beach (a non-home-based shore visit trip), and so on. The convention of home-based and non-home based allows for the detailed development of trip chaining.

The basic zonal inputs required for shore trip generation are:

- Number of Rental Houses, Condos, and Apartments
- Number of Hotel/Motel Rooms, Bed & Breakfast Rooms, and Campsites
- Zonal Area (in miles)

The shore trip generation model is based upon travel characteristics developed from the beach travel survey conducted in four beach communities (Margate City, Cape May City, Ocean City and Wildwood City) on August 17 and 18, 1996. The survey emulated a travel diary approach within a face-to-face interview, and identified trips made by overnight vs. day-trip visitors. Derived trip rates were stratified by:

- Duration of stay (overnight vs. day trip)
- Type of town (commercial boardwalk or not, predominantly overnight vs. day trip, predominantly long-term housing vs. short term overnight housing);

- General housing unit type (HT1: long-term housing -- single family, apartment, condominium -- vs. HT2: transient housing -- hotels, motels, bed & breakfasts, campsites);
- Life cycle of visitors (any retired in living group, any kids in living group, all others)

The trip generation represents a "full shore activity day", which is estimated to be the summer Saturday for which the surveys were performed. Trip generation is performed on a daily basis, in production-attraction format.

Home based trip productions are computed first for overnight visitors on the basis of housing units. Access trips (the journey from the permanent residence to shore residence) are computed with the productions at the shore end of the trip. Non-home-based trip productions are computed from rates for which housing units are the independent variable, then their origins are reallocated to non-home sites. Day trip access productions for each town are computed as a function of the total access trip ends generated by overnight visitors in the town, using a factor derived from the survey for each town type. Day trip factors can be specified for each zone to adjust the overall number of day trips. Like overnight trips, the day trip access purpose is computed with the productions at the shore end of the trip.

Trip attractions are computed for each purpose as the sum of trip productions within each town. Attractions are then split to on-island activities (remaining generally within the town and not crossing to the mainland), and to off-island activities (visiting, eating, shopping, or other on the mainland or visiting an Atlantic City casino). On-island attractions are allocated within each town on the basis of various measures of non-residential activity: Beach frontage for beach trips; commercial and non-commercial boardwalk frontage for boardwalk trips; commercially zoned area for shop, eat meal, and some other trips; and housing units for the remaining other trips. (For purposes of trip activity, zonal trip attractions are computed on the basis of town control totals without crossovers to other towns. The trip distribution model, in linking productions to attractions, accounts for town-to-town crossovers.) Off-island attractions are allocated to mainland zones using county-specific factors for each purpose derived from the surveys. This process applies to both access trips (which are allocated to permanent residence according to survey data specific to each town) and to intra-shore trips which are making trips to incidental trip activities during their stay. The result of the shore trip generation process is zonal productions and attractions for each shore trip purpose, representing a summer Saturday full activity day.

The following is a more detailed description of the shore trip generation procedure:

- Trip rates and other model coefficients are first initialized. Tables 5-10 to 5-15 provide the trip rates.

STEP 1: First Pass Trip Generation (Overnight Productions):

- The town number and town code are obtained for every zone from the EQUIV file. The trip generation type is set based upon the type of town (one of the four survey towns is estimated to represent each of the other twelve beach towns). Table 5-16 provides the assigned trip generation types.

- The number of housing units in the zone is stratified by life cycle. Table 5-17 presents the split factors.
- Home-based productions are computed from the number of units in each trip generation type / household type / life cycle combination.
- Non-home-based productions are computed from the number of units in each trip generation type / household type / life cycle combination. Note that these trips are computed at the home site, but are incurred at other origins and destinations, so are reallocated later on.
- Trip productions are accumulated for each town by purpose. Also, total commercial area, boardwalk frontage (commercial and non-commercial), and housing units are accumulated for each town.

Table 5.10: Recreational Trip Generation Rates – Shore Visit (Beach)

Production Trip Rates by Lifecycle by Residence Type (by town)						
Lifecycle	Home Based			Non-home Base		
	LC1	LC2	LC3	LC1	LC2	LC3
Trip Generation Type 1						
Visitor - HT1	1.88	1.42	1.69	0.01	0.02	0.01
Visitor - HT2	1.58	1.79	1.52	0.20	0.05	0.08
Daytrip	0.80	0.92	0.09	0.50	0.62	0.76
Resident	1.75	2.00	1.27	0.80	0.95	0.36
Average	**1.57**	**1.57**	**1.39**	**0.05**	**0.06**	**0.15**
Trip Generation Type 2						
Visitor - HT1	1.35	1.76	1.86	0.15	0.02	0.06
Visitor - HT2	1.80	2.00	1.14	0.08	0.02	0.03
Daytrip	0.60	0.67	0.88	4.00	1.33	1.43
Resident	2.00	2.18	1.72	0.27	0.30	0.12
Average	**1.46**	**1.76**	**1.66**	**0.13**	**0.08**	**0.16**
Trip Generation Type 3						
Visitor - HT1	1.54	1.70	1.50	0.05	0.06	0.01
Visitor - HT2	1.07	1.64	1.96	0.27	0.07	0.15
Daytrip	0.29	0.24	0.60	1.18	1.55	1.16
Resident	1.67	0.96	0.60	0.80	1.20	0.20
Average	**1.32**	**1.42**	**1.41**	**0.20**	**0.26**	**0.19**
Trip Generation Type 4						
Visitor - HT1	1.64	1.48	1.71	0.29	0.08	0.18
Visitor - HT2	1.40	1.42	1.46	0.16	0.02	0.03
Daytrip	0.30	0.36	0.27	2.00	1.44	1.23
Resident	1.00	1.94	0.80	1.05	1.60	0.60
Average	**1.38**	**1.22**	**1.00**	**0.27**	**0.34**	**0.44**
External Towns						
Visitor - HT1	1.33	1.71	1.43	0.44	0.50	0.05
Visitor - HT2	1.27	1.35	1.07	0.30	0.08	0.08
Daytrip	1.00	1.14	2.00	2.15	1.20	1.05
Resident	1.33	1.40	0.50	1.15	1.35	0.50
Average	**1.24**	**1.55**	**1.20**	**0.09**	**0.03**	**0.09**
Total						
Visitor - HT1	1.55	1.63	1.64	0.05	0.06	0.07
Visitor - HT2	1.37	1.54	1.44	0.11	0.03	0.06
Daytrip	0.34	0.39	0.37	1.06	1.36	1.10
Resident	1.55	1.76	1.31	0.45	0.50	0.20
Overall Average	**1.38**	**1.43**	**1.35**	**0.17**	**0.20**	**0.21**

Table 5.11: Recreational Trip Generation Rates – Shore Visit (Boardwalk)

Production Trip Rates by Lifecycle by Residence Type (by town)						
Lifecycle	**Home Based**			**Non-home Base**		
	LC1	**LC2**	**LC3**	**LC1**	**LC2**	**LC3**
Trip Generation Type 1						
Visitor - HT1	0.59	0.55	0.53	0.05	0.09	0.03
Visitor - HT2	0.25	0.99	0.53	0.03	0.05	0.03
Daytrip	0.23	0.19	0.12	1.60	0.54	0.80
Resident	0.60	0.53	0.16	0.24	0.30	0.18
Average	**0.40**	**0.70**	**0.44**	**0.12**	**0.06**	**0.13**
Trip Generation Type 2						
Visitor - HT1	0.04	0.44	0.08	0.02	0.03	0.01
Visitor - HT2	0.70	2.00	1.30	0.03	0.06	0.07
Daytrip	0.55	0.45	0.29	0.98	1.32	0.98
Resident	0.30	0.27	0.08	0.03	0.06	0.04
Average	**0.03**	**0.43**	**0.10**	**0.11**	**0.22**	**0.18**
Trip Generation Type 3						
Visitor - HT1	1.04	1.36	0.82	0.02	0.03	0.01
Visitor - HT2	1.33	1.40	0.90	0.21	0.45	0.16
Daytrip	0.12	0.22	0.09	1.06	1.18	0.65
Resident	0.78	0.61	0.20	0.04	0.05	0.03
Average	**0.89**	**1.15**	**0.69**	**0.17**	**0.22**	**0.14**
Trip Generation Type 4						
Visitor - HT1	1.07	1.88	1.95	0.03	0.06	0.02
Visitor - HT2	2.40	2.08	1.78	0.04	0.08	0.03
Daytrip	0.30	0.24	0.16	2.00	1.67	1.52
Resident	1.00	0.18	2.00	0.02	0.10	0.12
Average	**1.70**	**1.53**	**1.25**	**0.09**	**0.43**	**0.55**
External Towns						
Visitor - HT1	0.22	0.86	0.49	0.03	0.06	0.02
Visitor - HT2	0.73	1.09	1.12	0.04	0.08	0.15
Daytrip	1.00	0.85	0.55	0.85	1.14	0.85
Resident	0.67	0.60	0.20	0.01	0.02	0.02
Average	**0.67**	**0.93**	**0.78**	**0.05**	**0.10**	**0.08**
Total						
Visitor - HT1	0.78	1.12	0.60	0.02	0.03	0.01
Visitor - HT2	1.46	1.57	1.00	0.03	0.06	0.07
Daytrip	0.23	0.19	0.12	0.98	1.32	0.98
Resident	0.53	0.47	0.14	0.03	0.05	0.04
Overall Average	**0.85**	**1.10**	**0.63**	**0.11**	**0.22**	**0.18**

Table 5.12: Recreational Trip Generation Rates – Shore Visit (Eat)

Production Trip Rates by Lifecycle by Residence Type (by town)						
Lifecycle	Home Based			Non-home Base		
	LC1	LC2	LC3	LC1	LC2	LC3
Trip Generation Type 1						
Visitor - HT1	1.00	0.56	1.27	0.05	0.09	0.07
Visitor - HT2	1.75	1.60	1.90	0.11	0.10	0.10
Daytrip	0.37	0.31	0.09	3.20	0.23	1.42
Resident	0.45	1.07	0.55	0.27	0.11	0.26
Average	**1.17**	**1.01**	**1.40**	**0.25**	**0.10**	**0.24**
Trip Generation Type 2						
Visitor - HT1	1.83	1.87	1.67	0.03	0.06	0.04
Visitor - HT2	1.99	2.00	1.14	2.20	2.00	2.20
Daytrip	0.18	0.15	0.29	2.00	1.78	1.61
Resident	1.47	1.91	1.04	0.06	0.22	0.03
Average	**1.68**	**1.76**	**1.38**	**0.06**	**0.21**	**0.03**
Trip Generation Type 3						
Visitor - HT1	0.65	0.93	0.76	0.01	0.01	0.02
Visitor - HT2	1.73	1.22	1.33	0.27	0.08	0.09
Daytrip	0.06	0.08	0.33	0.82	0.71	0.37
Resident	0.11	1.30	1.60	0.16	0.14	0.06
Average	**0.59**	**0.84**	**0.83**	**0.15**	**0.13**	**0.06**
Trip Generation Type 4						
Visitor - HT1	0.93	1.27	0.44	0.03	0.06	0.10
Visitor - HT2	1.20	1.42	1.24	0.16	0.08	0.10
Daytrip	0.15	0.12	0.36	1.00	0.79	0.59
Resident	0.50	1.15	0.40	1.00	1.00	1.07
Average	**0.46**	**1.08**	**0.79**	**0.18**	**0.23**	**0.27**
External Towns						
Visitor - HT1	1.33	0.85	1.22	0.44	0.88	0.10
Visitor - HT2	1.27	1.24	1.60	0.09	0.08	0.21
Daytrip	1.00	2.00	1.20	0.55	0.14	0.61
Resident	0.67	1.60	0.33	0.10	0.03	0.16
Average	**1.16**	**1.04**	**1.37**	**0.09**	**0.03**	**0.15**
Total						
Visitor - HT1	0.95	1.01	1.16	0.02	0.04	0.05
Visitor - HT2	1.41	1.42	1.59	0.11	0.10	0.11
Daytrip	0.19	0.16	0.31	0.91	0.72	0.65
Resident	0.57	1.35	0.87	0.16	0.16	0.17
Overall Average	**0.93**	**1.04**	**1.16**	**0.15**	**0.15**	**0.16**

Table 5.13: Recreational Trip Generation Rates – Shore Visit (Shop)

Production Trip Rates by Lifecycle by Residence Type (by town)						
Lifecycle	Home Based			Non-home Base		
	LC1	LC2	LC3	LC1	LC2	LC3
Trip Generation Type 1						
Visitor - HT1	0.82	0.58	0.64	0.02	0.04	0.07
Visitor - HT2	0.83	0.59	0.84	0.01	0.02	0.03
Daytrip	0.45	0.06	0.03	2.00	0.23	1.33
Resident	2.00	1.10	0.55	0.15	0.02	0.20
Average	**0.80**	**0.52**	**0.66**	**0.15**	**0.02**	**0.20**
Trip Generation Type 2						
Visitor - HT1	1.04	0.41	0.44	0.01	0.02	0.04
Visitor - HT2	1.50	2.00	0.57	0.01	0.03	0.05
Daytrip	0.50	0.67	0.35	0.26	0.33	0.45
Resident	0.40	0.45	0.48	0.03	0.06	0.11
Average	**0.86**	**0.48**	**0.42**	**0.03**	**0.06**	**0.11**
Trip Generation Type 3						
Visitor - HT1	0.57	0.39	0.42	0.01	0.02	0.01
Visitor - HT2	0.53	0.70	0.39	0.03	0.08	0.13
Daytrip	0.47	0.06	0.05	0.12	0.24	0.14
Resident	1.11	0.61	0.80	0.02	0.05	0.02
Average	**0.60**	**0.37**	**0.37**	**0.02**	**0.05**	**0.02**
Trip Generation Type 4						
Visitor - HT1	0.29	0.70	0.20	0.05	0.10	0.02
Visitor - HT2	0.72	0.40	0.45	0.03	0.08	0.13
Daytrip	0.50	0.07	0.05	0.23	0.46	0.27
Resident	1.00	0.48	0.65	0.05	0.10	0.19
Average	**0.58**	**0.40**	**0.26**	**0.05**	**0.10**	**0.19**
External Towns						
Visitor - HT1	0.25	0.58	0.36	0.03	0.05	0.10
Visitor - HT2	0.73	0.40	0.23	0.06	0.17	0.04
Daytrip	1.00	0.14	0.10	0.35	0.40	0.12
Resident	0.75	0.35	0.50	0.04	0.07	0.06
Average	**0.53**	**0.32**	**0.29**	**0.04**	**0.07**	**0.06**
Total						
Visitor - HT1	0.63	0.49	0.45	0.01	0.02	0.04
Visitor - HT2	0.72	0.43	0.55	0.01	0.03	0.05
Daytrip	0.45	0.06	0.03	0.26	0.33	0.45
Resident	0.78	0.43	0.51	0.03	0.06	0.11
Overall Average	**0.65**	**0.41**	**0.43**	**0.03**	**0.06**	**0.11**

Table 5.14: Recreational Trip Generation Rates – Shore Visit (Other)

Production Trip Rates by Lifecycle by Residence Type (by town)						
Lifecycle	Home Based			Non-home Base		
	LC1	LC2	LC3	LC1	LC2	LC3
Trip Generation Type 1						
Visitor - HT1	1.00	0.88	0.93	0.12	0.12	0.08
Visitor - HT2	0.83	0.68	1.15	0.32	0.09	0.06
Daytrip	1.58	0.62	0.09	1.20	0.62	0.98
Resident	1.38	1.10	1.36	0.20	0.11	0.18
Average	**0.83**	**0.74**	**0.97**	**0.09**	**0.08**	**0.18**
Trip Generation Type 2						
Visitor - HT1	1.78	0.94	1.78	0.19	0.19	0.13
Visitor - HT2	1.01	0.69	1.14	0.20	0.06	0.02
Daytrip	0.29	0.11	0.19	0.35	0.12	0.19
Resident	1.60	1.27	1.52	0.13	0.07	0.12
Average	**1.68**	**0.91**	**1.54**	**0.28**	**0.14**	**0.04**
Trip Generation Type 3						
Visitor - HT1	0.81	0.72	0.92	0.02	0.02	0.01
Visitor - HT2	1.73	0.47	0.59	0.27	0.08	0.19
Daytrip	0.35	0.08	0.19	0.59	0.39	0.23
Resident	1.67	2.35	1.80	0.22	0.12	0.20
Average	**0.87**	**0.64**	**0.77**	**0.11**	**0.08**	**0.05**
Trip Generation Type 4						
Visitor - HT1	0.29	0.59	0.98	0.29	0.29	0.17
Visitor - HT2	0.32	0.38	0.54	0.13	0.01	0.03
Daytrip	14.00	0.05	0.09	2.00	0.04	0.14
Resident	0.69	0.55	0.40	0.23	0.01	0.07
Average	**0.27**	**0.35**	**0.45**	**0.18**	**0.01**	**0.05**
External Towns						
Visitor - HT1	1.33	1.00	1.09	0.05	0.05	0.03
Visitor - HT2	1.27	0.93	1.03	0.18	0.05	0.13
Daytrip	1.84	0.72	1.20	0.58	0.18	0.31
Resident	2.00	1.60	0.50	0.12	0.06	0.11
Average	**1.16**	**0.94**	**1.03**	**0.09**	**0.04**	**0.08**
Total						
Visitor - HT1	0.97	0.80	1.18	0.03	0.03	0.02
Visitor - HT2	0.81	0.55	0.91	0.07	0.02	0.05
Daytrip	0.23	0.09	0.15	0.64	0.22	0.35
Resident	1.32	1.08	1.99	0.13	0.07	0.12
Overall Average	**0.89**	**0.63**	**0.94**	**0.10**	**0.05**	**0.09**

Table 5.15: Recreational Trip Generation Rates – Beach Access

Production Trip Rates by Lifecycle by Housing Type (by town)				
Lifecycle	Home Based			
	LC1	LC2	LC3	Average
Trip Generation Type 1				
Housing Type 1	0.82	1.51	1.19	1.33
Housing Type 2	0.92	0.94	0.73	0.83
Average	**0.77**	**1.11**	**0.75**	**0.92**
Trip Generation Type 2				
Housing Type 1	0.48	0.56	0.81	0.67
Housing Type 2	1.55	2.00	1.14	1.33
Average	**0.35**	**0.48**	**0.58**	**0.51**
Trip Generation Type 3				
Housing Type 1	0.82	0.96	0.76	0.89
Housing Type 2	0.65	1.04	1.25	1.01
Average	**0.57**	**0.77**	**0.70**	**0.72**
Trip Generation Type 4				
Housing Type 1	0.29	1.01	1.22	0.95
Housing Type 2	0.84	0.79	0.62	0.75
Average	**0.56**	**0.62**	**0.49**	**0.58**
Total				
Housing Type 1	0.68	0.89	0.79	0.83
Housing Type 2	0.58	0.75	0.61	0.68
Overall Average	**0.51**	**0.68**	**0.55**	**0.61**

Table 5.16: Town Numbers, Town Codes and Trip Generation Types

Town	Town Number	Town Code	Trip Generation Type
Atlantic City	1	1010	4
Brigantine	2	1015	2
Longport	3	1075	2
Margate City (Survey)	4	1080	2
Ventnor City	5	1110	2
Avalon	6	9005	2
Cape May City (Survey)	7	9010	1
Cape May Point	8	9015	2
North Wildwood	9	9035	4
Ocean City (Survey)	10	9040	3
Sea Isle City	11	9045	2
Stone Harbor	12	9050	2
Strathmere	13	9055	2
West Cape May	14	9060	2
West Wildwood	15	9065	2
Wildwood City (Survey)	16	9070	4

TripGeneration Types: 1 - Cape May City, 2 - Margate, 3 - Ocean City, 4 - Wildwood

Table 5.17: Stratification of Housing Type to LifeCycle Groups

Trip Generation Type	Life Cycle Group	Housing Type 1	Housing Type 2	Daytrip
1 (Cape May)	LC1 (Any retirees)	0.09	0.062	0.096
	LC2 (Any kids)	0.455	0.318	0.277
	LC3 (All others)	0.455	0.62	0.627
2 (Margate)	LC1 (Any retirees)	0.16	0.063	0.132
	LC2 (Any kids)	0.277	0.25	0.289
	LC3 (All others)	0.563	0.687	0.579
3 (Ocean City)	LC1 (Any retirees)	0.173	0.181	0.143
	LC2 (Any kids)	0.529	0.402	0.436
	LC3 (All others)	0.298	0.417	0.421
4 (Wildwood)	LC1 (Any retirees)	0.149	0.099	0.033
	LC2 (Any kids)	0.586	0.553	0.524
	LC3 (All others)	0.264	0.348	0.443

Housing Type 1 - House/Condo/Apartment

Housing Type 2 - Hotel/Motel/Bed 7 Breakfast/Campsite

STEP 2: Compute Day Trip Productions

- For each town, the number of total day trip access productions is computed by factoring the number of overnight access productions. Factors are specified uniquely for each trip generation type, and are tabulated in Table 5-18.
- Trip productions for all day-trip purposes are allocated to traffic zones within a town in proportion to beach-related activity and long-term housing. A fraction of the trips (shown in Table 5-18) controls the spread to housing. The beach-related activity is a composite measure which favors commercial boardwalk, followed by non-commercial boardwalk. If no boardwalk is in the town, then the beach activity measure is computed as the number of zones which treat the beach zone as their beach zone.
- Day trip attractions are assumed equal to productions, and are added to the Non-Home-Based totals for each town by purpose. They are then adjusted and allocated to zones along with the overnight trips, as discussed below.

Table 5.18: Daytrip allocation factors

	TripGen Type 1	TripGen Type 2	TripGen Type 3	TripGen Type 4
Weight of Boardwalk Commercial frontage for computing beach attractiveness	3	3	3	3
Weight of Boardwalk Non-Commercial frontage for computing beach attractiveness	1.5	1.5	1.5	1.5
Fraction of Day Access trip productions allocated to long-term housing instead of beach zones	0.25	0.25	0.25	0.25

STEP 3: Adjustments to Town Totals

- Total town trip attractions for each purpose are assumed to equal productions. If there is no boardwalk or commercial area coded in a town, then the attractions are moved to a nearby alternate town, as indicated in Table 5-19.
- The Eat Meal (EAT) and Shopping (SHP) trip attractions are split between on-island and off-island locations using factors derived from the survey, as shown in Table 5-20. Other (OTH) trip attractions are split among on-island, off-island, and Atlantic City casino destinations using factors derived from the survey, also shown in Table 5-20. Eat, Shop, and Casino totals are accumulated for off-island destinations in Cape May and Atlantic Counties and Atlantic City casinos, to be reallocated later.

Table 5.19: Alternate Town numbers for Commercial and Boardwalk

Town	Town Number	Alternate for Commercial	Alternate for Boardwalk
Atlantic City	1	1	1
Brigantine	2	2	1
Longport	3	3	5
Margate City (Survey)	4	4	5
Ventnor City	5	5	5
Avalon	6	6	9
Cape May City (Survey)	7	7	16
Cape May Point	8	7	16
North Wildwood	9	9	9
Ocean City (Survey)	10	10	10
Sea Isle City	11	11	10
Stone Harbor	12	12	9
Strathmere	13	10	10
West Cape May	14	14	7
West Wildwood	15	15	16
Wildwood City (Survey)	16	16	16
Wildwood Crest	17	17	16

Table 5.20: Trip Attraction split factors

	TripGen Type 1	TripGen Type 2	TripGen Type 3	TripGen Type 4
Fraction of EAT trips to off-island	0.02	0.16	0.15	0.03
Fraction of SHP trips to off-island	0.06	0.19	0.14	0.05
Fraction of OTH trips to off-island	0.07	0.21	0.13	0.01
Fraction of OTH trips to Casino	0.03	0.08	0.08	0.05
Fraction of BWK trips using Commercial portion of boardwalk	0.6	0.8	0.7	0.8
Fraction of OTH trips attracted to commercial instead of housing	0.22	0.3	0.26	0.24

STEP 4: Second Pass Trip Generation (Attractions)

- Home-Based and Non-Home Based Beach (BCH) attractions are sent to the beach zone coded for each zone in the RECDATA file.
- Home-Based and Non-Home Based Boardwalk (BWK) attractions were adjusted in Step 3 to account for towns which do not have a boardwalk, reassigning them to a neighboring town which does. All Boardwalk trip attractions in a town are then allocated to boardwalk zones, in proportion to the amount of commercial and non-commercial frontage. Fractions shown in Table 5-20 split attractions between the

commercial and non-commercial part of the town's boardwalk. The boardwalk attraction weighting factor (BRDWLKATTF) in RECDATA can be used to further adjust the attractiveness of the boardwalk among zones.

- Eat Meal (EAT) and Shop (SHP) attractions were also adjusted in Step 3, reducing the on-island town totals to account for trips made to the mainland. The adjusted town totals are then distributed to zones within the town which have commercial activity, in proportion to the amount of commercially zoned land area. The commercial attraction weighting factor (COMMCLATTF) in RECDATA can be used to further adjust the attractiveness of commercial areas at a zone level.
- Other (OTH) trips were split in Step 2 to account for trips made to the mainland and Atlantic City casinos. The adjusted town total of Other trips is then distributed to zones within the town in proportion to housing and commercial activity. Factors specified in Table 5-20 are used to weight housing vs. commercial attractiveness.

5.3.2 Casino Trip Generation

This part deals with the unique recreational characteristics of Atlantic City's casinos and convention events. Casino trip generation is based upon the extensive trip generation studies which have been performed in Atlantic City to support casino site plan applications. Because of their traffic engineering impact orientation, virtually all studies have focused on the Friday evening peak hour, approximately from 4:30 to 5:30 p.m., with some additional attention paid to a Saturday night peak, approximately 7:00 to 8:00 p.m. It is estimated that the Friday evening peak represents the highest overall trip generation (including employees) and is taken as the basis for the "full casino activity day". Within the casino trip generation model, trip ends are initially computed for the Friday evening peak hour using established relationships which are then expanded to daily travel to represent the full activity day.

The basic zonal inputs required for casino and event trip generation are:

- Location of Casino/Event facility
- Casino Floor Space
- Casino Hotel Rooms
- Parking Percentages (allocation of visitors and employees to surface lots and garages)
- Casino Charter Bus Data (including daily arrivals, unloading areas, and staging areas)

Casino trip productions are computed for each casino zone, using established trip generation relationships which vary by size and composition of the casino, and by whether growth is an expansion of an existing facility or an entirely new facility. For casinos that are expanded the following equations are applied:

For hotel rooms:

Arrivals = 0.15 trips per added room

Departures = 0.05 trips per added room

For casino floor space:

Arrivals = 1.54 trips per 1,000 sq.ft. floor space

Departures = 0.92 trips per 1,000 sq.ft. floor space

For new casinos, the following equations are applied:

For casino floor space <75,000 sq ft:

Arrivals = 1.76 x (55 + 2.63 x KSF)

Departures = 0.77 x (66 + 3.60 x KSF)

Where KSF = casino floor space in thousands of feet

(Note - no factor for hotel rooms)

For casino floor space = 75,000 to 99,999 sq ft.

Casino Rate:

Arrivals = 0.65 x (702 + (((KSF-75) / 25) x (1200-702)))

Departures = 0.35 x (702 + (((KSF-75) / 25) x (1200-702)))

Room Rate:

Arrivals = 0.75 x (0.40 x (rooms – 1000))

Departures = 0.25 x (0.40 x (rooms – 1000))

For casino floor space > 100,000 sq ft:

Arrivals = 0.65 x (1200 + (0.50 * (rooms – 1000)))

Departures = 0.35 * (1200 + (0.50 * (rooms – 1000)))

For existing facilities not being expanded, the field-inventoried trip generation is used. These trip ends are hourly vehicle trips, and include both Casino Access (CAC) and Casino Visit (CVT) purposes.

Using factors derived from an analysis of casino garage parking tickets, the crossover ratio of casino visitors is used to split the above total casino trips to Casino Access (CAC) vs. Casino Visit (CVT) purposes. The above peak hour vehicle trip productions are converted to peak hour person trip productions, using occupancy factors derived from traffic counts.

Using time adjustment factors derived from traffic counts and contained within the model's temporal file, Casino Access and Casino Visit trip productions are adjusted to represent the "full activity day" daily total. The total Casino Access (CAC) attractions are set equal to total Atlantic City CAC productions, and are allocated to model traffic zones and to cordon stations according to prior casino visitor survey data. The total Casino Visit (CVT) attractions are set equal to total Atlantic City CVT productions, and are allocated to casino zones proportional to overall trip activity.

Event trip productions are exogenously estimated by the user and specified in the input recreational data file. Event access trip (EAC) attractions are distributed to model traffic zones and to cordon stations using the same distribution as casino visitors.

Daily casino bus totals (arriving only) are specified by the user in the input recreational data file. These are converted to productions and attractions, and multiplied by an estimated person occupancy to produce person trip ends.

The result is a set of production / attraction files for each casino / event trip purpose, representing a summer Friday full activity day.

5.4 Validation Results

Table 5-21 presents the results of the base year 2010 non-recreational trip productions and attractions. As can be seen, a perfect match has been obtained between the modeled and surveyed person trips per household. Figure 5-7 depicts the estimated productions graphically.

Table 5.21: Non-recreational Trip Generation Validation 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	

Figure 5.7: Model-Estimated Non-recreational Trip Productions

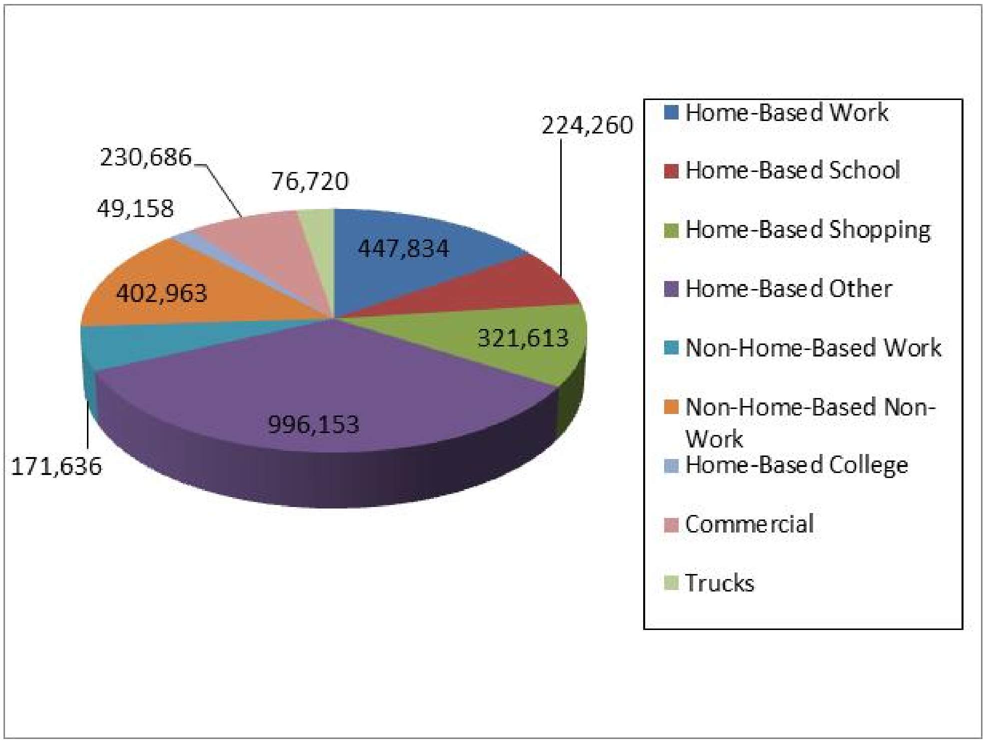
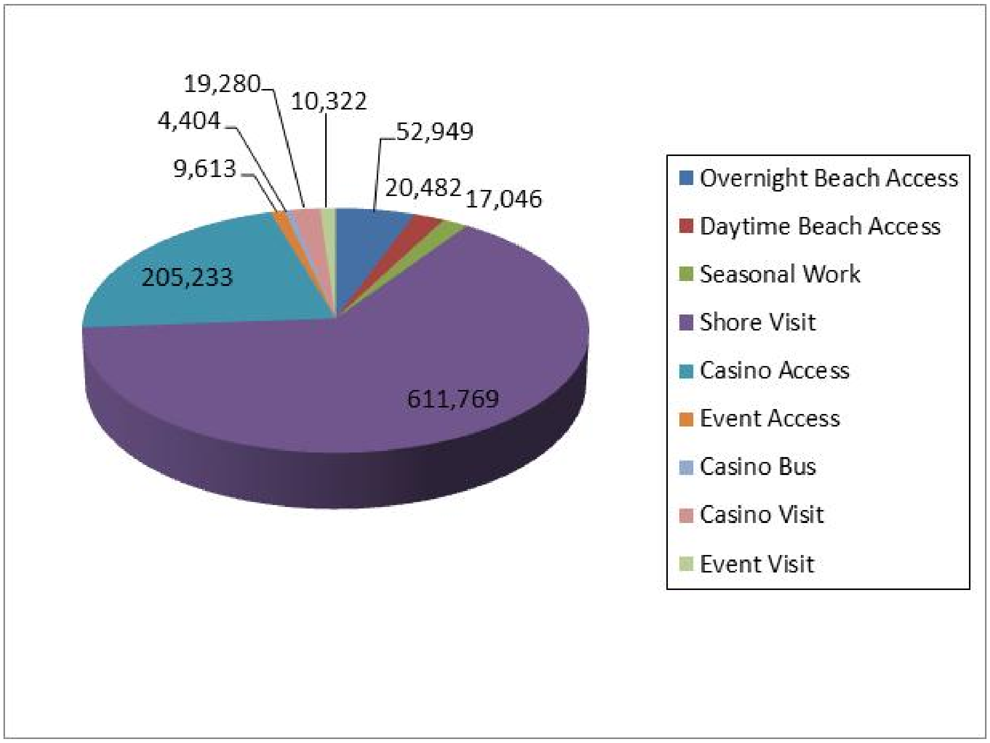


Table 5-22 presents the results of the base year 2010 recreational trip productions and attractions. As there was no new survey data to compare these results, the numbers were deemed appropriate based on a comparison with those from the previous version of the model, which was validated to match the survey data. Figure 5-8 depicts the estimated productions graphically.

Table 5.22: 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**

Figure 5.8: Model-Estimated Recreational Trip Productions



6 Trip Distribution

Trip Distribution is the second step in the 4-step travel demand modeling process in which the zonal productions and attractions estimated by the trip generation step are linked together. This chapter describes the processes in detail including the recent updates implemented.

6.1 Gravity Model

Trip distribution in a 4-step model is typically performed using a gravity model in which it is assumed that the trips from a zone are distributed to destinations in proportion to their attractiveness and inversely proportional to their special separation. This can be represented as follows:

$$Ti\text{-}j = P_i * \frac{Aj * Fi\text{-}j * Ki\text{-}j}{\sum \left(A_j * Fi\text{-}j * Ki\text{-}j \right)}$$

where:

Ti-j = trips produced by zone i and attracted to zone j

Pi = trip productions in zone i

Aj = trip attractions in zone j

Fi-j = friction factor for the i-j zone-zone pair

Ki-j = adjustment factor (K-factor) for the i-j zone-zone pair

Friction factor curves define the 'friction' or impedance for trip interchanges as a function of distance, i.e. these curves imply that there will be less propensity for a trip interchange between zone pairs as the distance between them increases. Friction factors are defined by trip purpose and by internal-internal (I-I) and internal-external (IX/XI). The curves in the previous model were revisited and adjusted in such a way so that the model-estimated average trip length and trip length frequency distributions by trip purpose obtained from the 2001 NJ Household survey had a close match with the observed data.

For the HBW, SCH, NHBW and peak XI/IX purposes, the peak highway travel times were used to distribute the trips; for the other purposes the off-peak highway travel times were used to perform the distribution.

K-factors are used in the gravity model equations to represent the effect of all the other unmeasured influences on travel patterns. These are most commonly used to adjust the basic gravity model results to account for physical boundaries, such as rivers, or for other non-quantifiable effects, such as districts with special attractions. It is generally advisable to minimize the use of these factors. Therefore, the latest version of the SJTDM does not utilize K-factors although those were present in the previous model.

The trip distribution in the SJTDM was performed by trip purposes separately for the I-I and IX/XI purposes. For the trip purposes that were stratified by income, the distribution was performed by income. This is a preferred approach in travel modeling with the benefit of being able to match the right people with the right opportunities thereby improving the accuracy of the process. Many gravity models allocate too many low-income workers to downtown jobs, because the downtown jobs are near the low-income residents. However, those jobs tend to be white-collar jobs, filled largely by non-low-income suburbanites. Continuing to stratify trip distribution by income level should help the model estimate the correct origin-destination patterns.

6.2 Validation Results

Average trip lengths (time and distance) and trip length frequency distributions (TLFD) were derived from the 2001 NJ Household survey data and served as the 'observed' dataset for calibrating the trip distribution model. The observed TLFD were summarized in 2-minute time intervals and 1-mile distance increments. The friction factors by trip purpose (and by income category as applicable) were adjusted to obtain a close match between model-estimated and observed TLFD. Table 6-1 presents a comparison of the average trip lengths (minutes) from the model and the survey data for the non-recreational trip purposes. Similar information in terms of distance (miles) is shown in Table 6-2. It can be seen that a reasonable match was obtained between the model and observed data. Note that similar comparisons could not be performed for the recreational purposes as the 1996 Beach survey data was not available to extract the observed trip lengths.

Table 6.1: Model vs. Observed Average Trip Lengths (mins)

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 6.2: Model vs. Observed Average Trip Lengths (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

Figure 6-1 illustrates the comparison of the TLFD for the HBW I-I purpose. It can be seen that a reasonable match was obtained between the model and observed TLFD. Similar comparisons were performed for the other non-recreational trip purposes for which observed data was available and satisfactory match was observed as can be seen from Figures 6-2 to 6-6. Table 6-3 presents a summary of the total trips by purpose.

Figure 6.1: Model vs Observed Trip Length Frequency Distribution - HBW I-I

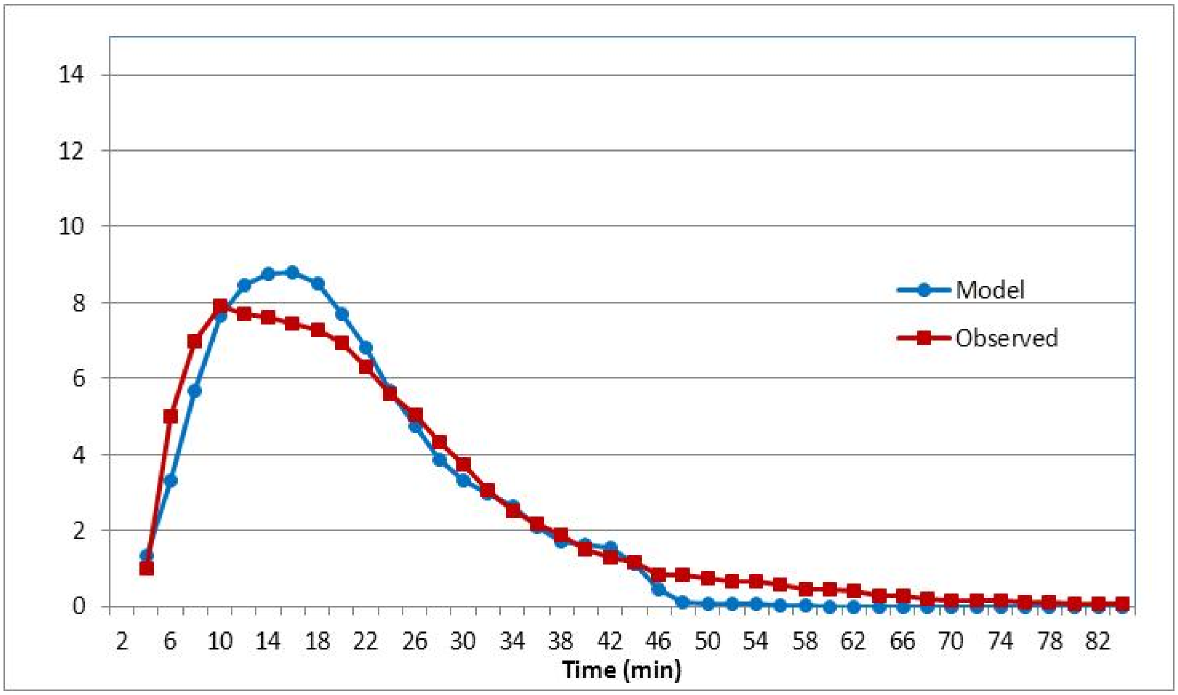


Figure 6.2: Model vs Observed Trip Length Frequency Distribution - SCH I-I

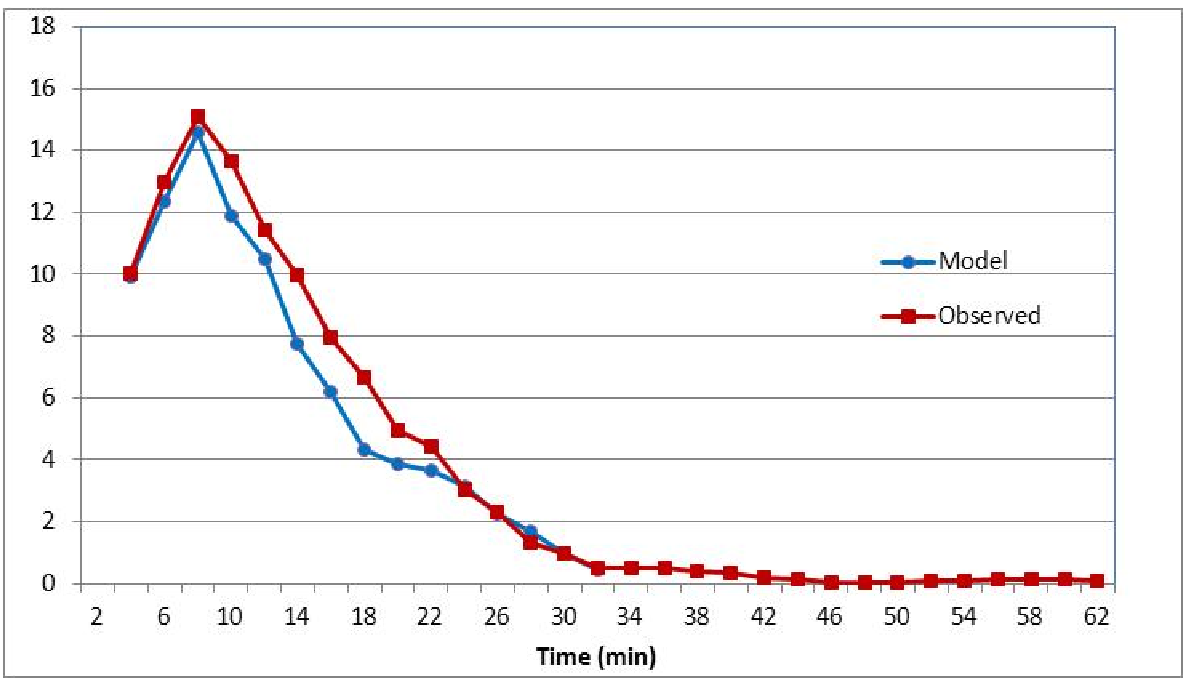


Figure 6.3: Model vs Observed Trip Length Frequency Distribution - HBS I-I

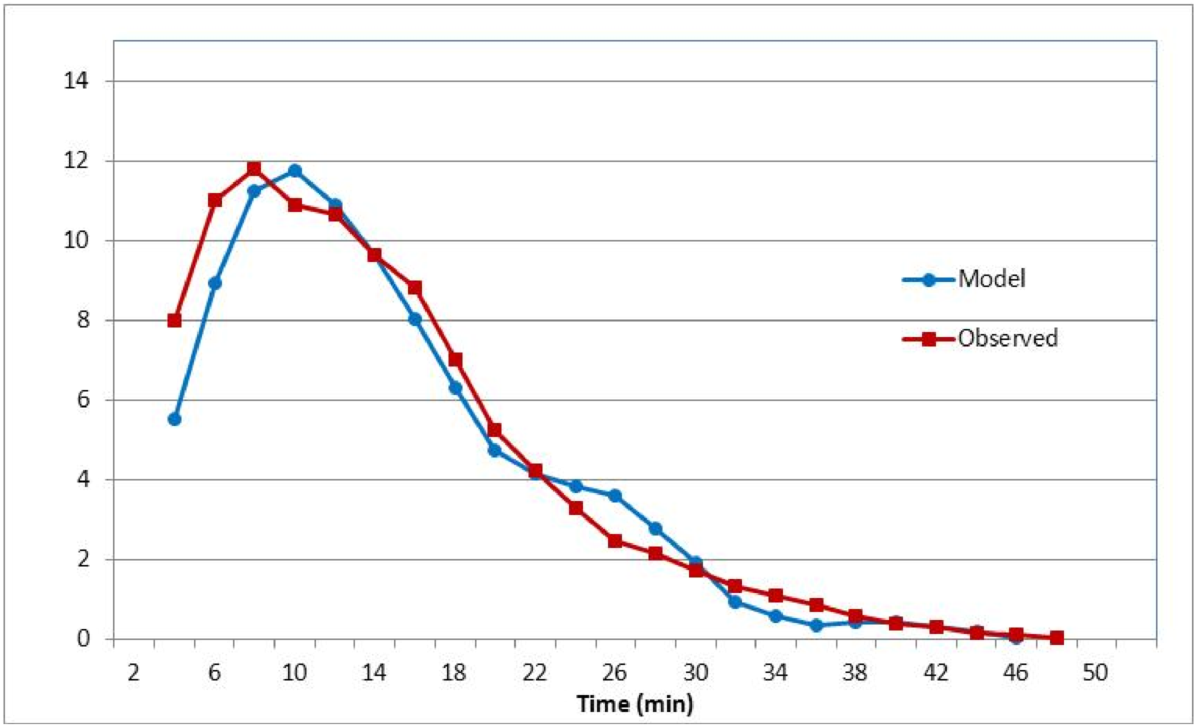


Figure 6.4: Model vs Observed Trip Length Frequency Distribution - HBO I-I

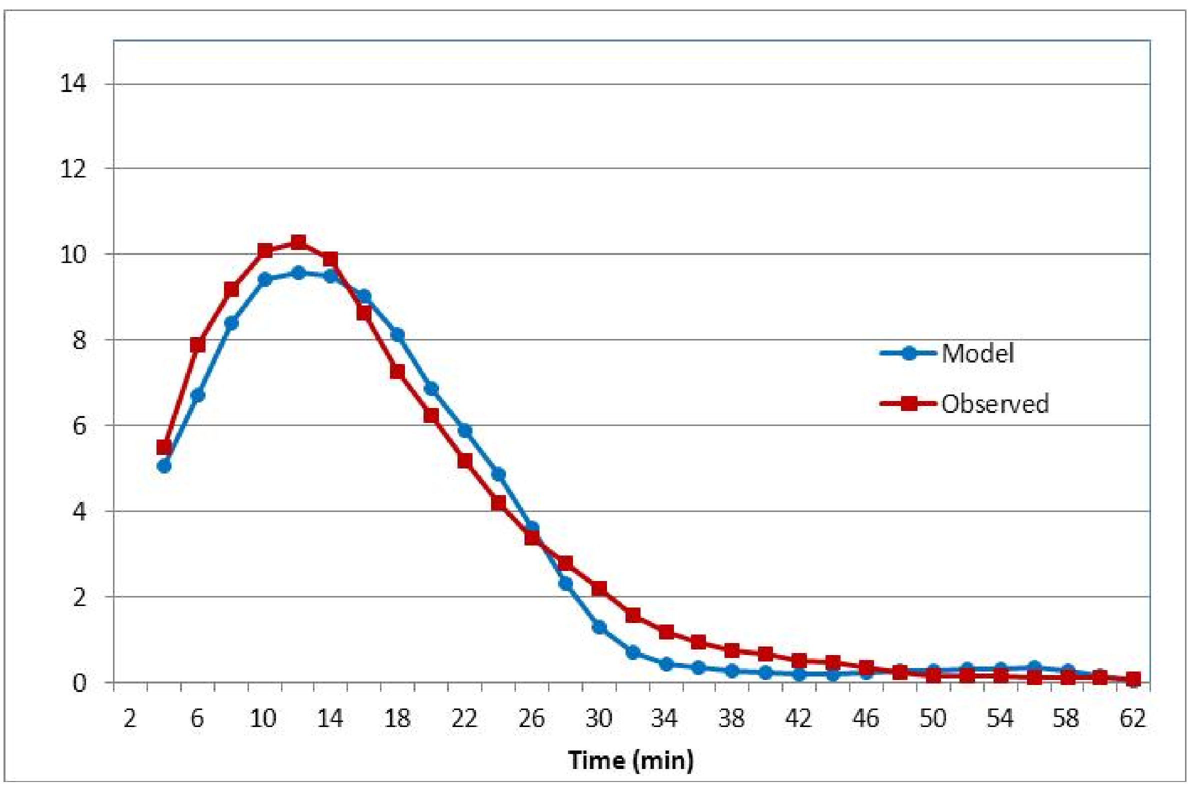


Figure 6.5: Model vs Observed Trip Length Frequency Distribution - NHBW I-I

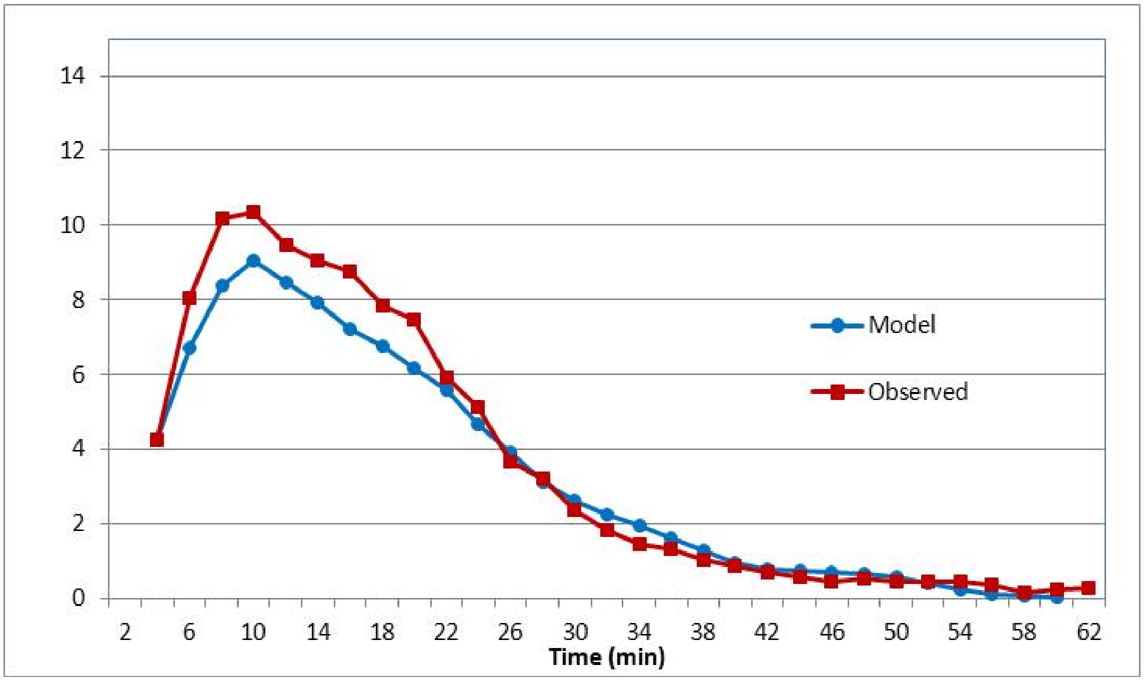


Figure 6.6: Model vs Observed Trip Length Frequency Distribution - NHBNW I-I

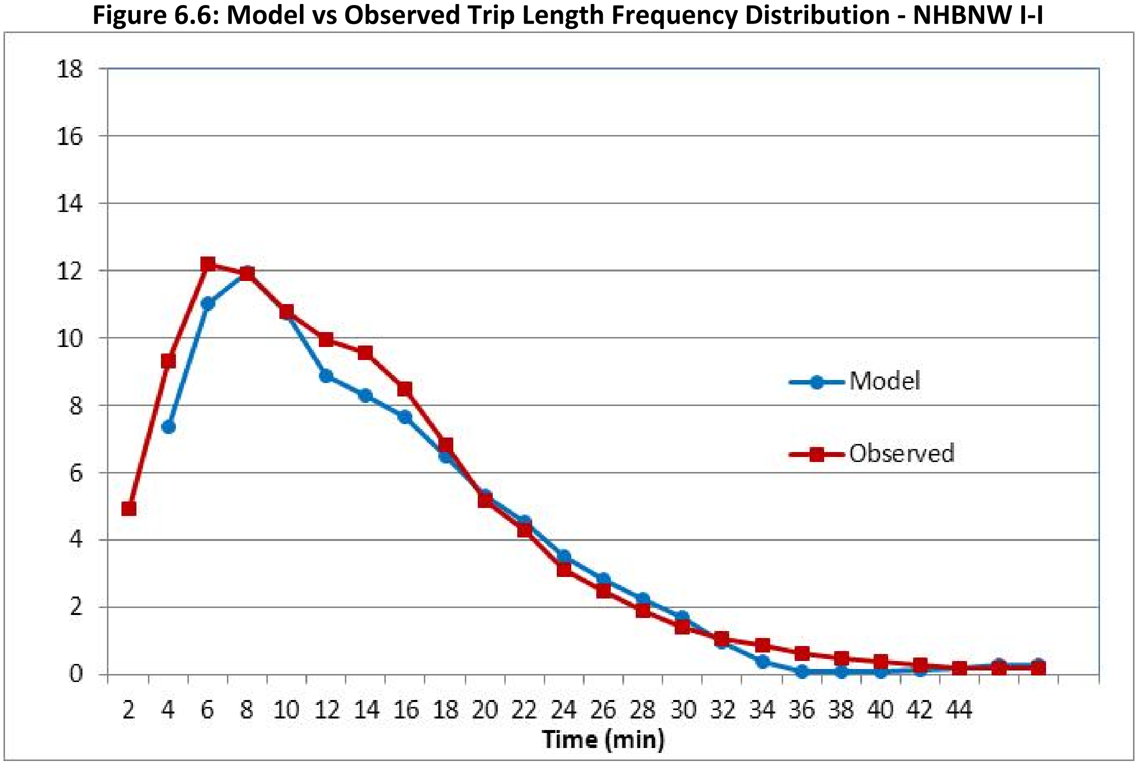


Table 6.3: Trip Distribution Results: Total Trips by Purpose

Purpose	Trips
HBW Income 1	19,748
HBW Income 2	46,262
HBW Income 3	79,826
HBW Income 4	113,639
SCH Income 1	29,366
SCH Income 2	37,722
SCH Income 3	64,368
SCH Income 4	72,180
HBS Income 1	40,340
HBS Income 2	47,656
HBS Income 3	70,532
HBS Income 4	89,984
HBO Income 1	136,381
HBO Income 2	140,459
HBO Income 3	213,028
HBO Income 4	266,241
NHBW	140,761
NHBNW	344,214
COLL	40,449
COMM	211,632
TRK	61,780
BAC	37,224
DAC	14,142
SWK	17,046
SHV	611,769
CA	163,413
EA	7,626
CBS	3,509
CVT	19,280
EVT	10,322
Total	**3,150,899**

7 Mode Choice

Mode Choice is the process in which person trips between origin-destination pairs that were developed in the trip distribution step are split into the various available modes such as highway, transit and their sub-modes. This chapter describes the mode choice model in the SJTDM along with recent updates and validation results. The external-internal mode choice model recently developed is also discussed here.

7.1 Internal-Internal Mode Choice Model

This section describes the SJTDM mode choice model for the internal-internal trips.

7.1.1 Model Structure

The mode choice model in the SJTDM is a nested logit model. This nesting structure has been carried forward with some refinement from the previous version of the model as it follows state-of-the-practice in mode choice modeling. The structure varies slightly depending on the trip purpose. Figure 7-1 illustrates the mode choice nesting structure for the HBW, CAC and EAC purposes. At the higher level nest are the drive-alone, carpool, transit and bike/walk modes. At the lower level nest under the main transit nest are the bus and rail choices. The third level nest below the bus and rail sub-nests contains the choice of access modes, i.e. walk vs. drive. The only modification to the structure in comparison to the previous model is the elimination of the sub-nest under carpool which split carpool trips into PnR and Non-PnR. Since there are only a few PnRs in the modeled region, along with a relatively low magnitude of those trips estimated in the previous model and a desire to reduce unnecessary complexity, the PnR/Non-PnR sub-nest has been removed.

Figure 7.1: Mode Choice Model Nesting Structure (HBW, CAC and EAC)

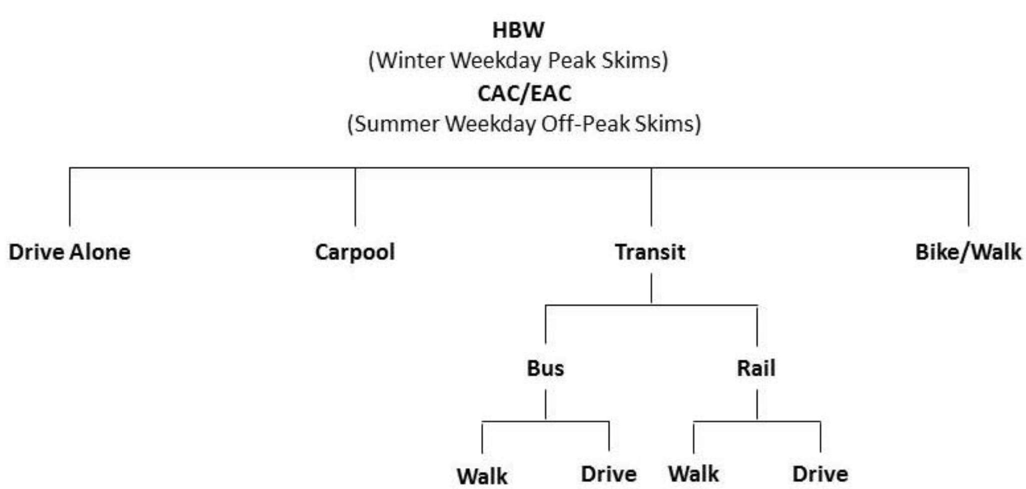


Figure 7-2 illustrates the mode choice nesting structure for the SCH purpose. The School Bus mode that was present in the previous mode choice model for the SCH purpose was removed from the model structure and instead the school bus shares have been asserted based on survey data, as described later in this chapter. Therefore, this mode choice for SCH trips is only for those trips that do not use school bus. Note that there is no need for the transit sub-nest as there is less propensity for a SCH trip to drive to (regular) bus or utilize rail, so only the walk-transit mode is assumed under the transit choice.

Figure 7.2: Mode Choice Model Structure (SCH)

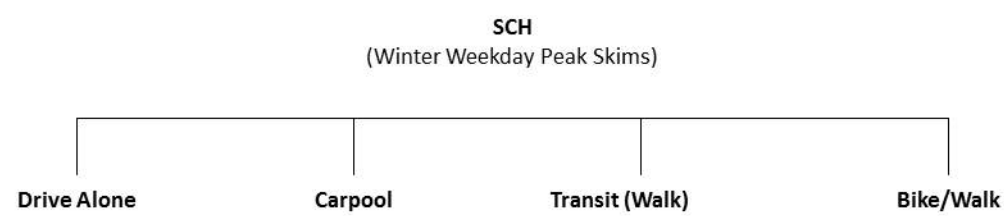
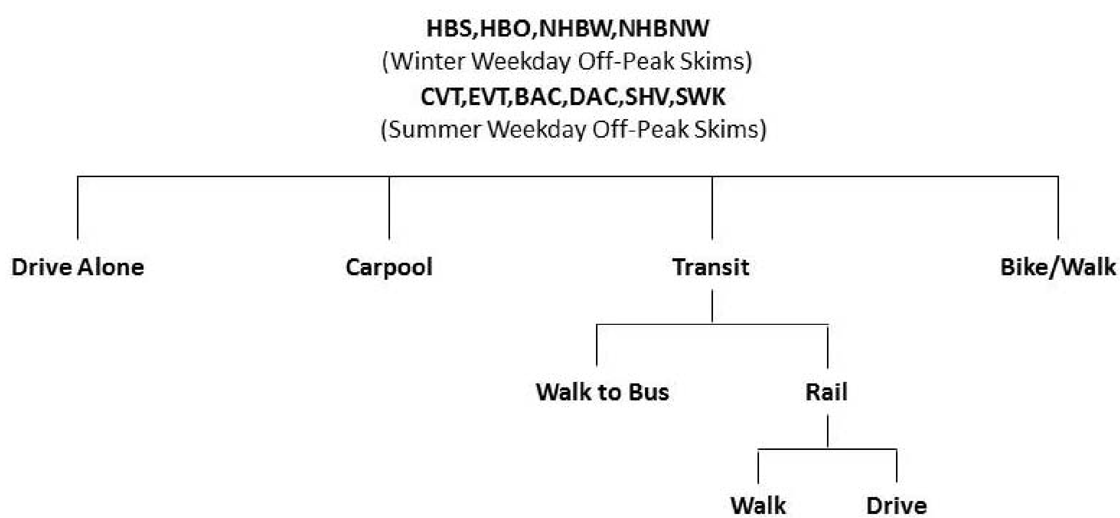


Figure 7-3 illustrates the mode choice nesting structure for the remaining purposes. Note that there is no drive-bus choice as there is less tendency for these purposes to utilize it.

Figure 7.3: Mode Choice Model Structure (All Other Purposes)



The share of trips between a TAZ pair that will be utilized for a given mode is calculated using the following equation:

$$p_i = \frac{e^{U_i}}{\sum^{n} e^{U_k}}$$

Where:

p_i = probability that trip will use mode i

U_i = disutility of mode i = a + b*Time + c*Cost, etc., where a,b,c are calibrated coefficients

(these are generally negative)

e = exponential function

Σe^{U_i} = sum of e^U for all modes 1 to n

This function has the following properties:

- For any TAZ pair, the probabilities for all available modes sum to 1.0.
- As any mode i becomes "worse" (i.e., higher time, cost, etc.), relative to other modes, its disutility increases (becomes more negative) and its share decreases.

The disutility of the nested modes is the natural logarithm of the sum of the disutilities of the individual submodes (also known as the "logsum"). For instance, the disutility of choosing the bus sub-mode under the transit nest is calculated as:

$$U_{Bus} = c_{nest} * \ln(e^{U_{WBus}} + e^{U_{DBus}})$$

Where:

U_{Bus} = disutility of bus transit mode

c_{nest} = "nesting coefficient" for bus mode under the transit nest

U_{WBus} = disutility of walk-to-bus transit mode

U_{DBus} = disutility of drive-to-bus transit mode

ln = natural logarithm function

The nesting coefficient is a value between 0.0 and 1.0 which indicates, in the above example, how sensitive transit-bus disutility is to the competition between walk access and auto access.

7.1.2 Input Data

Besides the person trips estimated by the trip distribution model for every zone pair, the mode choice model requires an estimate of the characteristics of each mode for every zone pair in the network. The most important characteristics are the travel time and cost of using each mode for the trips represented by each origin-destination pair. This information is determined by using the highway and transit skims generated by earlier steps in the model.

The cost of traveling by auto is calculated by multiplying the highway distance (from the highway skims) by a value representing the incremental cost per mile of auto operation: 11.5 cents/mile. This includes the cost of gasoline, oil, tires, and maintenance but excludes the fixed cost of auto ownership such as depreciation and insurance. Similarly, transit skims include out-of-vehicle time (OVT), in-vehicle time (IVT), number of transfers and fare.

Other data requirements include the following:

- Daily Average Parking Cost: This is the average commercial parking rate for each zone, for all-day parking, expressed in cents in 2010 dollars. This was updated based on the most recent parking cost information available. This rate is used for work-related trips. The model multiplies the parking cost by the percentage of people who actually pay anything for parking, assumed to be 7.1% of all workers (based on work in other areas). This then yields the net average cost of parking. In this model, the resulting parking cost is divided by 2 so as to allocate half the daily cost to the home-to-work trip.
- Hourly Average Parking Cost: This is the average commercial parking rate for each zone, for short-term (hourly) parking, expressed in cents in 2010 dollars. This was updated based on the most recent parking cost information available. This rate is used for all non-work trip purposes. The model multiplies the parking cost by the percentage of people who actually pay anything for parking, assumed to be 2.0% of all non-work trips (based on work in other areas). That value is then multiplied by the average non-work parking duration, assumed to be 1.5 hr. This then yields the net average cost of parking.
- Area type: The area type is used to look up a value for highway terminal time at each end of the trip, which is defined as the out-of-vehicle time for the auto mode. The terminal times by area type were presented in Chapter 3 (Table 3-8).

7.1.3 Coefficients and Constants

Several variables are utilized in the utility expressions which differ by mode and sub-mode. These variables have associated coefficients the values of which were reviewed from the previous model and modified to meet FTA guidance, based on professional judgment and also adjusted as part of the model validation process. The NJ Household survey from 2001 served as the observed data source from which mode shares were derived for calibrating these coefficients. There were a few variables in the previous SJTPO mode choice model that seemed to be irrelevant, contrary to good practice or difficult to justify and therefore were eliminated from the model. Table 7-1 presents the variables that were retained and their description.

Table 7.1: Mode Choice Model Variable Definitions

Variable	Definition
Time	For Drive Alone, the zone-zone travel time from the highway network (SOV paths). For Carpool, the zone-zone travel time from the highway network (HOV paths) plus 1.1 minutes/passenger "pickup time". For Walk, the zone-zone highway network distance multiplied by 20 min/mi (3 mph). For Bike, the zone-zone highway network distance multiplied by 5 min/mi (12 mph).
Terminal Time	Sum of the terminal time at origin and destination zones (see Section 3).
Operating Cost	Incremental auto operating cost, calculated as the zone-zone highway network distance multiplied by 11.5 cents/mi.
Parking Cost	For HBW, half the daily commercial parking rate, multiplied by the percent of commuters who actually pay for parking, divided by the average vehicle occupancy. For the other purposes, the hourly commercial parking rate, multiplied by the percent of non-work trips who actually pay for parking, divided by the average vehicle occupancy.
CBD Flag	A yes/no flag that indicates whether or not the production zone is in the CBD (yes = 1).
In-Vehicle Time	Transit in-vehicle (bus run) time.
Out of Vehicle time	Transit total out-of-vehicle time, including access walk, initial wait, transfer wait, and egress walk.
FARE	Total transit fare.
Transfer (Bus)	Number of bus transfers.
Transfer (Rail)	Number of rail transfers
Auto Access Time	Auto access time to transit.
Distance	Highway distance, using the SOV path for Drive Alone and the HOV path for Carpools.
Walk/Bike incentive employees	Percent of employees in the attraction zone which have a walk or bike incentive available.

Source: Table 9-6, SJTDM Model Development and Validation Report, August 1998, Garmen Associates

Table 7-2 presents the final calibrated coefficient values. Per FTA guidance, the coefficient of In-vehicle time (IVT) is between -0.02 and -0.03. The ratio of OVT/IVT is 1.5, which is at the low range of what is typical and recommended, but is consistent with the notion that OVT is more onerous than IVT. Transit transfers are penalized with a value equivalent to 10 extra minutes of travel time.

Table 7.2: Mode Choice Model Coefficients

Mode	Variable	HBW	SCH	HBS	HBO	NHBW	NHBNW	Recreation
Drive Alone	Time	-0.0300	-0.0200	-0.0200	-0.0200	-0.0200	-0.0200	-0.0200
	Terminal Time	-0.0450	-0.0300	-0.0300	-0.0300	-0.0300	-0.0300	-0.0300
	Operating Cost	-0.0024	-0.0016	-0.0016	-0.0016	-0.0016	-0.0016	-0.0016
	Parking Cost	-0.0024	-0.0016	-0.0016	-0.0016	-0.0016	-0.0016	-0.0016
Carpool	Time	-0.0300	-0.0200	-0.0200	-0.0200	-0.0200	-0.0200	-0.0200
	Terminal Time	-0.0450	-0.0300	-0.0300	-0.0300	-0.0300	-0.0300	-0.0300
	Operating Cost	-0.0024	-0.0016	-0.0016	-0.0016	-0.0016	-0.0016	-0.0016
	CBD Flag	0.1000						
Transit	In-vehicle Time	-0.0300	-0.0200	-0.0200	-0.0200	-0.0200	-0.0200	-0.0200
	Out of Vehicle Time	-0.0450	-0.0300	-0.0300	-0.0300	-0.0300	-0.0300	-0.0300
	Fare	-0.0024	-0.0016	-0.0016	-0.0016	-0.0024	-0.0016	-0.0016
	Transfer (Bus)	-0.3000	-0.2000	-0.2000	-0.2000	-0.3000	-0.2000	-0.2000
	Transfer (Rail)	-0.3000	-0.2000	-0.2000	-0.2000	-0.3000	-0.2000	-0.2000
	Auto Access Time	-0.0450	-0.0300	-0.0300	-0.0300	-0.0300	-0.0300	-0.0300
	CBD Flag	0.4500	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
	Distance			0.4	0.4		0.13	0.13
Walk/Bike	Time	-0.0300	-0.0200	-0.0200	-0.0200	-0.0200	-0.0200	-0.0200
	walk/bike incentive employees	-0.1375				-0.1375		
	CBD Flag	0.3000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000

Table 7-3 presents the final calibrated bias constants for the various modes and sub-modes.

Table 7.3: Mode Choice Model Bias Constants

Mode	HBW Inc1	HBW Inc2	HBW Inc3	HBW Inc4	SCH Inc1	SCH Inc2	SCH Inc3	SCH Inc4
Carpool	-2.0000	-2.5000	-3.0000	-3.5000	3.0000	1.5000	1.5000	2.0000
Transit	0.0000	-0.2500	-0.2500	-0.2500	-0.5000	-0.5000	-0.5000	-0.5000
Walk/Bike	6.0000	5.0000	4.0000	3.0000	6.0000	5.0000	4.0000	3.0000
Transit-Rail	1.0000	1.0000	1.0000	1.0000	0.9000	0.9000	0.9000	0.9000
Transit-Drive-Rail	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Transit-Drive-Bus	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000
Walk/Bike - Bike	-7.6000	-7.9000	-8.7000	-2.8000	-2.3000	-2.4000	-1.8000	-1.5000

Mode	HBS Inc1	HBS Inc2	HBS Inc3	HBS Inc4	HBO Inc1	HBO Inc2	HBO Inc3	HBO Inc4
Carpool	-0.5000	-0.3000	-0.3000	-0.3000	0.2000	0.1000	0.1000	0.1000
Transit	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000
Walk/Bike	-1.0000	-2.0000	-3.0000	-4.0000	2.0000	1.0000	-0.5000	-1.0000
Transit-Rail	0.9000	0.9000	0.9000	0.9000	0.9000	0.9000	0.9000	0.9000
Transit-Drive-Rail	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Transit-Drive-Bus	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000
Walk/Bike - Bike					-1.9000	-2.2000	-2.2000	-2.2000

Mode	NHBW	NHBNW	BAC	DAC	SWK	SHV	CA/EA	CVT/EVT
Carpool	-2.0000	0.1000	5.0000	3.0000	-2.0000	4.0000	2.0000	2.0000
Transit	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000
Walk/Bike	-2.0000	1.5000	5.0000	5.0000	-3.0000	9.0000	-5.0000	3.0000
Transit-Rail	1.0000	0.9000	0.9000	0.9000	0.9000	0.9000	0.9000	0.9000
Transit-Drive-Rail	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Transit-Drive-Bus	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000
Walk/Bike - Bike		-4.0000	-4.5000	-4.5000	-4.5000	-4.5000	-4.5000	-4.5000

A nesting coefficient of 0.5 was used at all levels of the transit nest. This value is asserted and clearly a judgment call, but it represents the middle ground in terms of the sensitivity between modes in the transit nest relative to all other modes.

The school bus trips for the Home-based school trip purpose were not determined by the mode choice model. A more appropriate approach was adopted in which a set of shares based on survey data were applied regionally to all trips, particularly since the school bus availability or routing is not known. School trip shares can vary based on trip length to the school, with non-motorized trips more likely for short trips. Based on SJTPO survey data, school buses carry approximately half of all K-12 school trips.

Also, although bike/walk has been carried forward from the previous model as a separate mode, those trips are not assigned later in the model chain as the model does not have a walk/bike network. However, it was retained for future model enhancements.

For intrazonal trips, the highway and transit impedance tables provide insufficient information to permit the calculation of modal shares as for other zone-zone pairs. The mode shares of such trips were assumed to be similar to the observed mode shares. The intrazonal model shares are shown in Table 7-4. The model assumes that for intrazonal trips all transit users will walk to bus and walk/bike users are split 90% walk to 10% bike.

Table 7.4: Intrazonal Mode Shares

Mode	Trip Purpose											
	HBW	SCH	HBS	HBO	NHBW	NHBNW	BAC/DAC	SWK	SHV	CA/EA	CBS	CVT/EVT
Drive Alone	86%	5%	55%	46%	80%	40%	5%	70%	5%	5%	100%	55%
Carpool	7%	30%	40%	47%	15%	55%	80%	15%	20%	80%	0%	15%
Transit	2%	0%	0%	1%	0%	0%	5%	5%	5%	5%	0%	5%
Walk/Bike	5%	15%	5%	6%	5%	5%	10%	10%	70%	10%	0%	25%

7.1.4 Validation Results

The application of the mode choice model resulted in model-estimated mode shares by trip purposes, which were compared with the observed mode shares from the 2001 Household Survey data. Note that observed shared were not available from the 1996 Beach survey for validation purposes. Table 7-5 presents a comparison of the estimated vs. observed mode shares for the non-recreational trip purposes. It can be seen that a reasonable match was obtained for all the purposes.

Table 7-6 presents the model-estimated mode shares for the Recreational trip purposes. The shares appear reasonable. The beach/casino/event access trips are estimated to be predominantly carpool trips, which is plausible. Seasonal work is estimated to be largely drive-alone trips. The short distance shore visit purpose is estimated to be mostly walk/bike trips. There was no data with which to calibrate the mode choice models for the recreation purposes, so the observed mode shares by purpose from the previous model was used as a basis for comparison.

Table 7.5: Mode Choice Validation Results (Non-recreational purposes)

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%**	**100%**
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%**	**100%**
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%**	**100%**

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%**	**100%**
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%**	**100%**
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%**	**100%**

Table 7.6: Mode Choice Model Results (Recreational purposes)

Purpose	Mode	Mode Share	Purpose	Mode	Mode Share
BAC	Drive-Alone	0.3%	CA	Drive-Alone	6.4%
	CarPool	99.6%		CarPool	92.6%
	Bike-Walk	0.0%		Bike-Walk	0.0%
	Bus	0.0%		Bus	0.2%
	Rail	0.0%		Rail	0.8%
	Total	**100%**		**Total**	**100%**
DAC	Drive-Alone	3.0%	EA	Drive-Alone	6.4%
	CarPool	96.8%		CarPool	92.0%
	Bike-Walk	0.0%		Bike-Walk	0.0%
	Bus	0.1%		Bus	0.2%
	Rail	0.0%		Rail	1.4%
	Total	**100%**		**Total**	**100%**
SWK	Drive-Alone	76.8%	CVT	Drive-Alone	40.7%
	CarPool	17.3%		CarPool	36.3%
	Bike-Walk	0.5%		Bike-Walk	21.7%
	Bus	5.3%		Bus	1.2%
	Rail	0.2%		Rail	0.0%
	Total	**100%**		**Total**	**100%**
SHV	Drive-Alone	1.3%	EVT	Drive-Alone	25.8%
	CarPool	43.2%		CarPool	38.5%
	Bike-Walk	55.5%		Bike-Walk	27.1%
	Bus	0.1%		Bus	8.7%
	Rail	0.0%		Rail	0.0%
	Total	**100%**		**Total**	**100%**

7.2 External-Internal Mode Choice Model

As the SJTDM model geography has been revised, several transit routes coded in the model were truncated at the external boundary, as mentioned in Chapter 4. In order to account for the transit trips that cross the model boundaries, a new external-internal mode choice model was developed for the SJTDM as a "quick-response" technique. This process was developed per the request from NJ Transit, SJTPO and the peer reviewer. This section describes the model in detail.

7.2.1 Input Data

This model performs mode choice from each of the external stations in the model to three external geographies, namely Philadelphia Center, rest of Philadelphia County, and the Camden area. One of the primary inputs to this model is the % distribution of trips from each of the external stations to these three external geographies. This was determined from DVRPC's TIM 1.0 model and is summarized in Table 7-7.

Table 7.7: Percent distribution from external stations to external geographies

External Station #	Road Name	Philadelphia Center	Rest of Philadelphia Co	Camden Area	Other
1401	NJ 444 - Garden State Parkway	0	0	0	100
1402	NJ 563- Green Bank Road	0	0	0	100
1403	NJ 542- Nesco Road	0	0	0	100
1404	US 206	0	0	0	100
1405	NJ 534- Jackson Road	0	0	0	100
1406	Jackson Medford Road	0	0	0	100
1407	Kettle Run Rd (Cooper Rd)	0	0	0	100
1408	NJ 536- Hopewell Road	0	0	0	100
1409	NJ 73	0	1	0	99
1410	US 30- White horse pike	2	1	1	96
1411	NJ 691 Watsontown Road	0	0	1	99
1412	NJ 689 Cross Keys Road	0	0	0	100
1413	NJ 706 Erial Road	1	1	1	97
1414	NJ 705 Sickerville Road	4	4	6	86
1415	Atlantic City Express	11	13	5	71
1416	NJ 42	6	4	5	85
1417	NJ 654- Hurfville Crosskeys Road	0	0	0	100
1418	NJ 651 Green Tea Road	0	0	0	100
1419	NJ47- Delsa Road	2	2	3	93
1420	NJ 553 Main St	0	0	0	100
1421	NJ 682 Carpenter St.	0	0	0	100
1422	NJ 55 Freeway	5	7	4	84
1423	NJ 635 Richwood Pitman Rd (Lamb Rd)	0	0	0	100
1424	NJ 609 Barnes Boro Road	0	0	0	100
1425	NJ 667Cedar Road	0	0	0	100
1426	NJ 45- Bridge town pike	1	1	2	96
1427	I 95- NJ turnpike	0	1	0	99
1428	NJ 551- Kings highway	0	0	0	100
1429	NJ 653- Paulsboro Road	5	3	6	86
1430	I 295	2	3	2	93
1431	NJ 44 -Broad St.	0	0	0	100
1432	US 322- Commodore Barry Bridge	0	2	0	98
1433	Delaware Memorial Bridge	0	0	0	100
1434	Ferry near US 9 in CapeMay	0	0	0	100

The other input requirement of this model is the 'level-of-service' i.e., travel time and costs from each external station to each of these external geographies by auto, bus and rail. The travel times by auto to Camden center were determined based on google maps and the bus and rail times to Camden center determined based on schedules available from NJ Transit. The times and costs to the other two geographies were estimated from those for Camden as follows (based on NJT Schedules and professional judgement and can be updated later if more accurate information can be obtained):

Auto time to Philadelphia Center (min) = Auto time to Camden (min) + 10 min

Auto distance to Philadelphia Center (mi) = Auto distance to Camden (mi) + 3 mi

Bus time to Philadelphia Center (min) = Bus time to Camden (min) + 15 min

Bus cost to Philadelphia Center ($) = Bus cost to Camden ($) + $3

Rail time to Philadelphia Center (min) = Rail time to Camden (min) + 10 min

Rail cost to Philadelphia Center ($) = Rail cost to Camden ($) + $3

Auto time to rest of Philadelphia (min) = Auto time to Camden (min) + 20 min

Auto distance to rest of Philadelphia (mi) = Auto distance to Camden (mi) + 6 mi

Bus time to rest of Philadelphia (min) = Bus time to Camden (min) + 30 min

Bus cost to rest of Philadelphia ($) = Bus cost to Camden ($) + $5

Rail time to rest of Philadelphia (min) = Rail time to Camden (min) + 25 min

Rail cost to rest of Philadelphia ($) = Rail cost to Camden ($) + $5

Auto costs were determined by multiplying auto distance by auto operating cost of 11.5 cents/mi and dividing by a value of time of $7/hour, which is similar to the HBW value of time ($7.50).

Tables 7-8 to 7-10 present the auto, bus and rail times and costs to Camden, Philadelphia CBD and rest of Philadelphia County.

Table 7.8: Auto, Bus and Rail times and costs to Camden

External Station #	Road Name	Distance (mi)	Auto Time (min)	Bus Time (min)	Bus Cost ($)	Rail Time (min)	Rail Cost ($)
1401	NJ 444 - Garden State Parkway	54	64	0	$0.00	0	$0.00
1402	NJ 563- Green Bank Road	49	58	0	$0.00	0	$0.00
1403	NJ 542- Nesco Road	41	54	0	$0.00	0	$0.00
1404	US 206	33	46	0	$0.00	0	$0.00
1405	NJ 534- Jackson Road	24	35	0	$0.00	0	$0.00
1406	Jackson Medford Road	24	39	0	$0.00	0	$0.00
1407	Kettle Run Rd (Cooper Rd)	20	28	0	$0.00	0	$0.00
1408	NJ 536- Hopewell Road	19	26	0	$0.00	0	$0.00
1409	NJ 73	19	26	0	$0.00	0	$0.00
1410	US 30- White horse pike	17	23	40	$3.10	35	$4.00
1411	NJ 691 Watsontown Road	18	24	0	$0.00	0	$0.00
1412	NJ 689 Cross Keys Road	18	26	0	$0.00	0	$0.00
1413	NJ 706 Erial Road	17	24	0	$0.00	0	$0.00
1414	NJ 705 Sickerville Road	17	23	0	$0.00	0	$0.00
1415	Atlantic City Express	16	22	40	$3.10	35	$4.00
1416	NJ 42	17	22	40	$3.10	0	$0.00
1417	NJ 654- Hurfville Crosskeys Road	17	25	0	$0.00	0	$0.00
1418	NJ 651 Green Tea Road	17	26	0	$0.00	0	$0.00
1419	NJ47- Delsa Road	16	23	40	$3.10	0	$0.00
1420	NJ 553 Main St	18	25	45	$3.10	0	$0.00
1421	NJ 682 Carpenter St.	17	25	0	$0.00	0	$0.00
1422	NJ 55 Freeway	17	24	0	$0.00	0	$0.00
1423	NJ 635 Richwood Pitman Rd (Lamb Rd)	17	21	0	$0.00	0	$0.00
1424	NJ 609 Barnes Boro Road	19	25	0	$0.00	0	$0.00
1425	NJ 667Cedar Road	20	26	0	$0.00	0	$0.00
1426	NJ 45- Bridge town pike	16	25	45	$3.10	0	$0.00
1427	I 95- NJ turnpike	15	25	0	$0.00	0	$0.00
1428	NJ 551- Kings highway	17	25	45	$3.10	0	$0.00
1429	NJ 653- Paulsboro Road	16	21	0	$0.00	0	$0.00
1430	I 295	17	21	0	$0.00	0	$0.00
1431	NJ 44 -Broad St.	18	23	45	$3.10	0	$0.00
1432	US 322- Commodore Barry Bridge	22	27	0	$0.00	0	$0.00
1433	Delaware Memorial Bridge	37	41	0	$0.00	0	$0.00
1434	Ferry near US 9 in CapeMay	91	95	0	$0.00	0	$0.00

Table 7.9: Auto, Bus and Rail times and costs to Philadelphia Center

External Station #	Road Name	Distance (mi)	Auto Time (min)	Bus Time (min)	Bus Cost ($)	Rail Time (min)	Rail Cost ($)
1401	NJ 444 - Garden State Parkway	57	74	0	$0.00	0	$0.00
1402	NJ 563- Green Bank Road	52	68	0	$0.00	0	$0.00
1403	NJ 542- Nesco Road	44	64	0	$0.00	0	$0.00
1404	US 206	36	56	0	$0.00	0	$0.00
1405	NJ 534- Jackson Road	27	45	0	$0.00	0	$0.00
1406	Jackson Medford Road	27	49	0	$0.00	0	$0.00
1407	Kettle Run Rd (Cooper Rd)	23	38	0	$0.00	0	$0.00
1408	NJ 536- Hopewell Road	22	36	0	$0.00	0	$0.00
1409	NJ 73	22	36	0	$0.00	0	$0.00
1410	US 30- White horse pike	20	33	55	$5.80	45	$6.50
1411	NJ 691 Watsontown Road	21	34	0	$0.00	0	$0.00
1412	NJ 689 Cross Keys Road	21	36	0	$0.00	0	$0.00
1413	NJ 706 Erial Road	20	34	0	$0.00	0	$0.00
1414	NJ 705 Sickerville Road	20	33	0	$0.00	0	$0.00
1415	Atlantic City Express	19	32	55	$5.80	45	$6.50
1416	NJ 42	20	32	55	$5.80	0	$0.00
1417	NJ 654- Hurfville Crosskeys Road	20	35	0	$0.00	0	$0.00
1418	NJ 651 Green Tea Road	20	36	0	$0.00	0	$0.00
1419	NJ47- Delsa Road	19	33	55	$5.80	0	$0.00
1420	NJ 553 Main St	21	35	60	$5.80	0	$0.00
1421	NJ 682 Carpenter St.	20	35	0	$0.00	0	$0.00
1422	NJ 55 Freeway	20	34	0	$0.00	0	$0.00
1423	NJ 635 Richwood Pitman Rd (Lamb Rd)	20	31	0	$0.00	0	$0.00
1424	NJ 609 Barnes Boro Road	22	35	0	$0.00	0	$0.00
1425	NJ 667Cedar Road	23	36	0	$0.00	0	$0.00
1426	NJ 45- Bridge town pike	19	35	60	$5.80	0	$0.00
1427	I 95- NJ turnpike	18	35	0	$0.00	0	$0.00
1428	NJ 551- Kings highway	20	35	60	$5.80	0	$0.00
1429	NJ 653- Paulsboro Road	19	31	0	$0.00	0	$0.00
1430	I 295	20	31	0	$0.00	0	$0.00
1431	NJ 44 -Broad St.	21	33	60	$5.80	0	$0.00
1432	US 322- Commodore Barry Bridge	25	37	0	$0.00	0	$0.00
1433	Delaware Memorial Bridge	40	51	0	$0.00	0	$0.00
1434	Ferry near US 9 in CapeMay	94	105	0	$0.00	0	$0.00

Table 7.10: Auto, Bus and Rail times and costs to rest of Philadelphia County

External Station #	Road Name	Distance (mi)	Auto Time (min)	Bus Time (min)	Bus Cost ($)	Rail Time (min)	Rail Cost ($)
1401	NJ 444 - Garden State Parkway	60	84	0	$0.00	0	$0.00
1402	NJ 563- Green Bank Road	55	78	0	$0.00	0	$0.00
1403	NJ 542- Nesco Road	47	74	0	$0.00	0	$0.00
1404	US 206	39	66	0	$0.00	0	$0.00
1405	NJ 534- Jackson Road	30	55	0	$0.00	0	$0.00
1406	Jackson Medford Road	30	59	0	$0.00	0	$0.00
1407	Kettle Run Rd (Cooper Rd)	26	48	0	$0.00	0	$0.00
1408	NJ 536- Hopewell Road	25	46	0	$0.00	0	$0.00
1409	NJ 73	25	46	0	$0.00	0	$0.00
1410	US 30- White horse pike	23	43	70	$7.30	60	$8.50
1411	NJ 691 Watsontown Road	24	44	0	$0.00	0	$0.00
1412	NJ 689 Cross Keys Road	24	46	0	$0.00	0	$0.00
1413	NJ 706 Erial Road	23	44	0	$0.00	0	$0.00
1414	NJ 705 Sickerville Road	23	43	0	$0.00	0	$0.00
1415	Atlantic City Express	22	42	70	$7.30	60	$8.50
1416	NJ 42	23	42	70	$7.30	0	$0.00
1417	NJ 654- Hurfville Crosskeys Road	23	45	0	$0.00	0	$0.00
1418	NJ 651 Green Tea Road	23	46	0	$0.00	0	$0.00
1419	NJ47- Delsa Road	22	43	70	$7.30	0	$0.00
1420	NJ 553 Main St	24	45	75	$7.30	0	$0.00
1421	NJ 682 Carpenter St.	23	45	0	$0.00	0	$0.00
1422	NJ 55 Freeway	23	44	0	$0.00	0	$0.00
1423	NJ 635 Richwood Pitman Rd (Lamb Rd)	23	41	0	$0.00	0	$0.00
1424	NJ 609 Barnes Boro Road	25	45	0	$0.00	0	$0.00
1425	NJ 667Cedar Road	26	46	0	$0.00	0	$0.00
1426	NJ 45- Bridge town pike	22	45	75	$7.30	0	$0.00
1427	I 95- NJ turnpike	21	45	0	$0.00	0	$0.00
1428	NJ 551- Kings highway	23	45	75	$7.30	0	$0.00
1429	NJ 653- Paulsboro Road	22	41	0	$0.00	0	$0.00
1430	I 295	23	41	0	$0.00	0	$0.00
1431	NJ 44 -Broad St.	24	43	75	$7.30	0	$0.00
1432	US 322- Commodore Barry Bridge	28	47	0	$0.00	0	$0.00
1433	Delaware Memorial Bridge	43	61	0	$0.00	0	$0.00
1434	Ferry near US 9 in CapeMay	97	115	0	$0.00	0	$0.00

7.2.2 Methodology

The XI/IX trips by purpose estimated during the trip distribution step are first split into the external geographies based on the splits in Table 7-7. The EI Mode Choice process is then applied to the resulting trips based on the level-of-service characteristics in Tables 7-8 to 7-10. The EI Mode choice process was implemented as a multinomial logit model with the choice of auto, bus and rail. The process is applicable to XI/IX trips for the non-recreational trip purposes only. For simplicity, the mode share calculations in the logit model was specified for 'work' and 'non-work' purposes and applied based on whether the trip purpose is work-related or not, i.e., the 'work' shares were applied to the HBW and NHBW purposes and 'non-work' shares applied to the SCH, HBS, HBO and NWK purposes.

A time coefficient of -0.03 and cost coefficient of -0.0024 was used for the work purposes whereas a time coefficient of -0.02 and cost coefficient of -0.0016 was used for the non-work purposes. Same set of coefficients were used for all modes. The transit out-of-vehicle time determined from the transit skims were weighted by 1.5 (same weight applied to transit pathbuilding of I-I trips) and added to in-vehicle time to calculate total transit travel times. All computations related to transit were performed for both the walk and drive access modes. The final output of this process are trip tables segregated by auto (drive-alone), walk-bus, drive-bus, walk-rail and drive-rail after the modal trips from all three external geographies are combined together. This combined EI modal trip table is then added to the I-I modal trip table for the highway and transit assignments.

7.2.3 Validation Results

Table 7-11 shows a comparison of the EI trip estimates by the model by geographic region in comparison to the targets developed from transit ridership data obtained from NJ Transit. It can be seen that the results look reasonable.

Table 7.11: 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%**

8 Temporal Model

Due to the presence of the shore communities of Atlantic and Cape May Counties and especially the attraction of Atlantic City casinos, the SJTPO region has high seasonal and daily variation in traffic. Therefore the previous version of the SJTDM accounted for this variation via the provision of a 'temporal' model that could develop an estimate of travel demand for summer and winter for both weekday and weekend conditions.

The trips estimated by the model via the trip generation, distribution and mode choice step are developed for a 'full-activity' day, which is a hypothetical day in which each trip purpose produces the maximum number of trips. The temporal model applies seasonal factors, day of week factor and time of day factors (together referred to as 'temporal factors' in this chapter) to the mode choice output trip tables to develop trip tables by mode by time period which are then assigned to the highway and transit networks. These trips represent a user-defined analysis day which could be the combination of any month and any day of the week (weekday, Friday, Saturday or Sunday) for a total of 48 possible combinations. This chapter discusses the details of the temporal model.

8.1 Temporal Factors

Since no recent survey data was available to update the temporal factors, these were carried forward from the previous model. The only modification to the factors was related to the trip purpose modifications, i.e. for trip purposes that were combined, the temporal factors were averaged. Table 8-1 summarizes the source of the hourly distributions used for each "source day" for each purpose.

Table 8.1: Data Sources for Full-activity Day Hourly Distributions

Trip Purpose	Purpose Code	Full-Activity Day	Source of Hourly Data
Home Based Work	HBW	September Weekday	Berks Household Survey
Home Based Shop	HBS	September Weekday	Berks Household Survey
Home Based Other	HBO	September Weekday	Berks Household Survey
Home Based School	SCH	September Weekday	Berks Household Survey
Non-home Based Work	NHBW	September Weekday	Berks Household Survey
Non-home Based Non-work	NWK	September Weekday	Berks Household Survey
Heavy Truck	TRK	December Weekday	1991 Truck O/D Survey, Lincoln/Holland Tunnels & GW
Commercial Truck	COM	December Weekday	1991 Truck O/D Survey, Lincoln/Holland Tunnels & GW
Casino Access	CAC	July Saturday	
Event Access	EAC	July Weekday	
Shore Access	BAC	August Saturday	NJ Beach Travel Survey
Shore Visit	SHV	August Saturday	NJ Beach Travel Survey
Seasonal Work	SWK	August Saturday	
Casino Bus Access	CBS	July Weekday	SJTA

Table 8-2 summarizes the daily variations in trip purposes, while Table 8-3 summarizes the monthly variations.

Table 8.2: Daily Factors by Trip Purpose

Trip Purpose	Purpose Code	Day-to-Day Adjustment Factors			
		Weekday	Friday	Saturday	Sunday
Home Based Work	HBW	1.0000	1.0148	0.4815	0.3031
Home Based Shop	HBS	1.0000	1.1967	1.3579	0.8052
Home Based Other	HBO	1.0000	1.0148	0.4815	0.3031
Home Based School	SCH	1.0000	1.0000	0.2144	0.0656
Non-home Based Work	NHBW	1.0000	1.0148	0.4815	0.3031
Non-home Based Non-work	NWK	1.0000	1.0148	0.4815	0.3031
Heavy Truck	TRK	1.0000	1.0148	0.4815	0.3031
Commercial Truck	COM	1.0000	1.0148	0.4815	0.3031
Casino Access	CAC	0.6896	0.9046	1.0000	0.8033
Event Access	EAC	1.0000	1.0000	1.0000	1.0000
Shore Access	BAC	0.5665	0.9000	1.0000	0.4903
Shore Visit	SHV	0.4016	0.4422	1.0000	0.9998
Seasonal Work	SWK	0.4453	0.6238	1.0000	0.9997
Casino Bus Access	CBS	1.0000	1.3118	1.4501	1.1649

Table 8.3: Monthly Factors by Trip Purpose

Trip Purpose	Purpose Code	Month-to-Month Adjustment Factors											
		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Home Based Work	HBW	1.1546	1.1386	1.0821	1.0213	0.9861	0.9574	0.9488	0.9360	1.0000	1.0128	1.0128	1.0288
Home Based Shop	HBS	0.8998	0.8238	0.9705	0.9831	1.1118	1.1181	1.0633	1.0770	1.0000	1.0432	1.0707	1.5386
Home Based Other	HBO	1.1546	1.1386	1.0821	1.0213	0.9861	0.9574	0.9488	0.9360	1.0000	1.0128	1.0128	1.0288
Home Based School	SCH	1.0000	1.0000	1.0000	1.0000	0.9188	0.4594	0.0520	0.0860	1.0000	1.0000	1.0000	1.0000
Non-home Based Work	NHBW	1.1546	1.1386	1.0821	1.0213	0.9861	0.9574	0.9488	0.9360	1.0000	1.0128	1.0128	1.0288
Non-home Based Non-work	NWK	1.1546	1.1386	1.0821	1.0213	0.9861	0.9574	0.9488	0.9360	1.0000	1.0128	1.0128	1.0288
Heavy Truck	TRK	1.1223	1.1067	1.0518	0.9928	0.9585	0.9306	0.9223	0.9098	0.9720	0.9845	0.9845	1.0000
Commercial Truck	COM	1.1223	1.1067	1.0518	0.9928	0.9585	0.9306	0.9223	0.9098	0.9720	0.9845	0.9845	1.0000
Casino Access	CAC	0.7641	0.7325	0.8157	0.7388	0.7639	0.7687	1.0000	0.8918	0.8253	0.8333	0.7528	0.7762
Event Access	EAC	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Shore Access	BAC	0.0109	0.0266	0.0898	0.1625	0.3564	0.5740	0.9301	1.0000	0.4347	0.1805	0.0751	0.0448
Shore Visit	SHV	0.0109	0.0266	0.0898	0.1625	0.3564	0.5740	0.9301	1.0000	0.4347	0.1805	0.0751	0.0448
Seasonal Work	SWK	0.0109	0.0266	0.0898	0.1625	0.3564	0.5740	0.9301	1.0000	0.4347	0.1805	0.0751	0.0448
Casino Bus Access	CBS	0.6332	0.8071	0.9969	0.9640	1.0026	1.0061	1.0000	1.0425	0.9922	1.0391	0.9811	0.7723

The daily and monthly factors as a function of the source day factors are shown in Figures 8-1 to 8-7 for selected trip purposes.

Figure 8.1: Daily and Monthly Factors – HBW (Home to Work)

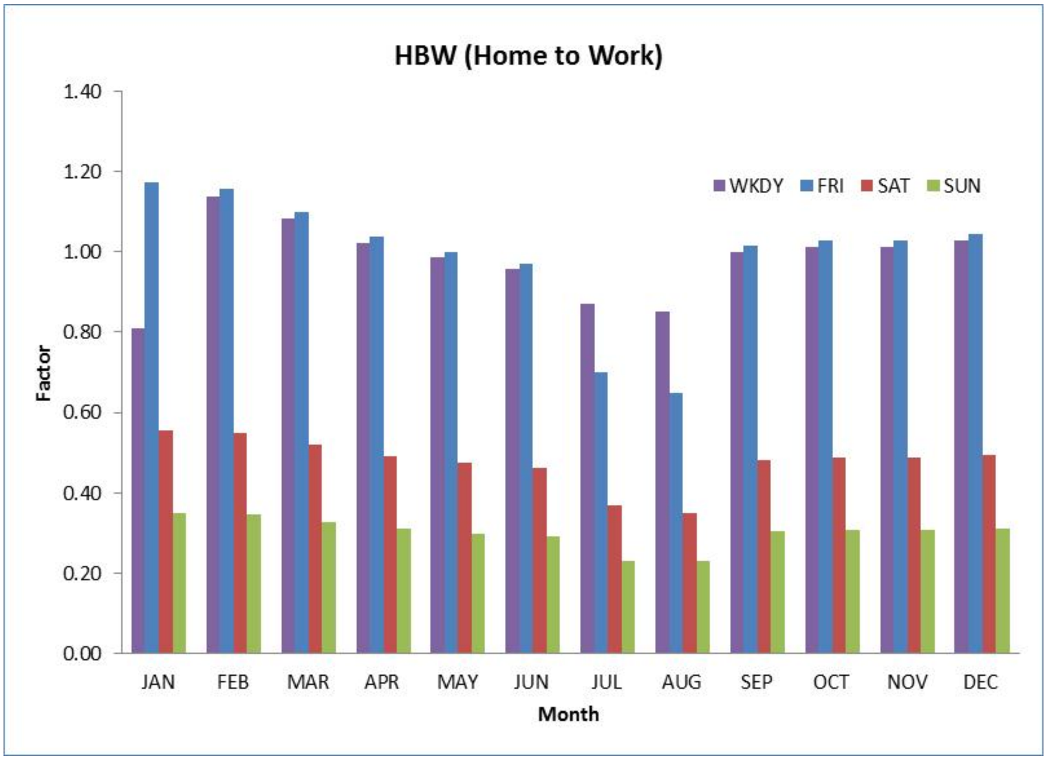


Figure 8.2: Daily and Monthly Factors – HBW (Work to Home)

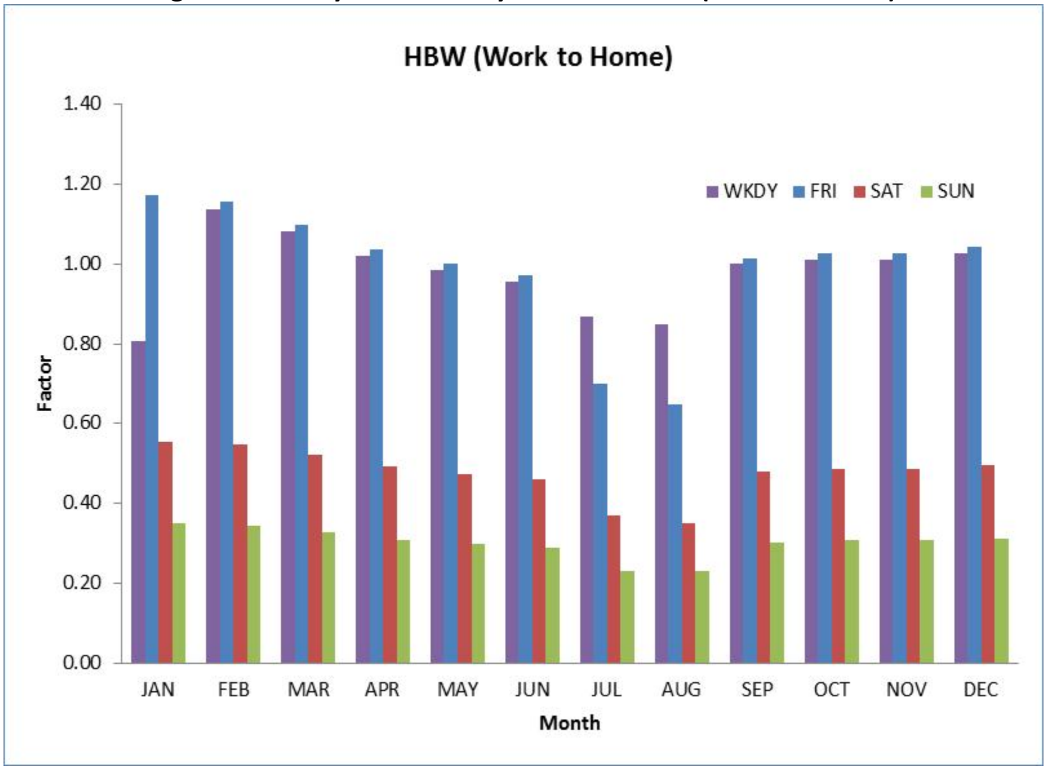


Figure 8.3: Daily and Monthly Factors – HBS (Home to Shop)

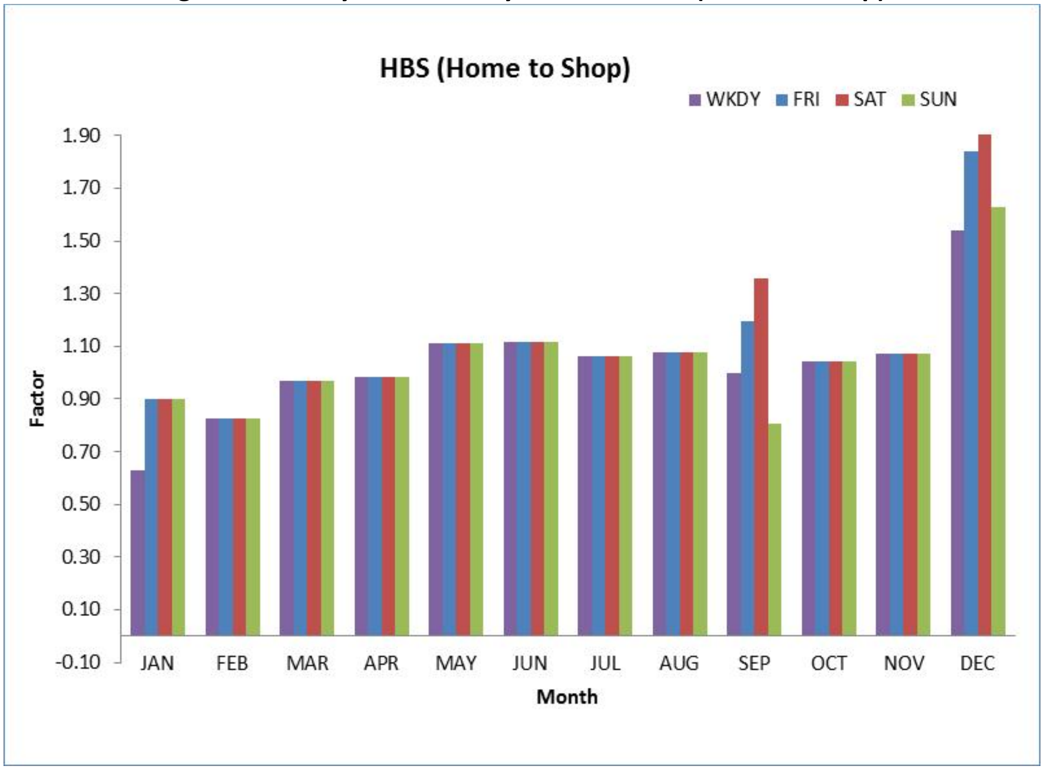


Figure 8.4: Daily and Monthly Factors – HBS (Shop to Home)

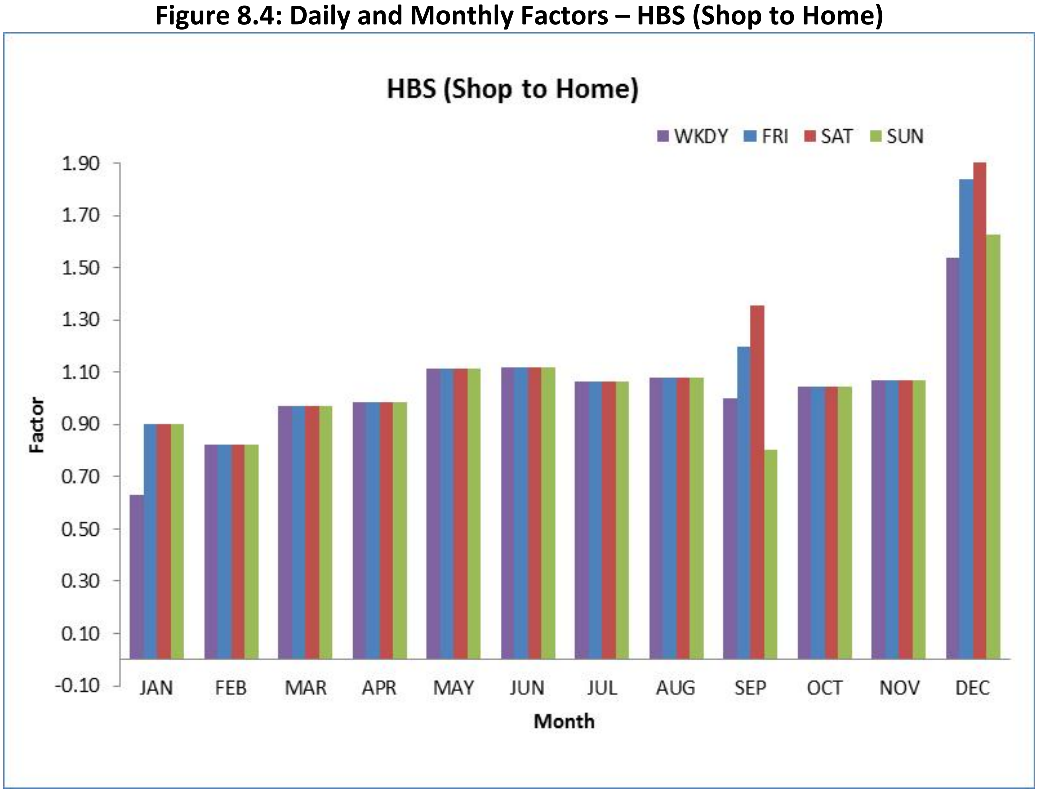


Figure 8.5: Daily and Monthly Factors – CAC (Home to Casino)

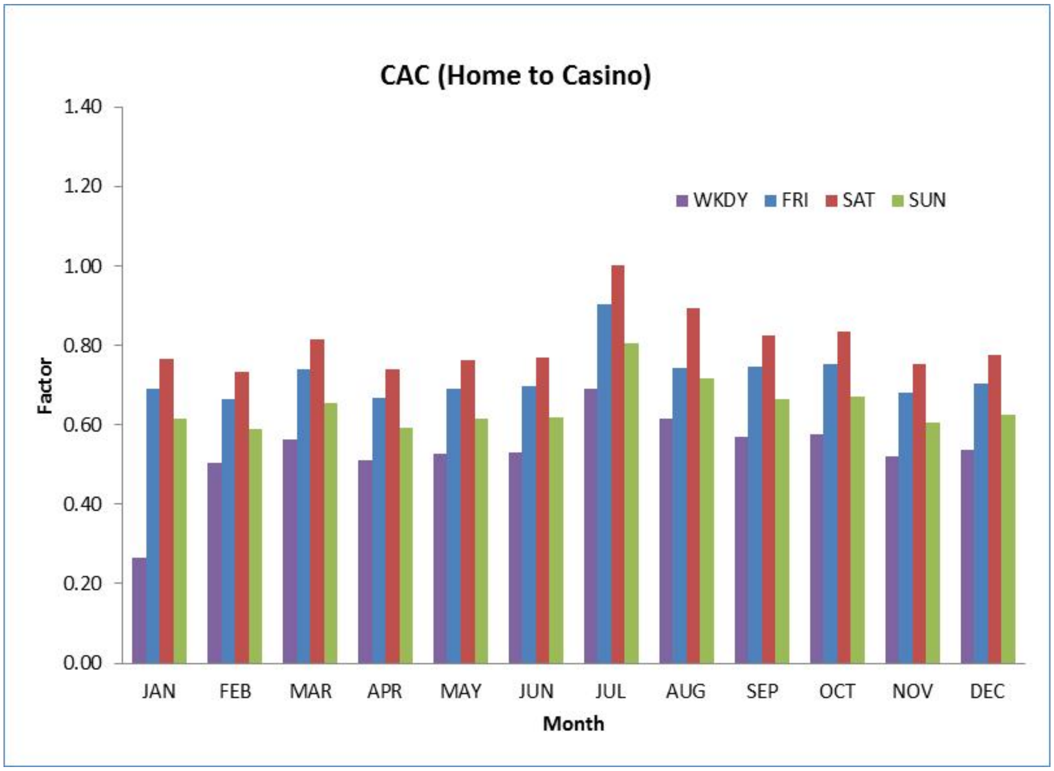


Figure 8.6: Daily and Monthly Factors – CAC (Casino to Home)

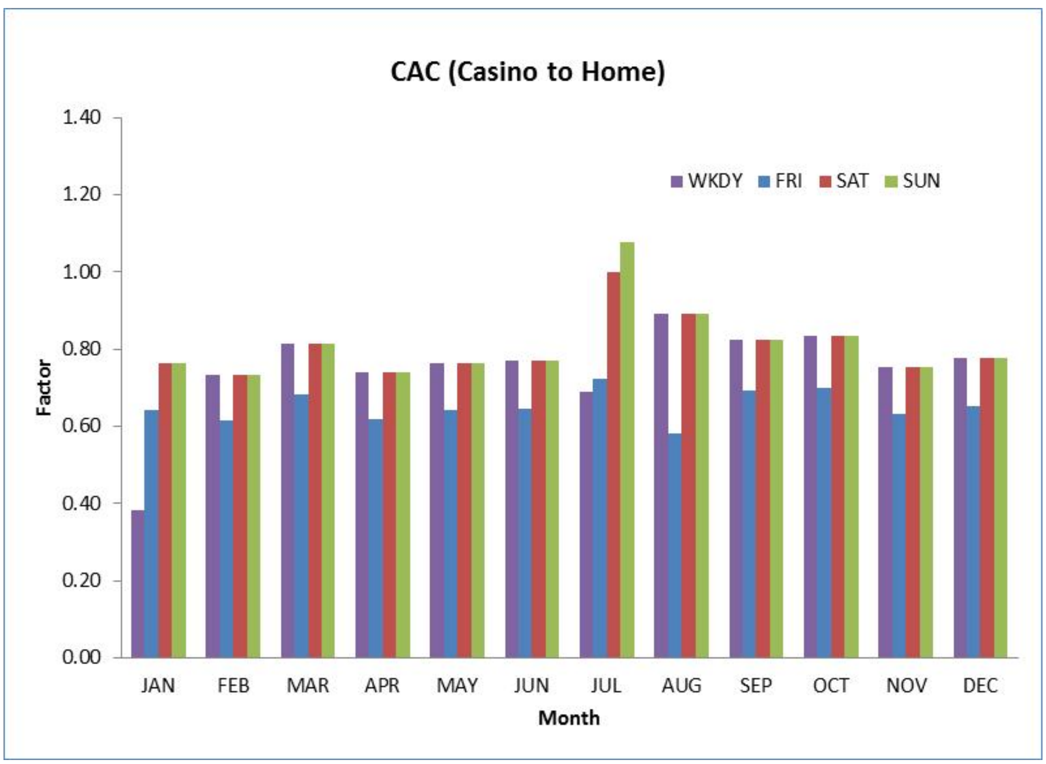
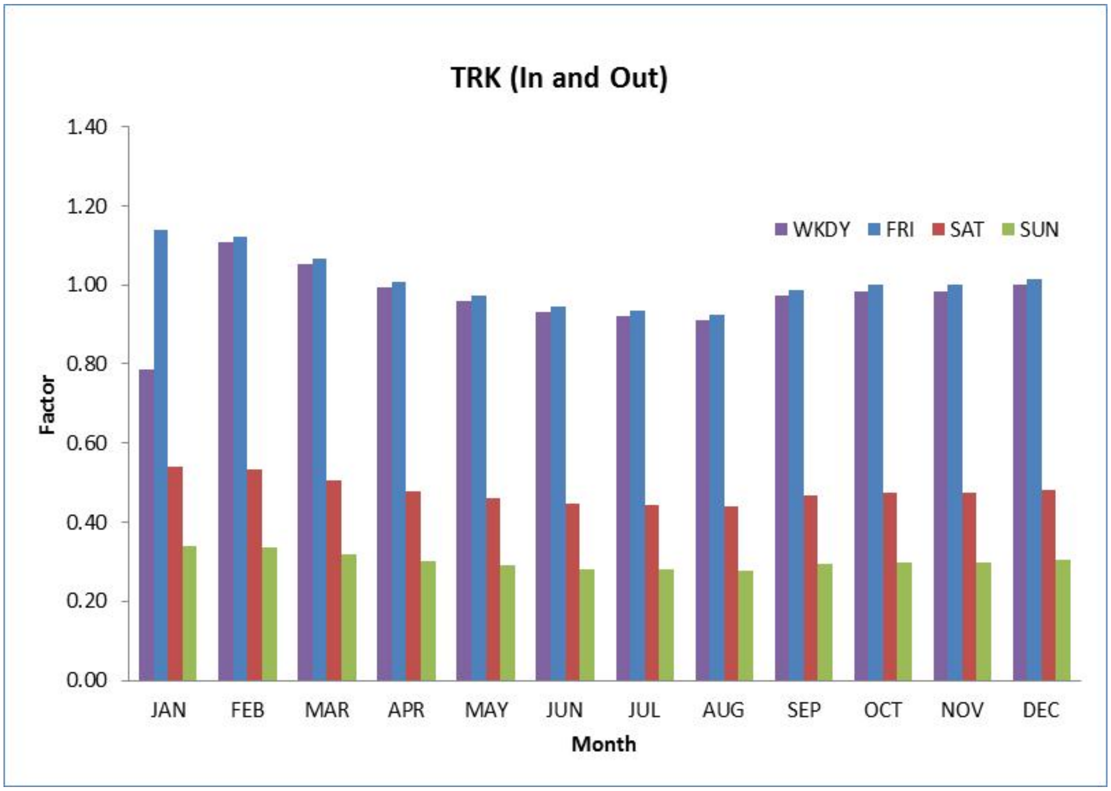


Figure 8.7: Daily and Monthly Factors – TRK (In and Out)



8.2 Application of Temporal Model

The primary inputs to the temporal model are the trip tables output from the mode choice step namely the daily vehicle trip tables by purpose by auto and carpool and the daily transit person trip tables by purpose by bus and rail and by walk-access and drive-access. The temporal factors are applied to each trip purpose by direction (production to attraction and attraction to production). The four time periods into which the vehicle trip tables are split are: AM peak (6 - 9 AM), midday (9 AM - 3 PM), PM peak (3 - 7 PM), and night (12 AM - 6 AM and 7 PM to 12 AM). The resulting vehicle trip tables are then grouped into three purposes: HBW, HBO and NHB in preparation for the toll diversion highway assignment. Table 8-4 shows the grouping of the trip purposes. The resulting transit person trip tables are grouped together as one purpose by the four modes namely walk-bus, drive-bus, walk-rail and drive-rail.

Table 8.4: Vehicle Trip Table Purpose Grouping

Purpose Category	Trip Purpose	Purpose Category	Trip Purpose	Purpose Category	Trip Purpose	Purpose Category	Trip Purpose	Purpose Category	Trip Purpose
			HBS						
			HBO		NHBW				
			SCH		NWK				
HBW	HBW	HBO	CAC	NHB	CVT	Commercial	COMM	Truck	TRK
	SWK		EAC		EVT				
			BAC		SHV				
			DAC						
			CBS						

8.3 Validation Results

A check of the reasonableness of the temporal model is a comparison of the % trips by time period in comparison to the observed traffic counts by time period. Since the counts were performed for the months of May and August, this comparison was done for these months. Table 8-5 presents a comparison of the % counts by time period from the model and observed count data, which looks reasonable.

Table 8.5: Comparison of trips by time period: model vs observed

Period	May		August	
	Model	Observed	Model	Observed
AM	16%	15%	15%	13%
MD	38%	36%	38%	36%
PM	25%	28%	25%	28%
NT	21%	21%	22%	23%
Daily	**100%**	**100%**	**100%**	**100%**

9 Peak Hour Model

For typical analysis purposes, the development of peak period trip tables as described in the previous chapter is sufficient. However, there may be applications where the analysis of travel in the peak hour is needed. Therefore, the SJTDM's temporal model includes factors by trip purpose to convert daily trip tables into AM and PM peak hour trips which can then be used to perform AM and PM peak hour highway assignments. These factors have been carried forward from the previous model and were developed from a variety of sources as mentioned in Table 8-1. The need for this peak hour model is most likely to be limited to highway vehicle trips and therefore this process was applied only to vehicle trips and not to transit trips. Figures 9-1 to 9-9 illustrate the hourly distribution of traffic for selected trip purposes.

Figure 9.1: Hourly Distribution - HBW (Direction: Home to Work)

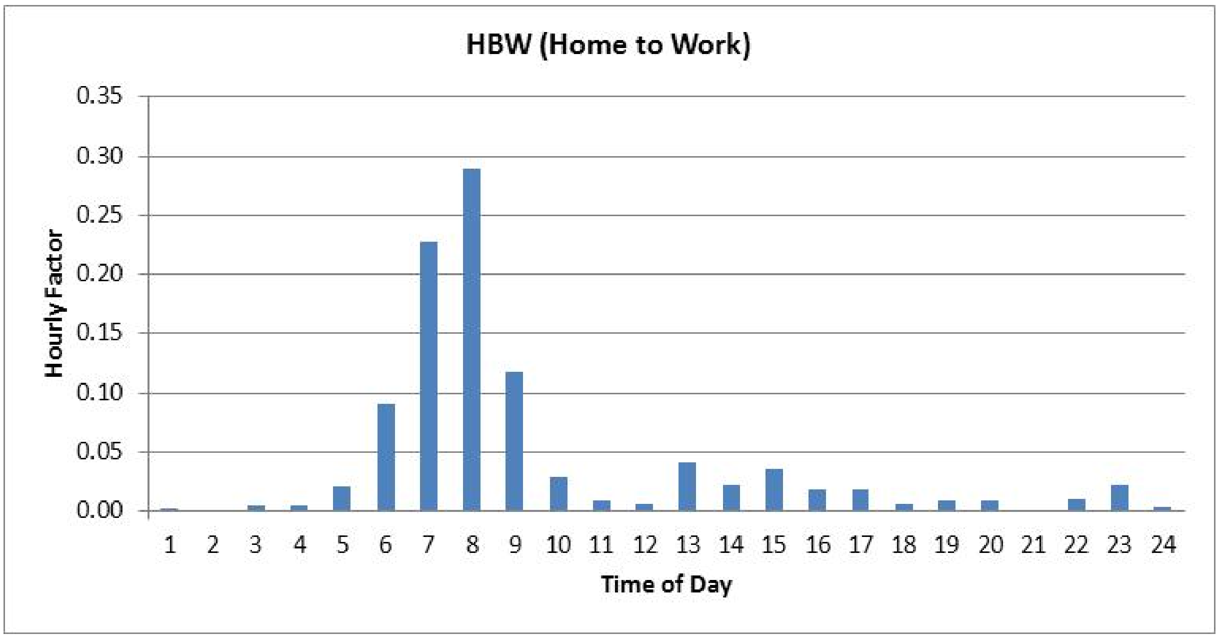


Figure 9.2: Hourly Distribution - HBW (Direction: Work to Home)

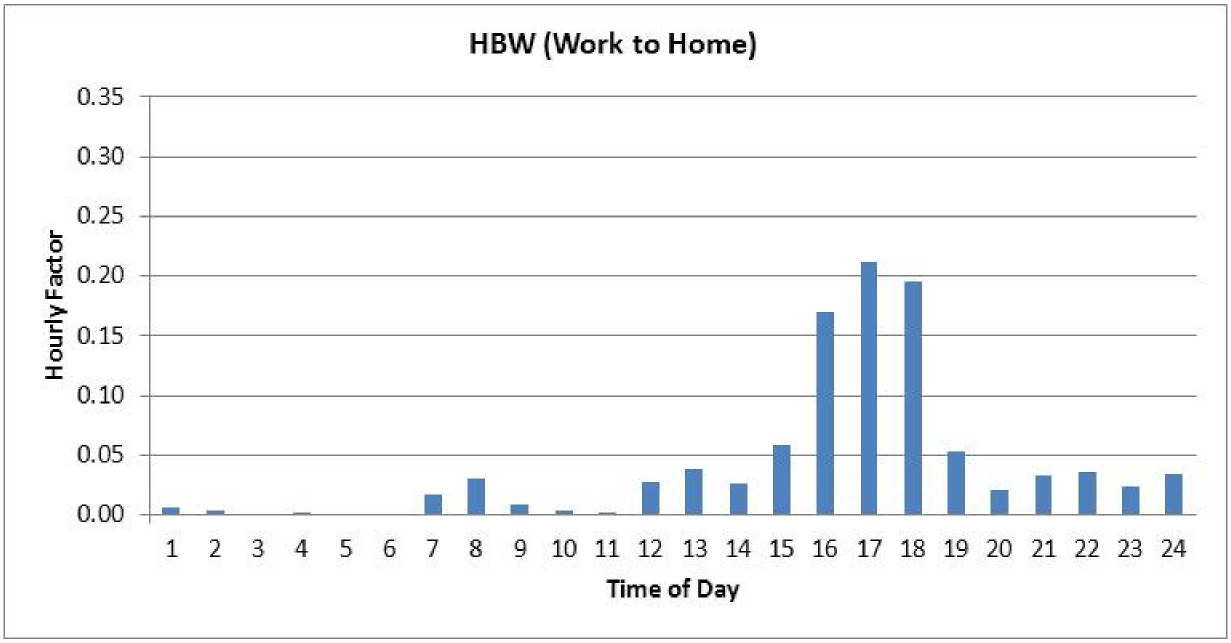


Figure 9.3: Hourly Distribution - HBS (Direction: Home to Shop)

Figure 9.4: Hourly Distribution - HBS (Direction: Shop to Home)

Figure 9.5: Hourly Distribution - CAC (Direction: Home to Casino)

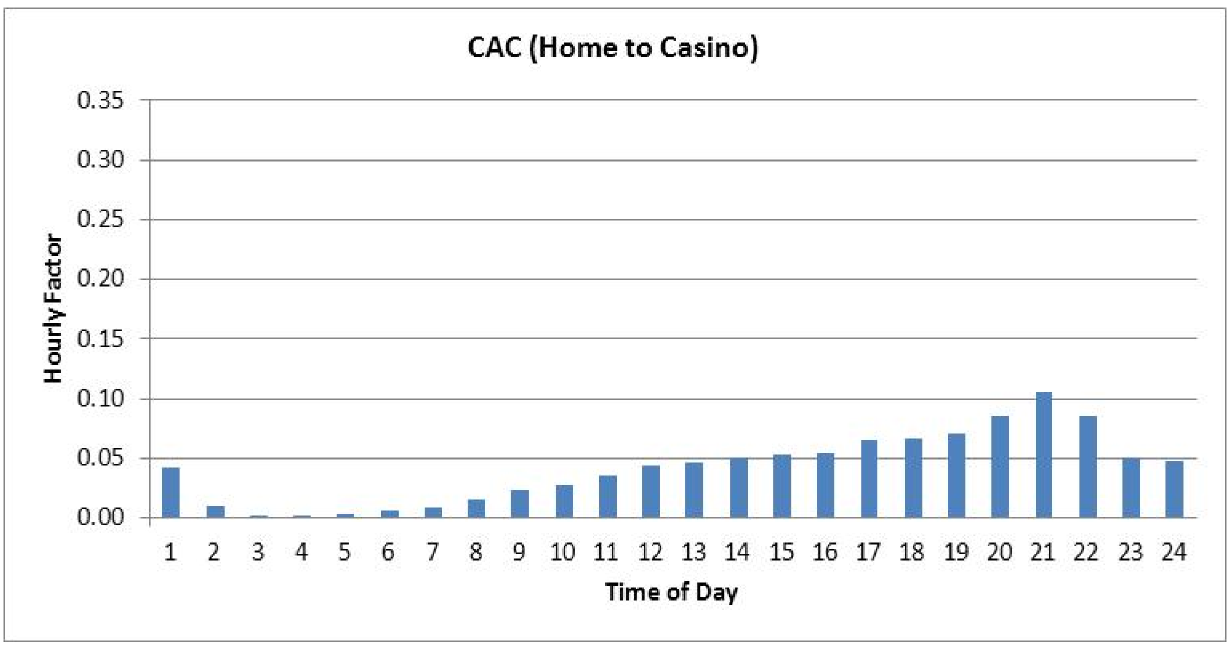


Figure 9.6: Hourly Distribution - CAC (Direction: Casino to Home)

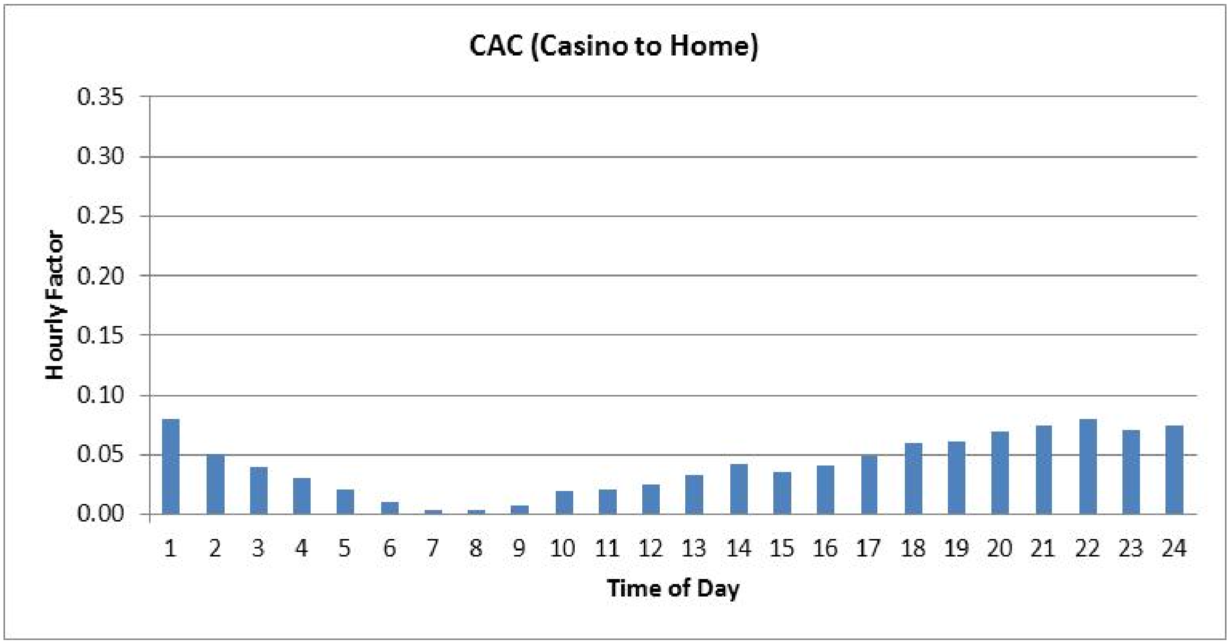


Figure 9.7: Hourly Distribution - EAC (Direction: Home to Event)

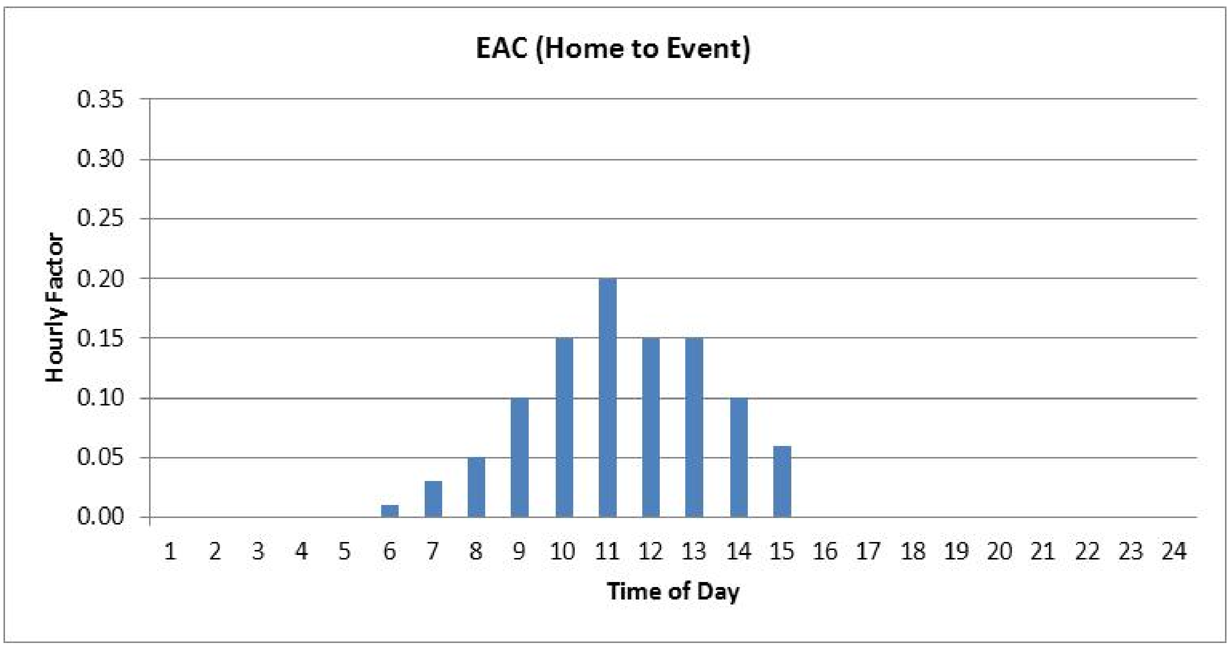


Figure 9.8: Hourly Distribution - EAC (Direction: Event to Home)

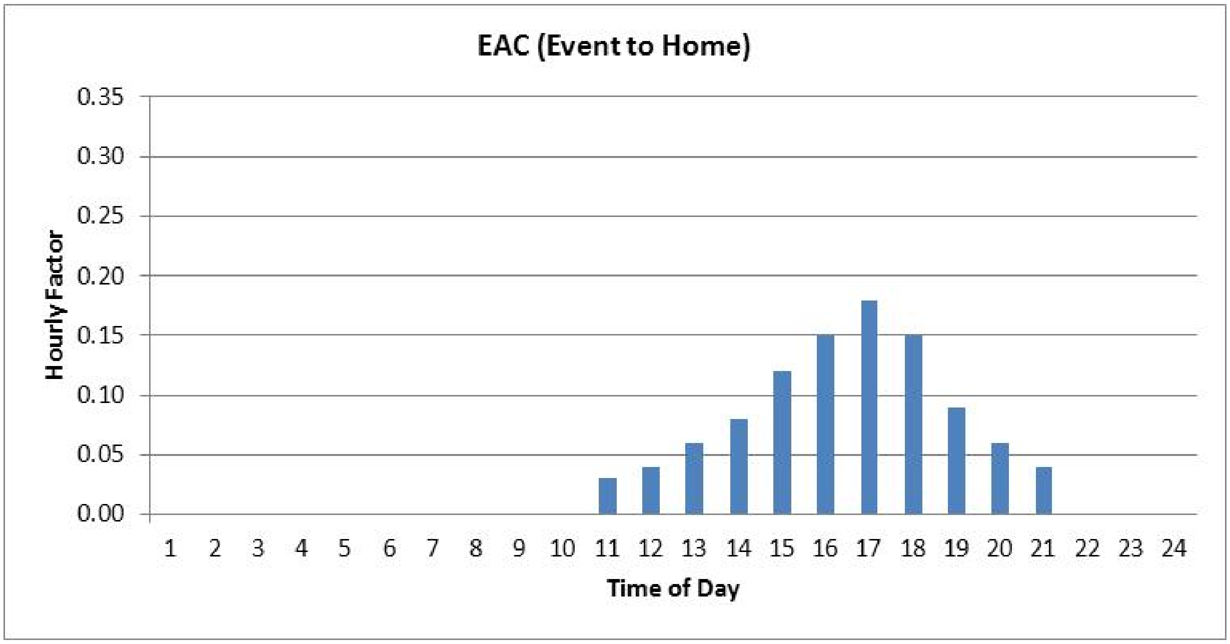
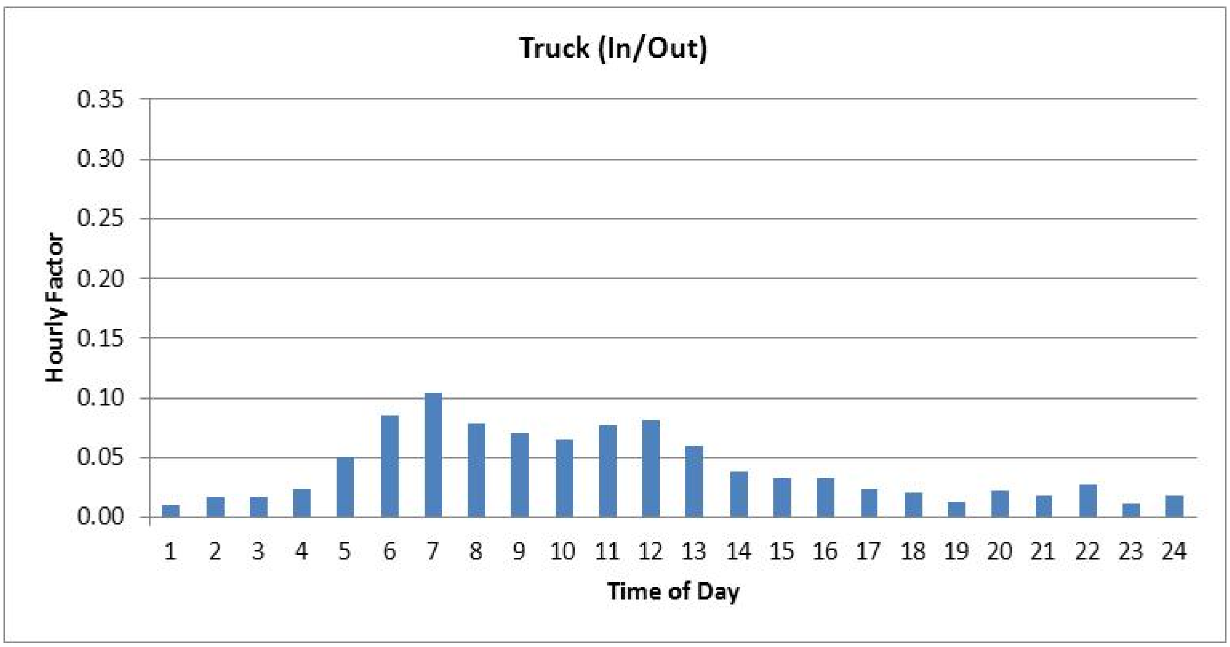


Figure 9.9: Hourly Distribution - Truck (Direction: In and Out)



10 Highway Assignment

Highway Assignment is the step in which the vehicle trip tables are loaded onto the highway network to produce link volumes. This chapter discusses the data collected for validating the results of highway assignment, the newly implemented advanced toll diversion process and the validation results.

10.1 Data Sources

The primary source of data for validating the highway assignment step is traffic counts. As part of the South Jersey Model Improvements project, an extensive data collection effort was undertaken to compile traffic counts. The following sections provide details on this effort.

10.1.1 Automatic Traffic Recorder (ATR) counts

The link traffic volumes generated from the traffic assignment step are typically compared with the observed counts along 'screenlines' which are imaginary lines that capture major movements. For the SJTDM, nine screenlines were developed to serve this purpose and are shown in Figure 10-1. It is required that as many traffic counts as possible be available along screenlines. Therefore, after a review of the available traffic counts along the screenlines, locations where counts were not available were identified as those where ATR counts should be performed.

ATR counts were performed at 44 locations by direction over mostly 7 days during Spring of 2011 and Summer of 2011. The following provides a summary of this data collection effort:

- Spring Counts in May 2011
    - Conducted between May 16th and May 23rd
    - 7-days counts (31 locations)
    - 7-days classified counts (2 locations)
    - 2-days counts (11 locations)
- Summer Counts in August 2011
    - Conducted between August 16th and August 23rd
    - 7-days counts (42 locations)
    - 7-days classified counts (2 locations)

Figure 10-2 illustrates the Spring ATR count locations and the Summer count locations are shown in Figure 10-3. The count data were processed and summarized for the model validation task by developing an average of weekday counts (mostly excluding Mondays and Fridays). Separate count data sets were developed for Spring and Summer. The counts were also summarized by the four time periods in the SJTDM namely, AM peak, Mid-day, PM peak and Night.

Figure 10.1: Screenline Locations

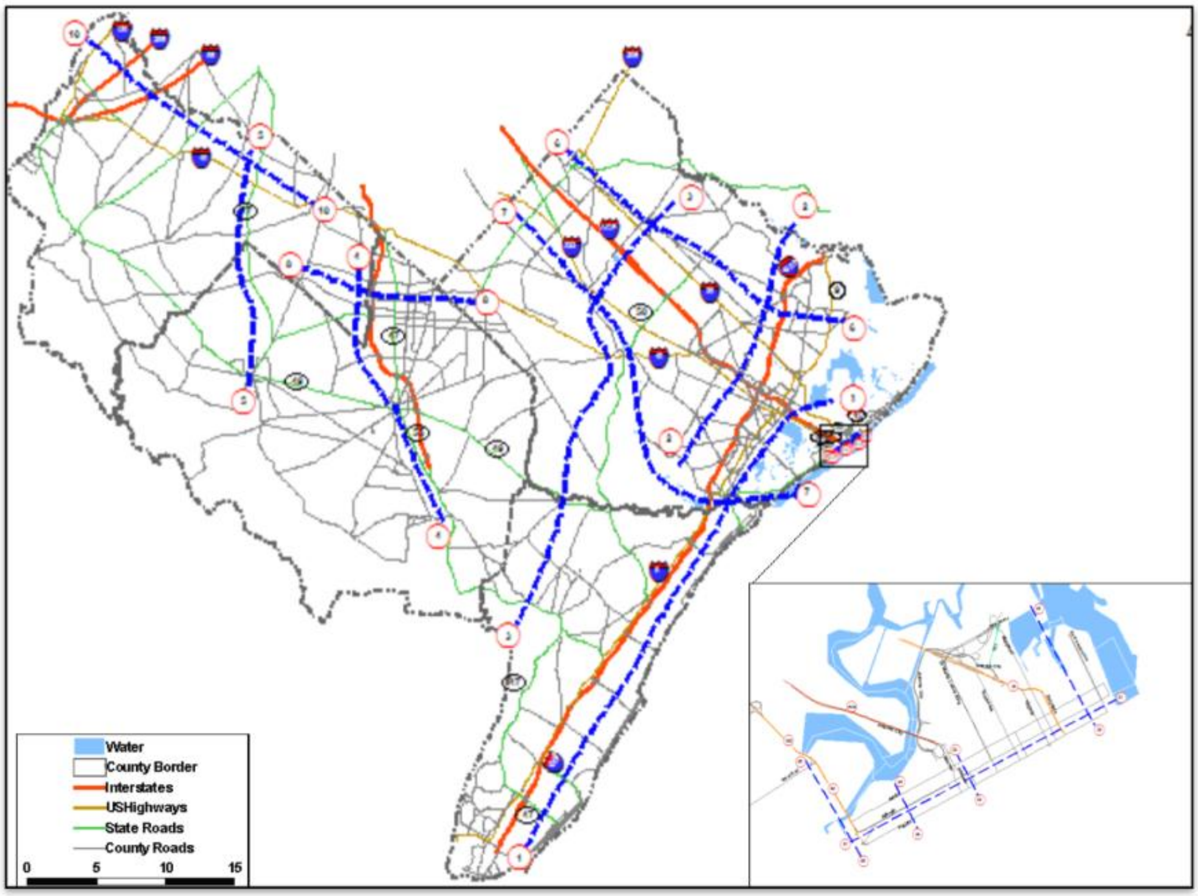


Figure 10.2: Spring ATR Count Locations

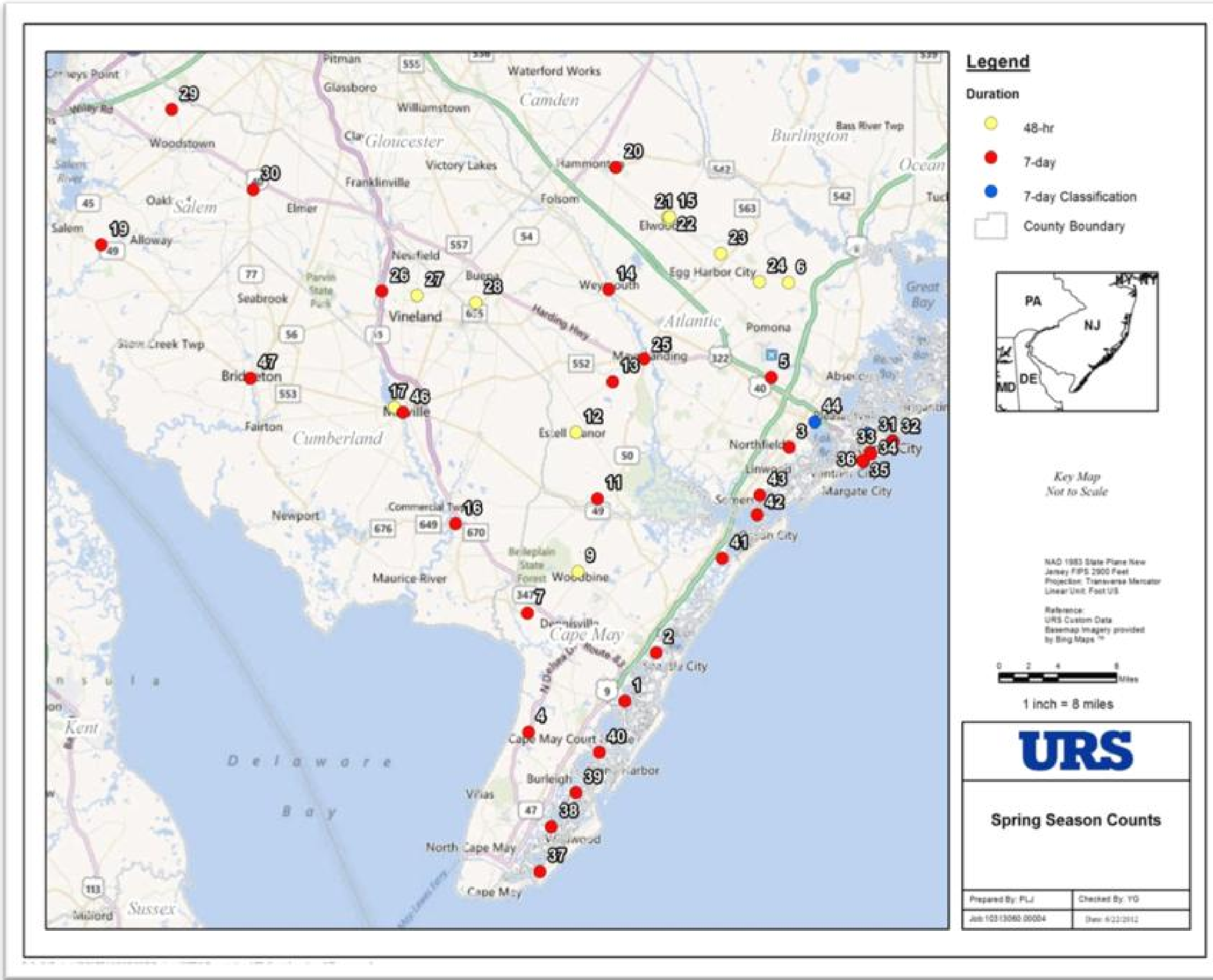
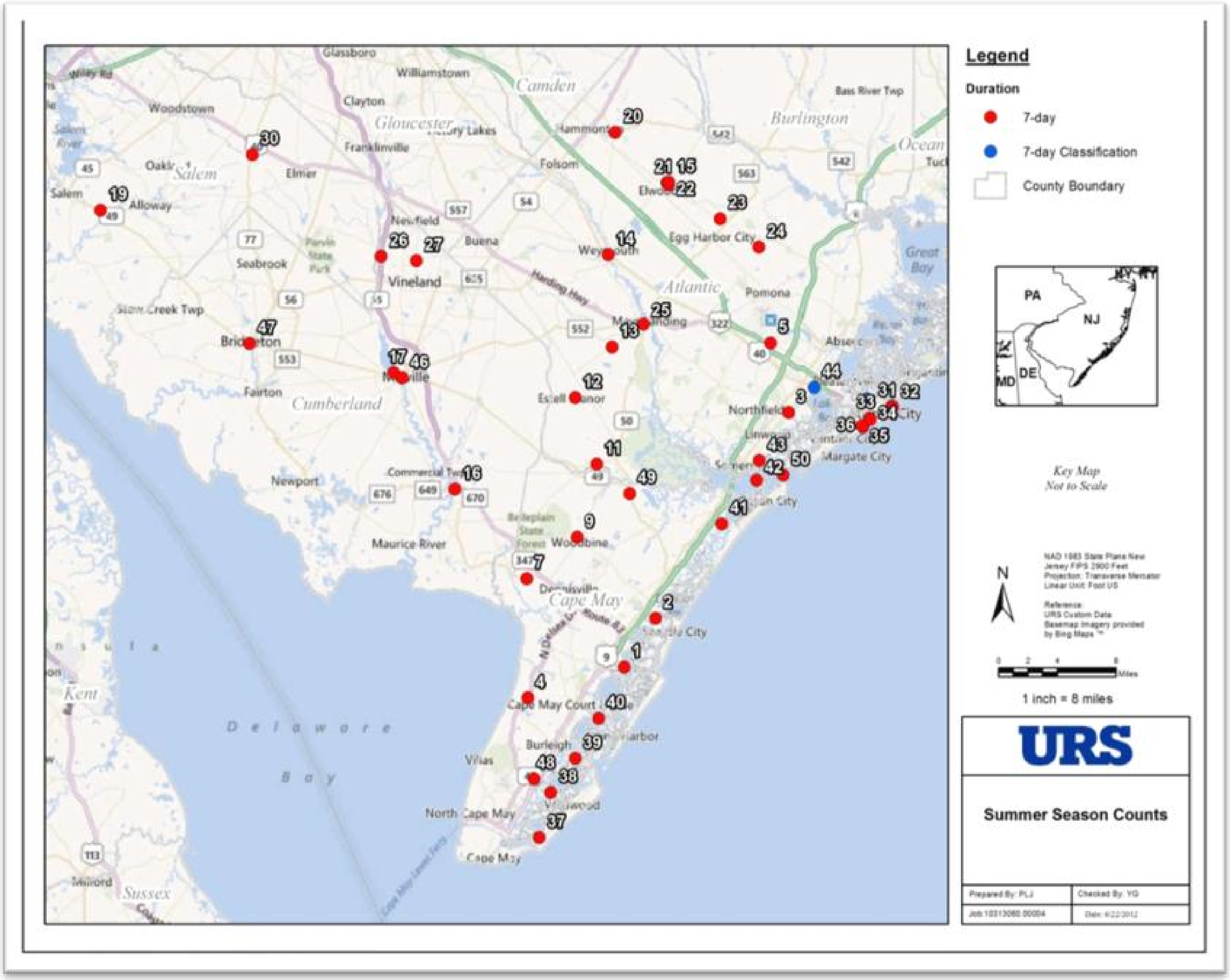


Figure 10.3: Summer ATR Count Locations



10.1.2 Other traffic count sources

The ATR counts were performed at those screenline locations where recent traffic counts were not available. Some of the sources from which recent traffic counts were obtained are NJDOT, NJ Turnpike Authority (for counts along NJ Turnpike and Garden State Parkway), South Jersey Transportation Authority (Atlantic City Expressway counts), Counties and City of Atlantic City. The counts extracted from these sources were primarily average annual daily traffic (AADT) by direction.

10.1.3 Travel Time Runs

Besides performing validation of the traffic volumes, speeds estimated by the model also needs to be reasonable. Therefore, several corridors were identified where travel time runs should be performed. These are shown in Figure 10-4 and Table 10-1 for the Spring runs. Similar information is shown in Figure 10-5 and Table 10-2 for the Summer runs. The Spring runs were conducted between May 18th and June 16th, 2011. The Summer runs were conducted between September 3rd and 4th, 2011. The runs were conducted between 7 AM and 6 PM.

Figure 10.4: Spring Travel Time Run Corridors

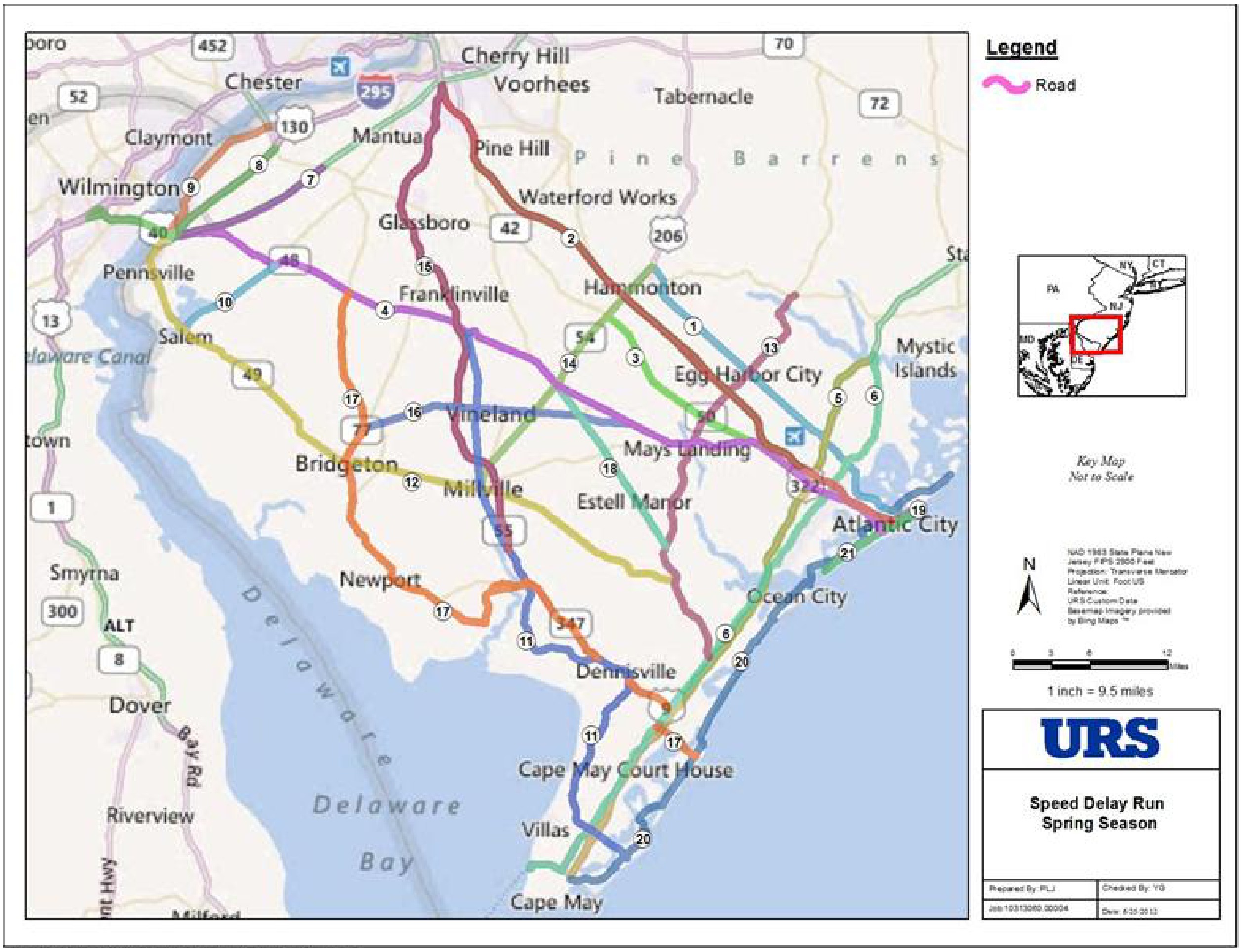


Table 10.1: Spring Travel Time Run Corridors

Serial Number	Road No.	Road name	Starting Point	Ending Point	Approx. Distance (mi)
1	US-30	White Horse pike	NJ 54 / US 206 near Hammonton	Pacific ave., Atlantic City	30.00
2	NJ 42 (ACE)	Atlantic City Express	NJ 55 near Glendora	Pacific ave., Atlantic City	42.80
3	US 322	Black Horse pike	NJ 54 near Folsam	US 40 Hamilton Mall	15.50
4	US 40	Harding Highway	Memorial Bridge Over Delaware River	Pacific ave., Atlantic City	65.00
5	GSP	Garden State Parkway	US 9 near Collins Cove near Republic	Ocean Dr, CapeMay Harbour	49.20
6	US9	Main St/Shore Rd/New Rd	GSP near Collins Cove near Republic	CapeMay Lewes	50.60
7	I 95	NJ Turn Pike	Auburn Rd, Auburn	Memorial Bridge Over Delaware River	12.00
8	I 295		Perkin Town Rd near Pedriktown	Memorial Bridge Over Delaware River	10.50
9	US130	Shell Rd/ Virginia ave	Perkin Town Rd near Pedriktown	Memorial Bridge Over Delaware River	9.20
10	NJ 45	Kings Highway	US 40 near Woodstown	NJ 49 near Salem city	11.80
11	NJ 47	Delsa Dr	US 40 near Malga	Ocean ave, Wildwood	51.40
12	NJ 49		NJ 50 near Tuckohoe	Memorial Bridge Over Delaware River	54.25
13	NJ 50		Clarks landing Rd near Weekstown	US 9 near Seaville	32.80
14	NJ 54		Chew Rd, Hammonton Airport	NJ 55 near Millville	22.20
15	NJ 55		NJ 42 near Glendora	NJ 47 near Port Elizabeth	30.60
16	NJ 56	Landis Rd	US 40 near Mizpah	NJ 77 & CR 611 meeting	19.90
17	NJ77-CR609-CR553-CR676-Highland St.-CR 649-CR670-NJ347-NJ47-NJ83-US9-CR601		US 40 near Daretown	Via 1-NJ 49 near Bridgeton Via 2-NJ 47 near Maurice town Ending at Avalon ave near Avalon	57.44
18	CR 557	Tuckahoe Rd	NJ 50 near corbin city	US 40 near Vineland- Downstown airport	15.90
19	Baltic ave & Fair mount ave	Baltic ave & Fair mount ave	N Maine ave near Absecon inlet	N Hartford ave near AC Hilton Casino	2.58
20	CR 621- CR 619- NJ 152- Ventor ave- Atlantic		GSP near 7 th ave near CapeMay Harbour	14 th St.N near Brigantine	46.74
21	Pacific ave (Atlantic city) & Atlantic ave(Margarate city)	Pacific ave & atlantic ave	S New Hampshire ave near Absecon inlet	S 11th ave near Longport	7.50

Figure 10.5: Summer Travel Time Run Corridors

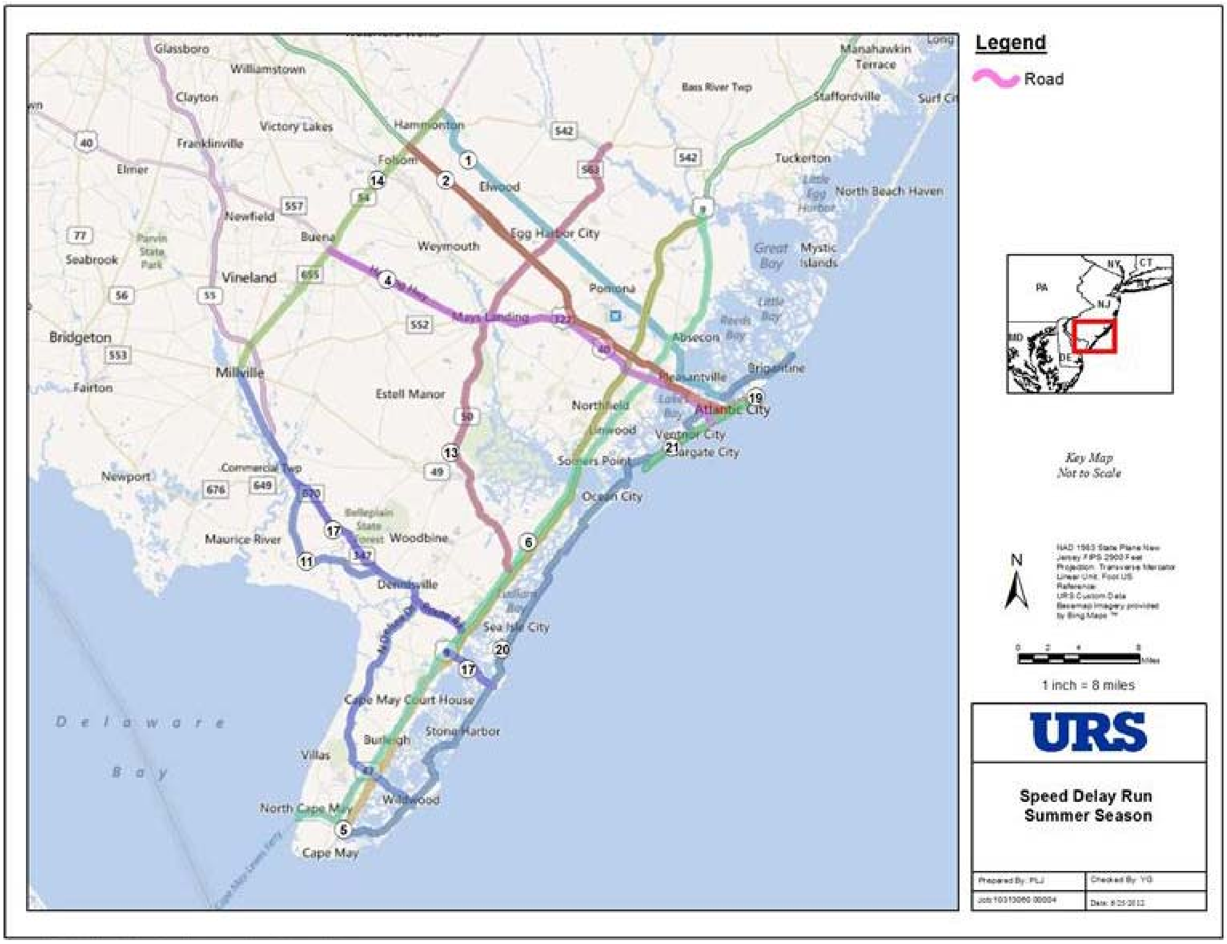


Table 10.2: Summer Travel Time Run Corridors

Serial Number	Road No.	Road name	Starting Point	Ending Point	Approx. Distance (mi)
1	US-30	White Horse pike	NJ 54 / US 206 near Hammonton	Pacific ave., Atlantic City	30.00
2	NJ 42 (ACE)	Atlantic City Express	NJ 54 / US 206 near Folsom	Pacific ave., Atlantic City	25.68
3	US 40	Harding Highway	US 54 near Buena	Pacific ave., Atlantic City	29.25
4	GSP	Garden State Parkway	US 9 near Collins Cove near Republic	Ocean Dr, CapeMay Harbour	49.20
5	US9	Main St/Shore Rd/New Rd	GSP near Collins Cove near Republic	CapeMay Lewes	50.60
6	NJ 47	Delsa Dr	US 54 near Miliville	Ocean ave, Wildwood	35.98
7	NJ 50		Clarks landing Rd near Weekstown	US 9 near Seaville	32.80
8	NJ 54		Chew Rd, Hammonton Airport	NJ 55 near Millville	22.20
9	NJ347-NJ47-NJ83-US9-CR601		NJ 47 near Leesburg	Avalon ave near Avalon	22.98
10	Baltic ave & Fair mount ave	Baltic ave and Fair mount ave	N Maine ave near Absecon inlet	N Hartford ave near AC Hilton Casino	2.58
11	CR 621- CR 619- NJ 152- Ventor ave- Atlantic ave- MLK- NJ 87		GSP near 7 th ave near CapeMay Harbour	14 th St.N near Brigantine	46.74
12	Pacific ave (Atlantic city) & Atlantic ave(Margarate city)	Pacific ave & atlantic ave	S New Hampshire ave near Absecon inlet	S 11th ave near Longport	7.50

10.2 Toll Diversion Assignment Methodology

The toll diversion model is basically a route choice model that is built into the traffic assignment step that allows the model to partition the trips between the best tolled route and the best non-tolled route for a given origin-destination zonal pair in each iteration of the equilibrium highway assignment process. The SJTDM's toll diversion process is structured as a binary logit model for each of the four trip modes in the model's highway assignment step – Drive-Alone, Carpool, Commercial Vehicles and Trucks and for each of the individual trip purposes for the Drive-Alone and Carpool modes (HBW, HBNW and NHB). The probability of selecting a toll road would be based on a utility function that estimates the tradeoff between travel time savings and the associated toll costs and also considers other travelers characteristics such as income. The model is structured to enable market segmentation by payment type (ETC, cash/video-tolling). The probability of choosing a toll path in the advanced toll diversion model is as follows:

Toll Share = 1/ (1 + e α*ΔT + b*Cost/ln(Inc) + c + etcbias)

where:

e = Base of natural logarithm (ln)

ΔT = time saving between toll road and non-toll road travel, in minutes

Cost = toll cost in dollars

Inc = median zonal annual household income

α = time coefficient

b = cost coefficient

c = toll road bias constant

etcbias = bias towards selecting toll routes with ETC payment

In the logit equation, the relationship between the 'α' and 'b' coefficients creates an implied value of time, i.e. VOT ($/hour) = [α/{b/ln(Inc)}]*60. These were determined to be in the range of $11 to $17 per hour for auto trips, assuming an average household income of $60,000 for the SJTPO region. The value of time is typically within the range of 50 to 70 percent of the average wage rate. For trucks, a relatively higher value of time is used that would reflect the greater sensitivity related to the delivery of the commodities being transported and costs associated with driver' salaries.

The toll road bias constant 'c' accounts for unobserved effects associated with the preconceived reluctance on the part of travelers to utilize toll roads. In regions such as the SJTPO area where toll facilities are present, the toll bias terms tend to be negligible, as travelers recognize the benefits, in terms of time saving provided by the toll facilities. The 'etcbias' term applies when both cash and ETC systems are implemented. The logit-based route choice model described above has several parameters that are typically estimated based on stated or revealed preference surveys. For the purposes of this study, the time and cost coefficients as well as the toll road and ETC bias constants will be initially borrowed from previous stated preference surveys conducted in other areas and also based on URS' experience on other toll road studies. The final values of these parameters are shown in Table 10-3. The parameters for Drive-Alone and Carpool were assumed to be identical for the HBW, HBNW and NHB purposes.

Table 10.3: Toll Diversion Model Parameters

Parameter	HBW	HBNW	NHB	COMM	TRK
Time Coefficient (Alpha)	0.2030	0.0950	0.1300	0.1070	0.1070
Cost Coefficient (Beta)	8.0200	5.4015	5.9877	0.2378	0.1070
Average Income	$60,000	$60,000	$60,000		
Value of Time ($/hour)	$16.77	$11.65	$14.39	$27.00	$60.00
Toll Bias Constant (const)	0.0000	0.0000	0.0000	0.0000	0.0000
ETC Bias Constant (etcb)	-0.2030	-0.0950	-0.1300	-0.1070	-0.1070
Equivalent penalty (min) - non-ETC	0	0	0	0	0
Equivalent penalty (min) - ETC	-1	-1	-1	-1	-1

Besides the route choice logit model described above, other salient features of the new toll diversion process are as follows:

- Transponder ownership: Each trip mode was segmented into percentages of vehicles with and without transponders. The transponder ownership was determined to be 70% based on data from other similar areas. In the absence of detailed data by geography, this value was used systemwide across all purposes and modes. If such data becomes available at a later time, these percentages could be stored within matrices, allowing for further segmentation geographically, e.g., urbanized corridors with higher transponder usage. These percentages are established by the user and are anticipated to increase in future years. The transponder trips would be split between free and ETC paths whereas the non-transponder trips would be split between free and cash/video paths.
- Commuter discount: Although there are no toll facilities in the SJTPO region that gives a discount to toll facility patrons who are frequent users of the toll roads, a 'commuter discount' feature has been included in the SJTDM for future use or policy testing. These frequent users are assumed to own a transponder (i.e ETC user) and this discount applies to only auto trips.
- Truck discount: Although there are no truck discounts for frequent truck users with transponders that utilize toll roads, this feature has been included in the SJTDM for future use or policy testing.
- Truck Multipliers: A 'truck multiplier' is defined as the ratio of the average tolls paid by trucks to the average toll paid by autos on the existing toll facilities. Based on actual toll rates charged for different vehicle classes on the toll facilities in the SJTPO area, a truck multiplier of 2.75 was derived and utilized.
- Cost function: In order to reflect the effect of tolls on route choice, the cost function in the highway assignment step could use time along with toll cost divided by value of

time. However, under the advanced toll diversion process that splits trips into free and toll paths based on time savings as well as toll cost, it was determined that including toll cost in the cost function would 'double-penalize' the choice of toll road usage. Therefore, the cost function used in the toll diversion process includes only time.

- Assigned modes: In order to conform to the Voyager limitation of a maximum of 20 loaded volume fields for the highway assignment process, it was necessary to combine some of the purposes and payment types. The HBW, HBNW and NHB trip purposes were combined together by payment type (ETC and Cash/Video) for the Drive-Alone and Carpool modes after trip table partitioning. The final modes assigned in the advanced toll diversion highway assignment are Drive-Alone, Carpool, Commercial vehicles and Trucks. These were assigned separately by free and toll trips.
- Diagnostics: The toll diversion process outputs several matrices which facilitate diagnosis for any selected zone pair. Among the matrices output are the toll probability matrix by mode/purpose, skim matrices (free time, cash time, etc time, distance, toll cost), trips by mode and payment type (free, cash or ETC). Another diagnostic feature included is the reporting by iteration (via a print file) by mode the free and toll path times, toll probability and trips by payment type for any user selected zone pair.
- Customized VDF curves: URS adopted customized VDF curves in the SJTDM toll diversion highway assignment process based on simulation studies for similar areas. These curves are shown by facility type in Figure 10-6.

A summary of the toll diversion model parameters along with the corresponding description and range of possible values assumed for the SJTDM is provided in Table 10-4. As mentioned above, some of these may be updated in future based on change in policy or for performing sensitivity testing.

Figure 10.6: Customized VDF Curves

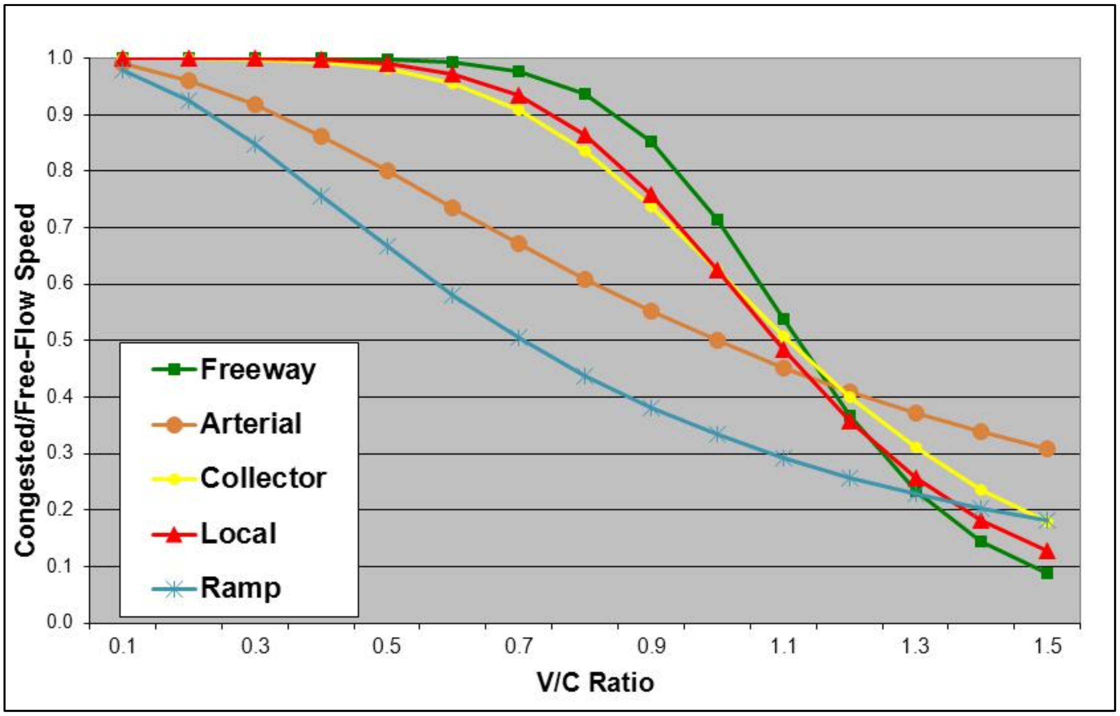


Table 10.4: Toll Diversion Process Parameters

Variable	Description	Range	Assumed Values
cpiadj	CPI factor to adjust for inflation	> = 1.00	1.00
autbias	Scale for auto toll bias	> = 0.00	1.00
trkbias	Scale for truck toll bias	> = 0.00	1.00
autoscale	Scale for toll diversion time and cost coefficients - auto	> = 0.00	1.00
trkscale	Scale for toll diversion time and cost coefficients - trucks	> = 0.00	1.00
etcshare	Transponder ownership market to partition trip tables	0.00 - 1.00	0.70 (70%)
percommu	Percentage of ETC users with commuter tags	0.00 - 1.00	0.0 (0%)
commuterdisc	Commuter discount for frequent users at existing ETC facilities	0.00 - 1.00	0.0 (0%)
trkmult	Multiplier to factor auto tolls to determine truck tolls	1.00 - 5.00	3.00
trkdisc	Frequent user discount applied to trucks using ETC toll facilities	0.00 - 1.00	0.0 (0%)
idiag	Origin zone for diagnostic purposes	any zone	622
jdiag	Destination zone for diagnostic purposes	any zone	305

10.3 Validation Results

The highway assignment process was performed for 10 iterations and 4 model feedback loops. The congested speeds are fed back at the end of a feedback loop to the trip distribution step in order to achieve consistency between the assumed peak speeds and model-estimated peak speeds, which is standard practice in travel demand models. The trip tables were loaded separately by the four time periods in the model namely AM peak, Mid-day, PM peak and Night. Outside the feedback loop, AM and PM peak hour highway assignments are also performed. The free trips estimated by the toll diversion model were loaded onto free paths without tolls and the toll trips were loaded onto tolled paths. The equilibrium assignment technique was used along with closure criteria of GAP=0.00001, RMSE=0.00001, AAD=0.1 and RAAD=0.005. Table 10-5 shows the peak hour/peak period ratios assumed for converting hourly capacity to peak period capacity. These were carried forward from the previous model developed using traffic counts; a review of the peak hour and peak period traffic counts collected during this study confirmed that these factors were reasonable and did not require updates.

Table 10.5: Peaking Factors for Highway Assignment

Period	Hours	Factor
AM peak	3	0.45
Midday	6	0.2
PM peak	4	0.29
Night	11	0.23

If the model can replicate base year traffic volumes with suitable accuracy, it can be assumed that it can be used as a tool to estimate future volumes with sufficient accuracy. The link volumes resulting from the highway assignment were compared with actual counts at various levels, i.e. by volume groups, facility type/area type and screenlines. The results presented here are for a model run for a May weekday as they represent annual average conditions consistent with the AADT counts obtained from other data sources and the May weekday counts collected as part of this model update project. Table 10-6 summarizes the validation results by volume groups. It can be seen that the results are within the recommended ranges. Higher accuracy is typically attained for high-volume roadways than the local lower-volume roadways.

Table 10.6: Validation Results by Volume Groups

Volume Group	Count Range	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**

Table 10-7 summarizes the validation results by the screenlines illustrated in Figure 10-1. It can be seen that overall the volumes match the counts well, although individual screenlines may show large variation.

Table 10.7: Validation Results (Daily) by Screenline

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**

Table 10-8 summarizes the validation results by facility type and area type. It can be seen that overall, the volumes are within 2% of the counts, although larger variations are observed for each facility type/area type category.

Table 10.8: Validation Results (Daily) by Facility Type/Area Type

FT\AT	1	2	3	4	Total
1	0	28,788	269,328	1,388,456	**1,686,572**
2	0	0	0	70,516	**70,516**
3	91,918	268,628	234,126	1,520,695	**2,115,367**
4	0	0	0	34,628	**34,628**
5	78,157	35,812	180,858	642,114	**936,941**
6	65,368	46,859	83,060	198,246	**393,533**
7	0	5,484	12,157	63,197	**80,838**
8	2,325	30,891	31,116	105,113	**169,445**
9	5,278	4,410	6,644	34,487	**50,819**
10	11,964	3,508	0	2,126	**17,598**
11	0	3,737	35,195	75,236	**114,168**
Total	**255,010**	**428,117**	**852,484**	**4,134,814**	**5,670,425**

Count

FT\AT	1	2	3	4	Total
1	0	29,030	252,943	1,284,924	**1,566,897**
2	0	0	0	72,432	**72,432**
3	98,804	276,005	231,642	1,528,309	**2,134,760**
4	0	0	0	29,584	**29,584**
5	102,030	34,980	221,184	732,119	**1,090,313**
6	72,046	39,129	85,881	208,556	**405,612**
7	0	7,736	12,472	54,363	**74,571**
8	5,278	25,590	38,304	114,383	**183,555**
9	11,638	6,694	8,351	50,176	**76,859**
10	9,270	3,946	0	2,462	**15,678**
11	0	3,360	47,340	75,220	**125,920**
Total	**299,066**	**426,470**	**898,117**	**4,152,528**	**5,776,181**

Table 10.8 (Continued): Validation Results by Facility Type/Area Type

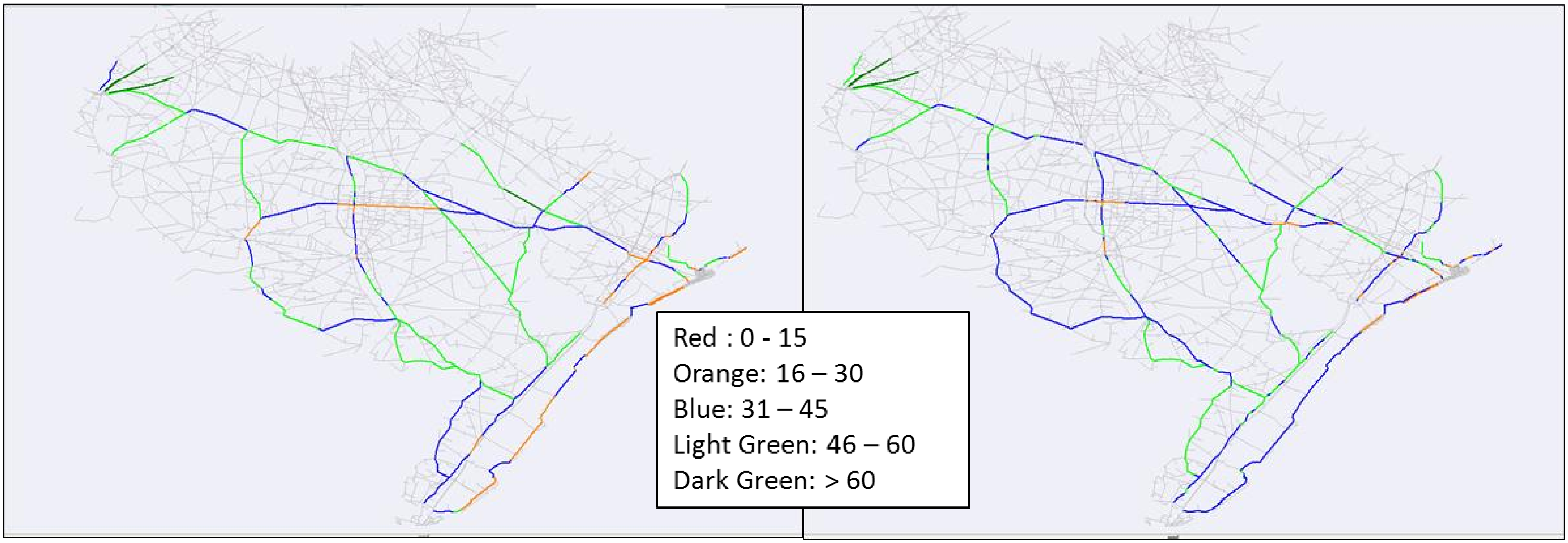
FT\AT	1	2	3	4	Total
1	0.00	1.00	1.07	1.08	**1.08**
2	0.00	0.00	0.00	0.97	**0.97**
3	0.93	0.97	1.00	0.99	**0.99**
4	0.00	0.00	0.00	1.17	**1.17**
5	0.77	0.98	0.82	0.88	**0.86**
6	0.95	1.07	0.97	0.96	**0.97**
7	0.00	0.72	0.98	1.16	**1.09**
8	0.44	1.20	0.81	0.92	**0.92**
9	0.45	0.66	0.80	0.68	**0.66**
10	1.09	1.01	0.00	0.86	**1.03**
11	0.00	1.11	0.74	1.00	**0.91**
Total	**0.86**	**0.99**	**0.95**	**1.00**	**0.98**

FT\AT	1	2	3	4	Total
1	0	2	13	68	**83**
2	0	0	0	4	**4**
3	12	35	26	221	**294**
4	0	0	0	6	**6**
5	16	11	36	211	**274**
6	9	8	19	48	**84**
7	0	2	2	16	**20**
8	2	6	10	74	**92**
9	4	2	5	18	**29**
10	5	2	0	2	**9**
11	0	1	7	22	**30**
Total	**48**	**69**	**118**	**690**	**925**

As mentioned earlier, it is also important to ensure that the model estimates speeds are comparable to observed speeds. Figure 10-7 shows a comparison of model-estimated AM peak speeds with observed speeds during the Spring season.

Figure 10.7: Speed Validation (AM Peak Period - Spring)

Observed **Model**



11 Transit Assignment

Transit Assignment is the step in which the transit person trips estimated by the model are loaded onto the transit network which comprises of the bus and rail routes along with the walk and drive access mode connectors. This chapter presents the transit assignment process in the SJTDM, recent enhancements and validation results.

11.1 Transit Assignment process

The transit assignment process in the SJTDM follows exactly the same process as the transit path-building as described in Chapter 4, the only difference being that transit trips are loaded onto the transit network. There are eight separate transit assignments, namely walk-bus, drive-bus, walk-rail and drive-rail each performed for the peak and off-peak time periods. All of the path-building parameters apply to the transit assignment step. Transit assignment in the SJTDM is performed outside the feedback loop, i.e. it is performed only once.

There are three transit networks used in the feedback day model runs: winter weekday peak, winter weekday off-peak, and summer weekday off-peak. Each of these transit networks possesses different characteristics, such as differences in service frequency or seasonal service availability.

The peak period transit assignments use the winter peak transit network whereas the off-peak assignments use the summer off-peak transit networks. No assignments use the winter weekday off-peak transit networks.

11.2 Validation Results

The primary output from loading the transit trips onto the transit network are the daily ridership by route. In order to compare model-estimated ridership with actual data, ridership data by route was compiled from various sources, primarily from NJ Transit. A few routes such as the jitneys in Atlantic City did not have any recent observed data and therefore do not have a good comparison point. Table 11-1 presents the model-estimated vs. observed daily transit ridership by transit route. At the individual route level, travel demand models do not typically estimate ridership very accurately. Therefore ridership validation is typically also reported at a more aggregate level such as primary corridors or transit company. Table 11-2 presents the model-estimated vs. observed daily transit ridership by transit company (owner) and Table 11-3 presents this comparison by group of routes as primary corridors. Since recent observed ridership data was not available for the Jitney routes (it was taken from the previous model documentation), the ridership validation is shown separately in the tables by excluding the Jitneys. It can be seen that the ridership numbers estimated by the model look reasonable compared to the observed data.

Table 11.1: Transit Validation Results by Route

Route	Ridership		Source (Observed)
	Model	Observed	
313	538	83	NJT Ridership and Zone Profile - 11/2010
315	290	62	NJT Ridership and Zone Profile - 11/2010
316	99	135	NJT SJ Bus Survey - 10/2011
319	182	143	NJT Ridership and Zone Profile - 11/2010
401	66	108	NJT Ridership and Zone Profile - 11/2010
402	329	155	NJT Ridership and Zone Profile - 11/2010
408	1,669	491	NJT Ridership and Zone Profile - 11/2010
410	55	145	NJT Ridership and Zone Profile - 11/2010
468	616	414	NJT SJ Bus Survey - 10/2011
501	1,154	406	NJT Ridership and Zone Profile - 11/2010
502	1,550	1,331	NJT Ridership and Zone Profile - 11/2010
504	171	603	NJT Ridership and Zone Profile - 11/2010
505	3,005	4,429	NJT Ridership and Zone Profile - 11/2010
507	2,344	1,149	NJT Ridership and Zone Profile - 11/2010
508	878	869	NJT Ridership and Zone Profile - 11/2010
509	1,011	651	NJT Ridership and Zone Profile - 11/2010
551	476	939	NJT Ridership and Zone Profile - 11/2010
552	2,214	927	NJT Ridership and Zone Profile - 11/2010
553	2,935	1,681	NJT Ridership and Zone Profile - 11/2010
554	1,962	1,062	NJT Ridership and Zone Profile - 11/2010
559	415	1,137	NJT Ridership and Zone Profile - 11/2010
ACRL	3,768	3,498	AC Rail Survey - 06/2006
Jitney #1	3,359	10,960	CENTRAL Model Development Report
Jitney #2	2,138	5,480	CENTRAL Model Development Report
Jitney #3	4,535	5,480	CENTRAL Model Development Report
Jitney #4	784	-	Not Available
ACRL Shuttle#1	894	332	NJ Transit - 07/2011
ACRL Shuttle#2	11	220	NJ Transit - 07/2011
ACRL Shuttle#3	457	287	NJ Transit - 07/2011
ACRL Shuttle#4	488	249	NJ Transit - 07/2011
Total	**38,393**	**43,426**	

Table 11.2: Transit Validation Results by Transit Owner

Owner	Description	Model	Observed
1	NJ Transit (South Jersey Region)	21,589	17,886
2	NJ Transit (DVRPC Region)	3,522	2,118
4	Private Operator Jitney (AC routes)	12,666	23,008
6	Salem County	616	414
Total		**38,393**	**43,426**
Excluding Jitney		27,577	21,506

Table 11.3: Transit Validation Results by Corridor Groups

Routes	Ridership	
	Model	Observed
401,402,468	1,011	677
408,313,410	2,262	719
315,316,551,554	2,827	2,198
502,553	4,485	3,012
319,552	2,396	1,070
501,504,505,507,508,509,559	8,978	9,244
ACRL, ACRL Shuttles	5,618	4,586
Jitneys	10,816	21,920
Total	**38,393**	**43,426**

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