Ocean County Transportation Model 2013 (OCTM-2013)

MODEL DEVELOPMENT MANUAL

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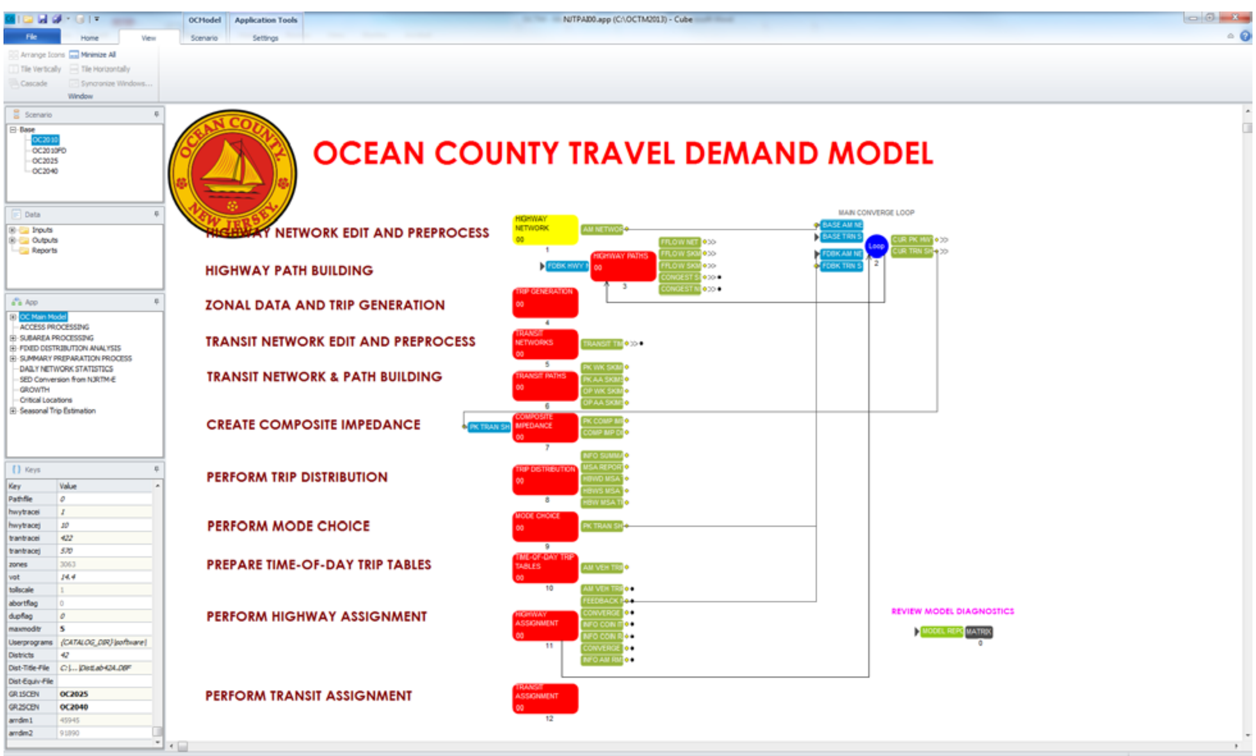
1.0 INTRODUCTION

Stantec, and its two subconsultants – Gallop Corporation and Amercom, were retained by the Ocean County Engineering Department to develop the new Ocean County Transportation Model (OCTM). The old Ocean County Transportation Model was developed using TRANPLAN software package that was obsolete and was not maintained any longer. The new model was developed using Citilabs' Cube Voyager Software Package, and was structured to be consistent with the MPO's Model, the NJTPA's NJRTM-E. Due to its similarity to the NJRTM-E, Stantec advises the model users to consult the NJRTM-E Model Development Manual for detail discussion about the model structure. The Manual is available on the NJTPA's website at the following URL http://www.njtpa.org/Data-Maps/Travel-Demand-Modeling.aspx and the document is listed at the lower section of the page in the "Model Documentation" section. The users can also access the document directly via the following URL http://www.njtpa.org/getattachment/Data-Maps/Travel-Demand-Modeling/Model-Development-Report8G.pdf.aspx .

The OCTM consist of a main model and a series of support applications. The support applications range from input preparation to output processing. Figure 1.1 shows the main application of the OCTM and its support applications. The users are also strongly advised to review the OCTM Users Guide for additional information on the support applications.

Figure 1.1 Ocean County Transportation Model Main Application



The model was calibrated and validated to the 2010 traffic conditions. The document presents the details of the model structures, features, and assumptions that were implemented in the new OCTM, as well as the results of the model calibration including summaries from various model components ranging from trip generation to highway and transit assignments. The organization of this document is described in the following section.

1.1 ORGANIZATION OF THE REPORT

The remainder of this report is organized in the following chapters:

Chapter 2 – Traffic Analysis Zones and Socioeconomic Data. This chapter describes TAZ system for the OCTM.

Chapter 3 – Data Collection and Sources. This chapter presents a summary of traffic counts, travel time data and other information used in developing the forecasts and discusses travel patterns in the area.

Chapter 4 – Highway Network Development. This chapter presents the development of OCTM highway network and the descriptions of its variables.

Chapter 5 – Highway Path Building. This chapter presents the path building process for the highway network.

Chapter 6 – Transit Network Development. This chapter describes the development of transit network using Public Transport Module.

Chapter 7 – Transit Path-Building. This chapter explains the methodology used to create paths for various transit modes.

Chapter 8 – Composite Impedance Estimation. This chapter presents the application of composite impedance as well as the variables that influence the impedance.

Chapter 9 – Model Calibration. This chapter shows the calibration and validation of the model components.

Chapter 10 – Additional Features. This chapter discussed additional features such as Seasonal Model, Critical Locations, and Future Scenarios.

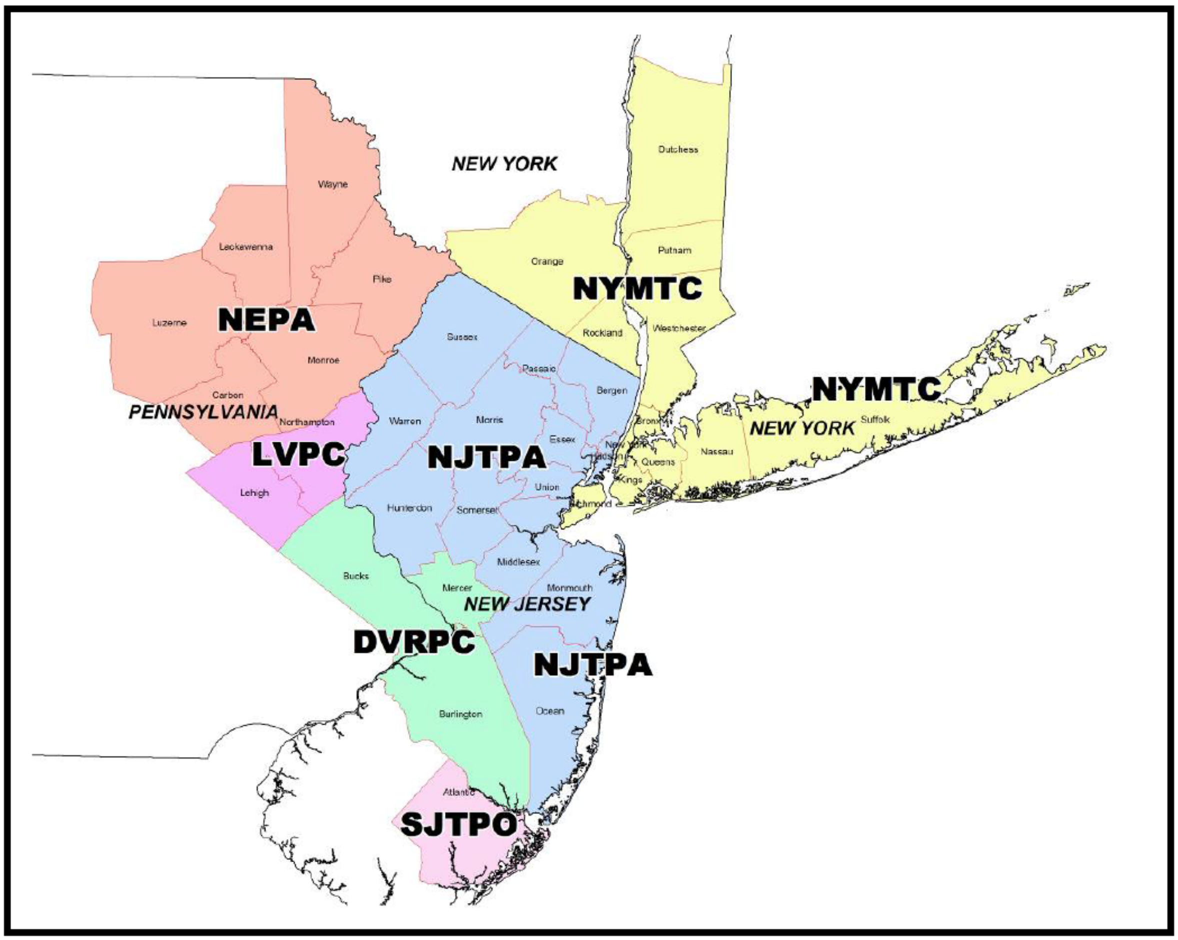
2.0 TRAFFIC ANALYSIS ZONES AND SOCIOECONOMIC DATA

2.1 INTRODUCTION

The OCTM geographical coverage is identical with the NJRTM-E geographical coverage. It comprises of six Metropolitan Planning Organizations (MPOs) across New Jersey, New York, and Pennsylvania as shown in Figure 2.1 and forty counties, including:

- North Jersey Transportation Planning Agency (NJTPA)
- South Jersey Transportation Planning Organization (SJTPO)
- New York Metropolitan Transportation Council (NYMTC)
- Delaware Valley Regional Planning Commission (DVRPC)
- Northeastern Pennsylvania Alliance (NEPA)
- Lehigh Valley Planning Commission (LVPC)

Figure 2.1 The OCTM Geographical Coverage



2.2 TRAFFIC ANALYSIS ZONES SYSTEM

The OCTM traffic analysis zones (TAZ) was developed based on the NJRTM-E TAZ system with additional refinement in the Ocean County Region. As part of this effort, Stantec, in coordination with NJTPA, has developed the OCTM TAZ System and provided reserved zones for each NJTPA county in anticipation for the new NJRTM-E TAZ system in its future calibration effort. An equivalency file between the current NJRTM-E and OCTM TAZ systems was also created for future use. Figure 2.2 shows an overlay of NJRTM-E TAZ System (in green) and the OCTM TAZ System (in red) focusing on the Ocean County Region.

The OCTM consists of 3063 TAZs, including 230 reserved zones. 352 of those zones are in Ocean County. In addition, 10 reserved zones are provided for Ocean County and bring the total zones to 362. Table 2.1 lists the TAZ equivalency between the NJRTM-E and the OCTM systems.

Figure 2.2 TAZ System in Ocean County Region

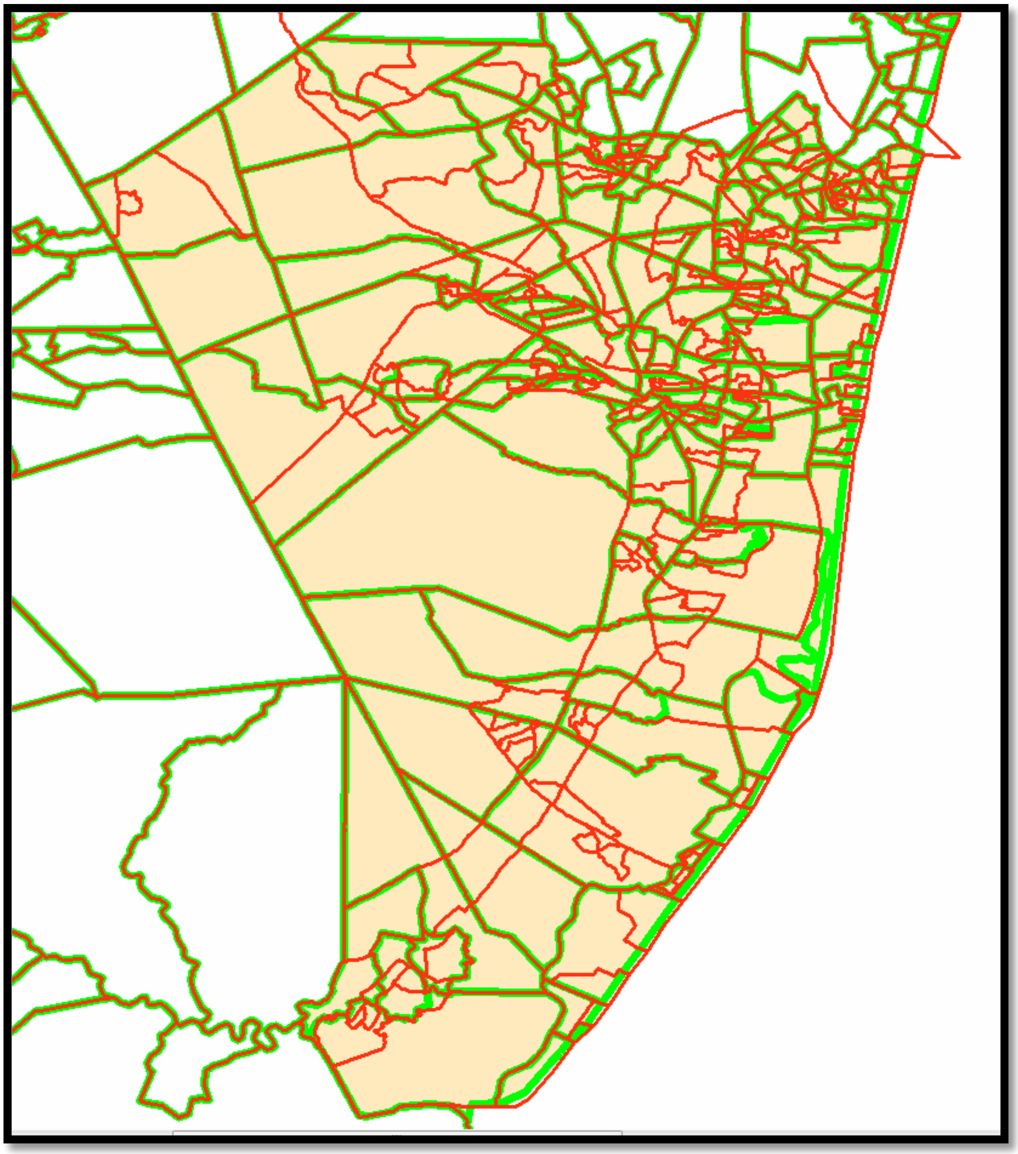


Table 2.1 The NJRTM-E and OCTM TAZ Comparison

Region	County	NJRTME - 2000 CENSUS		OCEAN COUNTY MODEL FINAL		RESERVED ZONE	
		Zone Numbers	No. of Zones	Zone Numbers	No. of Zones	Zone Numbers	No. of Zones
New Jersey	Atlantic	1 - 25	25	1 - 25	25		0
	Bergen	26 - 200	175	26 - 215	190	216 - 225	10
	Burlington	201 - 344	144	226 - 369	144		0
	Essex	345 - 571	227	370 - 600	231	601 - 610	10
	Hudson	572 - 751	180	611 - 791	181	792 - 831	40
	Hunterdon	752 - 783	32	832 - 863	32	864 - 873	10
	Mercer	784 - 907	124	874 - 997	124	998 - 1007	10
	Middlesex	908 - 1120	213	1008 - 1202	195	1219 - 1226	8
				1204 - 1214	11	1203	1
				1216 - 1218	3	1215	1
	Monmouth	1121 - 1264	144	1227 - 1379	153	1380 - 1389	10
	Morris	1265 - 1363	99	1390 - 1490	101	1491 - 1500	10
	Ocean	1364 - 1488	125	1501 - 1636	352	1637 - 1646	10
				2848 - 3063			
	Passaic	1489 - 1573	85	1647 - 1747	101	1748 - 1757	10
	Somerset	1574 - 1649	76	1758 - 1837	80	1838 - 1847	10
	Sussex	1650 - 1692	43	1848 - 1891	44	1892 - 1901	10
	Union	1693 - 1800	108	1902 - 2014	113	2015 - 2034	20
	Warren	1801 - 1827	27	2035 - 2061	27	2062 - 2071	10
New York	Bronx	1828 - 1833	6	2072 - 2077	6	-	0
	Dutches	1834 - 1835	2	2078 - 2079	2	-	0
	Kings	1836 - 1853	18	2080 - 2097	18	-	0
	Nassau	1854 - 1855	2	2098 - 2099	2	-	0
	New York (Manhattan)	1856 - 2092	237	2100 - 2336	237	2337 - 2366	30
	Orange	2093 - 2120	28	2367 - 2394	28	-	0
	Putnam	2121	1	2395 - 2395	1	-	0
	Queens	2122 - 2132	11	2396 - 2406	11	-	0
	Richmond	2133 - 2149	17	2407 - 2423	17	2424 - 2433	10
	Rockland	2150 - 2207	58	2434 - 2491	58	2492 - 2501	10
	Suffolk	2208	1	2502 - 2502	1	-	0
	Sullivan	2552	1	2503 - 2503	1	-	0
	Westchester	2209 - 2235	27	2504 - 2530	27	-	0
Pennsylvania	Bucks	2236 - 2306	71	2531 - 2601	71	-	0
	Carbon	2307	1	2602 - 2602	1	-	0
	Lackawanna	2308 - 2348	41	2603 - 2643	41	-	0
	Lehigh	2349 - 2375	27	2644 - 2670	27	-	0
	Luzerne	2376 - 2451	76	2671 - 2746	76	-	0
	Monroe	2452 - 2471	20	2747 - 2766	20	-	0
	Northampton	2472 - 2509	38	2767 - 2804	38	-	0
	Pike	2510 - 2522	13	2805 - 2817	13	-	0
	Wayne	2523 - 2550	28	2818 - 2845	28	-	0
Connecticut	Bridgeport	2552	1	2846 - 2846	1	-	0
	Fairfield Co. Other	2553	1	2847 - 2847	1	-	0
Total			**2553**		**2833**		**230**

2.3 SOCIOECONOMIC DATA

The socioeconomic data (SED) for the OCTM was provided by NJTPA from the Moody-Based estimates. The data was provided at the NJRTM-E TAZ Level. Stantec then disaggregated the data to the OCTM TAZ system using the zonal-equivalency file developed in Section 2.2. The equivalency file is provided in the OCTM directory and named "SPLIT.DBF". It is stored in the "NJRTME2013\OCApps\SED\APP" folder.

As part of this project, Stantec prepared three model-year scenarios, 2010 calibration year, 2025, and 2040. The SED for these three model years were prepared from the provided dataset. Table 2.2 shows the population, household, and employment summary by MCD for the Ocean County Region, and Table 2.3 presents the compounded annual growth rate (CAGR) between two consecutive model years. The population and household were estimated to grow slightly under one percent per year, while the employment has a stronger growth at one percent annually between 2010 and 2025 than between 2025 and 2040 at 0.6% per year.

Table 2.2 The Socioeconomic Data by MCD

Ocean County	2010			2025			2040		
MCD	POP	HH	EMP	POP	HH	EMP	POP	HH	EMP
Barnegat	20,936	8,128	2,419	24,064	9,823	3,049	28,268	11,607	3,609
Barnegat Light	257	124	115	281	142	118	365	185	141
Bay Head	968	459	296	1,141	584	413	1,146	587	436
Beach Haven	1,170	531	353	1,215	563	334	1,407	655	369
Beachwood	11,045	3,682	904	11,946	4,100	1,160	12,651	4,356	1,260
Berkeley	45,721	22,558	6,952	49,700	24,726	8,429	54,778	26,766	9,293
Brick	75,072	29,842	19,804	80,668	32,986	22,264	89,518	36,846	24,147
Toms River	91,261	34,772	39,665	100,091	39,385	44,800	109,232	43,231	46,697
Eagleswood	1,603	621	709	2,177	941	986	3,713	1,591	1,293
Harvey Cedars	533	271	70	578	303	91	605	319	104
Island Heights	1,673	683	311	1,767	738	375	1,767	738	375
Jackson	54,904	19,422	11,423	65,522	24,523	15,005	82,284	30,988	17,732
Lacey	27,644	10,183	5,637	30,009	11,360	6,355	34,549	13,090	7,077
Lakehurst	2,654	881	1,223	2,861	979	1,370	3,354	1,155	1,478
Lakewood	92,843	24,283	28,704	106,336	28,746	31,892	125,608	34,575	34,445
Lavallette	1,853	933	367	1,861	952	385	1,906	980	392
Little Egg Harbor	20,065	8,060	2,988	23,083	9,628	3,960	28,042	11,715	4,734
Long Beach	3,172	1,587	1,201	3,288	1,682	1,207	3,804	1,952	1,326
Manchester	43,022	22,835	5,386	47,652	25,801	6,970	56,420	30,329	8,540
Mantoloking	296	162	16	333	190	59	333	190	59
Ocean	8,332	3,483	1,255	9,568	4,155	1,526	10,909	4,768	1,745
Ocean Gate	2,011	832	125	2,107	881	193	2,107	881	193
Pine Beach	2,127	818	216	2,288	899	296	2,288	899	296
Plumsted	8,421	2,936	1,205	9,285	3,471	1,801	11,524	4,314	2,585
Point Pleasant	18,392	7,273	4,133	19,728	8,050	4,817	20,296	8,324	4,936
Point Pleasant Beach	4,665	1,985	2,479	4,930	2,165	2,642	5,182	2,294	2,784
Ship Bottom	1,475	719	842	1,569	793	906	1,615	820	923
South Toms River	3,684	1,098	293	4,018	1,240	351	4,597	1,431	414
Stafford	26,535	10,096	9,604	29,054	11,412	10,676	34,001	13,493	11,590
Surf City	886	458	31	922	487	43	922	487	45
Tuckerton	3,347	1,396	488	3,600	1,553	576	4,441	1,925	725
Total	**576,567**	**221,111**	**149,215**	**641,640**	**253,257**	**173,047**	**737,631**	**291,491**	**189,743**

Table 2.3 SED Growth Rate by MCD

Ocean County	2010-2025			2025-2040		
MCD	POP	HH	EMP	POP	HH	EMP
Barnegat	0.9%	1.3%	1.6%	1.1%	1.1%	1.1%
Barnegat Light	0.6%	0.9%	0.2%	1.8%	1.8%	1.2%
Bay Head	1.1%	1.6%	2.2%	0.0%	0.0%	0.4%
Beach Haven	0.2%	0.4%	-0.4%	1.0%	1.0%	0.7%
Beachwood	0.5%	0.7%	1.7%	0.4%	0.4%	0.6%
Berkeley	0.6%	0.6%	1.3%	0.7%	0.5%	0.7%
Brick	0.5%	0.7%	0.8%	0.7%	0.7%	0.5%
Toms River	0.6%	0.8%	0.8%	0.6%	0.6%	0.3%
Eagleswood	2.1%	2.8%	2.2%	3.6%	3.6%	1.8%
Harvey Cedars	0.5%	0.7%	1.8%	0.3%	0.3%	0.9%
Island Heights	0.4%	0.5%	1.3%	0.0%	0.0%	0.0%
Jackson	1.2%	1.6%	1.8%	1.5%	1.6%	1.1%
Lacey	0.5%	0.7%	0.8%	0.9%	0.9%	0.7%
Lakehurst	0.5%	0.7%	0.8%	1.1%	1.1%	0.5%
Lakewood	0.9%	1.1%	0.7%	1.1%	1.2%	0.5%
Lavallette	0.0%	0.1%	0.3%	0.2%	0.2%	0.1%
Little Egg Harbor	0.9%	1.2%	1.9%	1.3%	1.3%	1.2%
Long Beach	0.2%	0.4%	0.0%	1.0%	1.0%	0.6%
Manchester	0.7%	0.8%	1.7%	1.1%	1.1%	1.4%
Mantoloking	0.8%	1.1%	8.9%	0.0%	0.0%	0.0%
Ocean	0.9%	1.2%	1.3%	0.9%	0.9%	0.9%
Ocean Gate	0.3%	0.4%	3.0%	0.0%	0.0%	0.0%
Pine Beach	0.5%	0.6%	2.1%	0.0%	0.0%	0.0%
Plumsted	0.7%	1.1%	2.7%	1.5%	1.5%	2.4%
Point Pleasant	0.5%	0.7%	1.0%	0.2%	0.2%	0.2%
Point Pleasant Beach	0.4%	0.6%	0.4%	0.3%	0.4%	0.4%
Ship Bottom	0.4%	0.7%	0.5%	0.2%	0.2%	0.1%
South Toms River	0.6%	0.8%	1.2%	0.9%	1.0%	1.1%
Stafford	0.6%	0.8%	0.7%	1.1%	1.1%	0.5%
Surf City	0.3%	0.4%	2.3%	0.0%	0.0%	0.2%
Tuckerton	0.5%	0.7%	1.1%	1.4%	1.4%	1.6%
Total	**0.7%**	**0.9%**	**1.0%**	**0.9%**	**0.9%**	**0.6%**

3.0 DATA COLLECTION AND SOURCES

Data to support model calibration and validation efforts for various model components were gathered from numerous sources, including:

- 2010-2011 Regional Household Travel Survey (RHTS) by NJTPA and NYMTC
- Automatic Traffic Recorders (ATRs) counts provided by Ocean County to Stantec at the inception of this project.
- Traffic counts data from Lakewood and Joint-Base Regional Transportation Mobility Studies.
- Traffic counts data obtained from the NJDOT website including Weigh-in-Motion (WIM) Data, 48-hour continuous data, and Straight Line Diagram (SLD) traffic count.
- Traffic counts along Garden State Parkway obtained from the New Jersey Turnpike Authority (NJTA).
- Transit Ridership data from Ocean Ride.
- Transit Ridership data from the New Jersey Transit.

In addition to the aforementioned data, Stantec, assisted by its subconsultant AmerCOM, collected additional ATR count and Turning Movement Count (TMC) data at specific locations for this project.

3.1 2010-2011 NJTPA-NYMTC RHTS DATA

The 2010-2011 RHTS was conducted from September 2010 through November 2011 in a coordinated effort between NJTPA and NYMTC. In total, 31,156 households within the Tri-State area (New York / New Jersey / Connecticut) were recruited, and only 18,965 households completed the survey's travel diaries. The survey study area comprises 28-counties constituting the Tri-State metropolitan area that includes:

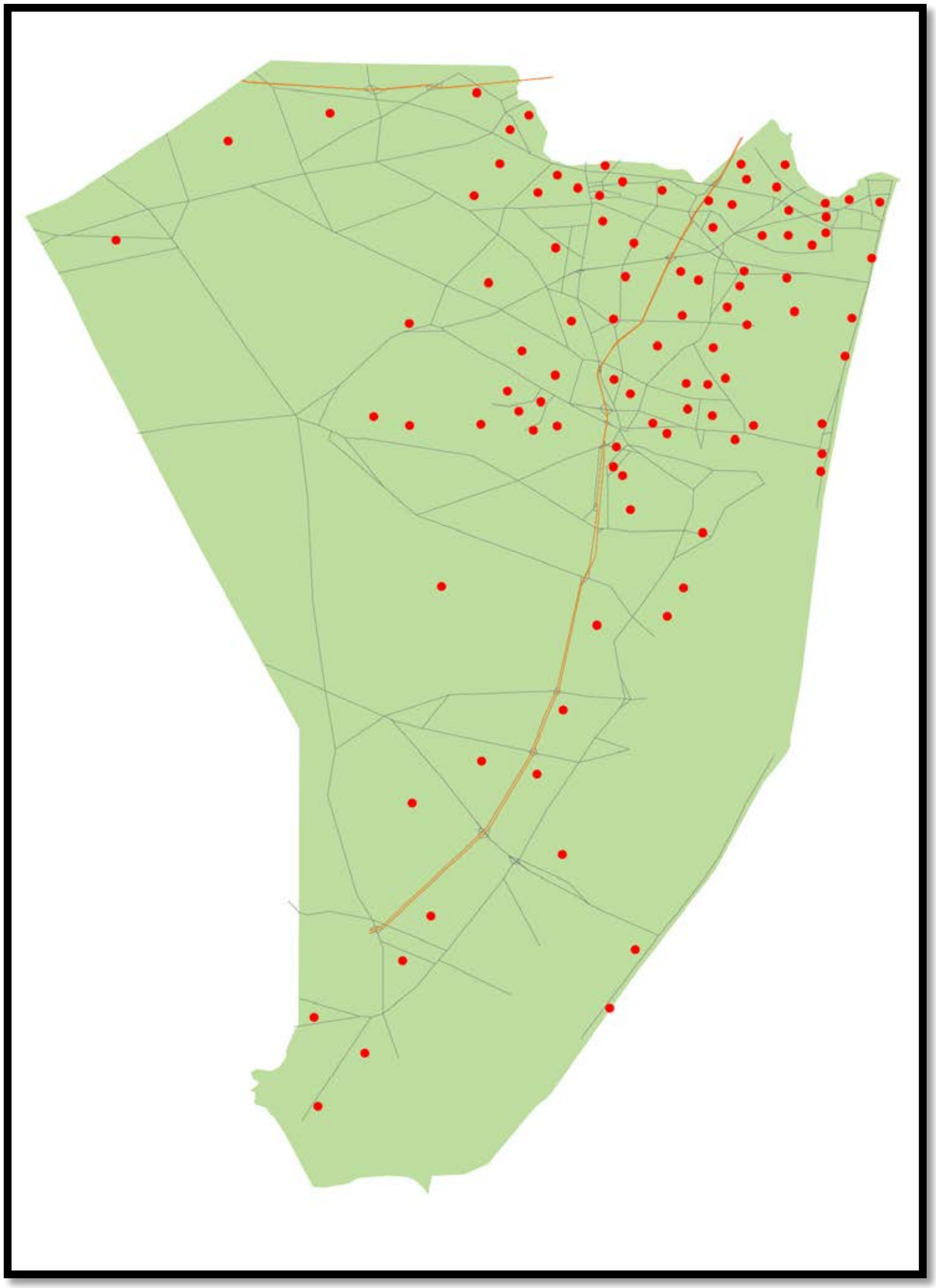
- New York: Bronx, Duchess, Kings, Nassau, New York, Orange, Putnam, Queens, Richmond, Rockland, Suffolk, and Westchester.
- New Jersey: Bergen, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Somerset, Sussex, Union, and Warren.
- Connecticut: Fairfield and New Haven.

The survey datasets comprises 18,965 household records, 39,789 person records, and 143,925 trip records. Of these records, only 519 households, and 1,032 persons were from the Ocean County Region. Compared to the total population and household in the region, the sample size is very small at approximately 0.2% as shown in Table 3.1. However, the locations of these samples were spread out over the region as displayed in Figure 3.1 providing good representation for the Ocean County.

Table 3.1 RHTS Sample Size for Ocean County

Type	Number of Samples	SED (2010)	% Sample
Household	519	221,119	0.2%
Person	1,032	576,572	0.2%

Figure 3.1 RHTS Sample Locations for Ocean County



Stantec also reviewed the Longitudinal Employer-Household Dynamics (LEHD) data from Census Bureau as an additional source. However, the data is very limited at County-Level and Stantec decided not to use it. Instead, Stantec used the calibration results from the 2008 Recalibration Project as synthetic observed targets to be used concurrently with the RHTS data in the several model component calibration such as Trip Distribution, and Mode Choice model components.

3.2 TRAFFIC COUNT DATA

As mentioned in the previous section, Stantec obtained the traffic counts from various sources. At the inception of this project, Ocean County provided Stantec with the traffic counts from previous studies within the Ocean County region. There were 18 counts locations that were provided from these studies to Stantec and the list of those locations were provided in Table 3.2. Stantec also obtained ten and six additional traffic counts from the Joint-Based Regional Transportation Mobility Study (JBRTMS) and Lakewood Studies, respectively. The locations of these counts are listed in Table 3.3. Note that these traffic counts were used only if the roadways were coded in the highway network.

Table 3.2 Traffic Count Locations from Ocean County

No.	Location	Municipality
1	Mantoloking Rd. (W. of the Bridge)	Brick
2	Route 70 (W. of River Ave.) EB	Brick
3	Route 70 (W. of River Ave.) WB	Brick
4	Herbertsville Rd. (S. of Monmouth Cty Line)	Brick
5	Squankum Rd.	Lakewood
6	Route 9 (SB)	Lakewood
7	Route 526/571 (btwn 195 to Rt 537)	Jackson
8	Route 539 (S. of Rt 537)	Plumsted
9	Route 537 (E. of Burlington Cty Line)	Plumsted
10	Jacobstown Rd. (S. Province Line Rd.)	Plumsted
11	Route 70 (E. of Burlington County)	Manchester
12	W. Bay Ave. (E. of GSP)	Barnegat
13	Route 539 (S. of GSP)	Little Egg Harbor
14	Route 72 (W. of Bridge)	Stafford
15	Lacey Rd. (E. of GSP)	Lacey
16	Veterans Blvd. (E. of GSP)	Berkeley
17	Montoloking Rd. (W. of the Bridge)	Brick
18	Route 537 (E. of Burlington Cty Line)	Plumsted

Table 3.3 Traffic Count Locations from JBRTMS and Lakewood Studies

Source	No.	Location
DBRTMS	1	CR 545 South of CR 537
	2	CR 630 West of the Base
	3	CR 670 West of Route 68
	4	CR 539 South of the Base - SB
	5	Route 70 West of Route 37 - WB
	6	Route 68 South of CR 537
	7	CR 667 South of CR 616
	8	CR 530 b/w CR 645 & CR 545
	9	CR 640 South of CR 537
	10	CR 547 South of CR 571
Lakewood	1	Prospect St. at Havenwood Court
	2	Cross St, S of Augusta Blvd
	3	Massachusetts Ave. at Lakewood Pine Blvd
	4	Oak St. between Vine Ave. and Albert Ave.
	5	Pine St at Avenue of the States
	6	Cedar Bridge Ave. at S. Clover St.

Stantec reached out to the New Jersey Turnpike Authority to request traffic counts along Garden State Parkway in the vicinity of Ocean County. Traffic counts in the Ocean County Region from the NJDOT's website were also downloaded. Those traffic counts that were collected on the years other than 2010 were converted into 2010 counts using assumed growth rate of one percent per year. The traffic counts gathered as part of this effort were usually between 2008 and 2014.

For the purpose of the screenline calibration, Stantec and its subconsultant, AmerCom, collected additional ATR counts at twenty locations, mostly at the locations of the screenlines, as shown in Table 3.4. Turning movements at selected locations were also collected as shown in Table 3.5. All traffic count locations used in the model calibration is shown in Figure 3.2. Roadway links where traffic counts are available are printed in black in this Figure. Traffic counts from the adjacent counties, such as Burlington and Monmouth, in the vicinity of Ocean County were also downloaded from the NJDOT's website.

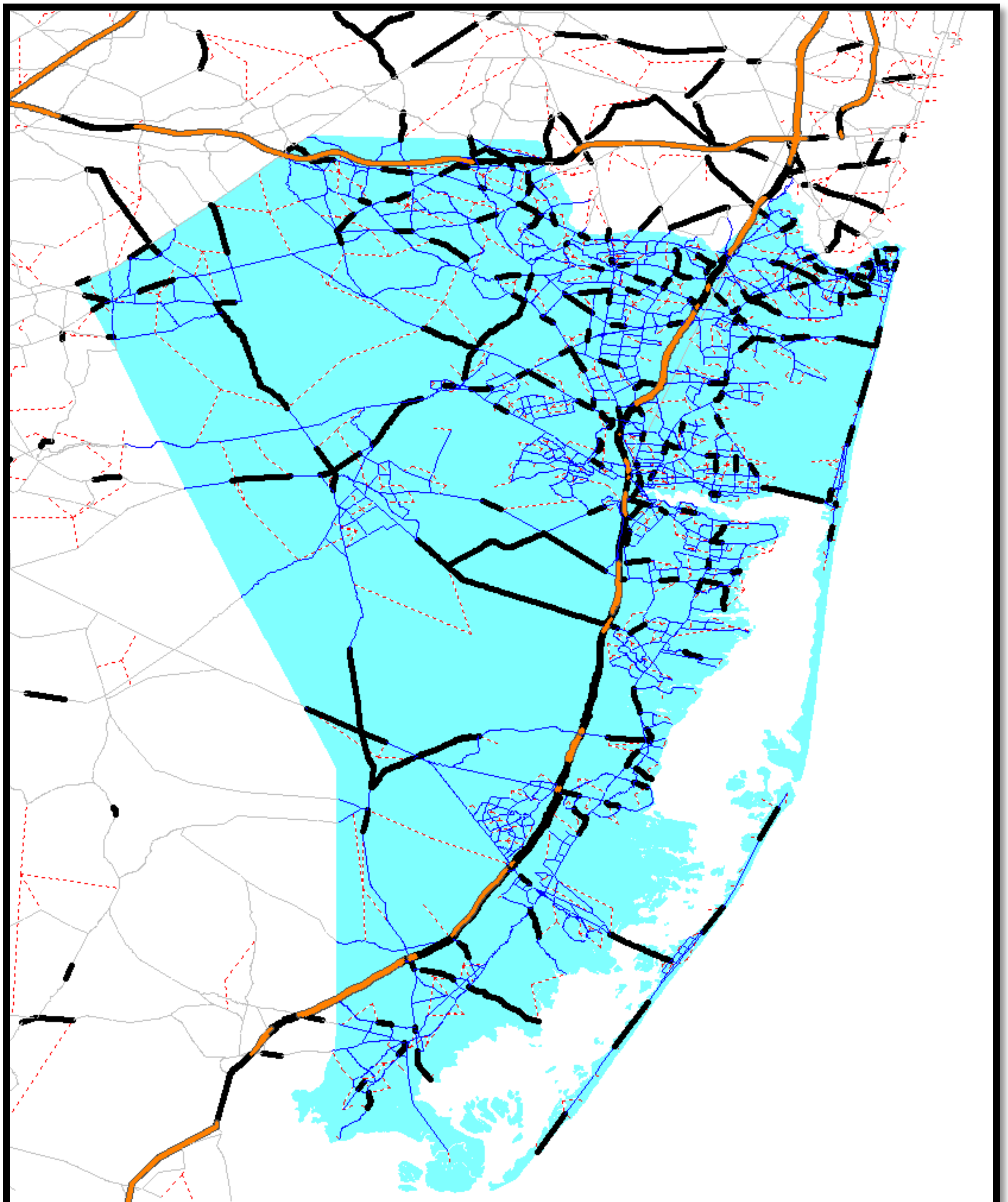
Table 3.4 Additional Traffic Count Locations

NO	ROAD NAME	LOCATIONS
1	NJ 70	Between Nj 37 And Ridgeway Rd/Rte 571
2	RT 527	Between Sunset Ave And Clayton Ave
3	US 9	Between Rt 571 And Whitty Rd
4	LAKEWOOD ALLENWOOD RD	Between Vienna Rd And Cascades Ave
5	NJ 88	Between Arnold Ave And Beaver Dam Rd
6	HYSON RD	Between Jackson Mills Rd And Harmony Rd
7	RT 532	Between Nj 72 And Rt 539
8	BUNTING BRIDGE RD	Between Rt 616 (Main St.) And Brindletown Rd
9	CHURCH RD	Between Gsp And Rt 623
10	NJ 72	Between Savoy Blvd And Rt 539
11	RT 527/CEDAR SWAMP RD	Between Diamond Rd And Cottrell Rd
12	HARMONY RD	Between Jackson Mills Rd And Ely Harmony Rd
13	OLD FREEHOLD RD	Between Dugan Ln And Gsp
14	FORT PLAINS RD	Between W Farms Rd And Farmingdale Rd
15	GEORGIA TAVERN RD	Between Peskin Rd And Windeler Rd
16	RT 527	Between Nj 70 And Down Hill Run
17	RT 528	Between Gsp And Airport Rd
18	NJ 70	Between Gsp And Airport Rd
19	NJ 70	Between Beckerville Rd And Wranglebrook Rd
20	US 9	Between Taylor Ln And Georgetown Blvd

Table 3.5 Turning Movement Count Locations

No	Intersection Location	Township
1	US 9 Madison Avenue and RT 528 Central Avenue/Hurley Avenue	Lakewood
2	US 9 Main Street and Barnegat Blvd	Barnegat
3	NJ 88 Sea Avenue and CO 632 Bridge Avenue	Point Pleasant
4	US 9 and Church Rd.	Toms River
5	CO 614 Lacey Rd. and CO 10 Manchester Ave.	Lacey
6	RT 539 Pinehurst Road and RT 528 Lakewood Road	Plumstead
7	NJ 70 and New Hampshire Avenue	Lakewood
8	US 9 Main Street and Rt 539 Green Street	Tuckerton
9	US 9 Atlantic City Blvd and CO 618 Central Pkwy / Butler Blvd	Berkeley
10	NJ 70 and RT 571 Ridgeway Road	Lakehurst

Figure 3.2 All Traffic Count Locations



3.3 TRANSIT RIDERSHIP DATA

Transit trips in Ocean County only account for a very small percentage of overall trips generated in the county. Those trips are generally served by the New Jersey Transit for long-haul trips, and by the local transit routes from Ocean Ride buses for intra-county trips. Table 3.6 listed the 2010 transit routes for the Ocean Ride and their frequencies of services. Of all Ocean Ride transit only Toms River Connection operates every day. Since the model estimated average daily traffic, only the Toms River Connection will be included in the model analysis.

Table 3.6 Ocean Ride Transit Routes

Route Name	Service Area Description	# of Service[(1)]			# of Service[(1)]			Service Day(s)
		DIR	PK	OP	DIR	PK	OP	
OC 1 Whiting	Whiting, Manchester, Berkeley, Toms River	to Toms River	1		to Whiting		2	Mon, Wed, Fri
OC 1A Whiting Express	Whiting, Lakewood, Ocean County Mall	to Toms River	1		to Whiting		1	Mon, Wed, Fri
OC 2 Manchester	Manchester, Lakehurst, Berkeley, Toms River	to Toms River		1	to Manchester		2	Tue, Thu
OC 3 Brick	Brick, Lakewood, Toms River	to Toms River		2	to Brick		2	Mon, Wed, Fri
OC 3A Brick/Point Pleasant	Brick, Point Pleasant Beach & Borough, Toms River, Ocean County Mall	to Toms River		1	to Point Pleasant		1	Tue, Thu
OC 4 Lakewood/Brick Link	Point Pleasant Beach Rail Station, Brick Township, Lakewood Industrial Parkway, Lakewood Bus Terminal							
OC 5 Lacey	Forked River, Barnegat Pines, Lankoka Harbor	to Lanoka Harbor		2	to Forked River		1	Tue, Thu
OC 6 Little Egg Harbor	Tuckerton, Eagleswood, Stafford, Barnegat	to Stafford	1	1	to Little Egg		2	Mon, Wed, Thu
OC 7 Eastern Berkeley	Ocean Gate, Pine Beach, Beachwood S. Toms River	to Toms River		1	to Berkeley		1	Tue, Thu
OC 8 Western Berkeley	Western Berkeley, Gardens of Pleasant Plains	to Toms River		1	to Berkeley		1	Tue, Thu
OC 9 Barnegat	Barnegat, Stafford, Ocean County Mall	to Stafford		1	to Barnegat		1	Tue
OC 10 Plumsted	Jackson, Lakewood, Brick, Manchester, Toms River	to Brick		1	to Plumsted		1	Tue, Thu
LBI-North	Brant Beach, Ship Bottom, Surf City, Barnegat Light, Beach Haven, Manahawkin	to Manahawkin		1	to Holgate		1	Tue
LBI-South		to Manahawkin		1	to Holgate		1	
Toms River Connection	Toms River to Lavallette	to Lavallette	2	4	to Toms River	3	4	Mon. - Fri.

Note:
[(1)]Transit Service Period Definition: Peak Period is AM Peak from 6am-9am; Off Peak is from 9am - 3pm

The NJT Buses serving Ocean County include Routes 64, 67, 137, 139, 317, 319, and 559. The 2010 average weekday transit ridership data obtained from the NJ Transit and Ocean Ride are shown in Table 3.7.

Table 3.7 The 2010 Bus Ridership Data

Agency	Line Name	Total Observed Ridership
New Jersey Transit	137	909
	139	471
	317	86
	319	151
	559	761
	64	29
	67	216
Ocean Ride	Toms River	369

4.0 HIGHWAY NETWORK DEVELOPMENT

4.1 INTRODUCTION

The OCTM highway network was developed based on the NJRTM-E highway network with additional roadway refinement within Ocean County. Many local roadways added to the highway network to provide more detail representation of the roadways in the County. This section provides a detailed description of the highway network development task for the OCTM project. The highway network process is used to abstract the actual roadway network as a representative network for subsequent processing. The highway network is used as the basis for estimating various impedance variables such as travel time and costs used by the trip distribution and mode choice models. The highway network is also used as input to the highway assignment process.

The highway network is developed as a series of links and nodes with the links representing roadway segments and the nodes representing their point of intersection. Nodes are also used as shaping points to align highway network links to the corresponding street configuration. The highway network also includes zone centroids which serve as terminal points for trips in the modeling process. These zones centroids also represent proxy locations for the socioeconomic data (population and employment) contained within the TAZs that generate trips in the OCTM. The centroids are attached to the highway network via hypothetical links called centroid connectors.

Each highway link contains various data that define the operational and physical characteristics of the given facility along with fields used to provide identification data, such as roadway names. In general these parameters are categorized into three groups:

- Physical/operational variables
- Identification variables
- Performance variables

The complete list of these variables is given in Appendix F of the OCTM User's Guide.

4.2 PHYSICAL/OPERATIONAL VARIABLES

These variables describe the physical and operational attributes of the highway network and define the type of highway links in the network, for example, links for freeways, arterials, etc., which in turn will affect the capacity and speed of the links. The techniques used to estimate speed and capacity are based on the 2000 HCM procedures and were implemented in order to provide sensitivity to a wider range of potential improvement types, such as signalization and intersection improvements, with the objective of providing more realistic estimates of capacity suitable for operational analysis, Several key variables will be discussed in the following sections include:

- Facility type
- Area Type
- Link Type
- Number of Lanes by Time Period
- Traffic Control Devices Variables
- Toll Variables

During the course of setting capacity and speeds for the links, the model will review the coded values and will generate a series of information statements, warnings, and fatal messages, based on the logic of these variables. Note also that there are other variables that influence the calculation of speed and capacity, such as shoulder conditions and parking conditions, but these variables have limited coding options which require less description.

4.2.1 Facility Type

The OCTM recognizes twelve different facility types that are stored in the "FT" variable. The twelve facility categories are as follows:

- Freeways (FT=1) – limited access roadway facilities, including toll facilities, with grade-separated interchanges and no traffic signals on the main lanes.
- Expressway (FT=2) – partially limited access roadway facilities with generally high speed limits, grade separated interchanges with other major facilities, and at-grade intersections with minor facilities.
- Principal Arterial Divided (FT=3) – arterials with moderately high speed limits (e.g. 35-50 mph), raised center medians with turning bays at intersections, parking restrictions, mainly serving through traffic rather than local property access.
- Principal Arterial Undivided (FT=4) – same as principal arterial divided except that there are no raised center medians and, generally, no bays for left turns.
- Major Arterial Divided (FT=5) – arterials with moderate speed limits (e.g. 30-45 mph), raised center median with turning bays at intersections, some parking restrictions, mainly serving through traffic although some local property access is permitted.
- Major Arterial Undivided (FT=6) – same as major arterials divided except that there are no raised center medians and, generally, no bays for left turns.
- Minor Arterial (FT=7) – arterials with moderately low speed (e.g. 25-35 mph) and few parking restrictions that serve some through traffic, some distribution of traffic from principal and major facilities to local streets and local property access.

- Collectors/Locals (FT=8) – roadways with moderately low speed limit (e.g. 25-35 mph) and few parking restrictions that serve mainly to collect and distribute traffic from principal, major, and minor facilities to local streets and local property access.
- High-Speed Ramps (FT=9) – ramps that generally connect freeway-to-freeway facilities, or also known as direct connector, have some relatively high speed limits, e.g. 50-60 mph.
- Medium-Speed Ramps (FT=10) – ramps that have moderately high turning radius and typically with speed limit approximately 40 mph.
- Low-Speed Ramps (FT=11) – ramps with low turning radius and low speed limit, e.g. 25 mph, includes jughandles.
- Centroid Connectors (FT=12) – "dummy" roadway link with unlimited capacity that serve solely to connect TAZs to roadway network.

4.2.2 Area Type

Four separate area types were identified for the purpose of estimating highway capacity and speeds. These types are stored in the "AT" variable. The four area types are as follows:

- CBD (AT=1) – this area type is designated particularly for areas where population and employment densities are typically very high, such as Manhattan, downtown Newark and Jersey City.
- Urban (AT=2) – characterized by high residential densities, small lots or single family dwelling units, many apartments, and mostly through streets. Employments interspersed throughout the residential areas.
- Suburban (AT=3) – characterized by low to medium residential densities, medium to large lots for single family housing units, homogenous land uses, restricted traffic flow restrictions such as cul-de-sacs, dead ends, traffic circles, and frequent stop signs.
- Rural (AT=4) – characterized by very low residential densities and much undeveloped or agricultural land, relatively few roads.

4.2.3 Link Type

This variable is created to serve as a permission code to utilize the highway link based on vehicle type mode and toll facility type. This variable is used in highway path building and highway assignment procedures to exclude links that are not illegible for paths being developed for certain trip markets, such as "SOV-Cash". There are sixteen (16) link types defined in the OCTM and they are listed below:

- Free All (Link Type 1) – non-tolled links designated for all modes.
- Free Auto Only (Link Type 2) – non-tolled links designated for auto mode only.

- Free Truck Only (Link Type 3) – non-tolled links designated for truck mode only.
- Urban Toll All (Link Type 4) – Urban tolled links designated for all trip modes (auto and trucks). Urban links are defined as links with Area Type 3 or higher (Area Types 1 to 3). The toll links are assumed to accommodate all types of toll payments, such as cash or electronic toll collection (ETC or EZ-Pass).
- Urban Toll Auto Only (Link Type 5) – Urban tolled links designated for auto mode only.
- Urban Toll Truck Only (Link Type 6) – Urban tolled links designated for truck mode only.
- Rural Toll All (Link Type 7) – Rural tolled links designated for all trip modes (auto and trucks).
- Rural Toll Auto Only (Link Type 8) – Rural tolled links designated for auto mode only.
- Rural Toll Truck Only (link Type 9) – Rural tolled links designated for truck mode only.
- Urban Free HOV Only (Link Type 10) – Urban free links for all HOV modes. This is a typical HOV link.
- Urban Toll HOV Only (Link Type 11) – Urban tolled HOV Only. This link type is prepared for a scenario where the HOV links are now tolled.
- Urban Toll SOV, Free HOV (Link Type 12) – Urban tolled links for SOV mode only, HOV mode is free. This is a typical use for HOT Lane scenarios.
- Urban Toll Non-HOV vehicles (Link Type 13) – Urban toll links, all vehicles except HOVs
- ETC Only All (Link Type 14) – Toll links dedicated for ETC patrons only (patrons with EZ-pass) for all modes. This link type is typical for congestion pricing or HOT lane scenarios where all payments are done electronically.
- ETC Only Auto Only (Link Type 15) – Toll links dedicated for ETC patrons and Auto mode only. Truck trips are not eligible to use this type of links.
- ETC Only SOV and Truck Toll, HOV Free (Link Type 16) – Toll links dedicated for all ETC patrons; however, only SOV and truck trips have to pay. HOV mode is free.

Note that the OCTM creates a total of nine different path sets based on mode (SOV,HOV, Truck) and toll usage (Free, Cash Payment, ETC Payment). It is important to note that the Link Type variable does not assess the toll cost. It is only used to determine if a path set can use the link in question. The following example is presented to describe the use of this variable in the path sets. The path-building and highway assignment process for an SOV cash “path” without EZ-Pass should exclude all links with link types:

- *3, 6, 9 because these links are limited to trucks only*
- *10, 11 because these links are limited to HOVs only*
- *14, 15, and 16 because these links are limited to vehicles with transponders (ETC).*

4.2.4 Number of Lanes

The OCTM provides three number of lane variables by time of day:

- *LanesAM – number of lanes for AM Peak period*
- *LanesPM – number of lanes for PM Peak period*
- *LanesOP – number of lanes for Midday and Night periods*

The purpose of having different variables for each time period is to accommodate the situations where the configuration of the roadway varies by time of day, such as a period-specific HOV lane or a roadway with a reversible lane. Typically, an HOV lane is usually applied to the peak direction reducing one lane from the available general-purpose lanes. During the off peak period, this lane is usually converted back into a general purpose lane. Having separate lane variables for each time period within a master network for each model year reduces the model complexity by providing a consistent network suitable for several different time-of-day analyses.

4.2.5 Traffic Control Devices

The traffic control device (TCD) parameters were added to the model to improve the representation of capacity, speed and intersection delay. The OCTM provides 13 TCD categories, defined as follows:

- Two-way stop (TCD 1)
- All-way stop (TCD 2)
- Yield (TCD 3)
- Ramp-meter (TCD 4)
- Signalized-uncoordinated-actuated (TCD 5)
- Signalized-uncoordinated-fixed (TCD 6)
- Signalized-coordinated-restricted progression (TCD 7)
- Signalized-coordinated-favorable progression (TCD 8)
- Signalized-coordinated-maximum progression (TCD 9)
- Freeway diverge point (TCD 10)
- Freeway merge point (TCD 11)
- No controls (TCD 12)
- Unknown (TCD 99)

As mentioned previously, the techniques to estimate speed and capacity utilize this variable as part of the 2000 HCM procedures. In addition to TCD variable, the model also includes additional signal-related variables that adjust time and capacity. These variables include:

- *NSIG* – number of signals in the link
- *SIGCYC* – Signal cycle in seconds
- *SIGCOR* – Signal coordination type
    0 = uncoordinated signal (default)

1 = coordinated-unfavorable
2 = coordinated-favorable
3 = coordinated-maximum progression

- *GC* – green time per cycle ratio

The detailed data for the TCD and its complimentary variables can be updated in the future as more comprehensive databases become available. Noted that due to the implementation of junction model in the Ocean County region, and in order to prevent the double-counting of TCD modeling, the TCD for Ocean County has been defined as TCD=12 (no controls). The impact of the TCD in Ocean County is controlled by the junction model.

4.2.6 Toll Variables

The OCTM requires several toll variables for different toll applications. The toll variables are listed below:

- TOLL – the toll cost values in dollars.
- MCTOLL – the scaled toll values to balance by direction especially for one-way toll, prepared for mode choice process. MCTOLL will be explained further following this list.
- TOLLAPC – a flag to identify the type of toll links, for example, HOV free toll links, truck-free toll links, etc. The TOLLAPC has thee values, with default value of 0. The default value indicates that toll is applicable to all modes (SOV, HOV, and truck). TOLLAPC of 1 indicates that toll is applied to all modes, except HOV. TOLLAPC of 2 indicates that toll is applied to all modes, except trucks.
- TOLLCLASS – toll class for lookup system. This variable provides flexibility to use toll values either directly from values coded in the link or values defined in a look-up table. The default value of TOLLCLASS is zero which is applied to all links without any toll values. TOLLCLASS between 1 and 98 indicates that the toll cost will be obtained from a look-up table. TOLLCLASS of 99 indicates that toll value is coded directly on the link. A detailed discussion about the toll look-up table will be given following this list.
- TOLLFACAM, TOLLFACPM, TOLLFACMD, TOLLFACNT – base toll factor for each time period (AM, PM, MD, and NT). This variable provides flexibility to have variable tolls for different time period. The default values of these variables are one (1), i.e., tolls are the same for all time periods and they are the same as the values coded in the toll links.
- FIXTOLL – this variable provides whether or not the toll cost is fixed through all assignment iterations, or can be adjusted for each assignment iteration such as for congestion pricing scenarios. The FIXTOLL variable has two values, a value 0 for variable tolls and a value of 1 for fixed toll rates. The default is fixed tolls.

MCTOLL variable is used to control cost allocation in mode choice and traffic diversion in highway assignment with facilities employing one-way tolling schemes. For mode choice, trips are provided in a production-attraction format, so the cost of each direction of an assumed round trip should be 50% of a one-directional toll and must be presented on both directions of facility since round trips originating on either side of the toll plaza will encounter the toll at some time of the day. However, for the purposes of traffic assignment, the full cost of the toll is posted in the direction that the toll is assessed, so that the diversion process can seek differing paths (free vs. toll) if such options are present. An example of this is directional tolling schemes employed at the Holland Tunnel and the Verrazano-Narrows Bridge. In this situation, certain travelers can enter New York eastbound in the morning via the Verrazano-Narrows bridge (paying a lower toll than the eastbound Holland Tunnel) and return back to New Jersey via the non--tolled westbound Holland Tunnel.

The default value for MCTOLL is zero (0) which indicates that the toll does not exist in the link. For links with toll values, there are two sets of MCTOLL values:

- MCTOLL=1 for links with same toll in both directions
- MCTOLL=+0.5 and -0.5 for links with one-way toll. The positive value (+0.5) is posted on link in the direction where the one-way toll is assessed, while the negative value (-0.5) is posted on the reverse, non-toll direction.

Figures 4.1 and 4.2 display the application of MCTOLL variable under differing conditions. These figures indicate what values should be input to TOLL and MCTOLL variables when representing either one-way or two-way toll collection plans.

Figure 4.1 MCTOLL for One-Way Toll Collection

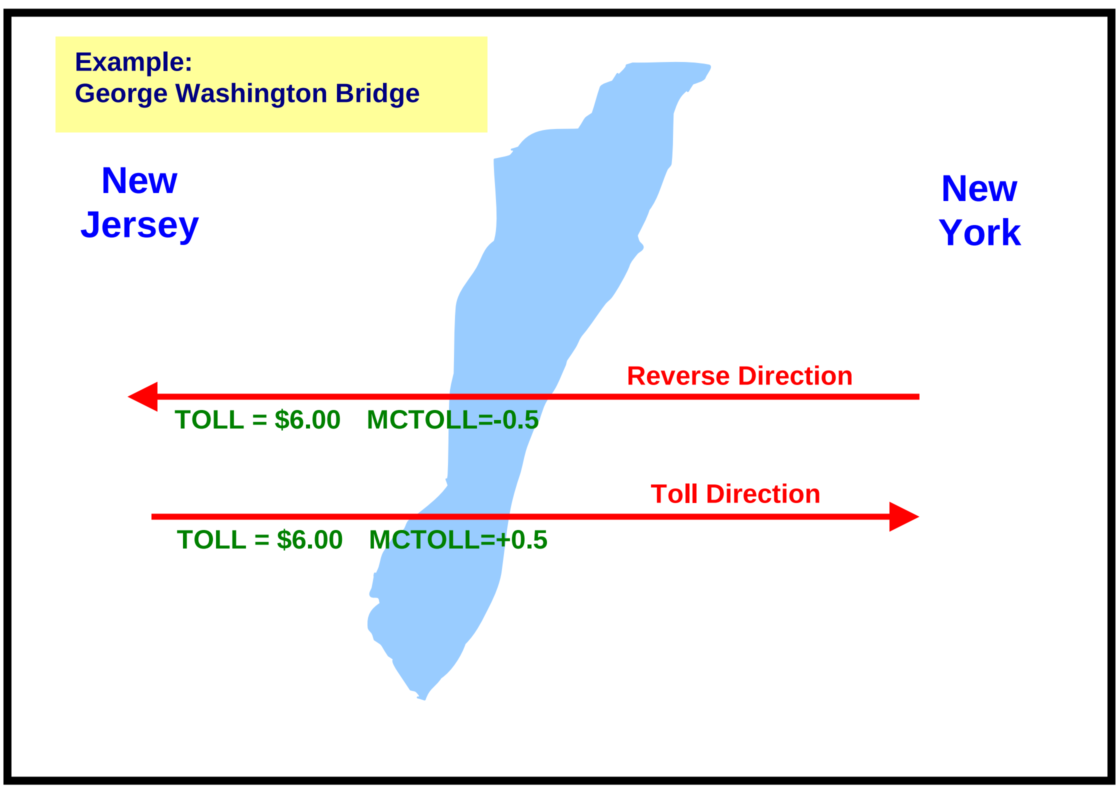
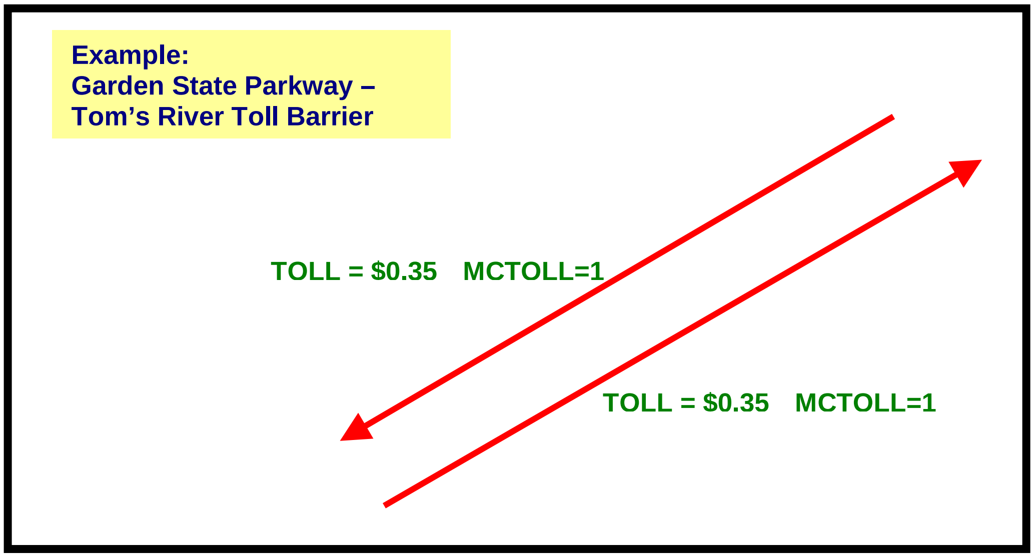


Figure 4.2 MCTOLL for Two-Way Toll Collection

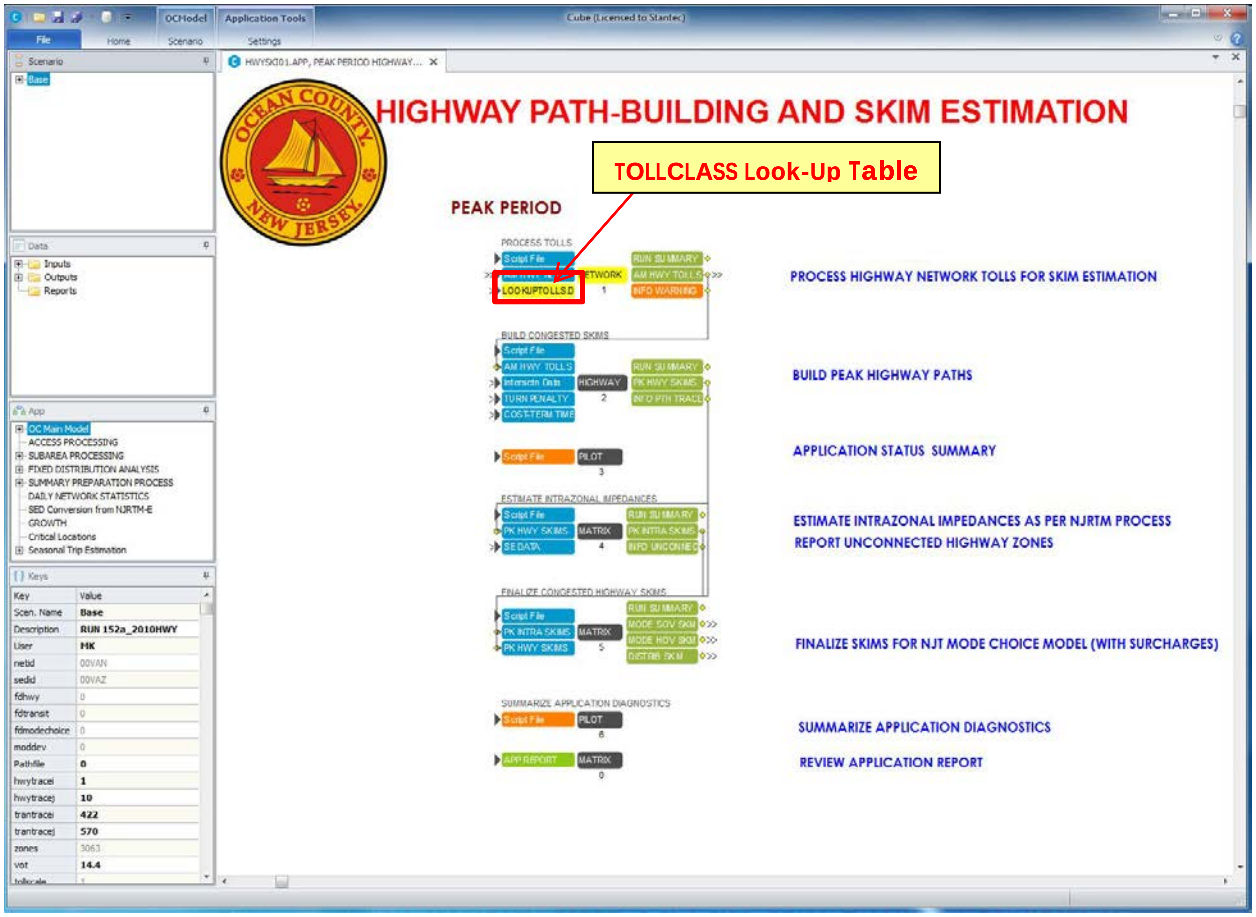


For one-way toll collection plan, the toll values for mode choice are the absolute values of the TOLL multiplied by MCTOLL. In the example above, both directions will have toll values of $3.00. In the assignment process, the assigned toll values will be the TOLL multiplied by a "factor". The "factor" is defined as one (1) if MCTOLL is greater than zero and defined as zero (0) if MCTOLL is less or equal to zero. In the example above, the TOLL value for the toll direction (from New Jersey to New York) is $6.00, while the TOLL value for the reverse direction is $0.00.

In contrast to the one-way toll collection plan at the George Washington Bridge, the MCTOLL variable is coded differently to represent the two-way toll collection situation for the Garden State Parkway toll plaza at Toms River, New Jersey. As shown in Figure 4.2, the MCTOLL variable is coded as 1.0 in direction which enables the toll to be properly assessed for both mode choice and the highway assignment procedures. Note that an equal toll cost (in this case $0.35) is applied to each direction of the link, just as was the case with the one-directional toll scheme. It should also be noted that the MCTOLL variable can be used to control the display of true tolling locations in CUBE. When displaying toll costs for links, the posting process can be controlled by limiting the display of TOLL on links where MCTOLL is greater than zero. This will display the actual toll in the direction that it is assessed.

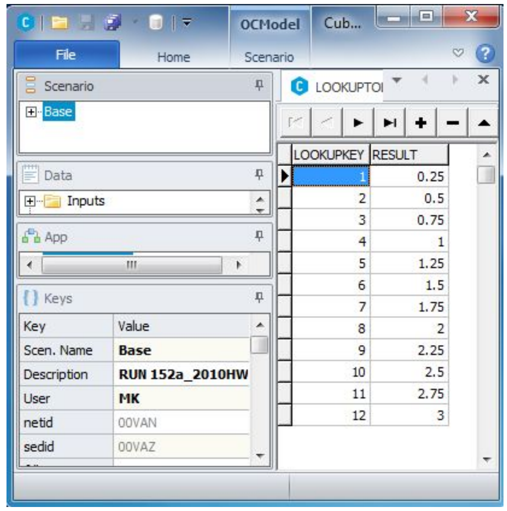
TOLLCLASS, as explained previously, is a variable to allow the use of toll rates either directly coded on the link or toll rates defined from the look-up table. The look-up table that contains the toll rate is stored in "LOOKUPTOLLS.DBF" file in the "Highway Path-Building and Skim Estimation" module, as shown in Figure 4.3.

Figure 4.3 Toll Class Look-Up Table



The OCTM model reserves 98 keys (TOLLCLASS=1-98) to be used for different toll rates. Currently, only 12 keys have been used as shown in Figure 4.4. The remaining keys are reserved for future use. Note that TOLLCLASS code 99 is used to indicate that the lookup table is not applied and that the toll posted on the link is the actual value.

Figure 4.4 Toll Class Table



4.2.7 Speed and Capacity Estimation

Speeds and capacity variables for the OCTM were developed by using relationships between facility type and area type. The values adopted for this effort were obtained from several sources including the speeds provided by the 2000 HCM procedures and were adjusted using professional judgment during the course of the model development. The recommended "ideal" uncongested speeds (off-peak speed), which are used as input to the highway path building process, are presented in Table 4.1. Note that these speeds represent theoretical upper limits or "ideal" values prior to considering other factors as number of lanes, grade, shoulder conditions, and traffic control devices that reduce these initial values. Initial estimates of congested speeds (peak speeds), which are used as input to first iteration of the highway path building process were assumed to be approximately 20% lower than the uncongested speed

Table 4.1 Uncongested Speed by Facility Type and Area Type

Facility Type	Area Type					
	Manhattan CBD	CBD	Urban	Suburban High	Suburban	Rural
Freeways	60	60	75	78	78	78
Expressways	50	55	65	65	65	65
Principal Arterials Divided	40	45	57	57	60	60
Principal Arterials Undivided	40	42	55	55	55	55
Major Arterials Divided	35	41	48	50	50	50
Major Arterials Undivided	35	41	46	50	50	50
Minor Arterials	30	35	37	40	45	45
Collectors/Locals	15	20	25	25	35	35
High-speed Ramps	55	55	55	55	55	55
Medium-speed Ramps	30	30	30	30	30	30
Low-speed Ramps	25	25	25	25	25	25
Centroid Connectors	10	10	10	10	10	10

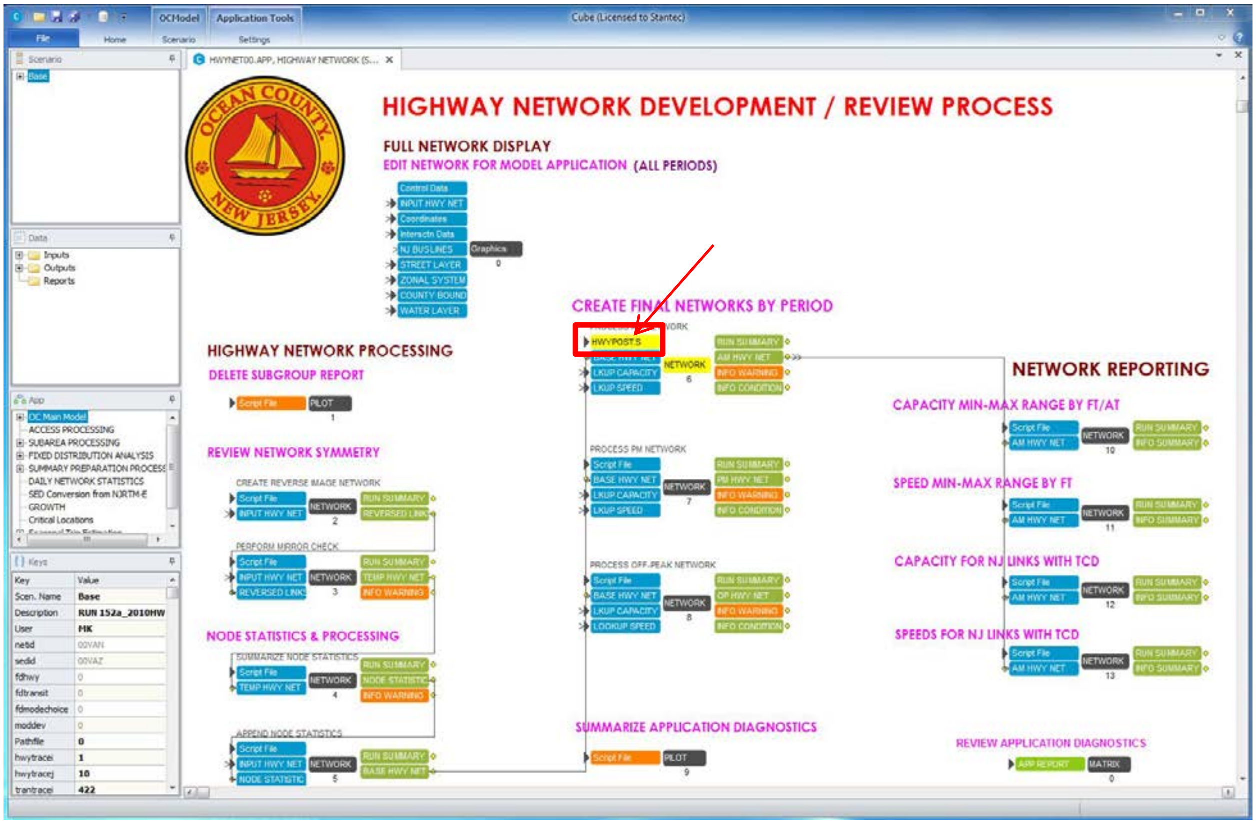
The “ideal” capacities were also assumed to be a function of facility type and area type. These initial hourly capacities per lane are listed in Table 4.2. The initial capacity values for each link were adjusted to take into account for geometric constraints or other impedances along the link, such as parking availability, traffic control devices, green time/cycle ratio, signal cycle length, etc.

Table 4.2 Initial Hourly Capacity per Lane

Facility Type	Area Type					
	Manhattan CBD	CBD	Urban	Suburban High	Suburban	Rural
Freeways	2000	2050	2100	2150	2200	2200
Expressways	1750	1800	1950	2000	2100	2100
Principal Arterials Divided	1700	1750	1800	1850	2000	2000
Principal Arterials Undivided	1550	1600	1750	1750	1900	1900
Major Arterials Divided	1500	1650	1700	1700	1850	1850
Major Arterials Undivided	1400	1500	1650	1650	1850	1850
Minor Arterials	1300	1400	1600	1600	1800	1800
Collectors/Locals	1000	1000	1000	1300	1300	1300
High-speed Ramps	1760	1760	1760	1760	1760	1760
Medium-speed Ramps	900	900	900	900	900	900
Low-speed Ramps	700	700	700	700	700	700
Centroid Connectors	9000	9000	9000	9000	9000	9000

The adjustments to speed and capacity are implemented during creation of period-specific networks and the procedures can be viewed in the control files in the “Highway Network Development Module” as shown in Figure 4.5.

Figure 4.5 Highway Network Development Module



4.3 IDENTIFICATION AND PERFORMANCE VARIABLES

The identification variables, as their name implies, contain information for identification purposes only and are used as part of the network display. The variables include roadway name, SRI, Milepost, county where the links are located, conformity-based project ID number, and the zone where the links reside.

The performance variables contain mainly the performance information such as traffic counts and the year those traffic counts were gathered. These variables are used primarily for reference purposes when comparing traffic forecasts to base year conditions. Note that provisions were made to permit three traffic count data sets, each with a separate reference year. It was envisioned that peak period counts, seasonal counts, or data sets with conflicting estimates could be stored in these fields as part of a future effort.

5.0 HIGHWAY PATH-BUILDING

5.1 INTRODUCTION

The highway path-building procedure is used to accumulate impedances for use by the trip generation, trip distribution, and the mode choice model components. The impedances include auto travel time, terminal time, and tolls for each origin-destination zonal pair. These impedance values are stored as a series of matrix files, often referred to as "skim" files. The content of each skim table is structured for use by one or more of the model components referenced above.

5.2 HIGHWAY PATH BUILDING PROCESS

The highway path-building process was developed to provide necessary travel time estimates for several model components. The trip generation component uses uncongested travel time as an accessibility variable for the allocation of attractions by income level. Highway travel times are used as part of the composite impedance terms that provides a measure of spatial separation for the trip distribution process. Lastly, the highway skims for time, distance, and toll costs are used as impedances for the mode choice model. The selection of the minimum path for each zonal pair was based solely on the highway travel time, since time is the primary component influencing travel determination. The path-building routine accumulates all of the remaining impedance variables as the minimum path for each zonal pair was processed.

The path-building process is performed for peak and off-peak periods. The off-peak path building process was performed only during the first iteration of the model, while the peak period skims are accumulated during each iteration of the model. Table 5.1 lists the skim variables for each time period.

The access and egress terminal times are defined at the area type of zone and the total terminal time for a given origin-destination zonal pair is the summation of egress time at the origin and the access time at the destination zone. The terminal times for each zone range between 1 and 7 minutes and are stored in the ZONECOSTTIME.DBF file.

Table 5.1 Highway Path-Building Impedance Variables

Time Period	Table No	Impedance Variables
Peak	1	congested time - SOV
	2	congested tolls (dollars) - SOV
	3	congested distance (miles) - SOV
	4	congested tolls (cents) - SOV
	5	congested time - HOV
	6	congested tolls (dollars) - HOV
	7	congested distance (miles) - HOV
	8	congested tolls (cents) - HOV
	9	terminal time (total access and egress time for i-j pairs
	10	SOV time + terminal time
	11	HOV time + terminal time
Off-Peak	1	uncongested time - SOV
	2	uncongested toll (dollar) - SOV
	3	uncongested distance - SOV
	4	uncongested toll (cents) - SOV
	5	uncongested time - HOV
	6	uncongested tolls (dollars) - HOV
	7	uncongested distance - HOV
	8	uncongested tolls (cents) - HOV
	9	terminal time (total access and egress time for i-j pairs
	10	SOV time + terminal time
	11	HOV time + terminal time
	12	uncongested time - Truck
	13	uncongested tolls (dollars) - Truck
	14	uncongested distance - Truck
	15	Truck time + terminal time

5.3 MODE SPECIFIC PATH BUILDING

In the path-building process, the NJRTME estimates paths for three different vehicle types or "modes", those being SOV, HOV, and Truck. The inclusion or exclusion of highway links for each mode-specific path is controlled by the "LINKTYPE" variable as described previously in the highway network development section of this document. This variable serves as a "permission" code to utilize the individual highway links based on travel mode and, during the highway assignment process, both mode and toll condition.

5.4 INTRAZONAL TIME ESTIMATION

The intrazonal time was estimated in the final step of the highway path-building process. This time was necessary for the trip distribution process. Intrazonal time was calculated based on the zonal size as follows:

- For zones in the detailed study area, the intrazonal time was calculated using half of the sum of time from two (2) closest “nonzero” zones, and then multiplied it by 0.60. The 0.60 value was obtained to replicate the intrazonal times in the original NJRTM.
- For zones in the more aggregated outlying regions (usually reflected by the zonal size of district level or higher), the intrazonal time was calculated using the time from the nearest zone multiplied by 0.6.

5.5 SKIM FILES FOR MODE CHOICE

As a final step in the highway path-building process, the skim files were formatted to be consistent with requirements for the NJ Transit mode choice model. The mode choice model was developed using a customized FORTRAN program that required matrix data to be provided in MINUTP format. To accommodate this requirement, the Voyager routines stored the output in this format as opposed to the standard matrix format. Table 5.2 lists the variables by time period.

Table 5.2 Skim File Structure for Mode Choice

Time Period	Table No	Impedance Variables
Peak/SOV	1	time (minutes)
	2	distance (1/100 miles)
	3	time (1/100 of minutes)
	4	costs (cents)
Peak/HOV	1	time (minutes)
	2	distance (1/100 miles)
	3	time (1/100 of minutes)
	4	costs (cents)
Off-Peak/All Modes	1	time (minutes)
	2	distance (1/100 miles)
	3	time (1/100 of minutes)
	4	costs (cents)

6.0 TRANSIT NETWORK DEVELOPMENT

6.1 INTRODUCTION

The primary purpose of the transit network was to develop estimates of the time and cost variables for peak and off-peak periods as required for the mode choice model. The transit network was also used as the basis to load trips within the transit assignment process. The transit path-building and assignment is performed using Public Transport (PT) routine. This routine is the same as the new transit module that was recently adopted by the NJRTM-E.

6.2 TRANSIT NETWORK COMPONENTS

6.2.1 Transit Network Modes

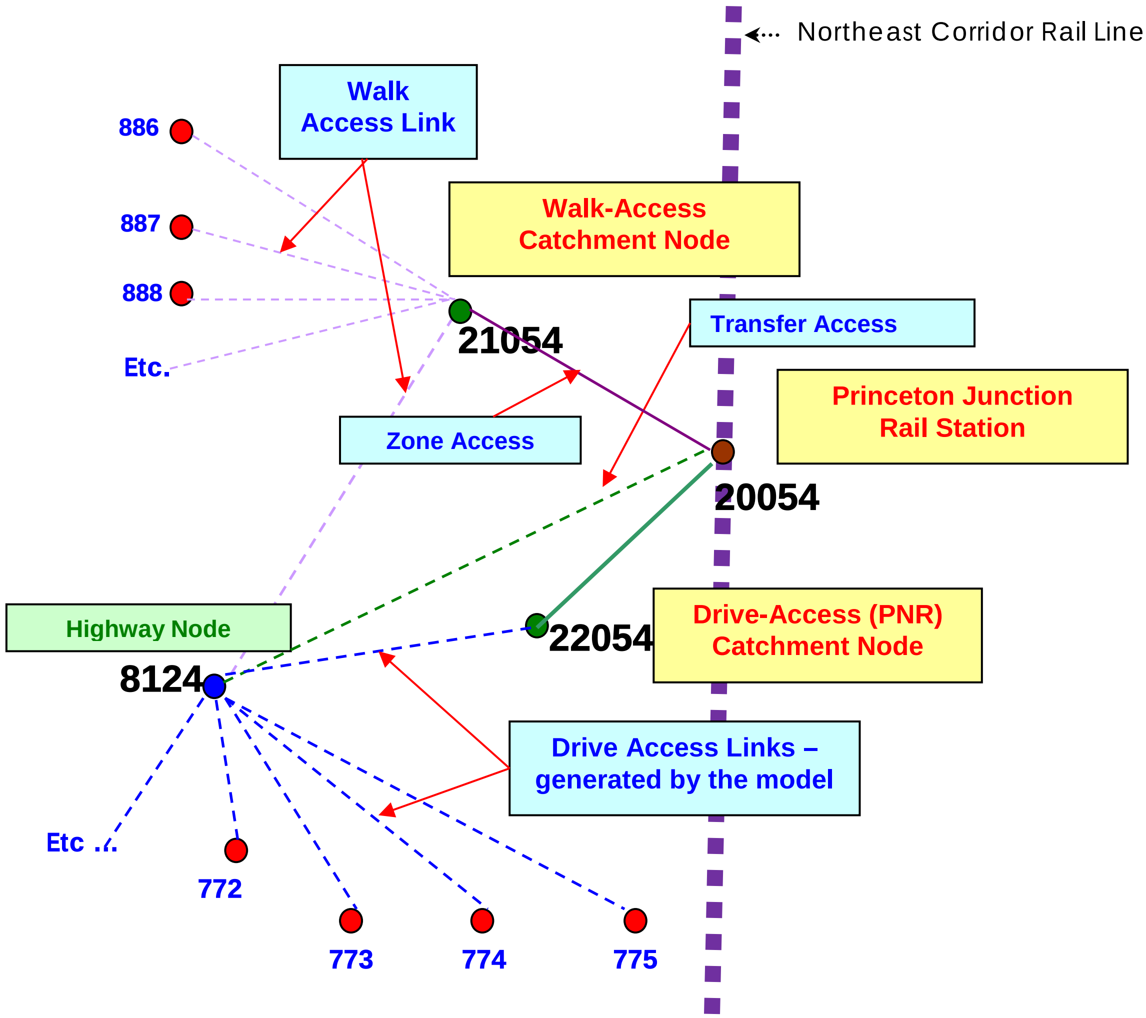
Similar to the highway network with the various types of facilities, the transit network was represented as a series of different "services". These services are abstracted as a series of "modes", reflecting the specific operating characteristics, such as use of shared right-of-ways in the case of bus services or the use of exclusive guide ways for the various rail services. Stratifying the network by mode is necessary since each type of transit service has different performance characteristics. For example, the performance characteristics of the commuter rail lines are significantly different than the local bus lines. The transit network was constructed by incorporating all of these "modes" representing the different type of transit services along with the necessary access and transfer connections. In the transit networks, modes represent actual transit routes, as well as walk/auto access connectors and "sidewalk" systems used to transfer in the CBD. It is common practice to refer to modes as being either "transit" or "non-transit" modes.

The various modes used in the OCTM transit network are listed in Table 6.1. As shown in the table, the first 10 modes represent the actual transit services provided in the region. Modes 11 -15 are the non transit modes which provide access and transfer linkages for the network. There are two different auto-access related modes (modes 11 and 15) used in the OCTM. Mode 11 includes the links connecting zones to gathering nodes at the major transit boarding points, such as PNR lots for express bus and rail lines. Mode 15 is used to provide a common "catchment" link between the PNR lot and the station and serves a single reference link to summarize all drive access trips using the station. Walk access to transit service is provided via Mode 14 links and includes a catchment link at major transit station. A schematic representation of this coding process is provided in Figure 6.1.

Table 6.1 Transit Network Modes

Mode Number	Mode Designation	Type of Service
1	Transit	Commuter Rail
2	Transit	PATH
3	Transit	NYC Subway
4	Transit	Newark Subway
5	Transit	Bus-Local
6	Transit	Bus-PABT
7	Transit	Bus PNR Bus
8	Transit	Ferry
9	Transit	Light-Rail Transit (LRT)
10	Transit	Long-Haul Ferry
11	Non-Transit	Auto Access to Zone to Gathering Node (PNR Lot)
12	Non-Transit	Walk Transfer
13	Non-Transit	Not-used
14	Non-Transit	Walk Access - Zone to Station
15	Non-Transit	Auto Gathering Access - Gathering Node (PNR Lot) to Station

Figure 6.1 Sample Access Coding from Princeton Junction Station



6.2.2 Transit Network Elements

The transit network consists of several elements that are maintained as separate files which are used as input to the TRNBUILD routine. The description of the coding structure and requirements for these elements is provided within the CUBE/VOYAGER documentation. The transit system includes:

- Transit routes for each transit mode.

- Non-transit access or transfer links for both walk and drive access.
- Transit nodes for the non-highway transit facilities such as stations for commuter rail lines, ferry terminals, and the subway system.
- Transit links for all non-highway transit lines as well as special connection links for the Hudson River XBL service, and PNR links.
- Park and Ride catchment zones for each station that define the zones that can utilize certain park and ride lots.

6.2.3 Transit Route Coding

The transit network is created during the model execution process as part of the transit path-building and assignment procedures. The transit network uses the underlying highway network as the basis for the transit routes. The transit network was coded to be consistent with the format required by the PT module. Although many line variables are available within PT to abstract transit routes, only certain variables were used in the OCTM. The variables utilized are listed as follows:

- Name – Route Name
- Mode – Transit Mode
- Oneway – Flag to indicated one-way or two-way routes
- Headway[1] – peak period headways in minutes
- Headway[2] – off peak period in minutes
- N - List of nodes identifying the orientation of a transit route through the network.

6.2.4 Transit Access Coding

The transit access coding in the OCTM was designed as a two-tier process. One tier represented auto access to the transit network. Each zone was assumed to be eligible for the auto-access, with connections to a predefined set of Park and Ride (PNR) lots. These access links were built using the existing highway links. In addition, PNR lots were also assumed to be accessible from certain zones. These zones were defined in the PNR Catchment Zones module and could be revised as necessary. The auto access mode was coded as mode 11 as discussed previously and listed in Table 6.1.

The auto-access links only connect zones to the node representing the PNR lots. To advance the travel from the PNR lots to the stations or express bus stops, a “catchment” link was utilized as a means of summarizing all trips accessing the station. These links were coded as mode 15 and each station has the specific catchment link included in the PNR coding statement.

The second tier represented walk access. Each zone has transit access automatically generated to available transit stops and the number of access links to each transit mode is controlled by the TRNBUILD path-building process. The automated walk access links were created using the underlying highway network and an assumed speed of three (3) mph walk speed. A maximum distance of 1 mile through the network grid was assumed for all modes except commuter rail (at 1.25 miles) and the Newark Subway (at 0.75 miles). In addition, certain zones in the immediate proximity of major transit stations had user-defined walk access links.

The mode choice model also requires that percentage of each zone within walk distance be calculated. This task was performed as part of the Transit Walk Access Coverage Application discussed in sections 4.6 and 5.1 of the User Guide. The procedure estimated the area percentage of each zone that is within ½ mile from transit service.

6.2.5 Transit Use Codes

As part of the NJRTM-E transit model refinement, which in turn was adopted by the OCTM, Stantec has developed a new coding process to represent "special use" transit facilities so as to minimize the coding of additional "parallel" transit only links. This new approach facilitates the coding of highway-based "special use" transit facilities such as exclusive bus lanes adjacent to general-purpose highway lanes (XBL) and preferential treatment such as queue jumps at traffic signals. This coding system also permits the coding of exclusive bus facilities such as those associated with a BRT-type system to be incorporated directly into the highway network, yet restricts the use of these links to the designated transit lines.

This coding system was implemented within the existing transit speed calculation process. The coding system contains three variables, each provided for the a.m. peak period and the off-peak period. The first variable (TCODExx, where xx is the period designation) is an index describing the type of special use transit facility. The second variable (TSCALExx) provides a time multiplier that enables the analyst to scale the transit time against the free flow or congested time highway time. The third variable (TADDxx) provides a time surcharge, either positive or negative, for transit vehicles on the link. The index variable TCODE is described in Table 6.2.

Table 6.2 TCODE Variable Description

TCODE	Description	Comments
0	Standard Roadway	Local street - use standard time factoring
1	Exclusive Bus Lane	XBL
2	Queue Jump Lane	US 22
3	Reserved	
4	Reserved	
5	Reserved	
6	Reserved	
7	Reserved	
8	Reserved	
9	Exclusive Bus ROW	BRT System - use hard coded time

The primary benefit of this coding approach is that the bus routes that utilized these special facilities can still reference to the existing highway network without resorting to coding transit-only links that would need to be maintained in separate files. With this coding process, an exclusive bus-only roadway and be incorporated into the highway network with TCODE=9. This system can also be used to incorporate other transit only links, such as rail lines, in the network, since all TCODES greater than 8 are not available for highway path-building and assignment.

Some examples of how this coding system can be applied are provided for the users review. For the XBL system, the user would code the relevant highway links with a TCODE value of 1.0. All links with this code utilize free flow travel time, which could then be scaled by the user (say 1.05) with the TSCALE variable, based on actual observed speeds. If the current XBL system encounters a ten-minute delay at the approach of the Lincoln Tunnel, that link would have a value of 10.0 in the TADD variable. Note that this process is independent of the level of congestion on the adjacent general use lanes. Hypothetically, if an alternative XBL system added a new lane and mitigated the delay at the Lincoln Tunnel approach, then TSCALE could be set to 1.0 and TADD set to 0.0.

In the case of a queue jump (TCODE=2) or some other shoulder treatment, the bus runtime would be scaled using congested travel time. The analyst has the option with the TSCALE variable to adjust the runtime to reflect conditions in the field. The TADD variable could then have an additional surcharge (positive or negative) to address any minor differences. Note in this case that the bus travel time in the future year would be affected by the general increase in level of congestion although the analyst could still refine this further if necessary.

In the case of an HOV lane that is available for express bus service, it would not be necessary to utilize the new coding procedure. Buses utilizing this lane, as well as all buses in the general use lanes would have travel times automatically adjusted in response to the congestion levels as part of the normal transit travel time estimation process.

6.2.6 Transit Network/Highway Network Integration

The NJRTME was designed so that the bus service in the transit network is referenced to the highway network in order to estimate travel time. This process ensures that the highway and transit times are estimated on a consistent basis. With this process, increases in highway congestion will results in increased bus travel time. The linkage between the travel time on the networks was performed with a distance-based approach, i.e., the highway travel time was amplified by a distance factored by speed adjustment constant, following formula below:

*Transit Time = Highway Time + distance * speed factor*

Where:

Transit Time = defined transit time for each highway link
Highway Time = estimated highway time in each network link

Distance = link distance
Speed Factor = Speed factor based on facility type and area type.

The speed adjustment factors are varied between peak and off peak periods. Tables 6.3 and 6.4 list the factors for peak and off-peak periods, respectively.

Table 6.3 Speed Adjustments Factors for Peak Period

FT	AT1	AT2	AT3	AT4
1	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00
3	1.00	0.85	0.70	0.60
4	1.20	1.20	1.00	0.60
5	1.70	2.50	2.20	0.70
6	1.70	2.80	2.50	0.70
7	1.90	2.80	2.50	1.25
8	2.00	2.80	2.50	2.00
9	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00

Table 6.4 Speed Adjustments Factors for Off-Peak Period

FT	AT1	AT2	AT3	AT4
1	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00
3	0.50	0.35	0.25	0.10
4	1.00	0.35	0.35	0.25
5	1.50	0.50	0.30	0.25
6	1.50	1.50	0.30	0.50
7	1.50	1.50	1.00	1.45
8	2.20	2.00	1.50	2.00
9	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00

The distance-based approach was used primarily to minimize the impact of highway time changes during the calibration process. Because the highway network congested time oscillated frequently and sometimes quite significantly for some links during the calibration process, this caused a significant change of transit time as well. To provide more stable transit time for the calibration effort, the distance-based approach was used. It is recommended that the more common approach of scaling travel time be considered as a future enhancement.

6.2.7 Transit Fare

The fare estimation procedure from the NJRTM-E was adopted for use by the OCTM to calculate the fares for each of the transit modes. The following fare systems exist among the different transit modes in use:

- A distance-based fare system based on the distance traveled between boarding and alighting location
- A zonal fare system based on the boarding and the alighting station
- A flat fare system where a boarding fare is collected for all passengers on a given route or mode
- Costs for specific Park and Ride (PNR) lots

Table 6.5 lists the fare systems used in the OCTM. Considering that transit is not the focus of the OCTM, the detail discussion of transit fare is not presented in this manual. Instead, the analysis is advised to consult the NJRTM-E Model Development Guide and NJRTM-E Revalidation Report available on the NJTPA website as previously mentioned in Chapter 1, for detail discussion about transit fares

Table 6.5 Fare Types

Mode	Fare Type
Commuter Rail	Zonal Fare
Local Bus	Distance-based fare system
LRT	Fixed fare system
NYC Subway	Fixed fare system
Newark Subway	Zonal Fare
Ferry	Zonal Fare
Express Bus	Distance-based fare system
PATH	Fixed fare system
PNR Lots	Station specific fares

7.0 TRANSIT PATH-BUILDING

7.1 INTRODUCTION

The transit path-building procedure is used to accumulate impedances for the transit modes that are available within the mode choice model. The impedances include transit in-vehicle time and various out-of-vehicle time measures such as walk time and wait time. The path-building procedures also estimate transit fares for each mode as part of a separate fare estimation program called "NJFARE2". These impedance values are accumulated in matrix files based on definition of the mode choice model variables. It should be noted that transit paths are established by time period for each "access submode/line-haul mode combination" and that paths are developed based on minimum travel times weighted by time component.

7.2 MODE HIERARCHY

Since travel through the transit networks often requires transfers between various transit modes, such as transfer from a NJ Transit commuter rail line to the PATH system, it is necessary to establish a hierarchy between the modes to define which mode is the "primary mode" and which modes act as secondary transfer modes. The OCTM adopted the hierarchical system developed for the NJRTM-E and the NJ Transit Mode Choice Model, which is based solely on the use of particular modes at any point during the travel path. The hierarchical system is defined as follows:

- A path is defined as the commuter rail mode if it contains time on the commuter rail lines.
- A path is defined as the "LRT mode" if includes time on the LRT lines, but not time on commuter rail lines
- A path is defined as the "PATH mode" if it includes time on PATH, but not the commuter rail mode or the LRT mode.
- A path is defined as the "bus mode" if it includes bus time or Newark Subway time but no other transit modes other than ferry time
- A path is defined as the "long haul ferry mode" if it includes only long-haul ferry time.
- A path is defined as the "ferry mode" if it includes only local ferry time.

7.3 PATH-BUILDING PARAMETERS

The path-building process was done separately for each walk-access and drive-access transit path mode options. A total of 12 transit path building processes were performed for each time period, consistent with the NJ Transit Mode Choice Model requirements. These access/line-haul mode combinations include:

- Walk-access and auto-access for bus
- Walk-access and auto-access for rail
- Walk-access and auto-access for PATH
- Walk-access and auto-access for LRT
- Walk-access and auto-access for ferry
- Walk-access and auto-access for long-haul ferry

In the transit path-building procedures, various time components were introduced and each time component was normally weighted to reflect how onerous that time component is to the user. For example, time spent waiting for a transit vehicle is perceived as more onerous or burdensome than the time spent in-vehicle traveling towards destination. The OCTM defined the values of out-of-vehicle time factors, which include wait and transfer times, in the range of 1.5 to 2.0. The list of path-building parameters is shown in Table 7.1.

Table 7.1 Path Building Parameters

Parameters	Values
Number of zone access links to:	
Rail, NYC Subway, Bus, Ferry, and Long-Haul Ferry	8
PATH	4
Newark Subway, LRT	3
Maximum walk distance (miles) to:	
Commuter Rail and Long-Haul Ferry	1.25
Newark Subway	0.75
All other modes	1.00
Assigned walk speed (mph)	3.0
Transfer Penalty (minutes) for:	
First Transfer	5.3
Second Transfer	6.9
Third Transfer	7.6
Fourth Transfer	8.2
Fifth Transfer and up	8.6
Initial wait factor for:	
Commuter Rail and Long-Haul Ferry	2.0
All other modes	1.5
Transfer wait factor for:	
Commuter Rail and Long-Haul Ferry	2.0
All other modes	1.5
Maximum impedance	655

In the path-building process, two sets of skim files by time-of-day were prepared: the peak and off-peak transit skims. The off-peak transit skim files were performed only in the first model iteration. The peak period transit skim files were performed during each model iteration in order to reflect changes in congested highway travel time and the resultant impact on highway-based transit run times.

As mentioned at the beginning of this section, the skim files were prepared for each "preferred" line-haul mode for each access mode. To obtain the desired paths for the preferred access/line-haul mode combinations, the times of individual modes are weighted to influence the creation of paths. To discourage the use of particular modes, weights in excess of 1.0 were applied. It should be noted that paths being created for a particular mode, even when weighted favorably may not result in the use of the required line-haul mode. If this condition exists for a given line-haul mode on a particular origin-destination zonal pair, that mode is rejected during the fare estimation process and the mode will not be an eligible option in the subsequent mode choice processing. Table 7.2 lists the in-vehicle time weights applied to each mode as part of path-building for a particular access/line-haul mode combination. Note that the weights by mode are identical by time period.

Table 7.2 Path Building Mode Weights

Path (Favored Mode)	Rail	Long Ferry	PATH	NYC Sub	NWK Sub	Local Bus	Expr Bus	PNR Bus	Ferry	LRT	Non-Transit
Peak Walk-to-Rail	1.0	1.2	1.5	2.0	1.0	2.5	6.0	6.0	1.2	1.2	2.0
Peak Walk-to PATH	4.0	4.0	1.0	2.0	1.0	1.5	4.0	4.0	4.0	4.0	1.5
Peak Walk-to-Bus	4.0	4.0	4.0	1.5	1.0	1.0	1.2	1.2	2.0	4.0	1.5
Peak Walk-to-Ferry	4.0	4.0	4.0	1.5	1.0	2.0	4.0	4.0	1.0	1.2	1.5
Peak Walk-to-LRT	4.0	4.0	1.2	1.5	1.0	2.0	4.0	4.0	1.5	1.0	1.5
Peak Walk-to-Long Dist. Ferry	1.2	1.0	4.0	1.5	1.0	2.0	4.0	4.0	1.2	1.2	2.0
Peak Drive-to-Rail	1.0	1.0	1.0	2.0	1.0	3.0	6.0	6.0	1.2	1.2	2.0
Peak Drive-to-PATH	4.0	4.0	1.0	2.0	1.0	2.0	4.0	4.0	4.0	4.0	1.5
Peak Drive-to-Bus	4.0	4.0	4.0	1.5	1.0	1.0	1.2	1.2	2.0	4.0	1.5
Peak Drive-to Ferry	4.0	4.0	4.0	1.5	1.0	2.0	4.0	4.0	1.0	1.2	1.5
Peak Drive-to-LRT	4.0	4.0	1.2	1.5	1.0	2.0	4.0	4.0	1.5	1.0	1.5
Peak Drive-to Long Dist. Ferry	1.2	1.0	4.0	1.5	1.0	2.0	4.0	4.0	1.2	1.2	2.0
Off-peak Walk-to-Rail	1.0	1.2	1.5	2.0	1.0	2.5	6.0	6.0	1.2	1.2	2.0
Off-peak Walk-to PATH	4.0	4.0	1.0	2.0	1.0	1.5	4.0	4.0	4.0	4.0	1.5
Off-peak Walk-to-Bus	4.0	4.0	4.0	1.5	1.0	1.0	1.2	1.2	2.0	4.0	1.5
Off-peak Walk-to-Ferry	4.0	4.0	4.0	1.5	1.0	2.0	4.0	4.0	1.0	1.2	1.5
Off-peak Walk-to-LRT	4.0	4.0	1.2	1.5	1.0	2.0	4.0	4.0	1.5	1.0	1.5
Off-peak Walk-to-Long Dist. Ferry	1.2	1.0	4.0	1.5	1.0	2.0	4.0	4.0	1.2	1.2	2.0
Off-peak Drive-to-Rail	1.0	1.0	1.0	2.0	1.0	3.0	6.0	6.0	1.2	1.2	2.0
Off-peak Drive-to-PATH	4.0	4.0	1.0	2.0	1.0	2.0	4.0	4.0	4.0	4.0	1.5
Off-peak Drive-to-Bus	4.0	4.0	4.0	1.5	1.0	1.0	1.2	1.2	2.0	4.0	1.5
Off-peak Drive-to Ferry	4.0	4.0	4.0	1.5	1.0	2.0	4.0	4.0	1.0	1.2	1.5
Off-peak Drive-to-LRT	4.0	4.0	1.2	1.5	1.0	2.0	4.0	4.0	1.5	1.0	1.5
Off-peak Drive-to Long Dist. Ferry	1.2	1.0	4.0	1.5	1.0	2.0	4.0	4.0	1.2	1.2	2.0

Skim matrices were prepared based on the mode choice requirements. Twelve skim files were prepared consistent with the path building processes performed, as mentioned above. Extensive information was stored in each skim file for use in the mode choice process. Table 7.3 shows the list of tables stored in a typical skim file.

Table 7.3 Skim File Table Format

Tables No	Description
1	In-Vehicle Time - IVTT
2	Total wait time
3	Walk time
4	Rail time
5	PATH time
6	NYC Subway & Staten Island Rapid Transit time
7	Newark City Subway time
8	Total Bus time (modes 5,6,7)
9	Ferry time & Port Authority Bus Lines time
10	LRT time
11	Drive time
12	Walk-access time
13	Number of transfer
14	Local Bus distance
15	PABT Bus distance
16	LRT distance
17	Commuter Rail first station
18	Commuter Rail last station
19	PNR Bus first station
20	PNR Bus last station
21	Ferry first station
22	Ferry last station
23	Initial wait time
24	Drive distance
25	PNR location
26	Total transit distance
27	Local bus time
28	PABT Bus first station
29	PABT Bus last station
30	PATH first station
31	PATH last station
32	Newark Subway first station
33	Newark Subway last station
34	LRT first station
35	LRT last station
36	Long-Haul Ferry time
37	Long-Haul Ferry first station
38	Long-Haul Ferry last station

7.4 TRANSIT FARE ESTIMATION

Within the path-building step, transit fares are calculated for each access model/line-haul mode combination. The fare estimation process is generated via a complex fare system used by NJ Transit as described extensively in the "Transit Network Development" section of this document. It is implemented with a customized C+ program which is called directly by CUBE. It provides several systems to assess fares along with surcharges for specific situations. In summary, those fare systems are described as follows:

- Distance-based fare system for bus modes
- Zone-based fare system for commuter rail, ferry, and Newark City subway modes
- Station-specific fare system for special bus station premiums
- Fixed fare system for LRT, NYC subway, and PATH

The transit fare for each origin-destination zonal pair is a function of the path selection. It is important to note, however, that the fare values do not influence the path selection process. Rather, it is based purely on the weighted travel times, as discussed earlier.

8.0 COMPOSITE IMPEDANCE ESTIMATION

8.1 COMPOSITE IMPEDANCE TERM DEVELOPMENT

The objective of utilizing a composite impedance term in the trip distribution process is to enable the routine to be sensitive to not only the highway travel time, but rather a more complete representation of the travel choices and costs between various origin-destination zonal pairs. Several methods have been investigated in the past and generally there is a strong preference to use the logsum term of the mode choice model since it is properly structured to represent the impedances offered by all modes and weighted to reflect the actual usage of these modes. The logsum term includes not only cost and time elements, but also the mode bias constants which account for nonmeasurable traveler preferences, such as safety and comfort. Initially Stantec investigated the use of the logsum term from NJ Transit Mode Choice Model. However this particular model has mode bias terms that vary by geographic market segment. This variation causes significant discontinuous impedance values when trips are being allocated across competing destinations. This level of variation was assumed to provide significant problems with the use of this term during the trip distribution and was therefore removed from consideration as the impedance term for this project.

An alternative impedance term was adopted for this project using a structure known as the "parallel conductance" formula. This particular formulation is flexible enough to incorporate most of the impedance terms in the traditional mode choice logsum term and can be structured to be sensitive to the actual mode choice of the zonal pair or subregions. The formula is structured as follows:

$$IC = 1.0 / (1.0/IH + MST/IT)$$

Where:

IC = Composite impedance for zonal pair i-j
IH = Highway impedance for zonal pair i-j for the "representative" auto mode
MST = Regional transit mode share
IT = Transit impedance for zonal pair i-j for the "representative" transit mode

Note that the highway and transit impedance terms would represent all elements of travel times and costs, by structuring the impedance for each mode as a generalized cost. With this approach, the composite impedance term would reflect all of the costs (fare, tolls, auto operating costs & parking) and the various time components (in-vehicle, waiting/walking) that are incorporated in the logsum term. For the OCTM, the generalized costs would be based on the values of time for each trip purpose obtained from the New Jersey Transit Mode Choice Model, which was based on the stated preference survey conducted by RSG in the early 1990s.

The modal share term provides a mechanism that effectively "weighs" the impact of the transit impedance into the composite term. Note that if transit mode share is zero, then the term defaults back to the highway-based impedance. If transit share is nonzero, the composite term is reduced in value in order to represent the aspect of having multiple services available between a given origin and destination. The transit modal share term in many applications is derived from a general "regional" transit share as opposed to the specific transit mode share of a given origin-destination zonal pair. The OCTM used the mode shares for each I-J zonal pair rather than a regional share value in order to more properly reflect within the composite term the degree of competiveness provided by the transit service for individual zonal pairs.

8.2 COMPOSITE IMPEDANCE VARIABLES

As part of developing the composite impedance estimates, it was necessary to adopt both the "representative" mode for the various auto modes and transit modes as well as the cost and time components that are included for mode choice. While the SOV auto mode would be the likely mode representing all auto modes due to its dominance and uniform characteristics, the selection of the representative transit mode was more complex. There are multiple line-haul modes available coupled with both walk access and drive access submodes. Stantec defined the "best" transit mode being used as the "reference" mode, as being the transit mode with the minimum travel time, appropriately weighted for in-vehicle and out-of-vehicle elements as well as transfer surcharges. The time and cost variables for each representative mode are as follows:

Auto Mode:

IH =TimeSOV + TollsSOV /100.0 * 60.0/14.4

Transit Mode

IT =TimeTIVT + TimeTOVT*2.5 + CostTRAN /100.0 * 60.0/14.4

where:

IH	= Highway impedance for zonal pair i-j for the auto mode
IT	= Transit impedance
TimeSOV	= Time for the SOV mode in minutes
TollsSOV	= Toll costs for the SOV mode in cents
TimeTIVT	= In-vehicle time (in-vehicle and drive access) for best transit mode in minutes
TimeTOVT	= Out-of-vehicle time (walk and wait) for best transit mode in minutes
CostTRAN	= Transit fare and PNR cost for best transit mode in cents

Note that the highway costs did not include parking costs since uniform data was not available for the entire study area as part of this project. Also, auto operating costs were not included since it was believed that these estimates should be determined based on speed rather than just distance and adequate information on fuel costs by speed were not available for this analysis. As such the SOV time variable serves as a proxy for the influence of both auto time and the cost of fuel on the distribution of trips. In contrast, the transit cost variable reflects both transit fares and parking costs at stations since this data is readily-available and is estimated with specificity as part of the transit networks.

8.3 COMPOSITE IMPEDANCE APPLICATION ISSUES

There are several implementation issues that need to be addressed when implementing the proposed composite impedance structure. The first issue is related to the inability of the impedance term to reflect the appropriate weight that should be applied to each mode that is represented in the composite term. When using the logsum term, the weighted effect of each mode's contribution to the overall "utility" is directly incorporated into the composite impedance value. Therefore, the introduction of a new mode or any reduction in service is properly reflected as part of the change in the overall impedance. In contrast, the parallel conductance formula includes only one representative mode for auto and transit. Potential inconsistencies can occur if changes in the mode representing the "best" path have offsetting characteristics. For example, consider a situation where the introduction of a new transit service that provides a better travel time, but at higher cost. In such cases, the new service, as the "best" transit mode, may have a marginally lower travel time, but a higher fare, that leads to a higher transit impedance term. The higher transit impedance term, if not properly controlled, would lead to a higher composite impedance value, causing trip distribution to allocate fewer trips between a given zonal pair in response to the introduction of an "additional" mode with better service. For several reasons, this is counter-intuitive. Most relevant is the fact that the previous transit mode deemed "best" prior to the new mode might still exist, so the overall service should not have a higher impedance value than the value prior to the new mode. To address this possible issue, Stantec did utilize specific i-j zonal pair transit mode shares, rather than the regional transit modal shares as a means of offsetting this concern. Note, however, this condition would only be possible in situations where the travel time gains for the new mode are minimal and differential fare for the new mode is significant.

The second implementation issue is the need to establish transit shares by zonal pair for use in the calculation as weighing mechanism. As mentioned above, the logsum value reflects the appropriate weighting of all modes as a function of their "utility". If the logsum approach is used, by simply executing the mode choice model prior to trip distribution, the "logsum" composite impedance term and share percentages for each mode are established simultaneously prior to trip distribution. Distribution is then performed and the percentages shares are applied to resulting person trips to create the final trips by mode for each zonal pair.

In contrast, the parallel conductive technique requires the transit share in order to form the composite impedance value. Prior applications of this technique simply specified a "regional" transit share to be used to weigh the transit contribution for the combined term, but this approach limits the sensitivity since each zonal pair would have the same transit weighting, even though transit level of service may vary significantly between certain origin-destination zonal pairs. Stantec elected to use a separate weighing approach with the specific transit share for each zonal pair. This necessitated the creation of transit shares prior to the execution of the mode choice model.

In order to prepare transit shares for the initial model iteration, a support application was developed that establishes shares based on a previous model run. These initial shares are applied only during the first model iteration, with all subsequent iterations using shares developed from the previous iteration of the current execution.

9.0 MODEL CALIBRATION

9.1 INTRODUCTION

Model calibration was performed for each model component from Trip Generation to Highway Assignment. Since the OCTM was derived from the NJRTM-E with special focus on the Ocean County Region. Stantec maintained the original NJRTM-E parameters and formulas as much as possible. Adjustment factors specific to the Ocean County Region were added whenever necessary.

As previously mentioned Section 3.1, the 2010-2011 NJTPA-NYMTC RHTS data was used to calibrate the trip generation model and trip distribution model components, supplemented by the 2008 NJRTM-E Revalidation results.

It should also be noted that the OCTM model consists of four time-of-day periods, although most of the calibration summaries are presented in daily estimates. The four time-of-day periods are:

- Morning Peak Period between 6 and 9 AM
- Midday Period between 9AM and 3 PM
- Afternoon Peak Period between 3 and 6 PM
- Night Period between 6PM and 6AM

9.2 TRIP GENERATION

The OCTM trip generation component was developed using standard technique commonly found within the four-step urban travel demand models. These techniques include a cross classification process for trip productions and linear regression equations for trip attractions. The OCTM trip production's cross classification and trip attraction's linear regression equations were adopted directly from the 2008 NJRTM-E Revalidation model. During the trip generation calibration process, additional adjustment factors specific for the Ocean County Model were introduced in order to replicate the trip production and attraction obtained from the 2010-2011 RTHS data. The adjustment factors were applied to the final trip productions and attractions prior to being distributed in the Trip Distribution Module. The adjustment factors were developed for the five income groups of each trip purpose as shown in Table 9.1.

Consistent with the NJRTM-E, there are six trip purposes in the OCTM, include:

- Home-Based Work Direct (HBWD)
- Home-Based Work Strategic (HBWS)
- Home-Based Shop (HBS)
- Home-Based Other (HBO)
- Non-home Based Work (NHBW)
- Non-Home Based Other (NHBO)

The comparison of total trip production and attraction by purpose is shown in Table 9.2. The trips are only for those that are produced in the Ocean County Region or attracted to the region. The trip production and attraction summaries by income group for each purpose are shown in Tables 9.3 to 9.8.

Table 9.1 Trip Generation Adjustment Factor for Ocean County Region

Trip Purpose	Income Group	Adjustment Factors	
		Production	Attraction
HBWD	1	5.7903	1.0129
	2	0.8576	0.9096
	3	0.6639	1.0294
	4	1.3789	1.5553
	5	1.0081	2.7499
HBWS	1	1.3117	1.3914
	2	0.6297	1.0575
	3	1.1179	1.6905
	4	0.6616	1.6260
	5	2.3771	3.5032
HBS	1	0.5717	1.0133
	2	0.6357	1.0676
	3	0.7808	0.9593
	4	1.3918	0.9092
	5	3.6673	1.0236
HBO	1	3.8742	1.0162
	2	0.7666	0.9785
	3	0.7120	0.8687
	4	0.6131	1.1159
	5	2.7741	1.2451
NHBW	1	1.2318	1.2318
	2	1.5215	1.5215
	3	1.2697	1.2697
	4	1.0889	1.0889
	5	1.3094	1.3094
NHBO	1	1.4762	1.4762
	2	1.5348	1.5348
	3	1.3802	1.3802
	4	1.4109	1.4109
	5	1.0619	1.0619

Table 9.2 Trip Production and Attraction Comparison by Purpose

PURPOSE	TRIP PRODUCTION			TRIP ATTRACTION		
	OBSERVED	ESTIMATED	% DIFFERENCE	OBSERVED	ESTIMATED	%DIFFERENCE
HBWD	262,671	262,672	0.0%	197,020	197,033	0.0%
HBWS	98,733	98,734	0.0%	85,789	85,790	0.0%
HBS	157,991	157,988	0.0%	151,016	151,016	0.0%
HBO	507,249	507,250	0.0%	491,639	491,692	0.0%
NHBW	110,033	110,034	0.0%	110,033	110,034	0.0%
NHBO	256,746	256,761	0.0%	256,746	256,761	0.0%
TOTAL	**1,393,424**	**1,393,439**	**0.0%**	**1,292,244**	**1,292,325**	**0.0%**

Table 9.3 Trip Production and Attraction Comparison by Income - HBWD

PURPOSE	TRIP PRODUCTION			TRIP ATTRACTION		
	OBSERVED	ESTIMATED	% DIFFERENCE	OBSERVED	ESTIMATED	%DIFFERENCE
INCOME 1	5,674	5,674	0.0%	4,953	4,953	0.0%
INCOME 2	30,634	30,634	0.0%	19,300	19,301	0.0%
INCOME 3	84,088	84,090	0.0%	60,780	60,782	0.0%
INCOME 4	108,035	108,033	0.0%	82,952	82,960	0.0%
INCOME 5	34,240	34,240	0.0%	29,035	29,037	0.0%
TOTAL	**262,671**	**262,672**	**0.0%**	**197,020**	**197,033**	**0.0%**

Table 9.4 Trip Production and Attraction Comparison by Income - HBWS

PURPOSE	TRIP PRODUCTION			TRIP ATTRACTION		
	OBSERVED	ESTIMATED	% DIFFERENCE	OBSERVED	ESTIMATED	%DIFFERENCE
INCOME 1	2,106	2,106	0.0%	1,765	1,764	0.0%
INCOME 2	5,948	5,948	0.0%	5,520	5,520	0.0%
INCOME 3	38,057	38,058	0.0%	34,855	34,855	0.0%
INCOME 4	35,065	35,066	0.0%	30,359	30,359	0.0%
INCOME 5	17,556	17,557	0.0%	13,292	13,292	0.0%

Table 9.5 Trip Production and Attraction Comparison by Income - HBS

PURPOSE	TRIP PRODUCTION			TRIP ATTRACTION		
	OBSERVED	ESTIMATED	% DIFFERENCE	OBSERVED	ESTIMATED	%DIFFERENCE
INCOME 1	13,581	13,581	0.0%	12,456	12,474	0.1%
INCOME 2	22,851	22,850	0.0%	20,081	20,093	0.1%
INCOME 3	55,347	55,346	0.0%	54,729	54,754	0.0%
INCOME 4	52,398	52,397	0.0%	51,013	50,974	-0.1%
INCOME 5	13,814	13,814	0.0%	12,737	12,720	-0.1%
TOTAL	**157,991**	**157,988**	**0.0%**	**151,016**	**151,016**	**0.0%**

Table 9.6 Trip Production and Attraction Comparison by Income - HBO

PURPOSE	TRIP PRODUCTION			TRIP ATTRACTION		
	OBSERVED	ESTIMATED	% DIFFERENCE	OBSERVED	ESTIMATED	%DIFFERENCE
INCOME 1	33,463	33,460	0.0%	30,517	30,633	0.4%
INCOME 2	77,550	77,544	0.0%	78,215	78,316	0.1%
INCOME 3	218,559	218,565	0.0%	212,607	212,717	0.1%
INCOME 4	137,355	137,359	0.0%	132,704	132,502	-0.2%
INCOME 5	40,322	40,323	0.0%	37,596	37,523	-0.2%
TOTAL	**507,249**	**507,250**	**0.0%**	**491,639**	**491,692**	**0.0%**

Table 9.7 Trip Production and Attraction Comparison by Income - NHBW

PURPOSE	TRIP PRODUCTION			TRIP ATTRACTION		
	OBSERVED	ESTIMATED	% DIFFERENCE	OBSERVED	ESTIMATED	%DIFFERENCE
INCOME 1	1,441	1,441	0.0%	1,441	1,441	0.0%
INCOME 2	8,852	8,855	0.0%	8,852	8,855	0.0%
INCOME 3	42,013	42,013	0.0%	42,013	42,013	0.0%
INCOME 4	39,902	39,897	0.0%	39,902	39,897	0.0%
INCOME 5	17,825	17,828	0.0%	17,825	17,828	0.0%
TOTAL	**110,033**	**110,034**	**0.0%**	**110,033**	**110,034**	**0.0%**

Table 9.8 Trip Production and Attraction Comparison by Income - NHBO

PURPOSE	TRIP PRODUCTION			TRIP ATTRACTION		
	OBSERVED	ESTIMATED	% DIFFERENCE	OBSERVED	ESTIMATED	%DIFFERENCE
INCOME 1	16,871	16,911	0.2%	16,871	16,911	0.2%
INCOME 2	41,826	41,861	0.1%	41,826	41,861	0.1%
INCOME 3	112,120	112,158	0.0%	112,120	112,158	0.0%
INCOME 4	70,778	70,700	-0.1%	70,778	70,700	-0.1%
INCOME 5	15,151	15,131	-0.1%	15,151	15,131	-0.1%
TOTAL	**256,746**	**256,761**	**0.0%**	**256,746**	**256,761**	**0.0%**

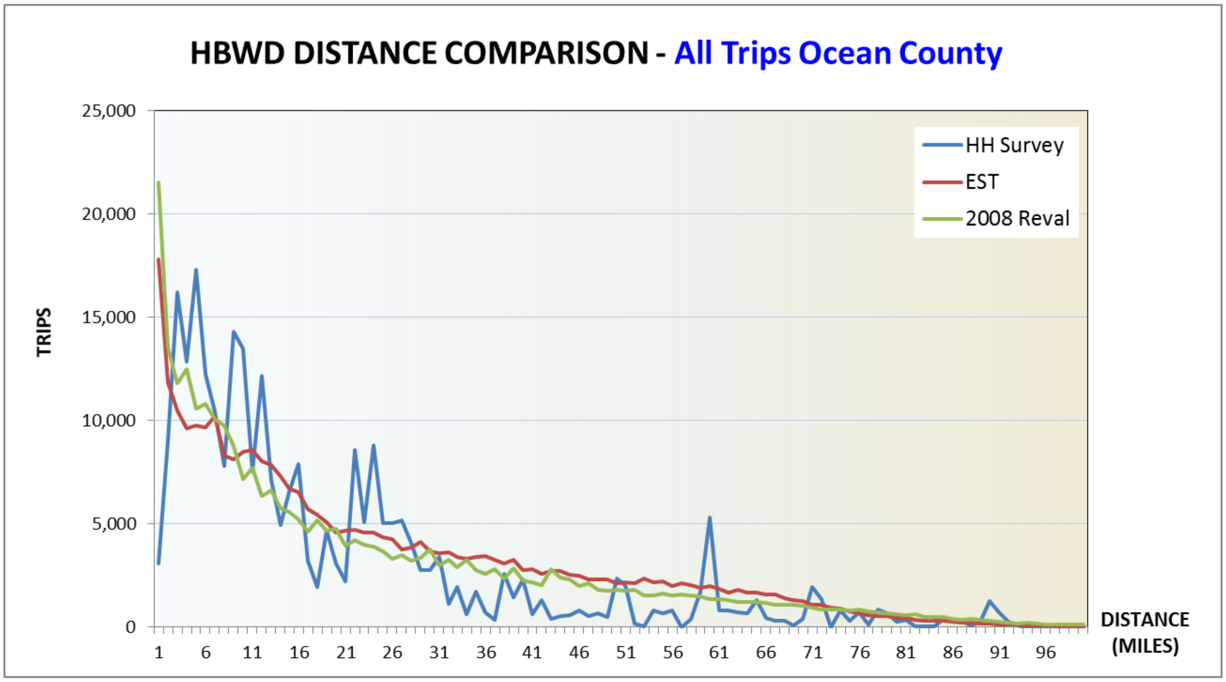
9.3 TRIP DISTRIBUTION

The trip distribution calibration focused on developing the inter- and intra-zonal travel flows. The estimated travel flows were compared to the observed flows that were developed from the various sources, such as the RHTS data and the 2008 NJRTM-E synthetic data. As previously mentioned in Section 3.1, the RHTS data is very limited at the county-level, therefore the introduction of the synthetic data from the 2008 NJRTM-E Revalidation results is important.

The OCTM utilizes standard "Gravity Model" procedures to perform the trip distribution process. The objective of the trip distribution is to develop friction-factors and k-factors that properly replicate the observed average trip length and also maintain the observed trip flow pattern. The trip distribution calibration process follows the same approach as the calibration of the NJRTM-E.

The trip flows were calibrated by comparing the frequency distribution of travel time and distance for each trip purpose for trips generated or attracted to Ocean County Region. The travel time and trip distance frequency distributions were used to help model the distribution of trips both produced and attracted to Ocean County. The frequency distributions by trip purpose are shown in Figures 9.1 to 9.6, while the average impedances (travel time and distance) by trip purpose are shown in Table 9.9.

Figure 9.1 HBWD Frequency Distribution



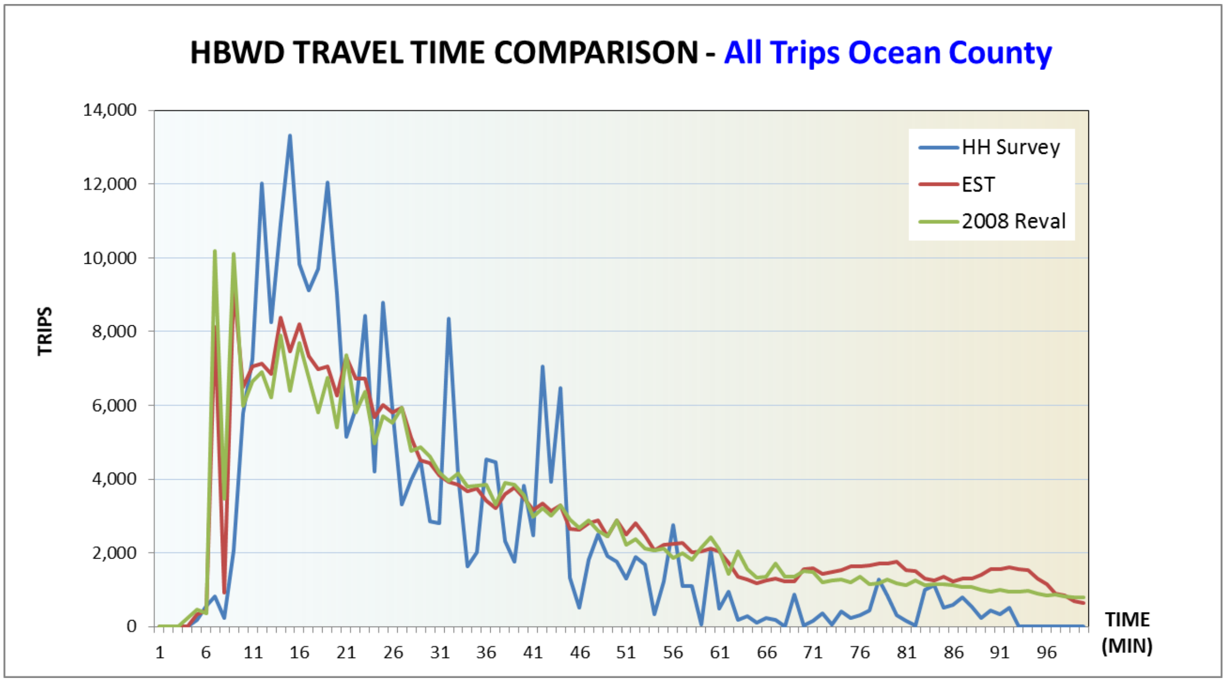
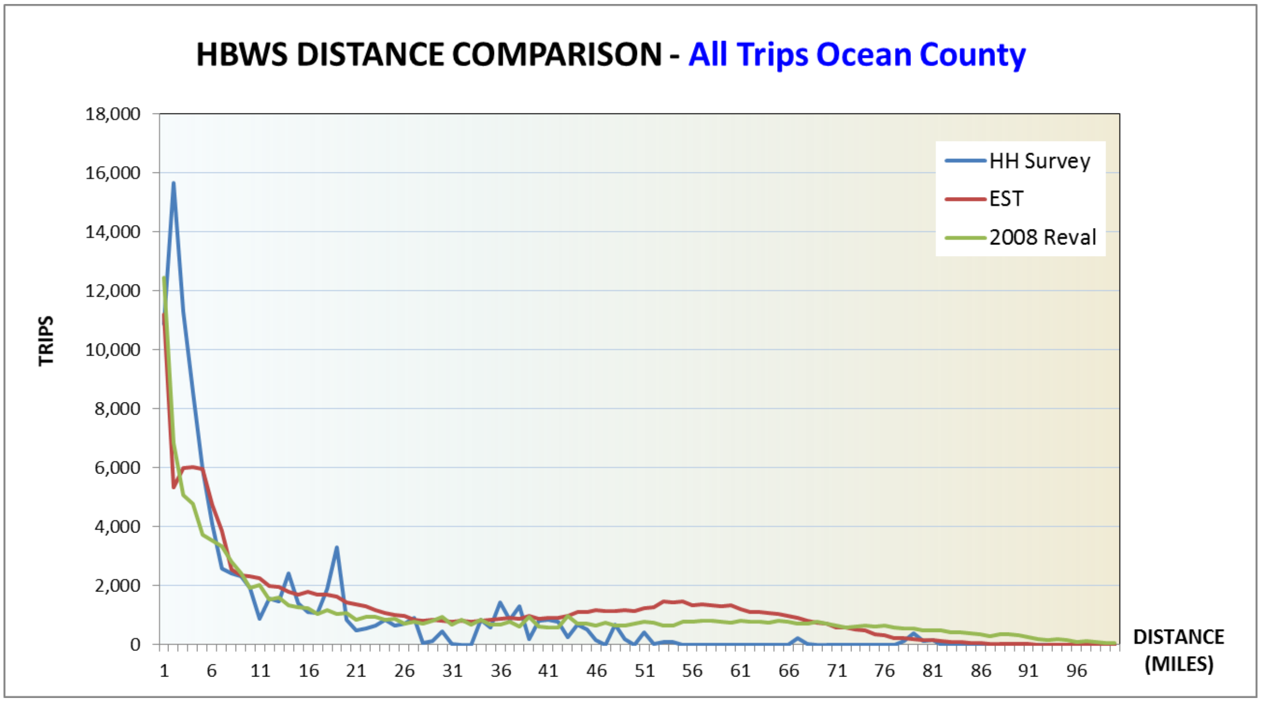


Figure 9.2 HBWS Frequency Distribution



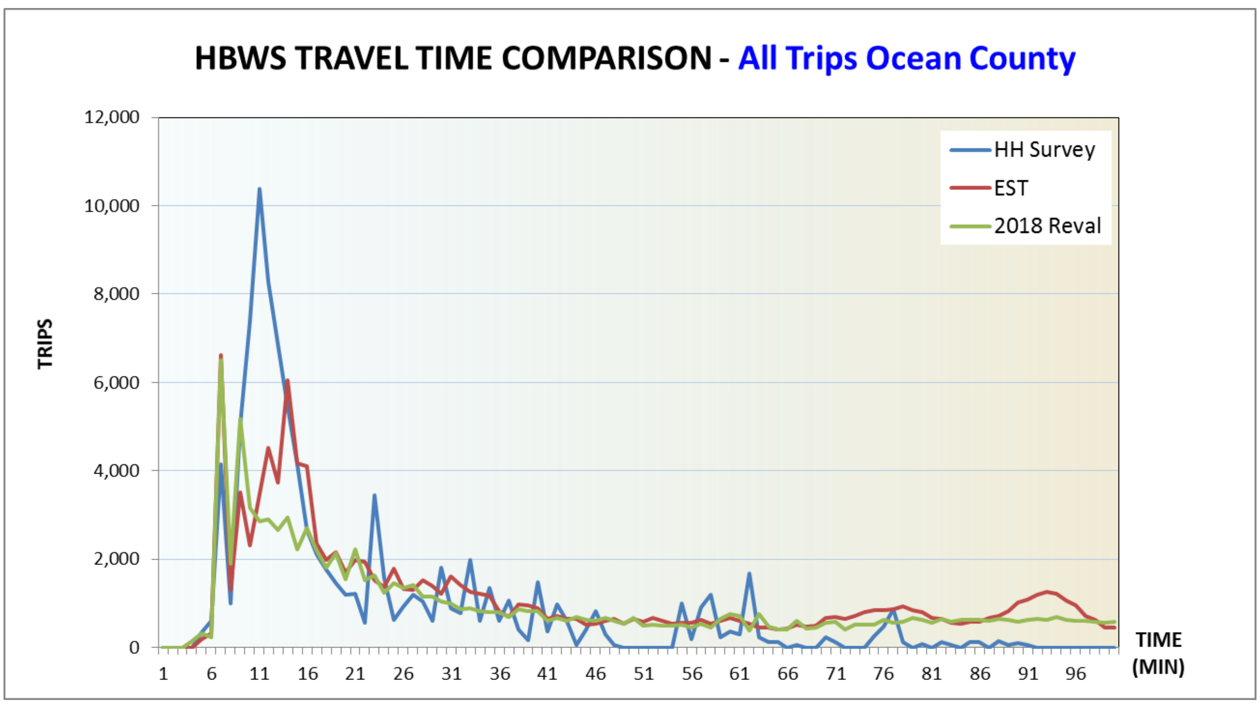
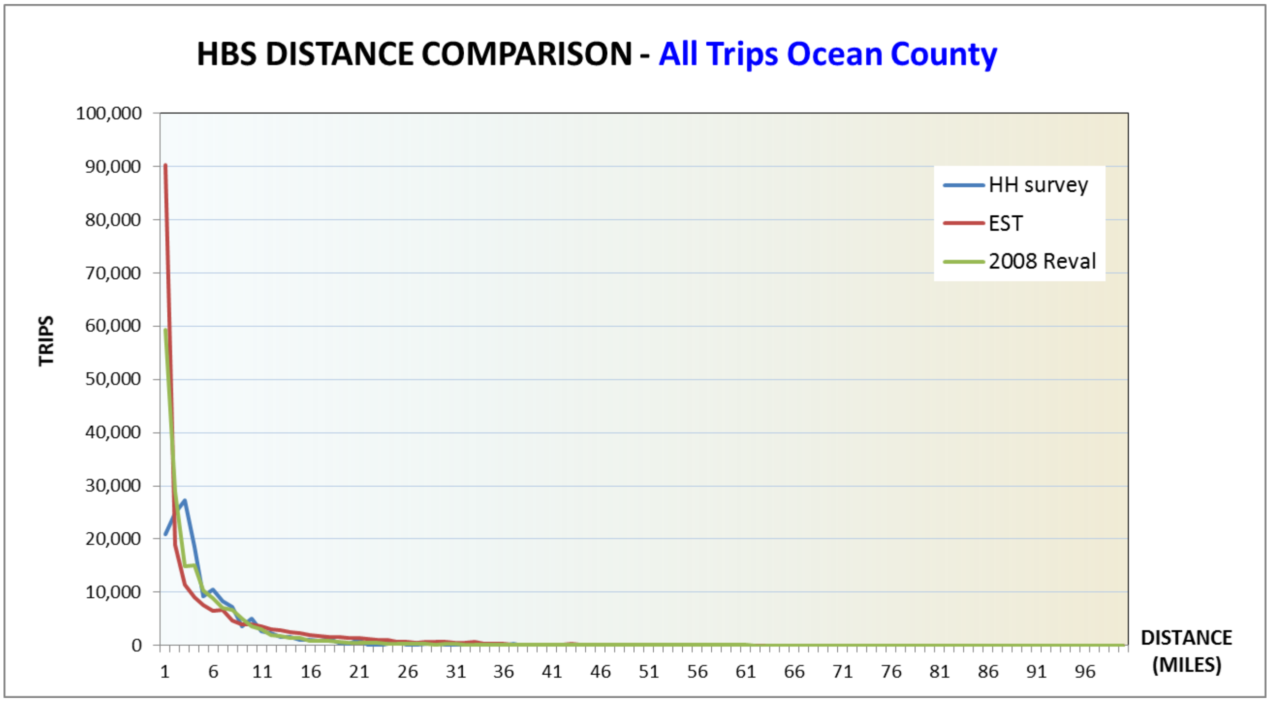


Figure 9.3 HBS Frequency Distribution



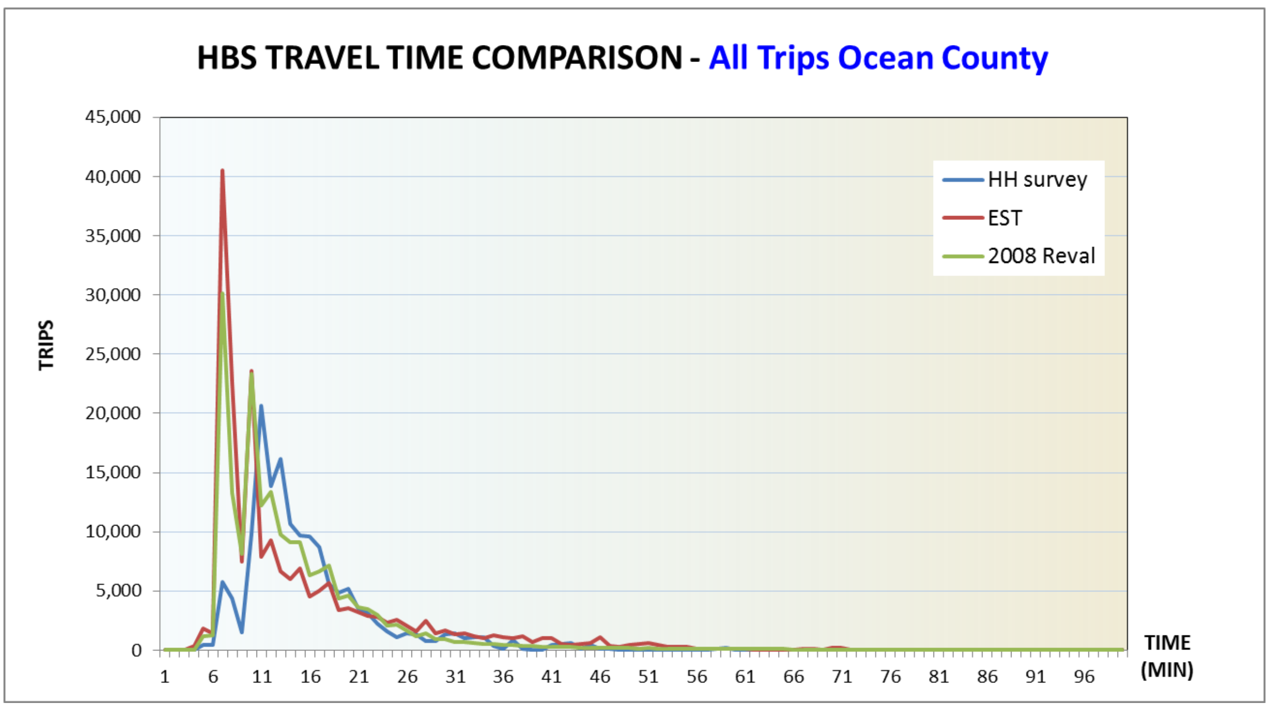
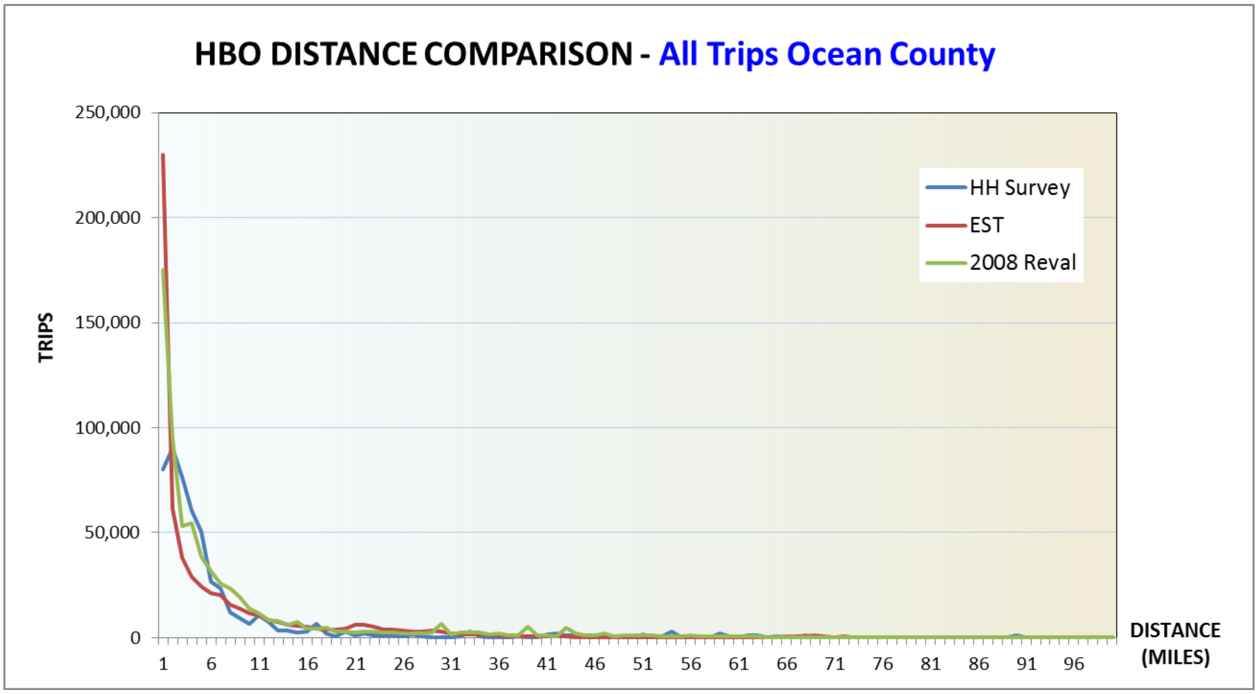


Figure 9.4 HBO Frequency Distribution



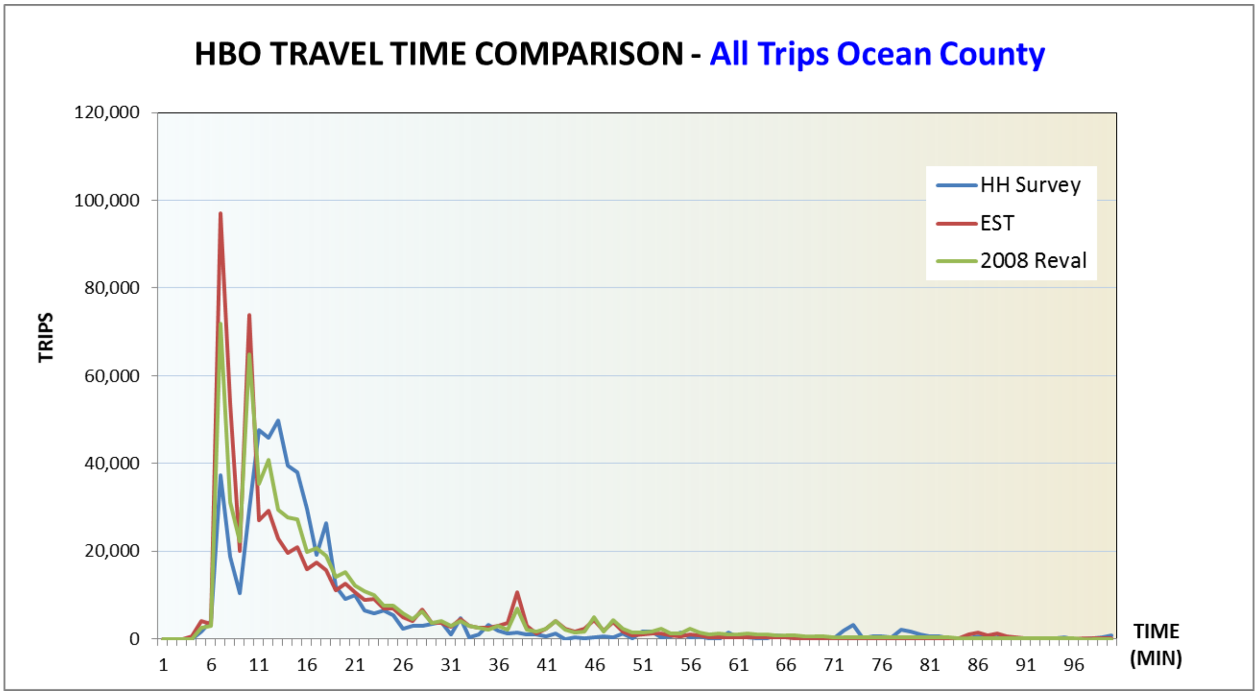
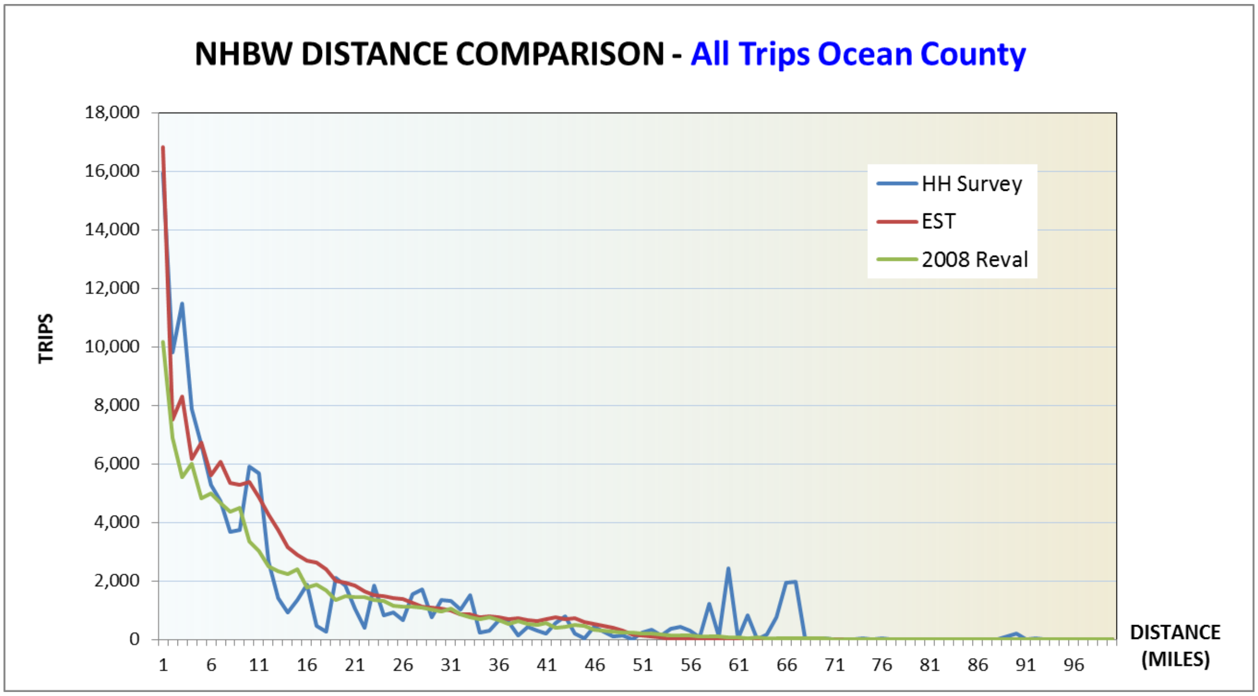


Figure 9.5 NHBW Frequency Distribution



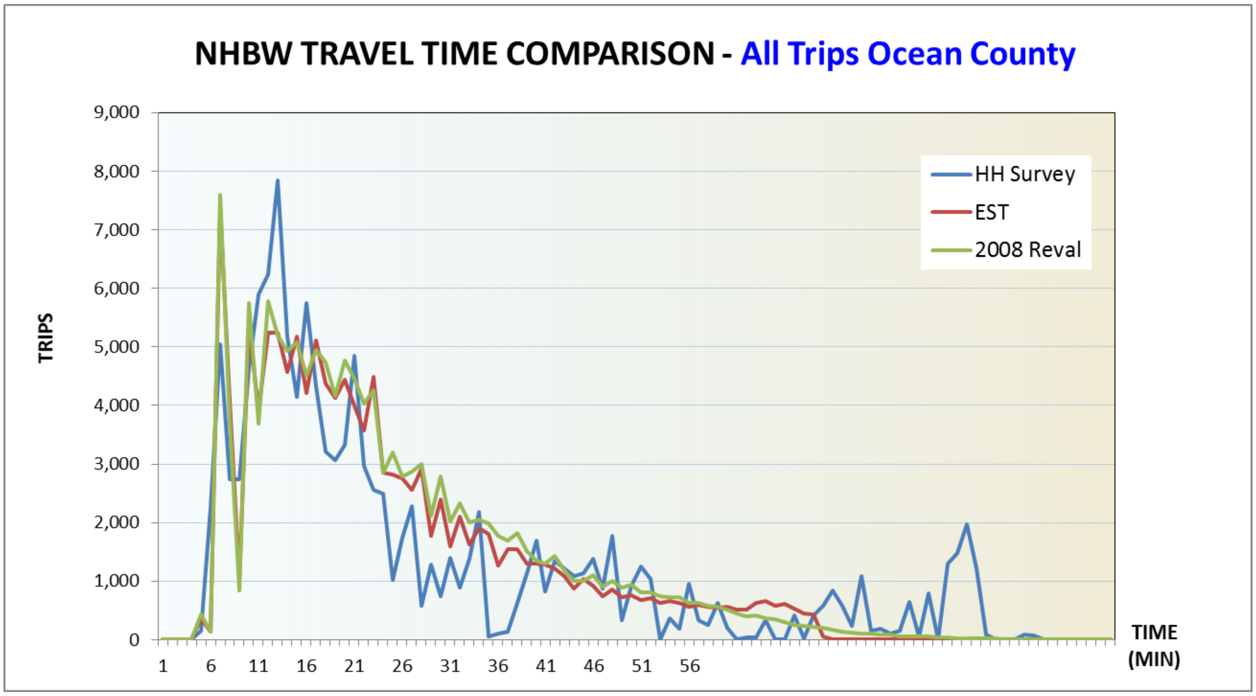
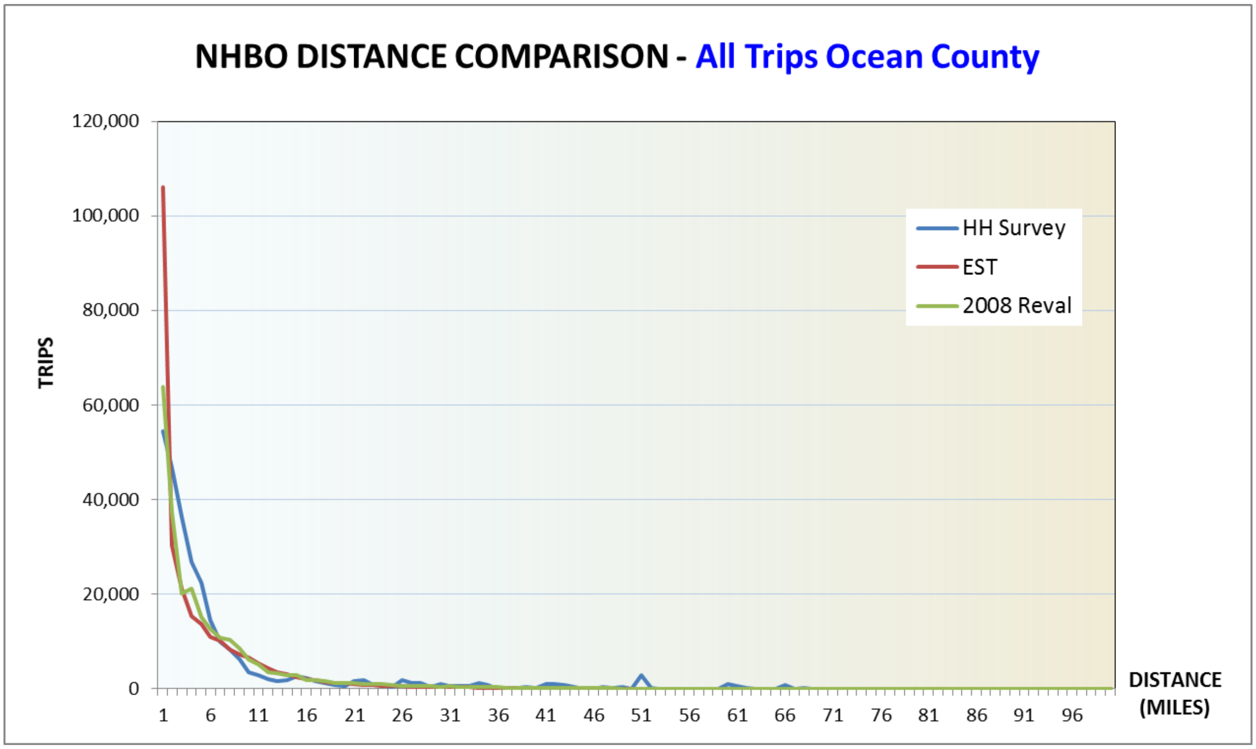


Figure 9.6 NHBO Frequency Distribution



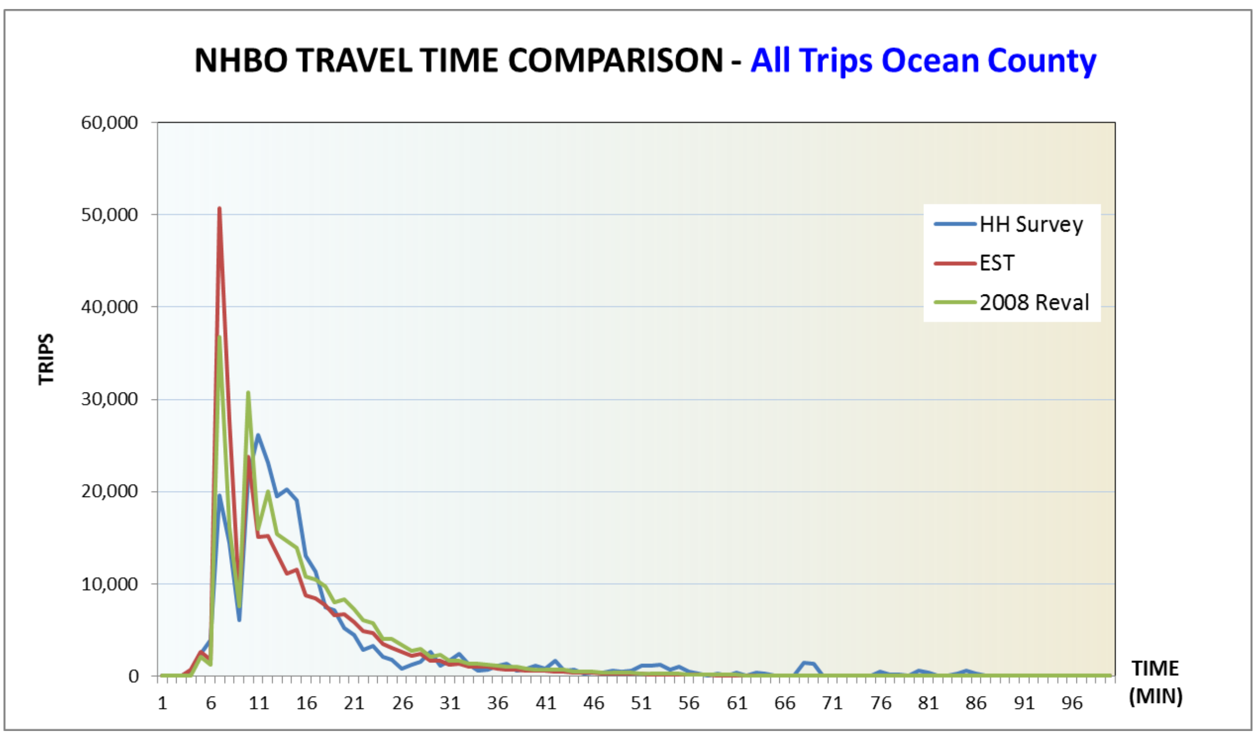


Table 9.9 Average Impedances by Purpose

TRIP PURPOSE	AVERAGE DISTANCE (MILES)			
	2010 RHTS	2011 REVAL. (YEAR 2008)	ESTIMATED	%DIFF (EST Vs. 2011 REVAL)
HBWD	20.5	23.7	24.9	5.2%
HBWS	11.6	27.9	26.0	-6.9%
HBS	5.4	5.3	5.9	10.6%
HBO	7.7	8.9	7.3	-17.1%
NHBW	16.1	13.9	12.6	-8.9%
NHNW	7.3	5.9	5.0	-15.9%
TOTAL	**10.8**	**12.7**	**12.0**	**-5.1%**

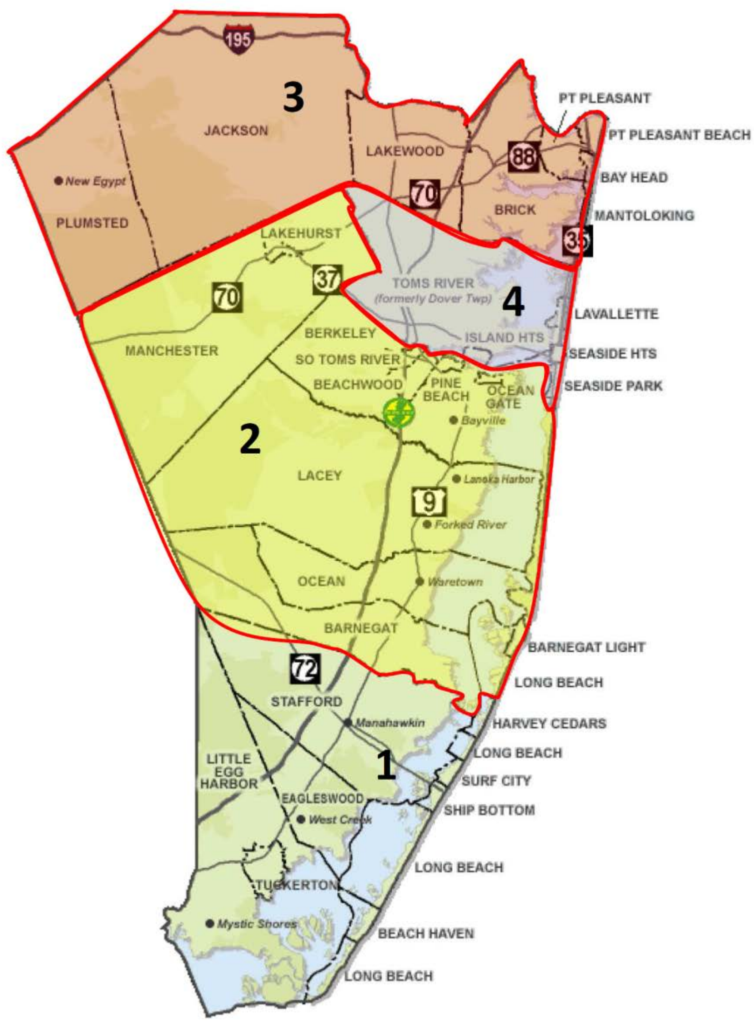
TRIP PURPOSE	AVERAGE TRAVEL TIME (MINUTES)			
	2010 RHTS	2011 REVAL. (YEAR 2008)	ESTIMATED	%DIFF (EST Vs. 2011 REVAL)
HBWD	33.4	39.2	41.3	5.3%
HBWS	20.7	45.0	43.7	-2.8%
HBS	15.4	14.7	15.5	5.4%
HBO	17.2	18.5	17.4	-6.0%
NHBW	26.8	25.2	24.8	-1.5%
NHNW	16.7	15.7	14.4	-8.6%
TOTAL	**21.1**	**24.2**	**24.0**	**-1.0%**

TRIP PURPOSE	AVERAGE SPEED (MPH)			
	2010 RHTS	2011 REVAL. (YEAR 2008)	ESTIMATED	%DIFF (EST Vs. 2011 REVAL)
HBWD	36.8	36.2	36.2	-0.1%
HBWS	33.7	37.3	35.7	-4.2%
HBS	21.1	21.6	22.7	5.0%
HBO	26.8	28.7	25.3	-11.9%
NHBW	36.1	33.0	30.5	-7.4%
NHNW	26.2	22.6	20.8	-8.0%
TOTAL	**29.2**	**29.3**	**27.6**	**-5.9%**

Ideally, district-to-district trip flow would also help to gauge how close the estimated trip distribution replicated the observed data. However, considering that the RHTS data at-county level is very limited, it is impossible to construct a meaningful trip interchange data. Instead, Stantec developed the percentage production and attraction by district. For this purpose, Ocean County was divided into four districts as shown in Figure 9.7, as follows:

- District 1 – Beach Haven, Eagleswood, Harvey Cedars, Little Egg Harbor, Long Beach, Ship Bottom, Stafford, and Tuckerton
- District 2 – Barnegat, Barnegat Light, Beachwood, Berkeley, Lacey, Lakehurst, Manchester, Ocean, Pine Beach, South Toms River
- District 3 – Bay Head, Brick, Jackson, Lakewood, Mantoloking, Plumsted, Point Pleasant
- District 4 – Island Heights, Toms River

Figure 9.7 District Definition



Tables 9.10 to 9.15 show the percent distribution comparison by district for each purpose.

Table 9.10 Percent Distribution by District - HBWD

HBWD

DISTRICT	PERCENT DISTRIBUTION PRODUCTION			PERCENT DISTRIBUTION ATTRACTION		
	HH SURVEY	2008 REVALIDATION	ESTIMATED	HH SURVEY	2008 REVALIDATION	ESTIMATED
1	11%	9%	11%	6%	9%	12%
2	34%	31%	28%	14%	18%	16%
3	39%	41%	42%	46%	46%	46%
4	16%	19%	18%	35%	28%	27%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 9.11 Percent Distribution by District - HBWS

HBWS

DISTRICT	PERCENT DISTRIBUTION PRODUCTION			PERCENT DISTRIBUTION ATTRACTION		
	HH SURVEY	2008 REVALIDATION	ESTIMATED	HH SURVEY	2008 REVALIDATION	ESTIMATED
1	10%	9%	12%	9%	9%	12%
2	24%	32%	29%	14%	17%	16%
3	43%	41%	42%	47%	47%	46%
4	22%	19%	18%	30%	28%	27%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 9.12 Percent Distribution by District - HBS

HBS

DISTRICT	PERCENT DISTRIBUTION PRODUCTION			PERCENT DISTRIBUTION ATTRACTION		
	HH SURVEY	2008 REVALIDATION	ESTIMATED	HH SURVEY	2008 REVALIDATION	ESTIMATED
1	11%	8%	10%	14%	10%	10%
2	25%	37%	32%	18%	26%	28%
3	36%	38%	40%	37%	39%	38%
4	28%	17%	17%	32%	25%	24%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 9.13 Percent Distribution by District – HBO

HBO

DISTRICT	PERCENT DISTRIBUTION PRODUCTION			PERCENT DISTRIBUTION ATTRACTION		
	HH SURVEY	2008 REVALIDATION	ESTIMATED	HH SURVEY	2008 REVALIDATION	ESTIMATED
1	9%	8%	11%	8%	7%	7%
2	15%	34%	30%	17%	26%	26%
3	50%	40%	42%	49%	44%	46%
4	26%	18%	16%	25%	22%	22%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 9.14 Percent Distribution by District - NHBW

NHBW

DISTRICT	PERCENT DISTRIBUTION PRODUCTION			PERCENT DISTRIBUTION ATTRACTION		
	HH SURVEY	2008 REVALIDATION	ESTIMATED	HH SURVEY	2008 REVALIDATION	ESTIMATED
1	4%	10%	12%	2%	10%	12%
2	16%	17%	16%	14%	17%	16%
3	46%	44%	44%	50%	44%	44%
4	34%	30%	28%	34%	30%	28%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 9.15 Percent Distribution by District - NHBO

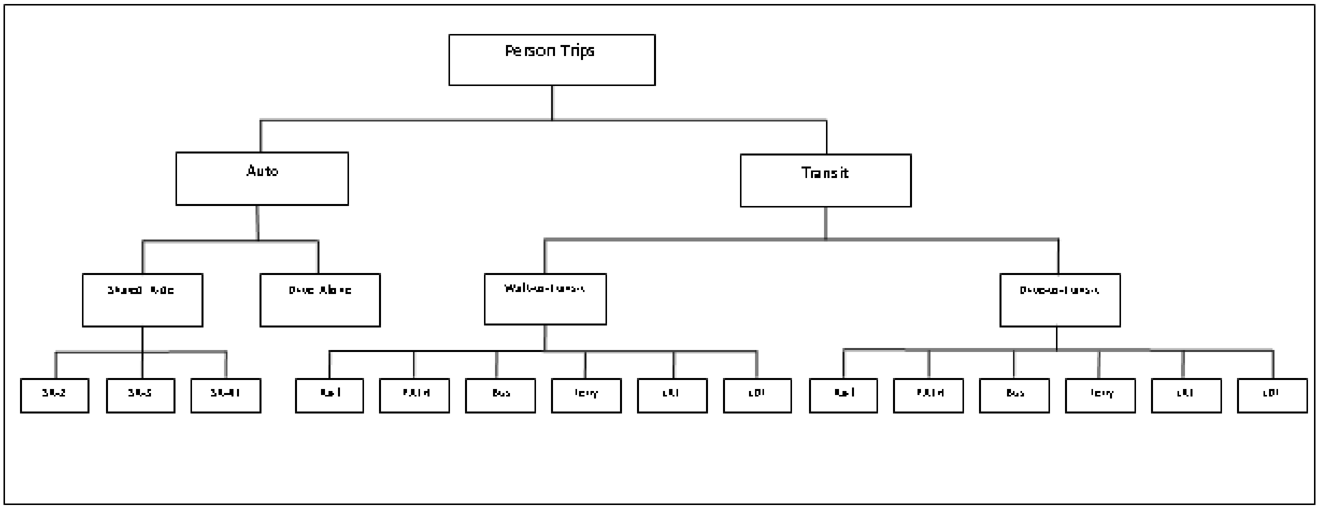
NHBO

DISTRICT	PERCENT DISTRIBUTION PRODUCTION			PERCENT DISTRIBUTION ATTRACTION		
	HH SURVEY	2008 REVALIDATION	ESTIMATED	HH SURVEY	2008 REVALIDATION	ESTIMATED
1	12%	10%	12%	12%	10%	12%
2	16%	24%	23%	17%	24%	23%
3	46%	39%	41%	45%	39%	41%
4	26%	27%	24%	26%	27%	24%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

9.4 MODE CHOICE

The mode choice model for the OCTM is adopted from the NJRTM-E and the NJ Transit's North Jersey Travel Demand Forecasting Model (NJTDFM). The mode choice is a typical step within a traditional 4-step travel forecasting model. In this step, trips in each zone-to-zone cell of the person trip table are divided among the different available travel modes. The selection of travel mode is a function of the characteristics of each mode that is available for that particular origin-destination zonal pair and the characteristics of the traveler, the production zone, and the attraction zone. The mathematical function used in the mode choice model to perform this split is known as a nested logit model. Figure 9.8 shows the nesting structure of this model.

Figure 9.8 Nesting Structure for Mode Choice Model



The calibration results are shown in Tables 9.16 to 9.21. It is apparent from both observed and estimated data, that the transit trips in the Ocean County is insignificant.

Table 9.16 Mode Choice Comparison - HBWD

MODE	HBWD (Person Trips)					
	2010 RHTS		2008 Revalidation		Estimated	
	Trips	Pct	Trips	Pct	Trips	Pct
SOV	229,980	87.6%	255,448	87.3%	230,753	84.7%
HOV2	11,106	4.2%	25,965	8.9%	30,397	11.2%
HOV3	3,950	1.5%	4,116	1.4%	4,906	1.8%
HOV4	7,528	2.9%	3,474	1.2%	3,929	1.4%
Walk-Transit	477	0.2%	723	0.2%	367	0.1%
Drive-Transit	9,630	3.7%	2,949	1.0%	2,053	0.8%
TOTAL	**262,671**	**100.0%**	**292,675**	**100.0%**	**272,404**	**100.0%**

Table 9.17 Mode Choice Comparison - HBWS

MODE	HBWS (Person Trips)					
	2010 RHTS		2008 Revalidation		Estimated	
	Trips	Pct	Trips	Pct	Trips	Pct
SOV	72,202	73.1%	90,252	84.7%	82,936	83.5%
HOV2	12,913	13.1%	9,090	8.5%	11,409	11.5%
HOV3	10,114	10.2%	1,799	1.7%	1,916	1.9%
HOV4	3,504	3.5%	1,399	1.3%	1,528	1.5%
Walk-Transit	0	0.0%	848	0.8%	238	0.2%
Drive-Transit	0	0.0%	3,173	3.0%	1,275	1.3%
TOTAL	98,733	100.0%	106,561	100.0%	99,303	100.0%

Table 9.18 Mode Choice Comparison - HBS

MODE	HBS (Person Trips)					
	2010 RHTS		2008 Revalidation		Estimated	
	Trips	Pct	Trips	Pct	Trips	Pct
SOV	85,040	53.8%	76,123	44.7%	70,779	44.8%
HOV2	61,780	39.1%	66,912	39.3%	61,988	39.3%
HOV3	7,270	4.6%	13,432	7.9%	12,432	7.9%
HOV4	3,488	2.2%	13,599	8.0%	12,585	8.0%
Walk-Transit	413	0.3%	71	0.0%	35	0.0%
Drive-Transit	0	0.0%	16	0.0%	6	0.0%
TOTAL	157,991	100.0%	170,153	100.0%	157,824	100.0%

Table 9.19 Mode Choice Comparison - HBO

MODE	HBO (Person Trips)					
	2010 RHTS		2008 Revalidation		Estimated	
	Trips	Pct	Trips	Pct	Trips	Pct
SOV	205,267	40.5%	264,772	42.3%	208,404	41.1%
HOV2	164,889	32.5%	211,138	33.7%	173,776	34.3%
HOV3	65,279	12.9%	77,508	12.4%	63,802	12.6%
HOV4	70,051	13.8%	71,632	11.4%	59,195	11.7%
Walk-Transit	1,763	0.3%	374	0.1%	250	0.0%
Drive-Transit	0	0.0%	852	0.1%	1,101	0.2%
TOTAL	507,249	100.0%	626,276	100.0%	506,528	100.0%

Table 9.20 Mode Choice Comparison - NHBW

MODE	NHBW (Person Trips)					
	2010 RHTS		2008 Revalidation		Estimated	
	Trips	Pct	Trips	Pct	Trips	Pct
SOV	89,127	84.7%	61,235	76.3%	82,550	75.4%
HOV2	9,952	9.5%	10,871	13.5%	15,547	14.2%
HOV3	4,168	4.0%	5,313	6.6%	7,440	6.8%
HOV4	1,714	1.6%	2,618	3.3%	3,766	3.4%
Walk-Transit	245	0.2%	170	0.2%	138	0.1%
Drive-Transit	0	0.0%	62	0.1%	75	0.1%
TOTAL	105,206	100.0%	80,268	100.0%	109,515	100.0%

Table 9.21 Mode Choice Comparison - NHBO

MODE	NHBO (Person Trips)					
	2010 RHTS		2008 Revalidation		Estimated	
	Trips	Pct	Trips	Pct	Trips	Pct
SOV	121,848	46.5%	79,953	35.4%	120,111	46.8%
HOV2	96,443	36.8%	83,963	37.2%	77,467	30.2%
HOV3	23,447	9.0%	42,081	18.6%	42,168	16.4%
HOV4	18,502	7.1%	19,737	8.7%	16,778	6.5%
Walk-Transit	1,577	0.6%	44	0.0%	172	0.1%
Drive-Transit	0	0.0%	11	0.0%	59	0.0%
TOTAL	261,817	100.0%	225,789	100.0%	256,755	100.0%

9.5 HIGHWAY ASSIGNMENT

The highway assignment calibration focused on the standard comparison of volumes and VMT by various classification, such as facility type and area type. The assignment calibration also focused on the screenline volumes and the distribution of the traffic among the roadways that construed the screenlines. The calibration also reviewed the traffic along the Garden State Parkway, the major limited-access facility that crosses the Ocean County in the north-south direction.

Tables 9.22 and 9.23 show the volume and VMT comparison between observed count data and estimated volumes by facility type and by area type. At the regional, the estimated volume is approximately within three percent of the observed data. At facility type level, the ratios are generally within ten percent, except for two categories where the counts are very limited. At area type level, the estimated volumes are within three percent of the observed traffic counts. At more disaggregated level, the differences are more pronounced although they are generally within reasonable tolerance as shown in Tables 9.24 and 9.25.

Table 9.22 Volume Comparison by Facility Type and by Area Type

FACILITY TYPE	VOLUME			
	OBSERVED	ESTIMATED	EST/OBS	COUNTS
Limited-Access Facility	1,987,944	1,919,450	0.97	57
Expressway	70,394	78,017	1.11	4
Principal Arterial Divided	432,846	461,363	1.07	30
Principal Arterial Undivided	918,859	898,826	0.98	96
Minor Arterial Divided	38,298	32,251	0.84	4
Minor Arterial Undivided	1,081,585	1,025,965	0.95	202
Minor Arterials	462,332	424,416	0.92	142
Collector/Local	167,625	162,291	0.97	54
TOTAL	**5,159,883**	**5,002,579**	**0.97**	**589**

BY AREA TYPE

AREA TYPE	VOLUME			
	OBSERVED	ESTIMATED	EST/OBS	COUNTS
Urban	177,635	173,042	0.97	14
Suburban	4,596,118	4,445,463	0.97	505
Rural	386,130	384,074	0.99	70
TOTAL	**5,159,883**	**5,002,579**	**0.97**	**589**

Table 9.23 VMT Comparison by Facility Type and by Area Type

BY FACILITY TYPE

FACILITY TYPE	VOLUME		
	OBSERVED	ESTIMATED	EST/OBS
Limited-Access Facility	2,538,454	2,484,880	0.98
Expressway	79,229	94,804	1.20
Principal Arterial Divided	381,003	414,055	1.09
Principal Arterial Undivided	539,799	578,708	1.07
Minor Arterial Divided	23,193	19,762	0.85
Minor Arterial Undivided	932,434	898,981	0.96
Minor Arterials	273,583	246,441	0.90
Collector/Local	87,881	88,115	1.00
TOTAL	**4,855,576**	**4,825,746**	**0.99**

BY AREA TYPE

AREA TYPE	VOLUME		
	OBSERVED	ESTIMATED	EST/OBS
Urban	92,209	87,518	0.95
Suburban	4,131,227	4,115,123	1.00
Rural	632,140	623,105	0.99
TOTAL	**4,855,576**	**4,825,746**	**0.99**

Table 9.24 Volume Comparison by Facility Type and Area Type

OBSERVED VOLUME

FACILITY TYPE	AREA TYPE			
	Urban	Suburban	Rural	Total
Limited-Access Facility	--	1,811,904	176,040	1,987,944
Expressway	--	70,394	--	70,394
Principal Arterial Divided	66,904	365,942	--	432,846
Principal Arterial Undivided	93,614	803,796	21,449	918,859
Minor Arterial Divided	--	38,298	--	38,298
Minor Arterial Undivided	17,117	896,593	167,875	1,081,585
Minor Arterials	--	442,389	19,943	462,332
Collector/Local	--	166,802	823	167,625
TOTAL	**177,635**	**4,596,118**	**386,130**	**5,159,883**

ESTIMATED VOLUME

FACILITY TYPE	AREA TYPE			
	Urban	Suburban	Rural	Total
Limited-Access Facility	--	1,746,211	173,239	1,919,450
Expressway	--	78,017	--	78,017
Principal Arterial Divided	60,634	400,729	--	461,363
Principal Arterial Undivided	96,276	776,019	26,531	898,826
Minor Arterial Divided	--	32,251	--	32,251
Minor Arterial Undivided	16,132	844,680	165,153	1,025,965
Minor Arterials	--	405,824	18,592	424,416
Collector/Local	--	161,732	559	162,291
TOTAL	**173,042**	**4,445,463**	**384,074**	**5,002,579**

ESTIMATED VOLUME/OBSERVED VOLUME

FACILITY TYPE	AREA TYPE			
	Urban	Suburban	Rural	Total
Limited-Access Facility	--	0.96	0.98	0.97
Expressway	--	1.11	--	1.11
Principal Arterial Divided	0.91	1.10	--	1.07
Principal Arterial Undivided	1.03	0.97	1.24	0.98
Minor Arterial Divided	--	0.84	--	0.84
Minor Arterial Undivided	0.94	0.94	0.98	0.95
Minor Arterials	--	0.92	0.93	0.92
Collector/Local	--	0.97	0.68	0.97
TOTAL	**0.97**	**0.97**	**0.99**	**0.97**

TOTAL COUNTS

FACILITY TYPE	AREA TYPE			
	Urban	Suburban	Rural	Total
Limited-Access Facility	--	49	8	57
Expressway	--	4	--	4
Principal Arterial Divided	4	26	--	30
Principal Arterial Undivided	8	84	4	96
Minor Arterial Divided	--	4	--	4
Minor Arterial Undivided	2	162	38	202
Minor Arterials	--	124	18	142
Collector/Local	--	52	2	54
TOTAL	**14**	**505**	**70**	**589**

Table 9.25 VMT Comparison by Facility Type and Area Type

OBSERVED VMT

FACILITY TYPE	AREA TYPE			
	Urban	Suburban	Rural	Total
Limited-Access Facility	--	2,226,036	312,418	2,538,454
Expressway	--	79,229	--	79,229
Principal Arterial Divided	60,760	320,243	--	381,003
Principal Arterial Undivided	27,769	484,915	27,115	539,799
Minor Arterial Divided	--	23,193	--	23,193
Minor Arterial Undivided	3,680	653,656	275,098	932,434
Minor Arterials	--	257,474	16,109	273,583
Collector/Local	--	86,481	1,400	87,881
TOTAL	**92,209**	**4,131,227**	**632,140**	**4,855,576**

ESTIMATED VMT

FACILITY TYPE	AREA TYPE			
	Urban	Suburban	Rural	Total
Limited-Access Facility	--	2,182,977	301,903	2,484,880
Expressway	--	94,804	--	94,804
Principal Arterial Divided	60,123	353,932	--	414,055
Principal Arterial Undivided	23,927	520,885	33,896	578,708
Minor Arterial Divided	--	19,762	--	19,762
Minor Arterial Undivided	3,468	624,839	270,674	898,981
Minor Arterials	--	230,523	15,918	246,441
Collector/Local	--	87,401	714	88,115
TOTAL	**87,518**	**4,115,123**	**623,105**	**4,825,746**

ESTIMATED VOLUME/OBSERVED VMT

FACILITY TYPE	AREA TYPE			
	Urban	Suburban	Rural	Total
Limited-Access Facility	--	0.98	0.97	0.98
Expressway	--	1.20	--	1.20
Principal Arterial Divided	0.99	1.11	--	1.09
Principal Arterial Undivided	0.86	1.07	1.25	1.07
Minor Arterial Divided	--	0.85	--	0.85
Minor Arterial Undivided	0.94	0.96	0.98	0.96
Minor Arterials	--	0.90	0.99	0.90
Collector/Local	--	1.01	0.51	1.00
TOTAL	**0.95**	**1.00**	**0.99**	**0.99**

TOTAL COUNTS

FACILITY TYPE	AREA TYPE			
	Urban	Suburban	Rural	Total
Limited-Access Facility	--	49	8	57
Expressway	--	4	--	4
Principal Arterial Divided	4	26	--	30
Principal Arterial Undivided	8	84	4	96
Minor Arterial Divided	--	4	--	4
Minor Arterial Undivided	2	162	38	202
Minor Arterials	--	124	18	142
Collector/Local	--	52	2	54
TOTAL	**14**	**505**	**70**	**589**

The next comparison is by screenline. Figure 9.9 shows the screenline locations for this study, while Table 9.26 shows the total traffic by screenline. The comparison indicates that the estimated volumes are generally lower than the observed traffic, except for screenline no. 6.

Figure 9.9 Screenline Definition

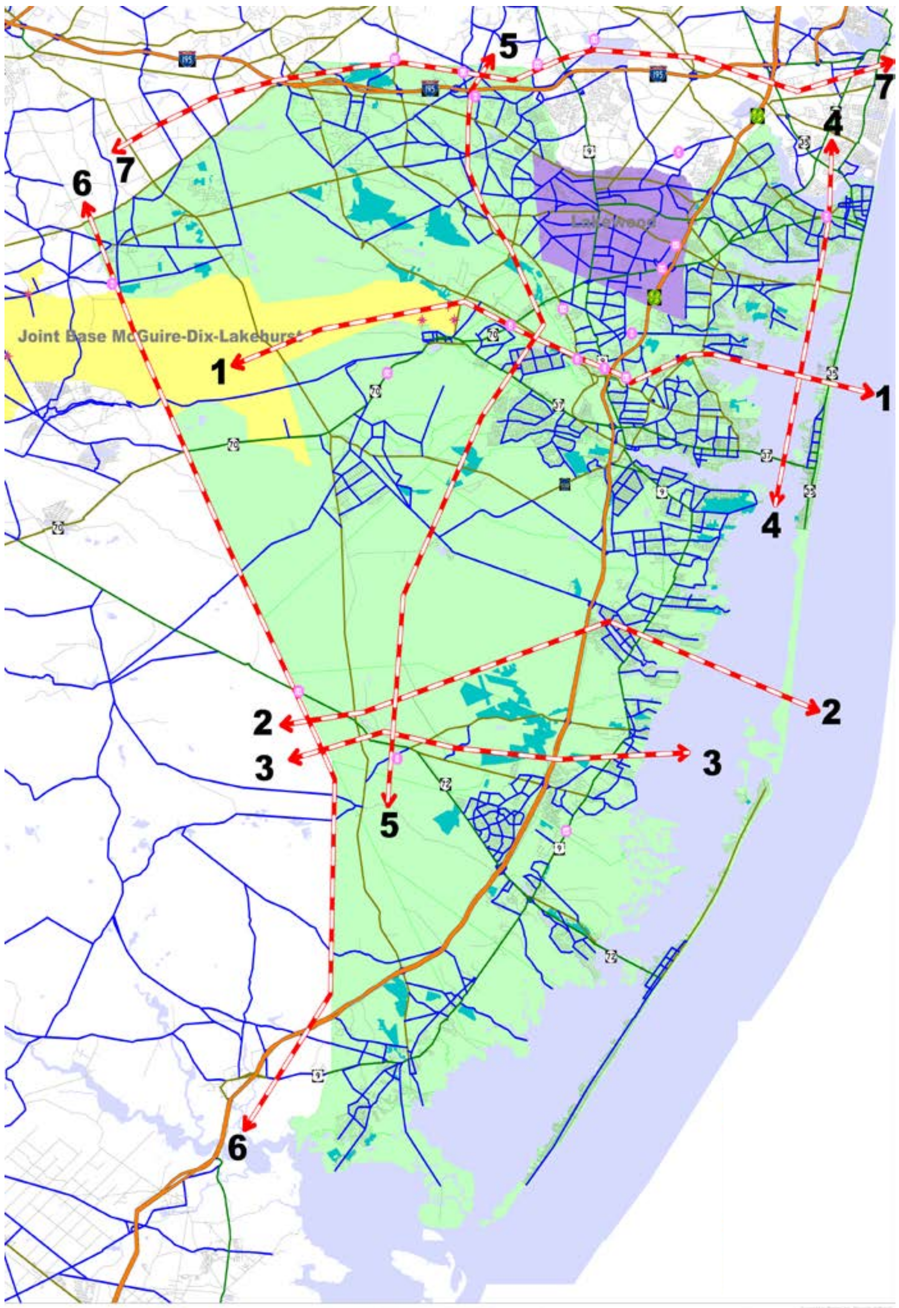


Table 9.26 Total Screenline Traffic Comparison

SCREENLINE NO	Total Screenline Traffic		
	Counts	Estimated	% Diff
1	271,854	242,326	-10.9%
2	101,084	95,177	-5.8%
3	95,786	92,632	-3.3%
4	83,551	75,560	-9.6%
5	180,332	168,260	-6.7%
6	86,877	93,739	7.9%
7	327,339	318,063	-2.8%

The distribution of screenline traffic among the roadways is shown in Table 9.27. At this level, the difference between observed and estimated traffic is more pronounced.

Table 9.27 Total Screenline Traffic Comparison

	LOCATION	Validation Year (2010)			
		Counts	Dist.	Estimated	Dist.
Screenline 1	RT 539/WHITING NEW EGYPT RD	11,450	4.2%	9,266	3.8%
	RT 547	11,448	4.2%	14,939	6.2%
	NJ 70	20,586	7.6%	18,238	7.5%
	RT 571	19,288	7.1%	16,112	6.6%
	RT 527	15,059	5.5%	7,391	3.0%
	US 9	27,950	10.3%	24,999	10.3%
	GARDEN STATE PARKWAY	86,100	31.7%	86,433	35.7%
	OLD FREEHOLD RD	16,606	6.1%	20,422	8.4%
	RT 549/HOOPER AVE	42,984	15.8%	30,849	12.7%
	NJ 35	20,383	7.5%	13,678	5.6%
	TOTAL	**271,854**	**100.0%**	**242,326**	**100.0%**
Scrnln 2	RT 539	6,506	6.4%	9,184	9.6%
	GARDEN STATE PARKWAY	75,900	75.1%	74,204	78.0%
	US 9	18,678	18.5%	11,790	12.4%
	TOTAL	**101,084**	**100.0%**	**95,177**	**100.0%**
Screenline 3	RT 539	4,112	4.3%	9,236	10.0%
	NJ 72	11,718	12.2%	9,494	10.2%
	RT 532	1,733	1.8%	2,356	2.5%
	GARDEN STATE PARKWAY	63,380	66.2%	62,237	67.2%
	US 9	14,843	15.5%	9,308	10.0%
	TOTAL	**95,786**	**100.0%**	**92,632**	**100.0%**
Screenline 4	NJ 35	19,359	23.2%	26,927	35.6%
	NJ 88	21,887	26.2%	13,057	17.3%
	BRIDGE AVE	10,601	12.7%	8,171	10.8%
	RT 528	9,202	11.0%	6,501	8.6%
	NJ 37	22,502	26.9%	20,903	27.7%
	TOTAL	**83,551**	**100.0%**	**75,560**	**100.0%**
Screenline 5	I-195	35,370	19.6%	40,619	24.1%
	CHANDLER RD	3,298	1.8%	1,511	0.9%
	HYSON RD	3,972	2.2%	5,481	3.3%
	RT 526/COUNTY LINE RD	12,700	7.0%	8,908	5.3%
	BENNETTS MILLS RD	8,817	4.9%	8,969	5.3%
	RT 528/E VETERAN RD	7,269	4.0%	4,577	2.7%
	RT 527	4,875	2.7%	8,262	4.9%
	RT 547	12,021	6.7%	11,448	6.8%
	NJ 70	23,773	13.2%	20,513	12.2%
	RT 571	11,293	6.3%	17,672	10.5%
	NJ 37	31,870	17.7%	20,472	12.2%
	RT 530/ PINEWALD KESWICK RD	8,114	4.5%	7,362	4.4%
	RT 614/LACEY RD	4,613	2.6%	2,178	1.3%
	NJ 72	11,718	6.5%	9,494	5.6%
	RT 532	628	0.3%	794	0.5%
	TOTAL	**180,332**	**100.0%**	**168,260**	**100.0%**

Table 9.27 - Continued

	LOCATION+K6:P34	Validation Year (2010)			
		Counts	Dist.	Estimated	Dist.
Screenline 6	MONMOUTH RD	6,294	7.2%	12,526	13.4%
	RT 528	4,050	4.7%	2,570	2.7%
	RT 616	4,950	5.7%	5,359	5.7%
	BUNTING BRIDGE RD	1,429	1.6%	173	0.2%
	NJ 70	11,268	13.0%	14,169	15.1%
	NJ 72	8,167	9.4%	9,845	10.5%
	GARDEN STATE PARKWAY	40,300	46.4%	41,308	44.1%
	RT 654/STAGE RD	823	0.9%	559	0.6%
	US 9	9,596	11.0%	7,229	7.7%
	TOTAL	**86,877**	**100.0%**	**93,739**	**100.0%**
Screenline 7	RT 539 FORKED RIVER RD	12,394	3.8%	7,264	2.3%
	RT 537	18,420	5.6%	13,443	4.2%
	RT 571	8,222	2.5%	9,700	3.0%
	RT 527/CEDAR SWAMP RD	8,047	2.5%	4,930	1.5%
	HARMONY RD	2,145	0.7%	4,522	1.4%
	OCEAN COUNTY 638/JACKSON MILLS RD	8,286	2.5%	4,463	1.4%
	OCEAN COUNTY 641	3,298	1.0%	1,511	0.5%
	FORT PLAINT RD	5,572	1.7%	11,065	3.5%
	US 9	44,744	13.7%	42,081	13.2%
	GEORGIA TAVERN RD	4,709	1.4%	2,914	0.9%
	RT 524A/SQUANKUM YELLOWBROOK RD	7,011	2.1%	6,526	2.1%
	RT 524	8,853	2.7%	4,964	1.6%
	GARDEN STATE PARKWAY	125,530	38.3%	114,996	36.2%
	NJ 34	40,286	12.3%	66,720	21.0%
	NJ 35	19,701	6.0%	12,458	3.9%
	NJ 71	10,121	3.1%	10,505	3.3%
	TOTAL	**327,339**	**100.0%**	**318,063**	**100.0%**

The final comparison for the highway assignment calibration is traffic along the Garden State Parkway. The summary of this comparison is shown in Table 9.28. While the difference on each segment is more pronounced, the difference of the total segments is within three percent.

Table 9.28 Traffic Comparison Along Garden State Parkway

Location	Direction	Daily Traffic Volume		
		Observed	Estimated	%Diff
Between Interchange 58 (Rt. 539) and Interchange 63 (Rt. 72)	NB	22,650	24,436	7.9%
	SB	22,340	22,041	-1.3%
Between Interchange 63 and Interchange 67 (Rt. 554)	NB	25,600	28,261	10.4%
	SB	25,560	27,484	7.5%
Between Interchange 67 and Interchange 69 (Rt. 532)	NB	32,860	32,143	-2.2%
	SB	30,520	30,094	-1.4%
Between Interchange 69 and Interchange 74 (Lacey Rd)	NB	38,440	37,494	-2.5%
	SB	37,460	36,709	-2.0%
Between Interchange 74 and Interchange 77 (Forrest Hill Parkway)	NB	38,440	39,924	3.9%
	SB	37,460	36,068	-3.7%
Between Interchange 77 and Interchange 80 (US 9/Rt. 530)	NB	40,250	40,866	1.5%
	SB	38,170	36,558	-4.2%
Between Interchange 80 and Interchange 81 (Rt. 527)	NB	55,610	56,027	0.7%
	SB	54,880	59,263	8.0%
Between Interchange 81 and Interchange 82 (Rt. 37)	NB	49,790	53,118	6.7%
	SB	51,180	54,947	7.4%
Between Interchange 82 and Interchange 83 (Rt. 9)	NB	52,100	49,281	-5.4%
	SB	54,520	49,819	-8.6%
Between Interchange 83 and Interchange 89 (Rt. 70/Rt. 528)	NB	44,540	46,266	3.9%
	SB	41,560	40,168	-3.4%
Between Interchange 89 and Interchange 90 (Rt. 549)	NB	61,630	52,161	-15.4%
	SB	59,740	56,832	-4.9%
Between Interchange 90 and Interchange 91 (Burnt Tavern Rd.)	NB	53,880	49,118	-8.8%
	SB	51,370	47,720	-7.1%
Between Interchange 91 and Interchange 98 (Rt. 34)	NB	61,430	58,462	-4.8%
	SB	64,100	56,534	-11.8%
Total	**NB**	**577,220**	**567,556**	**-1.7%**
	SB	**568,860**	**554,237**	**-2.6%**

9.6 TRANSIT ASSIGNMENT CALIBRATION

Ocean County has only limited transit lines that serve the county. Most of the buses provided by the NJ Transit and they usually serve inter-county trips. The only local service, by Ocean Ride, included in this analysis is Toms River Connection. Table 9.29 shows the ridership comparison by lines.

Table 9.29 Transit Ridership Comparison by Line

Line Name	Ridership	
	Observed	Estimated
137	909	745
139	471	111
317	86	38
319	151	103
559	761	212
64	29	12
67	216	192
Toms River	369	453

10.0 ADDITIONAL FEATURES

10.1 SEASONAL MODEL

The seasonal model was developed to capture additional traffic demand for people traveling to the New Jersey shores during the summer months. During the course of the project, it was decided that the seasonal traffic model would estimate the in-bound traffic (heading to the shores) on a high Summer Friday or Saturday, and the out-bound traffic (returning home) on Sunday.

The increase of summer traffic can be attributed to two categories:

- The increase of local activities.
- The in-flux of long-distance trips from nearby regions, such as New York City, Philadelphia, Trenton, and South Jersey.

The increase of local-activities is assumed to be proportional with the vacation housing available in the area. Table 10.1 provides the percentage of seasonal housing by municipality. The data was obtained from the 2010 Housing Units Summary from the Census website. The percentage of vacation housing units were then converted from MCD-Level to Zonal-Level using an MCD-Zones equivalency table developed for this model.

The additional traffic from the local trips is calculated using the following formula:

> Additional Local Trips for *i-j* cell = Average Daily Trips * the average of percent vacation housing units at location *i* and *j*

Only a portion of these trips is assumed to occur. Therefore, an adjustment factor is applied to these local trips. Currently, the factor is set to 0.50. The factor was determined with a trial and error approach to get the estimated trips replicating the very limited observed data. Please note that currently, the model is not calibrated due to lack of the available data.

The second component of the seasonal model is the in-flux on long distance trips. For the purpose of this model, Stantec assumed that there are four origin points for these trips:

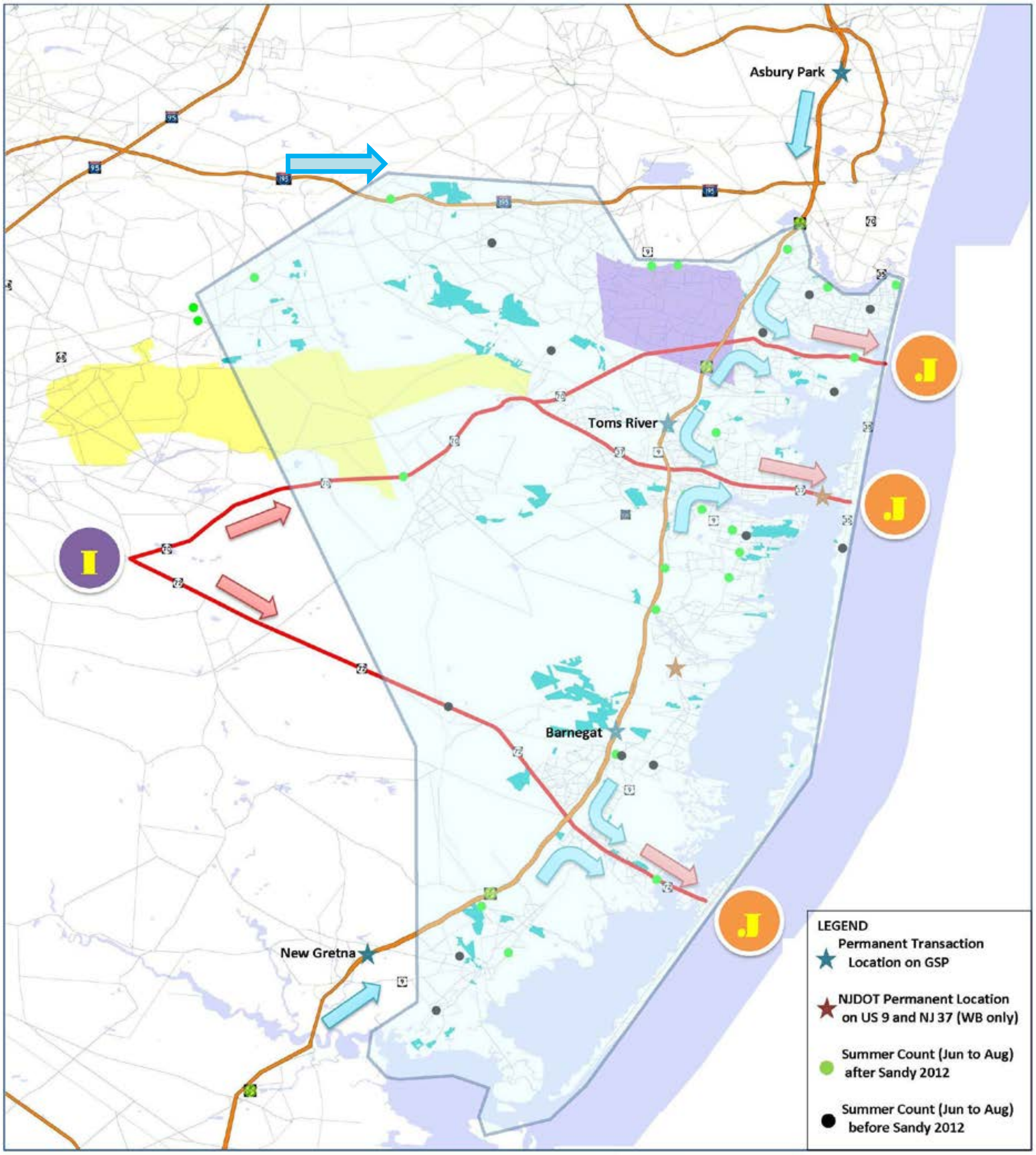
- Route 72 for the western market such as Philadelphia region.
- GSP near Asbury Park or Toms River for the northern market, such as NYC and North Jersey.
- GSP near New Gretna for southern market, such as South Jersey Region.
- I-195 for the western market such Trenton and Central Jersey.

Figure 10.1 shows the proximity of these locations, while Figure 10.2 shows the zonal representation of these locations in the highway network.

Table 10.1 Vacation Housing Percentage by MCD in Ocean County

MCD	Vacation House Percentage
Barnegat	0.0%
Barnegat Light	74.0%
Bay Head	46.0%
Beach Haven	75.0%
Beachwood	0.0%
Berkeley	9.0%
Brick	7.0%
Eagleswood	17.0%
Harvey Cedars	76.0%
Island Heights	0.0%
Jackson	0.0%
Lacey	0.0%
Lakehurst	0.0%
Lakewood	0.0%
Lavallette	59.0%
Little Egg Harbor	15.0%
Long Beach	80.0%
Manchester	0.0%
Mantoloking	42.0%
Ocean	16.0%
Ocean Gate	30.0%
Pine Beach	0.0%
Plumsted	0.0%
Point Pleasant	0.0%
Point Pleasant Beach	32.0%
Seaside Heights	40.0%
Seaside Park	63.0%
Ship Bottom	70.0%
South Toms River	0.0%
Stafford	20.0%
Surf City	72.0%
Toms River	15.0%
Tuckerton	23.0%

Figure 10.1 Screenline Definition

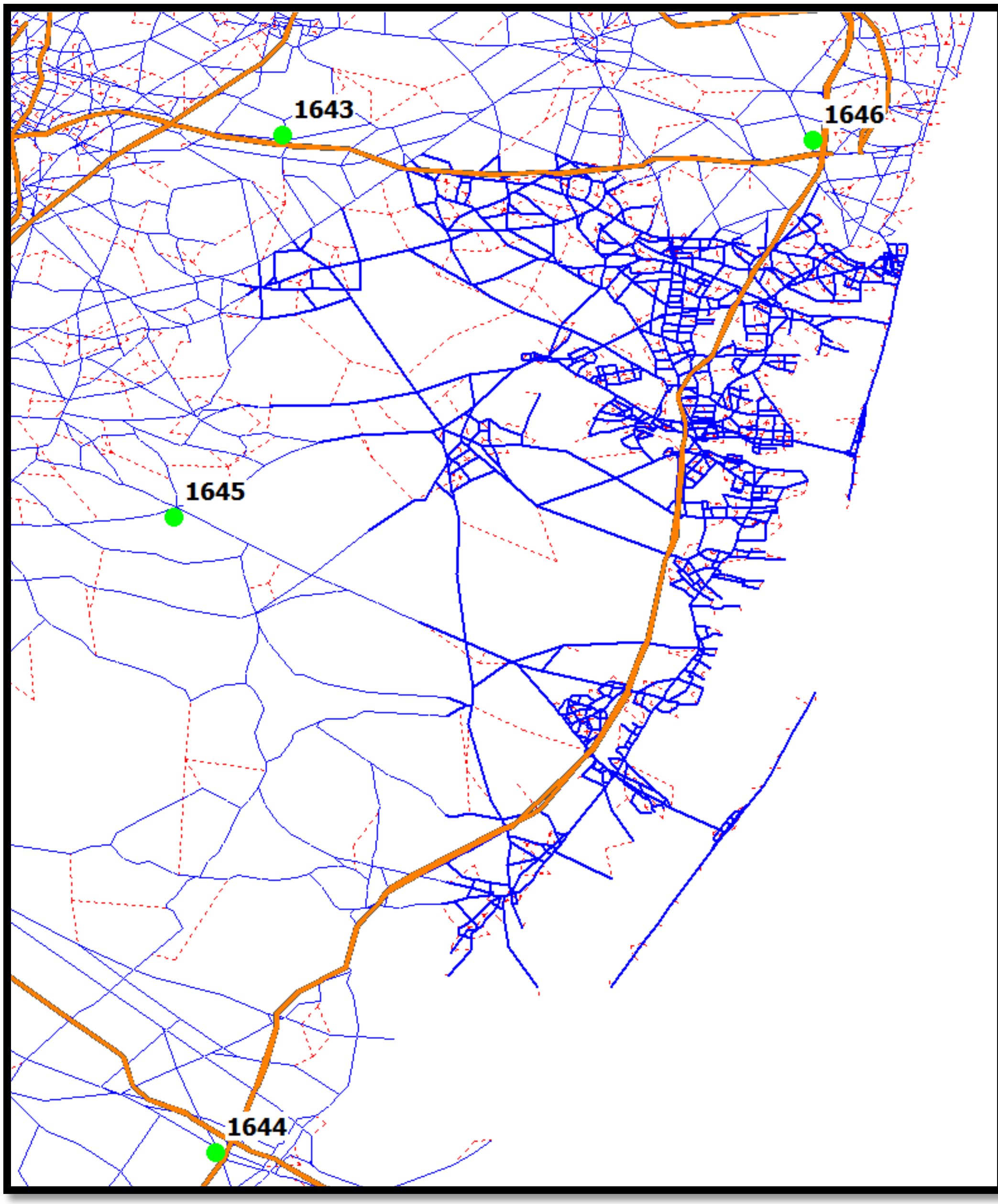


The four seasonal TAZs are as follows:

- Zone 1643 - represents the origin point for the western market such Trenton and Central Jersey.

- Zone 1644 – represents the origin point of the southern market, such as South Jersey Region.
- Zone 1645 – represents the origin point of the western market such as Philadelphia region.
- Zone 1646 – represents the origin point of the northern market, such as NYC and North Jersey.

Figure 10.2 Seasonal TAZ Representation



As the first step of the long-haul seasonal traffic estimation, Stantec gathered traffic count information from NJDOT's permanent stations and Garden State Parkway that can be used as proxy for these locations. There were very limited traffic counts that can be used for this purpose, since the counts should have both average daily counts, as well as counts for summer months by direction. Table 10.2 shows the comparison between high summer traffic volumes and AADT for the selected locations. Since there is no permanent count available on I-195, Stantec assumed that the western market from Trenton and Central Jersey is the same as the market from the South Jersey Region. It should also be noted that the 2013 counts on Garden State Parkway was used as proxy for the 2010 due to the availability of the data during the analysis.

Table 10.2 High Summer Month and AADT Traffic Comparison

Location	In-Bound			Out-Bound			Average Additional Summer Traffic
	High Summer Volume	AADT	Additional Summer Traffic	High Summer Volume	AADT	Additional Summer Traffic	
Rt. 72 Between Four Mile Road and Pakimpond Road	8,747	4,714	4,033	9,266	4,714	4,552	4,293
GSP at Toms River	65,903	42,288	23,615	66,153	45,735	20,418	22,017
GSP at New Gretna	27,700	20,139	7,561	26,840	19,515	7,325	7,443

The average additional summer traffic from Table 10.2 was used as the base for the long-haul trip production, and is summarized in Table 10.3. Additional adjustment factors were added to account for the discrepancy between the seasonal TAZ locations (shown in Figure 10-2) and the locations of the count, such that the estimated additional summer traffic replicate the observed data. The adjustment factors are listed in Table 10.4.

Table 10.3 Long-Haul In-Bound Trip Origin

Location	Average Additional Summer Traffic
North (GSP @ Toms River)	22,017
West (Rt. 72)	4,293
South (GSP @ New Graetna)	7,443
West (I-195) - assume similar to New Gretna	7,443

Table 10.4 Adjustment Factors In-Bound Trip Origin

Location	Production Adjustment Factors
North (GSP @ Toms River)	1.24
West (Rt. 72)	1.42
South (GSP @ New Graetna)	1.90
West (I-195) - assume similar to New Gretna	1.90

Stantec suggests that additional data are collected for future use. Full-calibration can be performed when those new traffic counts are available in the future, and all parameters and adjustment factors can also be adjusted accordingly based on the new data.

The attraction of the long-haul in-bound summer traffic was also estimated based on vacation housing units. The distribution of the trips from the four production zones to all potential attraction zones, zones with vacation housing, was performed using a simple gravity model with trips balanced to production.

The out-bound trips, which represent the return trips on Sunday, were calculated using similar approach as the in-bound trips. However, the production and attraction were reversed and the trips are balanced to attraction.

The daily seasonal trips were distributed into four time-of-day, AM, PM, Midday, and Night using the time of day factors developed from the GSP hourly summer traffic counts at Toms River Plaza on a summer day. The time-of-day factors are shown in Table 10.5

Table 10.5 Time-Of-Day Factors for Seasonal Trips

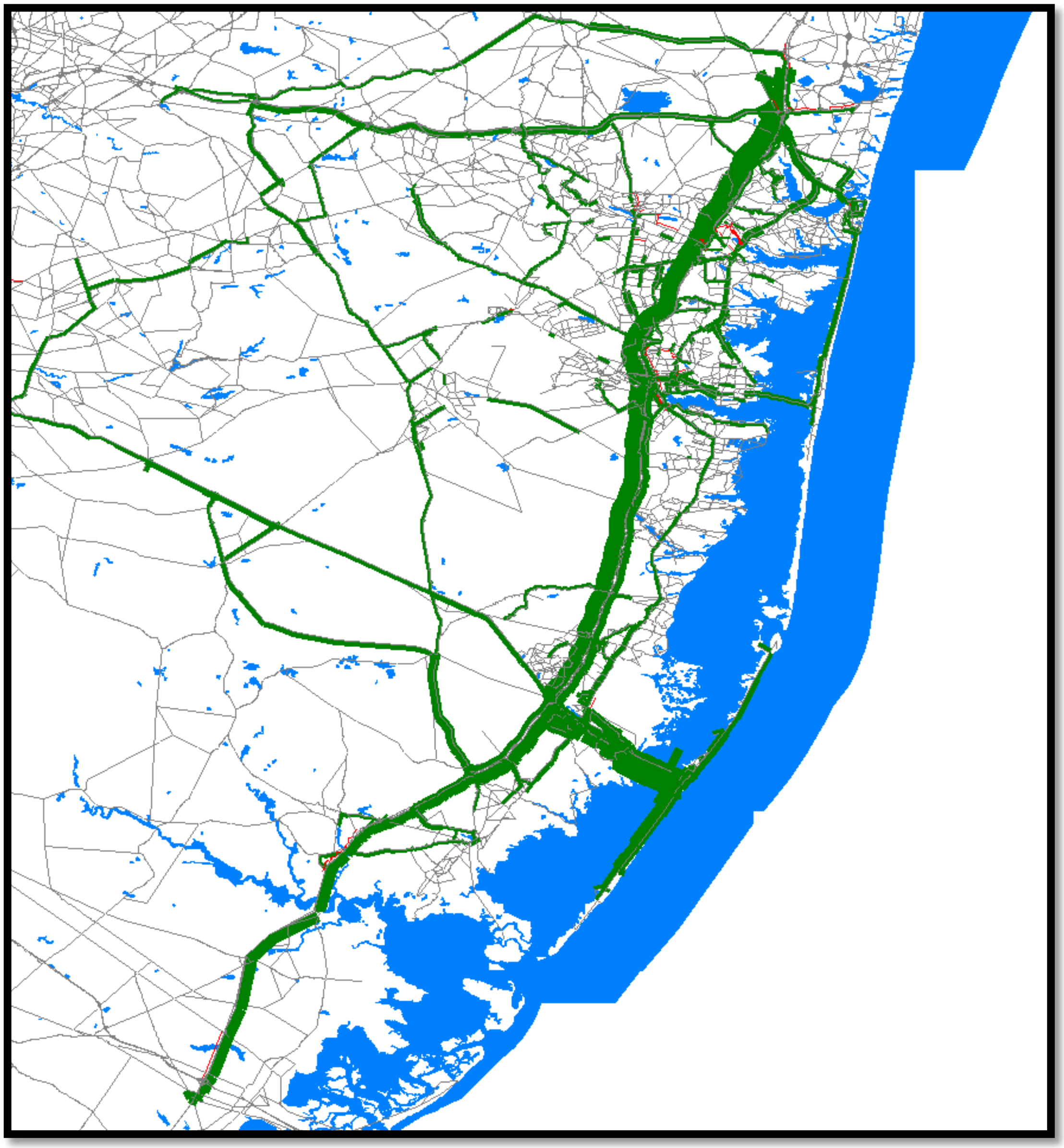
Toll Location	6-9 AM AM	9-3 PM MD	3-6 PM PM	6-6 AM NT	TOTAL
Toms River NB (OB)	4,439	25,705	12,106	23,903	66,153
Toms River SB (IB)	8,194	27,407	13,614	16,688	65,903
Toms River NB (OB)	6.7%	38.9%	18.3%	36.1%	
Toms River SB (IB)	12.4%	41.6%	20.7%	25.3%	

Table 10.6 shows traffic comparison between traffic counts and the estimated volumes at selected locations, while Figure 10.2 shows the AM-peak in-bound traffic. The results in Table 10.6 indicate that the estimated seasonal traffic on GSP is reasonably close to the traffic counts at Toms River Plaza. The estimated volume at New Gretna Plaza is approximately 12% higher than the traffic counts, while at Barnegat (SB), it is approximately 13% lower. The estimated traffic at Route 72 is approximately 40% and 20% higher for in-bound and out-bound traffic, respectively. These high percentages are partly due to small additional volumes, such that the small changes in volumes generated higher percentage numbers. It should be noted that the seasonal model application will create two loaded highway networks for each time period and daily. Only traffic volumes on their corresponding direction should be considered. For example, only in-bound traffic volumes, heading to the New Jersey Shores, will be obtained from the in-bound loaded network, and vice versa.

Table 10.6 Seasonal Traffic Comparison

Location	Direction	AADT			Seasonal Traffic			Additional Seasonal Traffic		
		Observed	Estimated	Diff	Observed	Estimated	Diff	Observed	Estimated	% Diff
Rt. 72 Between Four Mile Rd. & Pakimpond Rd.	Inbound (EB)	4,714	8,132	3,418	8,747	13,928	5,181	4,033	5,795	44%
	Outbound (WB)	4,714	11,512	6,798	9,266	17,000	7,734	4,552	5,488	21%
GSP @ Toms River Plaza	Inbound (SB)	42,288	40,168	-2,120	65,903	64,479	-1,424	23,615	24,311	3%
	Outbound (NB)	45,735	46,266	531	66,153	66,875	722	20,418	20,609	1%
GSP @ New Graetna NB	Inbound (NB)	26,250	20,269	-5,981	36,637	31,936	-4,701	10,387	11,667	12%
GSP @ Barnegat SB	Inbound (NB)	42,288	30,094	-12,194	65,903	50,550	-15,353	23,615	20,456	-13%

Figure 10.3 Example of AM-Peak Seasonal In-Bound traffic



For future year analysis, Stantec assumes that the long-haul traffic grows at a rate of 0.5% per year. This assumption was derived from a historical traffic count data from 2009 to 2014 along the GSP at three mainline locations including New Gretna, Barnegat, and Toms River. Table 10.7 shows the historical growth rates at these locations. Hurricane Sandy hit the Jersey Shore in 2012 which impacted the travel to Jersey Shore during that year and 2013. To minimize the impact of hurricane Sandy, the growth rate was calculated for two periods:

- Between 2009 and 2011, prior to Hurricane Sandy, and
- Between 2009 and 2014, to reflect a long term growth.

Table 10.7 Historical Growth Rate along GSP

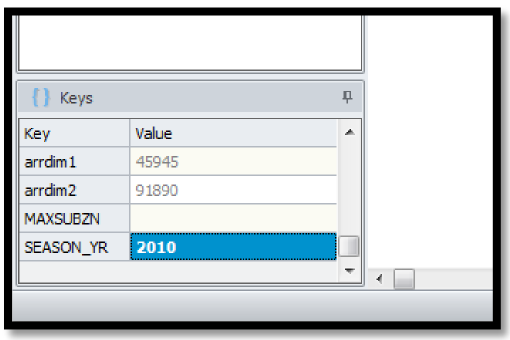
PLAZA LOCATION	DIR	AVERAGE DAILY TRAFFIC						% ACGR[(1)]	
		2009	2010	2011	2012	2013	2014	2009-2011	2009-2014
New Gretna	NB	20,470	20,040	19,410	19,951	19,835	19,436	-2.6%	-1.0%
	SB	20,620	20,260	20,020	20,588	20,649	20,058	-1.5%	-0.6%
Barnegat	NB	33,190	32,860	31,640	33,889	34,482	34,199	-2.4%	0.6%
	SB	31,630	30,520	29,700	31,819	32,375	32,112	-3.1%	0.3%
Toms River	NB	45,100	44,540	43,200	44,865	44,960	45,735	-2.1%	0.3%
	SB	42,070	41,560	40,510	42,907	42,775	42,288	-1.9%	0.1%
Total	**NB**	**98,760**	**97,440**	**94,250**	**98,705**	**99,277**	**99,370**	**-2.3%**	**0.1%**
	SB	**94,320**	**92,340**	**90,230**	**95,314**	**95,799**	**94,458**	**-2.2%**	**0.0%**

Note: (1) ACGR = Annual Compounded Growth Rate

The Garden State Parkway experienced a decline in traffic between 2009 and 2011. This is presumably due to the increase of fuel cost between those years that discouraged people from making discretionary travels. The long term growth rates between 2009 and 2014, indicate positive growth rates at Barnegat and Toms River Plazas, and negative rates at New Gretna Plaza. The total growth rate is approximately 0.1% per year. Considering that there is still an on-going recovery effort from Hurricane Sandy, Stantec assumed a higher annual growth rate, at 0.5% per year, for future year analysis. This growth rate assumption can be revisited upon the completion of the recovery effort, and as more historical data becomes available.

To account for the growth, the analyst has to input the analysis year for the seasonal model. The year has to be input into SEASON_YR key variable as shown in Figure 10.4.

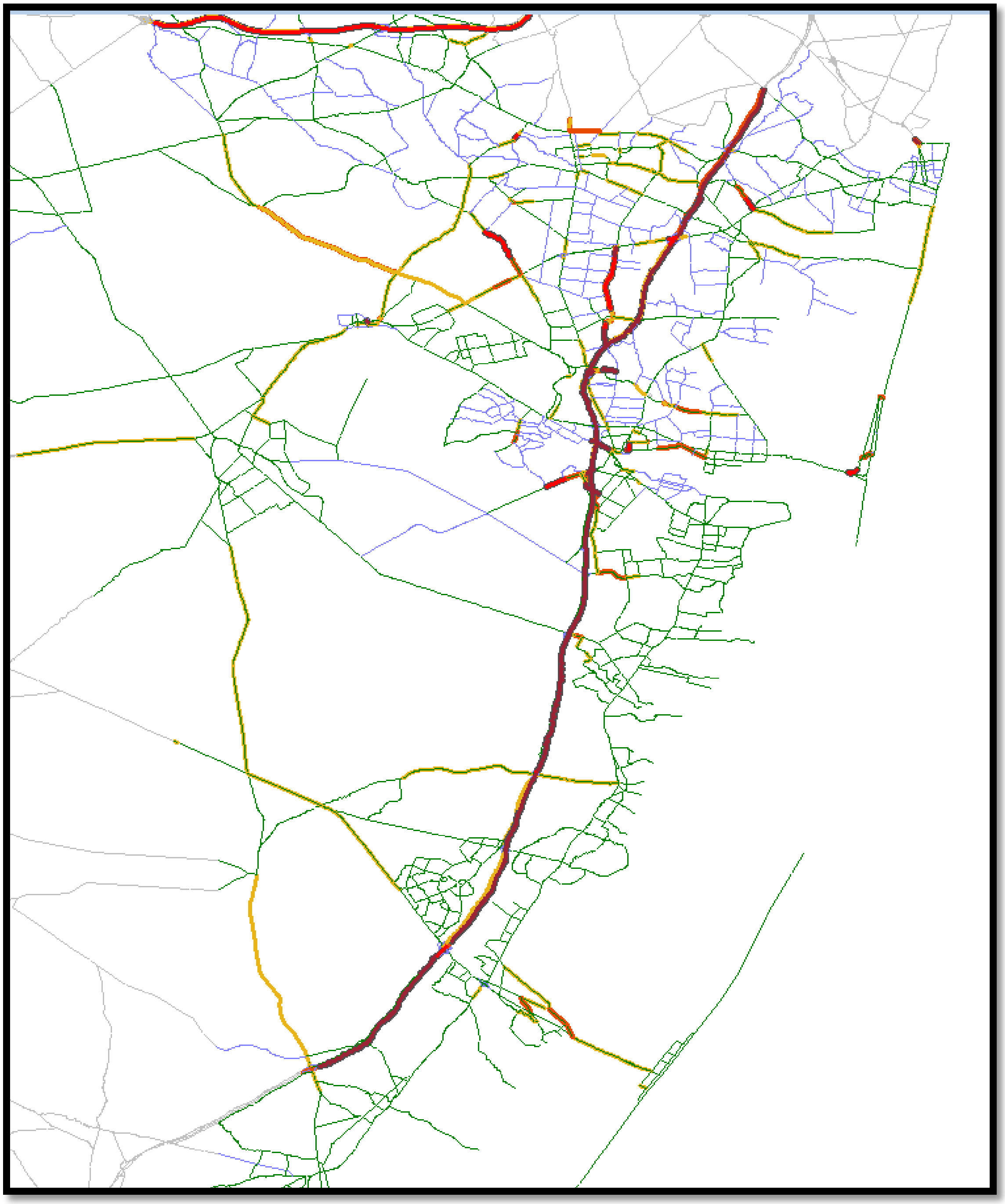
Figure 10.4 Example of AM-Peak Seasonal In-Bound traffic



10.2 CRITICAL LOCATIONS AND FUTURE YEARS FORECAST

As part of the 2010 calibration effort, Stantec also reviewed the locations of roadways that experience some level of congestion. Figure 10.5 shows an example of the congested locations estimated by the model during the AM Peak Hour period (6AM – 9 AM).

Figure 10.5 Example of AM-Peak Congestion Level

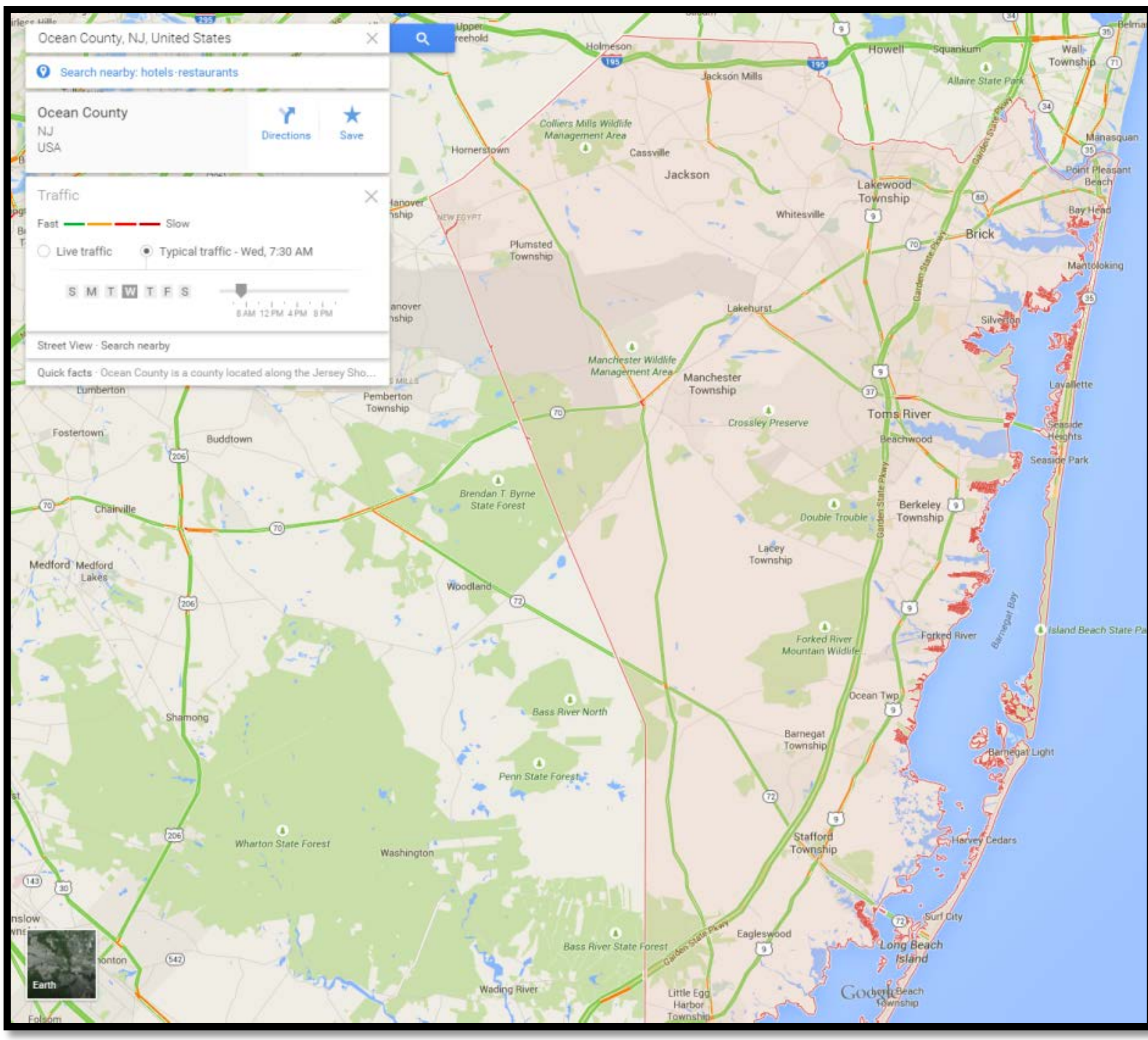


The color legend of this Figure is as follows:

- Brown – Level of Service F (V/C >1.0)
- Red – Level of Service E (V/C=0.90-1.00)
- Dark Orange – Level of Service D (V/C=0.75-0.90)
- Light Orange – Level of Service C (V/C=0.50-0.75)
- Green – Level of Service A & B (V/C<0.50)

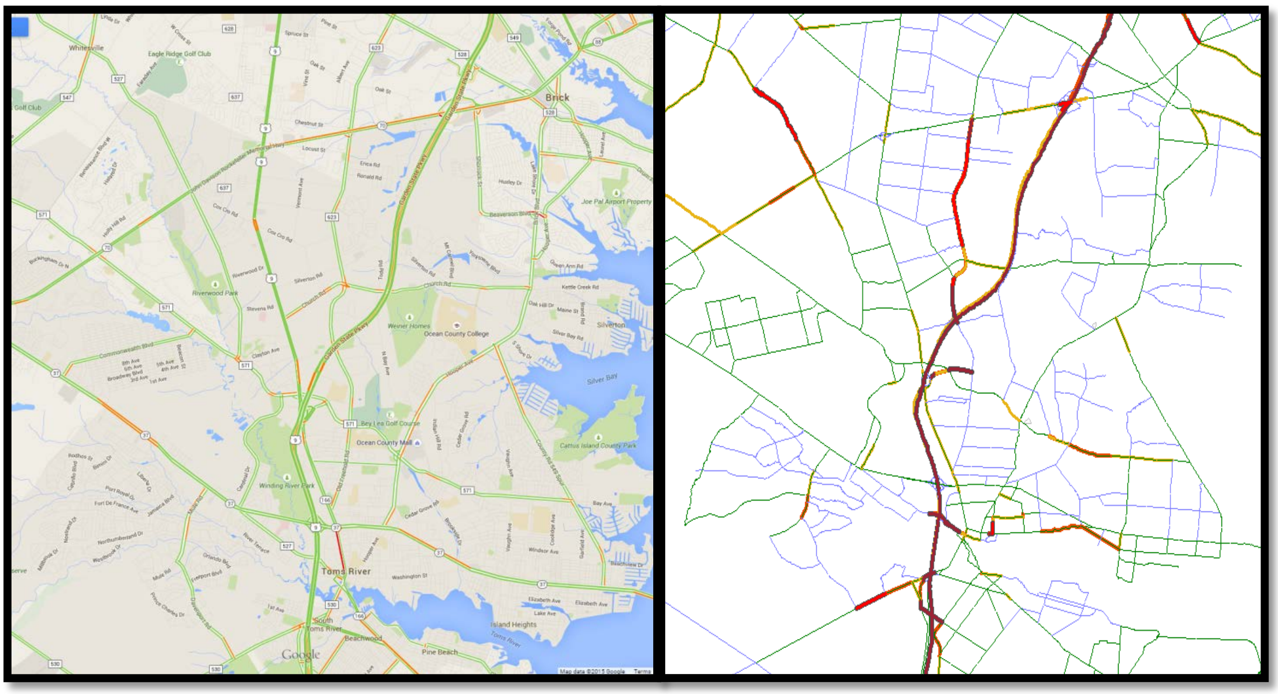
Figure 10.6 shows a typical Wednesday morning traffic around 7:30 AM from Google Maps.

Figure 10.6 Typical Wednesday Morning Traffic in Ocean County



Both figures show some congestion on the Garden State Parkway, even though the model estimates show a higher level of congestion along GSP. Google Map shows slightly more congestion on Route 9 compared to the model estimates. Focusing on the Toms River area, the model estimated higher congestion along Old Freehold Road, North Bay Avenue, and Route 527, while underestimated the congestion along Hoopers Avenue and Route 37 as shown in Figure 10.7.

Figure 10.7 Congestion Level in Toms River during AM Peak.



In addition to congestion check, Stantec also reviewed the estimated daily traffic volumes along US 9 and compared them to the observed data. Figure 10.8 shows the comparison of traffic counts and model estimated daily volumes. The estimated traffic volumes on the southern section, south of Veterans Blvd in Berkeley Township, are generally lower than the observed traffic counts. However, the estimated volumes are closer to the observed counts north of Veterans Blvd, and in segments even higher than the counts. The traffic comparison indicates that the estimated traffic along US 9 corridor is comparable to the count data.

Table 10.8 lists the important roadway locations where the AM Peak congestion was estimated by the 2010 model year results. The congestion was only measured by the roadways' V/C ratios. However, it should be noted that there are other factors that may impact the roadway congestion and could not be estimated precisely by the regional model, such as:

- Intersection delay – the regional and county models are macroscopic models, and they are not designed to estimate detailed operational characteristics of the roadways, even though some traffic control device modeling features were included in the models. The model is usually geared toward a broader analysis and general roadway trends in the study region. For corridor-level studies with its detailed operational characteristics, a finer analysis or microscopic analysis is required, such as traffic simulation studies. The simulation analysis can use a subarea trip tables that are derived from the regional model.

- Peak-hour congestion level – the regional model was designed to cover peak periods that extend more than one hour period. In the Ocean County Model, the peak periods, both AM and PM, are defined as a three-our period as discussed in Section 9.1. If the peak-spreading of traffic in a corridor is significantly less than three hours, the peak period V/C ratios will understate the congestion during the peak hour.

- Congestion caused by traffic entering and exiting driveways of commercial establishments. This type of congestion

Figure 10.8 Daily Traffic Comparison Along Route 9

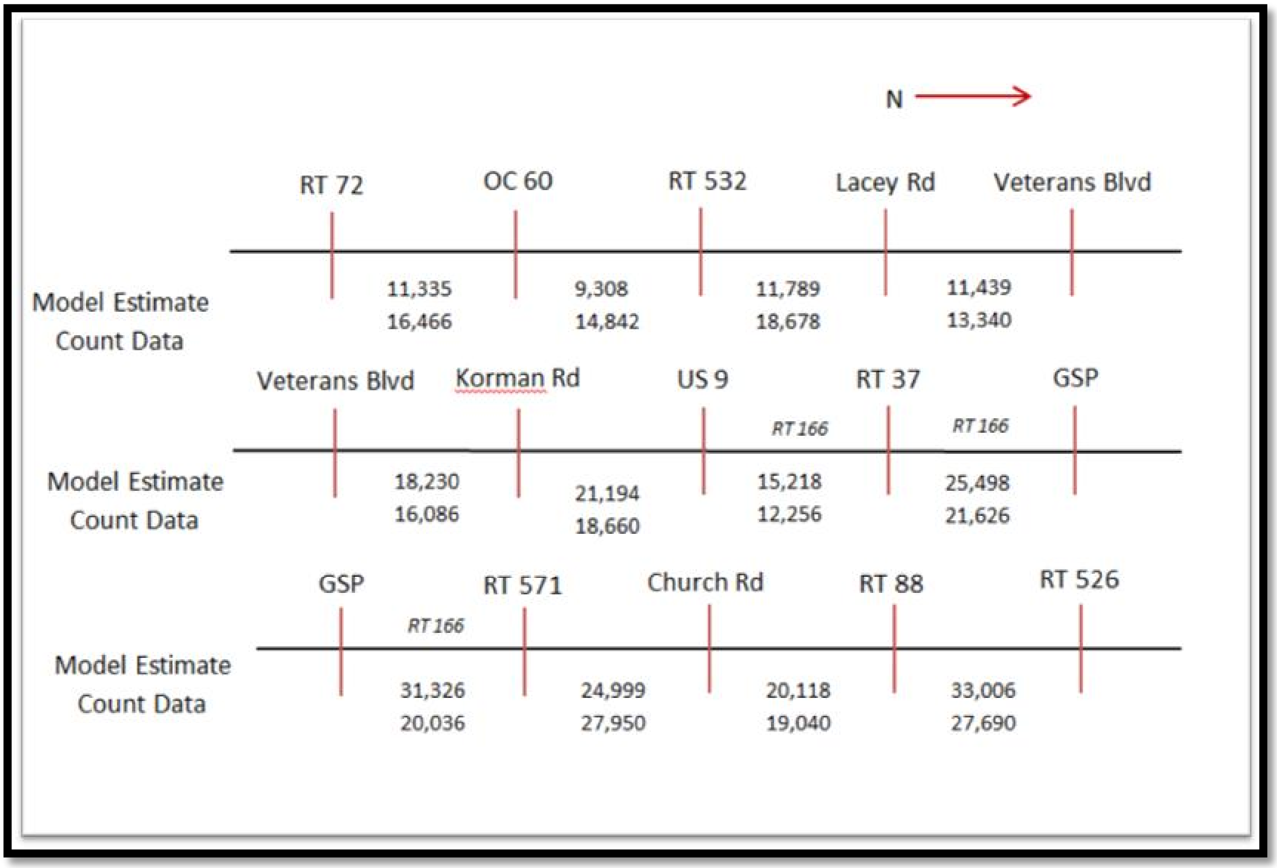


Table 10.8 Estimated Critical Locations in 2010

No	Roadway	Comments
1	Garden State Parkway	The model estimates indicate that congestion occurred along GSP. It should be noted that the estimates were for traffic prior to the widening of the GSP. The traffic comparison between the model estimated traffic and the traffic counts are within reasonable range as shown in Table 9.28.
2	US 9 Corridor	The model estimated some level of congestion between Rt. 37 and Church Road, and in the vicinity of Beachwood, and intersection with Rt. 70. The traffic comparison between model estimates and traffic counts are within reasonable range as shown in Figure 10.8. The Google Map shows a slightly higher congestiom level along Rt. 9, especially south of Berkeley Township.
3	Hoopers Avenue	The model estimated a lower congestion level along Hooper Avenue compared to Google Map. However, the congestion shown in Google Maps is usually located in the vicinity of an intersection which can be caused by an intersection delay.
4	Old Freehold Road	The model estimated a higher congestion level along Old Freehold Road compared to Google Map.
5	CR 549 Spur	The congestion level between CR 571 and Hooper Avenue is similar to the level shown in Google Map.
6	Route 37	The congestion level on Route 37 is estimated lower by the model compared to the level shown in Google Map

As part of this project, Stantec performed two future years model scenarios, 2025 and 2040. Several projects obtained from the FY2014 Conformity Project List were applied to the future highway networks. The list of the projects is shown on Table 10.9. In addition two project log files for Church Road Extension and North Bay Extension Projects were also prepared, although they are not applied to the network. The two log files are stored in the “Future Projects” sub-folder in the OCTM2013 folder.

Table 10.9 Future Projects

No	DB Number	Descriptions	Estimated Completion Year(1)
1	GSP1402	GSP Widening, Interchange 48 to Interchange 63 from 2 lanes to 3 lanes in each direction.	2013/2014
2	97080A	Intersection improvements at Route 9 and Lacey Road, providing an exclusive right-turn lane on Route 9 southbound as well as left-turn slots in both directions on Route 9.	2014
4	NS0414	Garden State Parkway Interchange 91 Improvements and Burnt Tavern Road Road.	2015
5	9147D	Improvements to the intersection of CR 528 include lengthening and widening of the left and right turn lanes on Route 35 to accommodate traffic volumes, lengthening approach tapers to current standards, and the installation of a new traffic signal.	2015
6	9028	Route 166 between Highland Parkway and Old Freehold Road will be widened to two travel lanes in each direction with no shoulders and a four-foot curbed median.	2018
7	94071A	Intersection Improvements at Rt. 72, along East Rd., Doc Cramer, and Washington Ave.	2017
8	11385	Approx. 3000’ feet of Rt. 72 (locally known as 8th and 9th Streets) and three cross roads (Barnegat Avenue, Central Avenue and Long Beach Boulevard) will be widened. Two-way traffic will be restored along Barnegat Avenue, Central Avenue and Long Beach Boulevard.	2018

The critical locations for 2025 and 2040 model years were also assessed. Figure 10.9 and Figure 10.10 shows the estimated congestion for model year 2025 and 2040, respectively. Critical locations along important roadways are summarized on Table 10.10, and discussions on suggested improvements are also included in the Table. Similarly, Figure 10.10 shows the estimated congestion for model year 2040 and the critical locations are presented on Table 10.11

Figure 10.9 Estimated Congestion Level in 2025

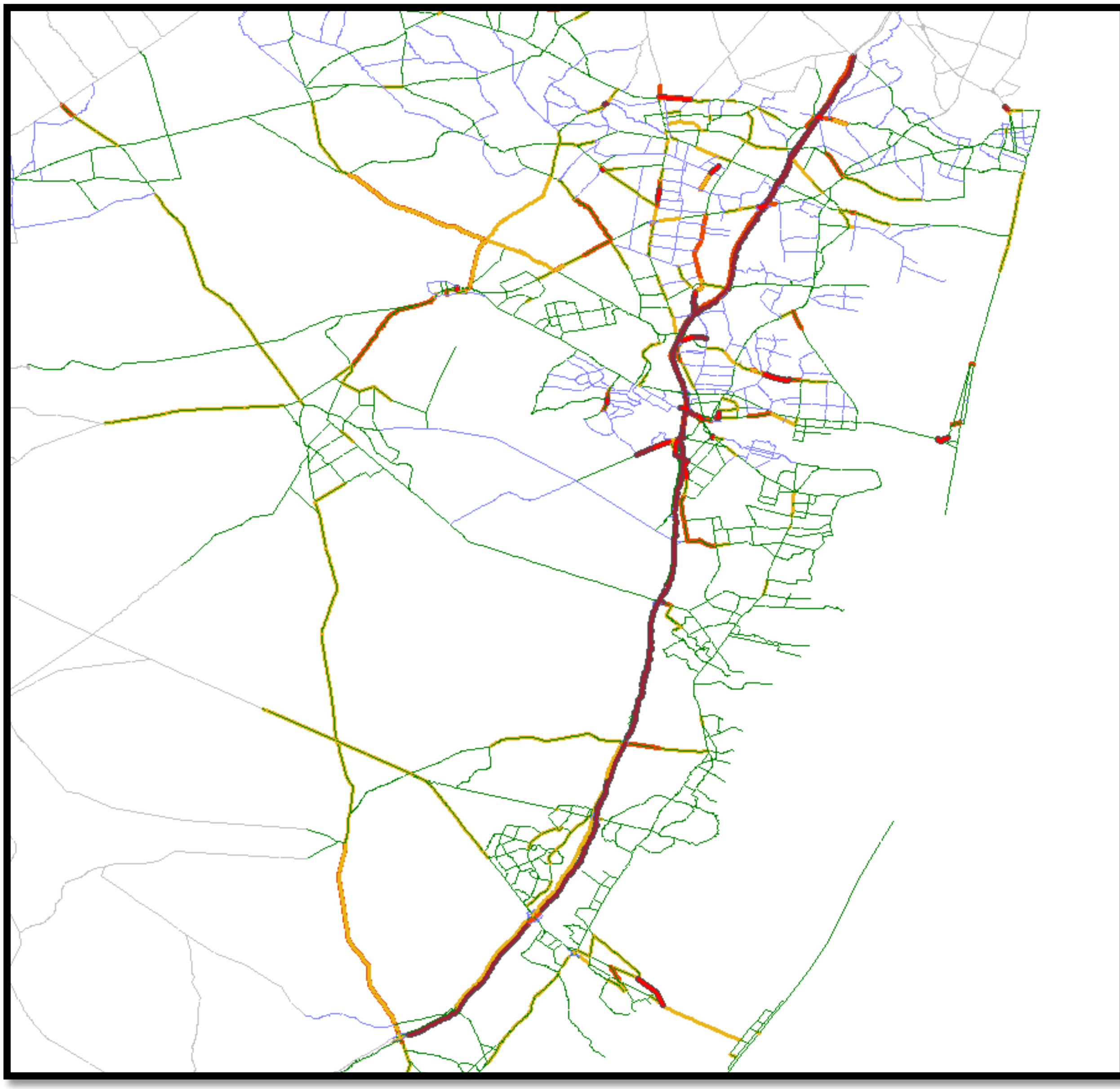


Figure 10.10 Estimated Congestion Level in 2040

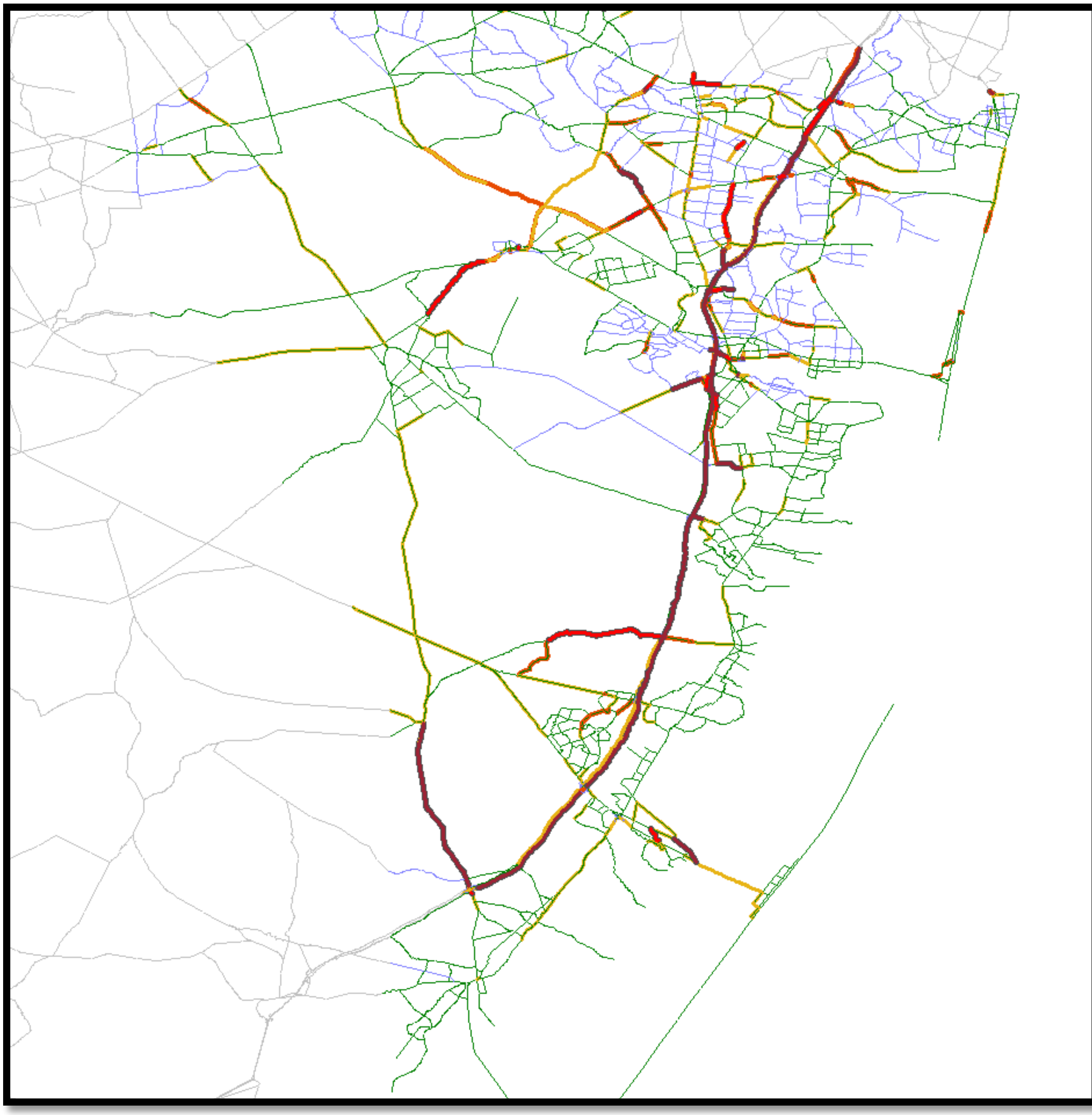
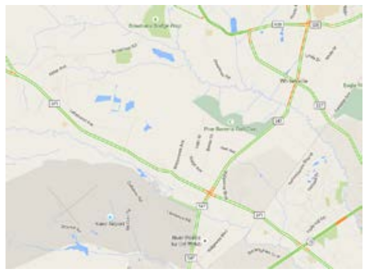


Table 10.10 Future Critical Locations and Suggested Improvements

No	Roadway	Findings	Recommended Strategy
1	Garden State Parkway	In both future years, the model estimated that GSP will continue to be congested. However, based on the base year results, the congestion level may be slightly overestimated.	Since this facility is mostly administered by NJ Turnpike Authority, Ocean County may need to coordinate a joint corridor study to monitor the congestion level along the facility, when it becomes an issue in the Future. However, the congestion level estimated by the model may be slightly overstated based on base year's traffic estimates along this facility when compared to the real congestion obtained from Google Map.
2	US 9 Corridor	There are increasing congestion levels between Rt. 37 and Rt 70 compared to the base year. The current Google Map, as shown in Figure 10.5, indicates that most of the congestions are localized congestion. This can be caused by signalization problems. The model also estimated localized congestion between Veeder Ln. and Rt. 532, although the congestion is not severe.	A microscopic corridor traffic study may be performed to review signal timing along the corridor as well as improving traffic signal coordination. A simulation model, such as VISSIM, can be used for the microscopic analysis using demand (subarea trip tables) obtained from the regional model.
3	Hoopers Avenue	The model estimated that there will be no to minimal congestion along Hoopers Avenue, only localized congestion at intersections with Rt. 549 Spurs and Rt. 70.	Intersection studies at both intersections.
4	Route 70	the model estimated future congestion along Rt. 70 between Rt. 571 and Rt. 528, especially at the GSP interchange. The model also estimated some level congestion just west of Lakehurst. Currently, Google also shows a minor congestion occurred in the vicinity of Lakehurst 	Corridor study may be performed at this segment, especially in the vicinity of GSP Interchange. Localized widening may be considered.
5	Old Freehold Road	The model continued to predict a high congestion level along this roadway. As indicated in the base year, the congestion level may be slighly overestimated.	The congestion along this road may be overestimated. Should the problem occur, a corridor and traffic signal study may be performed.

Table 10.10 Continued

No	Roadway	Findings	Recommended Strategy
6	Route 571 and Route 547	The model estimated a minor congestion along Rt. 571 and Rt. 547, as well as at the intersection of these two routes. 	A corridor and intersection study may be performed when the problem occurs.
7	Route 539 and Route 532 In Barnegat Township	The model estimated a high congestion level at these Routes, especially in 2040. However, this model estimates may overstate the congestion level based on the comparison of the base year estimates and the real congestion level shown in Google Map	The congestion along this road may be overestimated. Should the problem occur, a corridor and traffic signal study may be performed.
8	Route 72 between Route 539 and LBI	The model estimated a moderate level of congestion along this route. Currently, there is a moderate level of congestion in the vicinity of GSP and Rt. 9 as shown in Google Map. 	The congestion level along this corridor may not reach a severe-level. However, should this occur, a corridor and traffic study may be performed.

The model estimates indicate that the Garden State Parkway continue to be congested in 2025 and 2040 even though this facility was widen from 2 lanes per direction to 3 lane from Interchange 48 to Interchange 63 between 2010 and 2015. This indicates that the north-south trips continue to grow. The North-South improvement, such as the North Bay Avenue extension will help to remedy the congestion problem along the local parallel roads, and to Garden State Parkway in the vicinity of the project. Stantec executed the what-if scenario by adding the North Bay Avenue Extension to the highway network in the base year. The construction of North Bay Avenue extension will divert traffic from Old freehold Road, Garden State Parkway, and Hooper Avenue, as shown in Figure 10.11. The green bandwidth indicated the additional traffic diverted to the roadways due to the construction of North Bay Extension, while the red bandwidth indicates the traffic reduction. Additionally, local improvements on Old Freehold Roads, and Route 9 in the vicinity of GSP can also improve traffic operation in this area. It should be noted that the county model is a macroscopic model, and it is designed for a regional estimates. As the analysis becomes more detail, such as corridor analysis, additional model such as traffic simulation might be warranted to get a more detail estimates.

Figure 10.11 The Impact of North Bay Extension on Surrounding Traffic