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Technical Report

North East Regional Planning Model - Activity Based (NERPM-AB)

Prepared for
North Florida Transportation Planning Organization

Prepared by
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AADT - ANNUAL AVERAGE DAILY TRAFFIC
ABM - ACTIVITY BASED MODEL
ACS - AMERICAN COMMUNITY SURVEY
ASC - ALTERNATIVE SPECIFIC CONSTANT
BEBR - BUREAU OF ECONOMIC AND BUSINESS RESEARCH
CAC - CITIZENS' ADVISORY COMMITTEE
CBD - CENTRAL BUSINESS DISTRICT
CTPP - CENSUS TRANSPORTATION PLANNING PRODUCTS
EE - EXTERNAL-EXTERNAL
FDOE - FLORIDA DEPARTMENT OF EDUCATION
FDOT - FLORIDA DEPARTMENT OF TRANSPORTATION
FHWA - FEDERAL HIGHWAY ADMINISTRATION
HOV - HIGH OCCUPANCY VEHICLE
HTS - HOUSEHOLD TRAVEL SURVEY
IE - INTERNAL-EXTERNAL
II - INTERNAL-INTERNAL
IPF - ITERATIVE PROPORTIONAL FITTING
JTA - JACKSONVILLE TRANSPORTATION AUTHORITY
KNR - KISS AND RIDE
LRTP - LONG RANGE TRANSPORTATION PLAN
MAZ - MICRO ANALYSIS ZONE
MNL - MULTINOMIAL LOGIT
NAICS - NORTH AMERICAN INDUSTRY CLASSIFICATION SYSTEM
NERPM - NORTH EAST REGIONAL PLANNING MODEL: ACTIVITY BASED
NFTPO - NORTH FLORIDA TRANSPORTATION PLANNING ORGANIZATION
NHTS - NATIONAL HOUSEHOLD TRAVEL SURVEY
PNR - PARK AND RIDE
PUMA - PUBLIC USE MICRODATA AREA
PUMS - PUBLIC USE MICRDATA SAMPLE
QA/QC - QUALITY ASSURANCE/QUALITY CONTROL
RMSE - ROOT MEAN SQUARE ERROR
RSG - RESOURCE SYSTEMS GROUP
SOV - SINGLE OCCUPANCY VEHICLE
SR2 - SHARED RIDE 2 OCCUPANTS
SR3 - SHARED RIDE 3 OCCUPANTS
STDEV - STANDARD DEVIATION
TAZ - TRAFFIC ANALYSIS ZONE
TCC - TECHNICAL COORDINATION COMMITTEE
VC - VOLUME TO CAPACITY
VMT - VEHICLE MILES TRAVELED

1.0 INTRODUCTION

1.1 DISCLAIMER

The views and results expressed in this document do not represent the opinions of North Florida TPO and do not constitute an endorsement, recommendation, or specification by North Florida TPO. The document is based solely on the tasks and development conducted by RSG.

1.2 OVERVIEW

This report describes updates to the North Florida Transportation Planning Organization (NFTPO) activity-based travel demand model (NERPM-AB) to meet existing and evolving transportation planning needs. The new model system can address policies such as compact and mixed-use development, active transportation, transit, and pricing. The model is credible for forecasting demand for highway alternatives such as river crossings and network improvements, and appropriately sensitive to land-use changes such as new planned developments and provide useful information for traffic impact studies.

The report describes the model developments in detail and is also aimed to serve as a user's guide for the model updates. The activity based model (ABM) is integrated with Cube software, which is primarily used for network models (skimming and assignment) and auxiliary demand models (truck model and external truck demand). The ABM base-year model (2015) is calibrated using 2017 Household Travel Survey and 2016 transit on-board survey. The model system was also validated against observed data for traffic counts and transit ridership.

This project undertook the following key tasks to update the NERPM-AB activity-based model:

- Development of microzones for base year 2015
- Development of 2015 land-use data
- Development of population synthesis for base year 2015
- Development of 2045 land-use data
- Development of 2045 population synthesis
- Development of 2030 land-use data
- Development of 2030 population synthesis
- Implementation of latest version of DaySim
- Development of external trip inputs
- Development of cube model updates
- Calibration and validation of ABM
- Development of new model summaries

- Examine model sensitivities to land-use and network changes

The rest of this report refers to the new ABM system as NERPM-AB and is organized as follows. The next chapter, Chapter 2, describes the development of microzones for 2015. Then Chapter 3 presents development of land-use data and population synthesis for various model years. Chapter 4 discusses the cube model updates. Chapter 5 presents the model calibration and validation results. Chapter 6 describes the model summaries. At the end of the report, several appendices (Appendix A-B) provide supplemental information about various tasks performed during this project.

2.0 DEVELOPMENT OF MICROZONES AND 2015 LAND-USE DATA

As part of the Long-Range Transportation Plan (LRTP) update, the NERPM-AB model was updated, including migrating the base scenario from 2010 to 2015. This work involved development of updated land use and population data inputs for the new base year 2015 model scenario. The model structure was also updated to be easier to use and maintain. Although migrating from parcels to microzones is useful for land use data and trips, the auto and transit network modeling continue to use TAZs.

NERPM-AB uses two zones systems:

- TAZs for network modeling
- Microzones for land-use and ABM trips

The existing land use data such as households, employment by type, enrollment and parking is coded at the parcel level. There are approximately 700,000 parcels in the region, which makes it difficult to maintain, edit and attribute both the existing and alternative scenarios. This led to the creation and use of microzones as alternative, which is halfway between parcels and TAZs and are easier to maintain. Draft microzone geography and population synthesis were developed for the NERPM-AB model area. For this task, the microzones are assumed to be the blocks present in each block group from the Census data set. The existing parcel data was aggregated up to the microzones and aided in the QA/QC of the geography (i.e. zones with no households or employment were flagged for possible merging into neighbor zones).

2.1 DATA PROCESSING STEPS/METHODOLOGY

To create new microzones for the NERPM-AB model update, the raw block data in ArcGIS shapefile format was first downloaded from Census. Along with the blocks, shapefiles of water bodies, network, parcel and TAZ data were also either downloaded or collected from existing Model folders. The data downloaded from Census consisted of the entire Florida region out of which, the data for North Florida TPO was extracted using the six county codes:

- Baker (003)
- Clay (019)
- Nassau (089)
- Duval (031)
- Putnam (107)
- St. Johns (109)

The waterbodies were also merged in ArcGIS in one single data base. This data was used to eliminate or remove the area from the microzones. The next step involved bringing all the dataset under the same projection. While observing the boundaries of blocks and TAZs, it was found that some of the blocks were larger than TAZs and vice versa. This led to the overlapping of boundaries which will lead to irregular distribution of household and land use data. Therefore, the blocks and the TAZs were intersected to create MAZ pieces which served as the starting point for the new microzones. To distribute the parcel data, it was essential to find the centroid of the parcel polygons which is the next step in the methodology. The consultant calculated the centroids of the parcel polygons and then using 'Spatial Join' tool the block ID was added to the parcels.

Next, new parcel file was created by joining the data from the centroid file (including Block ID) to the polygon file using common parcel ID. The consultant then used 'Dissolve' tool to merge parcels into super parcels using Block ID. Finally, the super parcel data was transferred to the new microzone polygon shapefile using Block ID. In addition, the TAZ centroid was also calculated and the TAZ data was added to the microzones using 'Spatial Join' tool. Table 1 below shows the aggregation settings used to transfer data from parcels to microzones.

TABLE 1 AGGREGATION SETTINGS OF PARCEL DATA FIELDS

Parcel Field	Description	Aggregation Settings
sqft_p	The area of the parcel in thousands of square length units	SUM
hh_p	The number of households residing on the parcel	SUM
stugrd_p	The number of grade school (K-8) students enrolled at the parcel	SUM
stuhgh_p	The number of high school students enrolled at the parcel	SUM
stuuni_p	The number of college students enrolled at the parcel	SUM
empedu_p	The number of educational employees working at the parcel	SUM
empfoo_p	The number of food service employees working at the parcel	SUM
empgov_p	The number of government employees working at the parcel	SUM
empind_p	The number of industrial employees working at the parcel	SUM
empmed_p	The number of medical employees working at the parcel	SUM
empofc_p	The number of (other) office employees working at the parcel	SUM

Parcel Field	Description	Aggregation Settings
empret_p	The number of retail employees working at the parcel	SUM
empsvc_p	The number of (other) service employees working at the parcel	SUM
empoth_p	The number of other sector employees working at the parcel (typically agriculture, mining - not used for SACOG)	SUM
emptot_p	The total number of employees working at the parcel (equals the sum of the previous 9 values)	SUM
parkdy_p	The number of paid off street parking spaces on the parcel with per day pricing	SUM
parkhr_p	The number of paid off street parking spaces on the parcel with per hour pricing	SUM
ppricdyp	The average price per day for paid off street parking spaces on the parcel	MEAN
pprichrp	The average price per hour for paid off street parking spaces on the parcel	MEAN

The new microzones were then loaded along with the network and waterbody data to check for discrepancy. The following series of ArcGIS figures show the creation of new microzones. Figure 1 shows a section of the CBD area, Figure 2 shows a section of the suburban area, Figure 3 shows a section or rural area and Figure 4 shows the section of area along a major waterway. Figure 5 shows difference between the old microzone boundaries, that is before intersecting the MAZ and TAZ boundaries and new ones which is after intersection.

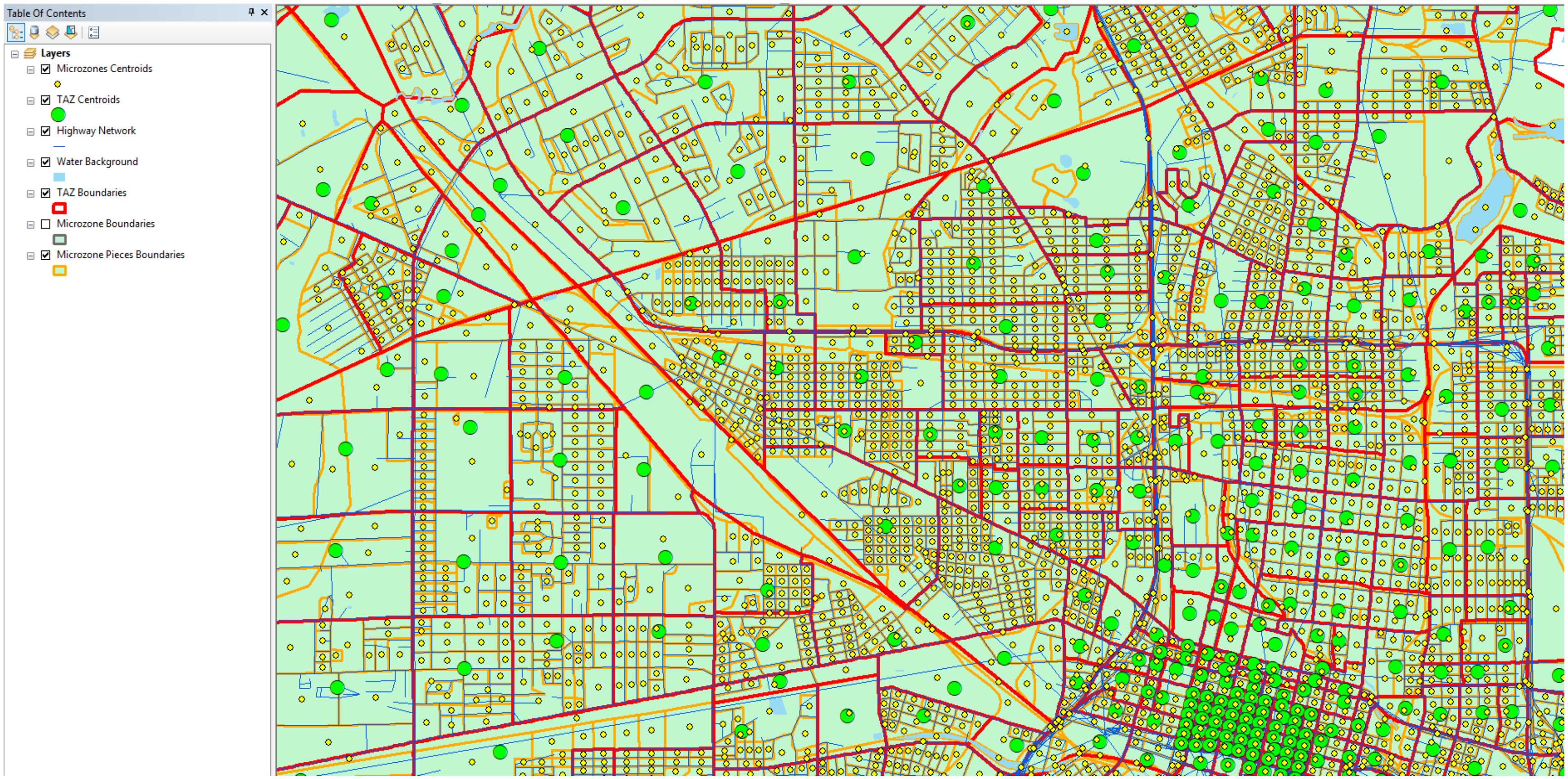


FIGURE 1 CBD AREA – URBANCORE, SPRINGFIELD, DOWNTOWN.

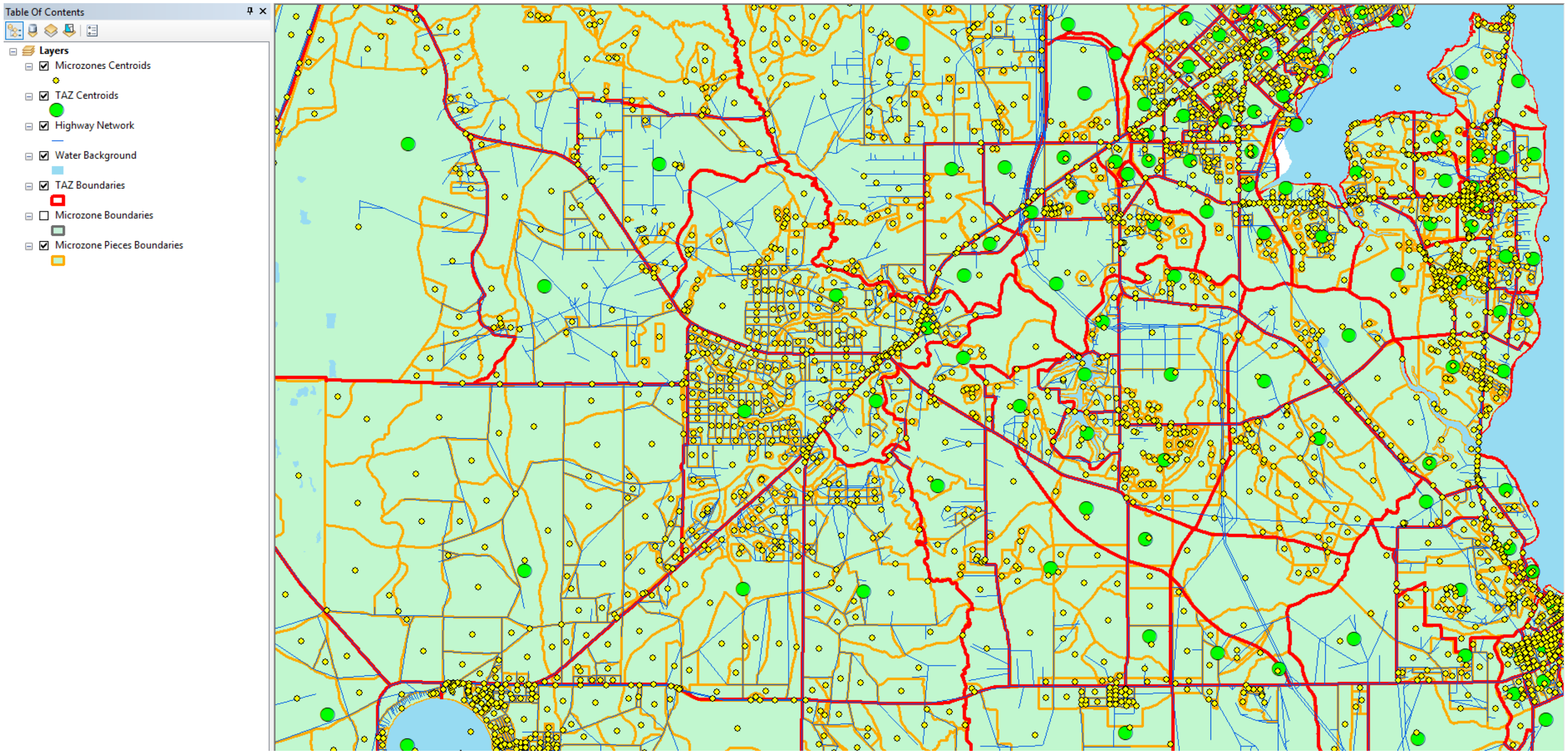


FIGURE 2 SUBURBAN AREA - MIDDLEBURG.

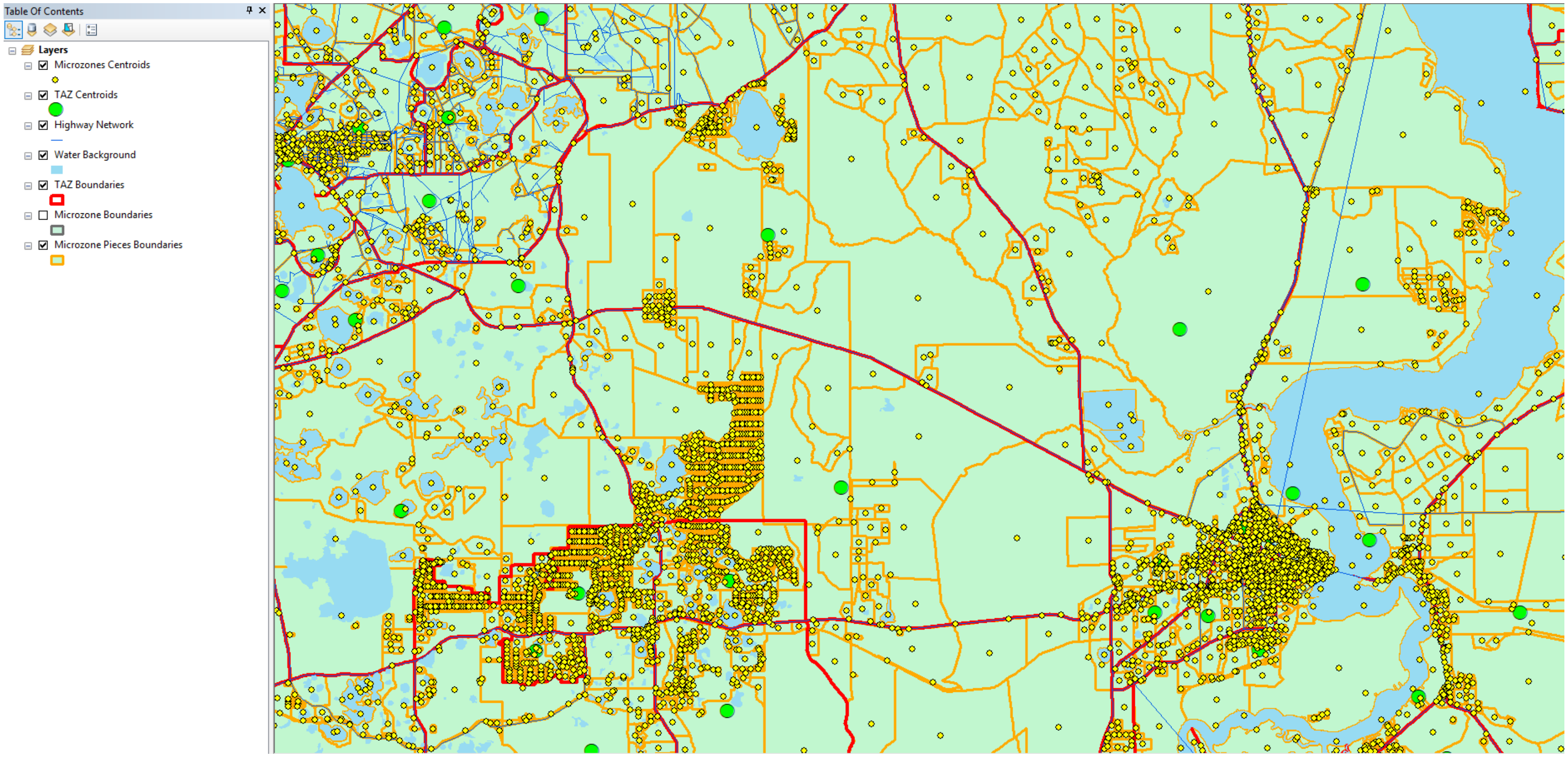


FIGURE 3 RURAL AREA - ETONIAH CREEK STATE FOREST, PALATKA.

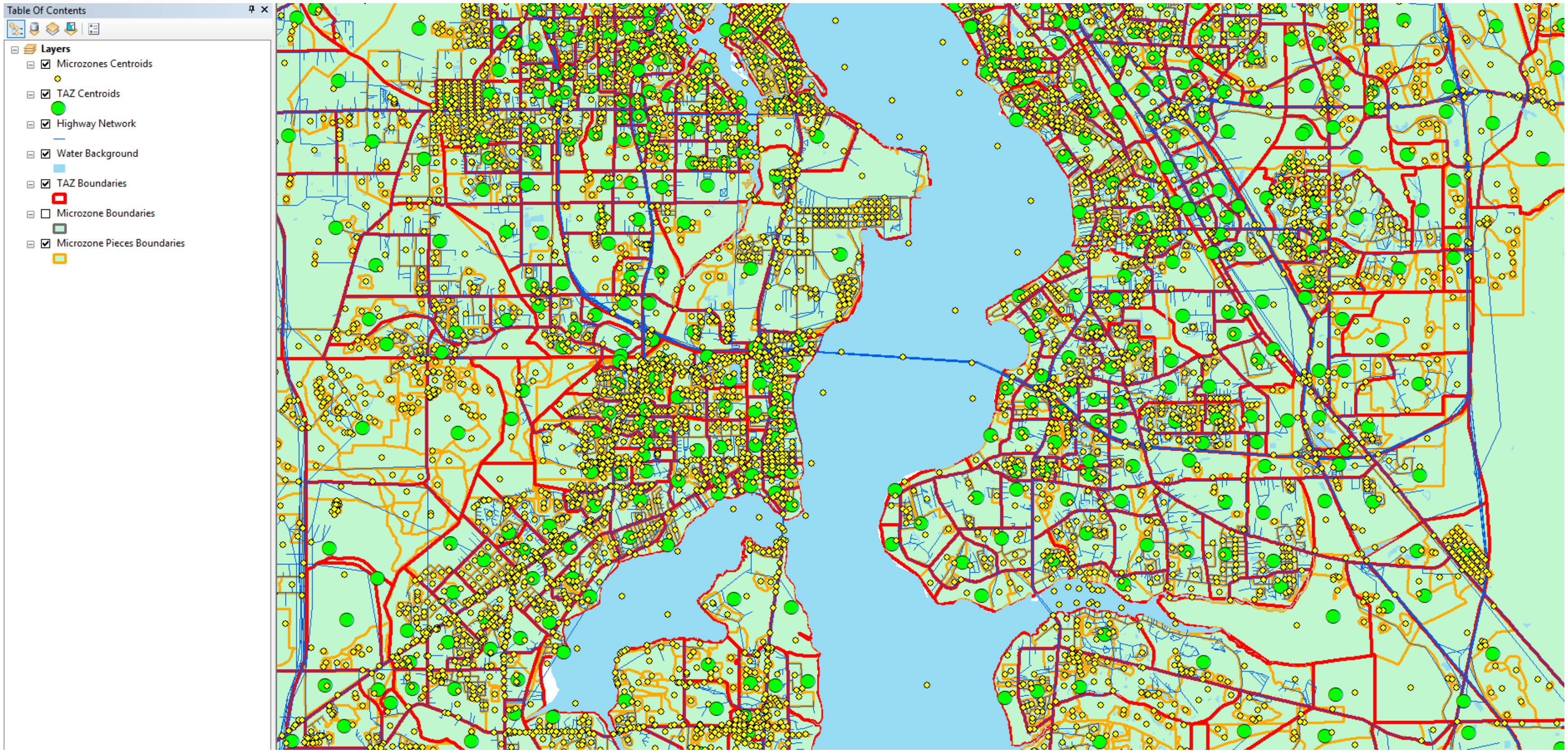


FIGURE 4 ALONG A MAJOR WATERWAY – HENRY H BUCKMAN BRIDGE.

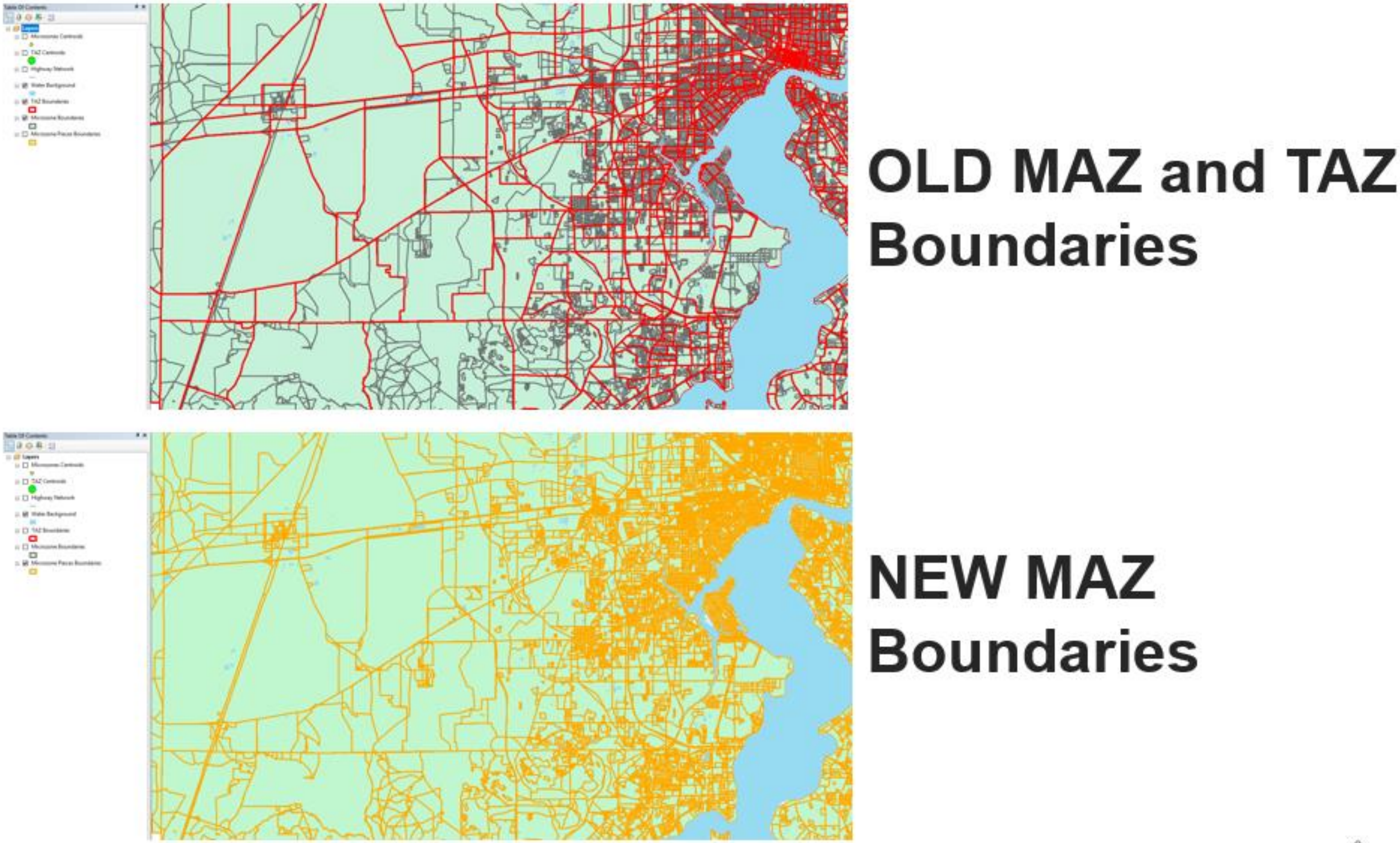


FIGURE 5 DIFFERENCE BETWEEN OLD MAZS AND NEW MAZS.

2.2 MICROZONE SUMMARIES

Once the microzones were formed, summary tables were created to check for consistency. Table 2 shows the frequency of microzones, parcels and TAZ by County. It can be observed that Duval has the highest frequency for all three categories which is intuitive since this County contains the CBD area.

Table 3 shows the distribution of households and employment by TAZs and MAZs. There are many empty microzones, which are kept for future year growth.

TABLE 2 MICROZONES BY COUNTY

County	Parcel Frequency	% Freq	Microzone Frequency	% Freq	TAZ Frequency	% Freq
003 – Baker	12,490	1.78	1,735	3.14	29	1.56
019 – Clay	84,529	12.02	7,796	14.13	184	9.88
031 – Duval	355,805	50.59	28,263	51.22	1,281	68.80
089 – Nassau	47,443	6.75	4,455	8.07	108	5.80
107 – Putnam	102,053	14.51	6,652	12.05	44	2.36
109 – St. Johns	100,950	14.35	6,283	11.39	216	11.60
Total	703,270	100.00	55,184	100.00	1,862	100.00

TABLE 3 MICROZONE HOUSEHOLDS AND EMPLOYMENT.

Category	MAZs	%	TAZs	%
Number of Households = Zero	33,426	60.57	179	9.61
Number of Households > Zero	21,758	39.43	1,683	90.39
Total	55,184	100	1,862	100
Number of Employment = Zero	45,549	82.54	86	4.62
Category	MAZs	%	TAZs	%
Number of Employment > Zero	9,635	17.46	1,776	95.38
Total	55,184	100	1,862	100
Zones with no parcels/MAZs	0	-	13	-
Zones joined to parcels/MAZs but HH=0 and Emp=0	32,549	-	21	-
Total Number of Households	582,199	-	582,199	-
Total Employment	736,435	-	736,435	-

2.3 EMPLOYMENT DATA

The NERPM-AB utilizes land use to predict travel patterns. These land use data are incorporated into various input files for both the Cube model and the DaySim model. This section explains how the land use data was updated for 2015 and which files used this data.

Employment data is stored at the microzone level, and nine types of employment are distinguished. The DaySim labels are provided in parentheses:

1. Education (empedu_p)
2. Food Service (empfoo_p)
3. Government (empgov_p)
4. Industrial (empind_p)
5. Medical (empmed_p)
6. Office (empofc_p)
7. Retail (empret_p)
8. Service (empsvc_p)
9. Other (empoth_p)

The 2015 data was updated using three sources of data:

1. The 2010 parcel employment data projected to 2015
2. Data provided by Infogroup and edited by North Florida TPO
3. Data provided by Cambridge Systematics as described in their June 30, 2017 memorandum “Development of 2015 Employment Data” for FDOT

To compare these three sources the data was converted to a common organization structure – the nine DaySim employment types above in each microzone. The project parcel data was already organized in this format and did not require conversion. The Infogroup data was organized by business and each entry included a point location (latitude and longitude), the number of employees, and a 3-digit NAICS code. Each entry was converted to a point in ArcMap and then spatially joined to the 2015 microzone shapefile. Each entry in the Cambridge Systematics data contained a census block ID, 3-digit NAICS code, and number of employees. Each entry was attached to its respective census block location in ArcMap and then spatially joined to the microzone file. For the latter two data sources, employees were assigned to one of the nine DaySim employment types based on the first two or three digits of their respective NAICS code using the crosswalk given in

Table 4.

TABLE 4 NAICS CODE TO DAYSIM EMPLOYMENT CROSSWALK

NAICS CODE	DAYSIM TYPE
11	empoth_p
21	empoth_p
22	empsvc_p
23	empsvc_p
31	empind_p
32	empind_p
33	empind_p
42	empofc_p
44	empret_p
45	empret_p
48	empsvc_p
49	empsvc_p
51	empofc_p
52	empofc_p
53	empofc_p
54	empofc_p
55	empofc_p
561	empofc_p
562	empsvc_p

NAICS CODE	DAYSIM TYPE
61	empedu_p
62	empmed_p
71	empsvc_p
721	empsvc_p
722	empfoo_p
811	empsvc_p
812	empsvc_p
813	empofc_p
814	empsvc_p
92	empgov_p

Because the three data sources did not match, a script was written to compare the number of employees in each microzone according to each data source. For microzones where two of the three sources had similar values (percent difference within 30% for over 100 employees, within 75% for 11 to 100 employees and within 150% for 10 or fewer employees), the average of the two similar values was used as the final employment number, and most of the microzones met these criteria. In cases where all three sources disagreed, the projected 2015 microzone data was used. In cases where two of the three sources had a value of zero, the source with a value greater than zero was used. After employment data was assigned to microzones, microzones with large changes were manually checked.

2.4 SCHOOL ENROLLMENT DATA

DaySim uses three categories of school enrollment data, grades K-8, grades 9-12, and college/university. Enrollment data was updated to 2015 by assigning 2015 enrollment numbers to the appropriate categories in each microzone.

North Florida TPO provided school enrollment data from the Florida Department of Education (FDOE). This kindergarten through twelfth grade enrollment was divided into public and private schools and separated by county. Each entry included the name of the school, its address, the number of enrolled students according to FDOE, and enrollment according to the website Public School Review. The two enrollment numbers were generally in agreement and FDOE data was used.

Latitude and longitude coordinates were included for most, but not all, of the colleges. No location data beyond address was included for the schools. The ESRI Geocoder included in ArcMap was used to create point locations for entries that did not include location information.

School data does not included the type of school, e.g. preschool, elementary school, K-8, high school. First school names were manually inspected to determine the school type, e.g. “SAMUEL W. WOLFSON HIGH SCHOOL” was coded as 9-12, “R. V. DANIELS ELEMENTARY SCHOOL” was coded as K-8. If the type of school could not be determined from the name and enrollment was 100 students or more, the school type was manually determined from a web search. Where enrollment was less than 100 students, total enrollment numbers were assigned to a microzone and then 2010 enrollment numbers were used to distribute the total enrollment between K-8 and 9-12 categories. In most cases, only one type of school was present in a microzone, so the total enrollment for that microzone matched a single enrollment category.

After assigning enrollment, microzones with large discrepancies between 2010 and 2015 enrollment numbers were manually checked and revised if warranted.

2.5 PARKING

Parking information was derived from FDOT parking shapefiles “Parking surface” and “g100freeway” and the website https://www.bestparking.com/jacksonville-fl-parking/. Data was visually checked against online maps. RSG added this parking data to the microzone DaySim input file, specifically, the fields parkdy_p, parkhr_p, ppricdyp, and pprichrp. Twenty-seven lots were used including 16 with day and hour rates and 11 hourly-rate only lots. Each lot entry contained a point location. Points were spatially joined to microzones in ArcMap. If a microzone contain multiple lots, the number of spaces were summed, and the parking price was calculated as a weighted average based on the number of spaces in each lot.

2.6 LODGING

North Florida TPO provided RSG with a list of 367 known hotels, motels, and bed and breakfasts from the Florida Department of Business and Professional Regulation. This list included each establishment’s name, address and number of rooms.

RSG used the ESRI Geocoder included in ArcMap by addresses to determine the location of each hotels. Spot checking the geocode showed that some hotels were not located correctly. As a check, the addresses were also run through Google’s geocoder, and these locations were compared with the ESRI-based locations. When discrepancies were found, the hotel’s location was determined from an internet search.

Lodging locations were then aggregated at the TAZ level and the final Hotel_Motel_TAZ_summary.txt was produced. This file was compared to the 2010 hotel file to check for major discrepancies. The number of rooms in 2010 and 2015 were 27,570 and 27,463, respectively. Approximately 3,200 rooms from the 2010 TAZs were not found in the 2015 TAZs, and approximately 3,100 rooms in the 2015 TAZs were not in the 2010 TAZs. In many cases, a hotel's location was changed to a neighboring TAZ, which contributed to the discrepancies between the two datasets.

2.7 SPECIAL GENERATORS

A special generator is a land use for which trip generation does not fall within the typical framework of the model. The file SPGEN_10A.DBF defines the behavior of special generators. A special generator is assigned to a single TAZ, and all trips associated with that generator originate or end at its respective TAZ. While the file lists 38 special generators, only two, Jacksonville International Airport and St. Augustine, have non-zero values of attraction or production. Effectively, these are the only special generators in the model.

The Airport had an attraction value of 15,000 in 2010. Based on several sources, RSG determined that the passenger traffic at the airport has decreased slightly between 2010 and 2015. CAPA – Centre for Aviation noted an overall downward trend in traffic since 2008 but traffic began to pick up in 2013[1]. The airport's website lists the 2010 and 2015 number of passengers as 5,602,000 and 5,502,000 respectively, which represents a 1.8% reduction in traffic. FDOT's 2015 Airport Profile of JAX showed similar findings. Given the small change over the years, we recommend leaving the airport's attraction value at 15,000 for 2015.

St. Augustine had an attraction value of 2,288 in 2010. This number accounts for tourists coming to the area. In 2010 and 2015, St. Johns County had 3.4 million and 6.3 million visitors, respectively, which represents an 85% growth over the five-year period. The 2015 number was considered an anomaly because it was the City's 450th birthday. However, 2016 was even higher with 6.8 million visitors, so an 85% increase may be reasonable. Increasing the attractions value by 85% to 4,240 could have a noticeable impact on links near the TAZ

[1] Data is based on Internet sources, as shown in the Lodging/SpecGen memo (file:///E:\Projects\Clients\jax\Data-Development\NorthFloridaTPO_DATA\Task_5_Lodging_SpecGen\memo_lodging_specGen.docx)

3.0 DEVELOPMENT OF POPULATION SYNTHESIS FOR 2015

Activity Based Models (ABMs) operate in a micro-simulation framework, wherein the travel choices of person and household decision-making agents are predicted by applying Monte Carlo methods to behavioral models. This requires a data set of households and persons representing the entire population in the modeling region. Population synthesis refers to the process used to create this data. Population synthesis requires a rich set of household and person level attributes by various levels of geography. The required inputs to population synthesis are a population sample and marginal distributions. The population sample is commonly referred to as the seed or reference sample and the marginal distributions are referred to as controls or targets. The process of expanding the seed sample to match the marginal distribution is termed population synthesis.

The software tool which implements this population synthesis process is termed as a population synthesizer. In this project, PopulationSim, an open platform for population synthesis funded by Oregon Department of Transportation was used. PopulationSim is used to generate population for the year of 2015 to represent the population in the NERPM-AB modeling region. The installation, setup and run description for PopulationSim is explained in Appendix A.

3.1 INPUT DATA FOR POPULATION SYNTHESIS

The main inputs to a population synthesizer are

- Disaggregate population samples (Seed Sample)
- Marginal control distributions (Control variables)

The Seed sample is obtained from the Census Public Use Microdata Sample (PUMS)

https://www.census.gov/programs-surveys/acs/data/pums.html

and the Marginal distributions of person and household attributes are obtained from Bureau of Economic and Business Research (BEBR) and Census respectively.

The next step is the preparation of inputs to PopulationSim which includes:

- Geographic cross-walk
- Seed population (Household and Person tables)
- Controls

PopulationSim can represent both household and person level controls at multiple geographic levels. Therefore, the user must define what geographic units to use for each control. The hierarchy of geographies is important when establishing controls. The Meta geography is the entire region. Currently, PopulationSim can accommodate only one Meta geography. The Seed geography is the geographic resolution of the seed data. There can be one or more Seed geographies. PopulationSim can handle any number of nested Sub-Seed geographies. The geography level (hierarchy) selected for NERPM-AB 2015 to which the marginal distributions are specified are as follows:

- Meta Geography: Super County (SCOUNTY)
- Seed Geography: PUMA
- Sub-seed Geography: TAZ and MAZ

Super-County is chosen instead of County due to overlapping of county and PUMA boundaries. Super County is the combination of multiple County to form one geographic area.

Preparing Geographic Cross-walk

The geographic cross-walk is used to aggregate controls specified at a lower geography to upper geography and to allocate population from an upper geography to a lower geography. Table 5 below shows a sample of the geographic crosswalk created for this project.

TABLE 5 GEOGRAPHIC CROSSWALK SAMPLE.

MAZ	TAZ	BLKGRP*	TRACTCE*	PUMA	SCOUNTY
1	310	120310143321	12031014332	1203104	12031000
2	305	120310143321	12031014332	1203104	12031000
3	253	120310143302	12031014330	1203104	12031000
4	431	120310162001	12031016200	1203106	12031000
5	2016	120310162001	12031016200	1203105	12031000

*Block group (BLKGRP) and *Census tract (TRACTCE) ID are also kept in the crosswalk for data extraction from the census since the data is only available in these regions.

Preparing Seed Sample

One of the main requirements for the seed sample is that it should be representative of the modeling region. The seed sample is obtained from PUMS dataset. The PUMS data contain five years of household records. The seed sample should be representative of the modeling region. It must contain all the specified control variables, as well as any variables that are needed for the travel model but not specified as controls. The PUMS data is downloaded from PUMS website and it is extracted both demographically and geographically for the North Florida TPO region using PUMA codes conforming to the region. There are 11 PUMA regions in the North Florida TPO area. The seed sample must include an initial weight field. In this project, the Seed sample contains a weight field, WGTP, which is used for control of total households.

Preparing Control Data

Controls or targets are the marginal distributions that form the constraints for the population synthesis procedure. The objective of the population synthesis procedure is to produce a synthetic population with attributes matching these marginal distributions. Controls can be specified for both household and person variables. The choice of control variables depends on the needs of the project. The mandatory requirement for a population synthesizer is to generate the right number of households in each travel model geography. Therefore, it is mandatory to specify a control on total number of households in each geographical unit at the lowest geographical level. If this control is matched perfectly, it ensures that all the upper geographies also have the correct number of households assigned to them. Once the raw data is obtained, it is aggregated or disaggregated to the desired geography to build these controls.

Level: Super County

The raw input data was downloaded at county level from: https://www.bebr.ufl.edu/sites/default/files/Research%20Reports/projections_2016_asrh.xlsx

Next, the data was aggregated to super county level. The data at super county level are person level attributes, namely, sex and person age group as shown below:

person_male **person_female** **person_age0to4** **person_age5to17**	**person_age18to24** **person_age25to54** **person_age55m**

Table 6 below shows the total 2015 population from University of Florida Bureau of Economic and Business Research (BEBR) data along with the person level attributes.

TABLE 6 BEBR SUPER COUNTY TOTALS (2015)

SCOUNTY	PERSONS	MALE	FEMALE	AGE0-4	AGE5-17	AGE18-24	AGE25-54	AGE55+
12109107	286,322	140,049	146,273	15,257	47,539	23,702	104,701	95,123
12031000	905,574	440,059	465,515	61,304	146,443	87,517	379,741	230,569
SCOUNTY	PERSONS	MALE	FEMALE	AGE0-4	AGE5-17	AGE18-24	AGE25-54	AGE55+
12003089	103,553	51,969	51,584	5,963	16,366	8,505	38,968	33,751
12019000	201,277	98,400	102,877	12,543	37,662	18,453	79,447	53,172

Level: TAZ

The raw input data was downloaded at various levels [Source: 2011-15 American Community Survey five-year estimates, ACS5]:

- Households by Household Size at Block Group Level
- Tenure by Age of Householder at Block Group Level
- Households by number of workers at Census Tract Level
- HHs by income at Census Tract Level

The data processed at TAZ level are household attributes:

hh_size_1 hh_size_2 hh_size_3 hh_size_4	hh_age_15_to_44 hh_age_45_to_64 hh_age_65_abv	hh_wrks_0 hh_wrks_1 hh_wrks_2 hh_wrks_3m	hh_inc_0_25 hh_inc_25_60 hh_inc_60_100 hh_inc_100_plus

Level: MAZ

The raw input data was obtained at parcel level for the year 2010 and calculated for 2015 using growth factor from 2010 to 2015. The data obtained is total number of households and then aggregated for each MAZ. Once the control files are prepared, the total number of households and persons are calculated across geographies to check for consistency as shown in Table 7 below.

TABLE 7 CONTROL DATA SUMMARY.

Data	Geography	Value
Total number of households	MAZ	582,199
Total number of households	TAZ	582,199
Number of households in HHSIZE=1	TAZ	155,522
Number of households in HHSIZE=2	TAZ	196,050
Number of households in HHSIZE=3	TAZ	87,996
Number of households in HHSIZE=4+	TAZ	110,821
Data	**Geography**	**Value**
Total number of persons (from HHSIZE)	TAZ	1,397,535
Total number of persons	SCOUNTY	1,397,534

3.2 POPULATIONSIM VALIDATION

One of the most critical steps in the population synthesis procedure is validation of the synthetic population. Validation provides clues about inconsistencies among controls, data processing errors or misspecification of settings. After a successful run of PopulationSim, the validation task is performed to check the synthetic population. PopulationSim reports the difference between the synthesized totals and the control totals for all the controls at each geographic level. The validation takes summaries and outputs from a PopulationSim run to generate plots and advanced summaries.

The following two statistics are computed as a part of this exercise:

- the standard deviation (STDEV) of the percentage difference – this measure informs us of how much dispersion from the average exists, and
- the percentage root means square error (RMSE) - an indicator of the proximity of synthesized and control totals.

The validation chart, a visualization of the disaggregate summary statistics – STDEV and RMSE of percentage differences is plotted. A form of dot and whisker plot is generated for each control where the dots are the mean percentage differences and horizontal bars are twice the STDEV or RMSE centered around zero. Figure 6 and Figure 7 display the validation plots for 2015 data.

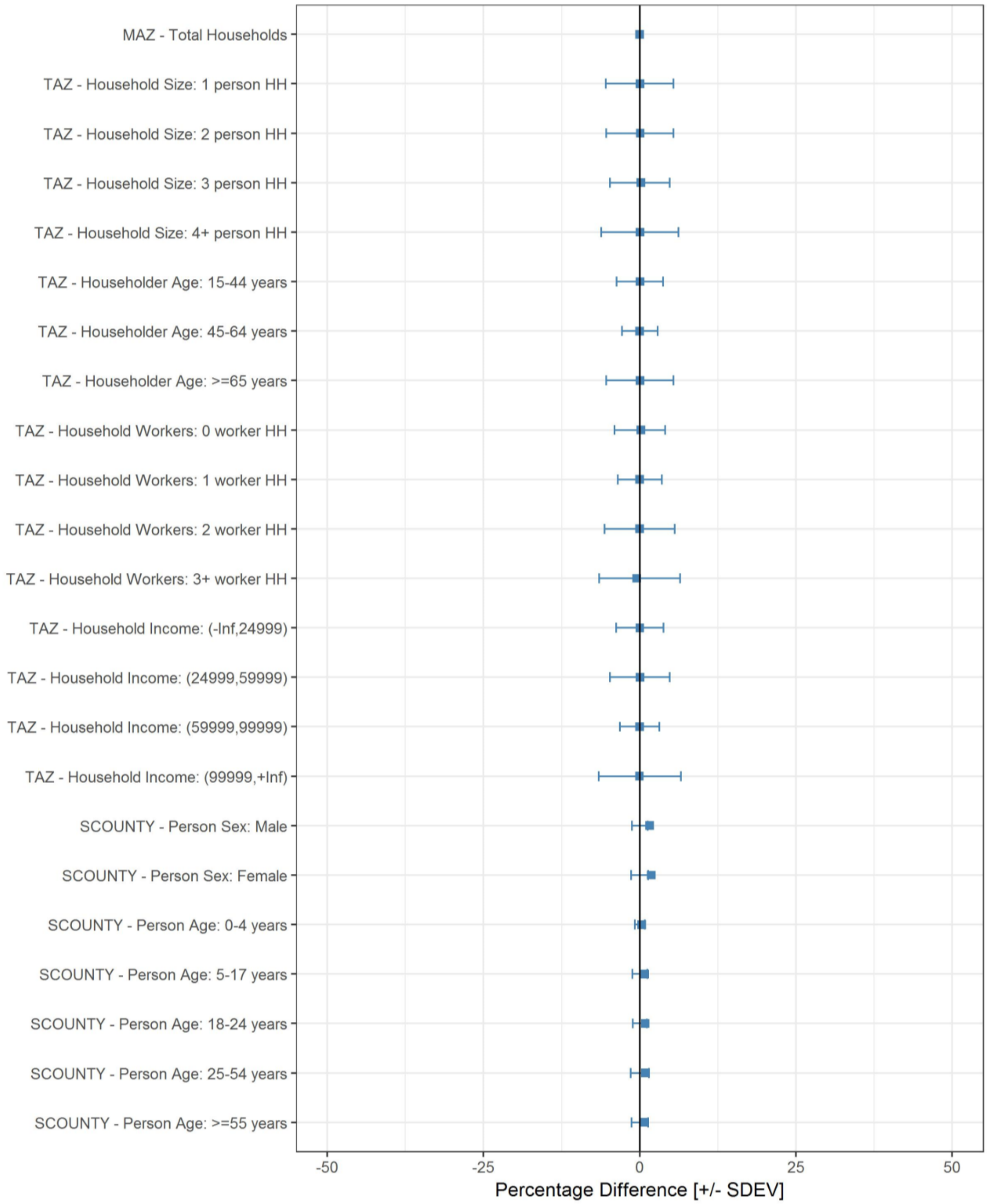


FIGURE 6 POPSIM VALIDATION (STANDARD DEVIATION).

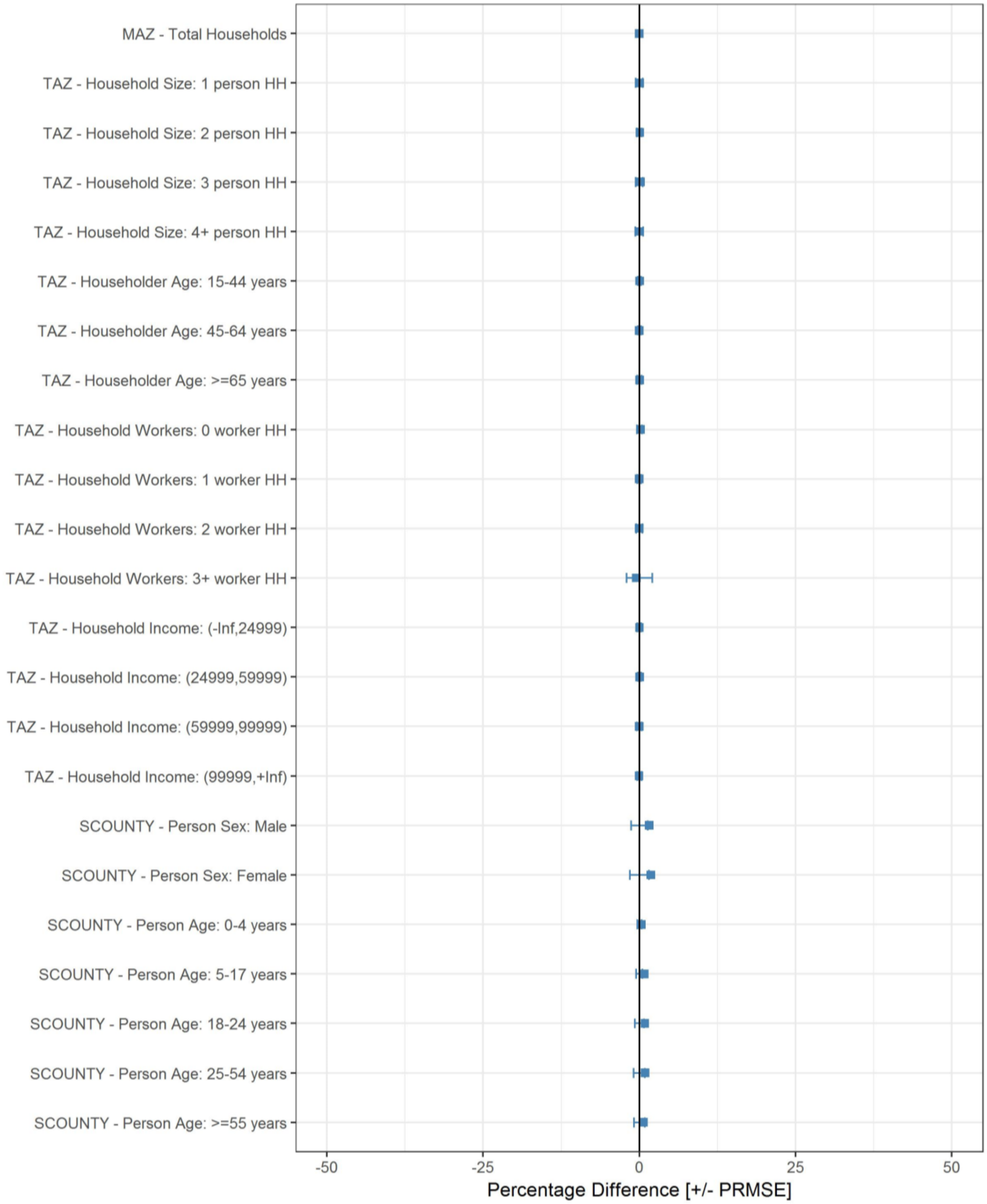


FIGURE 7 POPSIM VALIDATION (ROOT MEAN SQUARE ERROR).

After the completion of population synthesis, the final synthetic household and person data summaries were calculated and compared for consistency checks as shown in Table 8.

TABLE 8 POPULATIONSIM DATA SUMMARIES COMPARISON.

County	Total number of households		Total number of Persons	
	2010	2015	2010	2015
Baker	8,800	8,815	24,834	23,082
Clay	69,277	70,523	190,657	188,960
Duval	348,911	354,060	855,223	850,383
Nassau	32,235	32,983	80,593	76,792
Putnam	31,648	31,278	77,859	70,016
St. Johns	80,230	84,540	197,976	202,270
Total	571,101	582,199	1,427,142	1,411,503
Average Number of persons per HH (2010)	**2.499**			
Average Number of persons per HH (2015)	**2.424**			
Average Number of persons per HH (2015 Census)	**2.403**			

4.0 DEVELOPMENT OF 2045 LAND-USE DATA

This section describes the processes followed to create the 2045 land-use data and create the synthetic population for 2045. It describes the various internal and external data sources used and the methodology followed to create the land-use data for 2045.

To create 2045 land-use data, RSG used the 2015 base year land-use data as the starting point. Land-use forecasts for scenario years 2010 and 2040 were also used to calculate the growth rate. An external data source, Bureau of Economic and Business Research (BEBR), was used to calculate county wide growth rates, to be applied in special cases. The objective was to utilize available land-use data from 2015 and forecasts for 2010 and 2040 to create the data for 2045. Table 9 shows the total population of the six counties for years 2010, 2015, 2040 and 2045 retrieved from BEBR. These totals were used to calculate county wide growth rates from 2015 to 2045 and 2040 to 2045 which were later used to forecast 2045 data.

Table 10 shows the logic followed for various cases depending on the availability of valid values in previous years' data. The logic varied depending on the availability of non-zero values in the base years.

TABLE 9 BEBR COUNTY TOTALS

COUNTY	2010	2015	2040	2045
NASSAU	73,314	76,536	111,283	116,513
DUVAL	864,263	905,574	1,129,785	1,164,640
ST JOHNS	190,039	213,566	382,701	409,339
CLAY	190,865	201,277	304,669	320,265
BAKER	27,115	27,017	34,452	35,473
PUTNAM	74,364	72,756	75,078	75,518

TABLE 10 FORECASTING LOGIC FOR 2045

CASE	2010	2015	2040	2045
1	0	0	0	0
2	> 0	0	0	0
3	0	> 0	0	2015 * BEBR2045/BEBR2015
4	0	0	> 0	2040 * BEBR2045/BEBR2040
5	> 0	> 0	0	2015 * BEBR2045/BEBR2015
6	0	> 0	> 0	2040 * BEBR2045/BEBR2040
7	> 0	0	> 0	2040 * BEBR2045/BEBR2040
8	> 0	> 0	> 0	if 2015 + (2040-2010) > 0, then 2015 + (2040-2010) else 2040

The above forecasting logic resulted in MAZs with the 2045 household, employment and enrollment counts less than 2015 values. This occurred because of the similar trend in negative growth from 2010 to 2040. North Florida TPO commented that the 2045 counts should at least be equal to the 2015 values, if not greater. Hence, RSG set the floor of the 2045 counts to the 2015 value, ensuring that no MAZs have negative growth.

The total number of households obtained for 2045 was 1,004,721 across the region. Using the household size distribution from the 2015 PopulationSim controls, the implied population for 2045 was calculated and compared against BEBR 2045 totals. The household size distribution from 2015 was modified to account for the aging population trend observed in BEBR data (Figure 9). The modification is discussed in detail in the next section. To ensure that the implied population from the 2045 household counts match the BEBR population in 2045, adjustment rates were calculated for six counties and applied to the estimated household counts. After application of the adjustment rates, the final 2045 household counts in several MAZs were less than the 2015 household counts. In these cases, the 2045 value was set equal to the 2015 value. The final number of households in the region after adjustment is 963,386 in 2045. Employment and enrollment count for 2045 were obtained following a similar methodology. Total employment and total enrollment in 2045 are 1,102,150 and 643,524 respectively.

Table 11 shows the final values of total households, total employment and total enrollment for 2045 and corresponding values for 2015. Figure 8 shows the increase in households from 2015 to 2045.

TABLE 11 COMPARISON OF 2015 AND 2045 TOTALS

COUNTY	HOUSEHOLDS 2015	HOUSEHOLDS 2045	EMPLOYMENT 2015	EMPLOYMENT 2045	ENROLLMENT 2015	ENROLLMENT 2045
NASSAU	32,983	51,902	28,480	55,393	13,368	31,576
DUVAL	357,463	541,730	496,394	708,478	211,091	362,983
ST JOHNS	84,540	181,500	66,355	179,066	43,977	116,687
CLAY	70,523	132,830	46,539	105,158	40,877	98,998
BAKER	8,815	15,117	8,909	18,491	5,128	9,876
PUTNAM	31,278	40,307	21,521	35,564	14,856	23,404
TOTAL	**585,602**	**963,386**	**668,198**	**1,102,150**	**329,297**	**643,524**

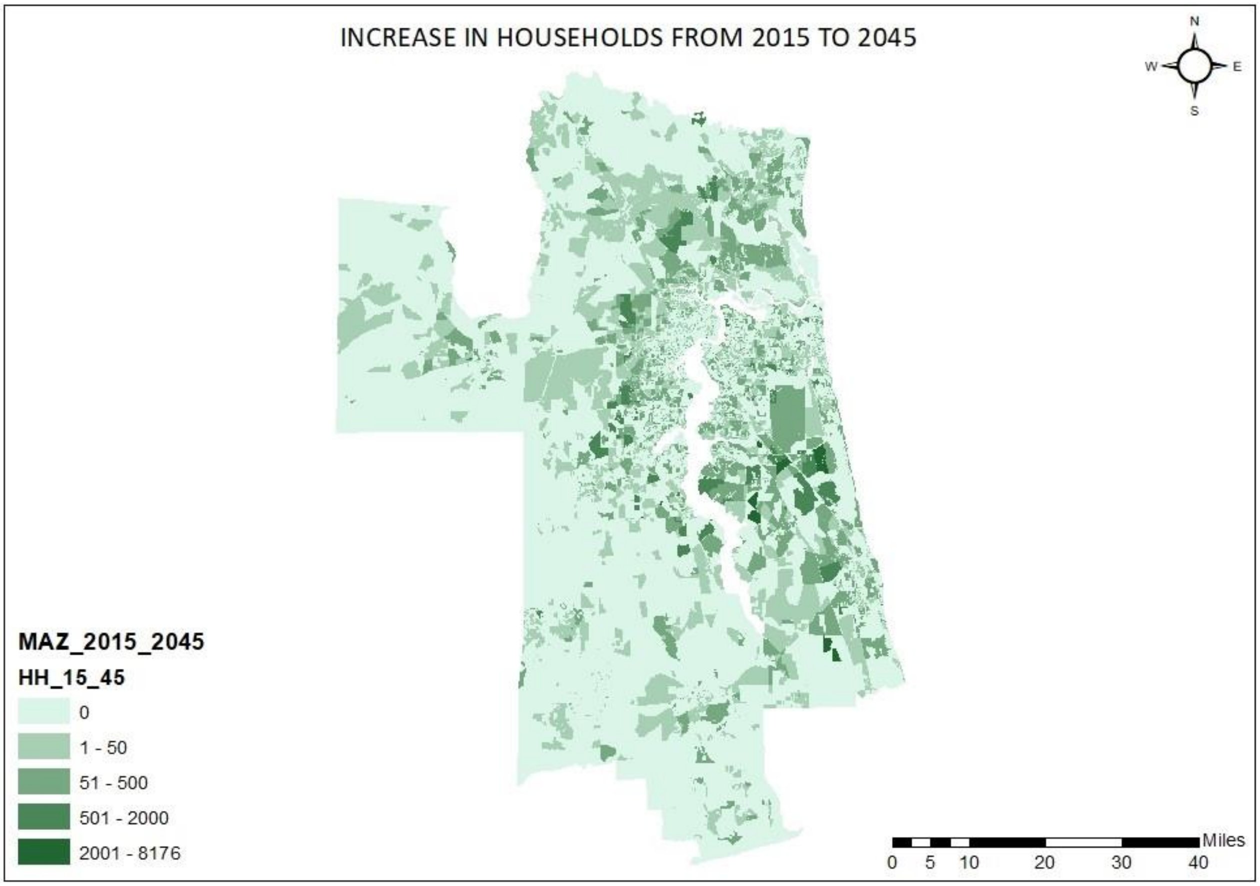


FIGURE 8 INCREASE IN HOUSEHOLDS FROM 2015 TO 2045

4.1 POPULATION SYNTHESIS FOR 2045

Controls refer to the targets that the Public Use Microdata Sample (PUMS) tries to match during synthetic population generation. Controls at three levels were required to run PopulationSim for North Florida TPO, COUNTY, TAZ and MAZ. The COUNTY level controls (Table 12) were obtained from BEBR data and the TAZ and MAZ level controls were prepared using the 2045 land-use data. Counties were grouped into super counties in order to use Census 2000 and Census 2010 PUMS data, with their different geographies, in the same procedure.

TABLE 12 COUNTY LEVEL CONTROLS FOR POPULATIONSIM 2045

SCOUNTY	PERSONS	MALE	FEMALE	AGE0-4	AGE5-17	AGE18-24	AGE25-54	AGE55M
PUTNAM AND ST JOHNS	484,857	236,952	247,905	24,268	75,251	34,859	181,863	168,616
DUVAL	1,164,640	565,479	599,161	73,366	178,972	104,779	440,368	367,155
BAKER AND NASSAU	151,986	75,008	76,978	7,794	21,657	10,771	52,109	59,655
CLAY	320,265	155,562	164,703	18,106	55,544	24,361	122,213	100,041

It was observed from the BEBR data that population in North Florida is aging from 2015 to 2045. This means that the proportion of 70+ years individuals is increasing. This means that as the population ages, the share of 1-person and 2-person households will likely increase and that of -person and 4+ person households will decrease.

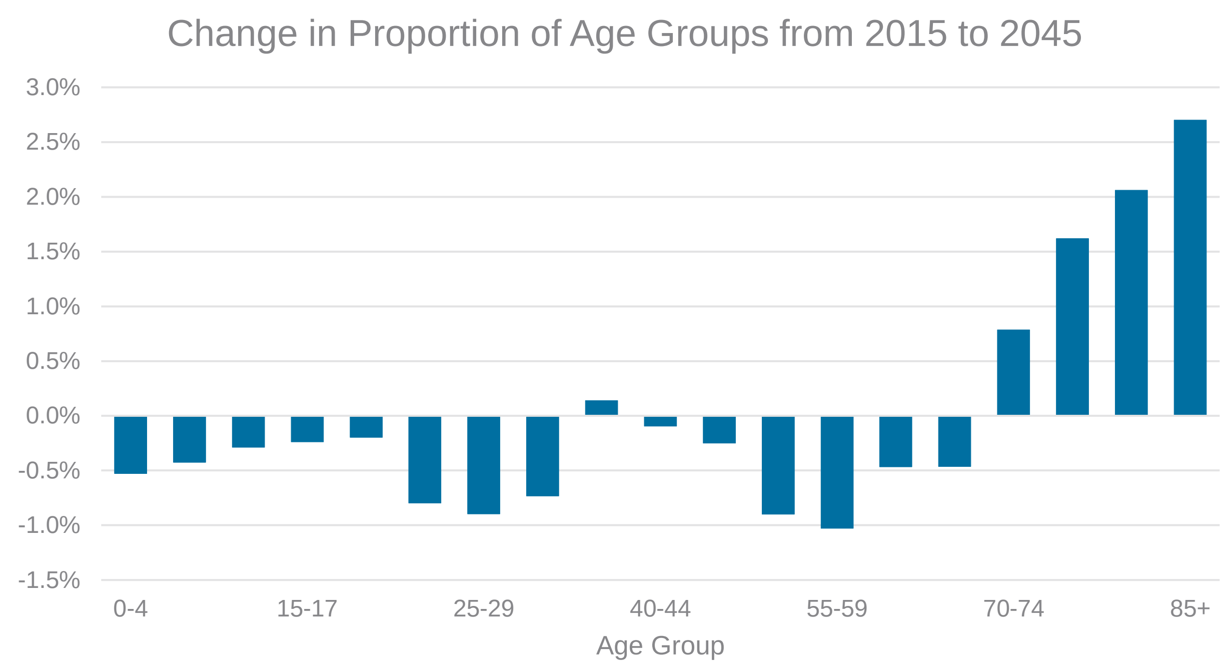


FIGURE 9 POPULATION IN AGING (BEBR DATA)

This led RSG to make assumptions that the distribution of households by household size will change in the future year and these assumptions need to be incorporated to the base year controls before scaling them up. It should be noted that base year controls do not change as a result of these assumptions, they only affect the future year controls. The following assumptions were made –

- If the sum of the proportion 3-person and 4+ person households for a certain TAZ is less than 10%, then no changes are made for that TAZ. The distribution is already skewed, so they are kept unchanged.
- If the proportion is more than 10% and less than 15% for a TAZ, then the proportion of 1-person and 2-person households in that TAZ increase by 5%. The proportion of 3-person and 4+ person households is proportionately decreased so that the total adds up to 100%.
- If the proportion is more than 15% and less than 20% for a TAZ, then the proportion of 1-person and 2-person households in that TAZ increase by 8%. The proportion of 3-person and 4+ person households is proportionately decreased so that the total adds up to 100%.
- If the proportion is more than 20% for a TAZ, then the proportion of 1-person and 2-person households in that TAZ increase by 10%. The proportion of 3-person and 4+ person households is proportionately decreased so that the total adds up to 100%.

This gradual increase is done to ensure that the resulting distribution of household size is not skewed. The distribution of households by number of workers, householder age and household income were kept the same as 2015. In the TAZ control file, the total households in 2045 were distributed according to the newly calculated distribution by household size. Similarly, households by number of workers, householder age and household income were distributed using the same distributions as 2015. There were cases where the 2015 household count was zero whereas that of 2045 was non-zero. This meant that no base year distribution was available for those TAZs and a county level distribution was applied instead. Table 13 shows the first five rows of the MAZ control file and

Table 14 shows the first five rows and a few selected columns of the TAZ control file.

TABLE 13 MAZ LEVEL CONTROL

MAZ	TAZ	PUMA	SCOUNTY	HOUSEHOLDS
1	310	1203104	12031000	155
2	305	1203104	12031000	0
3	253	1203104	12031000	55
4	431	1203106	12031000	0
5	2016	1203105	12031000	0

TABLE 14 TAZ LEVEL CONTROL (PARTIAL)

TAZ	HHS	PUMA	HHS1	HHS2	HHS3	HHS4M	WRK1	WRK2	WRK3	WRK4
1	194	1208900	74	106	6	8	73	68	47	6
2	1169	1208900	409	421	117	222	432	421	281	35
3	127	1208900	49	44	11	23	51	44	29	3
4	494	1208900	193	266	15	20	182	178	119	15
5	643	1208900	431	167	45	0	238	270	116	19

Using these three files as controls, PopulationSim was run for 2045 which created 963,386 synthetic households and 2,150,870 synthetic persons for the entire NFTPO region. The total population in 2045 according to BEBR is 2,121,748 which is slightly smaller than the synthetic population generated by PopulationSim. The difference is due to not allowing negative growth from 2015 to 2045 and forcing 2045 household counts to be at least equal to the 2015 counts. As a result, number of households were greater, which subsequently increased the population.

Figure 10 shows the comparison of observed controls vs. estimated synthetic population across multiple variables at the MAZ, TAZ and COUNTY levels. The small values of standard deviation, as seen in the figure, suggests that the synthetic population matches the targets well.

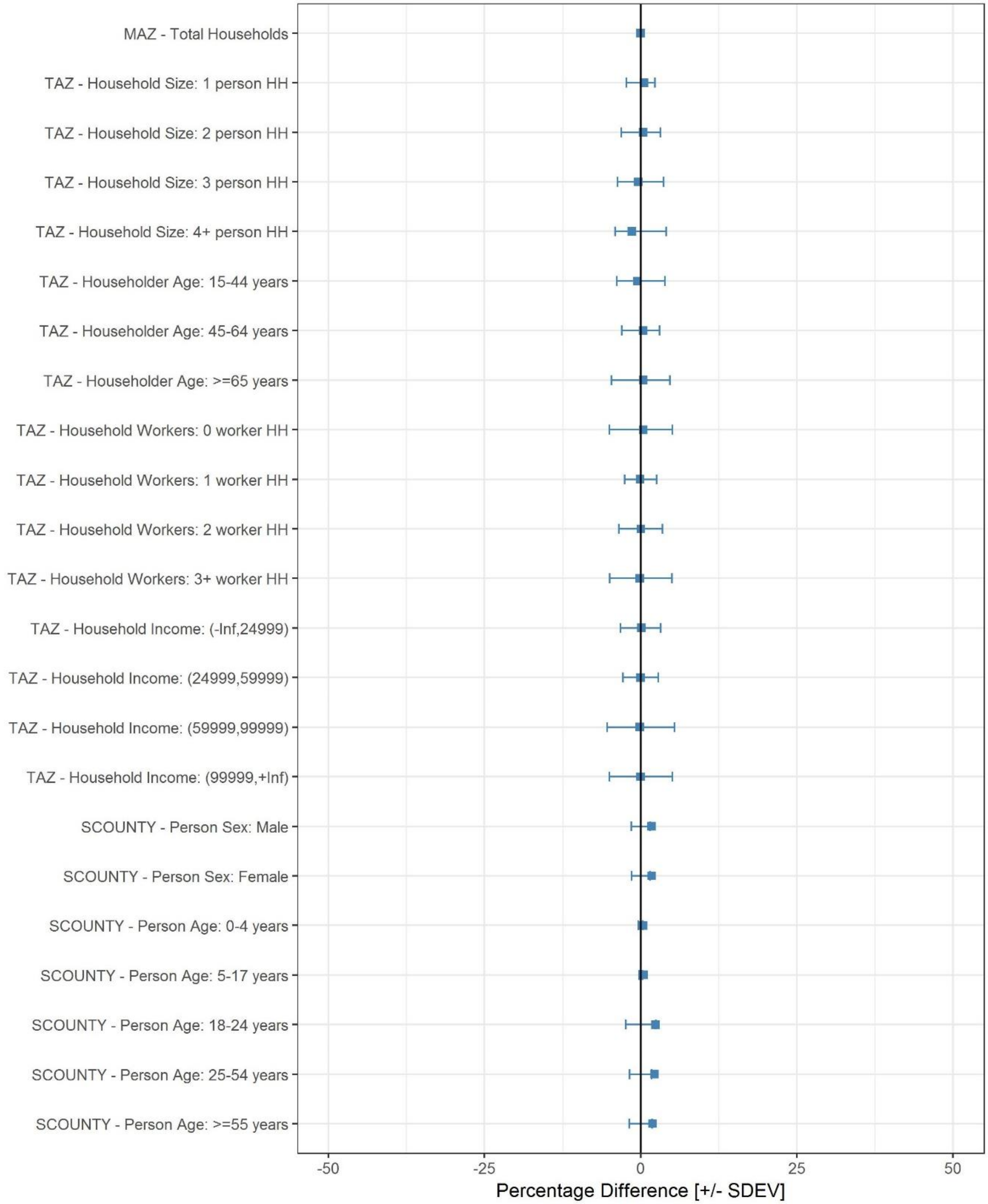


FIGURE 10 POPULATIONSIM CONTROLS VALIDATION (2045)

5.0 DEVELOPMENT OF 2030 LAND-USE DATA

This section describes the processes followed to create the 2030 land-use data and create the synthetic population for year 2030. The procedure followed to create 2030 data is similar to the procedure used to create 2045 data described above.

In order to create 2030 land-use data, RSG used the 2015 base year land-use data as the starting point. Land-use forecasts for scenario years 2010 and 2025 were used to calculate the growth rate. An external data source, Bureau of Economic and Business Research (BEBR), was used to calculate county wide growth rates, to be applied in special cases. The objective was to utilize available land-use data from 2015 and forecasts for 2010 and 2025 to create the data for 2030. Table 15 shows the total population of the six counties for years 2010, 2015, 2025 and 2030 retrieved from BEBR. These totals were used to calculate county wide growth rates from 2015 to 2030 and 2025 to 2030 which were later used to forecast 2030 data. Similar to

Table 10,

Table 16 shows the logic followed for various cases depending on the availability of valid values in previous years' data. The logic varied depending on the availability of non-zero values in the base years.

TABLE 15 BEBR COUNTY TOTALS

COUNTY	2010	2015	2025	2030
NASSAU	73,314	76,536	92,013	98,918
DUVAL	864,263	905,574	1,008,324	1,053,582
ST JOHNS	190,039	213,566	292,217	326,938
CLAY	190,865	201,277	247,223	267,757
BAKER	27,115	27,017	30,624	32,017
PUTNAM	74,364	72,756	73,721	74,182

TABLE 16 FORECASTING LOGIC FOR 2030

CASE	2010	2015	2025	2030
1	0	0	0	0
2	> 0	0	0	0
3	0	> 0	0	2015 * BEBR2030/BEBR2015
Case	2010	2015	2025	2030
4	0	0	> 0	2025 * BEBR2030/BEBR2025
5	> 0	> 0	0	2015 * BEBR2030/BEBR2015
6	0	> 0	> 0	2025 * BEBR2030/BEBR2025
7	> 0	0	> 0	2025 * BEBR2030/BEBR2025
8	> 0	> 0	> 0	if 2015 + (2025-2010) > 0, then 2015 + (2025-2010) else 2025

The above forecasting logic resulted in some certain MAZs with the 2030 household, employment and enrollment counts were smaller than 2015 counts. This resulted because of the similar trend in negative growth from 2010 to 2025 scenario years. North Florida TPO recommended that the 2030 counts should at least be equal to the 2015 values, if not greater. Hence, RSG set the floor of the 2030 counts to the 2015 value, ensuring that no MAZs have negative growth.

The total number of households obtained for 2030 was 803,003 across the region. Using the household size distribution from the 2015 PopulationSim controls, the implied population for 2030 was calculated and compared against BEBR 2030 totals. The household size distribution from 2015 was modified to account for the aging population trend observed in BEBR data (Figure 9). In order to make sure that the implied population from the 2030 household counts match the BEBR population in 2030, adjustment rates were calculated for six counties and applied to the estimated household counts. After the adjustment rates are applied, the final 2030 household counts in several MAZs fall below the 2015 household counts. In such cases, the 2030 value was set equal to the 2015 value. Another comparison was made between the household, employment and enrollment numbers of 2030 with that of 2045 and it was found that several MAZs had 2030 values higher than 2045. This is due to the fact that the parcel level data of scenario 2025 used to calculate the 2030 data had a higher number of households, employment and enrollment. Since there should be no MAZs with 2030 households greater than 2045, the 2030 values were capped at 2045. The final number of households in the region after adjustment is 779,154 in 2030. Employment and enrollment counts for 2030 were obtained following a similar methodology. Total employment and total enrollment in 2030 are 921,785 and 523,000 respectively.

Table 17 shows the final values of total households, total employment and total enrollment for 2030 and corresponding values for 2015.

TABLE 17 COMPARISON OF 2015 AND 2030 TOTALS

COUNTY	HH2015	HH2030	EMP2015	EMP2030	ENR2015	ENR2030
NASSAU	32,983	41,948	28,480	45,394	13,368	25,998
DUVAL	357,463	453,184	496,394	622,922	211,091	311,765
ST JOHNS	84,540	135,295	66,355	124,742	43,977	79,721
CLAY	70,523	100,980	46,539	81,119	40,877	75,838
BAKER	8,815	12,212	8,909	14,615	5,128	7,602
PUTNAM	31,278	35,535	21,521	32,993	14,856	22,076
TOTAL	**585,602**	**779,154**	**668,198**	**921,785**	**329,297**	**523,000**

5.1 POPULATION SYNTHESIS FOR 2030

Similar to 2045, controls for 2030 were obtained at three levels to run PopulationSim for North Florida TPO, specifically, COUNTY, TAZ and MAZ. The COUNTY level controls (Table 18) were obtained from BEBR and the TAZ and MAZ level controls were prepared using the 2030 land-use data.

TABLE 18 COUNTY LEVEL CONTROLS FOR POPULATIONSIM

SCOUNTY	PERSONS	MALE	FEMALE	AGE0-4	AGE5-17	AGE18-24	AGE25-54	AGE55M
PUTNAM AND ST JOHNS	401,120	196,142	204,978	20,893	62,021	28,958	145,008	144,240
DUVAL	1,053,582	511,950	541,632	67,691	166,588	96,195	411,432	311,676
BAKER AND NASSAU	130,935	65,219	65,716	6,926	19,104	9,357	44,840	50,708
CLAY	267,757	130,281	137,476	15,883	47,219	20,562	101,159	82,934

The increasing population trend seen in Figure 9 led to the incorporation of the assumptions to the base year controls before scaling up for 2030. The distribution of households by number of workers, householder age and household income were kept the same as 2015. In the TAZ control file, the total households in 2030 were distributed according to the newly calculated distribution by household size. Similarly, households by number of workers, householder age and household income were distributed using the same distributions as 2015. There were cases where the 2015 household count was zero and of 2030 was non-zero. This meant that no base year distribution was available for those TAZs and a county level distribution was applied instead. Table 19 shows the first five rows of the MAZ control file and Table 20 shows the first five rows and a few selected columns of the TAZ control file.

TABLE 19 2030 MAZ LEVEL CONTROL

MAZ	TAZ	PUMA	SCOUNTY	HHS
1	310	1203104	12031000	155
2	305	1203104	12031000	0
3	253	1203104	12031000	55
4	431	1203106	12031000	0
5	2016	1203105	12031000	0

TABLE 20 2030 TAZ LEVEL CONTROL (PARTIAL)

TAZ	HHS	PUMA	HHS1	HHS2	HHS3	HHS4M	WRK1	WRK2	WRK3	WRK4
1	167	1208900	63	92	5	7	64	58	40	5
2	1058	1208900	370	381	106	201	391	381	254	32
3	97	1208900	37	34	9	17	39	34	22	2
4	399	1208900	156	215	12	16	147	144	96	12
5	518	1208900	347	135	36	0	192	217	93	16

Using these three files as controls, PopulationSim was run for 2030 creating 779,154 synthetic households and 1,838,778 synthetic persons for the entire NFTPO region. The total population in 2030 according to BEBR is 1,853,394 which is slightly higher than the synthetic population generated by PopulationSim. The difference is due to not allowing negative growth from 2015 to 2030 and forcing 2015 and 2045 household counts to be at least equal to the 2030 counts.

Figure 11 shows the comparison of observed controls vs. estimated synthetic population across multiple variables at the MAZ, TAZ and COUNTY levels. The small values of standard deviation, as seen in the figure, suggests that the synthetic population matches the targets well.

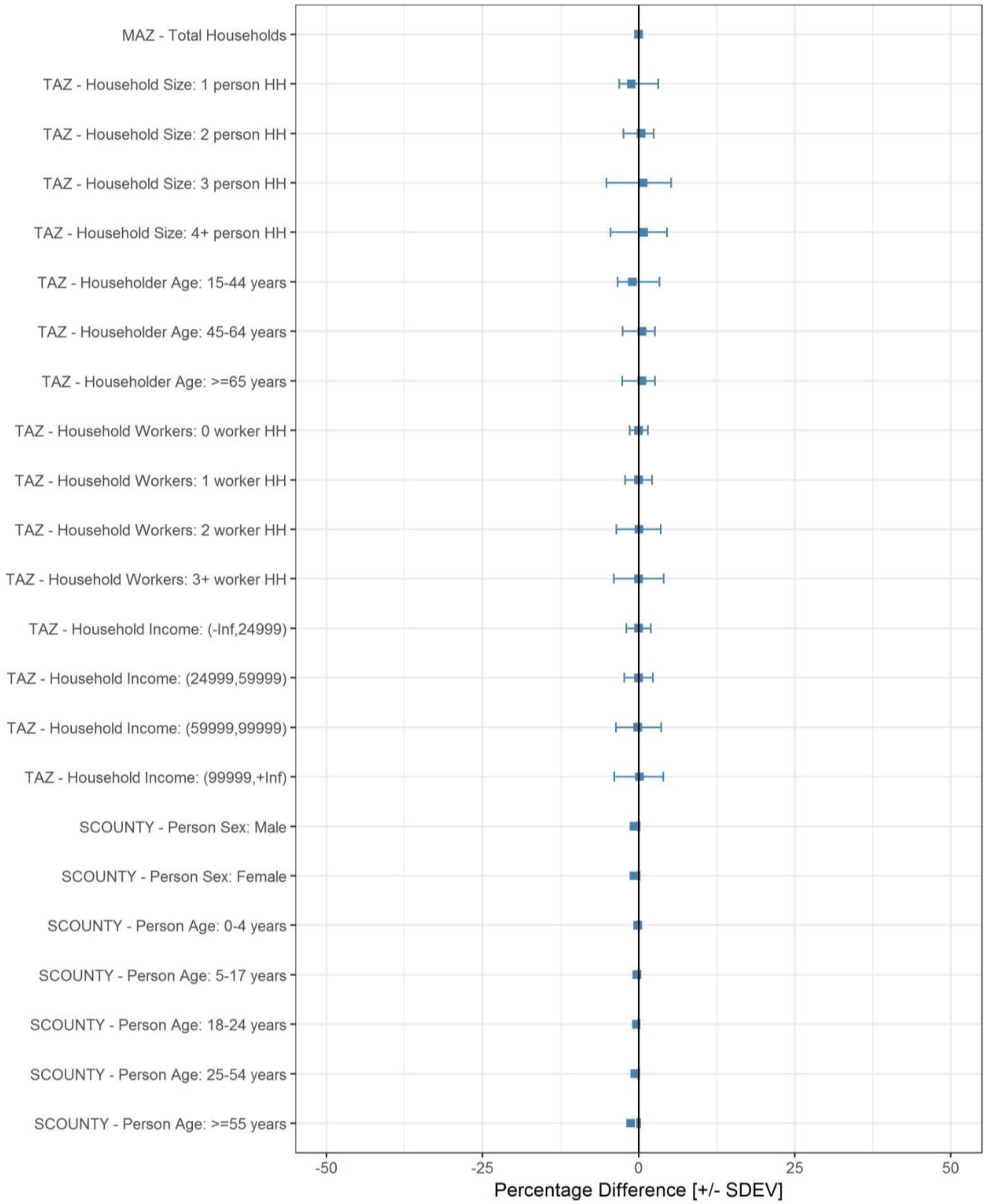


FIGURE 11 POPULATIONSIM CONTROLS VALIDATION (2030)

6.0 DAYSIM ABM MODEL UPDATE

After completion of base year 2015 data aggregation from parcels to microzones, DaySim was tested for the new geographies and the results compared against the parcel results to check for consistencies. The necessary input files were created for DaySim run as explained in detail in Appendix B. After a successful run of DaySim using updated 2015 Microzone and Population synthesis dataset, the results were compared with previous DaySim run using parcels. The following series of tables and figures show the consistency of the 2015 dataset in DaySim performance.

6.1 DAYSIM SUMMARY COMPARISON

Table 21 compares the vehicle availability across the three different types of DaySim runs. The first run included the parcel data set. The second run included the microzone input data as well as the updated DaySim including the node to node distance feature. The third run included the inputs from the second run and the household and population data from population synthesis for 2015. The percent total for all Counties look consistent across the three DaySim runs.

TABLE 21 VEHICLE AVAILABILITY

Estimated Households by Number of Vehicles and County (Parcel)							
	Number of Vehicles						
County	0	1	2	3	4+	Total	% Total
Baker	309	2,750	3,899	1,285	557	8,800	2%
Clay	2,154	19,501	32,064	11,436	4,123	69,278	12%
Duval	27,194	126,487	137,367	42,231	15,633	348,912	61%
Nassau	1,212	10,006	14,514	4,681	1,820	32,233	6%
Putnam	1,594	11,944	12,800	3,767	1,543	31,648	6%
St. Johns	3,097	25,256	36,209	11,566	4,102	80,230	14%
Total	35,560	195,944	236,853	74,966	27,778	571,101	100%
Estimated Households by Number of Vehicles and County (Microzone + Node to Node Distances)							
	Number of Vehicles						
County	0	1	2	3	4+	Total	% Total
Baker	333	2,781	3,868	1,261	557	8,800	2%
Clay	2,491	19,945	31,772	11,122	3,948	69,278	12%
Duval	28,867	126,963	136,315	41,659	15,108	348,912	61%
Nassau	1,329	10,195	14,426	4,515	1,768	32,233	6%
Putnam	1,627	11,994	12,767	3,750	1,510	31,648	6%
St. Johns	3,795	25,835	35,721	11,105	3,774	80,230	14%
Total	38,442	197,713	234,869	73,412	26,665	571,101	100%

Estimated Households by Number of Vehicles and County (Microzone + N2N Distances + PopSim 2015)							
	Number of Vehicles						
County	0	1	2	3	4+	Total	% Total
Baker	403	3,021	3,704	1,015	672	8,815	2%
Clay	2,742	21,083	31,758	11,032	3,908	70,523	12%
Duval	29,793	131,763	131,610	44,856	16,038	354,060	61%
Nassau	1,471	12,051	13,617	3,469	2,375	32,983	6%
Putnam	2,158	13,690	10,852	3,059	1,519	31,278	5%
St. Johns	3,652	28,418	37,278	11,588	3,604	84,540	15%
Total	40,219	210,026	228,819	75,019	28,116	582,199	100%

Figure 12 shows a distribution of home to work distances of individuals for the three DaySim runs. Due to relatively lower samples, the HTS dataset shows lumpy distributions. All the DaySim results show generally smooth and consistent distribution.

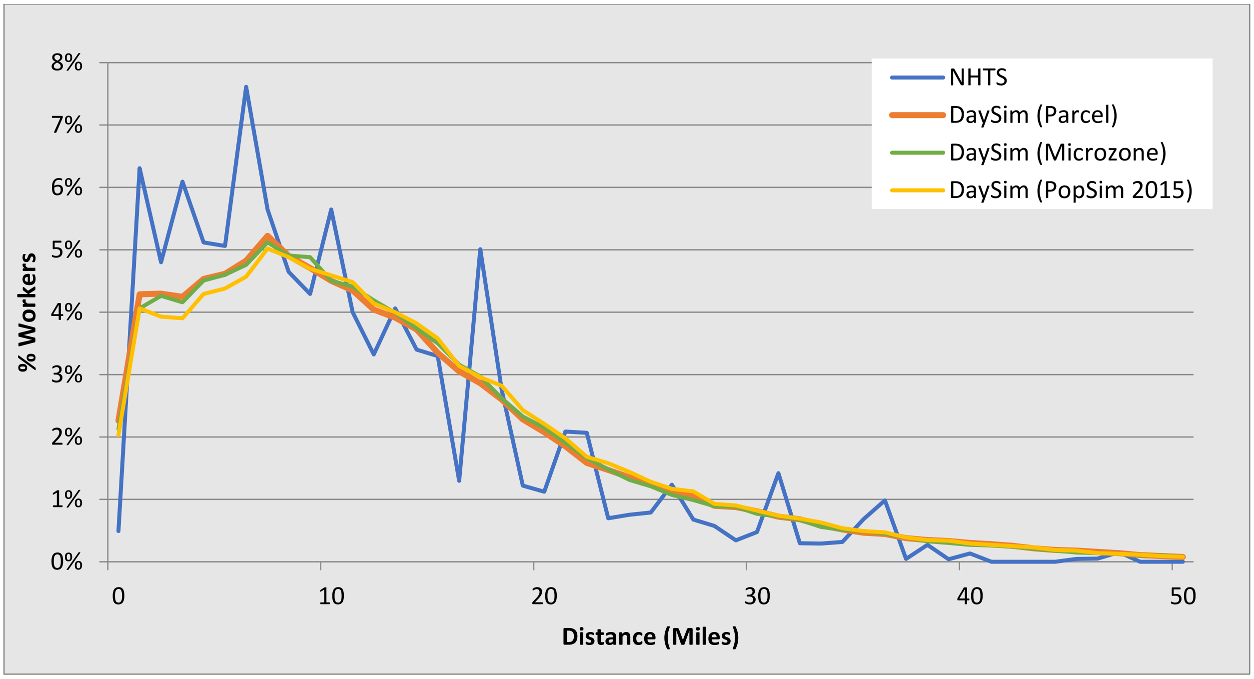


FIGURE 12 WORK LOCATION CHOICE: HOME-WORK DISTANCES.

Figure 13 shows a distribution of home to school distances of individuals for the three DaySim runs. Due to relatively lower samples, the HTS dataset shows lumpy distributions. All the DaySim results show generally smooth and consistent distribution.

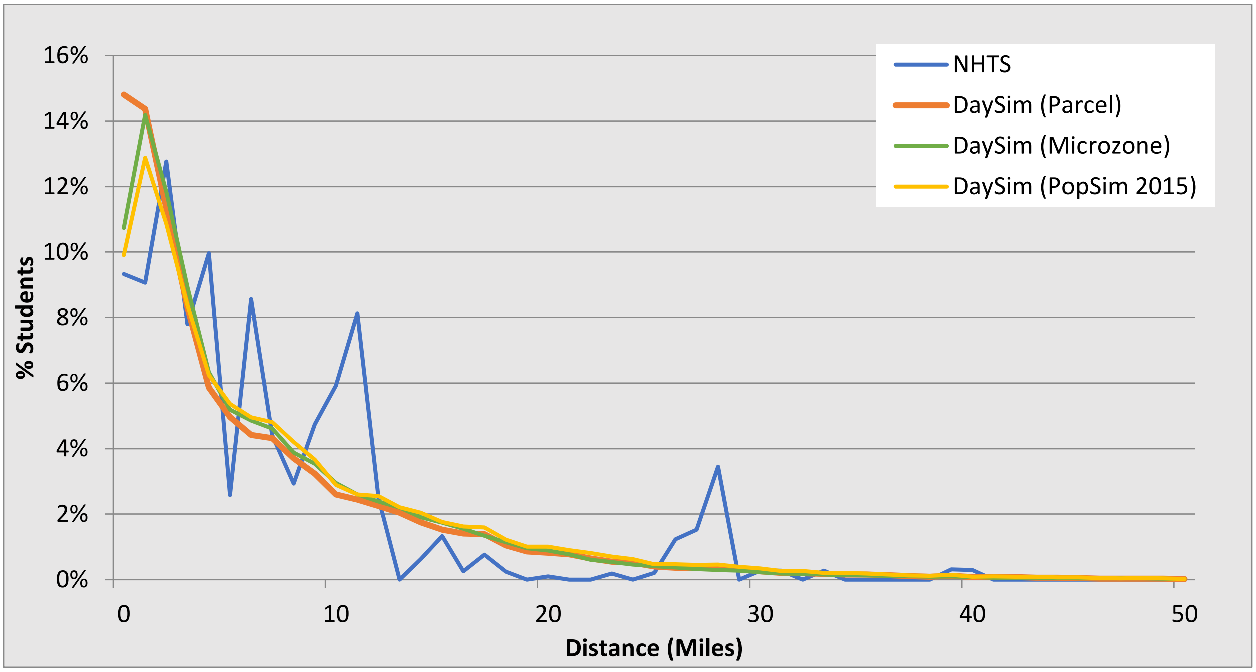


FIGURE 13 SCHOOL LOCATION CHOICE: HOME-SCHOOL DISTANCES.

Table 22 compares tours by purpose and person type across the three DaySim runs. The percent total across the tour purposes as well as the person type looks consistent.

TABLE 22 TOURS BY PURPOSE & PERSON TYPE

Purpose	Tours by Purpose			% Total (Parcel)	% Total (Microzone)	% Total (PopSim 2015)
	Parcel	Microzone	PopSim 2015			
Work	446,186	433,871	458,448	20.57%	20.18%	21.41%
School	203,181	195,477	196,634	9.37%	9.09%	9.18%
Escort	211,411	215,585	234,875	9.75%	10.03%	10.97%
Pers.Bus	273,253	275,738	255,118	12.60%	12.83%	11.92%
Shop	344,347	345,794	334,157	15.87%	16.08%	15.61%
Meal	138,612	139,199	124,038	6.39%	6.47%	5.79%
Soc/Rec	474,073	472,508	461,140	21.85%	21.98%	21.54%
Work-based	78,212	71,749	76,435	3.61%	3.34%	3.57%
Total	2,169,275	2,149,921	2,140,845	100.00%	100.00%	100.00%
Persontype	Tours by Person Type			% Total (Parcel)	% Total (Microzone)	% Total (PopSim 2015)
	Parcel	Microzone	PopSim 2015			
FT worker	873,964	864,205	912,307	40.29%	40.20%	42.61%
PT worker	259,317	257,626	162,927	11.95%	11.98%	7.61%
Retired	246,317	245,277	213,849	11.35%	11.41%	9.99%
Nonworker	313,728	312,677	373,957	14.46%	14.54%	17.47%
Univ.Stud	74,397	73,953	110,840	3.43%	3.44%	5.18%
Stud 16+	64,194	63,079	68,264	2.96%	2.93%	3.19%
Stud.5-15	337,358	333,104	298,701	15.55%	15.49%	13.95%
Under 5	0	0	0	0.00%	0.00%	0.00%
Total	2,169,275	2,149,921	2,140,845	100.00%	100.00%	100.00%

Table 23 compares trips by tour purpose and person type across the three DaySim runs. The percent total across the tour purposes as well as the person type looks consistent.

TABLE 23 TRIPS BY PURPOSE & PERSON TYPE

Purpose	Trips by Purpose			% Total (Parcel)	% Total (Microzone)	% Total (PopSim 2015)
	Parcel	Microzone	PopSim 2015			
Work	621,563	599,380	632,424	10.41%	10.15%	11.28%
School	205,926	197,994	198,936	3.55%	3.35%	3.55%
Escort	355,492	355,944	398,798	6.00%	6.04%	7.11%
Pers.Bus	482,082	483,000	451,496	8.70%	8.83%	8.05%
Shop	937,525	934,075	914,772	16.71%	16.79%	16.31%
Meal	342,056	338,042	314,379	5.75%	5.73%	5.61%
Soc/Rec	649,699	644,215	632,138	11.91%	11.96%	11.27%
Work-based	2,091,063	2,078,172	2,064,410	36.98%	37.14%	36.82%
Total	5,685,406	5,630,822	5,607,353	100.00%	100.00%	100.00%
Persontype	Trips by Person Type			% Total (Parcel)	% Total (Microzone)	% Total (PopSim 2015)
	Parcel	Microzone	PopSim 2015			
FT worker	2,361,771	2,335,255	2,473,142	40.29%	40.20%	44.11%
PT worker	712,885	708,125	449,892	11.95%	11.98%	8.02%
Retired	653,979	650,994	568,140	11.35%	11.41%	10.13%
Nonworker	824,706	821,433	978,196	14.46%	14.54%	17.44%
Univ.Stud	187,671	186,279	280,868	3.43%	3.44%	5.01%
Stud 16+	145,561	142,455	152,648	2.96%	2.93%	2.72%
Stud.5-15	798,833	786,281	704,467	15.55%	15.49%	12.56%
Under 5	0	0	0	0.00%	0.00%	0.00%
Total	5,685,406	5,630,822	5,607,353	100.00%	100.00%	100.00%

Table 24 and

Table 25 compares estimated tour modes and trips for all purposes across the three DaySim runs, respectively. The percent total across the modes looks consistent.

TABLE 24 ESTIMATED TOUR MODES: ALL PURPOSES

Mode	Estimated Tours			% Total (Parcel)	% Total (Microzone)	% Total (PopSim 2015)
	Parcel	Microzone	PopSim 2015			
Drive Alone	861,055	839,612	860,682	39.60%	38.98%	40.10%
SR2	541,981	548,781	536,961	24.93%	25.48%	25.02%
SR3	463,617	468,362	468,091	21.32%	21.75%	21.81%
Transit	22,115	23,796	22,115	1.02%	1.10%	1.03%
Bike	39,034	37,869	38,435	1.80%	1.76%	1.79%
Walk	176,796	166,527	154,883	8.13%	7.73%	7.22%
School Bus	69,757	68,875	65,110	3.21%	3.20%	3.03%
Total	2,174,415	2,153,822	2,146,277	100.00%	100.00%	100.00%

TABLE 25 ESTIMATED TRIPS BY MODE

Mode	Estimated Tours			% Total (Parcel)	% Total (Microzone)	% Total (PopSim 2015)
	Parcel	Microzone	PopSim 2015			
Drive Alone	2,667,125	2,607,784	2,685,434	46.89%	46.28%	47.87%
SR2	1,418,360	1,436,979	1,390,098	24.94%	25.50%	24.78%
SR3	923,041	931,974	918,627	16.23%	16.54%	16.37%
Transit	43,760	47,871	43,723	0.77%	0.85%	0.78%
Bike	83,125	81,801	80,835	1.46%	1.45%	1.44%
Walk	434,449	411,539	383,006	7.64%	7.30%	6.83%
School Bus	118,316	116,589	108,502	2.08%	2.07%	1.93%
Total	5,688,176	5,634,537	5,610,225	100.00%	100.00%	100.00%

Figure 14 to Figure 17 illustrate tour length and duration distribution for destination purposes, shopping and social/recreation. The figures show consistent distribution trends across the three DaySim runs.

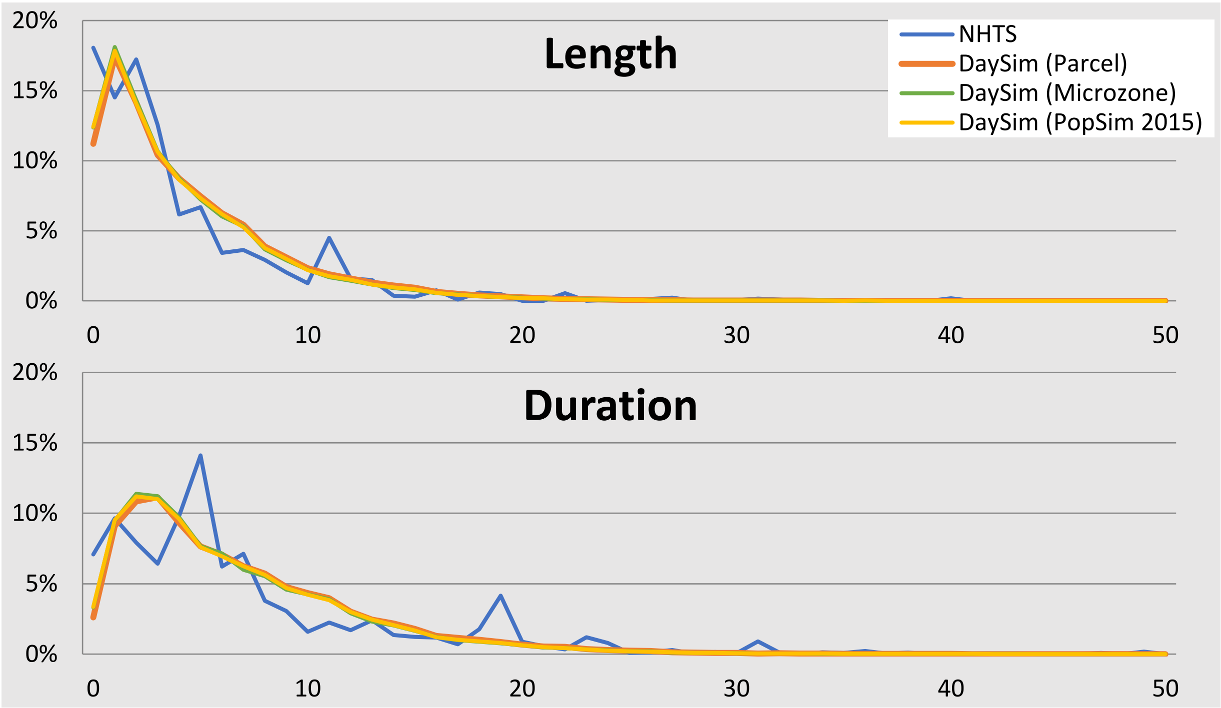


FIGURE 14 TOUR LENGTH & DURATION FREQUENCY DISTRIBUTION (SHOP).

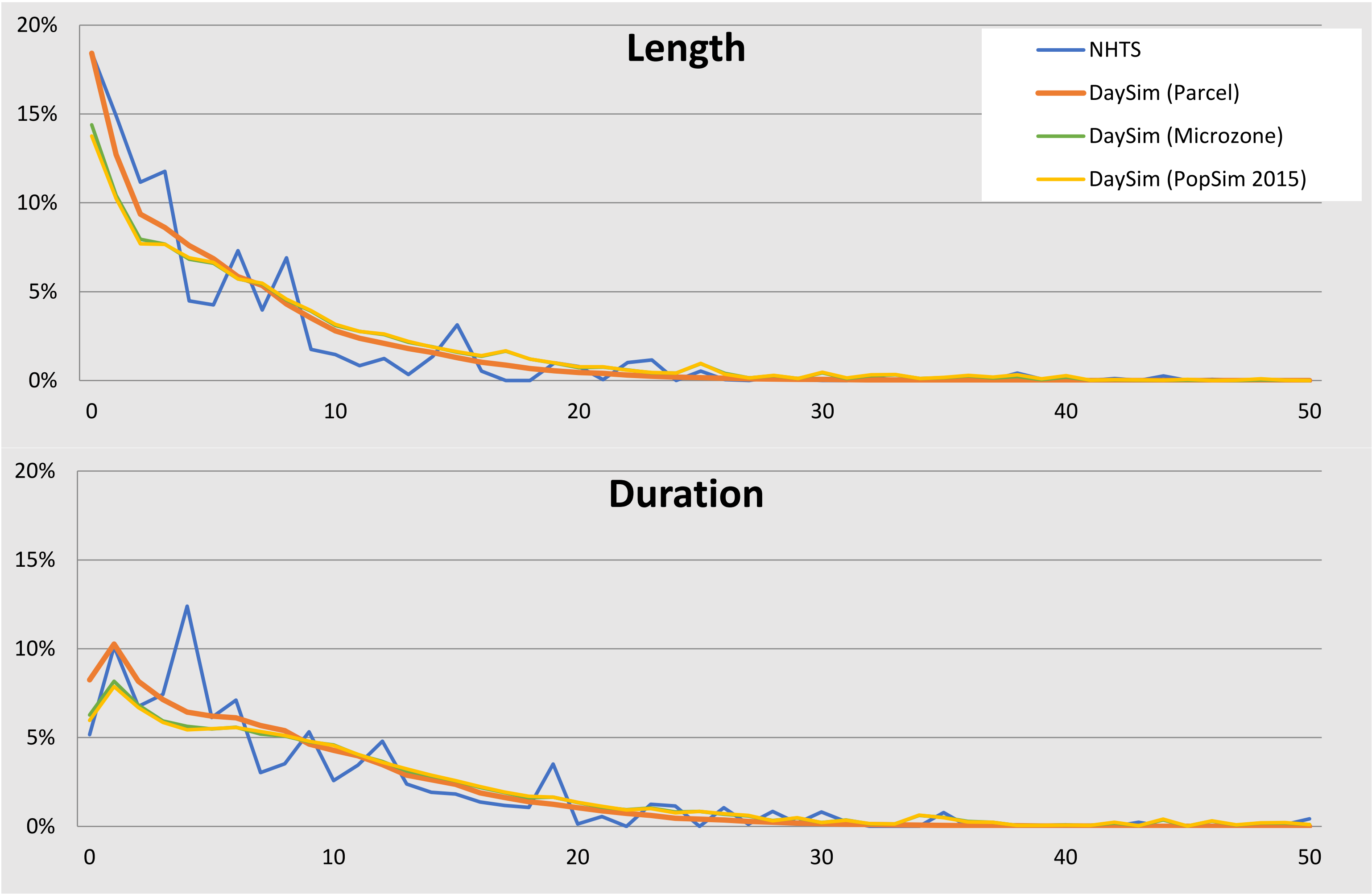


FIGURE 15 TOUR LENGTH & DURATION FREQUENCY DISTRIBUTION (SOC/REC).

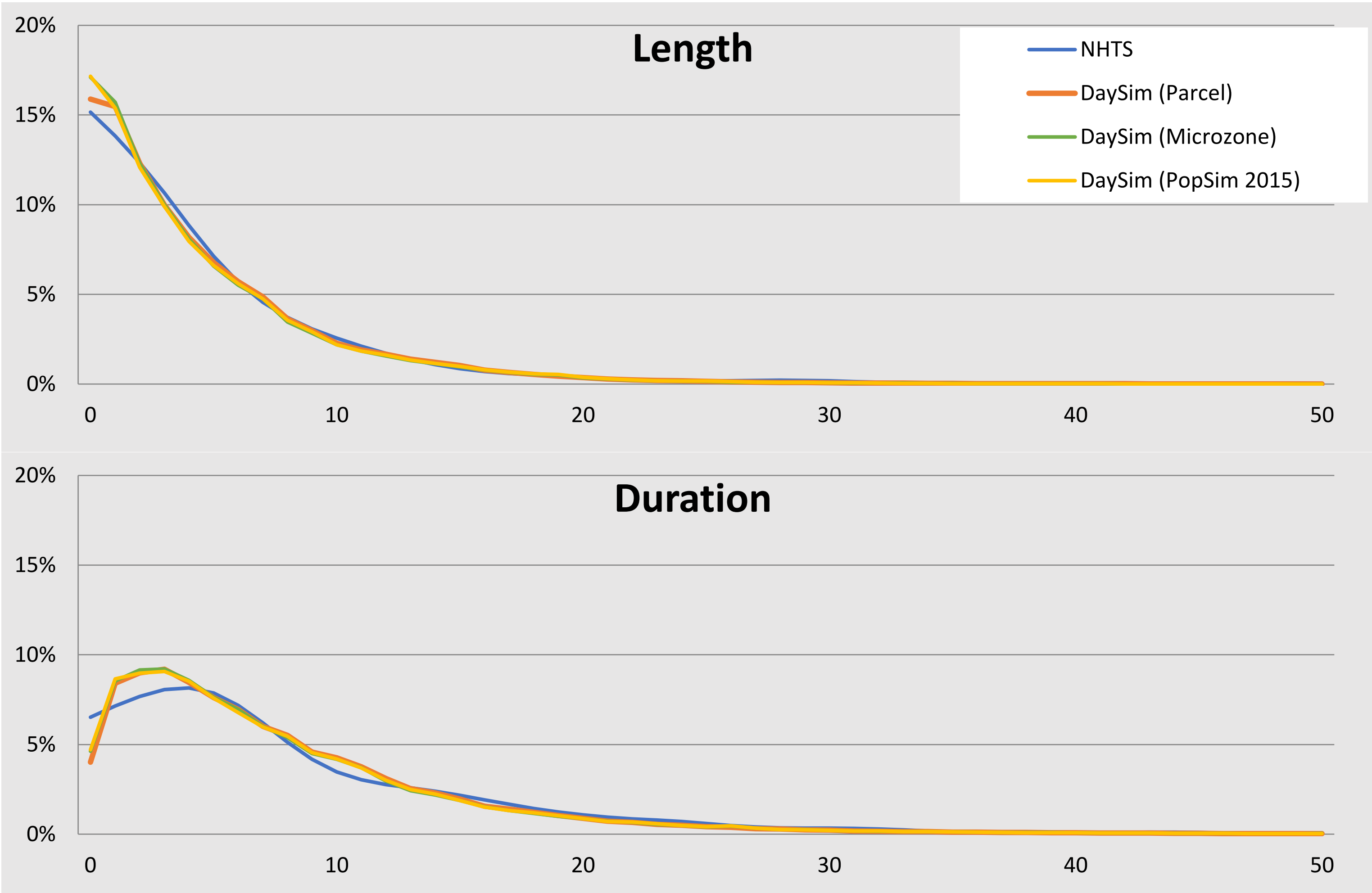


FIGURE 16 TRIP LENGTH & DURATION FREQUENCY DISTRIBUTION (SHOP).

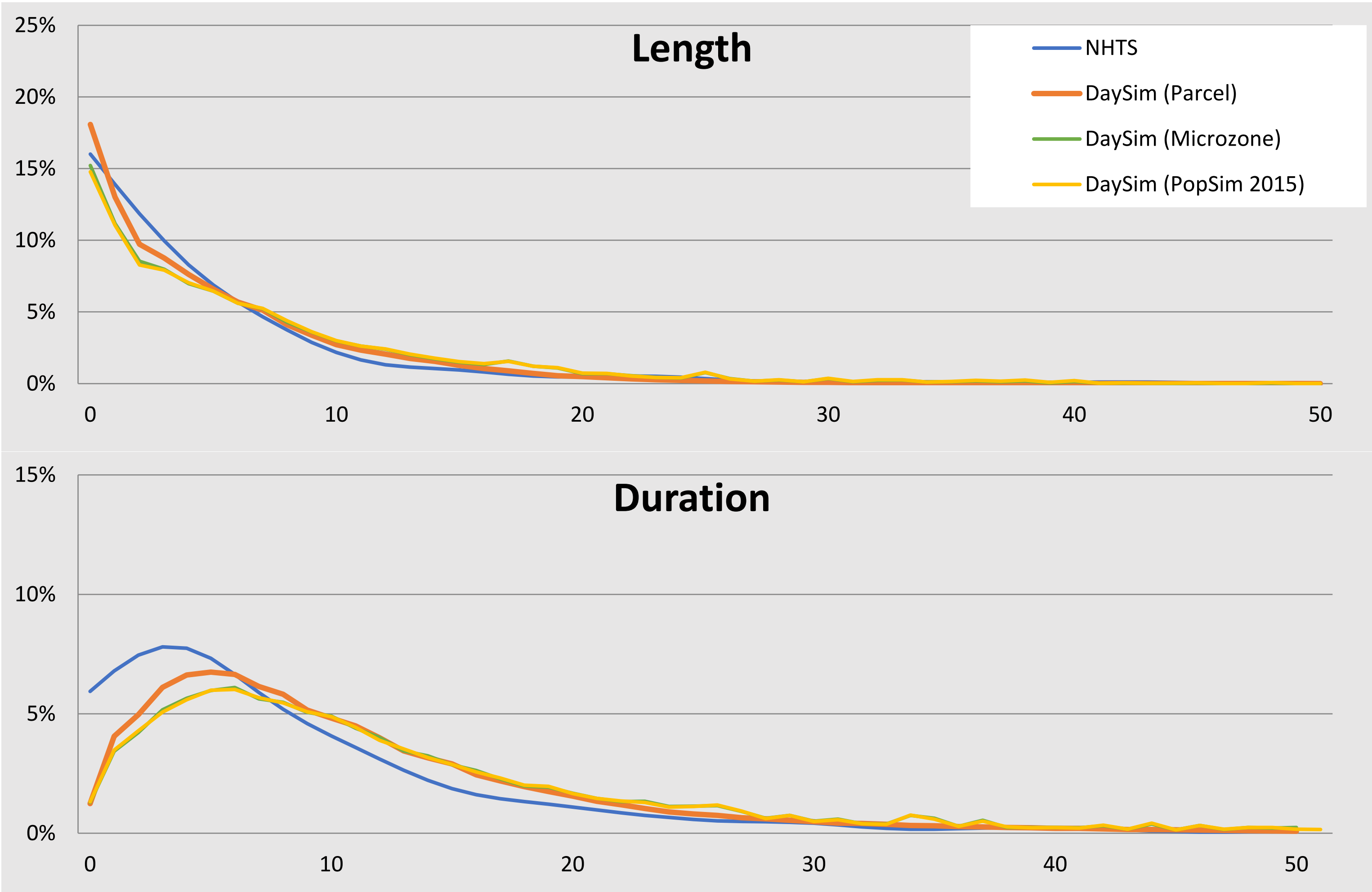


FIGURE 17 TRIP LENGTH & DURATION FREQUENCY DISTRIBUTION (SOC/REC).

Figure 18 and Figure 19 show the time-of-day distribution across the three DaySim runs. The distribution across the three DaySim runs generally smooth and matched.

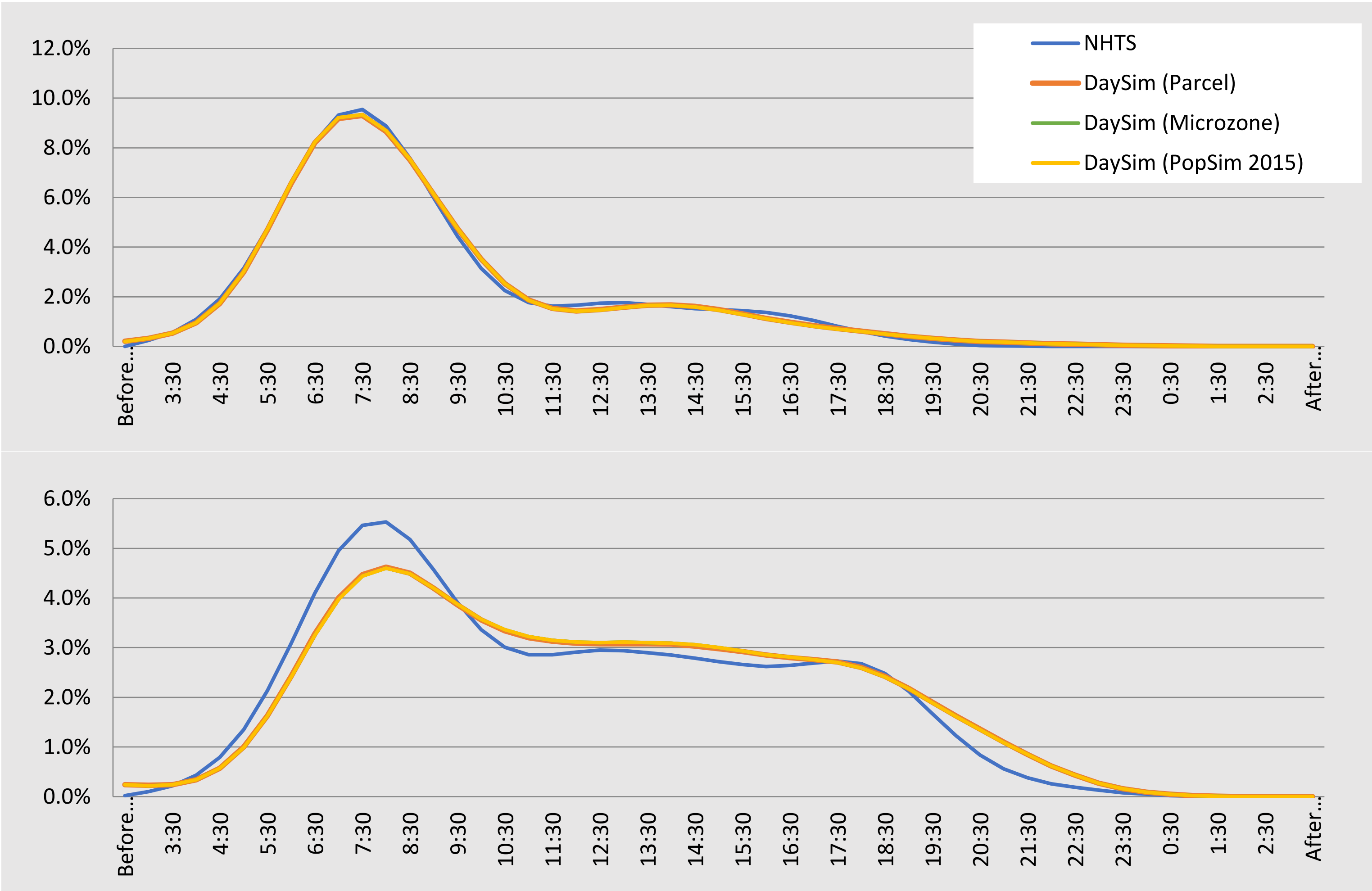


FIGURE 18 ESTIMATED TOUR ARRIVAL AT PERIOD TIMES.

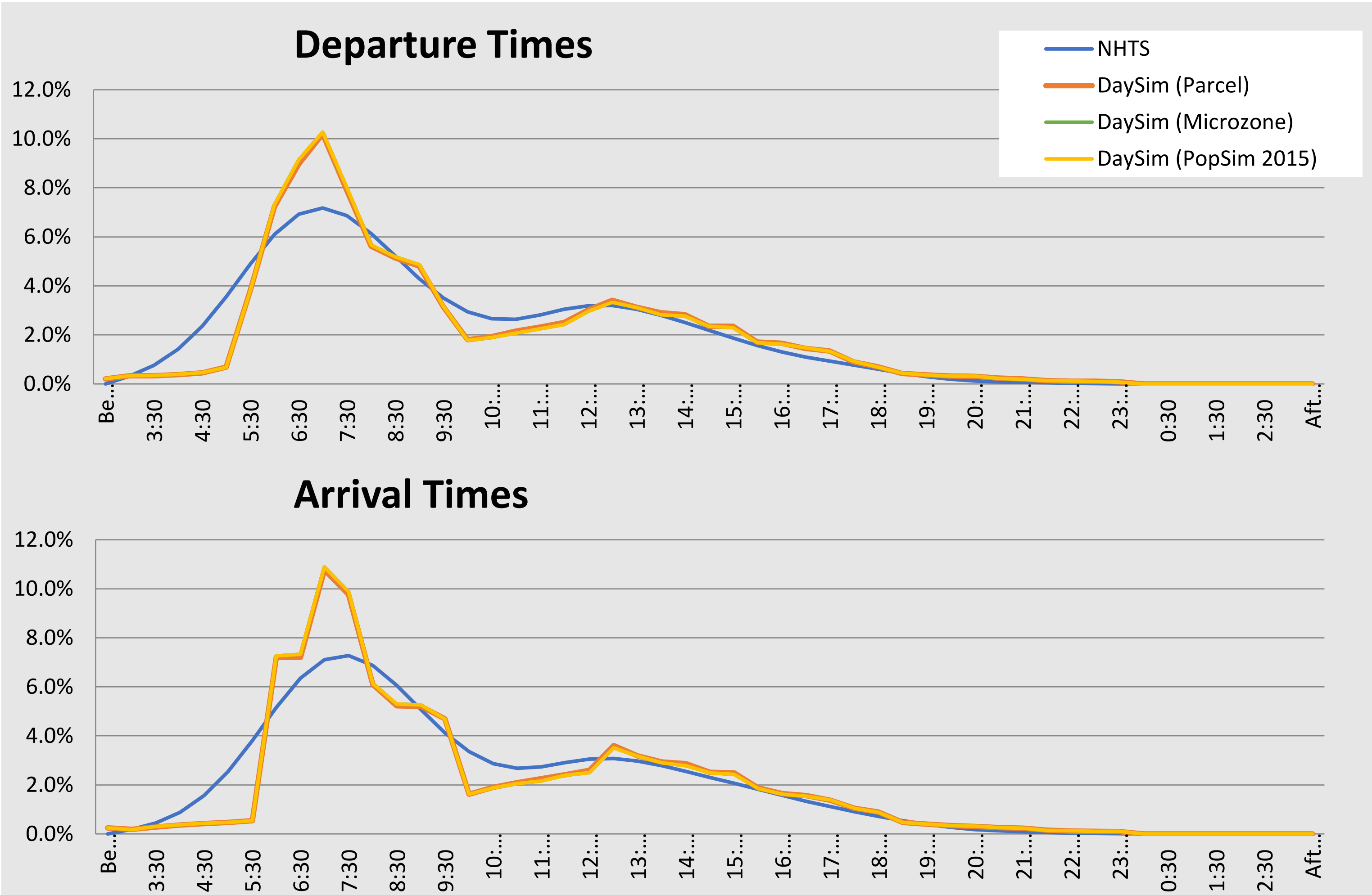


FIGURE 19 WORK STOP DEPARTURE & ARRIVAL TIMES.

7.0 DEVELOPMENT OF EXTERNAL MODEL INPUTS

7.1 DATA SOURCES

The source data for the X-X trip table has been obtained from Bluetooth detectors that were installed at 17 locations adjacent to highways at external model stations. This work was conducted under a separate contract with Florida DOT. The raw data from the Bluetooth deployment were obtained by HNTB and processed for further analysis by RSG.

- 2010 North Florida TPO model X-X trip table (EETRIPS.dbf): (29 nodes) The total trips originating for each external node and destined for other external nodes are calculated by assigning a proportion of the total incoming traffic (e.g. 16%). Incoming traffic is distributed from each origin external node to each other external node in proportion to the destination node's AADT.
- EE_O-D_Study spreadsheet provided by HNTB: (17 nodes) This spreadsheet was provided by HNTB and contains the raw matched BT X-X data, total traffic counts, total truck counts, matched BT X-X/X-I data (17 external and 150 internal nodes), and related pivot tables.

7.2 ESTIMATING THE BT EXPANSION FACTOR

The BT expansion factor (or penetration rate) is the percentage of total traffic recorded with having a discoverable Bluetooth device on or within the vehicle. The expansion factors imputed from the HNTB data were abnormally high given RSG's prior experience in working with data of this type. RSG requested, but never received from HNTB, the raw Bluetooth data. For this reason, RSG developed a method to estimate an expansion factor for each station.

The following steps were taken to generate and modify the BT expansion factors:

1. Preliminary BT expansion factors were generated by HNTB by calculating the ratio of matched X-X/X-I data to total traffic counts at each external station, by time of day and day of week. These factors were provided in a spreadsheet, EE_O-D_Study, on a tab named "Entry Node Data by TOD". The North Florida TPO travel model is based on weekday trips. Since travel patterns for Monday and Friday are often affected by weekend-related travel, RSG focused the analysis on data for Tuesday, Wednesday, and Thursday.
2. RSG identified three issues with the expansion factors in the data provided:

a. The matched X-X/X-I BT data doesn't represent the total BT data (thus overestimates the expansion factor);

b. The data was not fully "cleaned" which results in overestimating the expansion factor and, as a result, underestimating X-X trips;

c. The matched X-X/X-I BT data were mistakenly aggregated for two days whereas traffic counts represent one day (overestimating expansion factor by factor of 2). Because of this, the preliminary expansion factor needed to be divided by 2.

$$Expansion\ Factor_{it} = \frac{Prelim.Expansion\ Factor_{it}}{2}$$

where subscripts *i* and *t* represents i^{th} external node and t^{th} time of day.

3. We applied the revised expansion factor to the raw matched X-X BT data to calculate a revised estimate of X-X trips. This is explained in the next Section 1.3.
4. Then we aggregated the results and EETRIPS.dbf by origin nodes.
5. Then the ratios of aggregated EETRIPS to aggregated results are calculated for each external origin node (external BT detector).

$$ratio_i = \frac{aggregated\ EETRIPS_i}{aggregated\ results_i}$$

   a. Where $aggregated\ EETRIPS_i$ is the sum of X-X trips originating from i^{th} external node calculated using EETRIPS data; $aggregated\ results_i$ is the sum of X-X trips originating from i^{th} external node calculated using BT data and expansion factors.

6. These ratios are multiplied by the growth rate in AADT from 2010 to 2015 to adjust for traffic increases.
7. It is reasonable to assume that the growth rate of X-X trips would be similar to the growth rate of AADT from 2010 to 2015 passing through the same external station. In other words, the adjusted ratio (i.e. $ratio_i * traffic\ increase\ rate_i$) for each external station must be around 1. However, based on the data supplied by HNTB, the results show that adjusted ratios are much larger than 1.0 for eleven external stations, indicating that the expansion factors for these stations has been overestimated. We use the ratios calculated in the last step to adjust our expansion factors as follows:

- if ratio < 1.8, then use 1.8;
- if ratio > 4.4, then use 4.4;
- otherwise use the ratio.

$$Adjusted\ Expnsion\ Factor_{it} = \frac{Expansion\ Factor_{it}}{ratio_i * traffic\ increase\ rate_i}$$

These upper-bound (4.4) and lower-bound (1.8) were set to prevent the adjusted expansion factor to grow greater than 55% or become less than 2%.

7.3 ESTIMATING EXTERNAL-EXTERNAL TRIPS

The raw matched X-X BT data alongside with expansion factors are used to estimate the X-X trips. The raw matched X-X BT data is cleaned as follows:

- X-X trips with same vehicle ID, origin, destination, date, and detected within a 5-minute interval were counted. Only one trip per count bin was kept and the rest were removed.
- Trips where starting time was less than end time of vehicles last trip were also removed.
- Trips with short travel time (1 or 2) minute were included because we have no basis upon which to adjust.
- Only trips occurring on Tuesday, Wednesday, and Friday were utilized.
- The data collection period was two weeks, providing 6 days of BT data. The observed BT trips must be divided by 6 to adjust for data collection period.

Once the data were cleaned the following equation was used to estimate the X-X trips:

$$Est.trips_{ijt} = \frac{(observed\ BT\ trips_{ijt})/6}{Adjusted\ Expansion\ Factor_{it}}$$

Where $observed\ BT\ trips_{ijt}$ is the sum of trips origination from i^{th} external node and ending at j^{th} external node at t^{th} time-of-day, $Est.trips_{ijt}$ is the estimated sum of trips origination from i^{th} external node and ending at j^{th} external node at t^{th} time-of-day, and $Adjusted\ Expansion\ Factor_{it}$ is calculated in previous section.

7.4 QA/QC

This section compares the estimated X-X trip table with old model's X-X trip table to check the quality of results.

Figure 20 shows the plots of old model's X-X trips by origin and destination AADTs in year 2012 and estimated trips by origin and destination AADTs in year 2016.

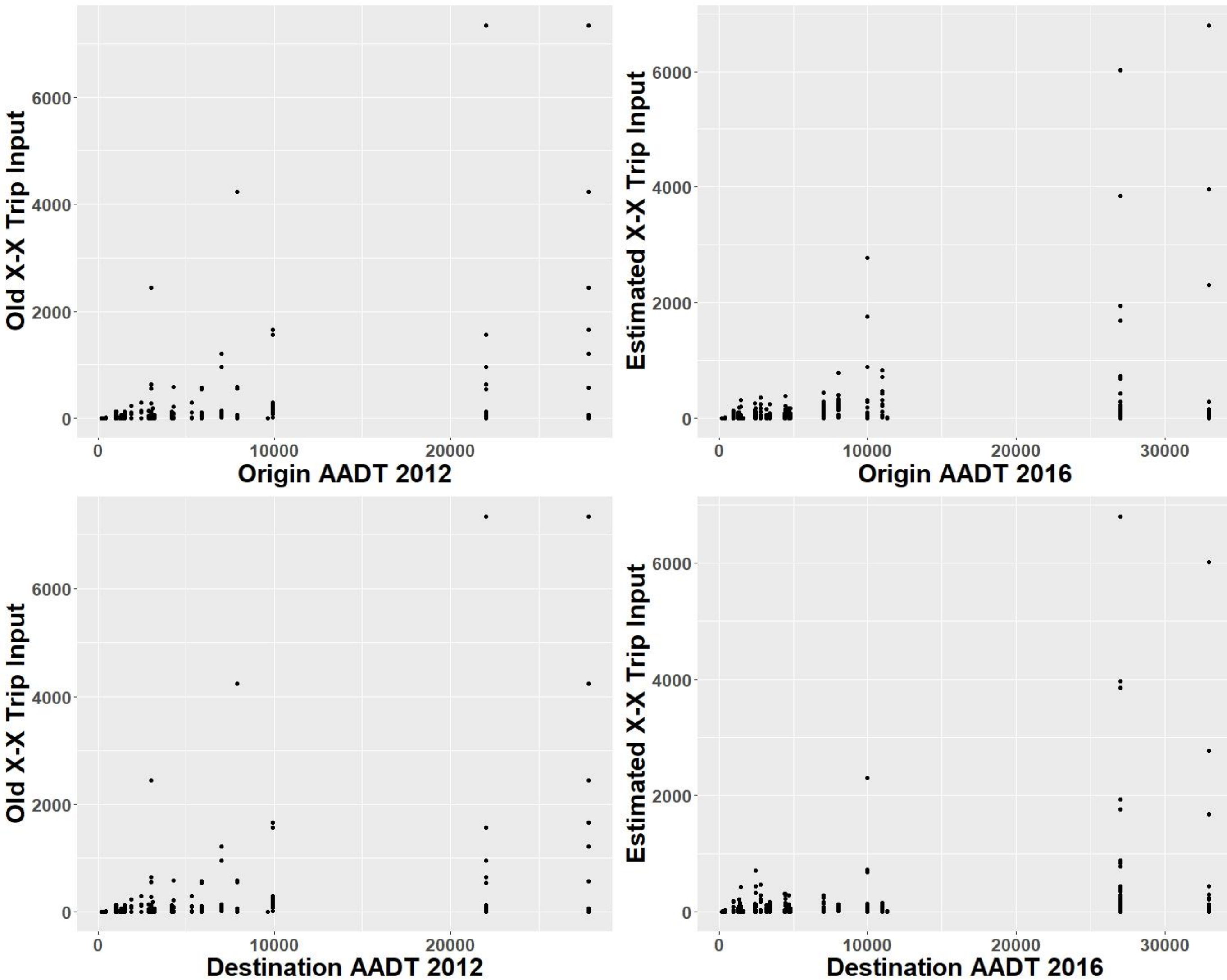


FIGURE 20 NUMBER OF TRIPS BY ORIGIN AND DESTINATION AADT

As illustrated by

Figure 20, in the previous version of the NERPM-AB X-X trips by origin is identical to X-X trips by destination. This suggests that the earlier model's X-X trips was generated based on the assumption that the number of inbound and outbound X-X trips are equal for each external station in old model. This is not always the case.

The earlier model's X-X trips for each station has two (or three) points representing significantly higher trips than the rest. These points are originating from or going to the two external stations with higher AADT. This suggests X-X trips were generated based on AADT. Other factors impacting likelihood of trips (e.g. distance, location, etc.) between O-D pairs were not considered.

Figure 21 shows the scatterplot of the earlier model's X-X trips vs. estimated X-X trips for identical O-D pairs with the best linear fit line. The linear fitted line shows the goodness of fit (R-squared) of 0.76. The line intercepts the estimated trips at 45, meaning the estimated trips in the new version are longer than old model's trips for lower values of old model's trips.

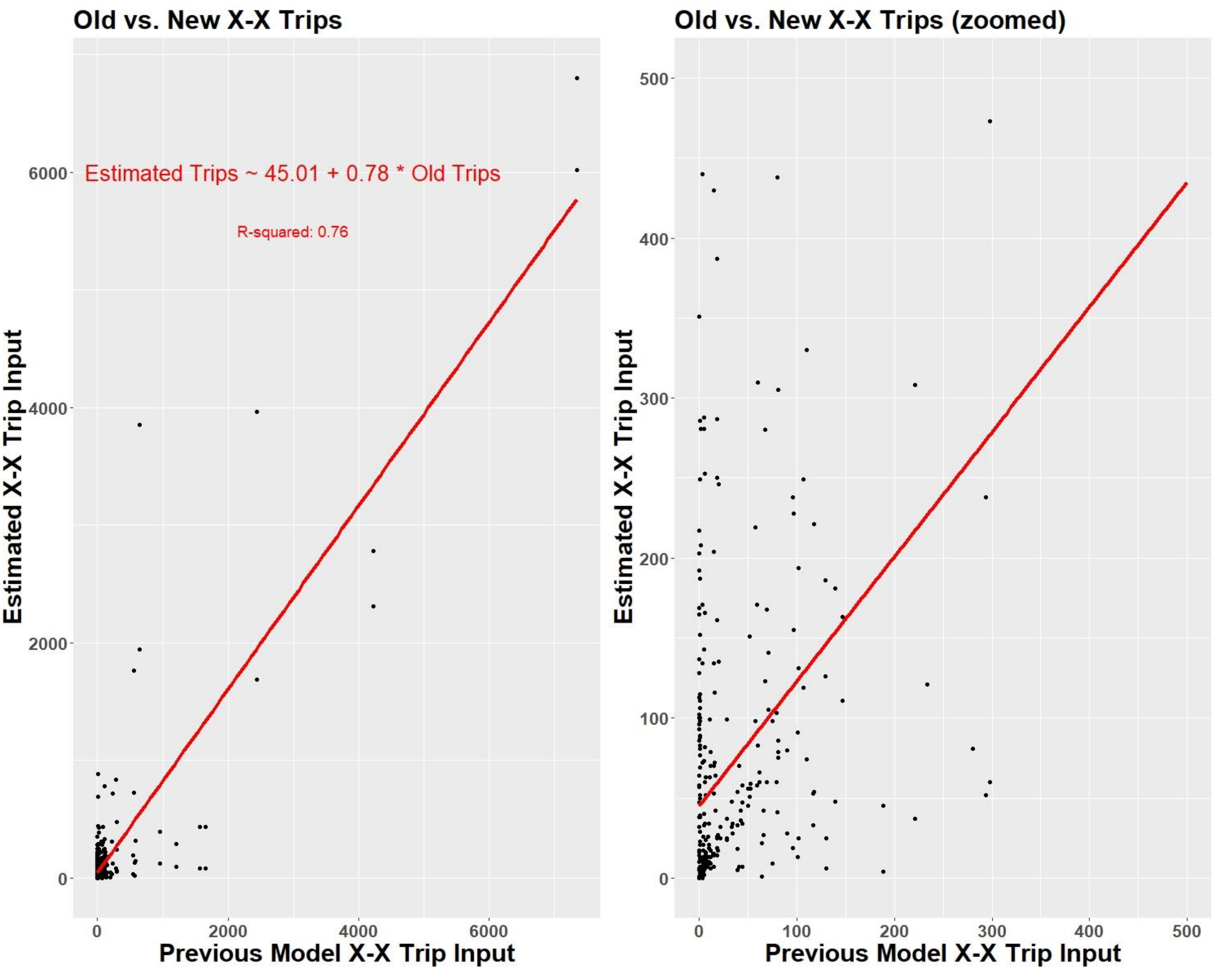


FIGURE 21 OLD MODEL VS. ESTIMATED X-X TRIPS

A significant portion of the earlier model's X-X trips are set to 0 or 1 for smaller trips values (<500). This is probably due to lack of data. However, the raw matched X-X BT data shows that number of trips between these X-X O-D pairs are higher, resulting in a more reliable estimate.

Table 26 shows the O-D pairs with highest volumes in the earlier model's X-X trips and estimated trips. The number of X-X trips to AADT ratio (shown in table 1) can be analyzed to check the validity of results. For example, 4231 trips per day is originating from node 2564 (US 301) and going to node 2550 (I-95 North) in the old model accounting for the 54% of total AADT of the origin location (node 2564) which is unreasonably high. However, the number of trips between this O-D pair in the estimated results is 2777 accounting for 28% of total AADT of the origin location which seems more reasonable.

TABLE 26 O-D PAIRS WITH HIGHEST TRIP VOLUME IN OLD MODEL AND ESTIMATED RESULTS

	ORZ	DRZ	Old Trips	Estimated Trips	OR AADT 2016	OR AADT 2012	DS AADT 2016	DS AADT 2012	Difference Old vs Estimated	Percent Difference Old vs Estimated	Old Trips to OR AADT Ratio	Old Trips to DS AADT Ratio	Estimated Trips to OR AADT Ratio	Estimated Trips to DS AADT Ratio
Top Old Trips Volume	2577	2550	7344	6017	27000	22000	32959	27820	1327	18.1%	33.4%	26.4%	22.3%	18.3%
	2550	2577	7344	6800	32959	27820	27000	22000	544	7.4%	26.4%	33.4%	20.6%	25.2%
	2550	2564	4231	2310	32959	27820	10000	7900	1921	45.4%	15.2%	53.6%	7.0%	23.1%
	2564	2550	4231	2777	10000	7900	32959	27820	1454	34.4%	53.6%	15.2%	27.8%	8.4%
	2550	2559	2442	3964	32959	27820	27000	25000	1522	62.3%	8.8%	9.8%	12.0%	14.7%
	2559	2550	2442	1684	27000	25000	32959	27820	758	31.0%	9.8%	8.8%	6.2%	5.1%
	2550	2568	1658	85	32959	27820	11000	9900	1573	94.9%	6.0%	16.7%	0.3%	0.8%
	2568	2550	1658	435	11000	9900	32959	27820	1223	73.8%	16.7%	6.0%	4.0%	1.3%
	2577	2568	1562	84	27000	22000	11000	9900	1478	94.6%	7.1%	15.8%	0.3%	0.8%
Top Estimated Trips Volume	2550	2577	7344	6800	32959	27820	27000	22000	544	7.4%	26.4%	33.4%	20.6%	25.2%
	2577	2550	7344	6017	27000	22000	32959	27820	1327	18.1%	33.4%	26.4%	22.3%	18.3%
	2550	2559	2442	3964	32959	27820	27000	25000	1522	62.3%	8.8%	9.8%	12.0%	14.7%
	2577	2559	639	3854	27000	22000	27000	25000	3215	503.1%	2.9%	2.6%	14.3%	14.3%
	2564	2550	4231	2777	10000	7900	32959	27820	1454	34.4%	53.6%	15.2%	27.8%	8.4%
	2550	2564	4231	2310	32959	27820	10000	7900	1921	45.4%	15.2%	53.6%	7.0%	23.1%
	2559	2577	639	1940	27000	25000	27000	22000	1301	203.6%	2.6%	2.9%	7.2%	7.2%
	2564	2559	560	1762	10000	7900	27000	25000	1202	214.6%	7.1%	2.2%	17.6%	6.5%
	2559	2550	2442	1684	27000	25000	32959	27820	758	31.0%	9.8%	8.8%	6.2%	5.1%
	2564	2577	10	888	10000	7900	27000	22000	878	8780.0%	0.1%	0.0%	8.9%	3.3%

Table 27 shows O-D pairs with highest trip difference (absolute value and percentage) between the old model and the estimated results. The number of X-X trips to AADT ratio in both the old model and estimated results seem reasonable. We have traced these O-D pairs in Google Maps to assess the likelihood of the old model vs. estimated results.

TABLE 27 O-D PAIRS WITH HIGHEST TRIP DIFFERENCE IN OLD MODEL VS. ESTIMATED RESULTS

	ORZ	DRZ	Old Trips	Estimated Trips	OR AADT 2016	OR AADT 2012	DS AADT 2016	DS AADT 2012	Difference Old vs Estimated	Percent Difference Old vs Estimated	Old Trips to OR AADT Ratio	Old Trips to DS AADT Ratio	Estimated Trips to OR AADT Ratio	Estimated Trips to DS AADT Ratio
Top Percentage Difference O-D	2550	2574	1	286	32959	27820	2800	2450	285	28500%	0.0%	0.0%	0.9%	10.2%
	2574	2550	1	249	2800	2450	32959	27819.5	248	24800%	0.0%	0.0%	8.9%	0.8%
	2564	2574	1	187	10000	7900	2800	2450	186	18600%	0.0%	0.0%	1.9%	6.7%
	2576	2552	1	152	7050	5300	4460.5	4305.5	151	15100%	0.0%	0.0%	2.2%	3.4%
	2576	2559	3	440	7050	5300	27000	25000	437	14567%	0.1%	0.0%	6.2%	1.6%
Top Count Difference O-D	2577	2559	639	3854	27000	22000	27000	25000	3215	503%	2.9%	2.6%	14.3%	14.3%
	2550	2564	4231	2310	32959	27820	10000	7900	1921	45%	15.2%	53.6%	7.0%	23.1%
	2550	2568	1658	85	32959	27820	11000	9900	1573	95%	6.0%	16.7%	0.3%	0.8%
	2550	2559	2442	3964	32959	27820	27000	25000	1522	62%	8.8%	9.8%	12.0%	14.7%
	2577	2568	1562	84	27000	22000	11000	9900	1478	95%	7.1%	15.8%	0.3%	0.8%

Figure 22,

Figure 23,

Figure 24 and Figure 25 show the O-D pairs with highest trips percentage difference between old model and estimated results (see The) on Google maps. The estimated results for these O-D pairs seems more reliable than old model's trips since:

- The old model's trips are significantly lower than observed matched BTs at these locations.
- The number of X-X trips to AADT ratio in the old model is zero whereas the estimated results ratio is between 1-10% which seems more reasonable.

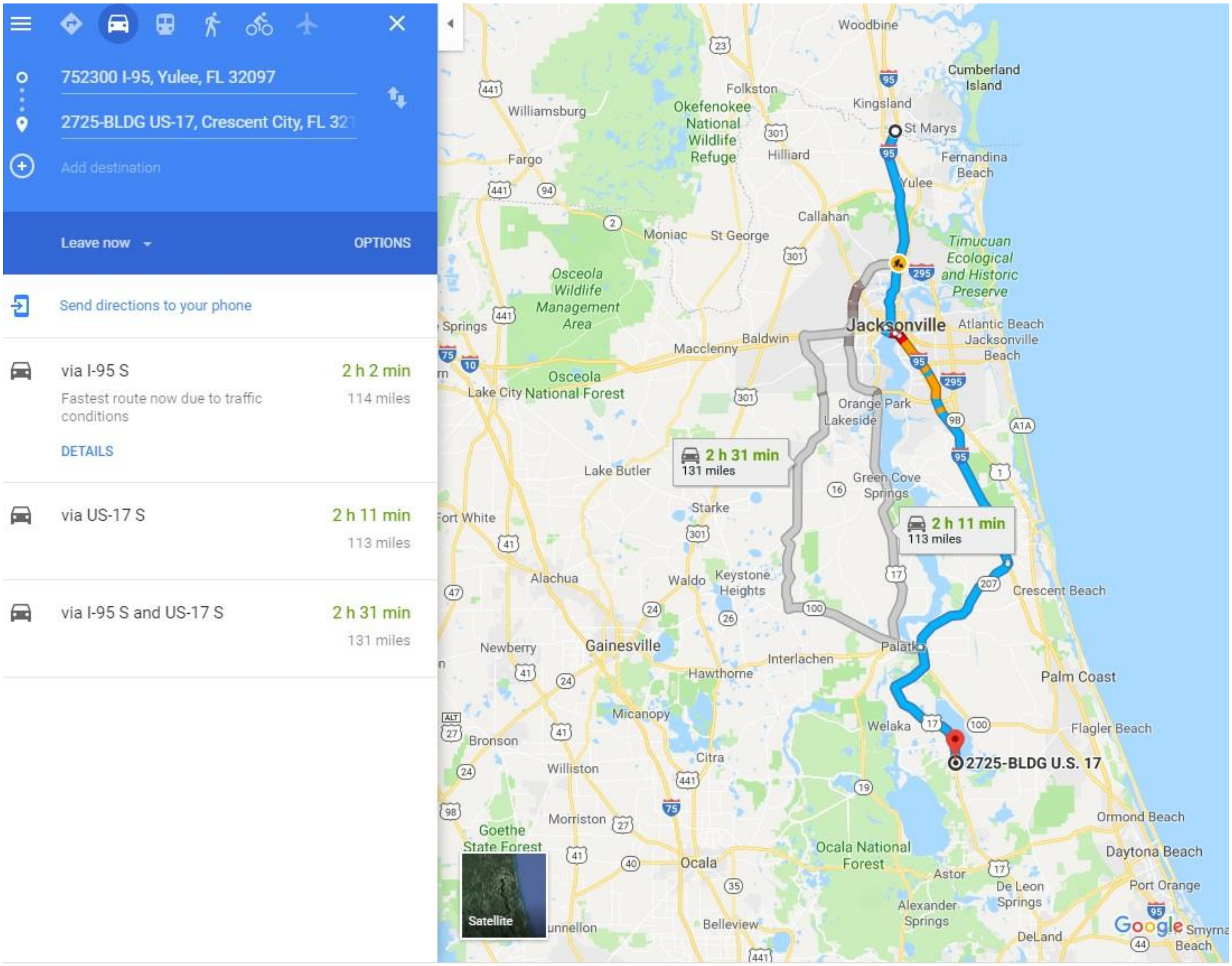


FIGURE 22 2550 (I-95 NORTH) – 2574 (US 17) – OLD MODEL TRIPS = 1 VS. NEW ESTIMATES = 286

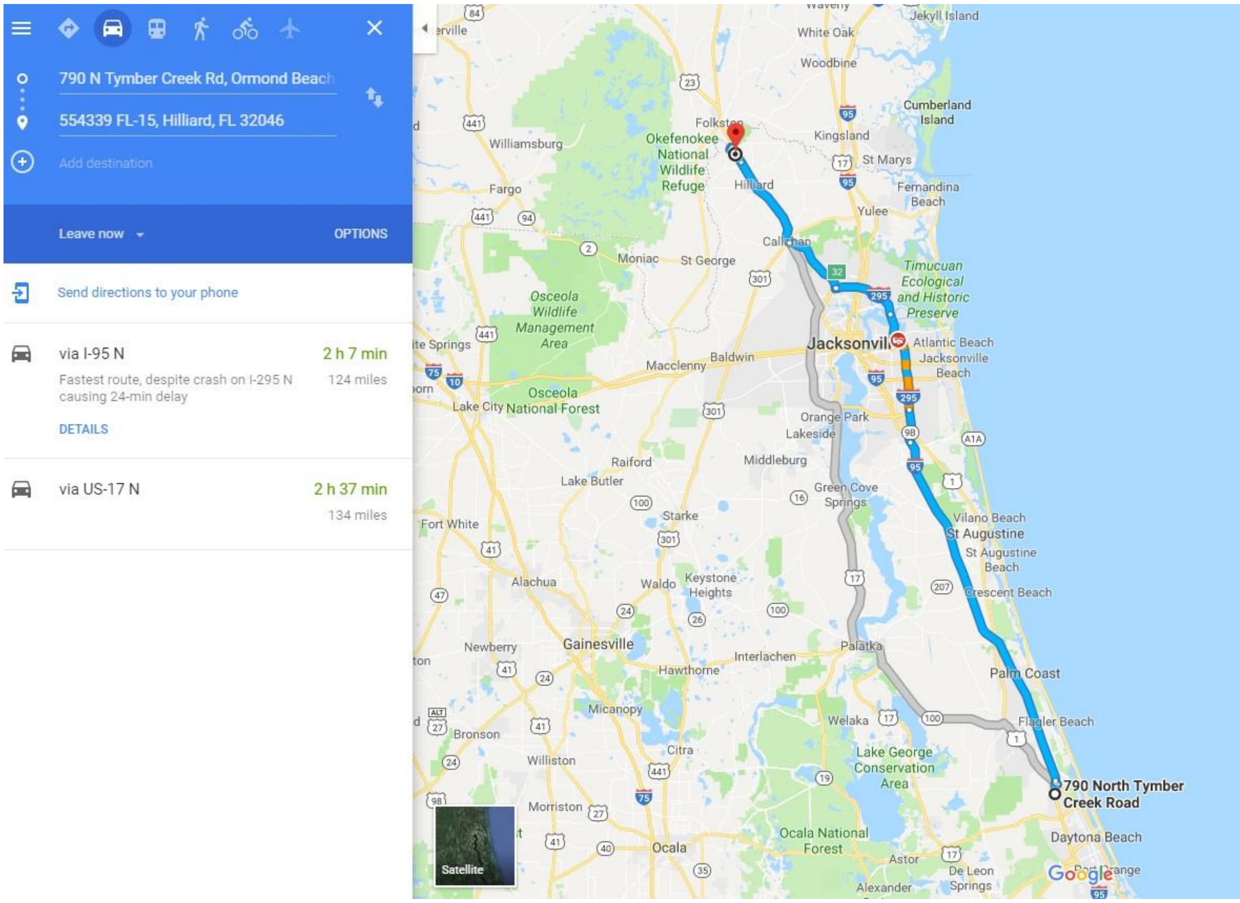


FIGURE 23 2564 (US 301) – 2574 (US 17) – OLD MODEL TRIPS = 1 VS. NEW ESTIMATES = 187

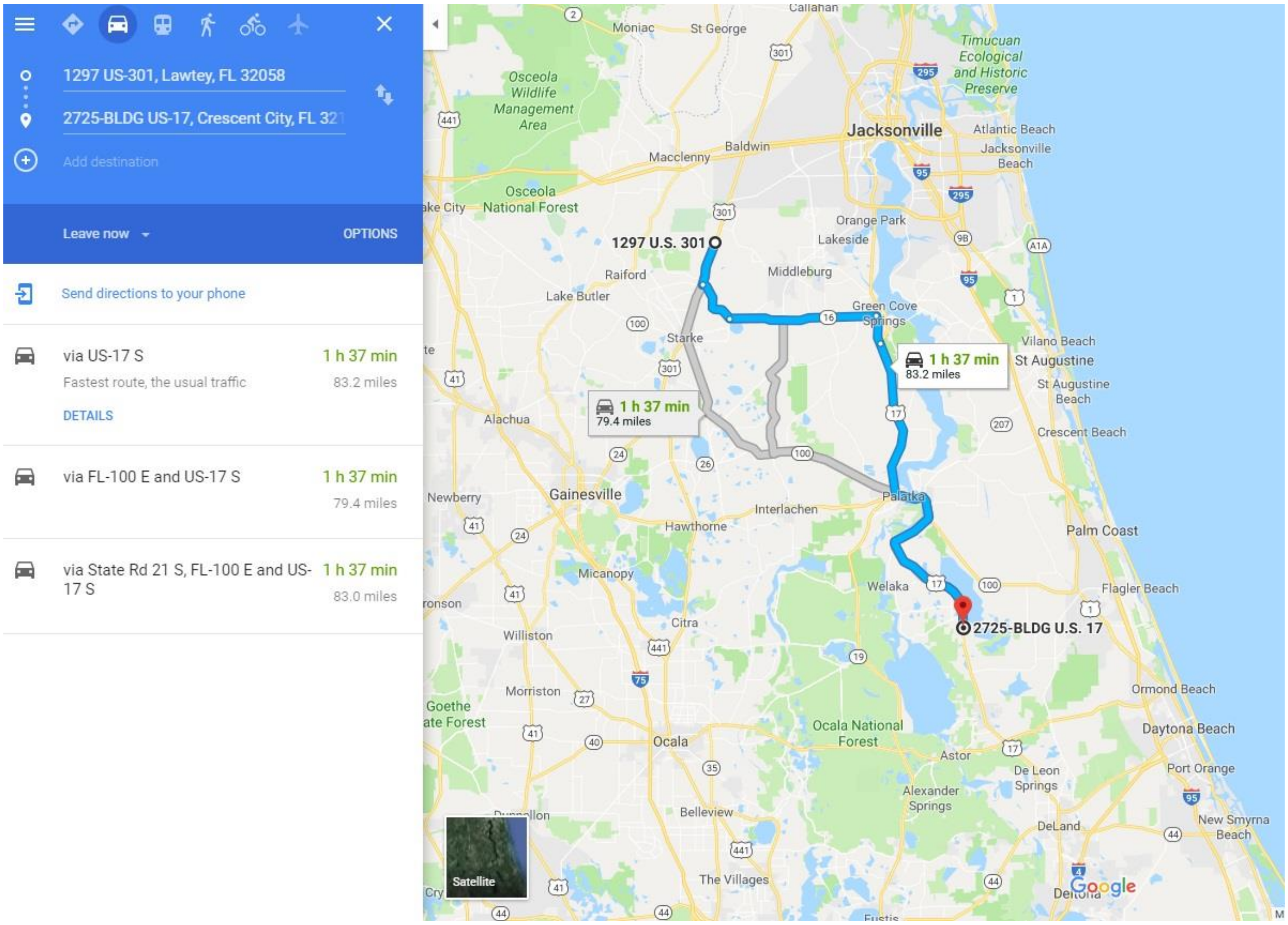


FIGURE 24 2576 (US 1 SOUTH) – 2552 (US 1 NORTH) – OLD MODEL TRIPS = 1 VS. NEW ESTIMATES = 152

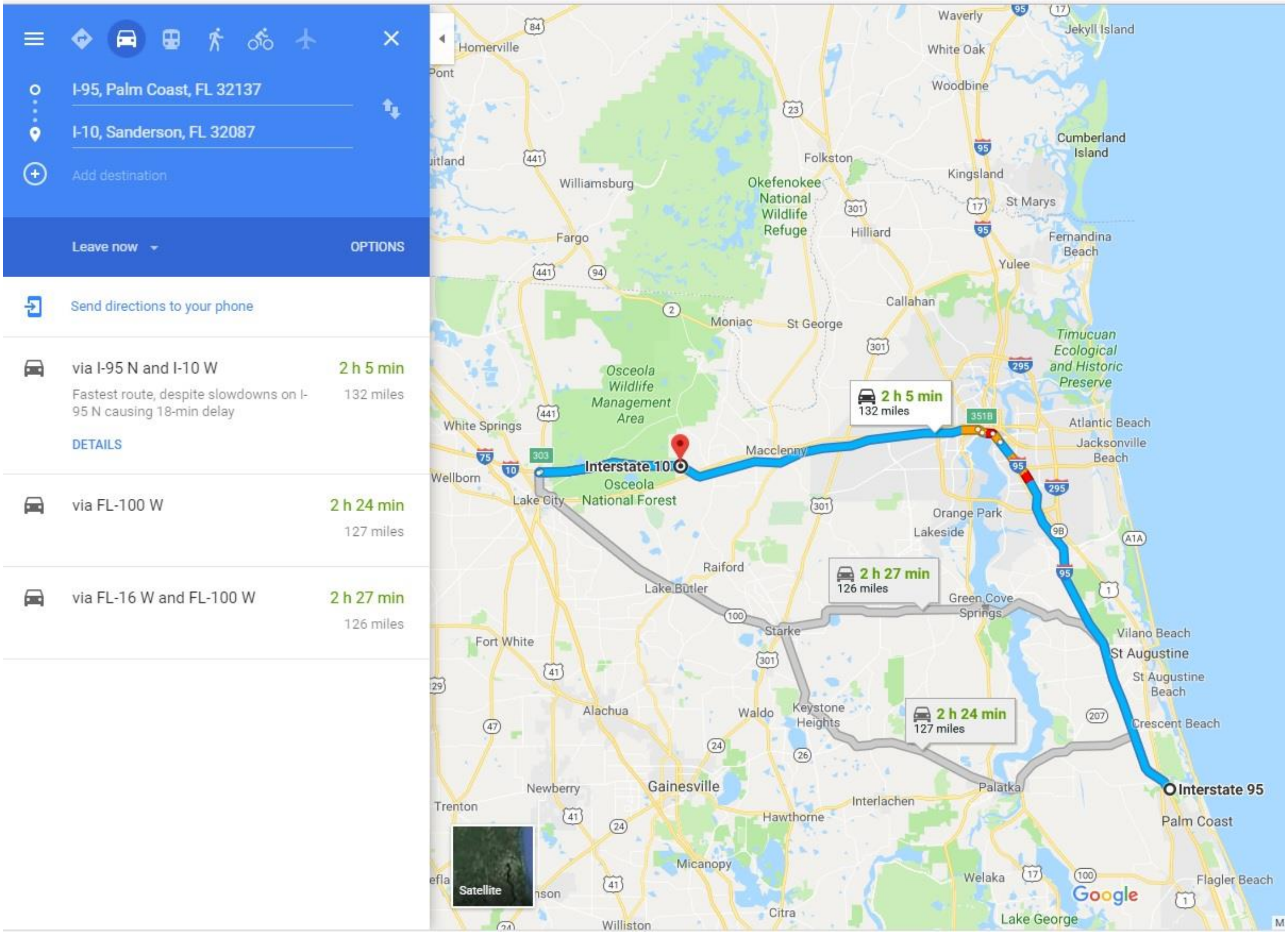


FIGURE 25 2576 (US 1 NORTH) – 2559 (I-10 WEST) – OLD MODEL TRIPS = 3 VS. NEW ESTIMATES = 440

Figure 26 to Figure 30 shows the O-D pairs with highest trip difference between old model and estimated results (see Table 27) on Google Maps.

Figure 26 shows the route from node 2577 (I-95 south) to node 2559 (I-10 west). Both origin and destination are located on interstates with relatively high AADT value. It is expected that significant trips occur for this O-D pair. As a result, estimated results (accounting for 14% of AADT) seems more reasonable than old model’s trip (accounting for only 3% of AADT).

Figure 27 shows the route from node 2550 (I-95 North) to node 2564 (US 301 west). The old model trips account for 54% of total AADT at the destination which seems very unlikely. Hence, the estimated result seems more reasonable.

Figure 28 shows the route from node 2550 (I-95 North) to node 2568 (SR 100). It is expected that a portion of traffic going from 2550 to 2564 be directed on to 2568. As a result, neither of the trips values (old model and estimated result) appear correct.

Figure 29 shows the route from node 2550 (I-95 North) to node 2559 (I-10 West). Both origin and destination are located on interstates with relatively high AADT value. It is expected that significant trips occur for this O-D pair. As a result, estimated results (accounting for 12% of AADT) seems more reasonable than old model's trip (accounting for only 9% of AADT).

Figure 30 shows the route from node 2577 (I-95 South) to node 2568 (SR 100). This route seems very unlikely since X-X trips going from south to west can use the faster route through interstates and there is almost no attraction location around node 2568. Hence, the estimated result are more reasonable.

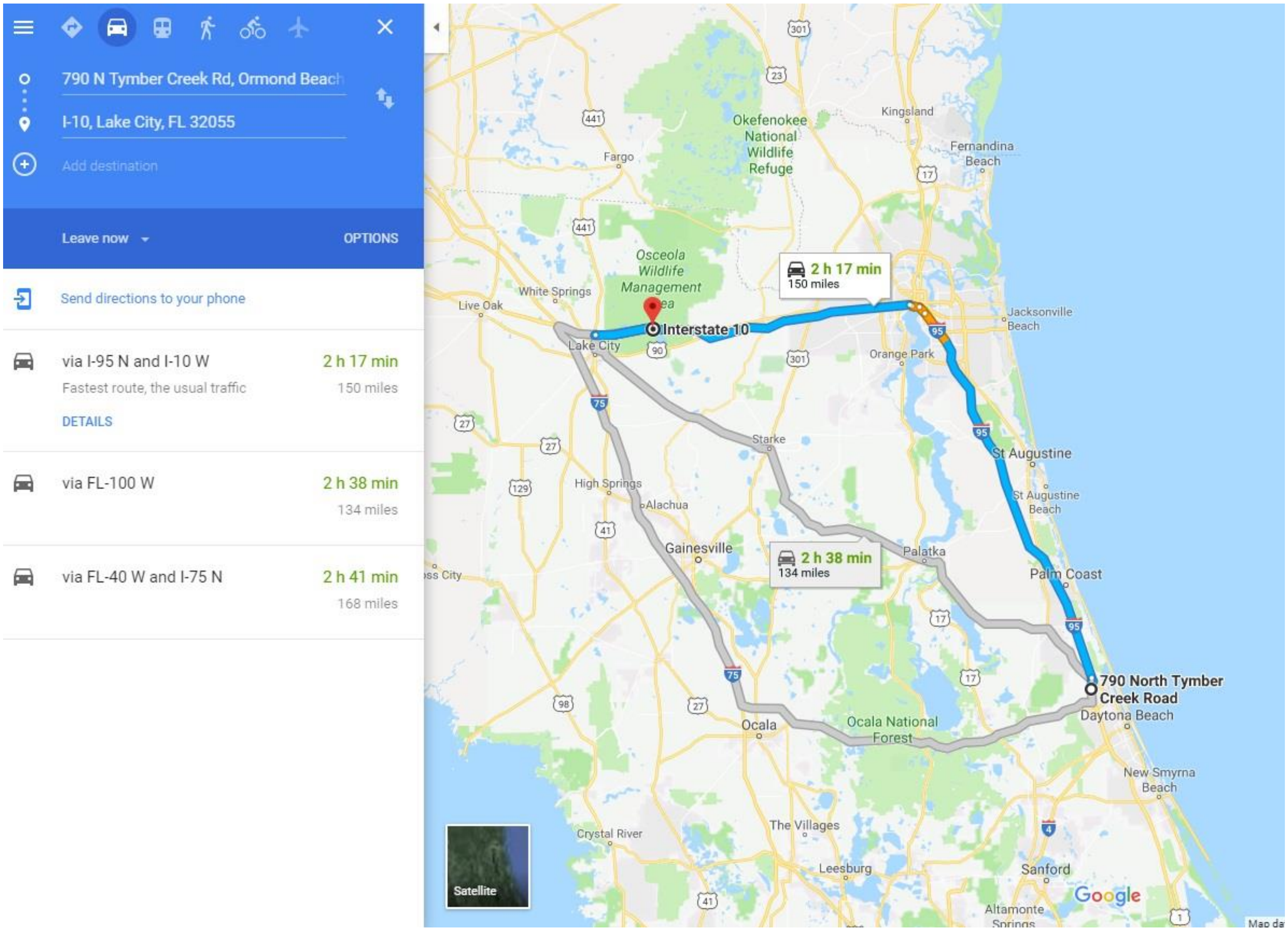


FIGURE 26 2577 (I-95 SOUTH) – 2559 (I-10 WEST) - OLD MODEL TRIPS = 639 VS. NEW ESTIMATES = 3854

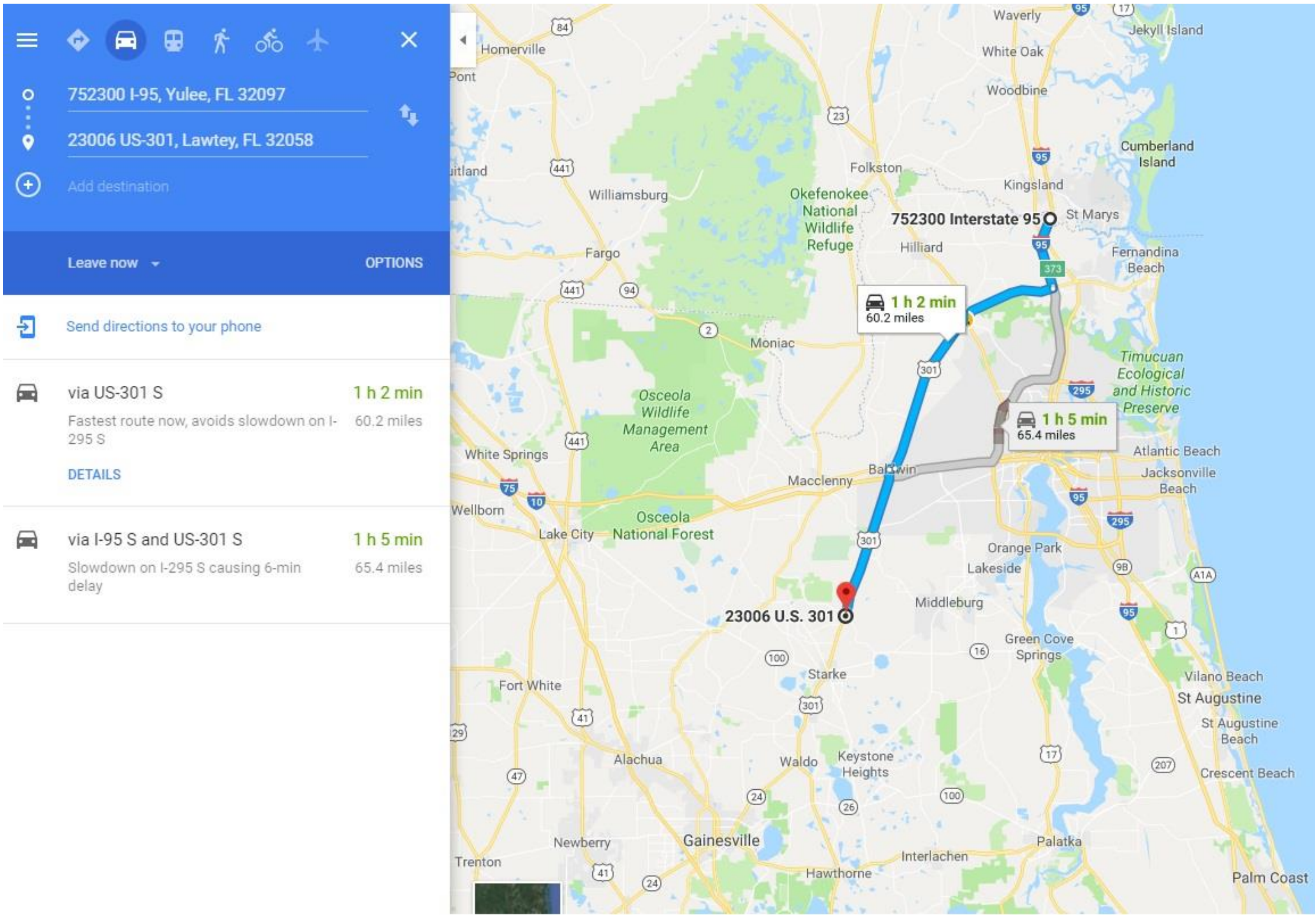


FIGURE 27 2550 (I-95 NORTH) – 2564 US 301) - - OLD MODEL TRIPS = 4231 VS. NEW ESTIMATES = 2310

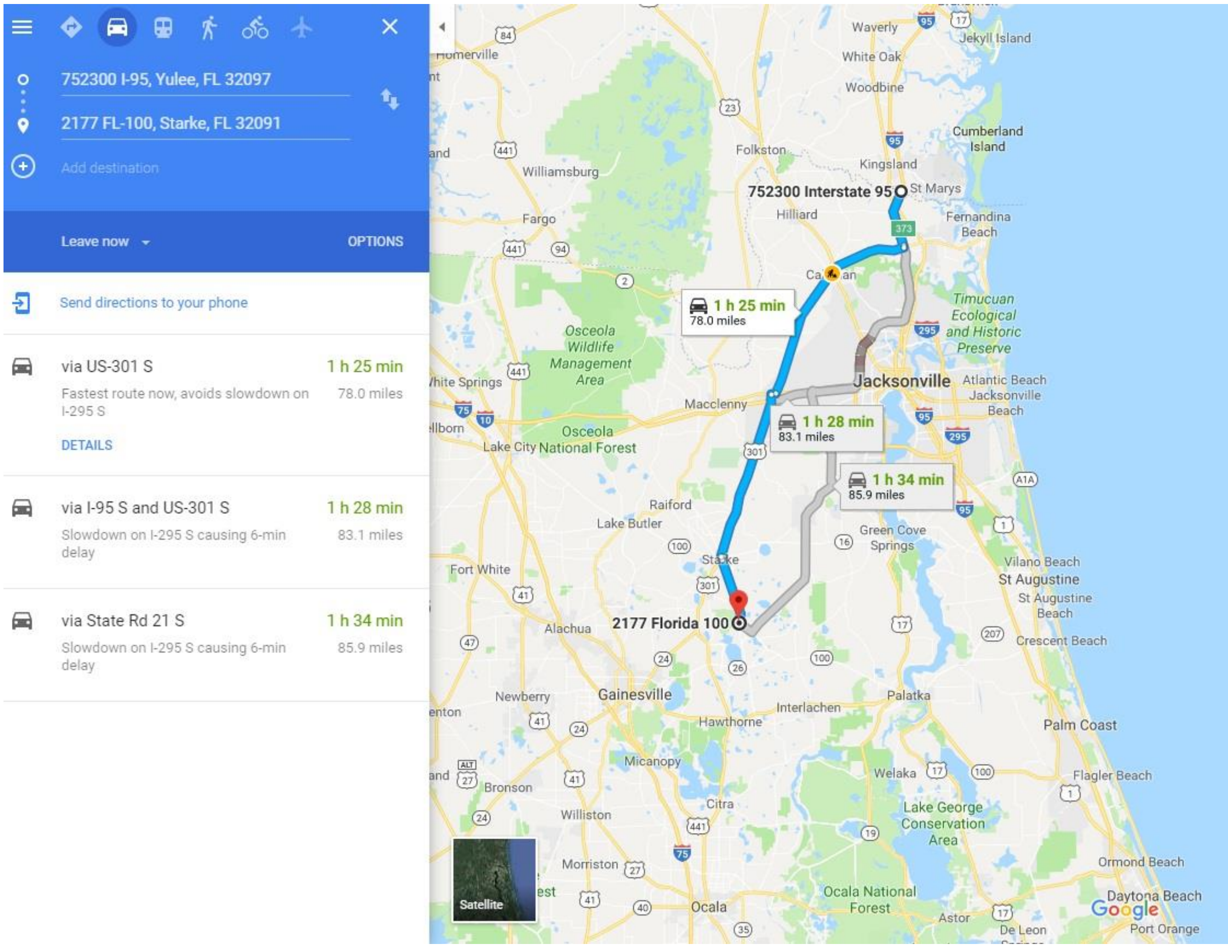


FIGURE 28 2550 (I-95 NORTH) – 2568 (SR 100 NORTH) - OLD MODEL TRIPS = 1658 VS. NEW ESTIMATES = 85

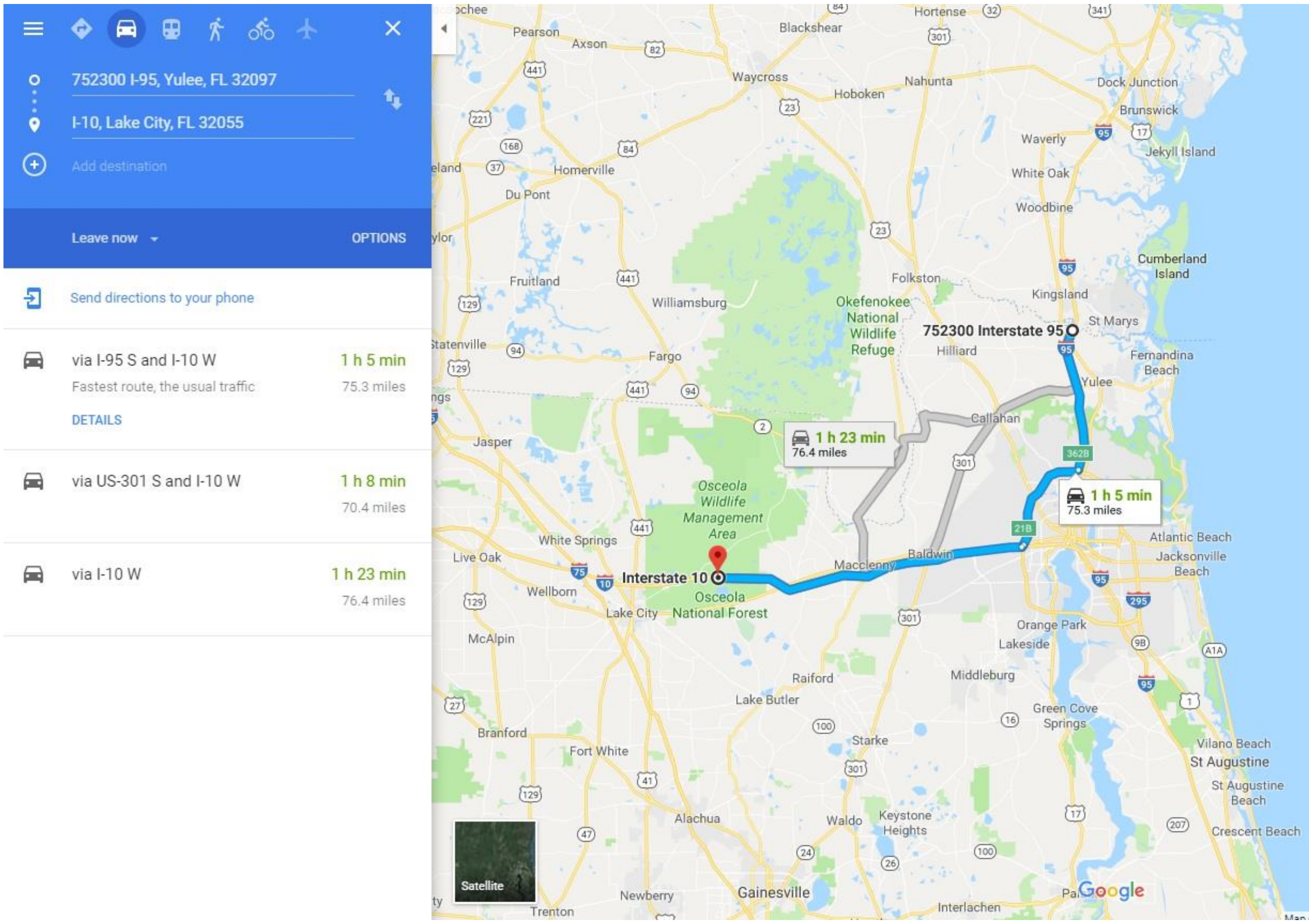


FIGURE 29 2550 (I-95 NORTH) – 2559 (I-10 WEST) - OLD MODEL TRIPS = 2442 VS. NEW ESTIMATES = 3964

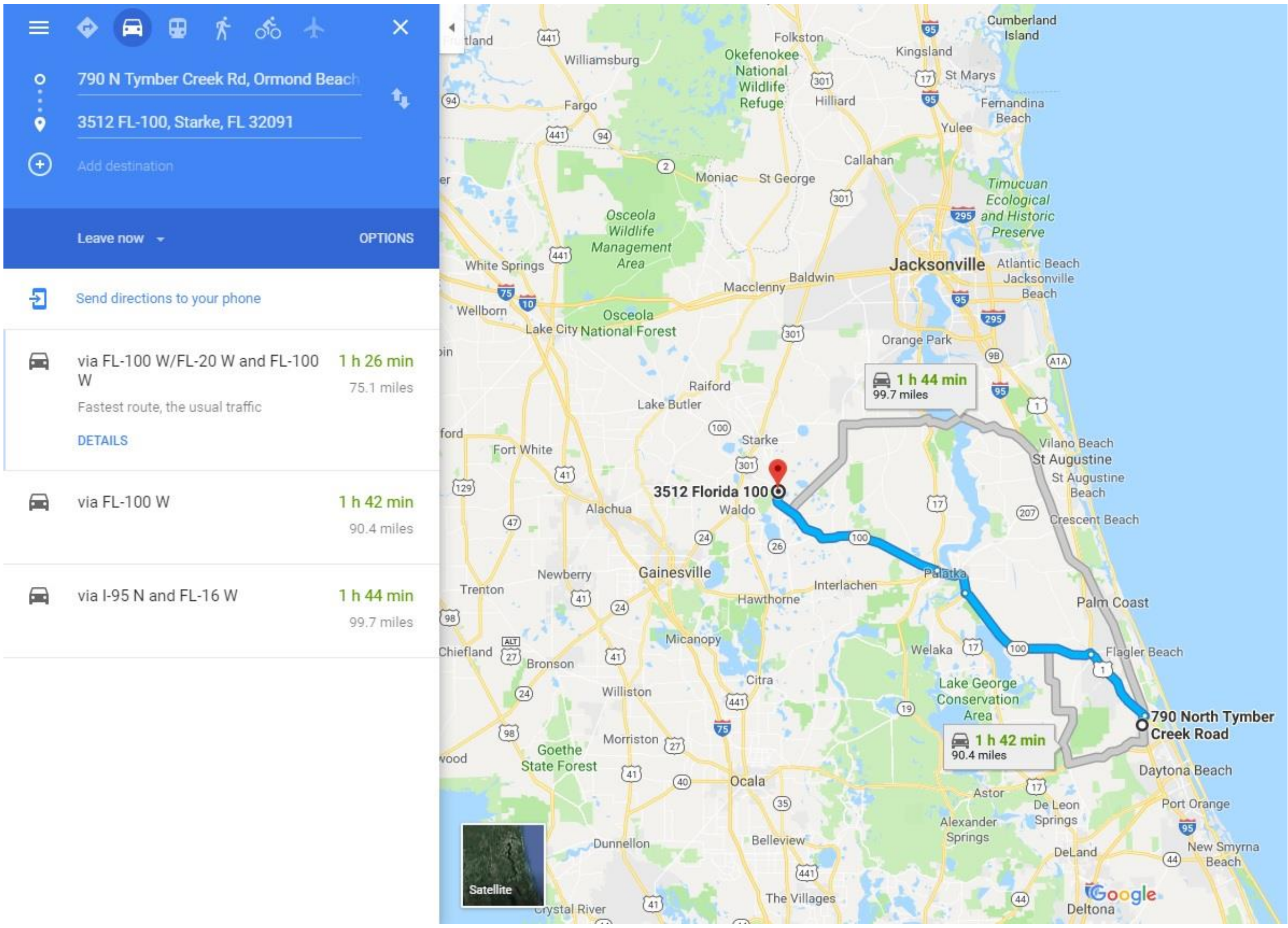


FIGURE 30 2577 (I-95 SOUTH) – 2568 (SR 100 NORTH) - OLD MODEL TRIPS = 1562 VS. NEW ESTIMATES = 84

7.5 CONCLUSION

In QA/QC section, we compared the new estimated X-X trip table with the previous estimated X-X trip table. We have concluded the new estimated X-X trip table is more reliable than the previous estimated X-X trip table due to:

1. The old X-X trip table is estimated based on the origin and destination's AADTs. Other factors impacting the likelihood of X-X trips (e.g. distance) were not considered. The new X-X trip tables are estimated based on the Bluetooth matches combined with AADT information (such as growth rate).
2. The old X-X trip estimation function (based on AADTs) is unable to provide a reliable estimate for O-D pairs with low AADT values. The updated X-X trip tables for lower volume external stations are estimated based on actual data and are not dependent on AADT.
3. The old X-X trip table estimated unreasonably large number of X-X trips compared to total origin/destination AADT.

The new estimated X-X trip table isn't 100% accurate, even though it is more reliable than old estimates. There are several ways to increase the accuracy of X-X trip table estimates in future:

1. Conduct a thorough data cleaning process on the raw Bluetooth data, as follows:
    a. Screen-out trips with same vehicle ID, origin, destination, and date that occur at almost same time of day
    b. Screen-out trips where starting time is earlier than ending time of vehicles last trip
    c. Screen-out trips with unreasonably high or low travel time
2. Calculate expansion factor based on all the detected Bluetooth devices at each external station instead of detected Bluetooth devices that were also detected by other Bluetooth stations.
3. Identify anomalies by checking data consistency at each station for different time-periods. For example, it is reasonable to assume that the penetration rate between 9-10 AM and 10-11 AM periods are similar for each external station.

8.0 NETWORK UPDATES

8.1 NETWORK LINK UPDATES

The previous Existing + Committed (E+C) network, known as 2040A in the 2010 model setup, was used as the starting point for the 2015 network. Table 28 lists the previous E+C network links that were modified to be consistent with 2015 base year conditions. Modifications included revisions to the number of lanes, facility type, and turn restrictions.

TABLE 28 E+C NETWORK (2040A) LINKS TO CHANGE FOR 2015 NETWORK

COUNTY	ROUTE	FROM	TO
Nassau	Chester Rd.	SR A1A	Green Pine Rd.
Duval	First Coast Expwy. (SR 23)	Clay CL	Argyle Forest Blvd.
Duval	First Coast Expwy. (SR 23)	Argyle Forest Blvd	I-10
Clay	First Coast Expwy. (SR 23)	Blanding Blvd (SR 21)	Duval CL
Duval	I-10 @ I-95	Roosevelt Ave. (US 17)	San Marco Ave.
Duval	I-295	SR 9B	J.T. Butler Blvd. (SR 202)
Duval	I-295	I-10	Commonwealth Ave.
Duval	I-295	Buckman Bridge	I-95
Duval	I-295	I-95 (South)	SR 9B
Duval	Martin Luther King Jr. Pkwy	at 21st St./Talleyrand Ave.	
Duval	SR 9B	Philips Hwy. (US1)	I-295
Duval	SR 9B	I-95	Philips Hwy. (US1)
Duval	US 301 (SR 200)	South of Baldwin	North of Baldwin
Duval	Blanding Blvd/SR 21	South of Old Jennings	North of CR 218
Duval	I-10 @ Beaver Street	Remove access to Beaver Street	
Nassau	US 301 (SR 200)	Duval CL	Callahan

8.2 TRANSIT NETWORK UPDATES

<JTA>

8.3 VOLUME COUNT UPDATES

The North Florida TPO provided AADT counts from 2015 FDOT portable traffic monitoring sites at point locations throughout the network. Each count was for total vehicles and did not include directionality or time of day factors. It was assumed that counts on bidirectional roads were equally split between both directions.

These points were spatially joined to the network links and then spot checked to ensure the join was accurate. Particular attention was paid to on and off ramps as they tended to have the least accuracy.

The NERPM-AB has four time periods: AM, midday (MD), PM, and night (NT). The 2010 network contains count data for each of these periods on some links. To create time of day count data for the 2015 counts, the 2015 count was distributed between the four time periods using the same ratio as the 2010 counts. Links with a 2015 count but no 2010 time of day counts used nearby 2010 time of day counts. If no 2010 count was nearby, that 2015 count was not used.

9.0 CUBE MODEL UPDATE

Several updates were made to the NERPM-AB Cube model during this project. The previous version of the model had model steps and scripting logic that was left over from the previous four-step model. Therefore, enhancements were made wherever necessary to make sure that the model system and results appear reasonable.

9.1 EXTERNAL-INTERNAL TRIPS CALIBRATION

While looking at auxiliary model demand it was found that IE trips are very long – average VMT per trip is approximately 32 miles, compared to 8 miles for internal trips. The VMT needed to be reduced by factoring either or both total IE or truck trips, or by factoring the length of IE trips for which the gravity model used to distribute them needed adjustment. To help inform this decision, the relationship between the observed counts and the estimated link volumes at external stations was investigated. It was found that both ends of I-95 and on I-10 were low, IE trips needed to be increased. It was also possible that the IE trips were traveling too far, which could be adjusted by making the friction factor curve used in trip distribution for IE trips steeper.

The first step taken to resolve this issue is the modification/balancing of External-External (EE) trips using Iterative Proportional Fitting (IPF). There were certain significant imbalances for certain stations, that is, significantly more origins than destinations, or vice-versa. The EE trip table (EETRIPS.DBF) is an input to the trip 'GENERATION' step in the NERPM-AB model. Table 29 below summarizes the EETRIPS for the current 2015 input to the North Florida TPO model by external stations for the major facilities I – 95 and I – 10.

TABLE 29 SUMMARY OF EE TRIPS FOR MAJOR FACILITIES (ORIGINAL INPUT)

TAZ	DESCRIPTION	TRIPS AS ORIGIN	TRIPS AS DESTINATION	ABSOLUTE DIFFERENCE
2550	I – 95 North	14,553	12,536	2,017
2559	I – 10 West	6,416	13,943	7,527
2577	I – 95 South	12,153	670	11,483

It can be noted that there are some significant imbalances for these stations, that is, more origins than destinations, or vice-versa. To minimize these inconsistencies, the EE trips are balanced using IPF method. The goal of the IPF method is that the estimated totals must equal the observed totals. In this case, from the EE trip matrix, the observed total is calculated by averaging row totals and column totals. Next, the EE trip matrix is balanced using the balancing factors over a series of iterations until the maximum difference is reduced. In the first iteration, the balancing factor is calculated by dividing the row observed totals with the row estimated totals. Then the matrix is multiplied with the balancing factors and a new estimated total is calculated. In the next iteration, the balancing factor is calculated using column totals and similarly the matrix is multiplied with the balancing factors to calculate a new estimated total. A total of 13 iterations is completed until the maximum difference calculated was less than 1. Table 30 summarize the

EETRIPS for the modified 2015 input to the North Florida TPO model and it can be observed that the balance of trips between external origins and destinations is maintained.

TABLE 30 SUMMARY OF EE TRIPS FOR MAJOR FACILITIES (MODIFIED INPUT)

TAZ	DESCRIPTION	TRIPS AS ORIGIN	TRIPS AS DESTINATION	ABSOLUTE DIFFERENCE
2550	I – 95 North	13,544	13,545	1
2559	I – 10	10,180	10,180	0
2577	I – 95 S	12,020	12,020	0

The next step is to adjust the trips attractions in the trip generation step of the model. The distribution of the trip attractions was adjusted using one percentage that considers both total productions and attractions instead of just total attractions. Once the adjustments were made, the output was checked to make sure the total EI trips is unchanged (see Table 31).

TABLE 31 EI TRIP COMPARISON

EI TRIP TYPE	PREVIOUS TRIPS	UPDATED TRIPS
SOV	62,268	62,268
HOV	39,669	39,669
Light Truck	2,997	2,997
Heavy Truck	10,992	10,992
Total	115,925	115,925

In the next step, the distribution model was run to see what effect it has on trip length. It was found that the average trip length of IE trips has slightly reduced. Therefore, in the next step, the IE trip friction factor curves were replaced with steeper curves and the IE trips were broken out into a separate trip distribution step and run using only 1 iteration in the model run. This reduced the average trip lengths of IE trips significantly as can be seen on

Table 32.

TABLE 32 COMPARISON OF AVERAGE TRIP LENGTH

PURPOSE	AVERAGE TRIP LENGTH IN MINUTES (ALL COUNTIES)		
	Previous	Updated	Difference
HBW	24.67	24.67	0
HBSH	22.25	22.24	-0.01
HBSR	25.33	25.32	-0.01
HBO	24.36	24.34	-0.02
NHB	17.99	17.99	0
Light Truck	16.29	16.29	0
Medium Truck	16.38	16.37	-0.01
Heavy Truck	16.44	16.44	0
IE_SOV	50.63	36.87	-13.76
IE_HOV	47.42	35.76	-11.66
IE_LT	50.46	35.74	-14.72
IE_HT	43.18	36.57	-6.61

Before running the updated distribution step, the EI input trip vector was adjusted to better match the counts at the external stations by scaling the percent difference at each external station. These enhancements to the model significantly increased the VMT as can be observed in Table 33.

TABLE 33 COMPARISON OF VMT

MODEL		DAYSIM	IE	EE	TRUCK	TOTAL
Previous	TRIPS	3,311,459	185,820	50,293	865,163	4,412,735
	VMT	28,268,172	6,024,135	3,714,863	5,969,775	43,976,945
	AVG. VMT	8.54	32.42	73.86	6.90	
Updated	TRIPS	3,214,837	185,831	50,339	415,067	3,866,073
	VMT	27,558,206	6,399,105	3,715,758	9,524,112	47,197,181
	AVG. VMT	8.57	34.44	73.81	22.95	

9.2 TRANSIT SKIMMING UPDATES

From the initial transit assignment results, it was found that the skyway/monorail boardings were significantly lower than observed boardings. Therefore, the next model enhancement made was to add alternative-specific constants (ASC) to DaySim for transit modes based on an in-vehicle time skim. For the transit alternatives that need to be modeled in the scenarios, the in-vehicle time (IVT) needs to be skimmed in a separate skim matrix, and any tour or trip that has the transit mode in the OD Pair should get the constant. The following table shows the ASC and IVT changes for various transit modes to be used in the model.

TABLE 34 IVT MODIFIER AND ASC BY TRANSIT MODE

MODE	IVT MODIFIER	ASC
1. Local and express Bus	1.0	0 min
2. Premium Bus	1.0	0 min
3. Circulator bus	1.0	0 min
4. Light, Heavy rail	0.9	-15 min
5. Commuter rail	0.7	-30 min
6. Other mode	1.0	0 min

To incorporate these constants in the model, the following changes were made

- Transit network preparation Cube script was changed to introduce the mode-specific weighing factor (RUNFACTOR) for rail mode
- Connectors Cube script was changed to develop all peak and off-peak connectors to include the rail mode
- Transit Skimming Cube script was changed to create separate skims for rail mode
- DaySim roster file was changed to include all transit sub-modes
- DaySim configuration file was changed to include the additive weights and path constants
- Replaced the old DaySim files with updated DaySim files to include the Jacksonville DLL files which includes the intra-county and river crossing effects.

9.3 HIGHWAY SKIMMING FOR TOLLS

In the E+C 2045 networks, express lanes or managed lanes were introduced in the highway network. Initially the toll variable, CARTOLL, was set at zero for all links. This was changed to 20 cents per mile (0.20). This value (CARTOLL) was then multiplied with the link length throughout the model setup to calculate the cost. Moreover, the occupancy for HOV2 and HOV3+ were also changed to 1.3 and 1.5, respectively.

10.0 DAYSIM MODEL CALIBRATION & VALIDATION

A calibration process adjusts the model to ensure that the model generates demand that reasonably follows the behavior depicted in observed data. The demand is defined as frequency of trips by origin and destination (OD) pair. The frequency of trips by OD pair can have different segmentation for ex. trip mode, time of day etc. The demand is then loaded on to network (assignment) to determine frequency of trips using each link in the network. For highway, this provides vehicle flows on every link (road) in the highway network and for transit, generates number of people (boardings) using each transit service.

After a model is calibrated to produce demand that reasonably predicts observed travel behavior in the region, the model is validated to ensure network-level usage of the demand. The model validation includes, on the highway side, comparing estimated traffic volume from the model with observed traffic counts, and on the transit side, comparing estimated transit boardings from the model with observed transit ridership.

The rest of this chapter presents model calibration and validation in separate sections. For each, first, the observed data are discussed followed by summaries from a final calibration and validated model run. In the end, a summary of the chapter presents key takeaways from the discussions.

In model calibration, alternative-specific constants (ASCs) and other model parameters are iteratively adjusted until the model generates demand that reasonably matches travel patterns in observed data. Typically, models are calibrated according to the following procedure: first, create comparisons between observed data and estimated model results. Next, calculate ASC adjustments by calculating natural log of the ratio between the observed value and the estimated value for each alternative. Then, add the adjustments to the ASCs from the previous iteration. Next, run the model with the updated constants. Table 35 presents a list of datasets utilized to calibrate the NERPM-AB.

TABLE 35 MODEL CALIBRATION DATASETS

DATASET	YEAR	SOURCE	PURPOSE
North Florida Household Travel Survey	2017		Jacksonville Tour Destination and other sub-models
Transit On-Board Survey	2016	Transit On-Board Survey Program	Transit Tours/Trips
CTPP	2010	Census	Worker Flow

The present effort used multiple datasets to calibrate the NERPM-AB. The 2017 North Florida Travel Survey was the primary dataset used during the calibration. Whenever available, additional datasets were utilized to inform more accurate information for particular types of travel. For example, transit on-board survey provided information about transit travel, informing transit travel targets (tours and trips) in mode choice calibration. Also, the 2010 CTPP ACS Journey to Work data provided flow of workers and used to validate estimated work location choice of North Florida residents.

North Florida Household Travel Survey

In spring 2017 the North Florida Transportation Planning Organization (North Florida TPO) commenced the 2017 North Florida Travel Survey (2017 HTS). The North Florida TPO was the lead agency for this study. Additional sponsors include the Florida Department of Transportation (FDOT). The North Florida TPO has a Board and Technical Coordinating Committee (TCC) and a Citizens' Advisory Committee (CAC), all of which were informed about the survey throughout its lifecycle. The survey consultants, RSG and the Hester Group, conducted the survey.

The North Florida survey region included Baker, Clay, Duval, Nassau, Putnam, and St. Johns counties. The primary purpose of the 2017 HTS was to collect current information about household and individual travel patterns for residents throughout the six-county North Florida region to support regional travel models. The 2017 HTS provides planners with comprehensive travel behavior datasets to help regional stakeholders and other local agencies understand current travel behaviors of people and households, which allow them to make informed planning and policy decisions.

The model calibration further processed the 2017 HTS data to prepare targets for model calibration. First, the data were filtered to keep only weekday travel by removing weekend and holiday travel. Then the travel weights were scaled appropriately to match total travel in the original survey data.

During preparing calibration targets, household and person level summaries used respective weights. The 2017 HTS data were geocoded for origin (home, tour, and trip) and destination locations (work, school, tour, and trip) to assign corresponding MAZ and TAZ in the North Florida TPO model region.

Transit On-Board Survey

A transit on-board survey was conducted in 2016 across the JTA service area, collecting data from approximately 31k transit trips. RSG expanded the data to represent total boardings at a route level based on observed ridership data and calculated total linked transit trips by adding the linked weight for each transit trip. Figure 31 shows the percent of transit trips from on-board survey by tour purposes.

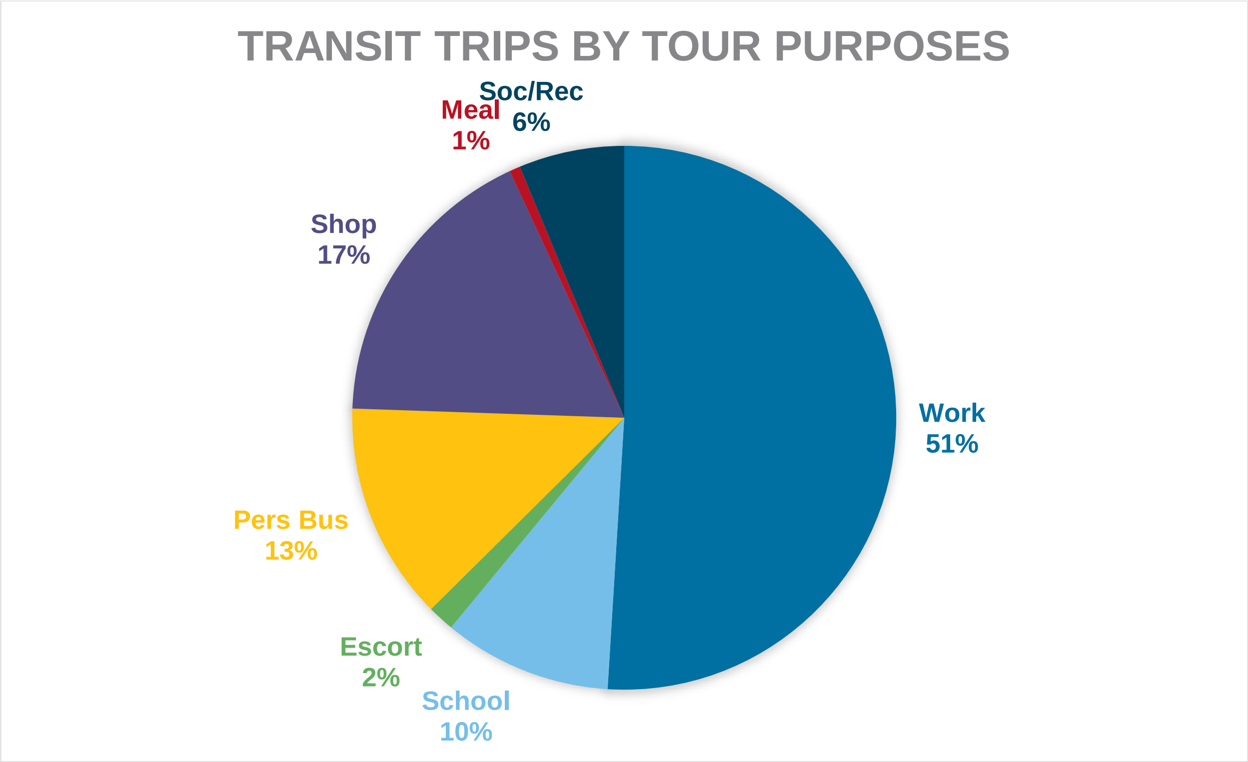


FIGURE 31 TRANSIT TRIPS BY TOUR PURPOSES

Worker Flows

Commute travel is a very important and significant component of any regional travel. Therefore, in addition to verifying number of workers by work location, it is essential to validate workers by their origin (home) and destination (work) locations. This project obtained 2010 CTPP ACS worker dataset and validated workers flow between home and work districts. The flows are compared at an aggregate level (6 Counties) since observed data are likely to show more variance/error at a more detailed geography. The dataset is obtained from the respective website.

10.1 CALIBRATION SUMMARIES

An R-utility summarizes DaySim outputs into statistics that are meaningful and easy to understand. The summaries are prepared by key model components and include work and school location, auto ownership, day pattern, tour/trip destination choice, mode choice, and time of day. These summaries from the final calibrated model are presented below.

Synthetic Population

Table 36 and

Table 37 compare synthetic population in DaySim with observed data (HTS for the North Florida TPO region). Note that compared to the HTS data, the synthetic population includes slightly more part-time workers. The total workers (full-time and part-time) in the synthetic population (663,578) were greater than the HTS data (599,749).

TABLE 36 POPULATION BY PERSON TYPE

PERSON TYPE	SURVEY	POPSIM
Full Time Worker	540,570	566,852
Part Time Worker	96,726	59,179
Retired	172,447	142,992
Non-Worker	203,794	208,490
University Student	43,943	55,998
Student Age 16+	37,901	48,543
Student Age 5-15	185,288	197,734
Kid under 5	83,362	102,243
Total	**1,326,484**	**1,419,578**

TABLE 37 POPULATION BY PERSON TYPE (%)

PERSON TYPE	SURVEY	POPSIM
Full Time Worker	41%	40%
Part Time Worker	4%	7%
Retired	13%	10%
Person type	SURVEY	POPSIM
Non-Worker	15%	15%
University Student	3%	4%
Student Age 16+	3%	3%
Student Age 5-15	14%	14%
Kid under 5	6%	7%
Total	100%	100%

Home to Work Distance

As presented in Table 38, the survey data indicate an average home to work distance of 13.2 miles regionwide. The ABM is calibrated to a distance (12.4 miles) close to the observed value. The distance by worker type are also reasonably calibrated between the two observed datasets.

TABLE 38 AVERAGE HOME TO WORK DISTANCE

WORKER TYPE	SURVEY	DAYSIM
Full Time	13.7	13.3
Part Time	9.1	6.8
Other	9.9	14.5
Total	13.2	12.4

Figure 32 shows a distribution of home to work distances of individuals. The X-axis is distance in miles and the Y-axis is share (%) of the total number of persons. Due to relatively lower samples, the observed dataset shows lumpy distributions. The ABM distribution is smoother and generally follows the observed distribution from the survey.

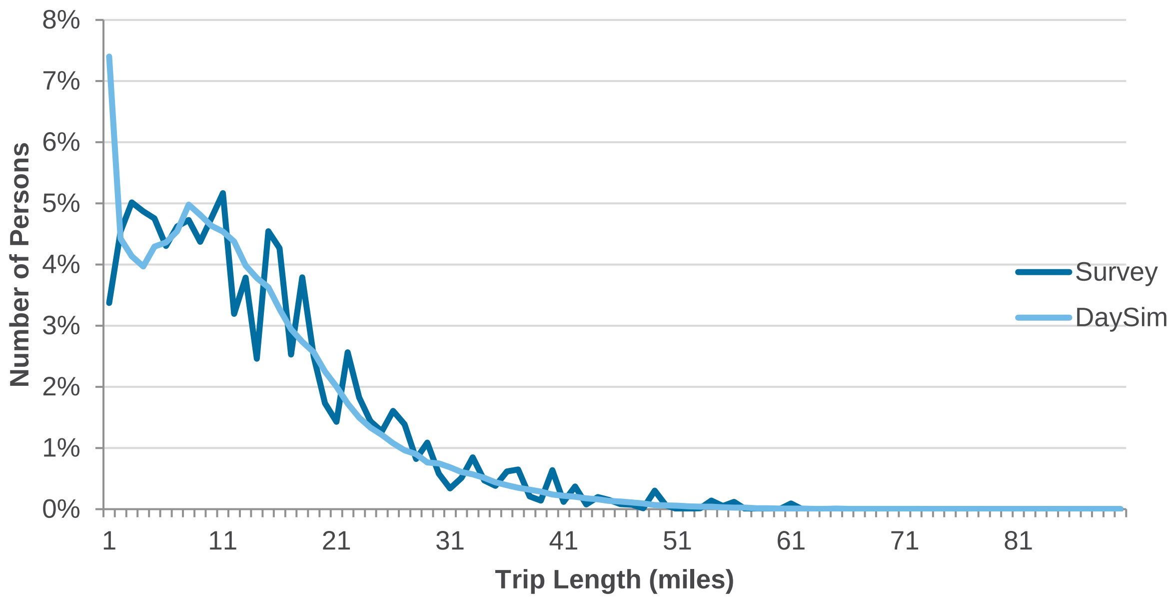


FIGURE 32 DISTRIBUTION OF HOME TO WORK DISTANCES

As shown in Table 39, estimated workers working at a location were compared at an aggregate geography (6 counties). The comparison is extended to compare estimated workers with observed workers from multiple data sources: CTPP and HTS. Note that the HTS data is scaled to match estimated workers by County. Generally, the observed data source shows some significant differences, however, the ABM compared reasonably well with the datasets.

TABLE 39 WORKERS BY COUNTY

COUNTY	CTPP	HTS	DAYSIM
1	7,283	5,383	9,681
2	59,391	80,418	84,565
3	286,647	400,012	420,057
4	18,556	17,424	32,801
5	13,779	10,901	20,362
6	64,325	79,338	97,402
TOTAL	**449,980**	**593,476**	**664,868**

Home to School Distance

As per HTS, in Table 40, the average distance travelled by students to go from home to school is 6.48 miles. The ABM is adjusted to a value (7.46 mile) close to the HTS, though slightly higher.

TABLE 40 AVERAGE HOME TO SCHOOL DISTANCE

WORKER TYPE	SURVEY	DAYSIM
Kids 5 to 15	5.40	5.69
Student 16+	7.06	6.95
University Student	14.09	13.99
Total	6.48	7.46

Figure 33 presents a comparison of observed and estimated frequency distribution of trip lengths between home and school. As DaySim is calibrated to follow the HTS profile, the DaySim trip length frequency distribution (TLFD) follows the HTS TLFD closely.

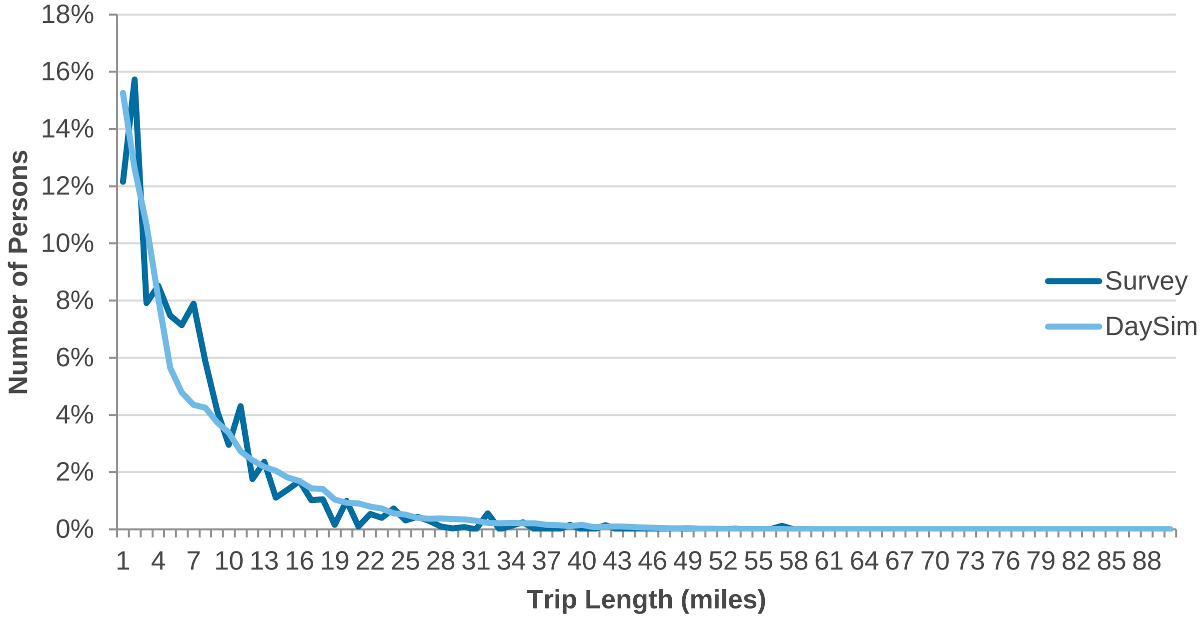


FIGURE 33 DISTRIBUTION OF HOME TO SCHOOL DISTANCE

Auto Ownership

The auto ownership model predicts number of vehicles owned by a household. The auto ownership model is structured as a multinomial logit (MNL) with five available alternatives: 0, 1, 2, 3, and 4+. Key variables are the numbers of working adults, non-working adults, students of driving age, children below driving age and income.

Table 41 and Table 42 present share of households by number of vehicles and drivers in the household from the HTS and the ABM respectively. Difference of household shares between the two datasets are presented in

Table 43. The ABM is calibrated to reasonably match the HTS shares.

TABLE 41 SHARE OF VEHICLES BY HOUSEHOLDS AND DRIVERS (HTS)

NO. OF DRIVERS	NUMBER OF VEHICLES					
	0	1	2	3	4+	Total
1	5.4%	26.7%	3.6%	0.2%	0.1%	35.9%
2	1.5%	9.1%	29.2%	5.3%	1.1%	46.1%
3	0.5%	2.0%	3.6%	4.5%	0.8%	11.4%
4+	0.0%	0.4%	1.7%	1.4%	3.2%	6.6%
Total	7.3%	38.1%	38.1%	11.4%	5.2%	100.0%

TABLE 42 SHARE OF VEHICLES BY HOUSEHOLDS AND DRIVERS (DAYSIM)

NO. OF DRIVERS	NUMBER OF VEHICLES					
	0	1	2	3	4+	Total
1	4.8%	25.9%	4.2%	0.9%	0.1%	35.9%
2	1.8%	10.1%	28.6%	4.7%	0.8%	46.1%
3	0.5%	1.4%	4.3%	4.0%	1.1%	11.4%
4+	0.1%	1.1%	1.7%	1.3%	2.5%	6.6%
Total	7.2%	38.5%	38.8%	11.0%	4.5%	100.0%

TABLE 43 DIFFERENCE IN VEHICLES SHARES BY HOUSEHOLDS AND DRIVERS

NO. OF DRIVERS	NUMBER OF VEHICLES					
	0	1	2	3	4+	Total
1	-0.5%	-0.8%	0.6%	0.7%	0.0%	0.0%
2	0.3%	1.0%	-0.6%	-0.5%	-0.2%	0.0%
3	0.0%	-0.6%	0.7%	-0.5%	0.3%	0.0%
4+	0.1%	0.7%	0.0%	-0.1%	-0.7%	0.0%
Total	-0.1%	0.4%	0.8%	-0.4%	-0.7%	0.0%

Day Pattern

Day pattern summaries compare observed and estimated resident travel (tours and trips) by purpose and person type. Table 44 compares tours by tour purpose. As per the HTS data, the majority are mandatory purposes (work-29% and school-16%) related. About 10% are shopping and 12% are social and recreational. The share of tours in the ABM are calibrated to match closely with the HTS data.

TABLE 44 TOURS BY PURPOSE

TOUR PURPOSE	HTS	ABM	DIFF (ABM-HTS)
Work	32%	29%	-3.0%
School	14%	16%	2.0%
Escort	14%	14%	0.0%
Personal Business	11%	12%	1.0%
Shop	10%	10%	0.0%
Meal	4%	4%	0.0%
Social/Recreation	12%	12%	0.0%
Work-based	3%	3%	0.0%
Total	**100.0%**	**100.0%**	**0.0%**

A tour rate is calculated as the number of tours divided by the number of persons. Table 45 compares tour rates by tour purpose. The HTS indicates on average 1.18 tours per person in the NFTPO region. The calibrated ABM produces a similar but slightly higher tour rate (1.26) for the region. The ABM tour rates by purpose match closely with tour rates in the HTS data.

TABLE 45 TOUR RATE BY PURPOSE

TOUR PURPOSE	HTS	ABM	DIFF (ABM-HTS)
Work	0.38	0.37	-0.01
School	0.17	0.20	0.03
Escort	0.17	0.18	0.01
Personal Business	0.13	0.15	0.02
Shop	0.11	0.13	0.02
Meal	0.05	0.05	0.01
Social/Recreation	0.14	0.15	0.02
Work-based	0.03	0.03	0.00
Total	**1.18**	**1.26**	**0.09**

Table 46 compares observed and estimated tours by person type. Generally, the tours in the ABM match with the HTS distribution by person type. The differences in tours for some person type are due to differences in population in the two datasets. As seen in Table 37, compared to the HTS distribution for the NFTPO region, the ABM is low on number of retirees and high on university students and kids under 5 years of age. This difference in population distribution is reflected in total tours for these person types.

TABLE 46 TOURS BY PERSON TYPE

PERSON TYPE	HTS	ABM	DIFF (ABM-HTS)
Full-Time Worker	46%	45%	-1.0%
Part-Time Worker	5%	6%	1.0%
Retired	12%	10%	-2.0%
Non-Worker	13%	12%	-1.0%
Person type	**HTS**	**ABM**	**DIFF (ABM-HTS)**
University Student	3%	4%	1.0%
Student 16+	3%	3%	0.0%
Student 5-15	13%	13%	0.0%
Kid Under 5	5%	7%	2.0%
Total	**100%**	**100%**	**0%**

As presented in

Table 47, comparison of tour rate by person type also exhibit some differences. These differences are small, and are, in part, due to the differences in the population counts by person type.

TABLE 47 TOUR RATE BY PERSON TYPE

PERSON TYPE	HTS	ABM	DIFF (ABM-HTS)
Full-Time Worker	1.33	1.42	0.08
Part-Time Worker	1.19	1.20	0.01
Retired	1.11	1.22	0.10
Non-Worker	1.00	1.07	0.08
University Student	1.07	1.23	0.16
Student 16+	1.13	1.20	0.07
Student 5-15	1.10	1.18	0.08
Kid Under 5	0.99	1.15	0.15
Total	**1.18**	**1.26**	**0.09**

The distribution of ABM trips by destination purpose matches well with the HTS data of the NFTPO region. The trip shares in the ABM are generally within 1-3% of the HTS shares.

TABLE 48 TRIPS BY PURPOSE

DESTINATION PURPOSE	HTS	ABM	DIFF (ABM-HTS)
Work	15%	13%	-1.9%
School	6%	6%	-0.1%
Escort	10%	10%	-0.8%
Personal Business	10%	13%	3.0%
Shop	11%	11%	0.0%
Meal	5%	5%	0.0%
Social/Recreation	7%	8%	1.0%
Home	36%	35%	-1.0%
Total	**100%**	**100%**	**0.0%**

As shown in

Table 49, according to the HTS data, a resident of the NFTPO region makes 3.20 trips in a day on average. The ABM produces a slightly higher estimate of the trip rate with 3.55 trips per person. The estimated trip rates by destination purpose match well with the HTS trip rates, with slightly higher trip rate for return home purpose.

TABLE 49 TRIP RATE BY PURPOSE

DESTINATION PURPOSE	HTS	ABM	DIFF (ABM-HTS)
Work	0.46	0.45	-0.02
School	0.19	0.21	0.02
Escort	0.34	0.34	0.01
Personal Business	0.31	0.47	0.15
Shop	0.35	0.38	0.03
Meal	0.17	0.18	0.01
Social/Recreation	0.24	0.30	0.06
Home	1.14	1.23	0.09
Total	**3.20**	**3.55**	**0.35**

As indicated in

Table 50, The HTS data suggests, on average, residents of the NFTPO region make 2.72 trips on a tour. The ABM produces a similar estimate of 2.81 trips per tour for the residents. The estimated trips per tour by destination purpose show slight differences but are generally like the HTS data.

TABLE 50 TRIPS PER TOUR BY PURPOSE

DESTINATION PURPOSE	HTS	ABM	DIFF (ABM-HTS)
Work	2.69	2.92	0.23
School	2.82	2.74	-0.08
Escort	2.93	2.94	0.02
Personal Business	2.86	2.84	-0.02
Shop	2.63	2.30	-0.33
Meal	2.39	2.21	-0.18
Social/Recreation	2.54	2.51	-0.03
Total	**2.72**	**2.81**	**0.09**

The distribution of model trips by person type categories is similar to the HTS data for the NFTPO region as shown in

Table 51. As described in comparison of tours by person type, the differences for some person categories (part-time workers, retired, non-worker, student 16+ and kids under 5 year) are due to differences in population of those persons in the two datasets.

TABLE 51 TRIPS BY PERSON TYPE

PERSON TYPE	HTS	ABM	DIFF (ABM-HTS)
Full-Time Worker	46%	46%	0.9%
Part-Time Worker	5%	6%	1.6%
Retired	13%	10%	-3.1%
Non-Worker	14%	13%	-1.1%
Person type	HTS	ABM	DIFF (ABM-HTS)
University Student	3%	3%	0.2%
Student 16+	2%	3%	0.1%
Student 5-15	12%	12%	-0.5%
Kid Under 5	5%	7%	1.8%
Total	**100%**	**100%**	**0.0%**

As presented in Table 52, similar to the tour rate by person type (see

Table 47), the regional trip rate in the ABM is slightly higher (3.55 trips/person) than the HTS trip rate (3.20 trips/person) for the NFTPO region. Comparison by person type categories also show higher trip rates in the ABM.

TABLE 52 TRIP RATE BY PERSON TYPE

PERSON TYPE	CHTS (SJV)	ABM	DIFF (ABM-CHTS)
Full-Time Worker	3.58	4.13	0.55
Part-Time Worker	3.36	3.29	-0.07
Retired	3.26	3.58	0.32
Non-Worker	2.85	3.05	0.20
University Student	2.82	2.82	0.00
Student 16+	2.69	2.65	-0.04
Student 5-15	2.80	2.98	0.18
Kid Under 5	2.65	3.47	0.81
Total	**3.20**	**3.55**	**0.35**

Other Tour Destination

A comparison of average tour lengths by purpose between the observed (HTS) and the model data is presented in Table 53. A tour length is calculated as distance between tour origin and primary destination. The comparison includes only non-mandatory tour purposes - mandatory tour purposes (work and school) have been discussed before (see Table 38 and Table 40). Due to insufficient sample size for each purpose category, shopping and personal business purposes are aggregated into the maintenance category, and shopping, meal and social/recreational purposes are aggregated into the discretionary category.

For each purpose, the average model tour length is calibrated within a range of the HTS values. Due to smaller sample size in the observed dataset, the tour length frequency distributions of the escort tours are very lumpy, Figure 36. This makes it difficult to know the real travel behavior for the escort tours. As shown in Figure 34, Figure 35 and Figure 37, the observed distributions for other tour purposes are relatively smoother due to more samples for these purposes. The ABM distributions are generally smooth and follow distributions from the observed dataset.

TABLE 53 AVERAGE TOUR LENGTHS FOR OTHER TOUR PURPOSE

TOUR PURPOSE	HTS	ABM
Maintenance	6.96	6.93
Discretionary	6.80	6.71
Escort	5.97	6.33
Work-based	3.53	3.49

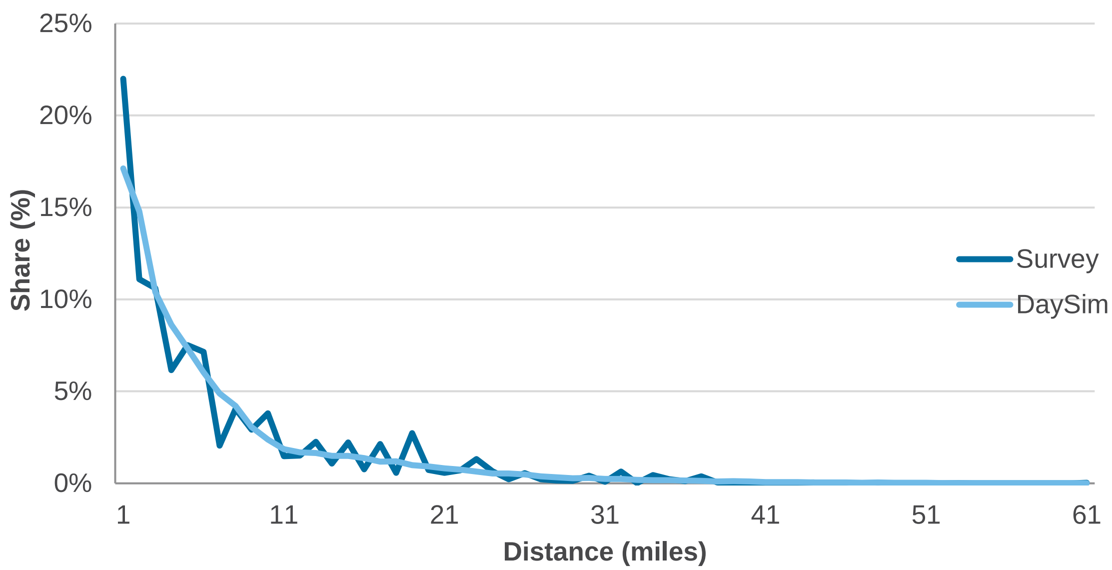


FIGURE 34 TOUR LENGTH DISTRIBUTION FOR DISCRETIONARY TRAVEL

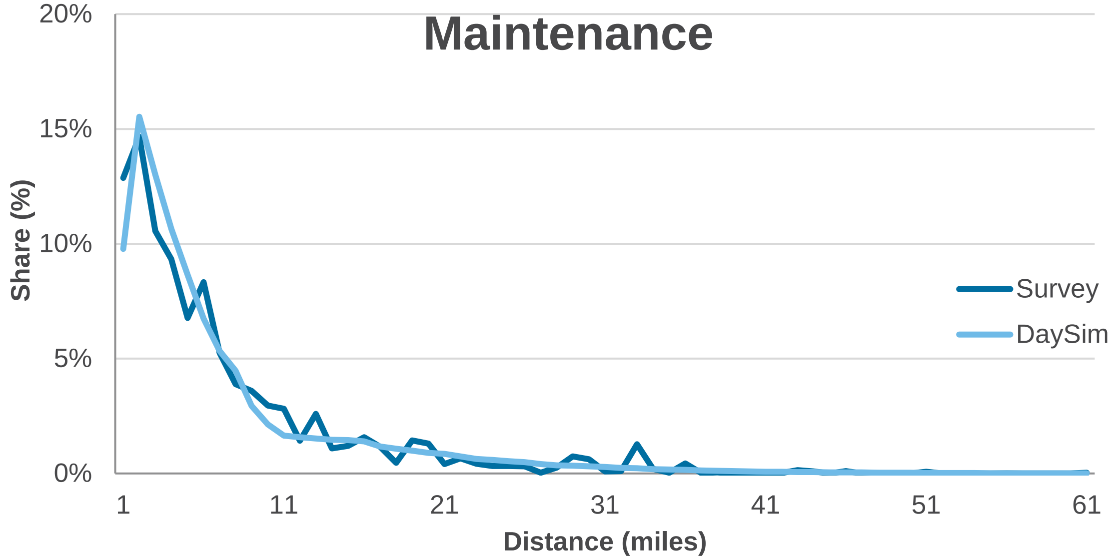


FIGURE 35 TOUR LENGTH DISTRIBUTION FOR MAINTENANCE LEVEL

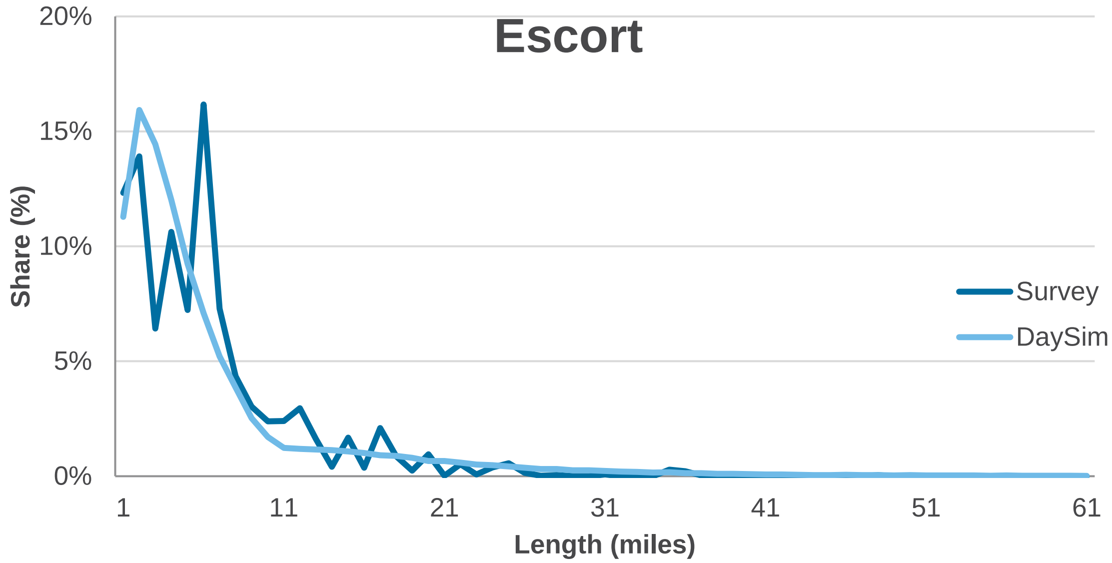


FIGURE 36 TOUR LENGTH DISTRIBUTION FOR ESCORT LEVEL

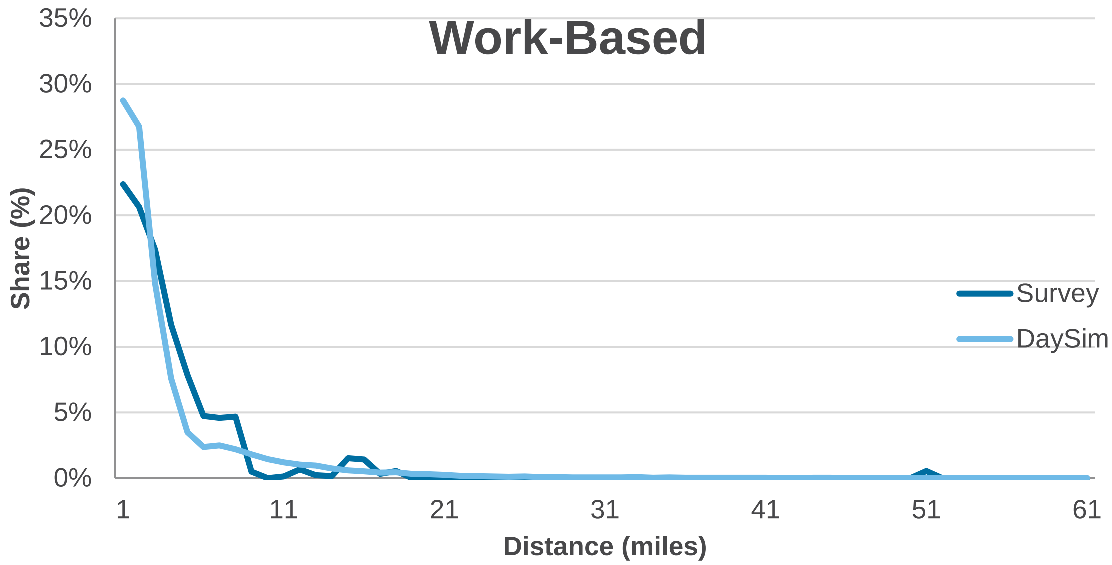


FIGURE 37 TOUR LENGTH DISTRIBUTION FOR WORK-BASED LEVEL

Tour Mode Choice

Tour mode is an abstract concept, defined as the main mode of travel used to get from the origin to the primary destination and back. The following 8 tour modes are available in the ABM: drive alone, shared-ride 2, shared-ride 3+, bike, walk, drive-transit, walk-transit, and school bus. The tour mode is coded in the survey based on a set of rules that are dependent on the combination of trip modes used on the tour. The rules can be summarized as follows:

- Any tour with a transit trip is defined as a transit tour
- Any transit tour with a PNR trip is defined as a PNR-transit tour
- Any transit tour with neither a PNR trip nor a KNR trip is defined as a walk-transit tour
- Any tour with a bicycle trip is defined as a bicycle tour
- Any tour with an auto trip is defined as an auto tour
- The highest occupancy mode of all auto trips on the tour is used to set the occupancy of the tour
- Remaining tours are walk tours

A similar set of rules is used in tour mode choice to constrain the availability of trip modes based on tour mode. These rules also influence the accessibilities used to choose the locations of intermediate stops on tours; for example, transit and walk accessibilities are used to choose stop locations on transit tours, rather than auto accessibility.

After scaling the original HTS targets to accommodate transit targets from the transit on-board survey, the HTS targets are scaled one more time for tour mode calibration. Generally, a tour mode choice calibration aims to adjust the mode choice model so that the distribution of tours by mode is similar to observed share. Therefore, tour mode choice adjustments are made to alternative-specific constants to match observed mode shares. As transit tour targets are calculated directly from a transit on-board survey, the model needs to be calibrated to the same numbers. However, when calibrated using mode shares, the number of transit tours based on the share of transit mode in the HTS will result in a different number due to a different value of total tours in the ABM. For example, if a survey says that there are 100 transit tours among 10,000 total tours, then the transit share would be 1%. However, if the model is generating 12,000 total tours then calibrating the model to the survey transit share of 1% will result in 120 transit tours. Since we want to calibrate the model to match the absolute number of transit tours inferred from the on-board survey, we adjust observed tours by mode, keeping the transit tours constant but scaling other modes to match total tours in the model by purpose and auto sufficiency.

Overall, the tour mode shares in the ABM match the HTS shares reasonably well (Figure 38). The comparison within the tour purpose categories is also similar as shown in

Table 54,

Table 55 and

Table 56. The HTS observe an overall tour mode share of 40.8% by drive-alone (SOV) and 24.6% and 19.4% by shared-ride 2 and shared-ride 3 respectively. Only 1.0% of the tours use some form of transit mode with most (0.9%) using walk to transit. The non-motorized tour modes (walk and bike) comprise 7.8% of the regional tours.

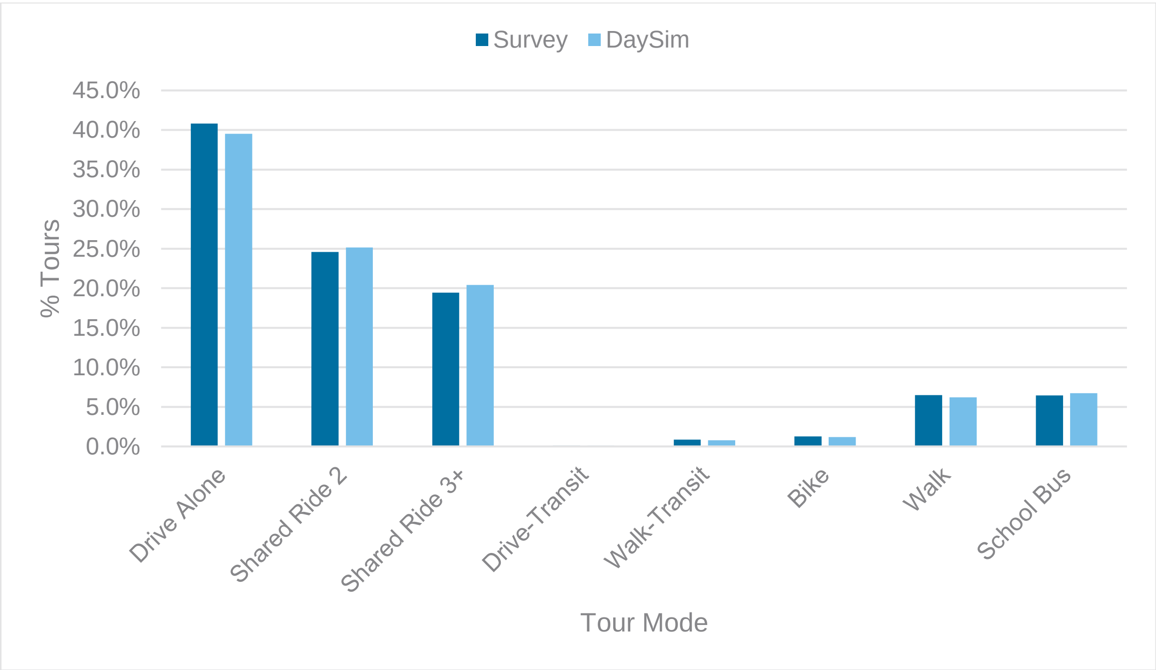


FIGURE 38 TOUR MODE SHARES (TOTAL)

TABLE 54 TOUR MODE SHARES (HTS)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	75%	11%	2%	39%	30%	**40.8%**
SR2	14%	24%	42%	29%	9%	**24.6%**
SR3+	8%	30%	52%	15%	5%	**19.4%**
Drive Transit	0%	0%	0%	0%	0%	**0.1%**
Walk Transit	1%	1%	0%	1%	0%	**0.9%**
Bike	0.6%	1.8%	0%	2.2%	1%	**1.3%**
Walk	1%	4%	3%	14%	5%	**6.5%**
School Bus	0%	28%	0%	0%	50%	**6.5%**
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

TABLE 55 TOUR MODE SHARES (ABM)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	76%	13%	2%	38%	32%	39.5%
SR2	14%	24%	40%	31%	7%	25.1%
SR3+	8%	31%	55%	16%	5%	20.4%
Drive Transit	0%	0%	0%	0%	0%	0.1%
Walk Transit	1%	1%	0%	1%	0%	0.8%
Bike	0.4%	1.2%	0%	2.1%	1%	1.2%
Walk	0%	3%	3%	13%	5%	6.2%
School Bus	0%	27%	0%	0%	50%	6.7%
Total	100%	100%	100%	100%	100%	100%

TABLE 56 TOUR MODE SHARES (HTS-ABM)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	1.1%	1.2%	-0.3%	-1.1%	1.9%	**-1.3%**
SR2	-0.1%	0.1%	-1.2%	1.1%	-1.2%	**0.5%**
SR3+	0.0%	0.1%	2.0%	1.1%	-0.4%	**1.0%**
Drive Transit	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
Walk Transit	0.0%	0.0%	-0.1%	-0.2%	0.0%	**-0.1%**
Bike	-0.2%	-0.6%	0.0%	0.0%	0.0%	**-0.1%**
Walk	-0.7%	-0.4%	-0.4%	-0.8%	-0.2%	**-0.3%**
School Bus	0.0%	-0.5%	0.0%	-0.1%	0.0%	**0.3%**
Total	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**

Trip Destination

Table 57As presented in Table 57, the HTS data suggest an average trip length of 7.77 miles region wide. For the same, the calibrated ABM produces only a slightly lower trip length value (7.68 miles). The trip lengths by trip destination purpose also match reasonably well.

TABLE 57 TRIP LENGTHS (MILES) BY DESTINATION PURPOSE

TRIP DESTINATION PURPOSE	HTS	ABM
Home	7.84	8.38
Work	11.59	10.97
School	6.91	7.85
Escort	6.70	6.20
Personal Business	7.23	6.56
Shop	5.71	5.77
Trip Destination Purpose	**HTS**	**ABM**
Meal	6.05	5.79
Social/Recreational	7.19	6.72
Total	**7.77**	**7.68**

Tour Time of Day

Plots of tour arrival and departure times at primary destination are presented in Figure 39 through Figure 46. The ABM distribution generally match well with the HTS distribution by purpose. The work-based arrival times are more peaked in the survey than in the model, which is common since the model tends to predict smooth distributions.

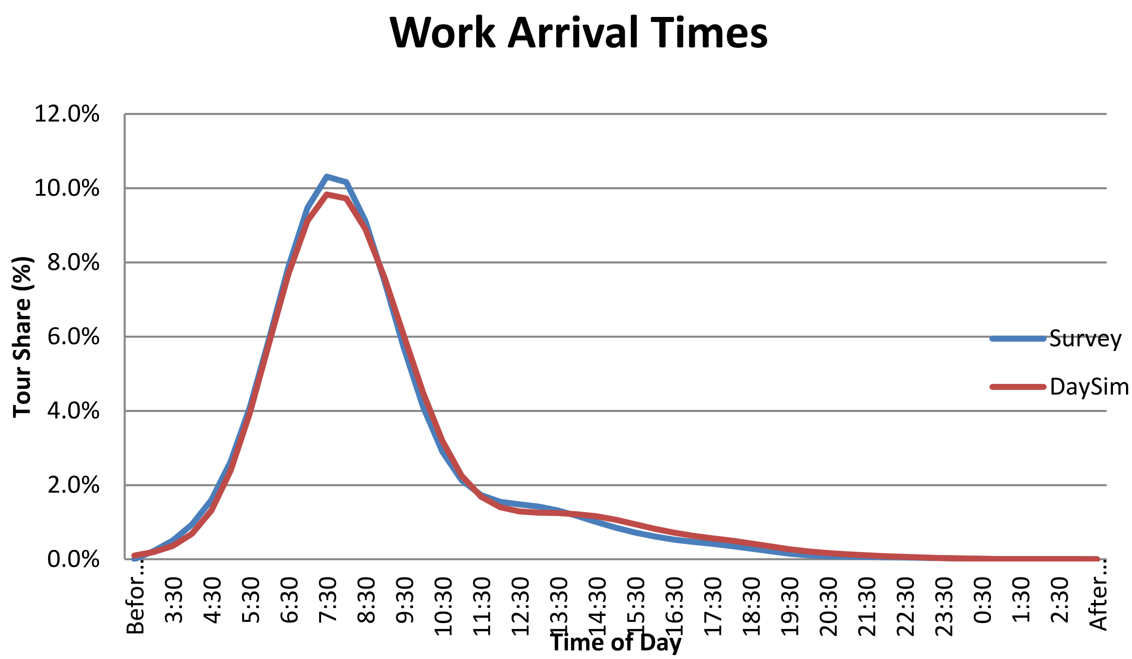


FIGURE 39 TIME OF DAY DISTRIBUTION OF WORK ARRIVAL TIMES

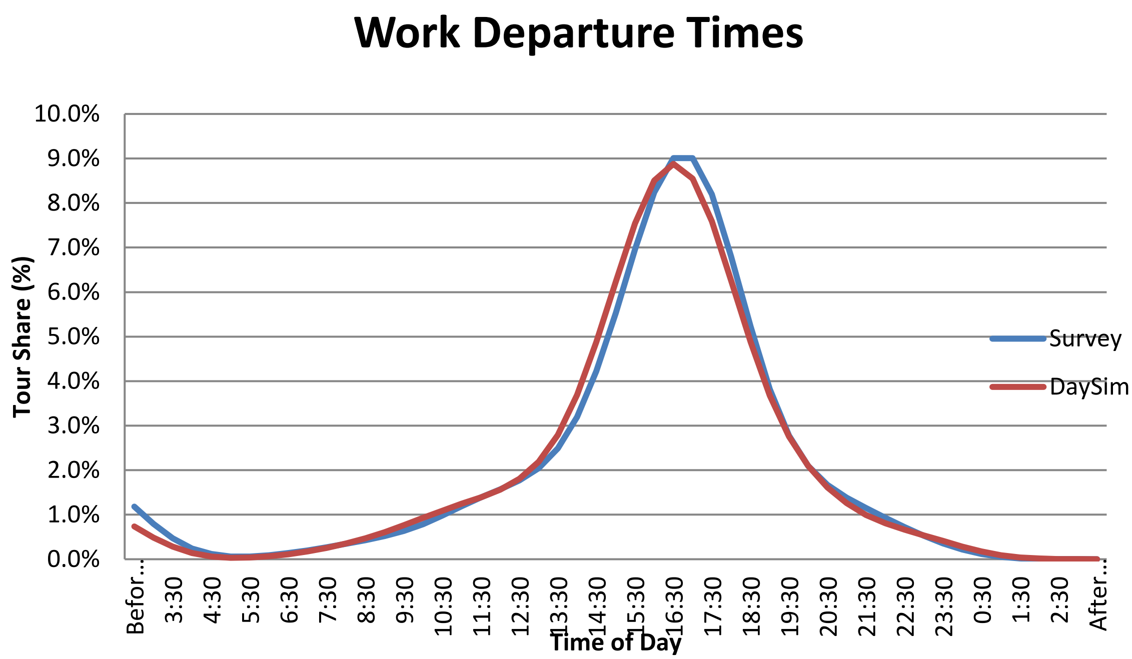


FIGURE 40 TIME OF DAY DISTRIBUTION OF WORK DEPARTURE TIMES

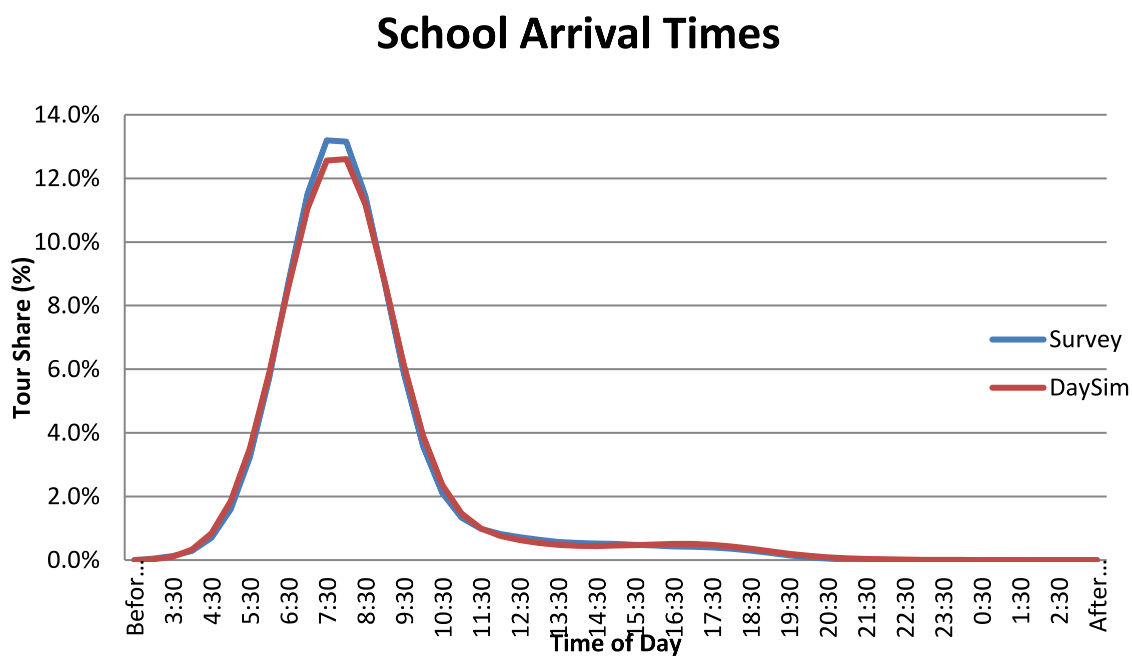


FIGURE 41 TIME OF DAY DISTRIBUTION OF SCHOOL ARRIVAL TIMES

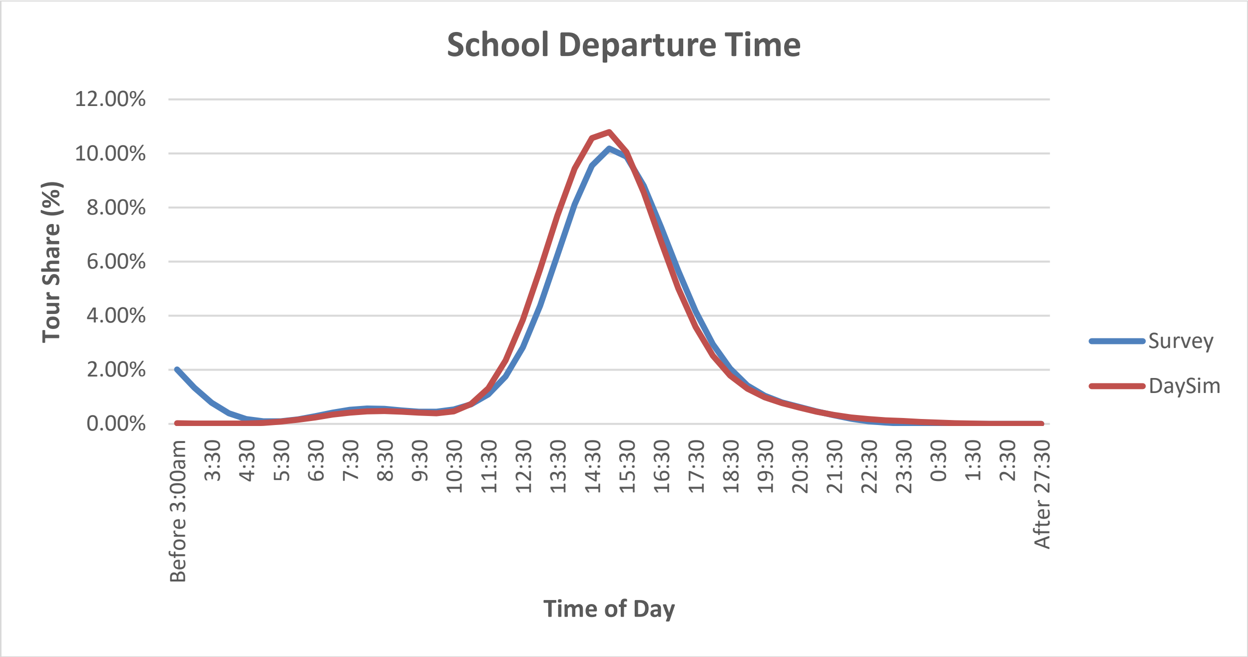


FIGURE 42 TIME OF DAY DISTRIBUTION OF SCHOOL DEPARTURE TIMES

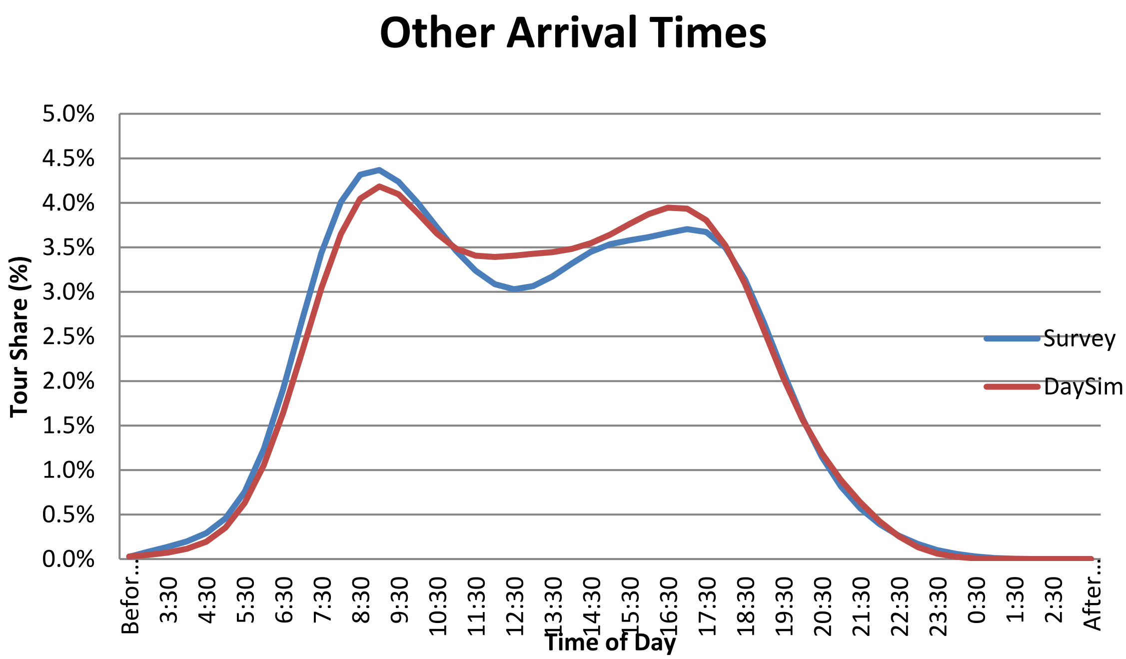


FIGURE 43 TIME OF DAY DISTRIBUTION OF OTHER PURPOSE ARRIVAL TIMES

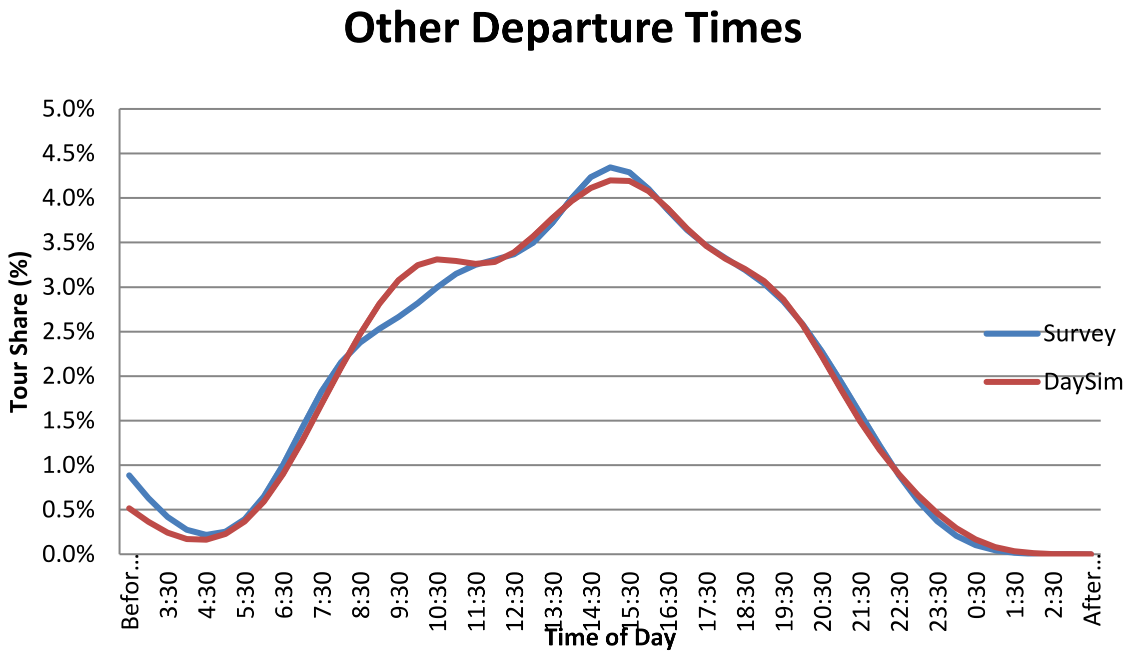


FIGURE 44 TIME OF DAY DISTRIBUTION OF OTHER PURPOSE DEPARTURE TIMES

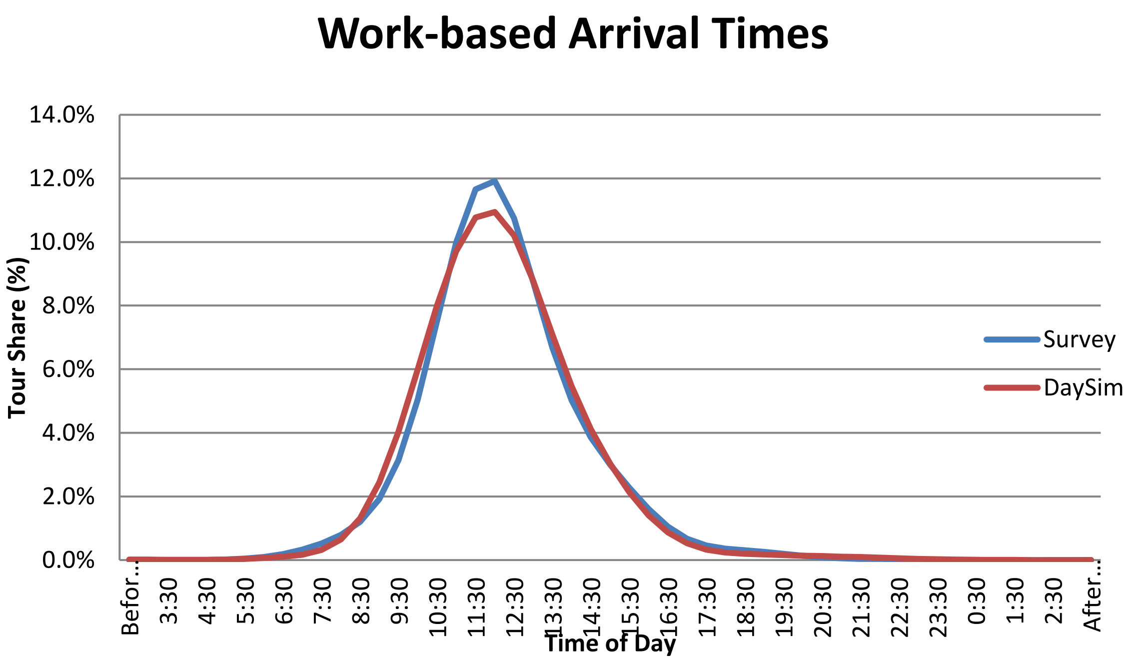


FIGURE 45 TIME OF DAY DISTRIBUTION OF WORK-BASED ARRIVAL TIMES

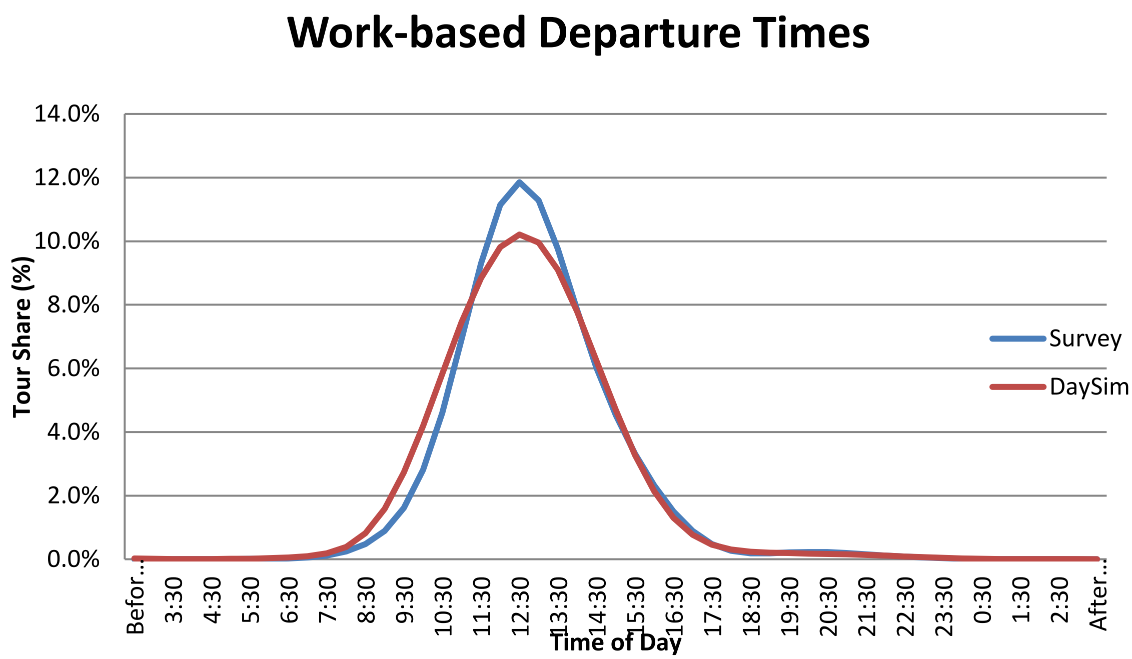


FIGURE 46 TIME OF DAY DISTRIBUTION OF WORK-BASED DEPARTURE TIMES

Trip Mode Choice

Trip mode targets are prepared from the HTS data for the NFTPO region and updated with transit trip targets from the transit on-board survey. Other mode targets are appropriately scaled to keep the total trips by purpose the same, similar to the process described above for creation of tour mode choice targets. This ensures that the absolute number of expanded transit trips from the transit onboard survey is matched in calibration.

The calibration process involves adjustment of alternative-specific constants to match observed trips by trip mode and tour mode within each tour purpose. The trip mode choice model can be thought of as a 'mode switching' model, in which the tour mode constrains which modes are available for trips on tours.

Overall, the ABM generates a trip mode distribution very similar to the observed distribution (Figure 47, Table 58, Table 59 and Table 60). The HTS data indicate that on an average weekday, 47.8% trips in the NFTPO region are drive alone and 41.8% are shared-ride (SR2 and SR3), approximately 0.6% resident trips are made by transit, and 7.2% are made by a non-motorized mode (walk or bike).

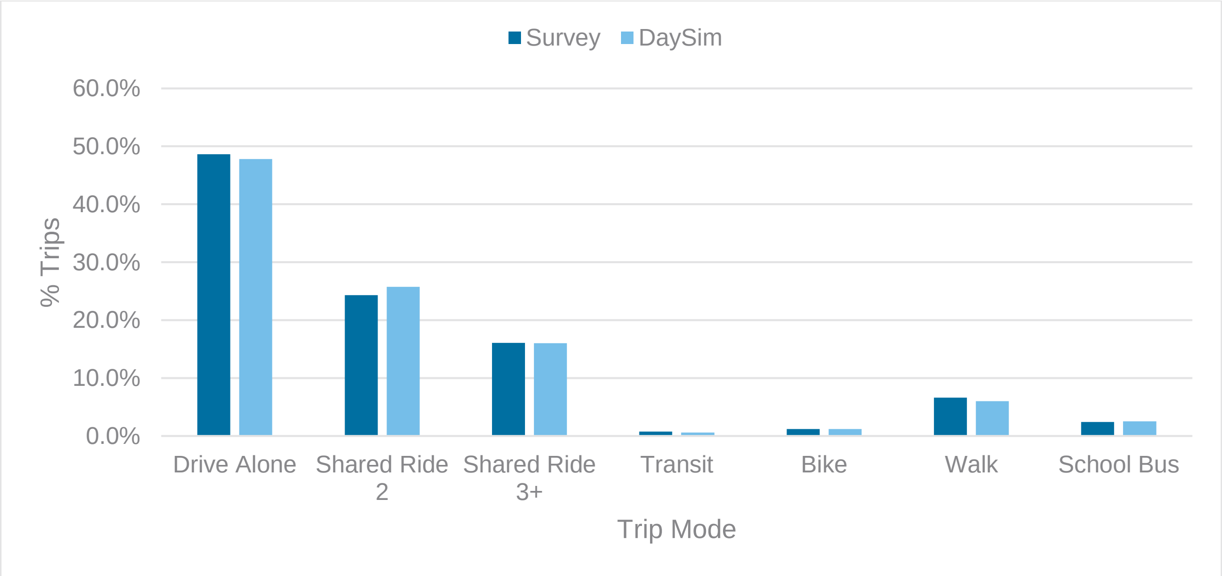


FIGURE 47 TRIP MODE SHARES (TOTAL)

TABLE 58 TRIP MODE SHARES (HTS)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	79%	13%	25%	42%	63%	**48.7%**
SR2	12%	31%	36%	29%	16%	**24.3%**
SR3+	5%	30%	36%	13%	10%	**16.1%**
Transit	1%	1%	0%	1%	0%	**0.8%**
Bike	1%	2%	0%	2%	1%	**1.2%**
Walk	2%	5%	3%	13%	10%	**6.6%**
School Bus	0%	19%	0%	0%	0%	**2.4%**
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

TABLE 59 TRIP MODE SHARES (ABM)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	81%	14%	25%	39%	66%	**47.8%**
SR2	11%	32%	37%	33%	15%	**25.8%**
SR3+	6%	29%	34%	13%	8%	**16.0%**
Transit	1%	1%	0%	1%	0%	**0.6%**
Bike	0%	1%	1%	2%	1%	**1.2%**
Walk	1%	5%	3%	12%	10%	**6.0%**
School Bus	0%	18%	0%	0%	0%	**2.5%**
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

TABLE 60 TRIP MODE SHARES (ABM-HTS)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	1.8%	1.1%	-0.1%	-2.4%	3.0%	**-0.8%**
SR2	-1.2%	1.2%	1.0%	3.8%	-1.1%	**1.5%**
SR3+	1.0%	-0.9%	-1.5%	-0.4%	-1.8%	**0.0%**
Transit	-0.1%	0.1%	-0.1%	-0.2%	0.0%	**-0.1%**
Bike	-0.1%	-0.1%	0.7%	-0.1%	0.0%	**0.0%**
Walk	-1.4%	-0.7%	0.0%	-0.5%	-0.1%	**-0.6%**
School Bus	0.0%	-0.7%	0.0%	-0.1%	0.0%	**0.1%**
Total	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**

10.2 MODEL SUMMARIES

There were additional summaries for which Cube and R scripts were created and integrated with the North Florida TPO model setup. These summaries are explained below:

VMT by VC Ratio

Table 61 shows the vehicle miles travelled (VMT) by volume to capacity (VC) ratio for the 2015 scenario run. Links with VC ratio less than 0.9 shows close to 70% of VMT.

TABLE 61 VMT BY VC RATIO (2045)

GROUP	VC RANGE	TOTAL VMT	PERCENT TOTAL
1	LT 0.9	32,420,897	69%
2	0.9 - 1.1	8,315,188	18%
3	1.1 - 1.3	4,184,136	9%
4	GT 1.3	1,942,692	4%
Total		46,862,913	100%

Trips by Mode and Income

Table 62 to Table 66 show the number of trips cross-tabulated by mode and income across all tour purpose categories as well as the totals for the 2015 scenario.

TABLE 62 TRIPS BY MODE AND INCOME (WORK)

MODE	INCOME CATEGORY (TOUR PURPOSE=WORK)				TOTAL
	0 - $30,000	$30,001 - $60,000	$60,001 - $100,000	Greater than $100k	
SOV	118,337	301,000	396,592	456,938	1,272,867
HOV2	14,623	34,896	50,957	56,161	156,637
HOV3	7,895	18,630	30,103	33,369	89,997
Walk	2,386	3,681	3,693	4,213	13,973
Bike	1,448	1,887	1,626	1,546	6,507
Transit	3,460	5,657	4,608	4,345	18,070
School Bus	-	-	-	-	-
Total	148,149	365,751	487,579	556,572	1,558,051

TABLE 63 TRIPS BY MODE AND INCOME (SCHOOL)

MODE	INCOME CATEGORY (TOUR PURPOSE=SCHOOL)				TOTAL
	0 - $30,000	$30,001 - $60,000	$60,001 - $100,000	Greater than $100k	
SOV	12,713	18,366	18,817	24,328	74,224
HOV2	40,626	49,641	52,709	54,866	197,842
HOV3	38,947	46,829	51,748	53,862	191,386
Walk	10,962	9,304	7,468	7,367	35,101
Bike	3,035	2,332	1,852	1,886	9,105
Transit	1,773	1,837	1,160	829	5,599
School Bus	37,742	29,624	24,293	24,854	116,513
Total	145,798	157,933	158,047	167,992	629,770

TABLE 64 TRIPS BY MODE AND INCOME (SHOP)

MODE	INCOME CATEGORY (TOUR PURPOSE=SHOP)				TOTAL
	0 - $30,000	$30,001 - $60,000	$60,001 - $100,000	Greater than $100k	
SOV	146,131	155,666	125,883	128,435	556,115
HOV2	86,406	105,298	85,034	78,173	354,911
HOV3	30,553	39,126	36,784	34,606	141,069
Walk	26,782	16,724	10,750	9,724	63,980
Bike	14,671	6,975	4,686	4,104	30,436
Transit	6,646	1,305	454	271	8,676
School Bus	-	-	-	-	-
Total	311,189	325,094	263,591	255,313	1,155,187

TABLE 65 TRIPS BY MODE AND INCOME (OTHER)

MODE	INCOME CATEGORY (TOUR PURPOSE=OTHER)				TOTAL
	0 - $30,000	$30,001 - $60,000	$60,001 - $100,000	Greater than $100k	
SOV	98,988	124,240	127,474	126,842	477,544
HOV2	113,215	137,754	136,434	128,404	515,807
HOV3	81,278	99,275	107,504	92,658	380,715
Walk	64,719	56,122	49,103	46,862	216,806
Bike	6,612	3,728	3,216	2,848	16,404
Transit	1,892	391	167	132	2,582
School Bus	-	-	-	-	-
Total	366,704	421,510	423,898	397,746	1,609,858

TABLE 66 TRIPS BY MODE AND INCOME (TOTAL)

MODE	INCOME CATEGORY (TOUR PURPOSE=TOTAL)				TOTAL
	0 - $30,000	$30,001 - $60,000	$60,001 - $100,000	Greater than $100k	
SOV	376,169	599,272	668,766	736,543	2,380,750
HOV2	254,870	327,589	325,134	317,604	1,225,197
HOV3	158,673	203,860	226,139	214,495	803,167
Walk	104,849	85,831	71,014	68,166	329,860
Bike	25,766	14,922	11,380	10,384	62,452
Transit	13,771	9,190	6,389	5,577	34,927
School Bus	37,742	29,624	24,293	24,854	116,513
Total	971,840	1,270,288	1,333,115	1,377,623	4,952,866

County-County Flows

Table 67 to Table 71 illustrates the county to county trip flows across all tour purpose categories as well as the total for the 2015 scenario.

TABLE 67 COUNTY TO COUNTY FLOWS (WORK)

COUNTY	BAKER	CLAY	DUVAL	NASSAU	PUTNAM	STJOHNS	TOTAL
Baker	9,970	609	4,341	218	6	97	15,241
Clay	583	96,482	57,232	595	2,246	5,793	162,931
Duval	4,368	57,362	971,410	16,058	1,071	46,739	1,097,008
Nassau	213	614	16,052	39,238	9	277	56,403
Putnam	8	2,242	1,080	9	30,976	3,057	37,372
StJohns	99	5,622	46,893	285	3,064	133,133	189,096
Total	15,241	162,931	1,097,008	56,403	37,372	189,096	1,558,051

TABLE 68 COUNTY TO COUNTY FLOWS (SCHOOL)

COUNTY	BAKER	CLAY	DUVAL	NASSAU	PUTNAM	STJOHNS	TOTAL
Baker	9,653	126	589	61	1	5	10,435
Clay	119	70,829	15,596	71	710	1,595	88,920
Duval	593	15,595	368,716	3,455	40	14,024	402,423
Nassau	65	68	3,453	21,999	-	19	25,604
Putnam	-	711	43	-	25,118	320	26,192
StJohns	5	1,591	14,026	18	323	60,233	76,196
Total	10,435	88,920	402,423	25,604	26,192	76,196	629,770

TABLE 69 COUNTY TO COUNTY FLOWS (SHOP)

COUNTY	BAKER	CLAY	DUVAL	NASSAU	PUTNAM	STJOHNS	TOTAL
Baker	16,171	231	1,266	100	1	8	17,777
Clay	226	130,419	19,427	251	1,677	1,172	153,172
Duval	1,279	19,449	662,513	6,246	200	18,006	707,693
Nassau	94	259	6,238	56,250	3	38	62,882
Putnam	1	1,686	194	3	65,419	554	67,857
StJohns	6	1,128	18,055	32	557	126,028	145,806
Total	17,777	153,172	707,693	62,882	67,857	145,806	1,155,187

TABLE 70 COUNTY TO COUNTY FLOWS (OTHER)

COUNTY	BAKER	CLAY	DUVAL	NASSAU	PUTNAM	STJOHNS	TOTAL
Baker	20,591	306	1,698	140	6	38	22,779
Clay	293	183,525	29,550	372	2,053	1,846	217,639
Duval	1,696	29,505	963,673	7,571	493	24,924	1,027,862
Nassau	154	383	7,535	64,728	5	96	72,901
Putnam	5	2,045	511	3	77,653	804	81,021
StJohns	40	1,875	24,895	87	811	159,948	187,656
Total	22,779	217,639	1,027,862	72,901	81,021	187,656	1,609,858

TABLE 71 COUNTY TO COUNTY FLOWS (TOTAL)

COUNTY	BAKER	CLAY	DUVAL	NASSAU	PUTNAM	STJOHNS	TOTAL
Baker	56,385	1,272	7,894	519	14	148	66,232
Clay	1,221	481,255	121,805	1,289	6,686	10,406	622,662
Duval	7,936	121,911	2,966,312	33,330	1,804	103,693	3,234,986
Nassau	526	1,324	33,278	182,215	17	430	217,790
Putnam	14	6,684	1,828	15	199,166	4,735	212,442
StJohns	150	10,216	103,869	422	4,755	479,342	598,754
Total	66,232	622,662	3,234,986	217,790	212,442	598,754	4,952,866

10.3 MODEL VALIDATION

A model validation tests the model's predictive capabilities before it is used to produce forecasts. There are two types of model validation; static validation, which compares model outputs against independent data that was not used to build the travel model, and dynamic validation, in which model inputs are systematically varied to assess the reasonableness of model responses. The static validation process compares outputs from model assignment with observed data. Model parameters are adjusted until the model outputs fall within an acceptable range of error.

In the assignment step, model demand (e.g. trips by time period, mode, and vehicle class\value-of-time) are loaded on to network. The output from this step includes vehicle flows on every link (road) in the highway network and for transit assignment, the output includes the number of boardings on each route. These are compared to observed traffic counts and observed transit ridership respectively. The two observed datasets (traffic counts and transit boardings) used in the present model validation are described in the next section, followed by highway and transit validation summaries.

Validation Data

Table 72 presents a list of datasets utilized in the validation of the NERPM-AB.

TABLE 72 MODEL VALIDATION DATASETS

DATASET	YEAR	SOURCE	PURPOSE
Traffic Counts	2015	North Florida TPO	Highway Validation
Transit On-Board Survey	2016	Transit On-Board Survey	Transit Validation

Highway Traffic Counts

Observed traffic counts are used to validate link-level estimated daily traffic flow generated by a model. The observed traffic counts are assembled from North Florida TPO. The data provides traffic counts on highways (interstates and state routes) in the State of Florida.

Transit Boardings

The transit boardings are assembled from transit 2016 on-board survey. This data provides daily ridership in year 2016 for their transit routes.

Highway Validation

The estimated traffic flows from the model and the observed traffic counts are compared in various dimensions, including:

- Region
- Facility Type
- Volume Group

Region

As described before, the observed traffic count database used in this model validation effort encompass 2,568 links on the highway network. The total traffic across these links sum up to 24.96 million vehicles. On the same links, the ABM produce a comparable estimate of traffic volume (25.01 million vehicles) and is only 0.2% higher than the total observed vehicle count.

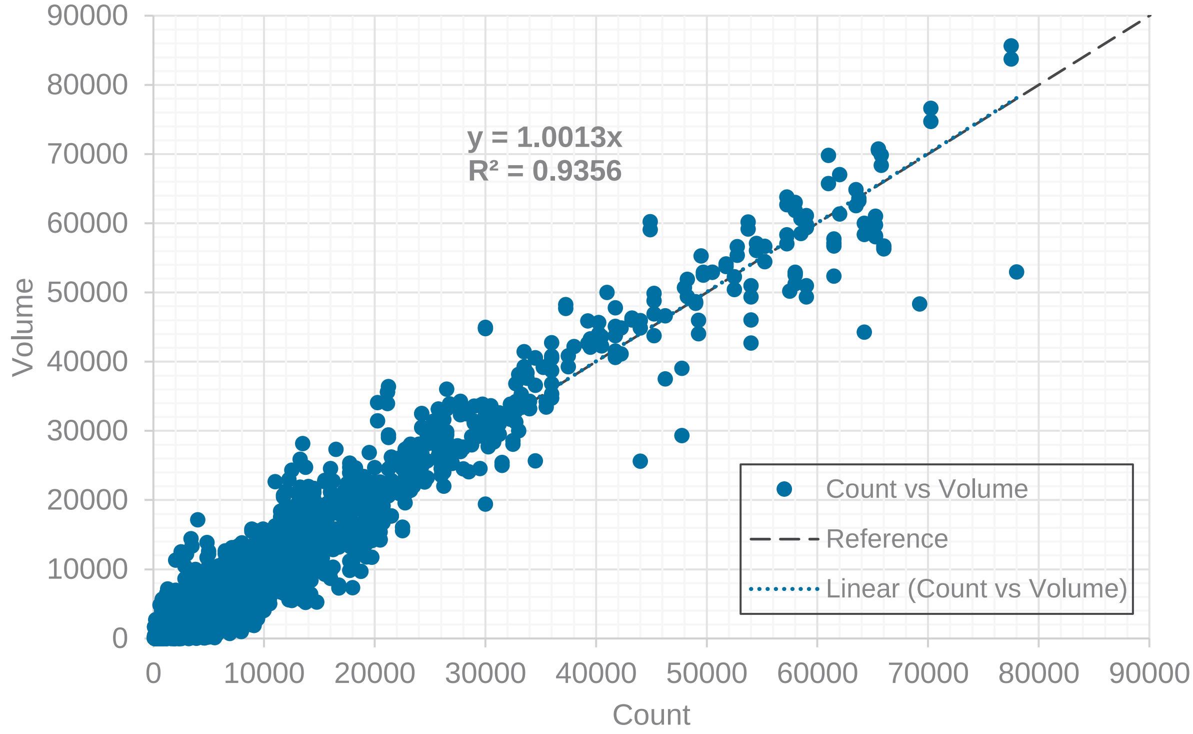


FIGURE 48 DAILY TRAFFIC COUNTS VS MODEL FLOWS

Regionally, the estimated traffic flows are compared with the observed traffic counts by creating a scatter plot, Figure 48. Points in the scatter plot are links where traffic counts are available. A point represents observed traffic count on the X-axis and the corresponding estimated flow on the Y-axis. The scatter plot includes several measures/guidelines assessing accuracy of the model flows with respect to the observed traffic counts. The plot includes a 45-degree line representing a virtual scenario of perfect match between traffic counts and estimated flows. The 45-degree line is useful in quickly identifying overestimation (flow>count) or underestimation (flow<count) of a flow. A highway validation aims to make most points as close to this line as possible. An ideal validation would have all count locations on the 45-degree line. However, perfect match for all count locations is almost impossible to achieve for various reasons such as error in traffic counts, simulation errors in the model etc. A linear regressed line of all points is also added to the plot. Slope of the regressed line measures regional match between the estimated flows and the traffic counts - a slope of less than 1 means underestimation region wide and more than 1 indicates overestimation. The plot also displays a R-squared value representing goodness of fit of all data points. As displayed in the scatter plot, the linear regressed line has a slope of 1.001 and R-squared value of 0.94. The slope indicates a that estimated flows are slightly overestimated compared to the traffic counts. The r-squared value close to 1.0 indicates that the fitted regression line represents the data well

Volume Group

The estimated and observed volumes are compared to the level of volume on the links. Table 73 and Table 74, compares the estimated traffic flows and the traffic counts in six volume groups that are formed based on the range of the observed traffic counts. Overall, links with lower volumes show larger differences and RMSE values. This is not surprising given that these links are more likely to be collectors or arterials and as we discussed previously, respective traffic counts are less reliable. Links with traffic volume higher than 25,000 outperform other volume groups. The lower volume (<25,000) links are underperforming.

TABLE 73 COMPARISON BY VOLUME GROUP

VOLUME GROUP		COUNT	MODEL	DIFF	DIFF (%)
>=0	<1000	97,775	153,283	55,508	57%
>=1000	<2500	660,534	651,194	(9,340)	-1%
>=2500	<5000	2,018,218	1,881,897	(136,321)	-7%
>=5000	<10000	4,435,844	3,677,684	(758,160)	-17%
>=10000	<25000	8,466,368	8,270,372	(195,996)	-2%
>=25000		9,278,218	10,375,403	1,097,185	12%
ALL		**24,956,957**	**25,009,833**	**52,876**	**0%**

TABLE 74 ROOT MEAN SQUARE ERROR (RMSE) BY VOLUME GROUP

VOLUME GROUP		SUM OF ERROR^2	# COUNTS	SUM OF COUNTS	RMSE
>=0	<1000	219,840,924	172	97,775	199%
>=1000	<2500	1,411,212,779	376	660,534	110%
>=2500	<5000	3,118,676,043	560	2,018,218	66%
>=5000	<10000	5,253,690,450	625	4,435,844	41%
>=10000	<25000	13,237,344,704	547	8,466,368	32%
>=25000		11,044,192,254	228	9,278,218	17%
ALL		**34,284,957,154**	**2,508**	**24,956,957**	**37%**

Facility Type

Table 75 presents a summary of links by facility type. The facilities in the NFTPO region are grouped into five categories: freeway/highway, arterial, collector, one-way and ramps. The table also contains the FHWA's guidelines of recommended threshold of difference for each facility type. Overall, the estimated traffic volume from the model matches closely (0%) with the total counts on the compared links. The comparison within the facility type is exhibit good match as well. The Collector and one-ways, show underestimation.

TABLE 75 PERCENT DIFFERENCE BY FACILITY TYPE

FACTYP	DESCRIPTION	COUNT	MODEL	DIFF	DIFF (%)
1	Arterial	11,214,566	10,889,194	(325,372)	-3%
2	Collector	1,743,475	1,494,340	(249,135)	-14%
3	Freeway	8,680,416	9,151,789	471,373	5%
4	One-way	339,150	322,165	(16,985)	-5%
5	Ramps	2,979,350	3,152,345	172,995	6%
	ALL	**24,956,957**	**25,009,833**	**52,876**	**0%**

Transit Validation

Transit ridership produced by the model is compared to observed ridership. The ridership (boarding) is compared regionally as well by transit line.

Region

Regionally, Table 76, the ABM generates only 5% more transit boardings then the observed data and the corresponding transit trips in the ABM are also well matched with the observed transit trips (5%).The model indicates a boarding rate of 1.64 which is close to the value (1.60) calculated from the observed data.

TABLE 76 TOTAL BOARDINGS

MEASURE	OBSERVED	ABM	DIFF	% DIFF
boardings	42,058	44,302	2,244	5%
trips	25,707	26,958	1,251	5%
boarding rate	1.60	1.64	(0.04)	0%

Transit Line

A comparison of ridership by transit line examines the model's ability of producing transit ridership by transit line. A scatter plot in Figure 49 shows the relationship between the transit boardings from the ABM and the observed boarding by transit line. The X-axis in the plot represent the observed boardings and the estimated boardings from the model are presented on the Y-axis.

The regression line fitting all data points shows a R-squared value of 0.72 indicating that it is a reasonable fit. This suggests that the model is predicting the transit behavior reasonably well.

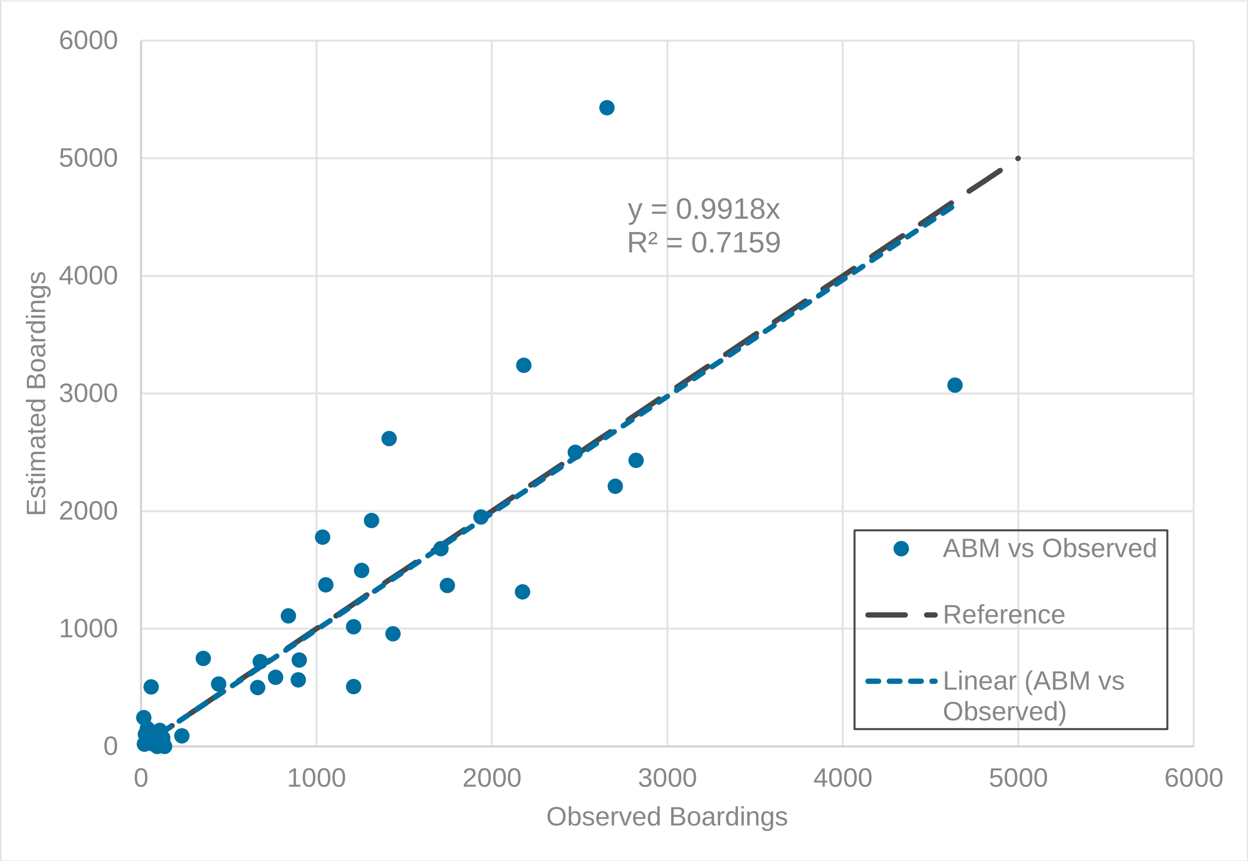


FIGURE 49 OBERSVED AND ESTIMATED TRANSIT BOARDINGS

A comparison of number of boardings by individual transit lines is presented in Figure 50. The X-axis is transit line id and the Y-axis is number of boardings. The transit lines are sorted from high observed boarding to low observed boarding. In general, the plot shows a reasonable match across all transit lines.

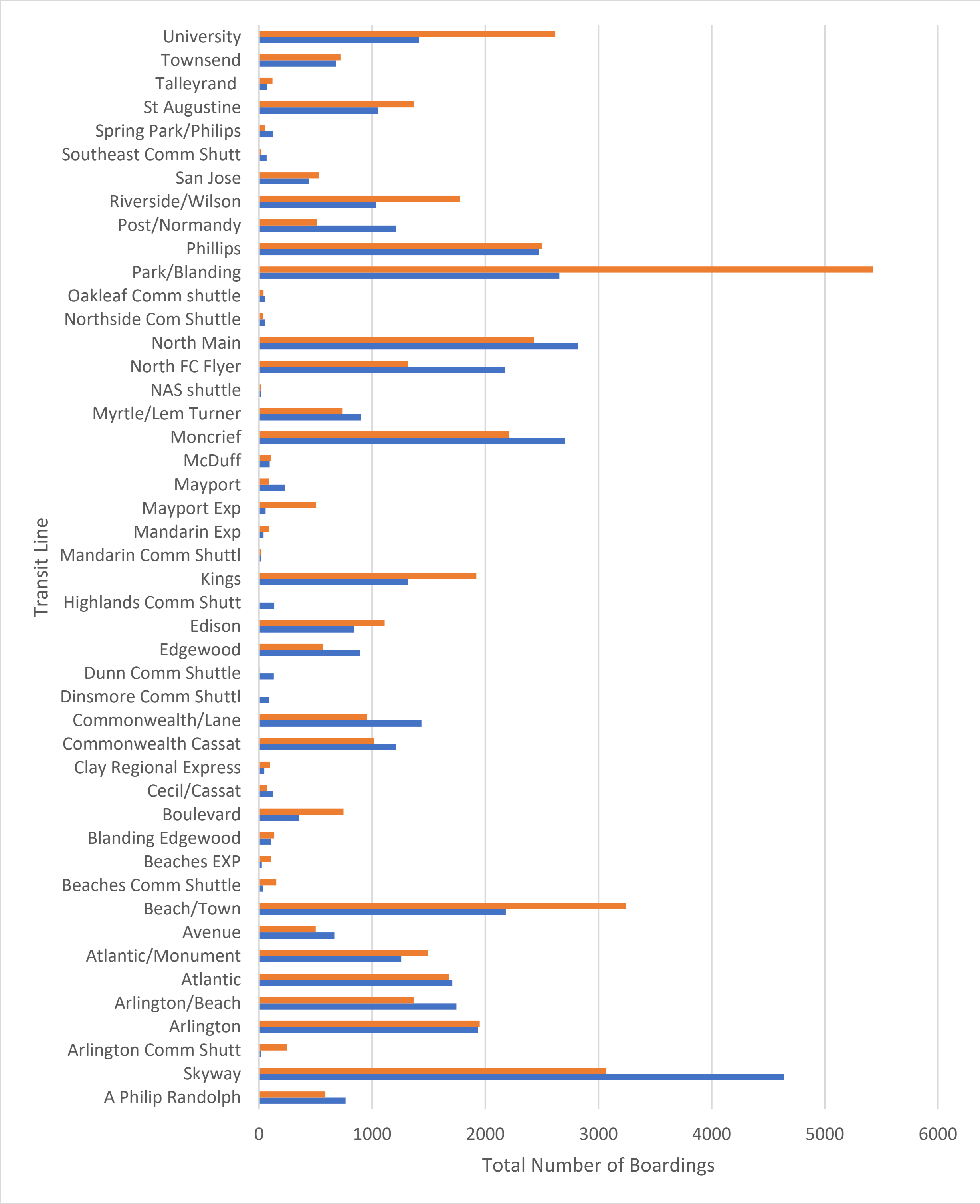


FIGURE 50 BOARDINGS BY TRANSIT LINE

APPENDIX A. SYNTHETIC POPULATION

This appendix describes the setup and process to generate synthetic population for the NERPM-AB model. The synthetic population is generated using PopulationSim which is an open platform for population synthesis, and it is automated using several R scripts and Windows Command Prompt batch files.

Development of PopulationSim was funded by Oregon Department of Transportation. PopulationSim is used to generate population for the year of 2015 to represent the population in the NFTPO modeling region. The objective of this task is to create a PopulationSim setup to work for NERPM:AB. All the data processing scripts are written in R and automated using batch files including processes to build geographic crosswalks, download Census data across various geographies, build controls, process the Public Use Microdata Sample (PUMS), running the PopulationSim software and generate validation summaries and plots. The following sections of this memo describe instructions on setting up a PopulationSim run, details of R scripts, batch files and validation results.

SOFTWARE REQUIREMENTS

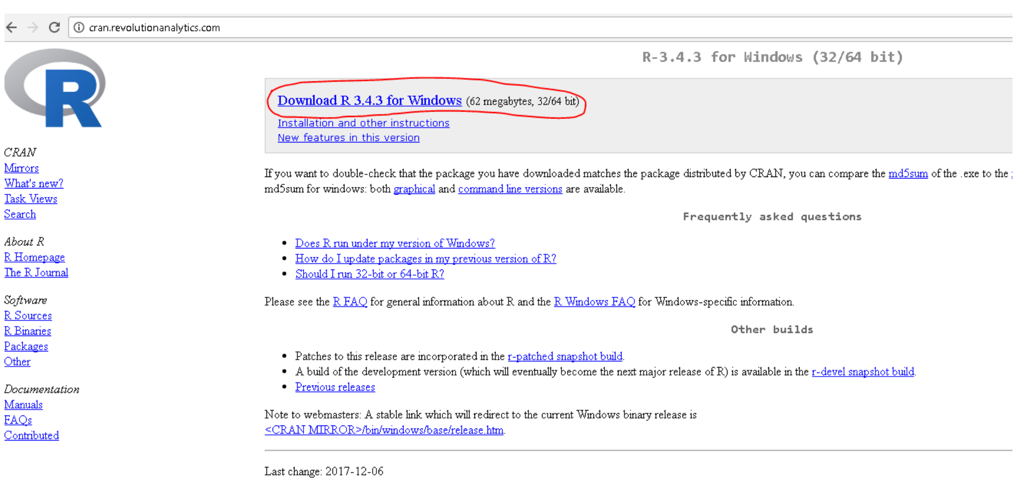
The instructions below are for a machine with Windows operating systems (Windows 7). To setup PopulationSim, following software are required:

- R
- Anaconda2 with Python 2.7

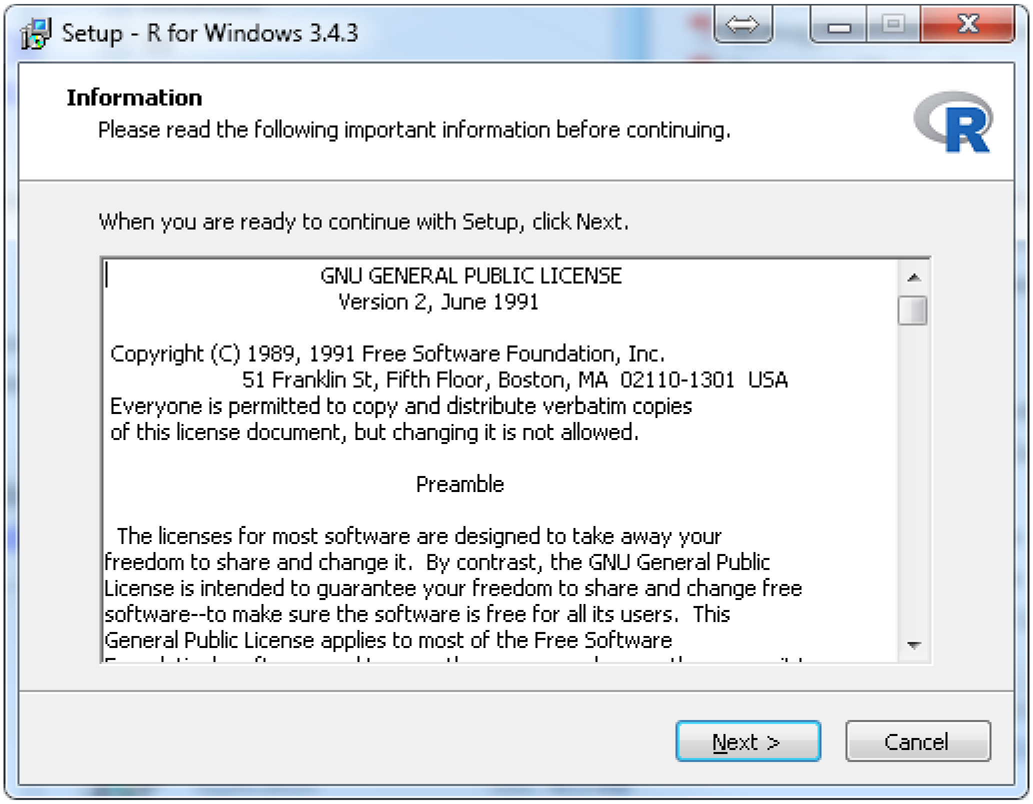
The subsequent sub-sections provide installation steps for the above software.

R

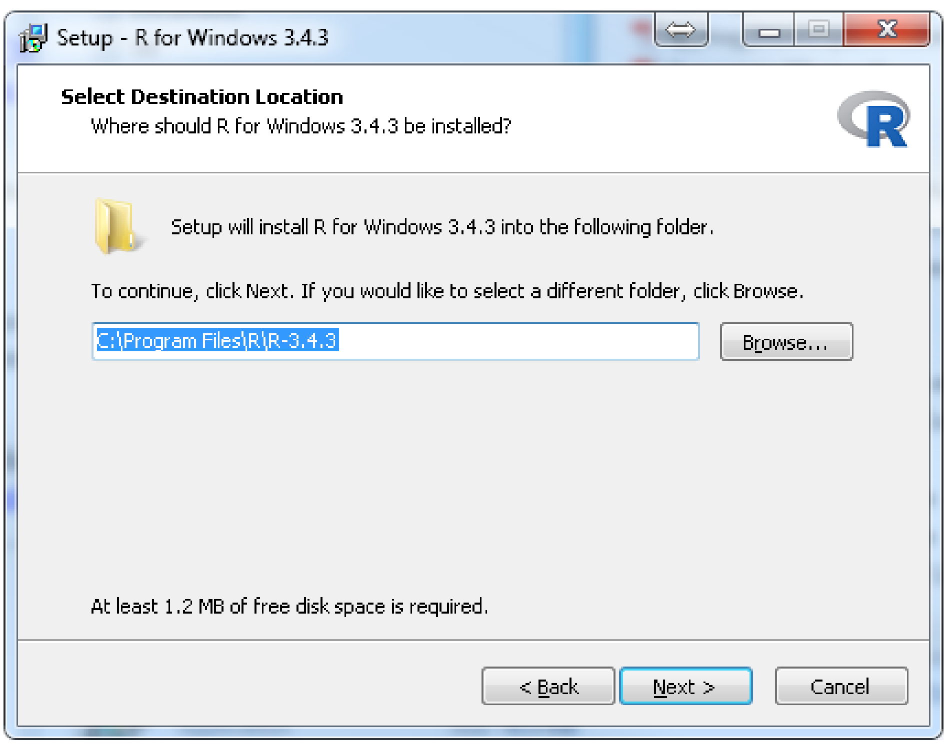
Go to the following page to download latest R (R 3.2.0 or later):
http://cran.revolutionanalytics.com/



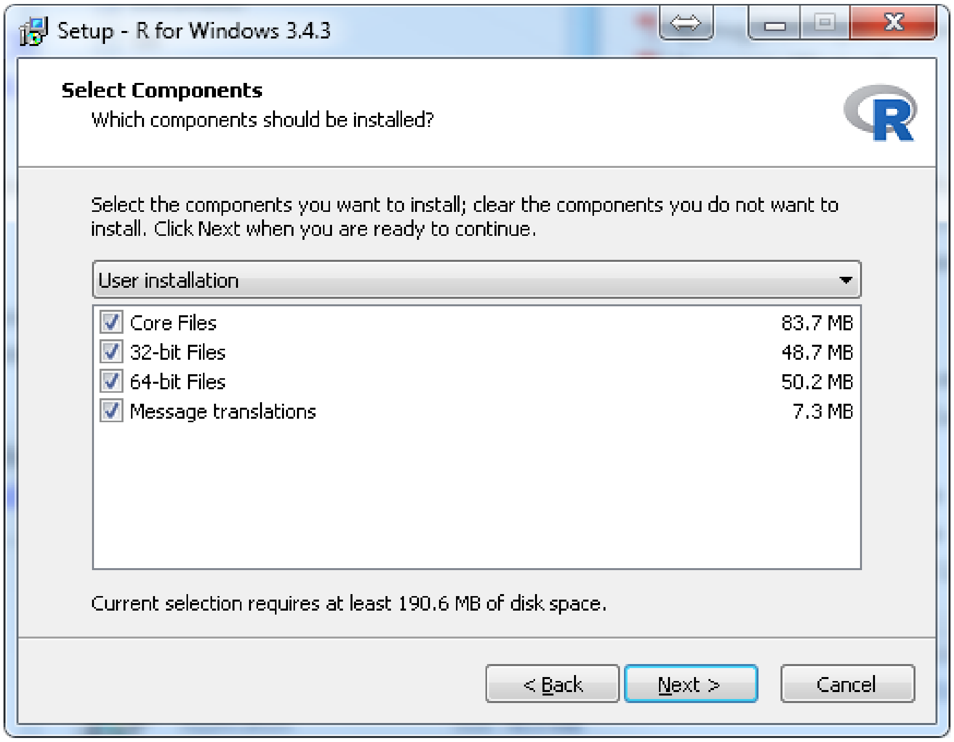
Click on “Download R.3.4.3 for Windows” and download the windows executable (R-3.4.3-win.exe) to a desired location on your machine. After the download is complete, go to the download folder and double click on the EXE file (R-3.4.3-win.exe).



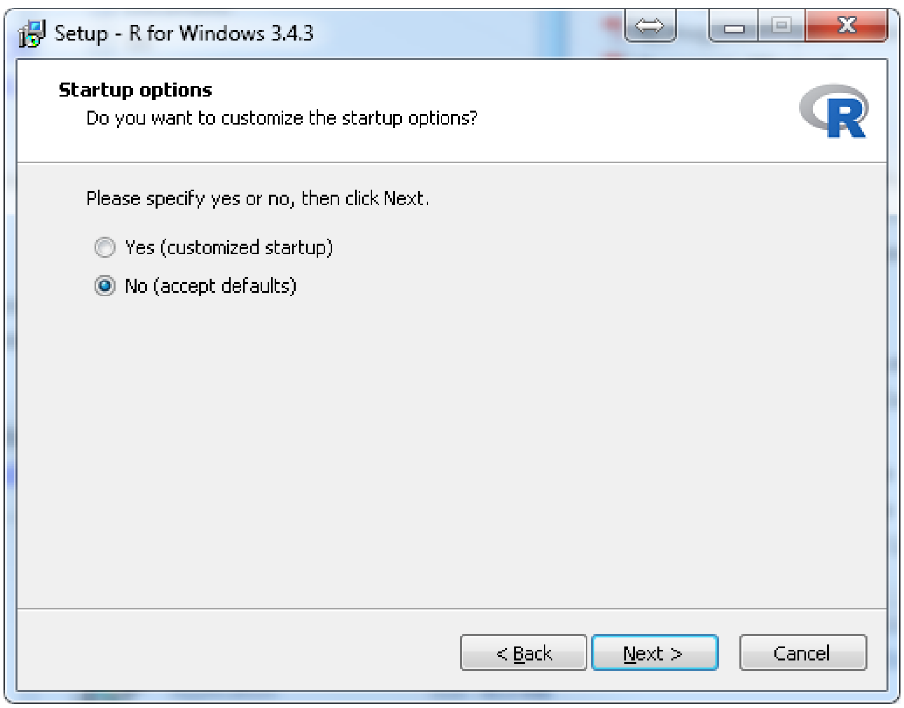
Click “Next”.



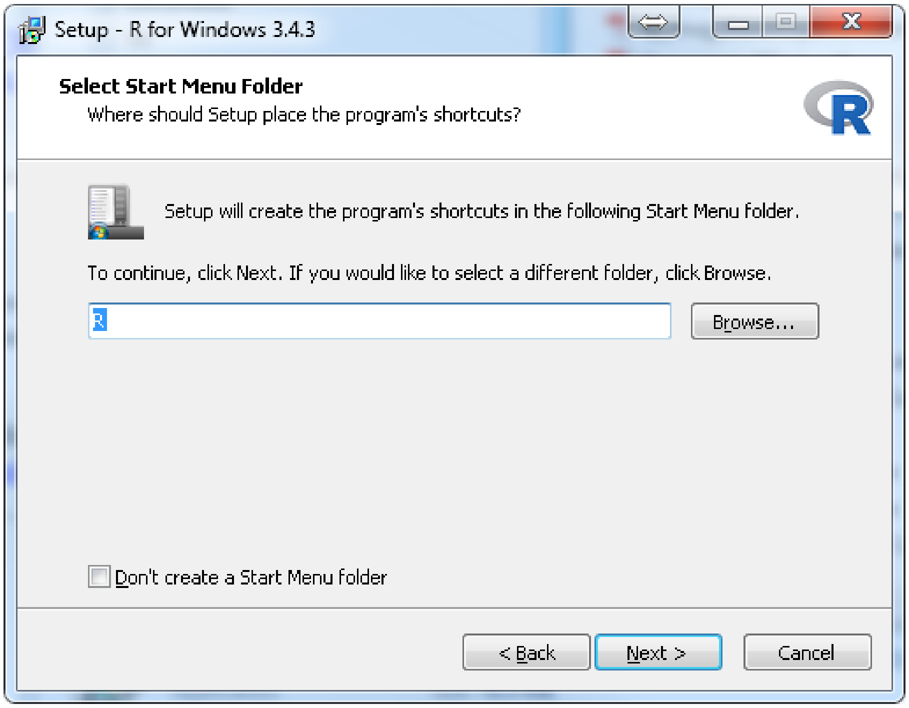
Choose a different folder if you want to install in a different location, otherwise keep the default and click “Next”.



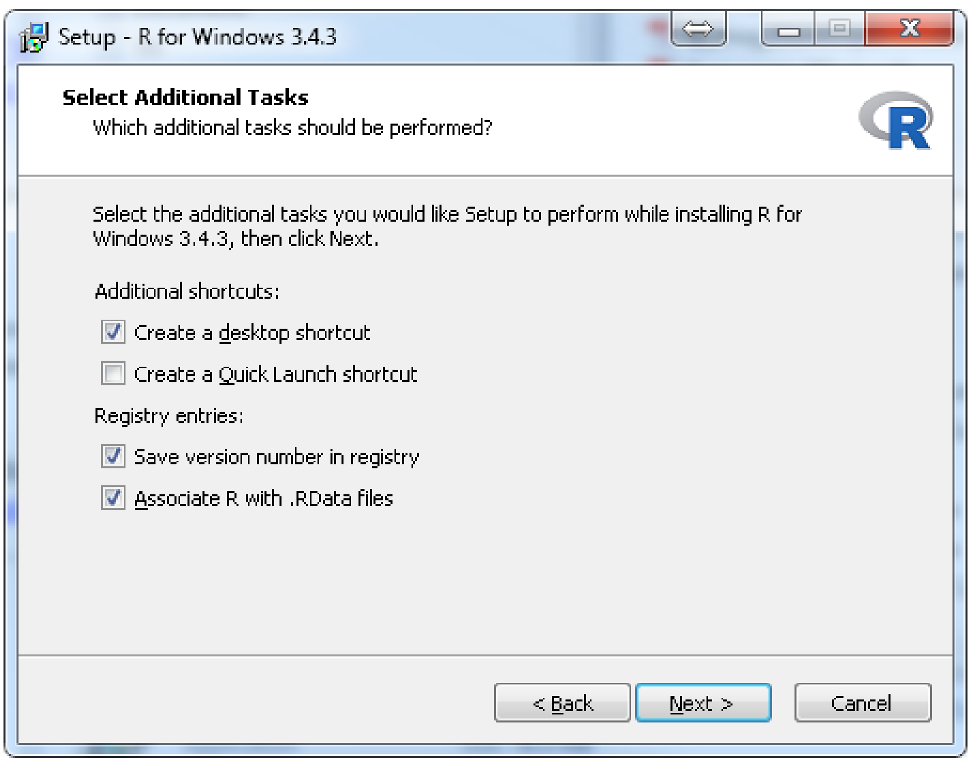
Keep the default options (as shown above) and click “Next”.



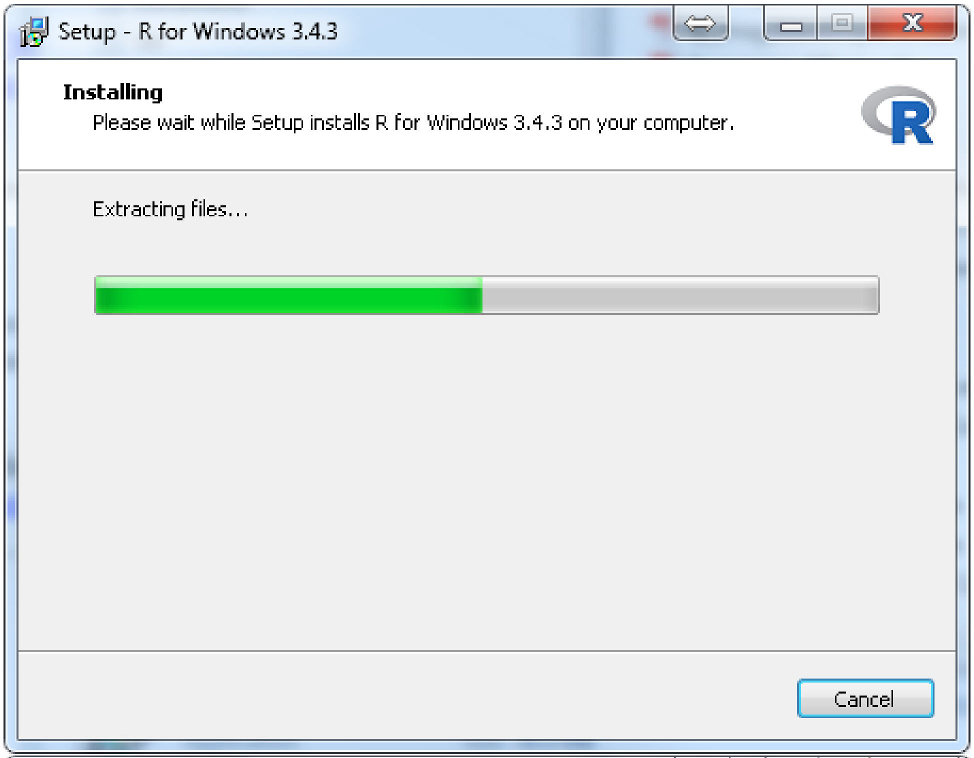
Accept defaults as startup options (check “No (accept defaults)”) and click “Next”.

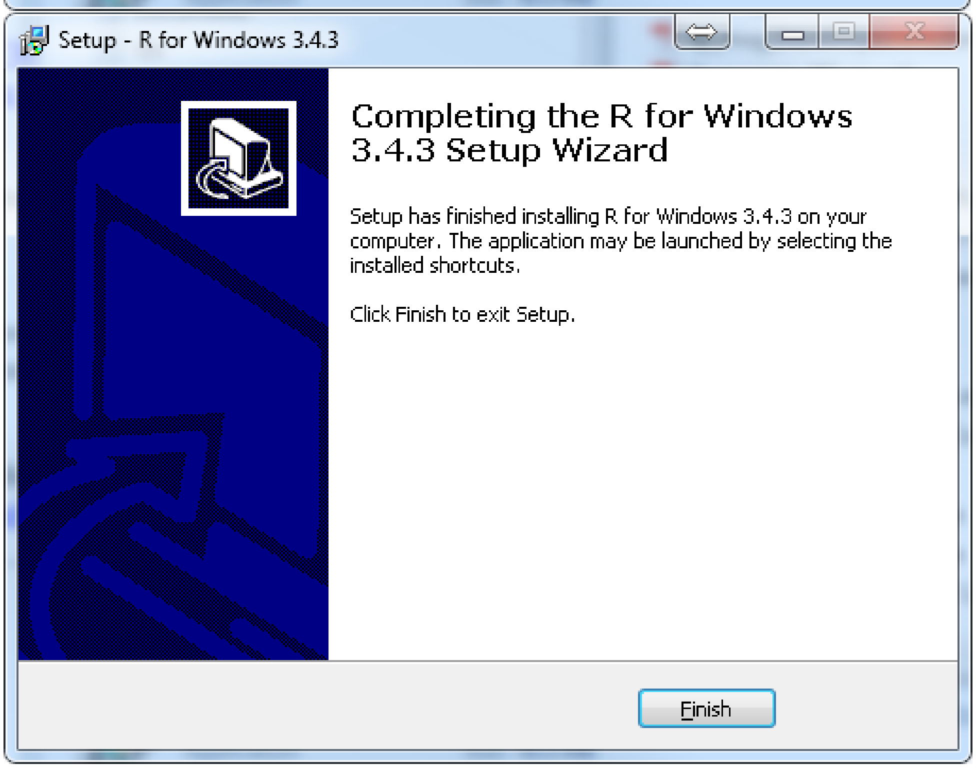


Choose a different folder if desired, otherwise keep the default and click “Next”.



Choose options as desired and click “Next”. This will start the installation.



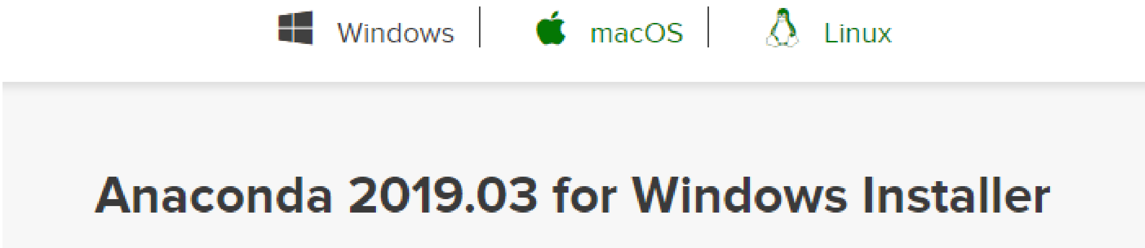


Once setup is finished, click “Finish” to complete the installation.

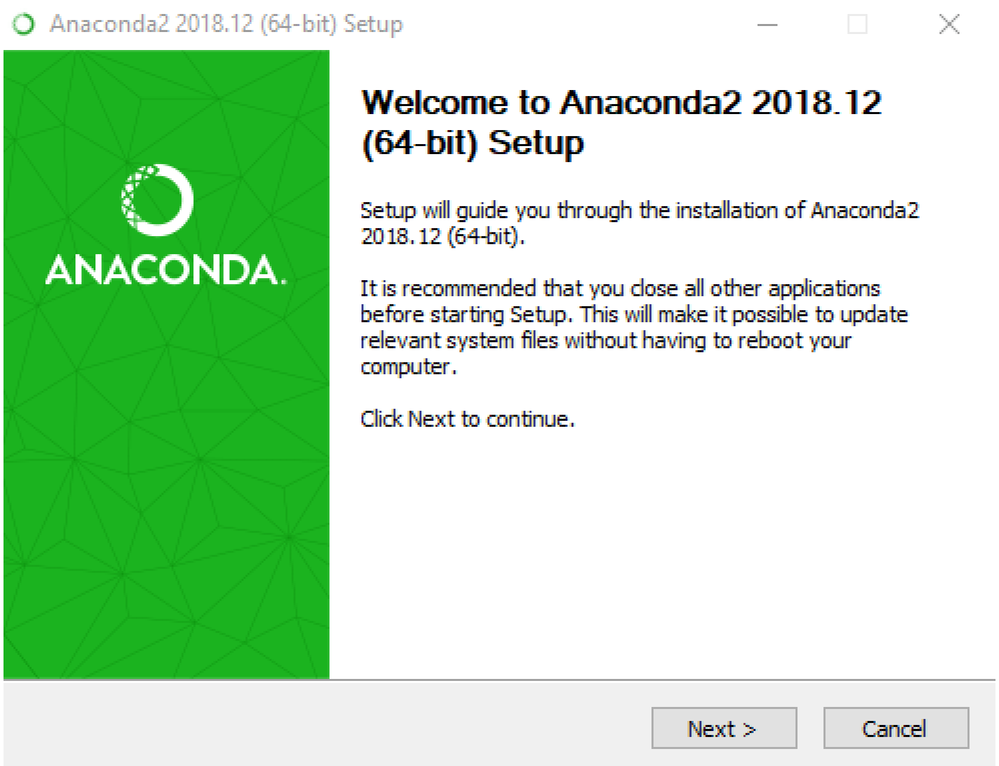
Anaconda with python 2.7

Go to the following page to download latest Anaconda (Python 2.7 version): https://www.anaconda.com/distribution/

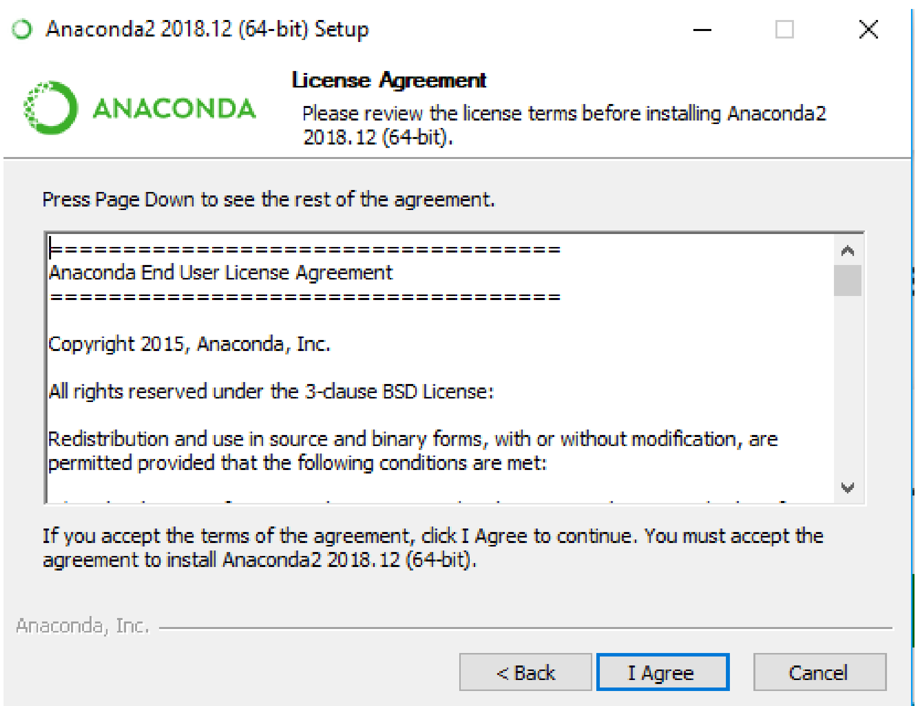
In this page, Click “Windows”:



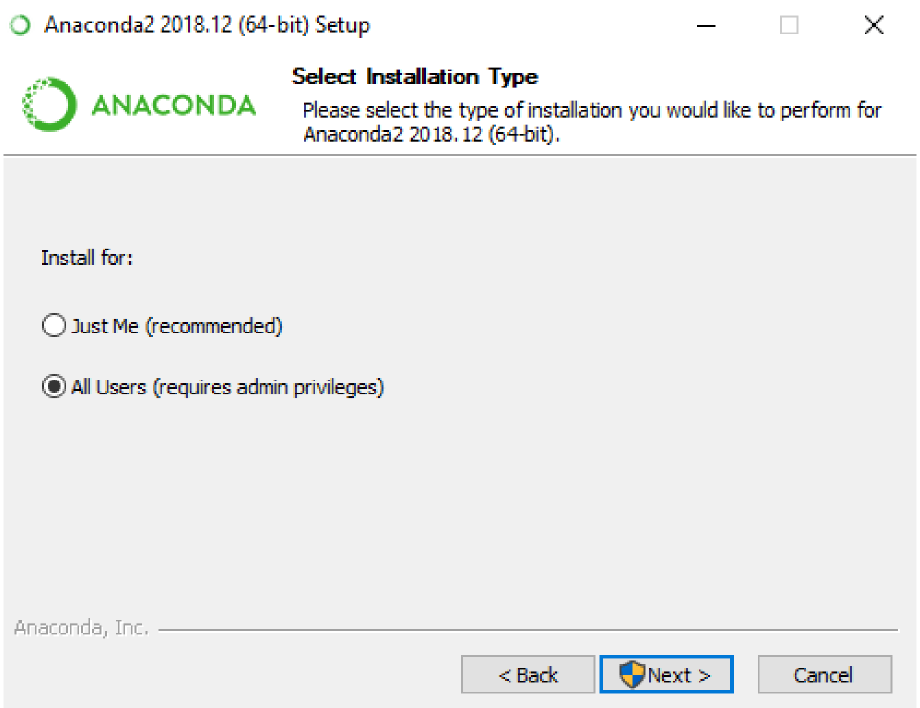
Download the **Python 2.7 version 64-Bit** windows executable (Anaconda2-2019.03-Windows-x86_64.exe) to a desired location on your machine. After the download is complete, go to the download folder and double click on the EXE file (Anaconda2-2018.12-Windows-x86_64).



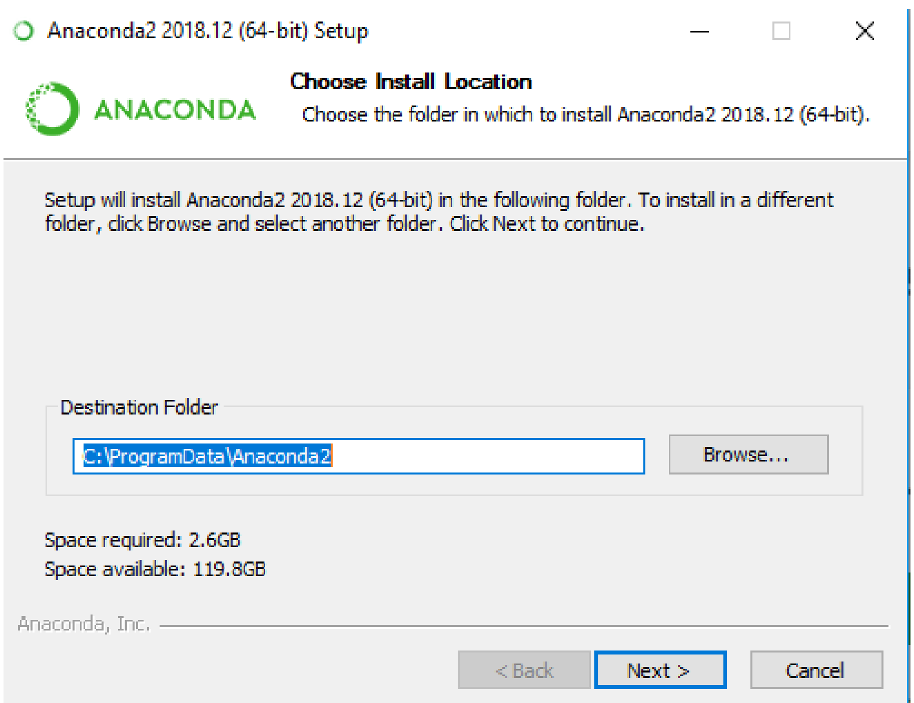
Click “Next”.



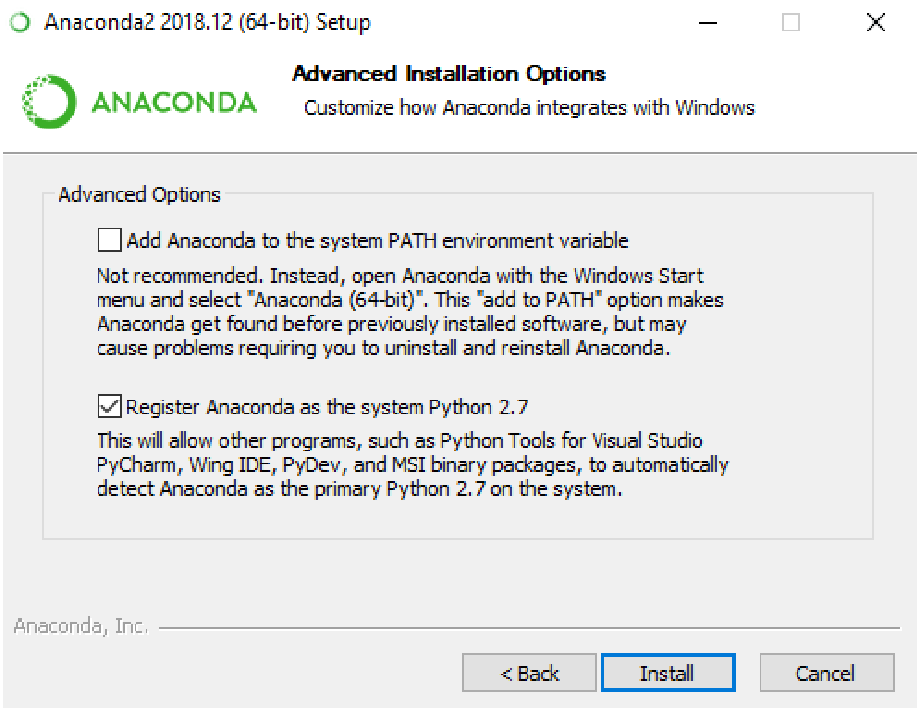
Click “I Agree”.



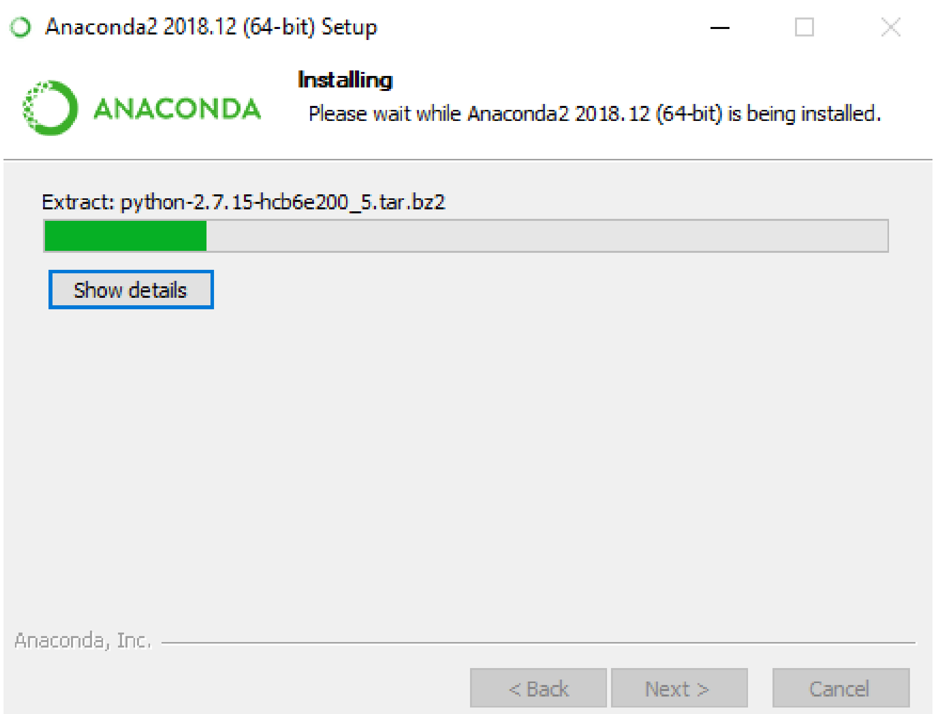
Make sure you have Admin privileges in the computer you are trying to setup the run. Then, Click “Next”.



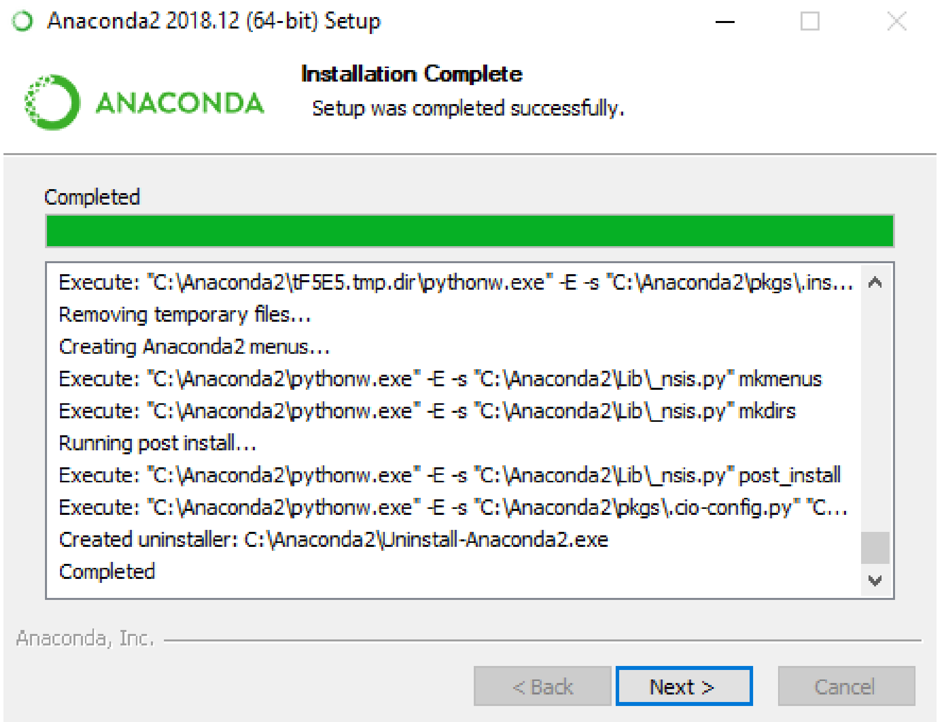
Choose a different folder if you want to install in a different location, otherwise keep the default and click “Next”.



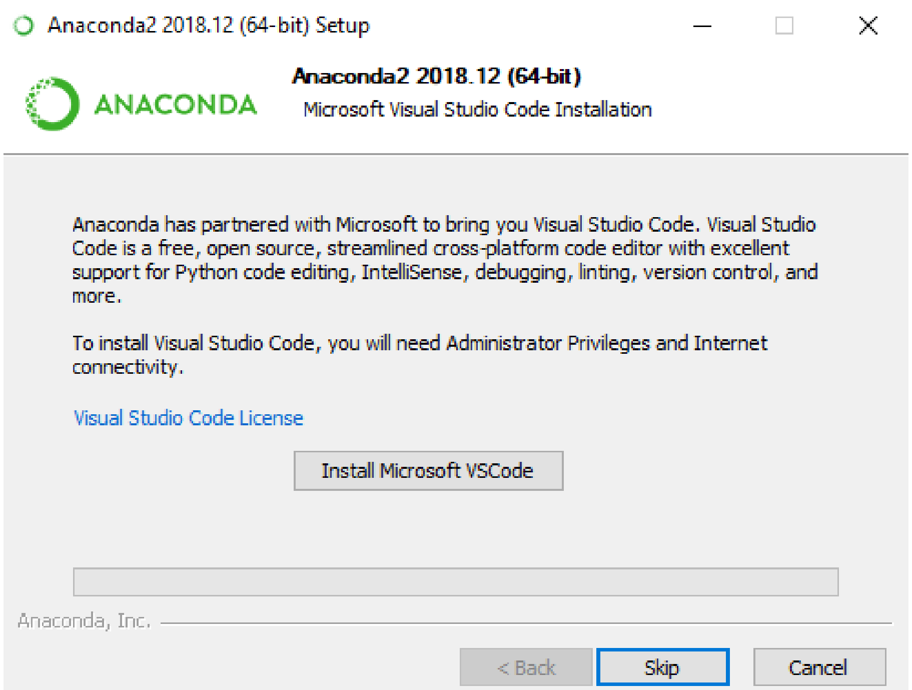
Keep the default options (as shown above) and click “Install”.



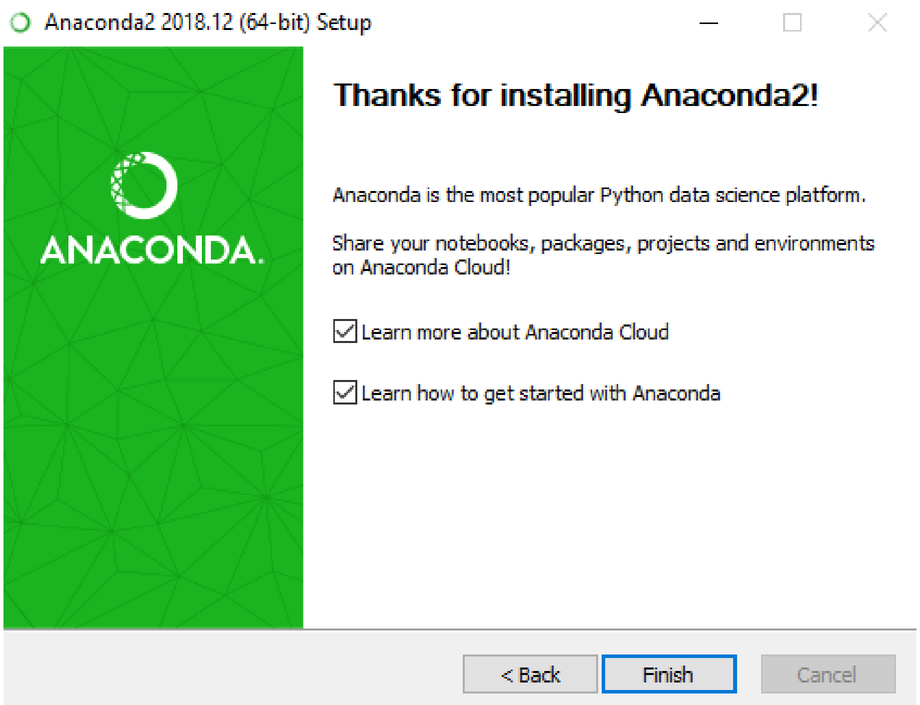
This will start the installation.



Once Installation is finished, click “Next”.



Click “Skip”.



Uncheck the two options above if you want to learn more or get started later. Click "Finish" to complete the installation.

In the next step, perform the following tasks:

- Create and activate an Anaconda environment (basically a Python install just for this project)
- Get and install other required libraries, which can be found online.
- Get and install the PopulationSim package on the activated conda Python environment

The details of these tasks can be found in the following PopulationSim github website:

https://rsginc.github.io/populationsim/getting_started.html

SETUP & RUN POPULATIONSIM

Setup Directory

Figure 51 presents the directory structure for the PopulationSim setup. To set up a PopulationSim run, the user must create the directory structure as shown in below.

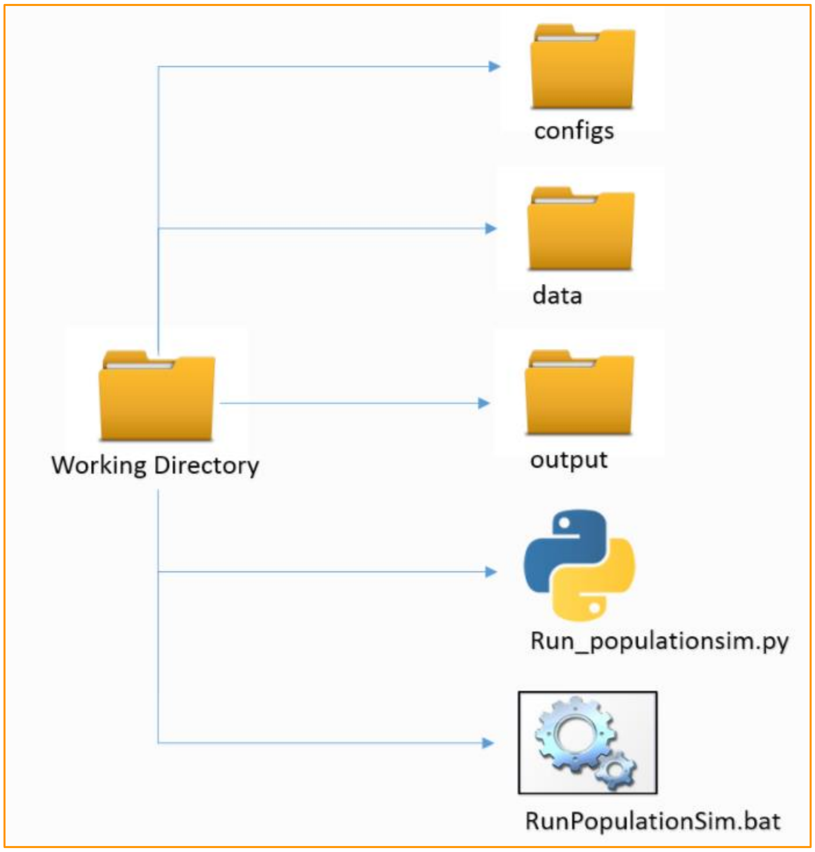


FIGURE 51 POPULATIONSIM DIRECTORY STRUCTURE

The folders and files in the directory are explained as follows:

- The *data* directory holds all the input data like seeds data, control data and crosswalks.
  - SCOUNTY Control totals
  - TAZ Control totals
  - MAZ Control totals
  - Geographic Crosswalk
  - Household Seed table
  - Person Seed table
- The *Anaconda2* directory houses the core PopulationSim software files and associated libraries and packages.
- The *configs* folder contains the **settings.yaml** file and **controls.csv** file
  - PopulationSim is configured using the **settings.yaml** file. For this project, it is configured to run in base mode which means it is run from beginning to end and produces a new synthetic population

    - **controls.csv** file specifies all the targets, geography, seed table, control field and their expression to the seed table required for the PopulationSim run.
- The *output* folder will have the final synthetic household and person file and summary attributes after a successful run.
- This batch file activates the PopulationSim environment and then calls the **run_populationsim.py** Python script to launch a PopulationSim run.
- PopulationSim is run using the **RunPopulationSim.bat** batch file in Command Prompt Window. Before starting the run, the path to the Anaconda install must be updated within this file.

The PopulationSim procedure is automated and once you have all the data in place, the user just needs to run the batch file from the command prompt window.

APPENDIX B. PREPARE DAYSIM INPUTS

Transit Stops File

The transit stops file is created using the input transit network from Jacksonville Transit Authority:

TROUTE_{Year}{Alt}.LIN

Follow the sequential step below:

- Create a gepdatabase (gdb) in Cube
- Import the input transit network file and the highway network file
- Export the nodes (PTNetwork_PTNode) to a shapefile
- Open the shapefile in ArcMap and select the nodes that have STOPNODE=1. These are the transit stops
- Export the selected nodes (stops) to a new stops shapefile
- Open the attribute table of the new stops file and add four fields: xcoord_p (double), ycoord_p (double), mode (int) and id (long).
- Calculate xcoord_p and ycoord_p using calculate geometry for the two fields.
- Join transit line by object id and calculate a new field “mode” equal to the MODE field in the line file (1-localbus, 2-skyway)
- Calculate stopid as “FID+1”.
- Keep only four fields in the attribute table: id, mode, x_coord, y_coord.
- Export all records in the attribute table to a csv file: Jacksonville_transitstops.csv

The stops file is in the following format:

id	mode	xcoord_p	ycoord_p
1	1	6309142	2167872
2	1	6309117	2166434
3	1	6309112	2165240
4	1	6307677	2165242
5	1	6306517	2165245
6	1	6306529	2166560
7	1	6306503	2167889
8	1	6309149	2169329
9	1	6309154	2170526
10	1	6309171	2171830
11	1	6307831	2173200
12	1	6306543	2173215
13	1	6305216	2173227
14	1	6303896	2173225
15	1	6303887	2174830

DaySim Data Editing

This section of the appendix contains various input data preparation and processing for DaySim updates. With the advent of the base year moving from 2010 to 2015, microzones replacing parcels and new population data, the inputs for DaySim needed to be updated. The following steps describe the DaySim input data preparation and update for the NERPM-AB model including the tool and input data used and output formed. The detail explanation of these tools can be found on the following GitHub page:

https://github.com/RSGInc/DaysimDataTools/tree/master/2_Parcel_Buffering

Network Data Preparation

This step calculates “nearby” node pairs of microzones for shortest distance path calculations to be used in DaySim.

Tool: **Network_DataPrepv2.exe**

Inputs:

- **input_node.csv** (Node x,ys from an all-streets network)
- **jax_MAZs_2015.dat** (The coordinates of the newly developed microzones)
- **jax_netprep.ctl** (Network prep control file)

Output:

- **input_od_pairs.csv** (for input to shortest path update tool)

Shortest Path Update

This step calculates all-streets node-to-node shortest path distances.

Tool: **DTALite64.exe**

Inputs:

- **input_od_pairs.csv** (from the Network Data Preparation tool)
- **input_node.csv** (from all-street network)
- **input_link_type.csv** (from all-street network)
- **input_link.csv** (from all-street network)
- **DTASettings.ini** (settings file)

Output:

- **output_shortest_path.txt** (for input to Buffering microzones)

Buffering micro-zones

This step calculates the new Microzone buffer measures to be used in DaySim.

Tool: **DSBuffTool.exe**

Inputs:

- **Jax_microzones_2015.csv** (Base Microzone file)
- **Jacksonville_Intersections.csv** (Street intersections file)
- **Jacksonville_transitstops.csv** (Transit stops file)
- **Jacksonville_openspaces.csv** (Open spaces/parks file)
- **input_node.csv** (All-street Network nodes file)
- **output_shortest_path.txt** (Node-to-node shortest path distance file)

Output:

- **buffered_microzone_2015.dat** (to be used in DaySim)
- **microzonenode.dat** (to be used in DaySim)
- **output_shortest_path.txt.bin** (Change extension using batch file)
- **output_shortest_path.txt.index** (Change extension using batch file)

The file extension of the last two outputs above need to be changed for reading into DaySim. The last three output files are used in DaySim to estimate short-distances for car, walk and bike trips.

All three DaySim Data tools can be run using **RunAll.bat** from the command prompt window.

DaySim Files Update

The following files were updated in the latest 2015 DaySim run:

- New **Microzone file** containing aggregated household and employment inputs and buffered measures instead of parcels
- **Household file** containing all household information with respect to the microzones
- DaySim **Configuration file** containing the DaySim execution settings
- A set of updated **DaySim input files**
- A set of new **Data files** for short distance calculation

To accurately calculate short car, walk and bike trips, short distance node-to-node measure is introduced in DaySim. This includes the following changes:

- Change in DaySim Configuration file
- Utilization of three additional files in DaySim:
    - Microzone node file (**microzonenode.dat**)
    - Node Index file (**output_shortest_path_txt_index.dat**)
    - Node distance file (**output_shortest_path_txt_bin.dat**)

Updating Land-use Manually:

The user can update the land-use file manually if changes are required in specific zones because of new development, changed land-use etc. The starting point for such changes should be **buffering micro-zones** step. One of the inputs to the buffering tool is the MAZ file, for example, ***Jax_microzones_2015.csv*** for the 2015 scenarios. This file should be manually updated for such changes and saved with the same name. The user should then run the buffer tool and copy the output file (***buffered_microzone_2015.dat***) to the scenario input directory. This concludes the land-use updates step.