Technical Memorandum #4:

Travel Demand Forecasting

October 2020

FINAL

MARTIN MPO
Metropolitan Planning Organization

Martin Metropolitan Planning Organization (MPO) 2045 Long Range Transportation Plan (LRTP)

This technical memorandum was developed based on data and analyses during the time period from December 2019 through May 2020. Subsequently the Martin MPO Policy Board approved the Draft 2045 Cost Feasible Plan – *Martin in Motion* in June 2020. *The Final* 2045 Cost Feasible Plan was adopted by the Martin MPO Policy Board in October 2020.

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1. Introduction

Travel demand forecasting is a key component of Martin MPO's 2045 Long Range Transportation Plan's (LRTP) – *Martin in Motion's* data driven analysis to identify mobility needs in the County. The purpose of Technical Memorandum #4 (TM 4) is to discuss the impact of anticipated changes in socioeconomic, demographic and land use characteristics as well as population and employment growth in Martin County over the next 25 to 30 years on travel demand and resulting traffic congestion. In addition, this memorandum also provides a documentation of the existing and committed roadway projects included in the Treasure Coast Regional Planning Model (TCRPM 5.0) that serves as the foundation to analyze future highway and transit needs. Further, TM 4 includes a discussion on scenario planning, which is an analytical framework that considers the impact of policy transformation and various investments on the transportation system. Scenario planning is listed as one of the proactive improvements in the FHWA's Federal Strategies for Implementation Requirements for LRTP Updates for the Florida MPOs, January 10, 2018.

This technical memorandum is organized as described below:

Chapter 1: Introduction – summarizes the purpose of the technical memorandum and report organization.

Chapter 2: Socioeconomic, Demographic and Land Use Changes – summarizes the changes in land use and socioeconomic composition of Martin County that provide a foundation to understand future travel demand and travel behavior in the County.

Chapter 3: Travel Demand Forecast – explains existing travel patterns, travel behavior as well as future travel demand and deficiency analysis to inform the data driven component of Martin MPO's needs assessment.

Chapter 4: Scenario Planning – discusses assumptions and methodology used to develop scenarios, describes the planning scenarios, and provides a comparative evaluation of the scenarios relative to the 2045 Cost Feasible Plan.

Chapter 5: Next Steps – summarizes how information included in this memorandum will be used to develop the 2045 Needs Plan and 2045 Cost Feasible Plan as the project continues to advance through the LRTP development process.

2. Socioeconomic, Demographic & Land Use Changes

The performance of a transportation network is impacted by the growth and transformation of population, households, and employment in the region. Because of this inextricable link, it is important to assess the Martin County's socioeconomic changes to develop an understanding of the region's evolving travel patterns. Growth in population and employment underscores the need for a wide selection of transportation options. Therefore, a thorough understanding of the socioeconomic growth will help make informed decisions on how and where transportation investments should be leveraged over the next 25 years.

This section summarizes changes in land use, demographic and socioeconomic composition of Martin County in preparation for the Martin MPO's 2045 LRTP – *Martin in Motion*.

2.1 Treasure Coast Regional Planning Model (5.0)

Much of the information contained within the report was utilized as data input to prepare the travel demand modeling process in forecasting the County's transportation needs through the year 2045. The socioeconomic datasets for the base (2015) and horizon (2045) years were obtained from Treasure Coast Regional Planning Model (TCRPM 5.0). The Treasure Coast Regional Planning Model Version 5.0 (TCRPM 5.0) is the regional travel demand modeling tool that is used to forecast travel behavior in Martin County. The TCRPM 5.0 is an activity-based travel demand model serving the regional transportation modeling needs for the three counties within Treasure Coast Region – Martin, St. Lucie, and Indian River County.

For the 2045 Long Range Transportation Plan (LRTP), TCRPM 5.0 was used to model three alternatives or networks: existing-plus-committed (E+C), 2045 Cost Feasible Plan and 2045 Needs Plan. Highway and transit level travel forecasts are developed in a time-of-day process that provides disaggregate information by periods during an average weekday. The TCRPM 5.0 model includes five (5) time periods:

- Early Peak Period
- AM Peak Period
- Mid-Day Peak Period
- PM Peak Period
- Evening Period

This section documents the findings of the population and employment 2045 forecast for 249 traffic analysis zones (TAZs) within Martin County and 1,261 traffic analysis zones (TAZs) within Treasure Coast Region as defined in the TCRPM 5.0 model.

2.2 Population and Employment Growth

This socioeconomic data reveals trends in demographics and employment from the base year (2015) to the horizon year (2045). This section presents major findings of projected growth in population and employment.

Table 2-1 shows the overall changes in population and employment between 2015 and 2045 at county level. Population in Martin County is projected to grow by 29,716 to reach almost 200,000 while employment will grow by 6,286 to reach just under 100,000 during the next 30 years. Overall, the region will continue to grow during this time; however, Martin County's population growth and employment growth during this period were lower than the population growth and employment growth of Treasure Coast Region as a whole.

Table 2-1: Population and Employment Growth, 2015-2045

Geography	Population, 2015	Population, 2045	Percent Change, 2015-2045	Employment, 2015	Employment, 2045	Percent Change, 2015-2045
Martin County	151,596	181,312	19.60%	92,700	98,986	6.78%
St. Lucie County	292,362	525,100	79.61%	108,097	183,349	69.62%
Indian River County	143,326	201,839	40.83%	76,386	94,626	23.88%
Treasure Coast Region	587,284	908,251	54.65%	277,183	376,961	36.00%

Population and employment growths are summarized by Traffic Analysis Zones (TAZs). **Figure 2-1** and **Figure 2-2** summarize total population and total employment in 2045, respectively. **Figure 2-3** and **Figure 2-4** show the changes in population and employment from 2015 to 2045. **Figure 2-5** and **Figure 2-6** present the population density in 2015 and 2045. **Figure 2-7** and **Figure 2-8** show the employment density in 2015 and 2045.

Figure 2-1: Total Population in 2045

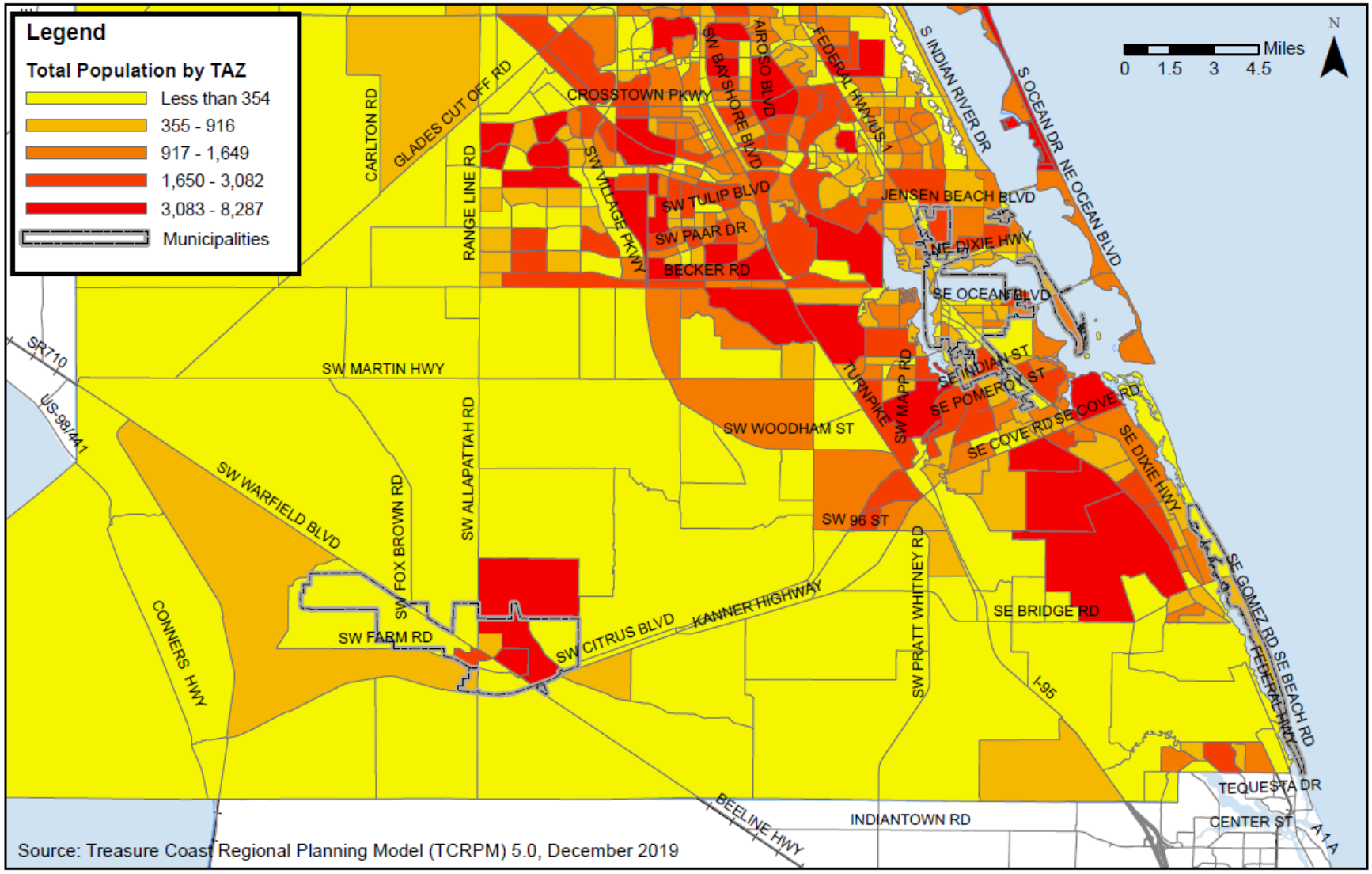


Figure 2-2: Total Employment in 2045

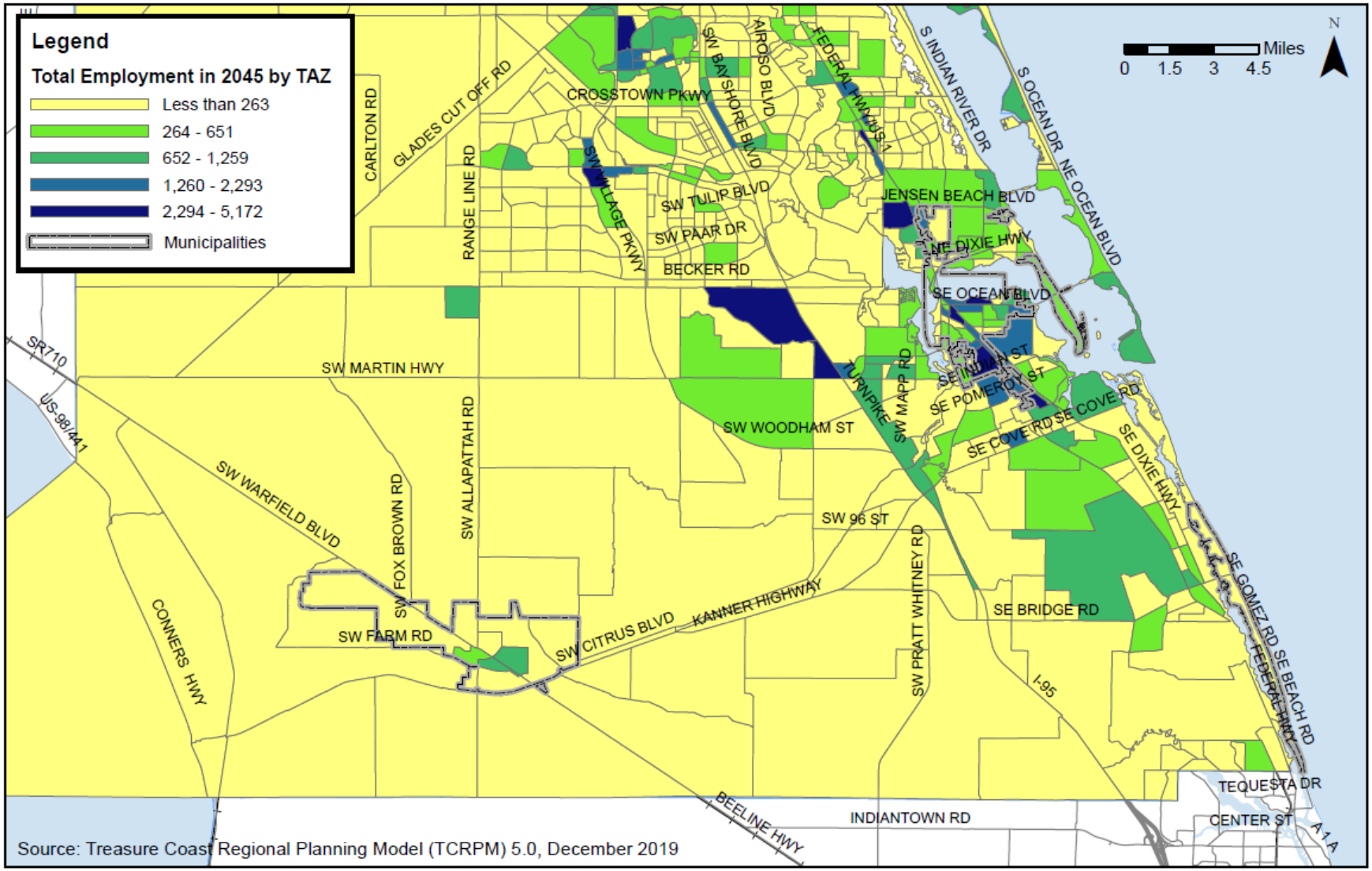


Figure 2-3: Changes in Population by TAZ, 2015-2045

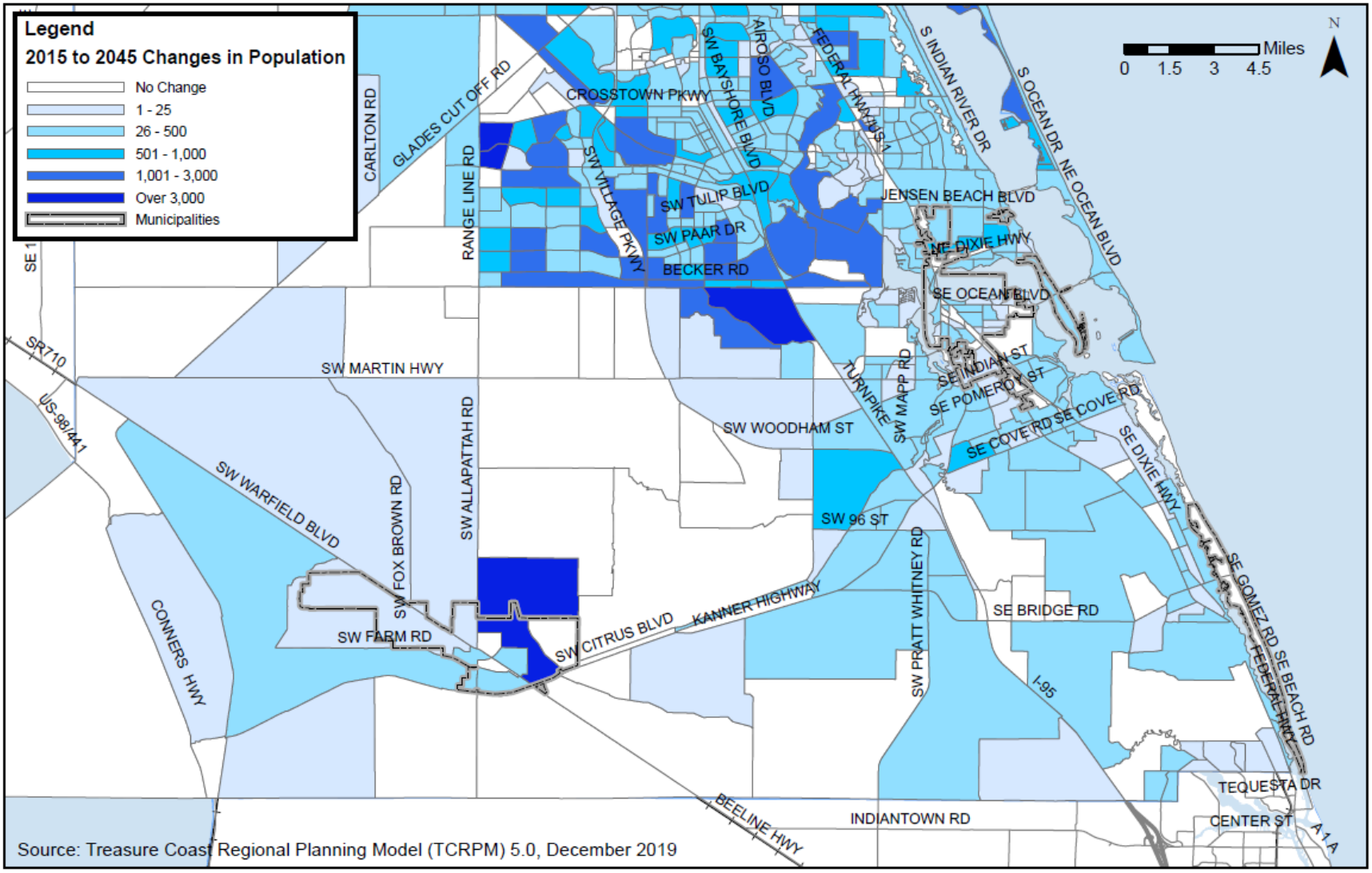


Figure 2-4: Changes in Employment by TAZ, 2015-2045

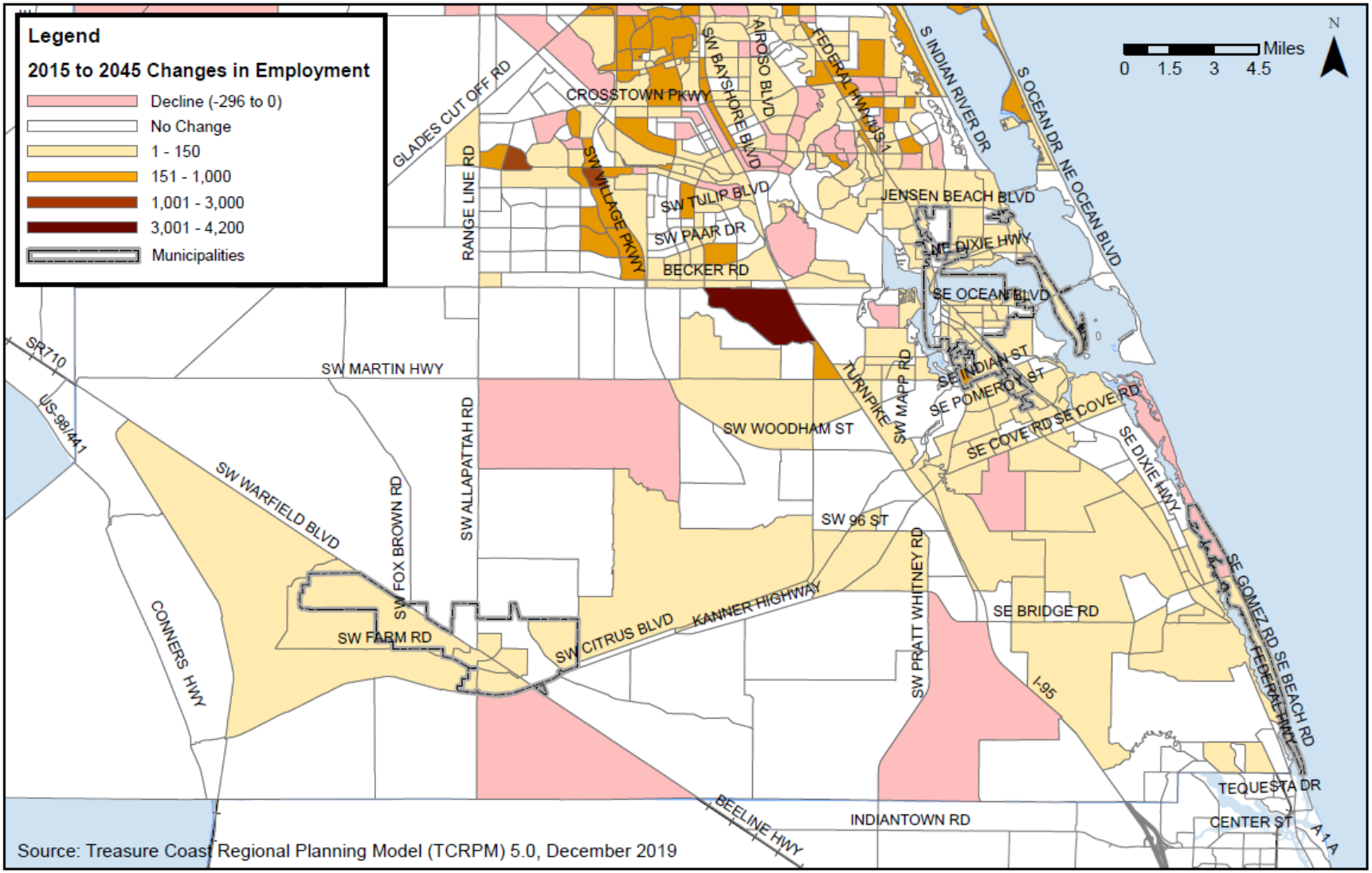


Figure 2-5: Population Density by TAZ, 2015

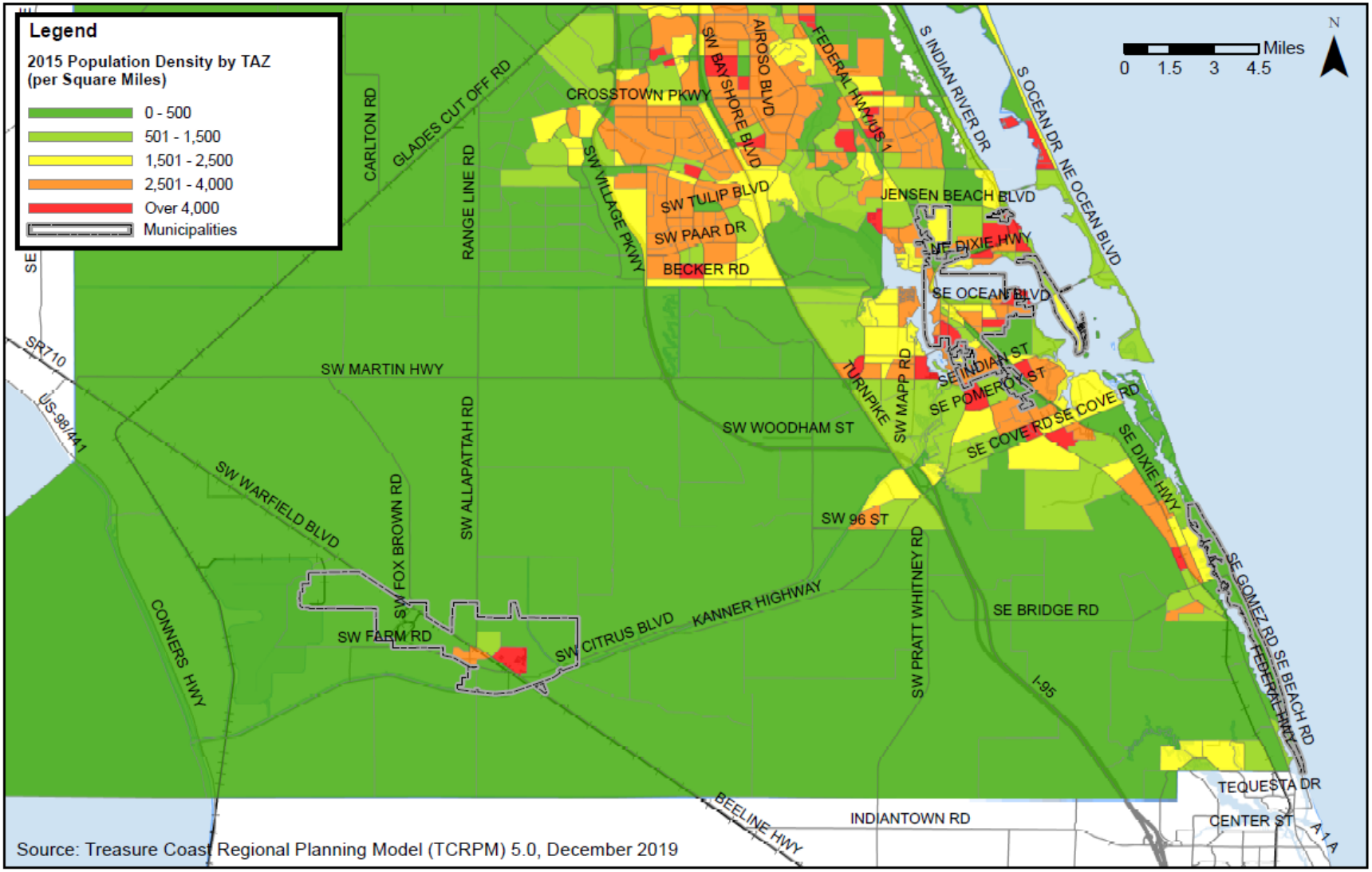


Figure 2-6: Population Density by TAZ, 2045

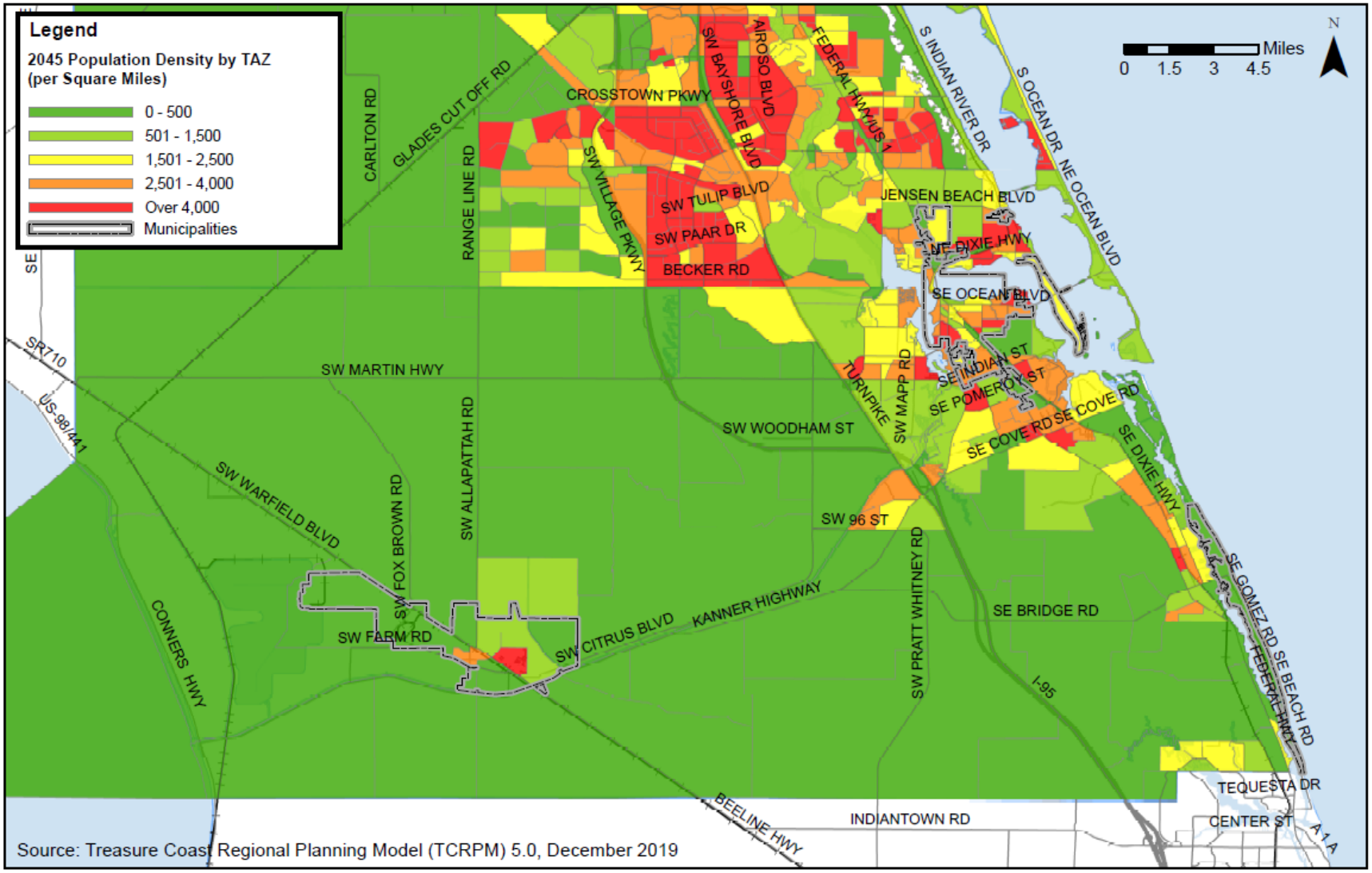


Figure 2-7: Employment Density by TAZ, 2015

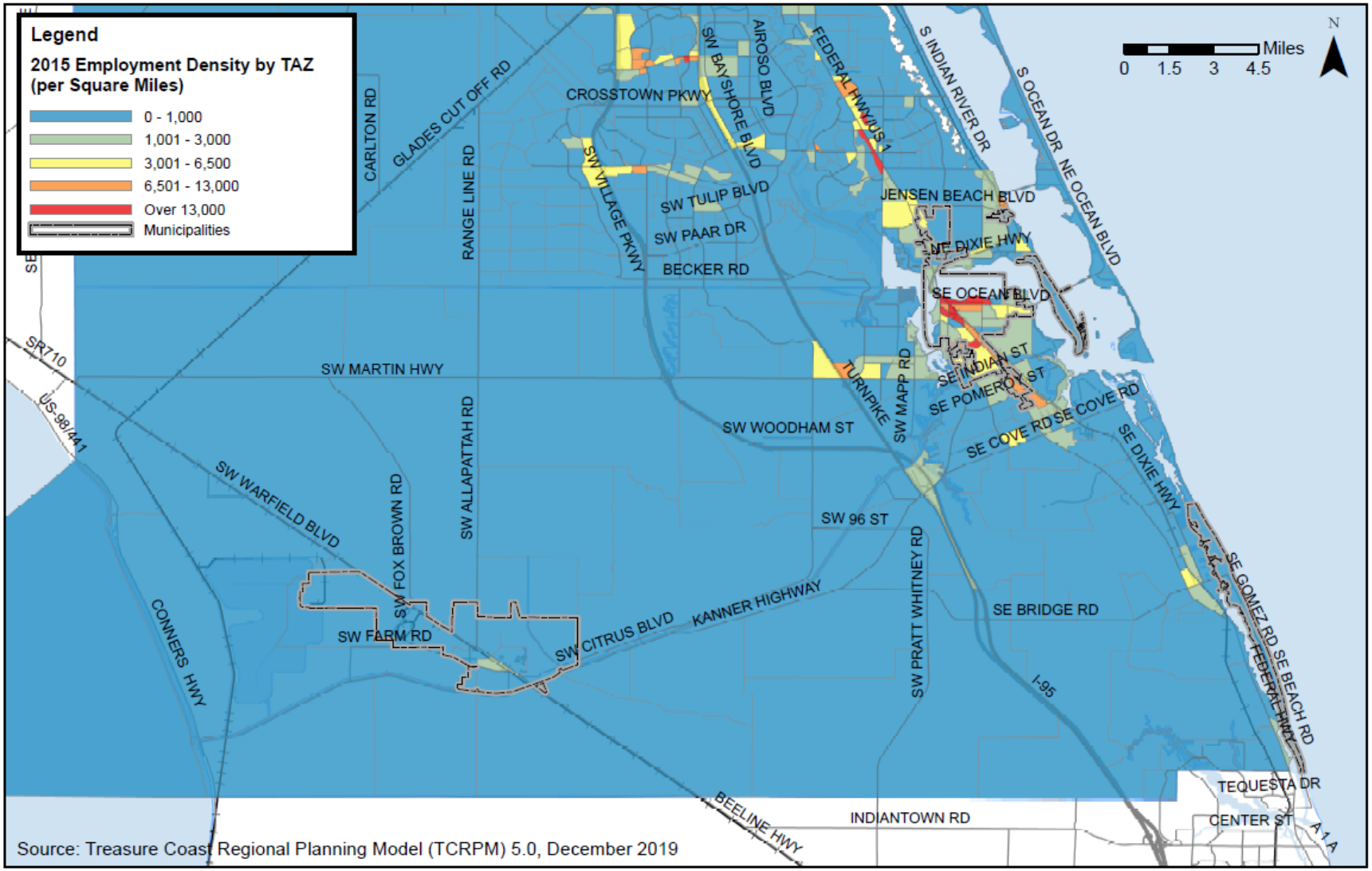
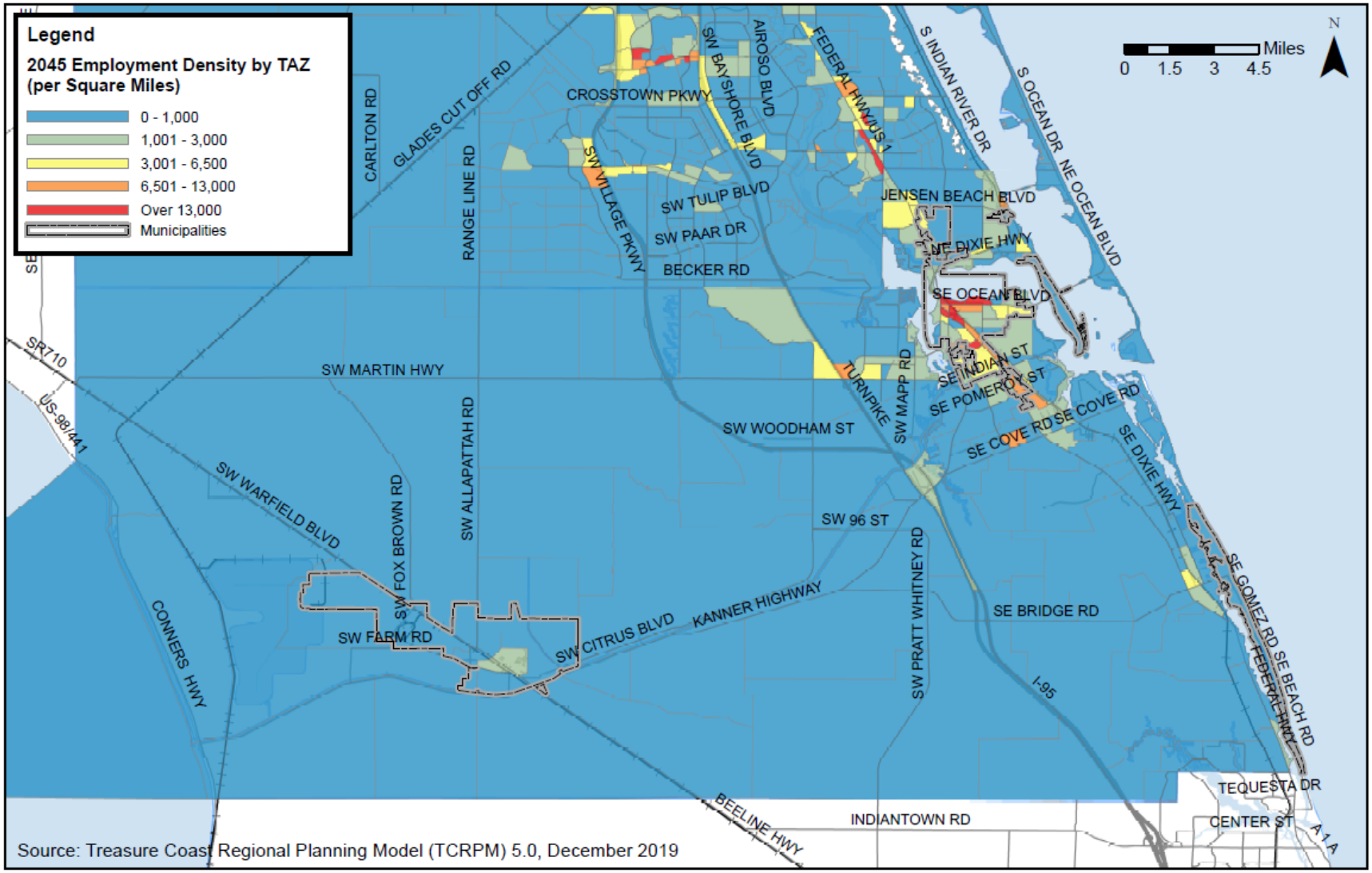


Figure 2-8: Employment Density by TAZ, 2045



2.3 Socioeconomic Characteristics

The maps that follow display various demographic distributions at the TAZ level in 2045, such as household characteristics, age, income, and ethnicity, among others. A summary is provided for each map below, with the maps following.

2.3.1 Household Characteristics

Figure 2-9 provides average household size by TAZ in 2045, forecasting an overall slight increase in average size from 2.23 persons in 2015 to 2.24 persons within Martin County in 2045. The map shows that sizes are commonly 2-4 people, though there are pockets of smaller households in dense areas or where the retiree population is expected to expand. Generally, household size is larger in the outskirts. **Figure 2-10** shows the changes in households from 2015 to 2045. The total households are expected to increase by 19% from 67,977 in 2015 to 81,127 in 2045.

Figure 2-11 provides the percent of households with children by TAZ in 2045. Generally, the percentage of households with children is forecast to drop from 23% in 2015 to 22% in 2045, reflecting an expected increase in older households without children. Generally, most households are not projected to have a child (defined as persons aged between 0 and 18 years old), though there are areas with 50% or more households with children, particularly in the west of Martin County.

Figure 2-12 shows the enrollment of students in primary and secondary education in Martin County. Primary education includes all students enrolled in kindergarten to 12th grade in both public and private institutions. Secondary education refers to all higher education including universities, colleges, and vocational schools. K-8 enrollment is expected to increase from 14,669 in 2015 to 20,397 (approximately 39%) in 2045, high school enrollment is expected to increase from 6,534 in 2015 to 7,822 (approximately 20%) in 2045, and the enrollment in college is expected to grow from 5,539 in 2015 to 5,839 (approximately 5%) in 2045. **Figure 2-13** shows the total enrollment by TAZ in 2045, and **Figure 2-14** shows the changes in school enrollment, the overall enrollment is expected to increase from 26,742 in 2015 to 34,058 (approximately 27%) in 2045.

Figure 2-9: Average Household Size by TAZ, 2045

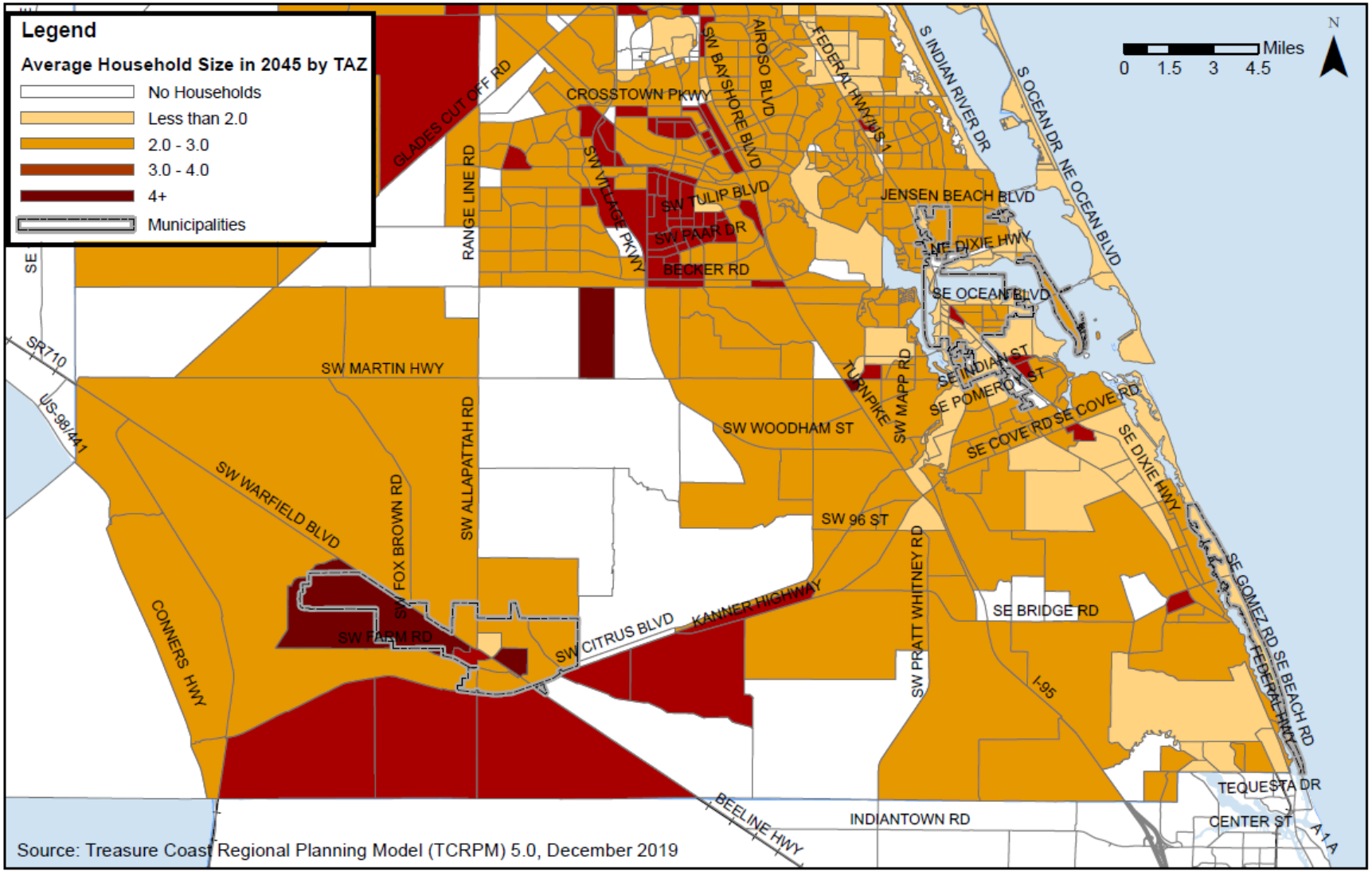


Figure 2-10: Changes in Households by TAZ, 2015-2045

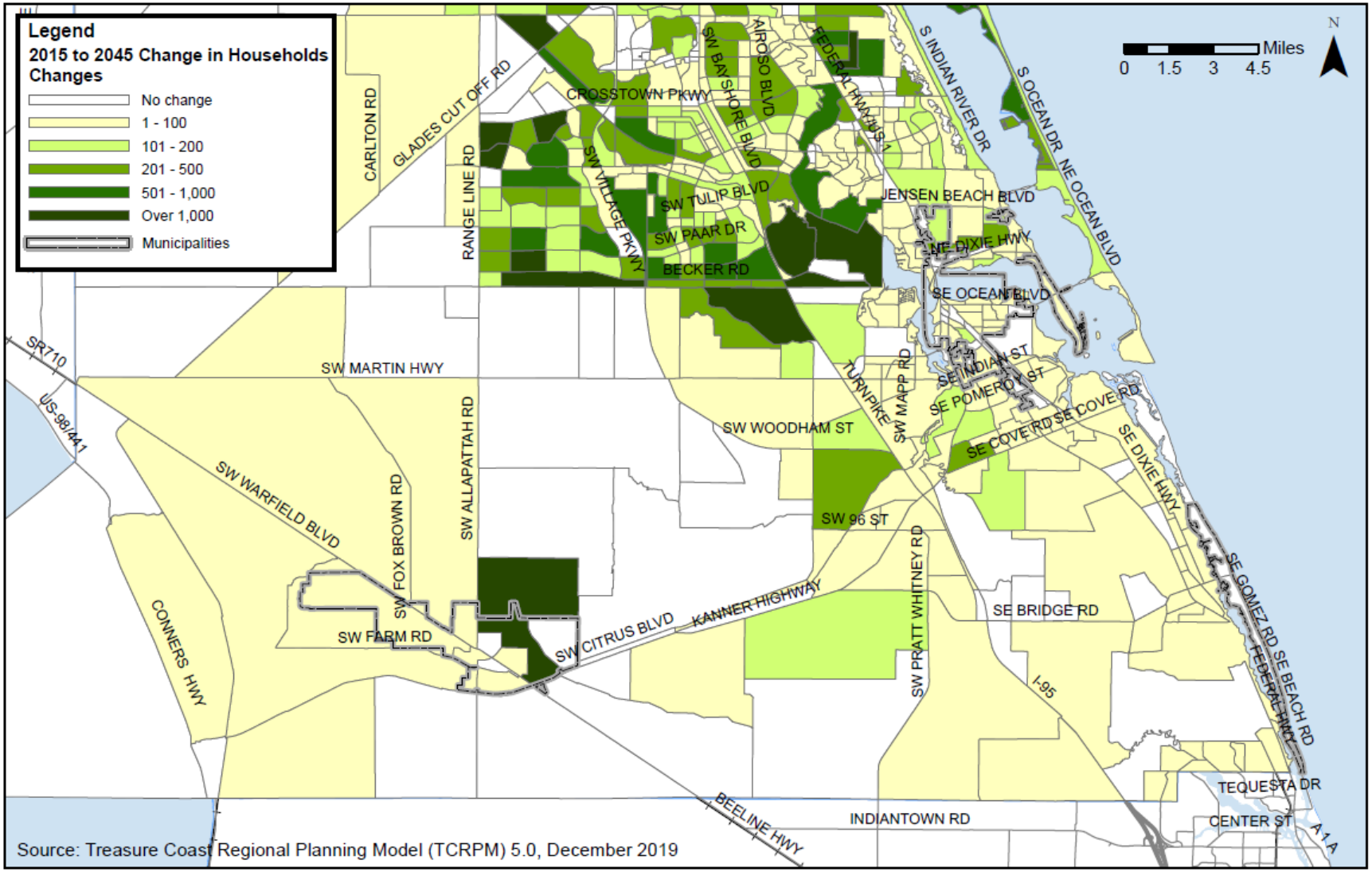


Figure 2-11: Percent Household with Children by TAZ, 2045

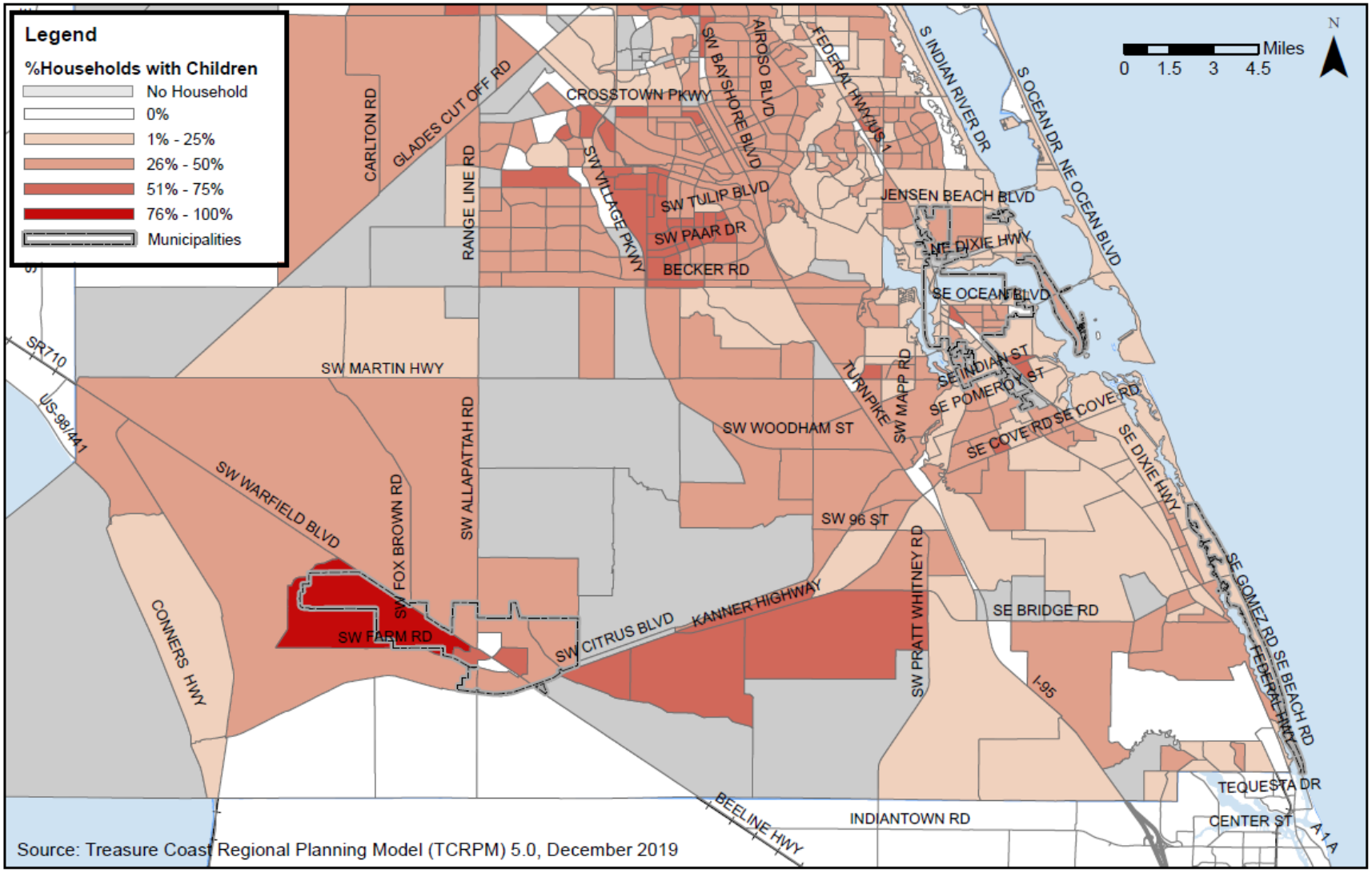


Figure 2-12: School Enrollment in Primary and Secondary Education by TAZ, 2045

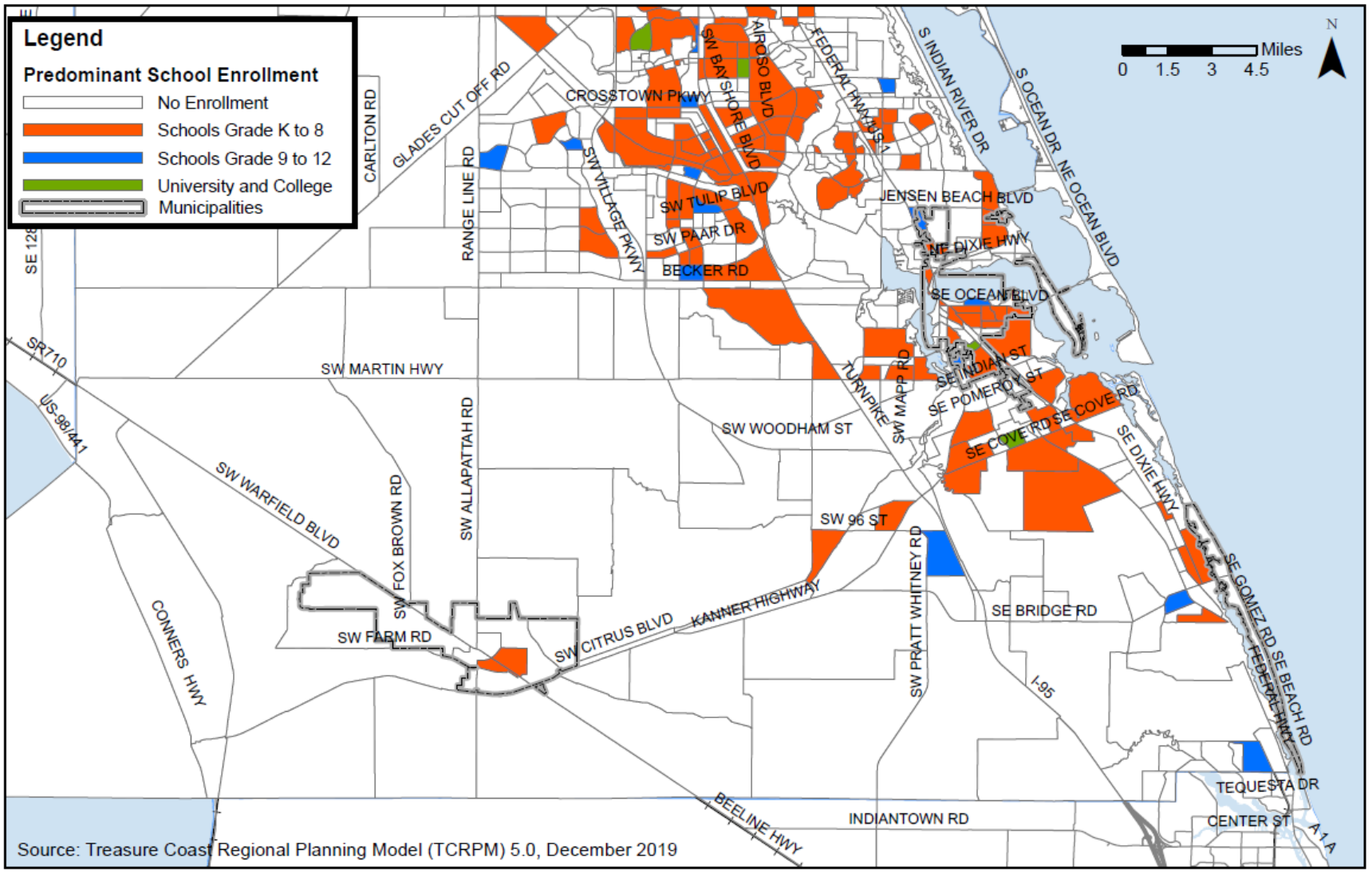


Figure 2-13: Total School Enrollment by TAZ, 2045

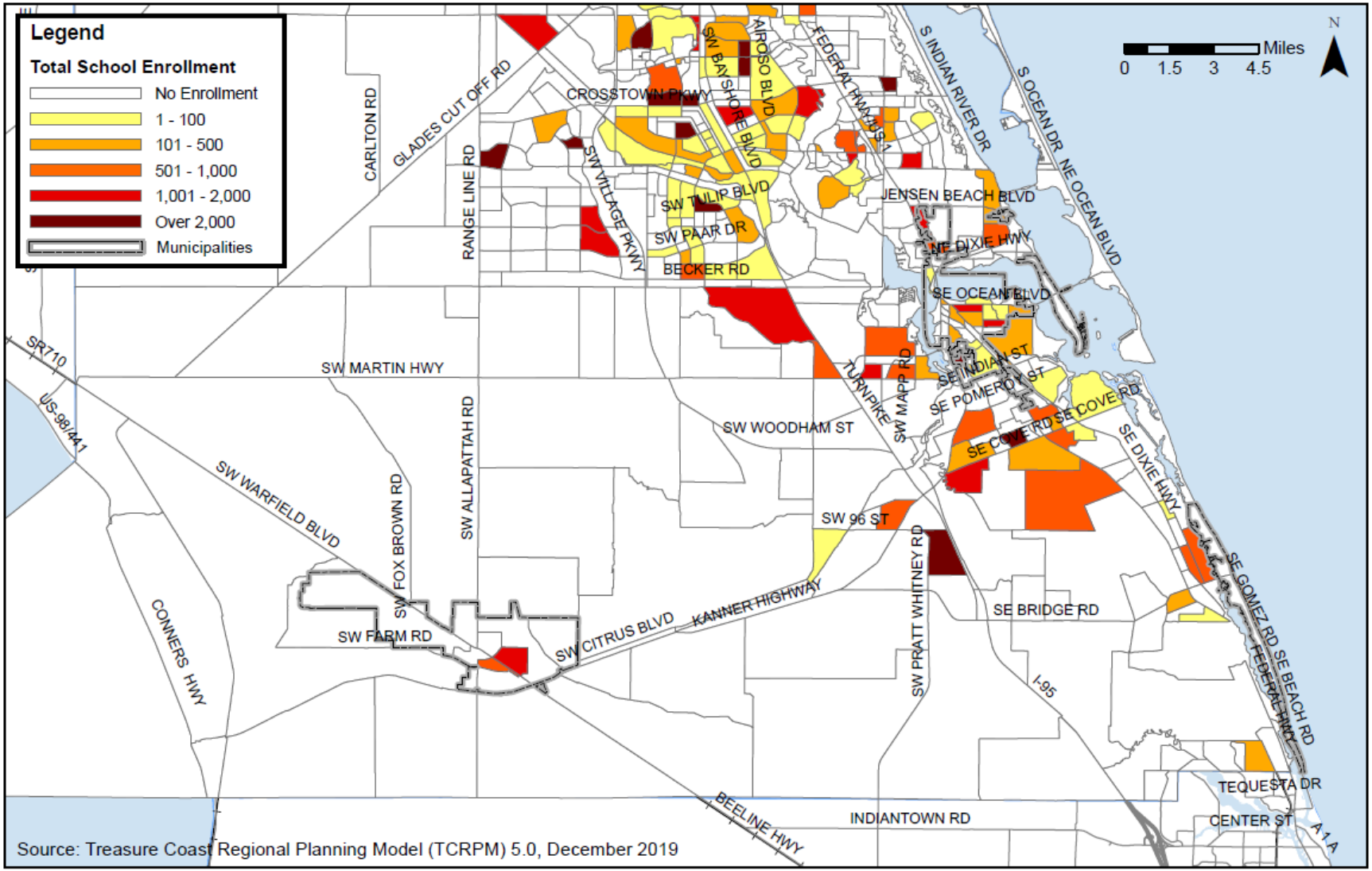
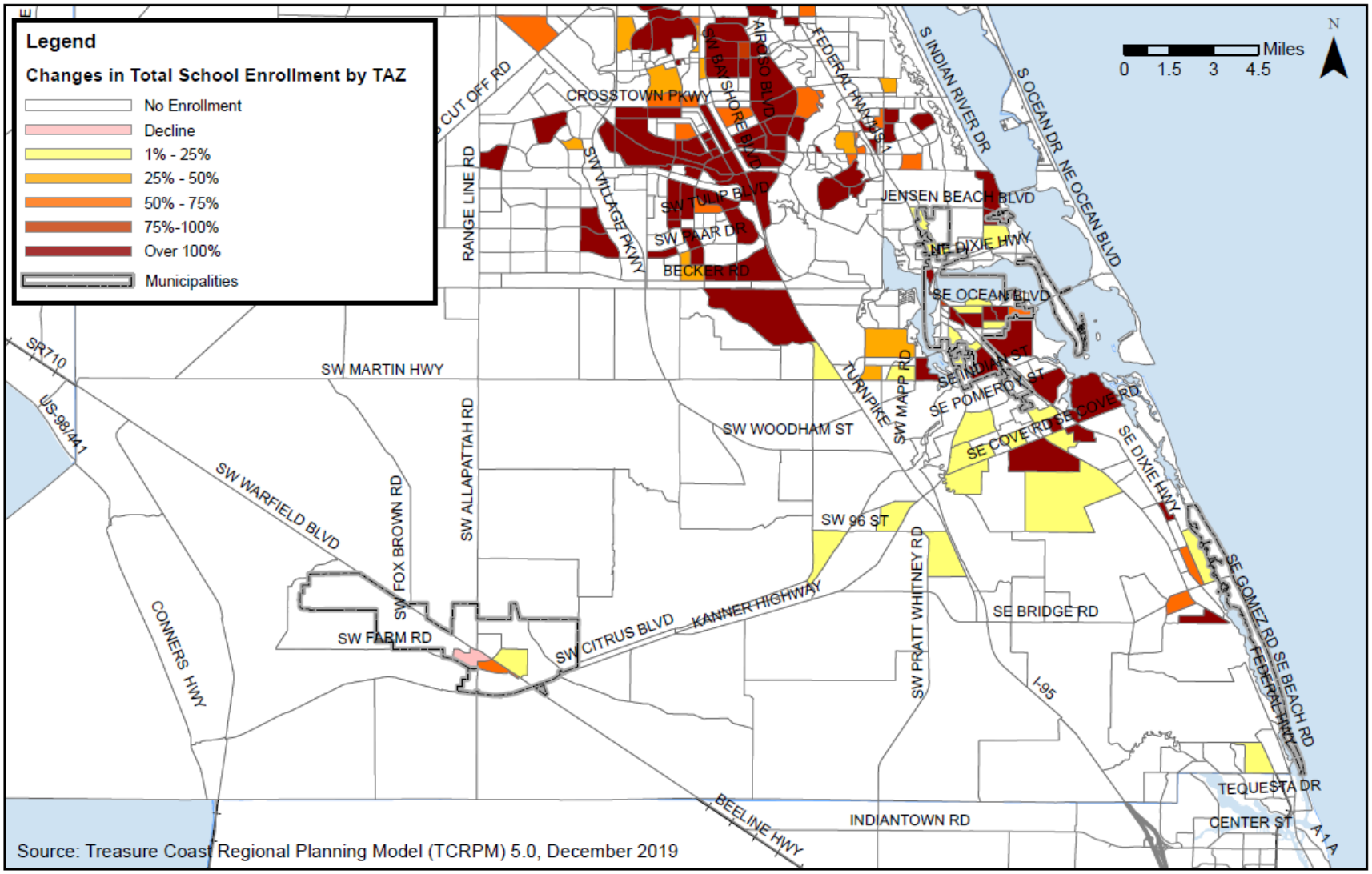


Figure 2-14: Changes in School Enrollment by TAZ, 2015-2045

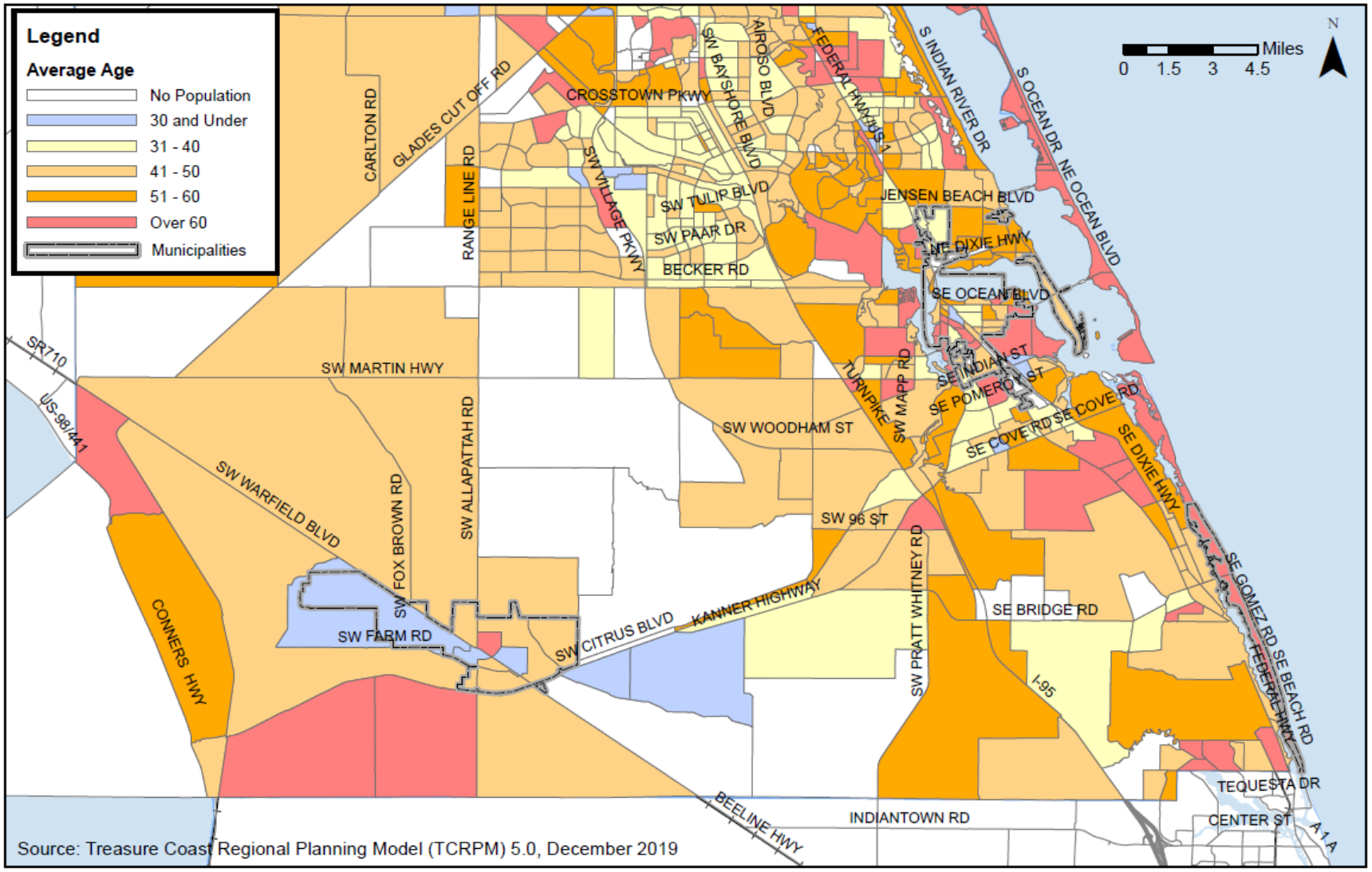


2.3.2 Age

Martin County has a higher proportion of older adults than the rest of the state. In groups under age 50, statewide percentages surpass Martin County percentages; however, above age 50, Martin County consistently has higher population proportions. Based on the U.S Census Bureau, 2019 Population Estimates, the county has a high share of older adults, with 31.5% age 65 and older, compared to 20.9% across the state. Older adults are concentrated along the coast. **Figure 2-15** displays the 2045 age distribution of Martin County.

Figure 2-15 shows average age by TAZ in 2045. The county, like the nation, is forecast to get older, and there is a strong correlation between average age and household size, so that the places with larger households generally have lower average ages (due to the presence of children). Overall, the average age is expected to increase from 47 in 2015 to 50 in 2045.

Figure 2-15: Average Age by TAZ, 2045



2.3.3 Income

Household income in Martin County, shown in **Table 2-2**, is similar to that of Florida, with median households earning $57,959, which is slightly higher than the statewide average of $53,267. The Census Bureau assesses poverty by comparing a household's income over a 12-month period to the poverty threshold (a monetary value) specific to the size of the household. The larger the household, the higher the threshold a household must meet to be considered above the defined poverty line.

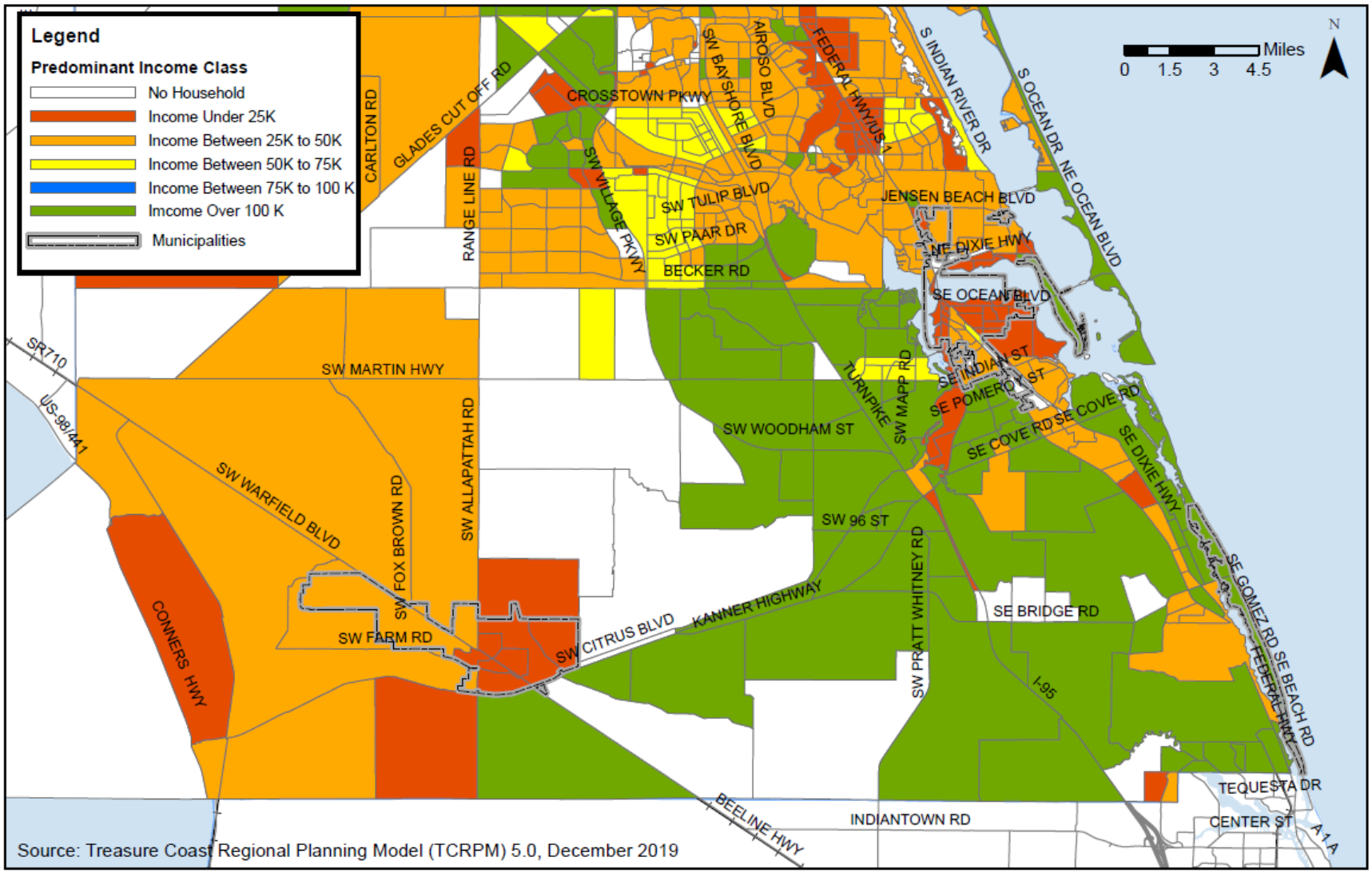
Table 2-2: Income in Martin County and Florida

Income and Poverty	Martin County	Florida
Median household income (in 2018 dollars), 2014-2018	$57,959	$53,267
Per capita income in past 12 months (in 2018 dollars), 2014-2018	$40,389	$30,197
Persons in poverty, percent	10.7%	13.6%

Source: U.S. Census Bureau, 2019 Population Estimates

Figure 2-16 provides predominant income class for each TAZ, including Class 1 (less than $25,000 per year per household), Class 2 (from $25,000 to $50,000 per year per household), Class 3 (from $50,000 to $75,000 per year per household), Class 4 (from $75,000 to $100,000 per year per household) and Class 5 (more than $100,000 per year per household). High concentrations of poverty, defined in this map by TAZs, are located near Indiantown and central Stuart.

Figure 2-16: Predominant Income Class by TAZ, 2045

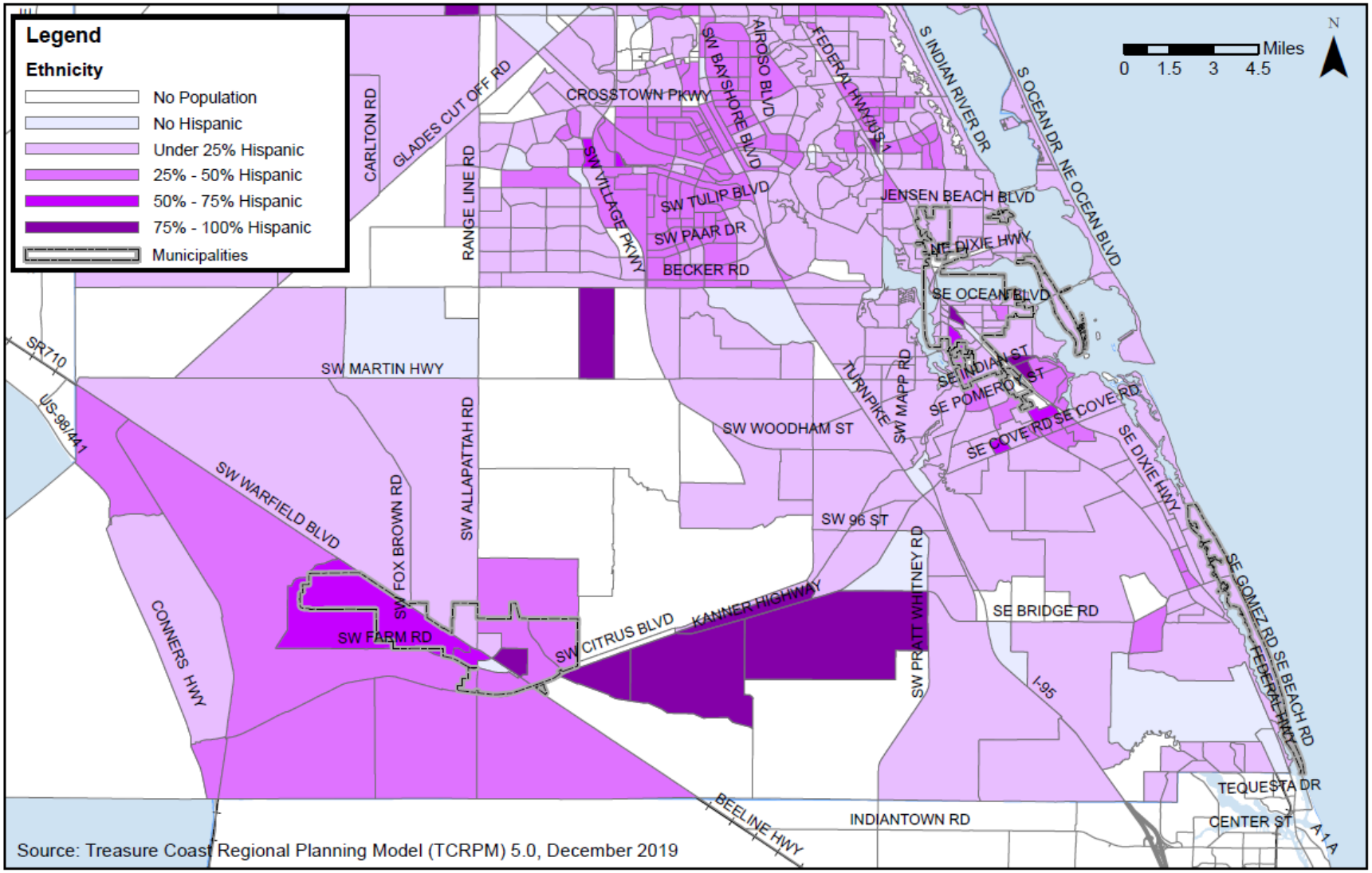


2.3.4 Ethnicity

According to the 2019 Population Estimates from U.S Census Bureau, Martin County has a Hispanic population of 14.2%, approximately half of Florida's overall minority percentage of 26.4%.

Figure 2-17 shows predominant ethnicity, focused on proportion of Hispanic populations. The overall proportion of Hispanic residents is expected to rise from 12% in 2015 to 17% in 2045. The forecast continues existing spatial patterns of ethnic diversity. The highest proportions of minority populations are on the west side of the county near Indiantown, an area dominated by agricultural uses and is generally rural.

Figure 2-17: Predominant Ethnicity by TAZ, 2045



2.4 Land Use

Figure 2-18 shows predominant housing type (single family, multi-family, or mobile home) by TAZ. The 2045 forecast continues the trend of increases in the proportion of single - family housing (from 62% to 63%), though at a slower rate. Still, most of the county is forecast to have single family housing as the predominant housing type.

Figure 2-19 shows the population in group quarters by TAZ in 2045 and **Figure 2-20** shows the changes in group quarters from 2015 to 2045. The Institutionalized Group, per the US Census, "includes facilities for people under formally authorized, supervised care or custody at the time of interview, such as correctional facilities, nursing facilities/skilled nursing facilities, in-patient hospice facilities, mental (psychiatric) hospitals, group homes for juveniles, and residential treatment centers for juveniles." The Non-Institutionalized College group quarters refer to those residing in college dormitories. The Non-Institutionalized Other, per the US Census, "includes facilities that are not classified as institutional group quarters, such as college/university housing, group homes intended for adult, residential treatment facilities for adults, workers' group living quarters and Job Corps centers, and religious group quarters." The overall population in group quarters is expected to rise from 4,064 in 2015 to 5,430 (approximately 34% increase) in 2045.

Figure 2-18: Predominant Housing Type by TAZ, 2045

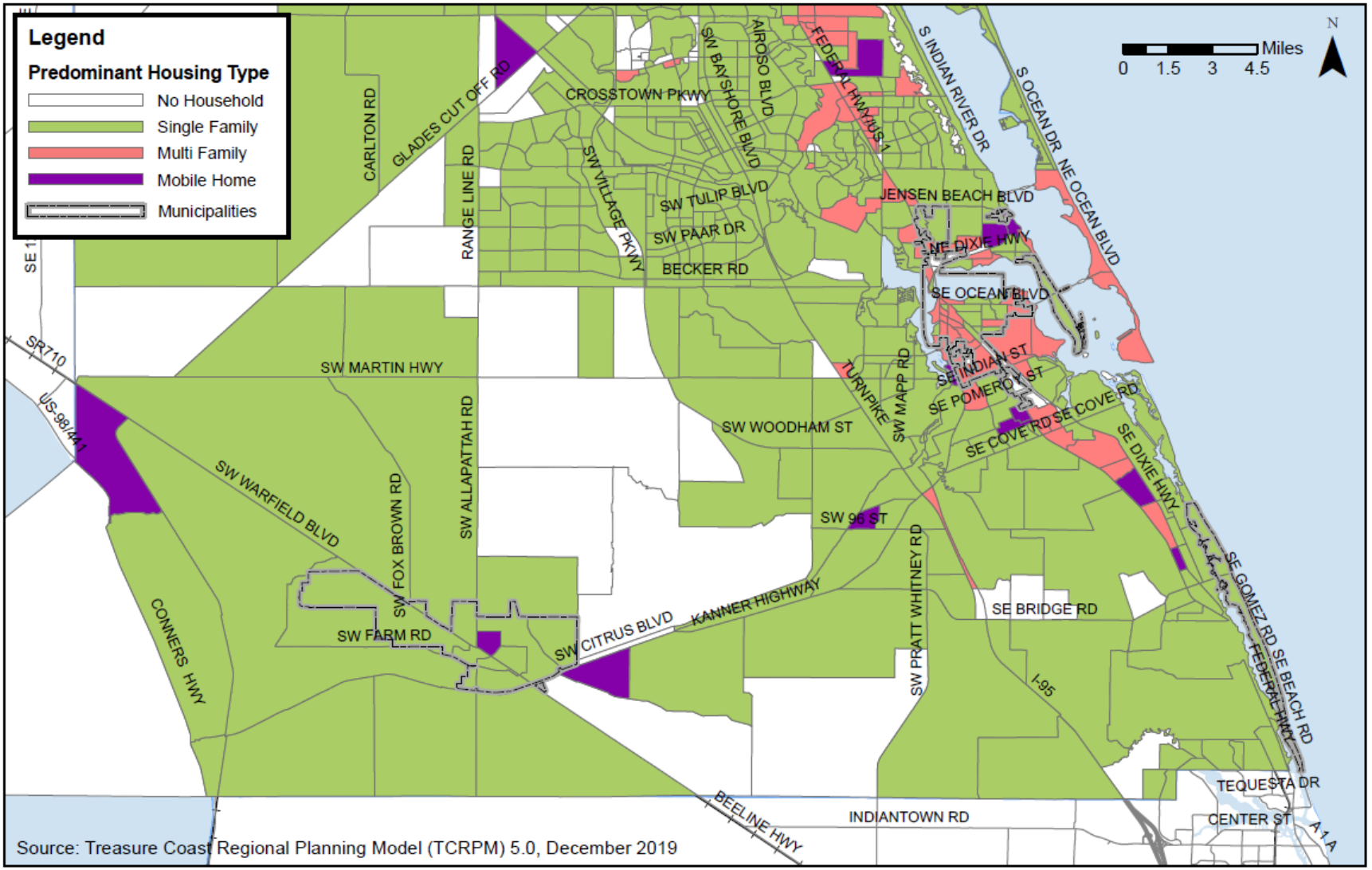


Figure 2-19: Group Quarters by TAZ, 2045

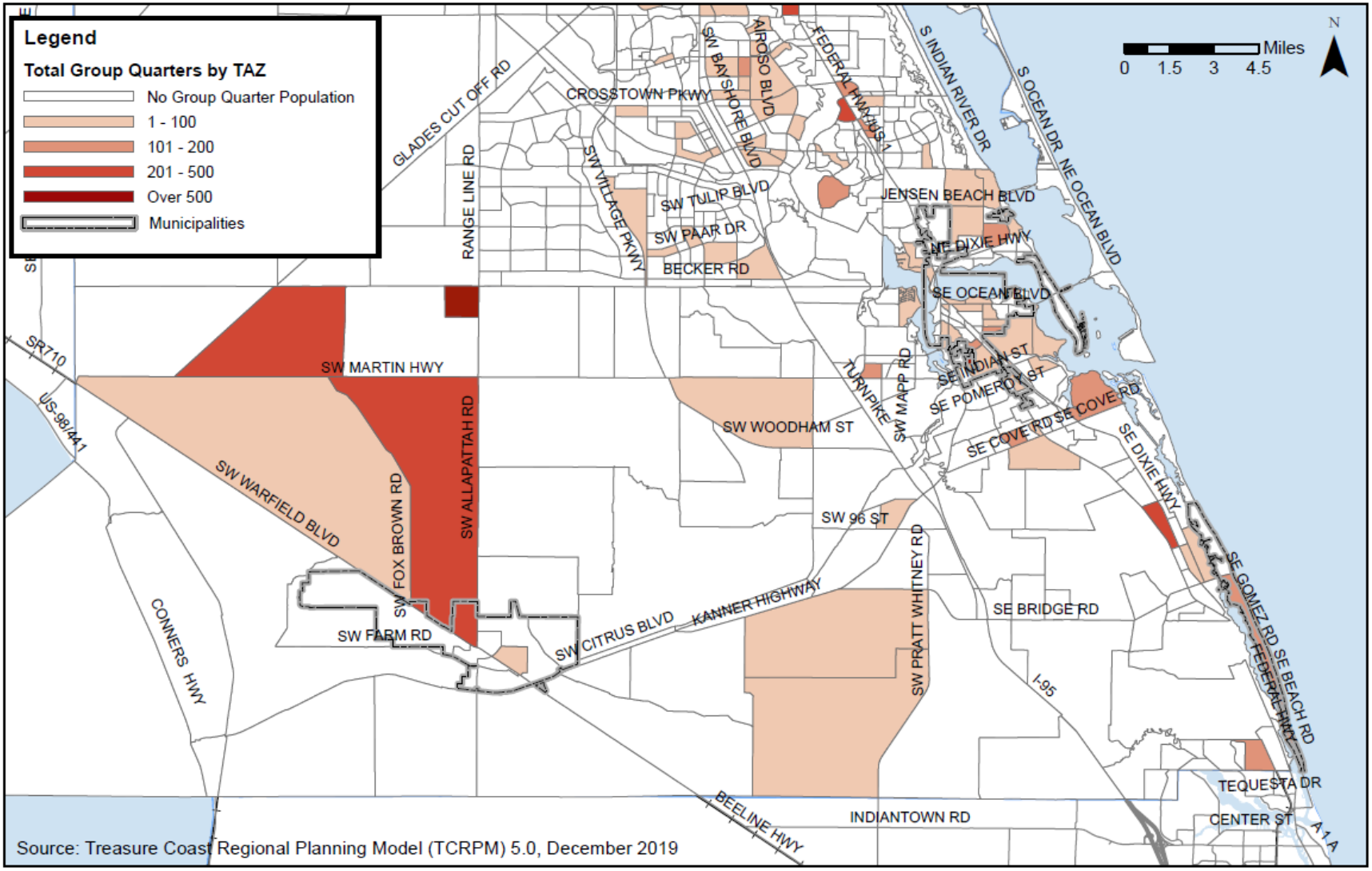
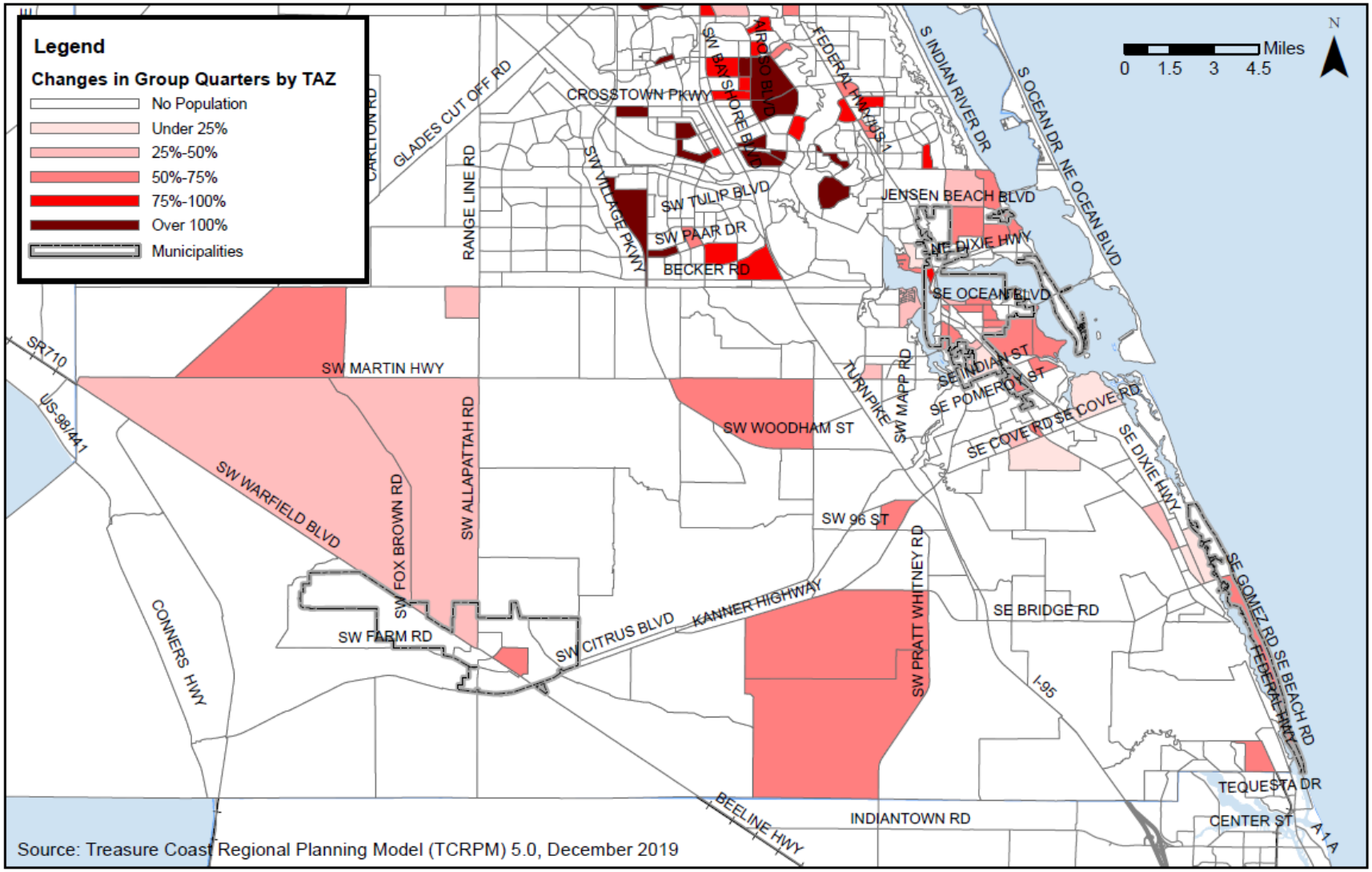


Figure 2-20: Changes in Group Quarters by TAZ, 2015-2045



3. Travel Demand Forecast

This chapter explains existing travel patterns, travel behavior as well as future travel demand and deficiency analysis to inform the data driven component of Martin MPO's needs assessment.

A travel demand model is a computer-based mathematical representation of the regional transportation system, socioeconomic conditions, and travel patterns. The model is based on a validation process using known traffic counts and socioeconomic data from a prior year. The model will determine how much demand for transportation services (i.e. traffic or trips) the region should expect in the future, based on changing conditions. A regional travel demand model has been developed for the Treasure Coast Region, which includes Indian River County, St. Lucie County, and Martin County. The Treasure Coast Region coordinated with each other to help develop the model. This model is known as the Treasure Coast Regional Planning Model 5.0 (TCRPM 5.0). Travel demand models are useful to project future transportation conditions and evaluate alternatives for future roadway system improvements. The travel estimates are then used to identify existing and projected deficiencies. The TCRPM 5.0 created by FDOT is one of the tools utilized for travel demand forecasting for the Martin 2045 LRTP.

3.1 Existing plus Committed (E+C) Network

3.1.1 Highway Network

The 2015 transportation network is the base year and the network has been adjusted to replicate the 2045 Existing plus Committed (E+C) transportation network incorporated in FDOT's Five Year Work Program (2015-2020) and the Martin MPO's Transportation Improvement Program (TIP) for fiscal years (FY) 2015 through FY 2020. The 2045 E+C projects provided in **Table 3-1** were coded into the 2015 base network. Since the construction along S Kanner Highway/SR 76 north of I-95 has been completed, the number of lanes, along S Kanner Highway in the base network, were updated from two lanes in each direction to three lanes. Socioeconomic data for 2045 was utilized in the 2045 E+C scenario.

Table 3-1: Committed Roadway Projects

Facility	From	To	Project Description
SR-710/Warfield Boulevard[1]	Milepost Marker 9.771	Milepost Marker 14.967	Reconstructing and widening SR-710 from a two-lane, two-way undivided roadway to four-lane divided roadway.
SR-76/Kanner Highway	South of CR-711/Pratt Whitney Road	SW Jack James Drive	Two lanes will be added, going from two to four.
SR-714/SW Martin Highway	Citrus Boulevard	SW Martin Downs Boulevard	Widening SR-714 from two to four lanes.

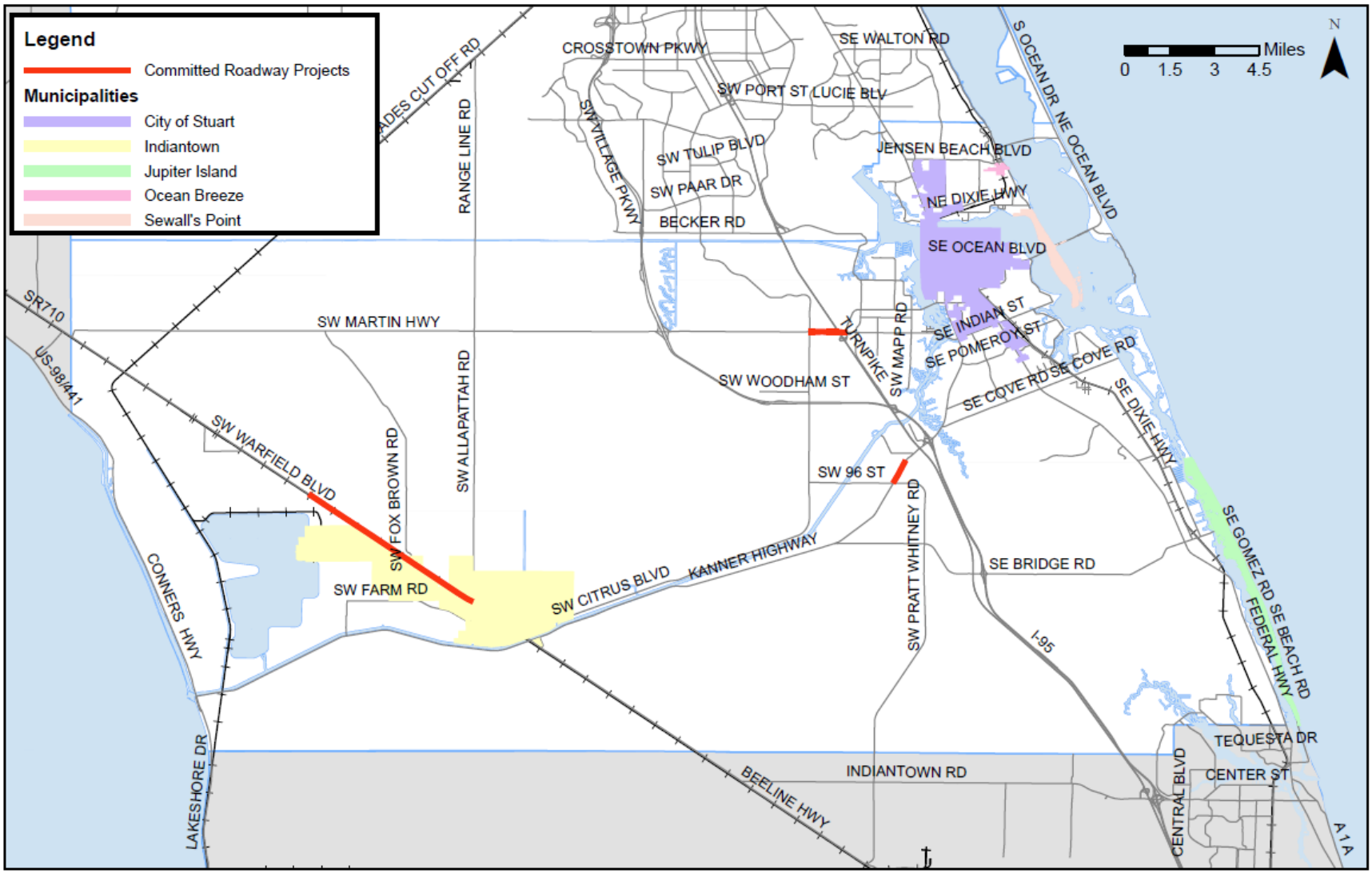
3.1.2 Roadway Deficiencies

The 2045 traffic demand projections developed using the TCRPM E+C network assume that no capacity-producing roadway improvements would be implemented from the years 2020 through 2045. The TCRPM E+C model assesses the impact of 25 years of growth on the roadway network. Model data such as traffic volume and V/C ratio were examined to identify roadway deficiencies resulting from the growth in travel over the 25-year period. Deficient roadways are candidates for potential future roadway improvements. When estimating the V/C ratio, capacities corresponding to the 2012 FDOT Quality/Level of Service Handbook Tables were utilized. Roadway capacity was modified in the model to reflect local government comprehensive plans.

The Martin County Roadway 2018 Level of Service Inventory and TCRPM data were examined to identify roadway deficiencies resulting from the growth in travel demand over the 25-year time horizon of the LRTP on the E+C roadway network. Various roadway network improvement alternatives were evaluated to identify which improvements would have the greatest impact on reducing future deficiencies. **Figure 3-2** depicts the roadway deficiencies in Martin County.

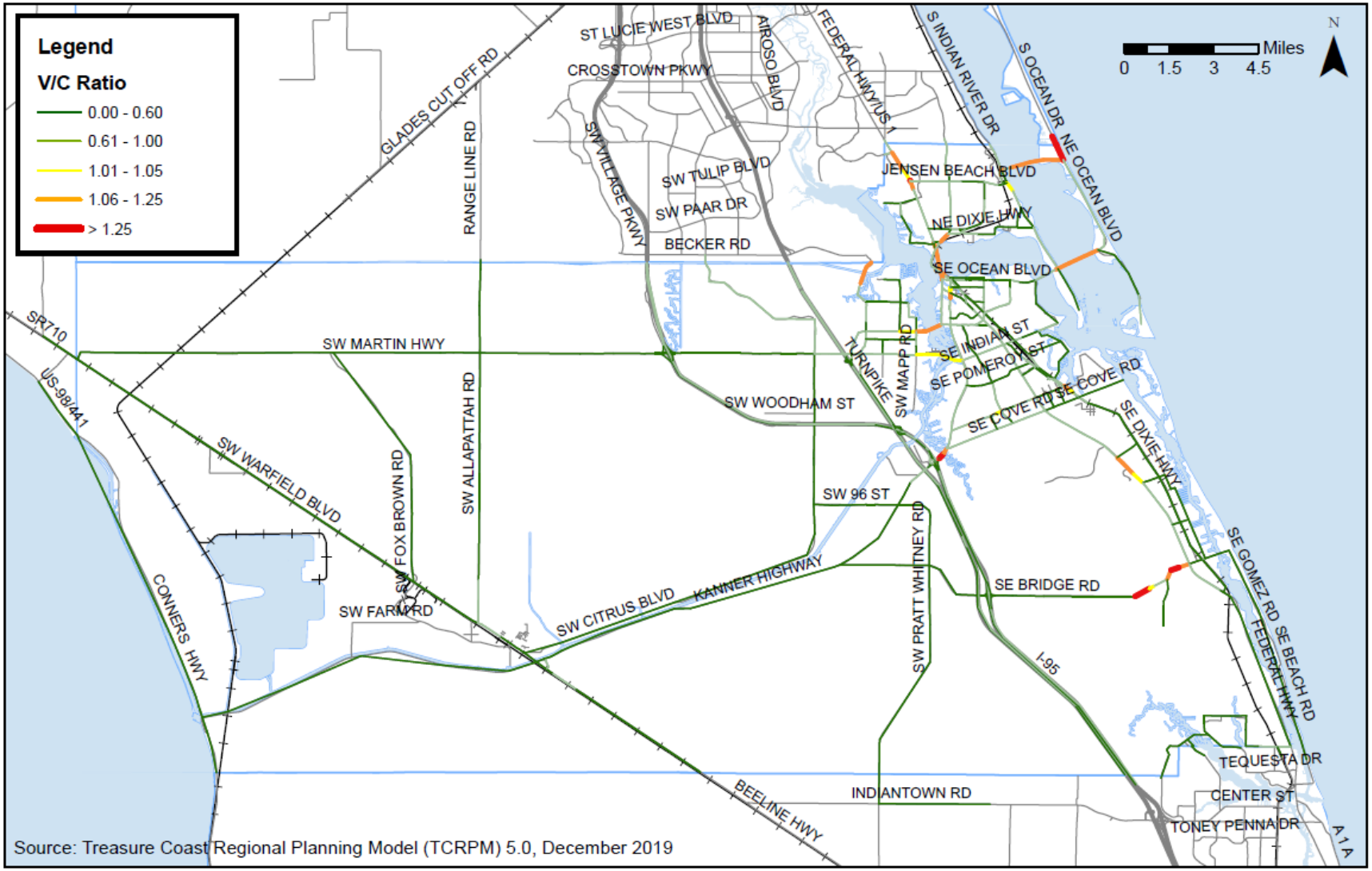
[1] The preliminary engineering and right-of-way phases for the SR-710/Warfield Boulevard widening project (from CR-609/Allapattah Road to the FPL Power Plant) are currently funded in the SIS First Five-Year Plan FY 20/21 – FY 24/25 adopted in July 2020. However, due to funding constraints, the construction phase ($41,422,000) was removed from the current SIS Second Five-Year Plan FY 25/26 – FY 30/31 that was adopted in July 2020. To allow for interim projects to be developed along the SR-710 corridor from CR-609/Allapattah Road to the Martin/Okeechobee County Line prior to the ultimate widening projects from 2 to 4 lanes, SR-710 project descriptions have been revised to "Roadway Improvement" projects to avoid any issues associated with planning consistency.
Highway capacity project on SR-710 has been removed from the E+C network. The MPO will submit the TCRPM 5.0 files for the E+C network as well as the 2045 Cost Feasible Plan (CFP) network after the MPO Policy Board adopts the 2045 LRTP – *Martin in Motion*.

Figure 3-1: Existing + Committed (E+C) Highway Projects*



* To ensure planning consistency with the Strategic Intermodal System (SIS) First Five-Year Plan FY 20/21 – FY 24/25 adopted in July 2020, the highway capacity project on SR-710 has been removed from the E+C network. The MPO will submit the TCRPM 5.0 files for the E+C network as well as the 2045 Cost Feasible Plan (CFP) network after the MPO Policy Board adopts the 2045 LRTP – *Martin in Motion*.

Figure 3-2: Roadway Deficiencies



3.1.3 Transit Network

Figure 3-3 presents a physical representation of the county and its municipalities and the current transit routes within Martin County. Currently, five routes comprise the Marty system, three fixed routes and two express routes, which include:

- Route 1, an intercounty route serving US 1 from the Port St. Lucie Walmart to Cove Road and providing connections to the Treasure Coast Connector in St. Lucie County.
- Route 2, primarily serving Indiantown.
- Route 3, primarily serving Stuart.
- Route 20x, an express route providing service from Stuart to Palm Beach County and providing connections to Palm Tran at Palm Beach Gardens Mall and the Veteran's Administration Medical Center (VAMC) in Palm Beach County.
- Route 30x[2], an express commuter route starting in Indiantown and ending in Hobe Sound at Bridge Road and Dixie Highway, making a connection with Route 20x at Bridge Road and US 1.

[2] Transit service description is consistent with Martin County's Transit Development Plan (TDP), 2020-2029 adopted in August 2019 as well as the transit network included in the TCRPM 5.0. Route 30x has been canceled and it is not currently operational. Route 4 was added to provide service between the South Stuart and Hobe Sound. More information on Route is available at https://www.martin.fl.us/BusSchedule.

Figure 3-3: Martin County Existing Transit Network

3.2 Existing Travel Patterns and Transportation Demand

This section describes the travel characteristics of Martin County. The focus is on work trips made by workers that live in Martin County as work trips make up more than 15% of the total daily traffic and are the single most important contributing factor to traffic congestion during peak hours. The analysis will be based on the 5-year (2012-2016) American Community Survey (ACS)/Census Transportation Planning Product (CTPP) data. CTPP is a data program sponsored by AASHTO with funding contributions from all state DOTs and some MPOs. The CTPP uses ACS samples for data tabulation and the dataset includes the following three parts:

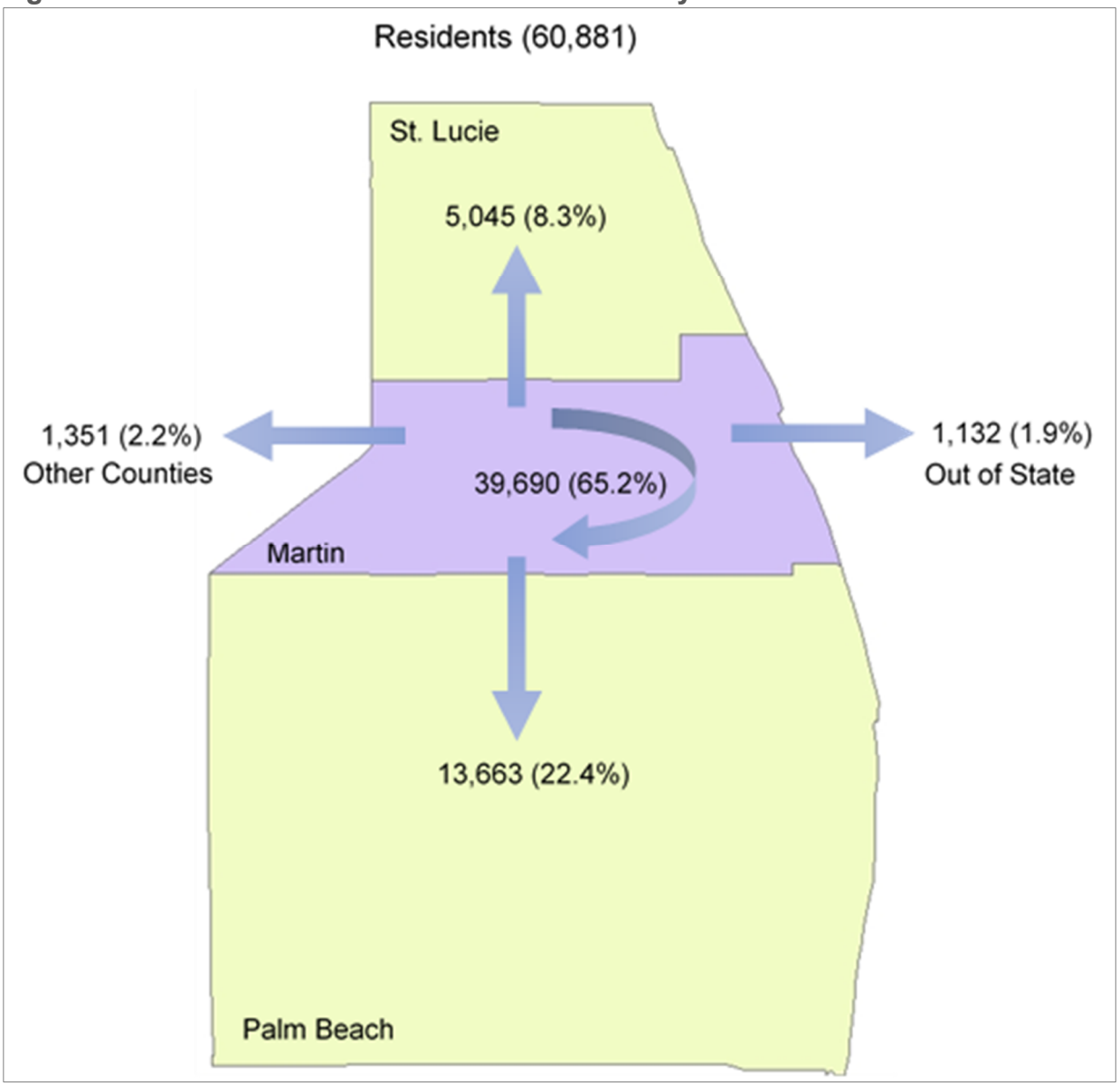
- Part 1: Residence-based tabulations summarizing worker and household characteristics
- Part 2: Workplace-based tabulations summarizing worker characteristics
- Part 3: Worker flows between home and work, including travel mode

The 2012-2016 ACS/CTPP dataset was released in March 2019 and provides most current and most comprehensive information on socio-economic and commute characteristics at various geographic levels.

3.2.1 Places of Work for Martin County Residents

Figure 3-4 illustrates the counties and places where residents of Martin County worked. Between 2012 and 2016, there were a total of 60,881 workers residing in Martin County. Close to two-thirds (65.2%) of the resident workers (39,690) in Martin County were employed within the County. Palm Beach County was the most popular workplace outside Martin County, employing 13,663, or 22.4% of the County's workforce. This was followed by the neighboring St. Lucie County where 5,045, or 8.3% of the Martin County resident workers traveled to work. There were 1,351 workers (2.2%) commuted to work in other counties in Florida, while a small percentage of people (1.9%, or 1,132) were employed out of the State.

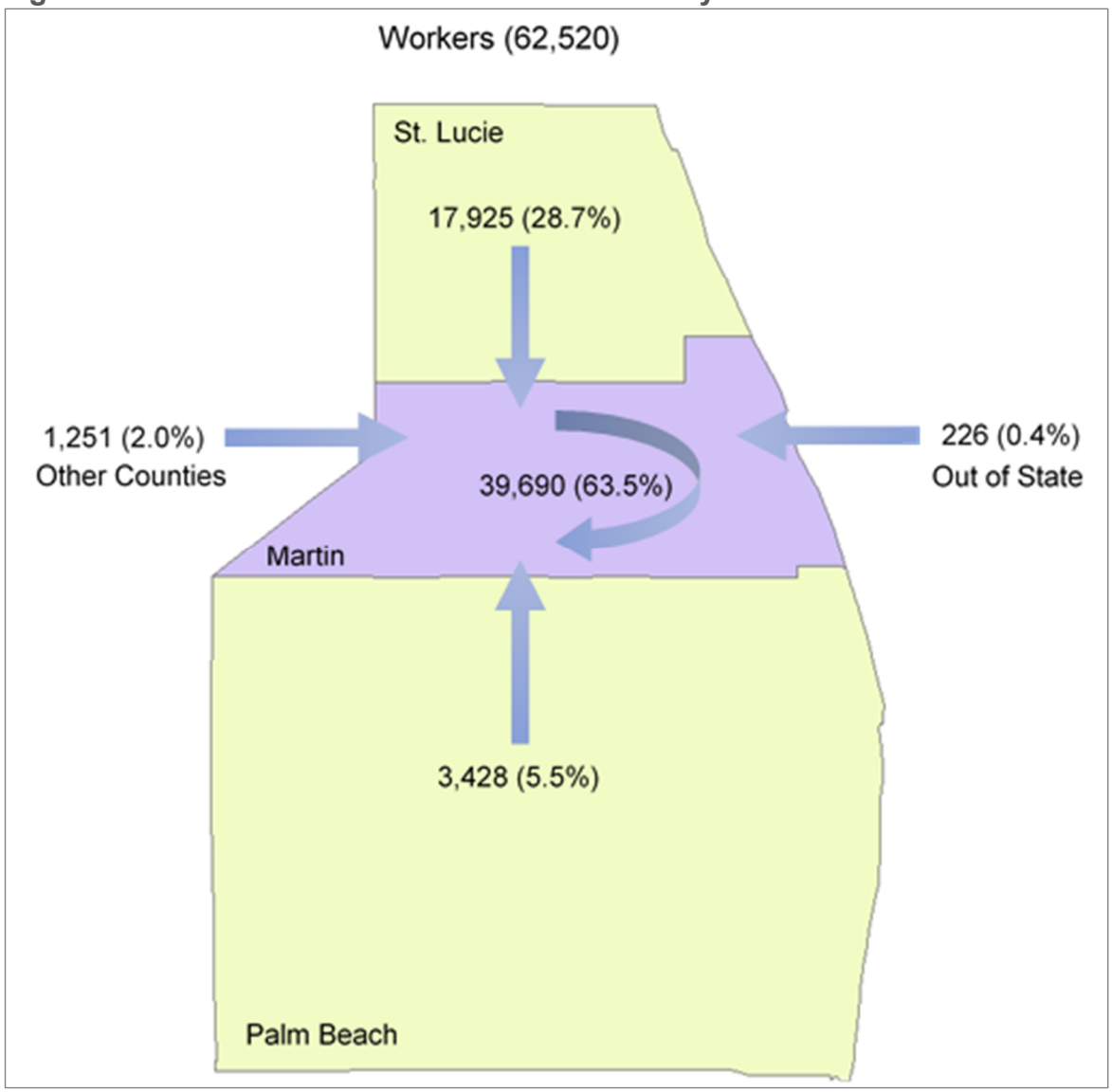
Figure 3-4: Work Place Counties for Martin County Residents



3.2.2 County of Residents for Martin County Workers

Figure 3-5 shows where workers in Martin County live. Between 2012 and 2016, a total of 62,520 workers were employed in Martin County. Compared to the 60,881 workers living in Martin County, Martin County provided more employment opportunities than the County's workforce and had an employment surplus of 1,639 jobs. About 28.7%, or 17,925 workers in Martin County lived in St. Lucie County. A smaller percentage, 5.5%, or 3,428 workers in Martin County came from Palm Beach County. Two percent (2%) or 1,251 people were residents of other Florida counties. There were 226 people traveling to Martin County to work from places outside Florida.

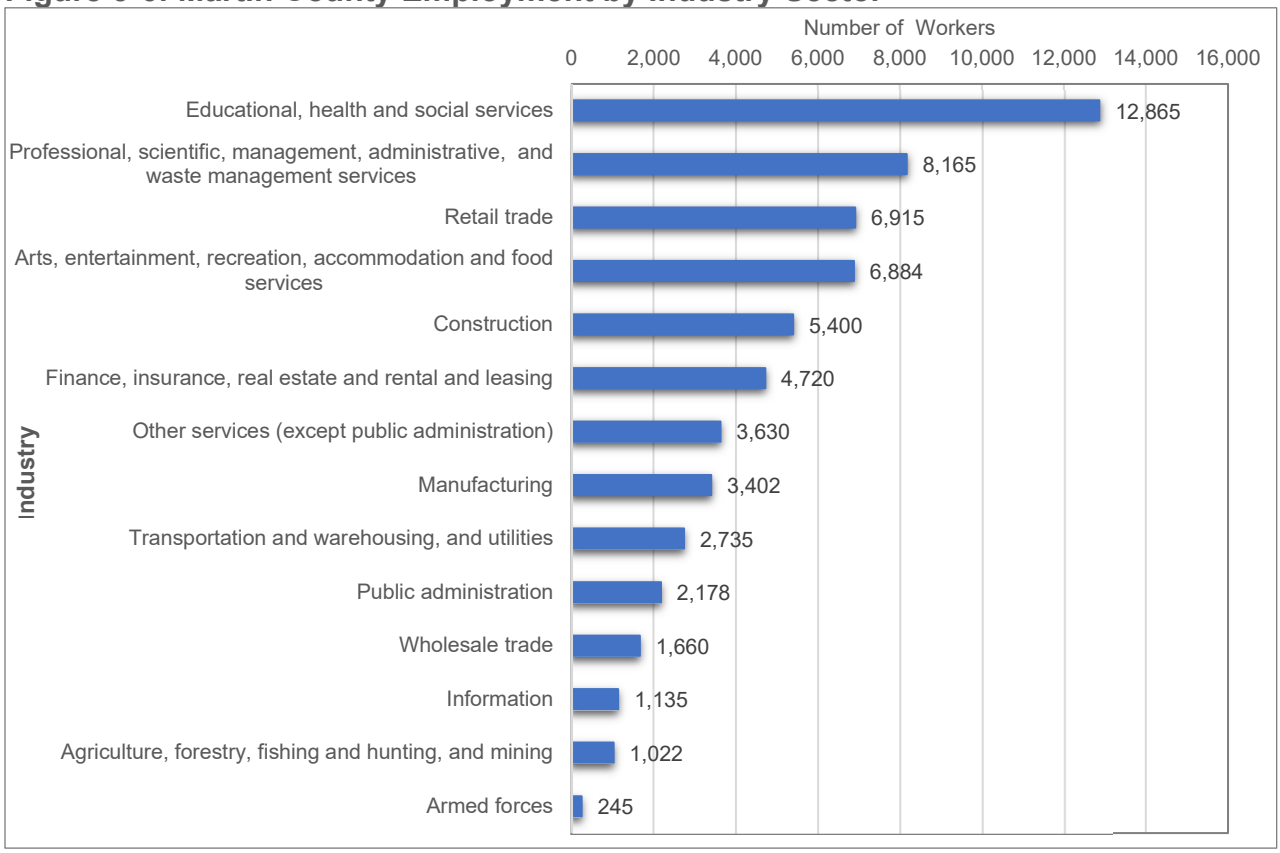
Figure 3-5: Residence Counties for Martin County Workers



3.2.3 Martin County Employment by Industry Sector

Figure 3-6 shows the employment in different industry sectors in Martin County in descending order between 2012 and 2016. "Education, health, and social services" was the largest industry sector, employing nearly 13,000 people. More than 8,000 people worked in "Professional, scientific, management, administrative, and waste management services" jobs. Close to 7,000 people were employed in "Retail trade" sector, and a similar number of people worked in "Arts, entertainment, recreation, accommodation, and food services". The "Construction" industry employed more than 5,000 people during the same period, making it the 5th largest industry in the County.

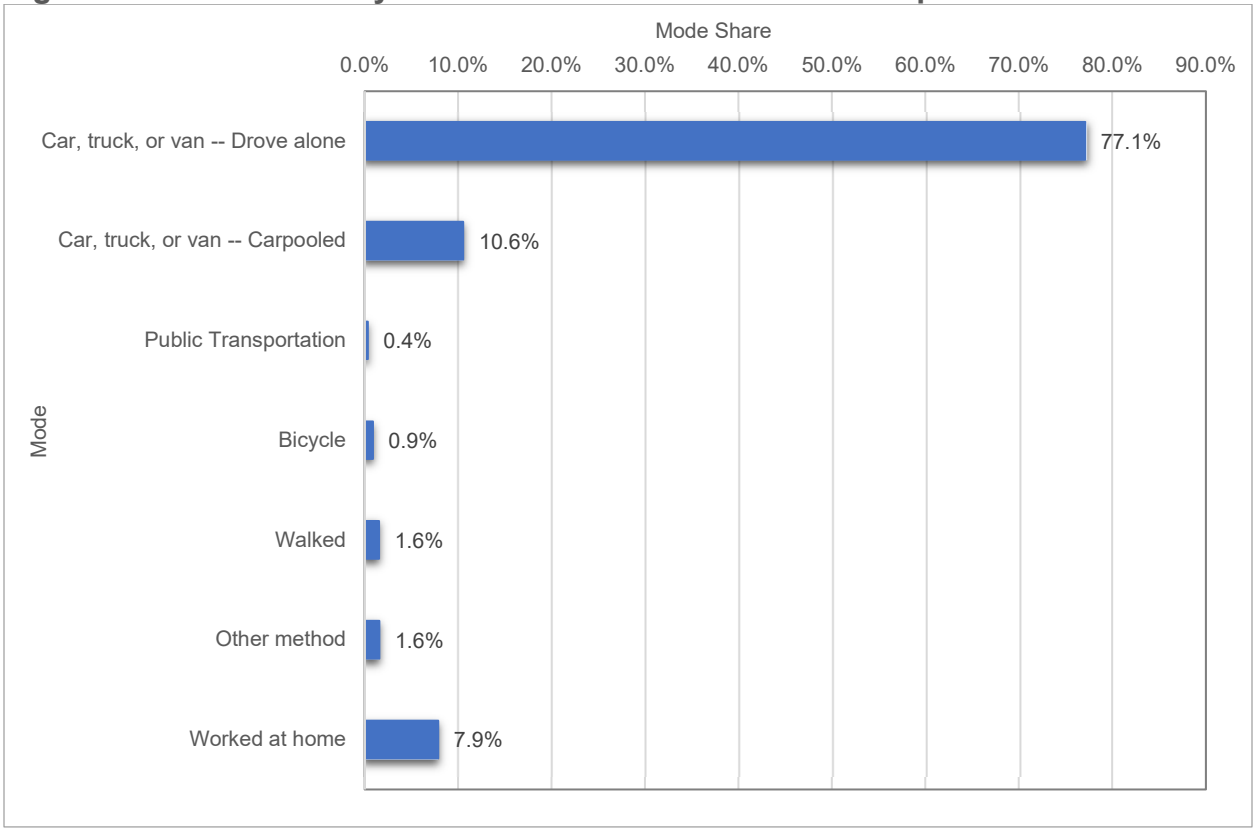
Figure 3-6: Martin County Employment by Industry Sector



3.2.4 Means of Transportation (MOT) to Work

Figure 3-7 depicts Means of Transportation distribution to work for workers that lived in Martin County between 2012 and 2016. “Drove Alone” was still the predominant mode of travel to work with 77.1%. Approximately 11% of workers commuted to work by carpool. Public Transportation made up about 0.4% of the mode shares, which was lower than the shares for Bicycle (0.9%) and Walk (1.6%). About 1.6% workers used “Other method” such as taxi or motorcycles to work. Nearly 8.0% of the employees worked from home.

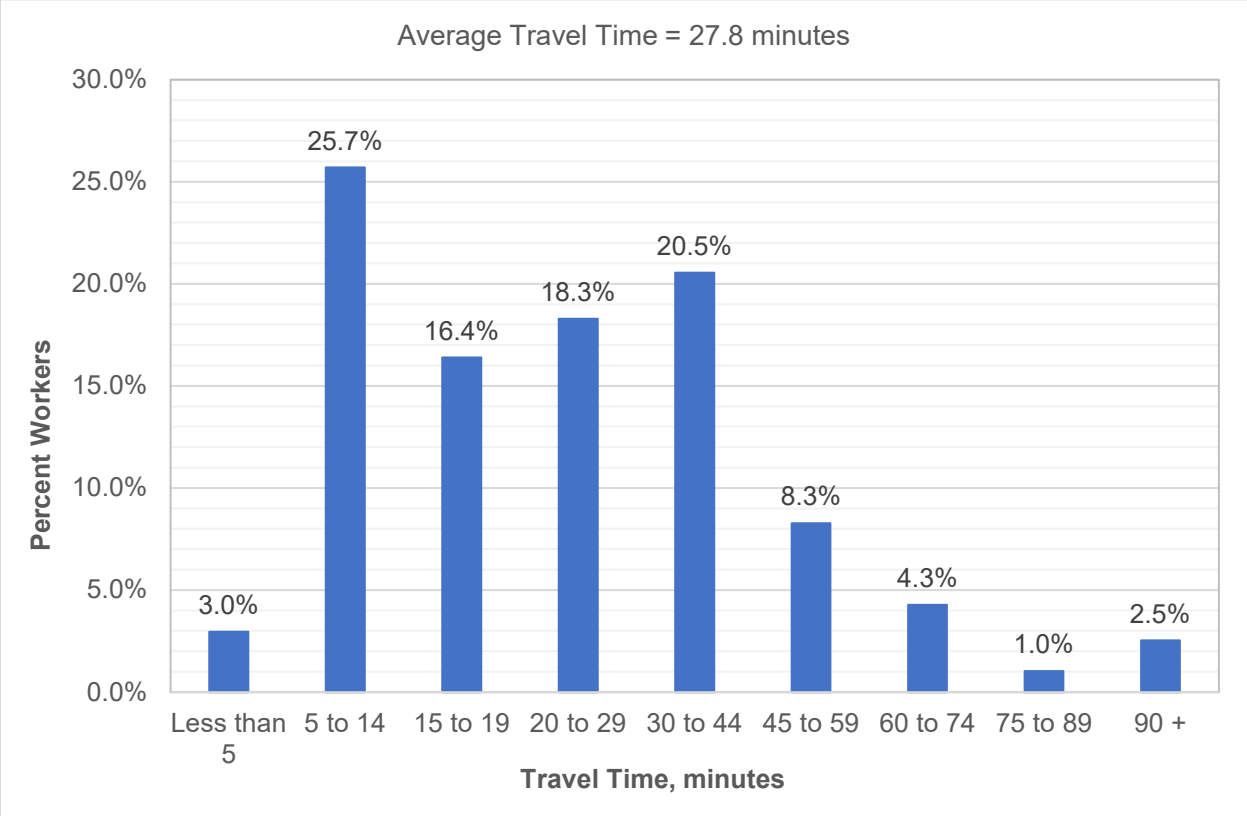
Figure 3-7: Martin County Resident Workers Means of Transportation to Work



3.2.5 Travel Time to Work

Figure 3-8 shows the travel time distribution for workers residing in Martin County between 2012 and 2016. Close to 25.7% of the workers took between 5 and 14 minutes to get to work. Another 21% took between 30 and 44 minutes to go to work. Over 16% people spent more than 45 minutes on the road to work. The average travel time for all employees that did not work from home was 27.8 minutes.

Figure 3-8: Martin County Resident Workers Travel Time to Work



3.3 Travel Demand Forecast, Year 2045

Using TCRPM 5.0, growth in travel demand was forecasted between the base year 2015 and future year 2045. **Tables 3-2**, **3-3** and **3-4** show total person trips in the base year 2015, future year 2045 and percentage growth between year 2015 and year 2045 respectively in the Treasure Coast Region.

Table 3-2: Average Weekday Person Trips Matrix, Base Year 2015

Geography	Indian River County	St. Lucie County	Martin County	External	Total
Indian River County	492,676	27,308	2,084	3,068	525,136
St. Lucie County	27,348	798,996	65,716	11,676	903,736
Martin County	2,044	65,756	416,704	13,936	498,440
External	3,068	11,676	13,936		28,680
Total	525,136	903,736	498,440	28,680	1,955,992

Table 3-3: Average Weekday Person Trips Matrix, Future Year 2045

Geography	Indian River County	St. Lucie County	Martin County	External	Total
Indian River County	674,516	45,940	3,056	3,440	726,952
St. Lucie County	46,020	1,496,576	103,744	19,912	1,666,252
Martin County	2,976	103,824	482,008	15,376	604,184
External	3,440	19,912	15,376		38,728
Total	726,952	1,666,252	604,184	38,728	3,036,116

Table 3-4: Growth in Daily Person Trips, Year 2015 to Year 2045

Geography	Indian River County	St. Lucie County	Martin County	External	Total
Indian River County	37%	68%	47%	12%	38%
St. Lucie County	68%	87%	58%	71%	84%
Martin County	46%	58%	16%	10%	21%
External	12%	71%	10%		35%
Total	38%	84%	21%	35%	55%

While person trips in the Treasure Coast Region will grow approximately 55% (from two million daily trips to three million daily trips) between 2015 and 2045 years, Martin County's transportation market is anticipated to grow by 21% (from 498,500 daily person trips to 604,200 daily person trips). This growth is proportional to the population growth forecasts for the County.

3.4 Deficiency Analysis

The deficiency analysis, which is one of the data driven components of 2045 Needs Assessment identified stresses in the transportation network[3]. This information in turn helped identify required improvement projects needed to maintain acceptable mobility conditions to an area's transportation network. As it relates to travel demand model, the type of projects identified as part of the needs assessment and included within the needs plan include roadway and transit capacity projects. A Needs Plan is fiscally unconstrained as funding requirements and anticipated revenue sources for the identified improvements are not taken into consideration until the development of the multimodal Cost Feasible Plan (CFP).

3.4.1 Volume to Capacity (v/c) Ratio

Volume-to-capacity (V/C) ratio is a measure of the traffic volume on a road compared to the capacity of the road. The capacity of a road depends on its physical and operational characteristics and varies by functional class. A higher V/C ratio indicates that the traffic volume of the road is nearing its capacity and is becoming congested. Volume-to-capacity (V/C) ratio was used to identify congestion in the transportation network as part of the 2045 Needs Assessment. **Table 3-5**, **Figure 3-9,** and **Figure 3-10** indicate that the traffic volume for some segments are nearing their capacity and are becoming congested.

Table 3-5: Volume to Capacity Ratio, 2045 – Congested Corridors

Facility	From	To	Volume to Capacity Ratio
SR-714/Martin Highway	CR-76A/Citrus Boulevard	Martin Downs Boulevard	0.93
Willoughby Boulevard	SR-714/ Monterey Road	SR-5/US-1/Federal Highway	0.74
Village Parkway Extension	SR-714/Martin Highway	St. Lucie County Line	0.21
Cove Road	SR-76/Kanner Highway	Willoughby Boulevard	0.57
Cove Road	Willoughby Boulevard	SR-5/US-1/Federal Highway	0.52
Cove Road	SR-5/US-1/Federal Highway	CR-A1A	0.20
CR-713/High Meadow Avenue	I-95	CR-714/Martin Highway	0.33
S Ocean Drive	North County Line	NE Causeway Boulevard	0.63
SE Bridge Road	Powerline Avenue	US-1/Federal Highway	0.82
SE Green River Parkway	NW Wright Boulevard	NW Dixie Highway	0.72
SW Murphy Road	Whisper Bay Terrace	North County Line	0.59
Federal Highway/US 1	SE Seabranch Boulevard	SE Osprey Street	0.70
Martin Highway	SW Mapp Road	SR-76/Kanner Highway	0.69
SW Martin Downs Boulevard	SW Matheson Avenue	SW Palm City Road	0.91

[3] E+C network with 2045 land use and socioeconomic data represents the 2045 Needs Assessment model outputs. This illustrates impact on the transportation network in Martin County if no additional improvements beyond those included in the FY 2020/21-FY 2024/25 are implemented. To ensure planning consistency with the Strategic Intermodal System (SIS) plans adopted in July 2020, the highway capacity project on SR-710 has been removed from the E+C network. The MPO will submit the TCRPM 5.0 files for the E+C network as well as the 2045 Cost Feasible Plan (CFP) network after the MPO Policy Board adopts the 2045 LRTP – Martin in Motion.

Figure 3-9: Congested Corridors, E+C Network, 2045

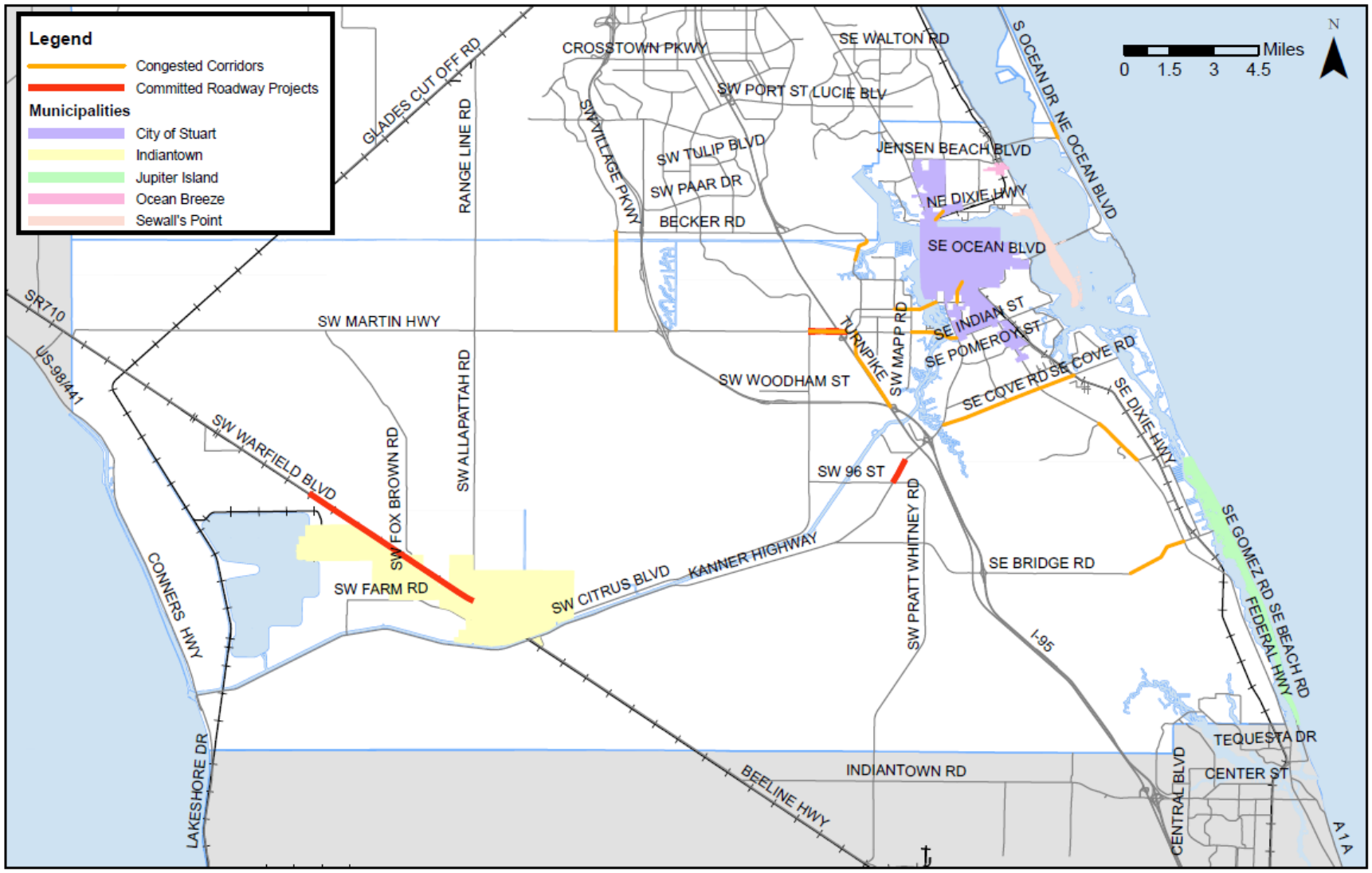
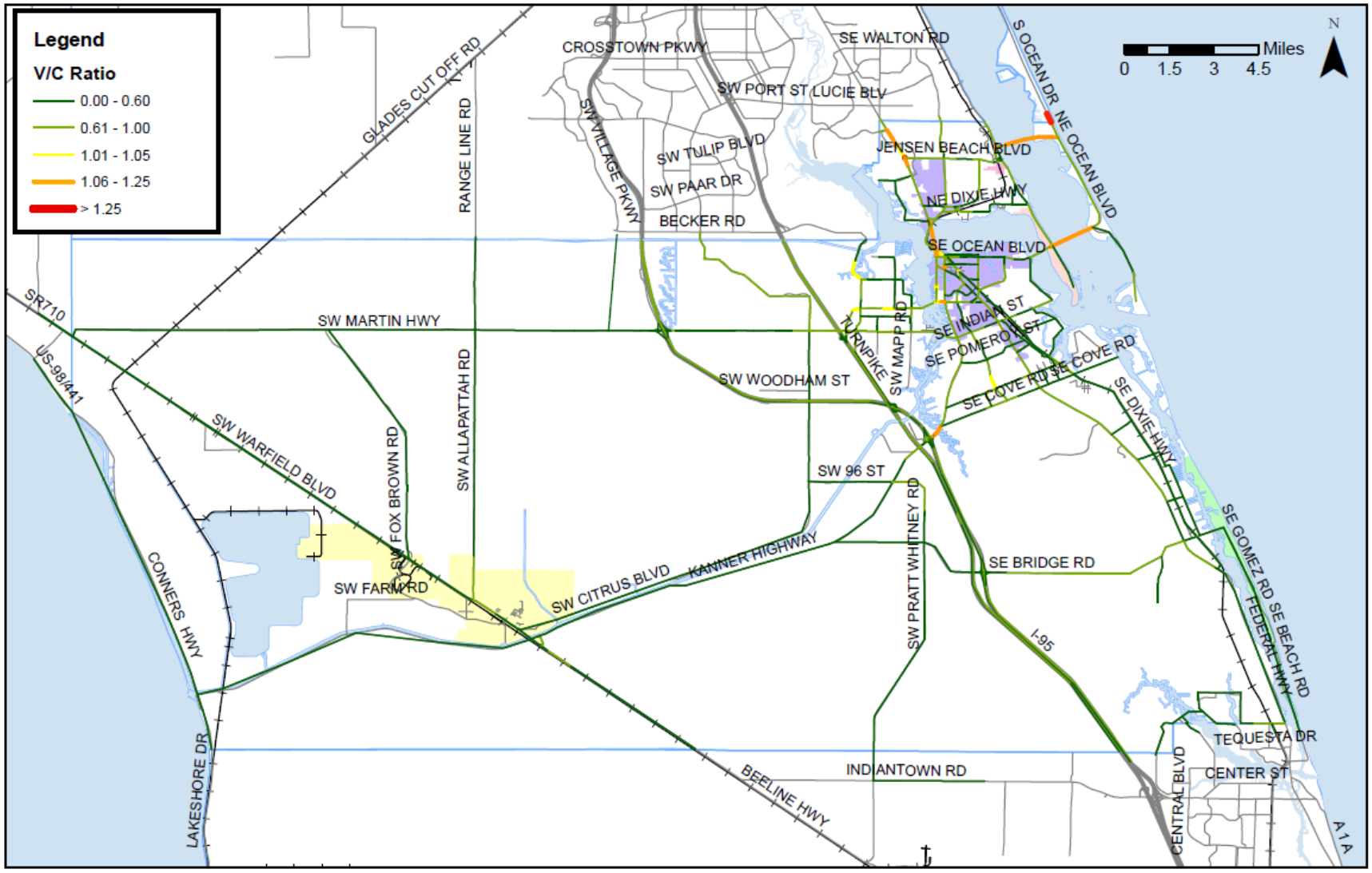


Figure 3-10: Volume to Capacity (V/C) Ratio, E+C Network with 2045 Land Use Data



3.5 Travel Demand Parameters

Table 3-6 shows travel demand parameters comparison for the base year 2015 and future year 2045 to illustrate order of magnitude growth of Martin County's transportation market and related metrics.

Table 3-6: Travel Demand Parameters

Demand Parameter	Base Year, 2015	E+C Network w/ Future Land Use, 2045[4]	Percent Change
Vehicle Miles Traveled (VMT), Daily	1,508,760	2,186,891	44.9%
Vehicle Hours Traveled (VHT), Daily	32,429	59,217	82.6%
Vehicle Hours of Delay (VHD), Daily	3,954	18,389	365.1%
Population	151,596	181,312	19.6%
Household	67,977	81,127	19.3%
VMT per household	22.2	27.0	21.5%
VMT per capita	10.0	12.1	21.2%
VHT per household	0.5	0.7	53.0%
VHT per capita	0.2	0.3	52.7%
Transit Ridership, Daily	787	859	9.1%

The metrics in **Table 3-6** show that the growth in VMT (approximately 44.9%) is more than double the population growth (approximately 19.6%) while VHT grows more than four times (approximately 82.6%) compared to the population growth (approximately 19.6%) in Martin County. Significant delay is forecast for the future year 2045 compared to the base year 2015.

[4] E+C network with 2045 land use and socioeconomic data represents the 2045 Needs Assessment model outputs. This illustrates impact on the transportation network in Martin County if no additional improvements beyond those included in the FY 2020/21-FY 2024/25 are implemented.
To ensure planning consistency with the Strategic Intermodal System (SIS) plans adopted in July 2020, the highway capacity project on SR-710 has been removed from the E+C network. The MPO will submit the TCRPM 5.0 files for the E+C network as well as the 2045 Cost Feasible Plan (CFP) network after the MPO Policy Board adopts the 2045 LRTP – *Martin in Motion*.

4. Scenario Planning

This chapter discusses assumptions and methodology used to develop planning scenarios, modeling approach, and provides a comparative evaluation of the scenarios relative to the 2045 Cost Feasible Plan. The scenario planning effort addresses one of the proactive improvements area as well as emerging issues – Mobility on Demand (MDD), which are included in the FHWA's *Federal Strategies for Implementation Requirements for LRTP Updates for the Florida MPOs, January 10, 2018*. Further, the scenario planning effort integrates FDOT's *Guidance for Accessing Planning Impacts and Opportunities of Automated, Connected, Electric and Shared-Use Vehicles, May 2018*.

4.1 Scenario Planning

The scenario planning exercise is an analytical framework that considers the impact of policy transformation and various investments on the transportation system. Consistent with federal and state guidance to incorporate multiple planning scenarios in the LRTP development process, the purpose of this effort is to evaluate impact of transportation improvements and strategies on travel behavior and transportation network capacity relative to the cost feasible plan. It should be noted that the improvements included in the scenario planning effort are not fiscally constrained. To that end, the scenarios includes projects and strategies that go beyond the 2045 LRTP Cost Feasible Plan.

Two alternative scenarios – Emerging Technologies and Enhanced Transit were developed for the Martin MPO. Each of the scenarios was compared to the Cost Feasible Plan. In addition to evaluating the systemwide performance of these scenarios, a high-level impact on revenues and costs was derived based on readily available data. A systemwide comparative evaluation provided the Martin MPO an overall framework to allocate resources available as "box items" or "set-aside" funds, make policy decisions regarding revenue sources as well as inform future planning efforts.

In addition to the regional travel demand model - Treasure Coast Regional Planning Model (TCRPM 5.0), some off-model adjustments were made to evaluate the impacts of the two scenarios. A detailed discussion of the assumptions, methodology, and evaluation results from the scenario planning effort follows.

4.1.1 Enhanced Transit Scenario

An Enhanced Transit Scenario emphasizes investment in public transportation to create a robust bus-based transit network that comprises fixed route bus service, express or commuter service, and Bus Rapid Transit (BRT) service. The emphasis in this scenario is on improving transit rider's experience and thereby attracting new riders. This improved experience includes short travel time, more frequent service or reduced headways, increased span of service, real time passenger information, enhanced bus stops as well as transit signal priority and even exclusive or dedicated lanes in case of BRT corridors. It should be noted that the future year land use and socioeconomic factors were considered to remain unchanged relative to the Cost Feasible Plan[5]. In addition to existing

[5] No changes were made to the 2045 land use and socioeconomic in the regional travel demand model (TCRPM 5.0). Holding the land use constant allowed for evaluating the impact of enhanced transit service on ridership, mode split and transportation network capacity between the Cost Feasible Plan and Enhanced Transit scenario.

fixed route bus service (Routes 1, 2, 3, 20x, and 30X) operated by MARTY, an Enhanced Transit Scenario comprises expanded transit services included in the Martin County's 2020-2029 Transit Development Plan, August 2019 and two BRT projects along SR-710 and US-1/Federal Highway. **Table 4-1** shows expanded transit service while **Table 4-2** includes BRT projects description and service characteristics as well as transit guideway configuration assumptions.

Table 4-1: Transit Service Expansion, Enhanced Transit Scenario

Project Description	Location/Geography	Improvement Category
Extend Route 2	Add a stop at Halpatiokee Park during peak commute hours, transfer opportunities to Routes 1 and 3. Closed door service during non-peak hours.	Restructure Route
Split Route 3 into Routes 3a and 3b	Same service coverage area but provides new service along Monterey Road between Willoughby Boulevard and US-1/Federal Highway. Maintain existing headways and transfer opportunities to Route 1 and to each other.	Restructure Route
Extend Route 20X	Extend service to Halpatiokee Park to the north and to Mangonia Tri-Rail Station in Palm Bach County to the south during peak commute hours only.	Restructure Route
Add later service for Routes 1, 2 and 3	Increase span of service by approximately 2 hours from 8:00 pm to 10:00pm. Current span of service is approximately 6:00 am to 8:00 pm, weekday service only.	Increase Span of Service
Add Saturday service for Routes 1, 2 and 3	Provide Saturday service from 6:00 am to 8:00 pm on Routes 1, 2 and 3.	Add Saturday Service
Double frequencies for Routes 2 and 3	Reduce headway on Route 2 from 40 minutes (Indiantown loop) and 95 minutes (Closed door eastbound service to Stuart) to 20 minutes and 48 minutes respectively. Reduce headway on Route 3 from 40 to 20 minutes.	Reduce Headway
New Jensen Beach Route	From Treasure Coast Square to Jensen Beach Park (serving Hoke Library, Jensen Beach Park, Hutchinson Island and Kiwanis Park-and-Ride).	New Service
New regional Turnpike commuter route to West Palm Beach Downtown Intermodal Transit Center	From US-1/Federal Highway and Kanner Highway to Intermodal Transit Center (serving FDOT Park-and-Ride at SW Martin Highway, West Palm Beach Virgin Trains USA/Brightline station, City Place and Palm Tran's Intermodal Transit Center). Peak hour service only with two morning and two evening trips.	New Service

Table 4-2: Bus Rapid Transit (BRT) Projects, Enhanced Transit Scenario

BRT Corridor	From/To	Span of Service	Headway (in minutes) (Peak/Off-Peak)	Transit Guideway Configuration	Station Location
SR-710	Martin /Palm Beach County Line to Indiantown (Indianwood Drive/SR-710)	6:00 am to 8:00 pm	10/20	Dedicated lanes for bus in addition to existing general-purpose travel lanes.	Every half mile or major intersections
US-1/Federal Highway	Martin /Palm Beach County Line to Port St. Lucie (just south of St. Lucie Blvd.)				

Compared to the 2045 Cost Feasible Plan, an Enhanced Transit Scenario provides approximately three to four times more transit service, an increase of approximately 311% revenue miles and almost 378% vehicle hours of local, express, and BRT service.

4.1.2 Emerging Technologies Scenario

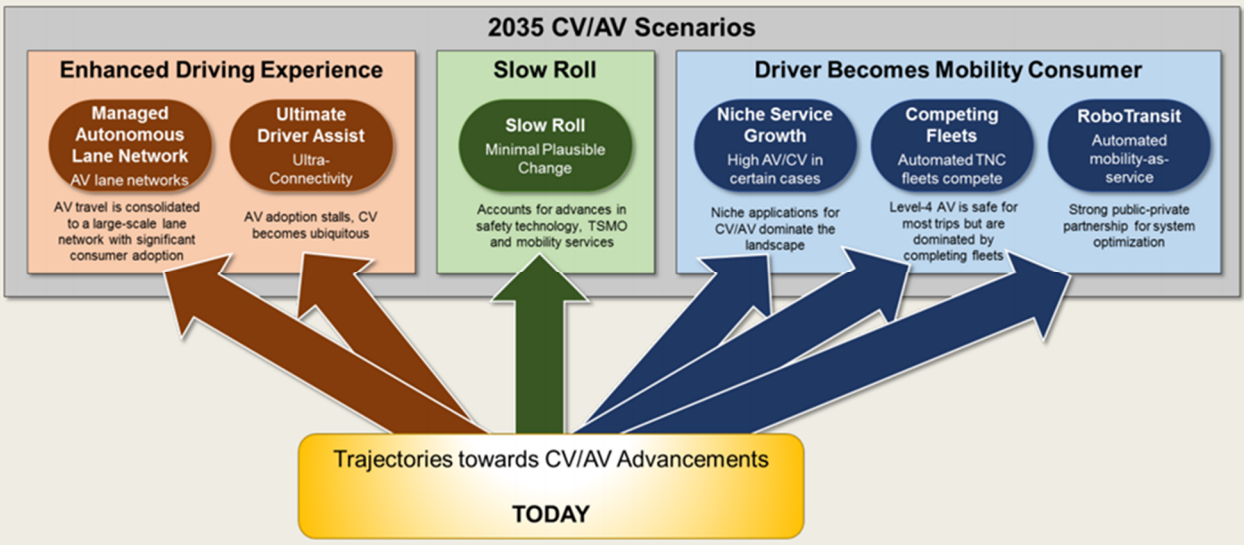
Technical Memorandum #2 –*Data Compilation, Review and Summary* provides a detailed discussion on emerging technologies and its impact on transportation and land use as well as evolution of the industry based on comprehensive literature review. Further, it describes Martin County's Intelligent Transportation Systems (ITS) network and discusses the Florida Department of Transportation's (FDOT) guidance on incorporating emerging technologies in the MPO's LRTP process as well as introduces initial assumptions for scenario planning exercise.

The proliferation of automated and connected vehicles, ride-hailing, bikesharing, microtransit, e-scooters, and at some point, autonomous trucks presents both challenges and opportunities for communities and public transit operators. The level of disruption and the impacts on land development, vehicle miles traveled, pollutant emissions, public transit ridership, and other key quality of life factors brings levels of uncertainty not seen in transportation since the advent of the automobile.

With respect to emerging technologies, the Martin MPO's 2045 LRTP scenario planning effort provides a framework that allows for existing and yet to be determined mobility options to contribute to economic development and quality of life while minimizing harmful unintended consequences. This approach acknowledges that automation, connectivity, and electrification will bring about significant changes that expand the diversity of transportation choices, and that these choices will involve increased participation by the private sector making greater use of shared fleets as a business model. It is important to recognize that the readiness of many technologies and corresponding services and products is overstated. Accordingly, a continued focus on actions that improve safety, decrease delay, and increase reliability under various levels of market penetration of these services and products is warranted rather than expending effort in an attempt to guess or select which ones will be successful at a certain point in time.

Given the uncertainty of when ACES and other emerging technologies will come online, it is prudent to plan around thresholds in addition to timeframes. FDOT in its *Guidance for Assessing Planning Impacts and Opportunities of Automated, Connected, Electric, and Shared-Use Vehicles, May 2018* incorporates the six Connected Vehicle/AV Scenarios developed by the Federal Highway Administration (**Figure 4-1**).

Figure 4-1: Connected Vehicle (CV)/Automated Vehicle (AV) Scenarios



Source: USDOT, November 2017[6]

Consistent with FDOT's guidance, Emerging Technologies Scenario assumes a certain level of market penetration of AVs or EVs for the planning horizon 2045 to evaluate the interplay between the technology and travel behavior as well as impacts on the transportation network[7]. Given the socioeconomic and demographic profile of Martin County, size of the metropolitan area and modest growth in jobs and population over the next 25 years, "Slow Roll" ACES scenario was considered to be a "good fit" and selected for further analysis. **Table 4-3** shows detailed assumptions for the six ACES scenarios included in **Figure 4-1** as well as highlights key AV/CV and EV sales and shared trips characteristic for "Slow Roll" scenario**.**

Slow Roll – Minimum plausible change – Nothing beyond currently available technology and investments already in motion.

[6] USDOT 5th ITS PCB University Workshop, Role of Connected and Automated Vehicles in Planning, November 2017 viewed on July 16, 2019 at https://www.pcb.its.dot.gov/universityworkshops/Nov2017/Day1_Azizi.pdf.

[7] Land use and socioeconomic changes resulting from emerging technologies were not evaluated as part of the scenario planning effort.

Table 4-3: ACES Potential Scenarios: Impacts on Progress toward Planning Goals

	LRTP Goal	Slow Roll	Niche Service Growth	Ultimate Traveler Assist	Managed Automated Lane Network	Competing Fleets	RoboTransit
		Minimum plausible change - Nothing beyond currently available technology and investments already in motion is adopted. (Baseline for comparison)	*Innovation proliferates, but only in special purpose or "niche" AV zones, including retirement communities, campuses, transit corridors, urban cores, and ports.*	*CV technology progresses rapidly, but AV stagnates – 85% of vehicles have V2X capability by 2035 due to NHTSA mandate allowing DOTs to manage congestion aggressively.*	*Certain lanes become integrated with CV and AV – 50-60% of vehicles (75% of trucks) have automation capability for platooning in controlled settings.*	*Automated TNC-like services proliferate rapidly, but do not operate cooperatively. VMT doubles due to induced demand and empty vehicle repositioning.*	*On-demand shared services proliferate and integrate with other modes via cooperative data sharing, policies, and infrastructure.*
ACES Shares - 2035	*AVs – L2*	50 – 60%	50 – 60%	50 – 60%	30 – 40%	30 – 40%	30 – 40%
	AVs – L3	0%	0%	0%	20%	1%	0%
	AVs – L4	0% / 0%	1 – 5% / 1 – 5%	0%	1%	30%	30%
	CVs in Fleet	40%	40%	85%	75%	75%	75%
	EV Sales (urban/all)	15% / 5 – 10%	15% / 5 – 10%	15% / 5 – 10%	15% / 5 – 10%	85% / 85%	85% / 85%
	Shared Trips (urban/all)	20% / 5 – 10%	20% / 5 – 10%	20% / 5 – 10%	20% / 5 – 10%	85% / 85%	85% / 85%
1.	*Safety & Security*	Level 2 driver assist features (e.g. lane tracking, automatic braking) reduce fatalities and serious injuries.	Prevalence of AVs allows "Vision Zero" goals to be realized in AV zones. Level 2 features improve safety elsewhere.	V2V communications enable 80% reduction in crashes systemwide.	V2V communications enable significant (but less than 80%) reduction in crashes systemwide.	Automated fleets and V2V communications enable 80% reduction in crashes systemwide, including realization of "Vision Zero" in urban areas.	Automated fleets and V2V communications enable 80% reduction in crashes systemwide, including realization of "Vision Zero" in urban areas.
2.	*Maintenance and Operations*	Truck platooning is common on rural interstate highways.	Improvements to lane markings, pavement maintenance and new V2X infrastructure are concentrated in AV zones.	CV roadside units proliferate to cover all roads with V2I infrastructure.	AV-only lanes on rural interstates and urban expressways and separate freight corridors allow for safe, efficient and automated travel. Eco-signal corridors reduce congestion and emissions in urban cores. Cooperative use of CV data allows DOTs to improve network operations systemwide.	Suburban freight centers are interface between automated long-haul trucking and local delivery. Evenly distributed EV charging network serves fleets. Maintenance of lane markings and pavement improves for AVs. Restricted data sharing prevents optimization of road capacity, increasing congestion.	Suburban freight centers are interface between automated long-haul trucking and local delivery. Evenly distributed EV charging network serves fleets. Maintenance of lane markings and pavement improves for AVs. Cooperative use of CV data allows DOTs to improve network operations systemwide, nearly eliminating congestion.
3.	*Mobility and Connectivity*	Mobility services reduce car ownership near urban cores, while increasing travel by elderly and disabled populations everywhere.	Car ownership falls dramatically in AV zones as residents shift to local mobility services.	Public transit improves efficiency, competitiveness and customer service due to real-time pricing, universal trip planning and multimodal integration.	Mobility services reduce car ownership near urban cores, while increasing travel by elderly and disabled populations everywhere. Transit becomes less competitive with managed lanes.	Vigorous competition between mobility service providers drives many toward car-free lifestyles. Door-to-door, transportation as low as $0.20/mile is available in most contexts, outcompeting traditional transit.	Personal mobility becomes a commodity, integrating door-to-door and fixed guideway transit in urban corridors. Automated long-haul and local freight makes immediate consumption universal. Regions offer universal shared mobility services as low as $0.20/mile.
4.	*Economic Competitiveness*	Widespread use of real-time travel info reduces costs of congestion.	AV zones gain significant advantages from efficient transportation, leading to increased desirability and rising real estate values.	Near elimination of congestion through cooperative dynamic routing and pricing incentives improves economic productivity.	Reduced congestion and automated trucking improve economic productivity.	Costs of local travel and long-haul trucking plummet due to automation, increasing economic productivity. Induced demand offsets savings with congestion costs.	Near elimination of congestion through cooperative dynamic routing and pricing incentives, combined with driverless travel, dramatically improves economic productivity.
5.	*Community Livability*		Quality of life improves in AV zones, leading to concerns about equitable access to technology benefits outside niche areas.		Businesses locate outside of the urban core and people to move to the suburbs and exurbs near managed lanes.	Parking is converted to other uses in urban and suburban areas.	Parking is converted to other uses in urban and suburban areas. Walkable mixed-use development dominates in transit corridors.
6.	*Environmental Stewardship*	Electrification trend continues, decarbonizing the transportation sector and reducing emissions.			Automation of long-haul trucking reduces rail mode share and convenience of driving reduces transit mode share, increasing VMT and emissions.	Fleets use EVs exclusively, making 85% of urban VMT (plus 50% suburban and 5% rural) electric, greatly reducing emissions. Gains are offset by VMT increases.	Fleets use EVs exclusively, making 85% of urban VMT (plus 50% suburban and 5% rural) electric, greatly reducing emissions. Shared use reduces offsetting VMT gains.

Source: FDOT's Guidance for Assessing Planning Impacts and Opportunities of Automated, Connected, Electric, and Shared-Use Vehicles, May 2018

4.2 Methods of Evaluation

As described in Sections 4.1.1 and 4.1.2, each scenario consists of a unique set of transportation improvements. Having non-overlapping improvements as well as consistent land use and socioeconomic data for both the scenarios as well as the 2045 LRTP Cost Feasible Plan helped evaluate the impact of policy transformation and investments on the transportation system and explain the performance of each scenario. Both the Enhanced Transit and Emerging Technologies scenarios were evaluated using the regional travel demand forecast model (TCRPM 5) and compared against the 2045 LRTP Cost Feasible Plan approved by the Martin MPO Policy Board in June 2020. Performance measures for evaluating the scenarios using TCRPM included:

- Vehicle Miles Traveled (VMT)
- Vehicle Hours Traveled (VHT)
- Congestion speed
- Transit ridership
- Trip length

In addition to using TCRPM, certain performance measures were evaluated using off-model techniques based on literature review and empirical data. Appropriate adjustments were made to performance measures to reflect local planning context. Off model calculations were used to determine the impact on the following performance measures:

- Greenhouse gas (GHG) emission
- Energy consumption
- Safety (Crashes)
- Transportation revenue (Funding)

The following is a brief description of the scenarios along with the discussion of modeling methodology for the two scenarios.

4.2.1 Regional Travel Demand Model

To evaluate performance measures, such as, VHT, VMT, congested speed, transit ridership, and trip length, the regional travel demand model – Treasure Coast Regional Planning Model (TCRPM) 5.0 was used.

Enhanced Transit Scenario Modeling Approach – New BRT routes, headways, and span of service adjustments for fixed route bus service and new commuter route was coded in the regional travel demand model. Fixed bus route modifications were coded based on transit networks provided by Martin County while span of service adjustments were incorporated in appropriate transit input files.

Because both the new BRT routes serve residents from Palm Beach in addition to Martin County residents, it was necessary to develop an external transit trip table to estimate the number of transit trips coming to and from Palm Beach County. Unlike other travel demand models or vehicle trip tables which are traffic analysis zone/micro analysis zone (TAZ/MAZ) based, the transit trip table in TCRPM 5.0 is based on Transit Access Points (TAP), which are pseudo-TAZs where transit boarding and alighting take place. The relevant steps in TCRPM model were run first to generate a list of TAPs, including TAPs

serving the external stations where transit trips from and to Palm Beach occur. The transit trip interchanges were developed using 2012-2016 ACS/CTPP county-to-county flows and mode share information. To account for the mode shift from auto trips to BRT trips, external-internal/internal-external (EI/IE) trips were adjusted accordingly. The model was run with the 2045 socioeconomic data, cost-feasible highway network, extended transit network, and newly developed EI/IE transit trip table and revised IE/EI vehicle trip table.

Emerging Technologies Scenario Modeling Approach - To model the impact of the "Slow Roll" Scenario, no changes were made to either the highway network or the transit network. However, it was assumed that there will be a 2.5% increase in vehicle trips to account for demand from underserved transportation market and a 5% reduction in transit trips to account for the mode shift from transit vehicles to ACES. On the supply side, because of the efficiencies resulting from enhanced safety features and better communication between the vehicles, it was assumed that there will be an increase in roadway capacity. In the TCRPM 5.0 model, the capacities for limited access facilities and freeways were increased by 5%, and capacities for uninterrupted arterials were increased by 2%. The capacities for other facilities remained the same. The model was run with the 2045 socioeconomic data, cost-feasible network, and revised trip tables and roadway capacities.

4.2.2 Off Model Adjustments

To evaluate performance measures such as GHG emission, energy consumption, safety (crashes), and transportation revenue (funding) as well as account for VMT resulting from shared-use vehicle and electric vehicles, off-model adjustments were applied based on available literature and empirical data. Below is a short discussion of off-model techniques and methodology used for each evaluation parameter.

Greenhouse gas (GHG) emission – Estimates for GHG emission were developed for each scenario by multiplying passenger miles for a given mode times emission rates per passenger mile from *Cato Institute's Policy Analysis, "Does Rail Transit Save Energy or Reduce Greenhouse Gas Emissions?", published April 14, 2008*. For transit, average passenger trip length was based on *2019 Florida Transit Information and Performance Handbook, FDOT*.

Energy consumption - To calculate the daily energy cost, the average kilowatt per hour rate from Florida Power & Light (FPL) was multiplied by the daily energy use under each scenario. Energy consumption rates for various modes and technology were based on *Cato Institute's Policy Analysis, "Does Rail Transit Save Energy or Reduce Greenhouse Gas Emissions?", published April 14, 2008.*

Safety (Crashes) – A range for potential reduction in crashes for Emerging Technologies scenario, which translates to improvement in safety for all users of the transportation system was based on FDOT's *Guidance for Assessing Planning Impacts and Opportunities of Automated, Connected, Electric, and Shared-Use Vehicles, May 2018*, which in turn uses Insurance Institute for Highway Safety study that provides a summary of the Institute's estimated reduction of various in-vehicle technologies.

Transportation revenue (Funding) – Change in anticipated federal, state, and local fuel taxes comprising transportation infrastructure funding resulting from an increased market share of autonomous vehicles and electric vehicles was estimated based on *Autonomous Vehicle (AV) and Alternative Fuel Vehicle (AFV) Florida Market Penetration Rate and VMT Assessment Study, Center for Urban Transportation Research (CUTR), October 2019.*

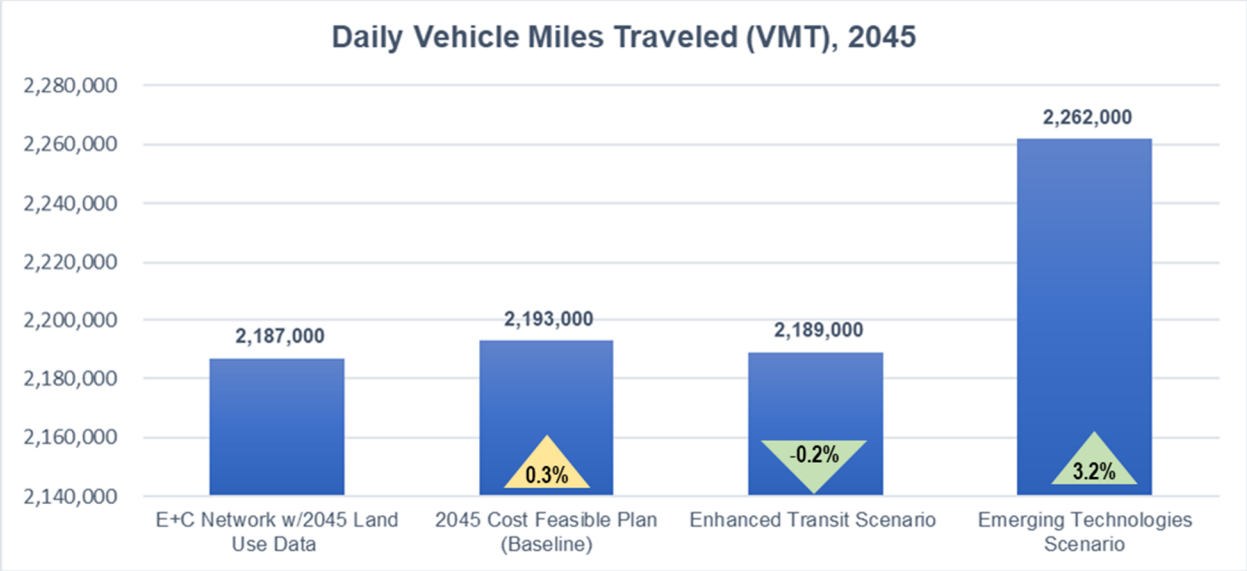
4.3 Scenario Evaluation

As explained in Section 4.2 of this technical memorandum, Enhanced Transit and Emerging Technologies scenarios were evaluated on a host of performance measures using the regional travel demand model and off-model calculations. The following is a description and comparison of evaluation results for the Enhanced Transit and Emerging Technologies scenarios relative to Martin MPO's 2045 LRTP Cost Feasible Plan. It should be noted that performance measures for Existing and Committed (E+C) Network with 2045 Land Use Data[8] are provided for reference purposes as well as to establish context for the 2045 Cost Feasible Plan baseline. In the figures below, the yellow triangle indicates change relative to the E+C Network while the green triangle shows change relative to the 2045 Cost Feasible Plan for any given performance measure.

4.3.1 Vehicle Miles Traveled (VMT)

Daily VMT represents the total travel demand on an average weekday in Martin County. **Figure 4-2** indicates that travel demand reduces marginally by approximately 0.2% in an Enhanced Transit Scenario while it increases by approximately 3.2% under Emerging Technologies Scenario.

Figure 4-2: Daily Vehicle Miles Traveled, All Trip Purposes, 2045



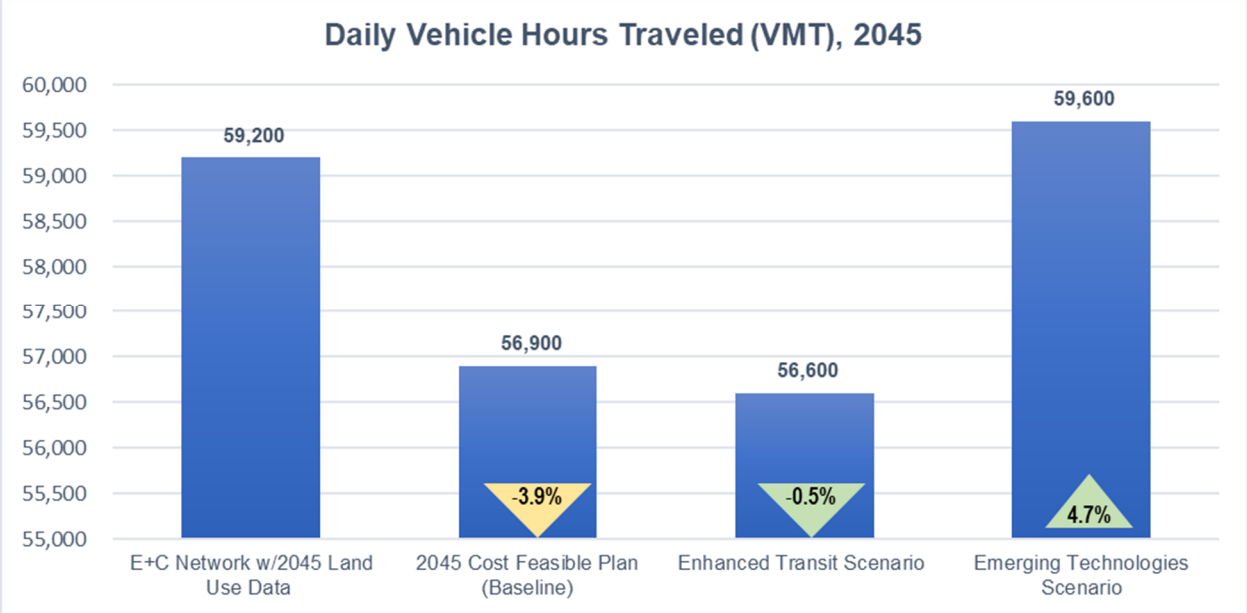
[8] E+C network with 2045 land use and socioeconomic data represents the 2045 Needs Assessment model outputs. This illustrates impact on the transportation network in Martin County if no additional improvements beyond those included in the FY 2020/21-FY 2024/25 are implemented.

While different levels of automation and market penetration will have varying impacts on travel demand, one way AVs can affect vehicle travel demand is through supplying shared mobility services to the currently underserved transportation markets, including youth, the elderly, and those with driving-prohibitive medical conditions. For Martin County, it is estimated that approximately 3% increase (or 66,000) in daily VMT could be attributed to shared mobility[9] resulting from AVs under Emerging Technologies scenario. Further, all the VMT for shared mobility would comprise an electric vehicle (EV) fleet. In addition, another 2% eVMT is estimated from personal automobiles as well as commercial usage. Overall, eVMT could comprises 5% of the total VMT in Martin County for Emerging Technologies Scenario[10].

4.3.2 Vehicle Hours Traveled (VHT)

VHT is the total number of hours that all automobiles spend on the road during an average weekday. **Figure 4-3** shows the system-wide measurement of VHT in the County. The results for the two scenarios are in the same general direction relative to the 2045 Cost Feasible Plan in that VHT reduces marginally by approximately 0.5% and increases by approximately 4.7% in Enhanced Transit and Emerging Technologies Scenarios respectively.

Figure 4-3: Daily Vehicle Hours Traveled, All Trip Purposes, 2045



[9] Estimated impact of new travel demand from the underserved population can result in a 2% to 14% increase in VMT. Between 2035 and 2048, AV market penetration will result in gradual increase in VMT from 3.8% to 15%. (Source: *Autonomous Vehicle (AV) and Alternative Fuel Vehicle (AFV) Florida Market Penetration Rate Study, Center for Urban Transportation Research (CUTR), October 2019)*.

[10] By 2048, eVMT is projected to account for approximately 25.1% of total VMT in Florida. (Source: *Autonomous Vehicle (AV) and Alternative Fuel Vehicle (AFV) Florida Market Penetration Rate Study, Center for Urban Transportation Research (CUTR), October 2019)*.

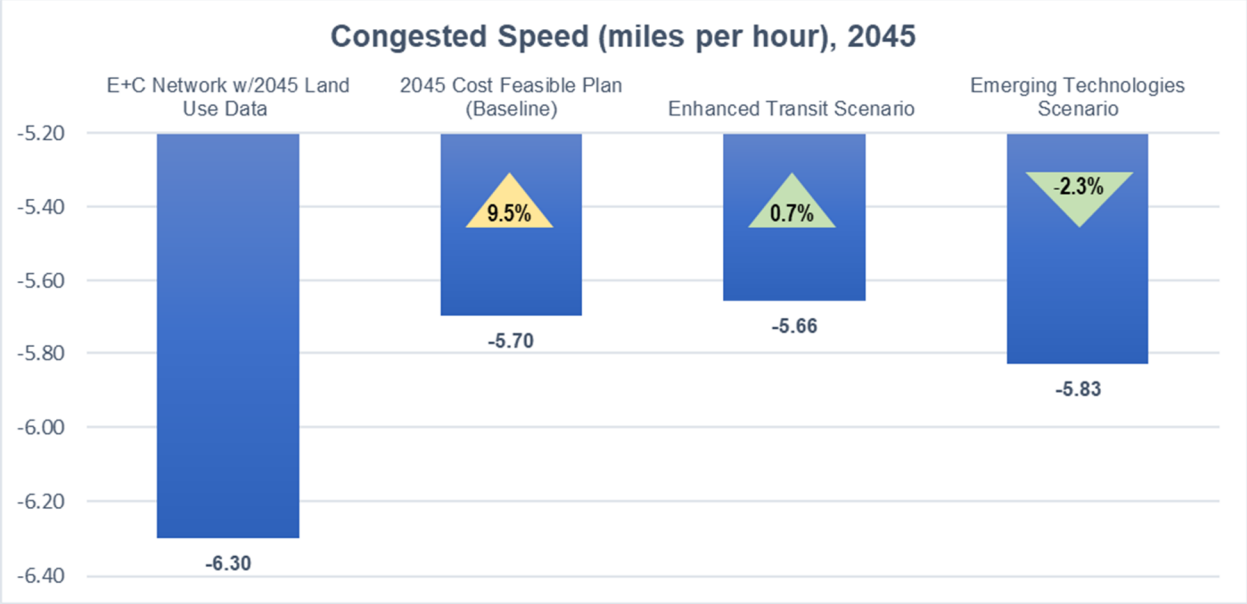
The reduction in VHT of approximately 3.9% in the 2045 Cost Feasible Plan compared to the E+C Network despite a slight increase in travel demand demonstrates that transportation investments in the Plan help improve mobility in the County.

4.3.3 Congested Speed

Congested speed measured in miles per hour (mph) for the transportation network affects travel time. At the systemwide level, lower congested speeds imply longer travel time between various origins and destinations in the County and vice versa. The change in congested speed between various scenarios shows either an improvement or degradation in travel time during to traffic congestion. This performance measure is highly correlated to the VHT. Lower congested speeds and longer travel time will generally result in higher VHT.

In Enhanced Transit Scenario, congested speeds show slight improvement of approximately 0.7% compared to the 2045 Cost Feasible Plan on a daily basis. Improvement in congested speeds can be expected to be higher in select corridors, especially those with BRT service during peak hours due to an increase in transit ridership. However, since transit mode split is miniscule one cannot expect dramatic changes in congested automobile speeds. On the other hand, congested speeds degrade under Emerging Technologies Scenario by approximately 2.3%. However, it should be noted that degradation in congested speed is not proportional to increase in travel demand (VMT) at 3.2% and VHT at 4.7. This indicates that the transportation network in Martin County can absorb higher travel demand to some extent due to an increase in roadway capacity from efficiencies yielded by ACES.

Figure 4-4: Congested Speed, 2045



Further, this metric demonstrates that as ACES comprise a larger market share, higher travel demand and resulting congestion will require Martin MPO to consider transportation

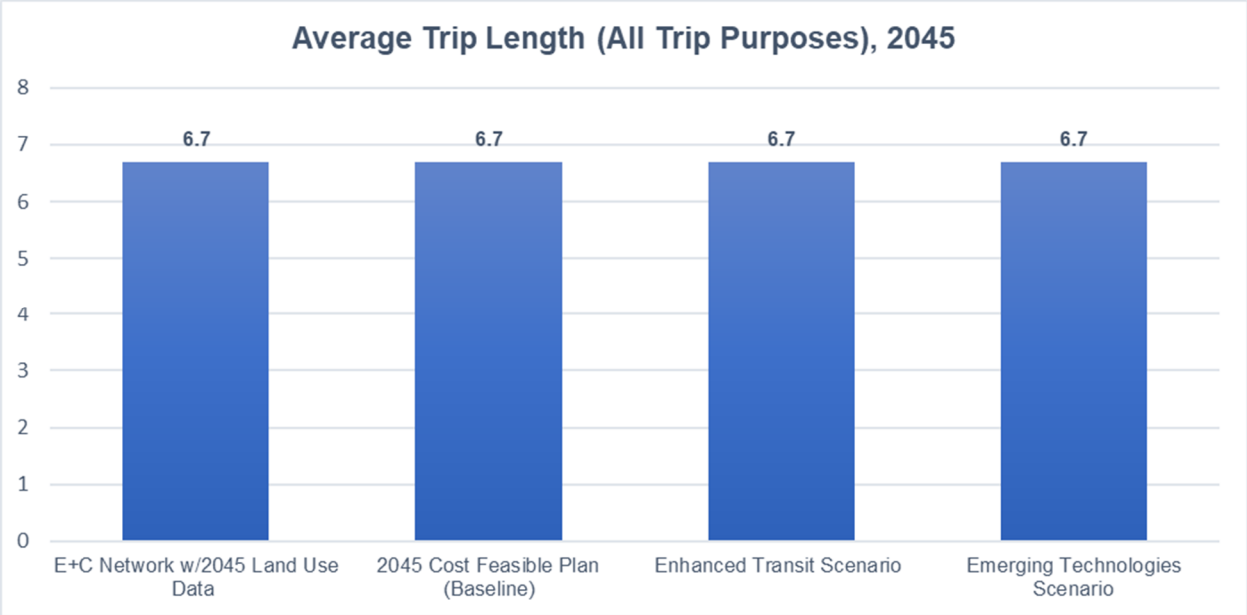
investment in a variety to Intelligent Transportation System (ITS)/TSM&O infrastructure to network efficiency.

An improvement of approximately 9.5% in congested speeds in the 2045 Cost Feasible Plan compared to the E+C Network despite an increase in travel demand illustrates that transportation investments in the Plan help improve mobility in the County.

4.3.4 Average Trip Length

Average auto trip length (the average distance traveled in miles) combined for all trip purposes remained constant at 6.7 miles in both an Enhanced Transit and Emerging Technologies Scenarios, as shown in **Figure 4-5**.

Figure 4-5: Average Trip Length, All Trip Purposes, 2045

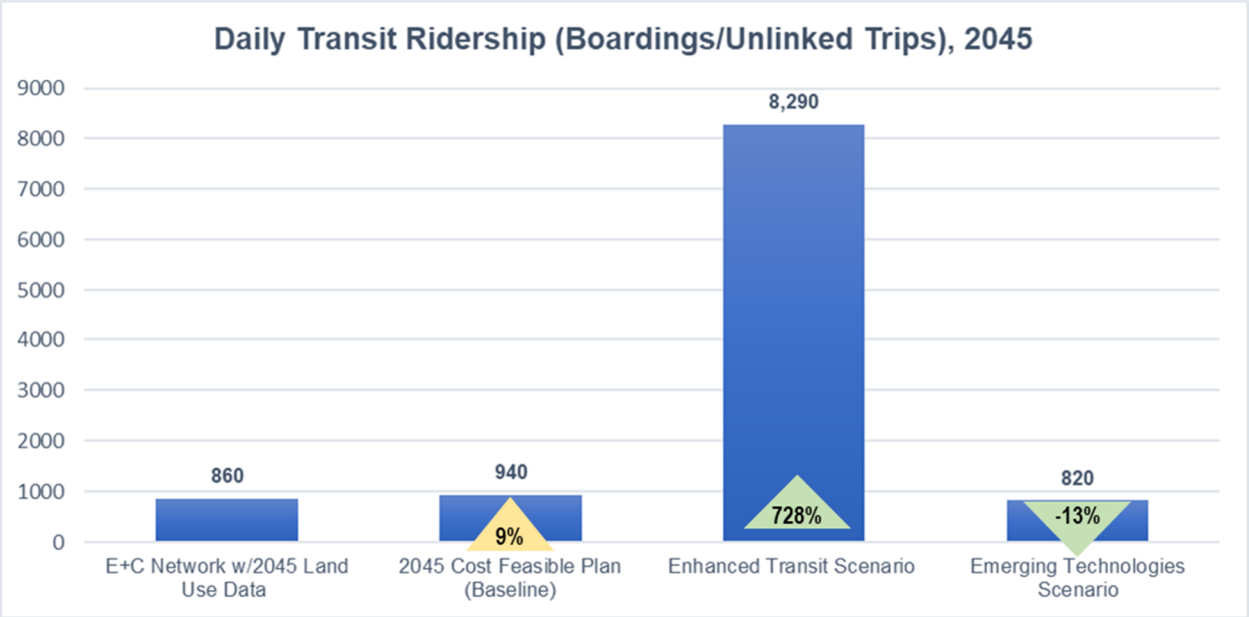


Since land use and socioeconomic data was static between various scenarios, it was expected that changes in average length would not occur. Jobs and housing location decisions are affected by transportation facilties and choices in the long term, which will likely impact travel behavior and trip lengths under the two scenarios.

4.3.5 Transit Ridership

Transit ridership measures the number of daily boardings (unlinked transit trips) on all public transportation modes, such as, local, commuter and BRT service in Martin County. Enhanced Transit Scenario showed a dramatic increase of approximately 782% in daily ridership compared to the 2045 Cost Feasible Plan (**Figure 4-6**).

Figure 4-6: Daily Transit Ridership, 2045



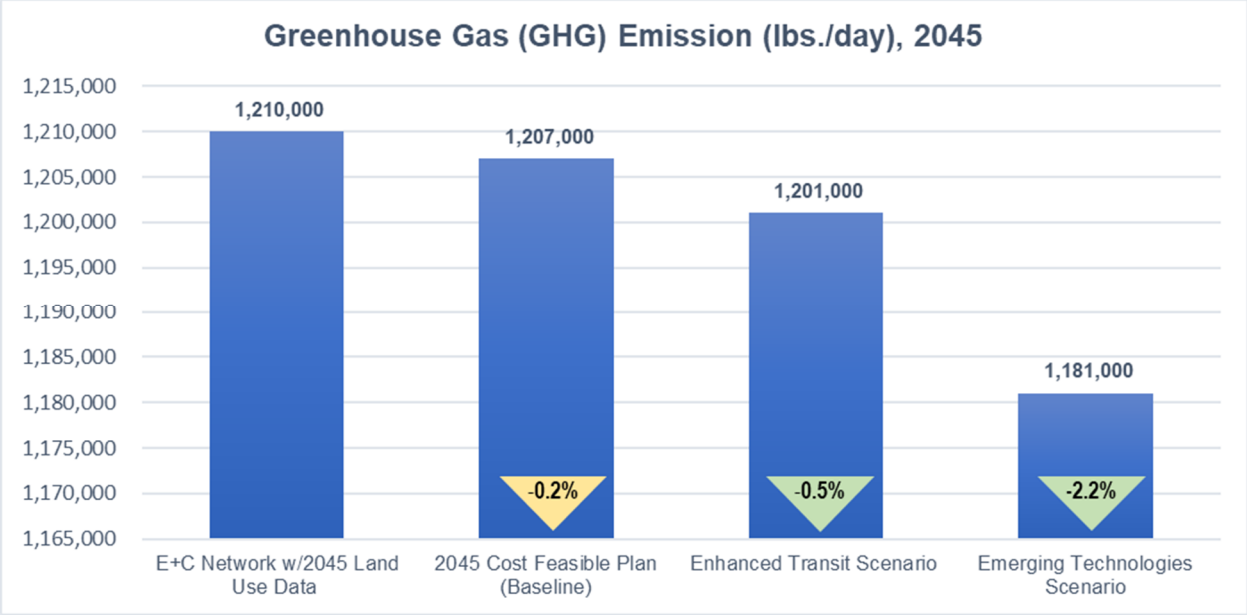
However, it should be noted that the under this scenario transit service levels were increased by approximately 311% revenue miles and almost 378% vehicle hours of local, express, and BRT service. This represents almost three to four times more transit service relative to the 2045 Cost Feasible Plan. Further, the increased transit boardings includes riders that transfer from local bus to express or commuter bus as well as BRT service. Typically, transfers account for 40% to 50% of the transit boardings. In other words, the proportion of "net new riders" may be not as significant as the total increase transit boardings.

Under Emerging Technologies Scenario, ridership is expected to reduce by approximately 13% relative to the 2045 Cost Feasible Plan. While the travel demand model considers mode choice in a sequential and objective manner, the real-world impacts may be more nuanced. Marty may focus on shared mobility for enhancing first and last mile connection, re-direct resources in priority corridors, offer Mobility on Demand (MOD) services in certain areas as well as partner with Transportation Network Companies (TNCs) to provide weekend and night service as well as paratransit service.

4.3.6 Greenhouse Gas (GHG) Emission

Carbon dioxide is one of the key components that exacerbates climate change and sea level rise. The transportation sector accounts for approximately 28% of GHG emissions. As shown in **Figure 4-7**, the Enhanced Transit and Emerging Technologies scenarios have positive impacts on GHG reduction. This can be explained due to shift from driving to transit and impact of AVs/EVs in Enhanced Transit and Emerging Technologies scenarios respectively.

Figure 4-7: CO_2 Emissions (lbs./day), 2045

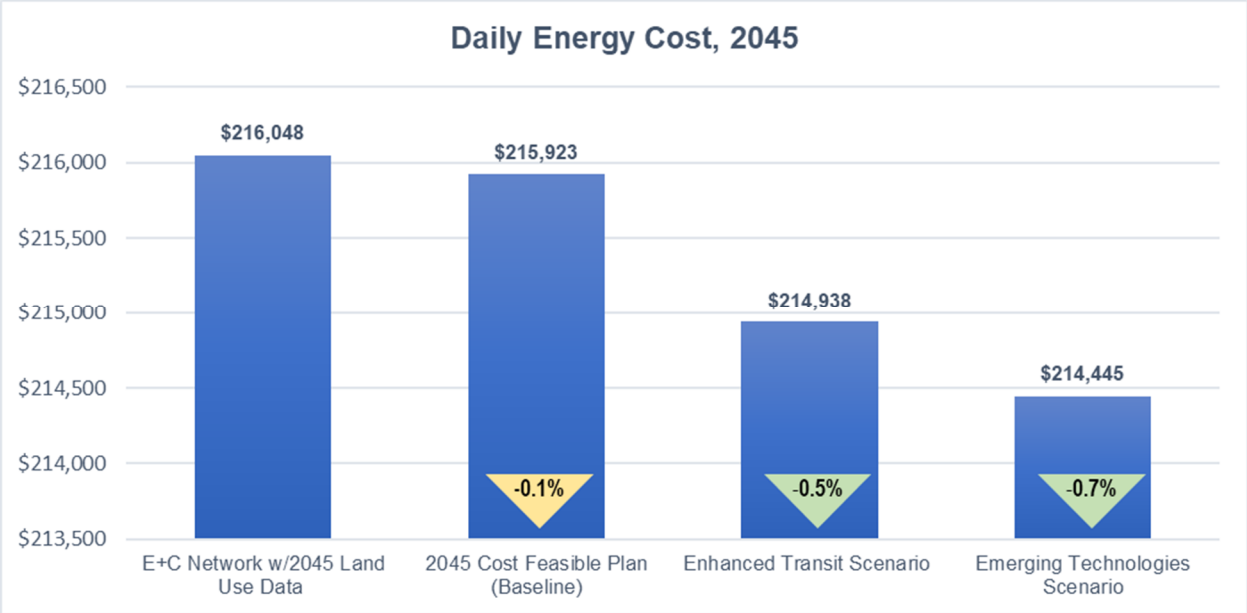


Since full EVs have zero tailpipe or direct emissions, an Emerging Technologies Scenario has a larger impact on reducing GHG emission compared to an Enhanced Transit Scenario. However, it should be noted emissions may be produced by the source of electrical power, such as a power plant.

4.3.7 Energy Consumption

Energy consumption was measured in terms of daily energy cost under various scenarios (**Figure 4-8**). Calculations were based on mode specific energy consumption rates.

Figure 4-8: Daily Energy Cost, 2045



The energy consumption rates were converted in kilowatt hour unit and multiplied by FPL rates to develop energy costs. As shown in Figure 4-8, both scenarios drive down the energy consumption with an Emerging Technologies Scenario outperforming an Enhanced Transit Scenario.

4.3.8 Safety (Crashes)

There is industry wide recognition of various types of safety features built into AVs/CVs and its potential to reduce crashes. According to Insurance Institute for Highway Safety (IIHS), basic forward-collision warning systems attribute to a seven percent reduction in crashes and automatic braking results in a reduction of 14% to 15%. With fully self-driving cars (Automation Level 4 or 5) crashes can be reduced up to 90 percent.

It should be noted that automated vehicles may have less impact on the overall safety because they represent only part of the predicted vehicle fleet, even by the year 2045, and cannot mitigate for human-controlled vehicles. For Emerging Technologies scenario, it is anticipated that crashes could be reduced by two to three percent.

4.3.9 Transportation Revenue (Funding)

The *Autonomous Vehicle (AV) and Alternative Fuel Vehicle (AFV) Florida Market Penetration Rate and VMT Assessment Study, October 2019* conducted by *Center for Urban Transportation Research (CUTR)* estimates that between State Fiscal Year (SFY) 2017/2018 to SFY 2047/2048, an increased adoption of AFVs and AVs will negatively impact tax revenue generation.

The transportation revenue losses will occur gradually as the AV and AFV industry matures and the share of eVMT as a percentage of total VMT increases[11]. In the 10-year period between SFY 2017/2018 to SFY 2027/208, fuel-based state revenue shortfall will range from less than one percent to 1.3% annually. Over the 30-year period from SFY 2017/2018 to SFY 2047/2048, the cumulative impact of AFV and AV market penetration will result in $18.3 billion in revenue losses, which is approximately eight percent of federal, state, and local fuel taxes. In SFY 2047–48, annual revenue losses will be about to about 26 percent of federal, state, and local fuel taxes.

Consistent with state level trends projected in the CUTR Study, it is assumed that transportation funding shortfall under Emerging Technologies Scenario will range from seven to nine percent over the 20-year period between 2026 to 2045.

To address potential transportation funding shortfalls, the Martin MPO could consider policy options, including imposing AFV fees and taxes, adjusting motor fuel excise taxes to better reflect the energy content of fuels (emission fees), mileage-based transportation funding options (road user fee/VMT fee), congestion pricing and tolling, and public-private partnership models to fund transportation infrastructure.

[11] Total eVMT in Florida is projected to reach 47.5 billion by 2048, accounting for about 14.0 percent of the overall VMT in the state (baseline scenario). Under a scenario of high growth in total Florida VMT, eVMT is projected to reach 12.5 percent of the overall state VMT in 2048. In the low-growth scenario, eVMT is forecasted to account for 16.1 percent of the total annual VMT.

4.4 Summary

Table 4-4 provides a summary of all the scenarios compared to the 2045 LRTP Cost Feasible Plan baseline across all performance measures. The data for Existing and Committed (E+C) Network with 2045 Land Use is provided for reference purposes as well as to establish context for baseline 2045 Cost Feasible Plan.

Table 4-4: Comparative Scenario Evaluation Summary

Performance Measures	E+C Network w/2045 Land Use Data	2045 Cost Feasible Plan (Baseline)	Enhanced Transit Scenario	Emerging Technologies Scenario
Vehicle Miles Travelled (VMT), Daily	2,187,000	2,193,000	2,189,000	2,262,000
e-VMT, Daily	-	*11,000*	*22,000*	*113,000*
Shared-Use VMT, Daily	-	*4,000*	*22,000*	*66,000*
Absolute Change from CFP	-	6,000	(4,000)	69,000
Percent Change from CFP	-	0.3%	-0.2%	3.2%
Vehicle Hours Travelled (VHT), Daily	59,200	56,900	56,600	59,600
Absolute Change from CFP	-	(2,300)	(300)	2,700
Percent Change from CFP	-	-3.9%	-0.5%	4.7%
Congested Speed (mile per hour), Original	-6.30	-5.70	-5.66	-5.83
Absolute Change from CFP	-	0.6	0.0	(0.1)
Percent Change from CFP	-	9.5%	0.7%	-2.3%
Trip Length (miles)	6.7	6.7	6.7	6.7
Absolute Change from CFP	-	0.0	0.0	0.0
Percent Change from CFP	-	0%	0%	0%
Transit Ridership (Unlinked Trips), Daily	860	940	8,290	820
Absolute Change from CFP	-	80	7,350	(120)
Percent Change from CFP	-	9%	782%	-13%
Greenhouse Gas Emissions (CO_2 lbs./day)	1,210,000	1,207,000	1,201,000	1,181,000
Absolute Change from CFP	-	(3,000)	(6,000)	(26,000)
Percent Change from CFP	-	-0.2%	-0.5%	-2.2%
Energy Cost, US dollars (Daily)	$216,048	$215,923	$214,938	$214,445
Absolute Change from CFP	-	($125)	($1,110)	($1,603)
Percent Change from CFP	-	-0.1%	-0.5%	-0.7%
Safety Change from CFP	-	-	-	-2% to -3%
Transportation Revenue Change from CFP	-	-	-	-7% to -9%

The focus of scenario planning effort was to provide the Martin MPO an analytical framework that considers the impact of policy transformation and various investments on the transportation system. Further, the intent of scenario planning is not to necessarily choose one scenario over the other but rather use the information to inform resource allocation between competing interests as well as proactively plan for technology disruptions in the transportation sector.

The following observations are worth noting:

- Having a significant impact on systemwide VMT and VHT is difficult.
- Long term decisions related to job and housing locations are key factors that affect trip length and other related factors such overall number of trips, congestion and GHG emissions.
- Transit ridership is sensitive to frequency and speeds.
- There is no silver bullet to alleviate congestion, and certainly emerging technologies cannot be relied upon to solve traffic congestion and safety issues.
- Elected officials need to consider policy options to address transportation funding shortfalls in the future years.
- Communities need to proactively invest in transportation infrastructure improvements to take full advantage of emerging technologies. The infrastructure improvements include road markings and signage, managed/dedicated AV lanes, the addition of drop-off lanes, ITS roadside devices to enhance vehicle-to-infrastructure (V2I) capabilities, and demand management strategies.

5. Next Steps

The project team will use data driven analysis as well as land use, demographic and socioeconomic analyses findings included in this technical memorandum to identify highway, transit, Transportation System Management and Operations(TSM&O), non-motorized and complete streets investments in Martin County as part of the 2045 Needs Assessment. Further, projects will be included in the 2045 Needs Plan for further evaluation and prioritization. Ultimately, project that have merit and meet the goals and objectives of the 2045 LRTP – Martin in Motion will be included in the 2045 Cost Feasible Plan based on project priority and funds availability. In summary, information included in this technical memorandum will assist the project team to develop the 2045 Needs Plan and 2045 Cost Feasible Plan to accomplish the community's vision for transportation in Martin County.

FINAL