Appendix E: Travel Demand Model Documentation

TRAVEL DEMAND MODEL DOCUMENTATION

For HINESVILLE AREA METROPOLITAN PLANNING ORGANIZATION (HAMPO)

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Prepared for

Georgia Department of Transportation

GDOT
Georgia Department of Transportation

MODERN MOBILITY partners

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ACRONYMS AND ABBREVIATIONS

AADT	Annual Average Daily Traffic
CTPP	Census Transportation Planning Package
E+C	Existing + Committed
E-E	External-External
FHWA	Federal Highway Administration
GDOT	Georgia Department of Transportation
HAMPO	Hinesville Area Metropolitan Planning Organization
HBO	Home-Based Other
HBS	Home-Based Shopping
HBW	Home-Based Work
HPMS	Highway Performance Monitoring System
I-E	Internal-External
IEPC	Internal-External Passenger Car
IETRK	Internal-External Truck
I-I	Internal-Internal
IITRK	Internal-Internal Truck
LOS	Level of Service
MPO	Metropolitan Planning Organization
MTP	Metropolitan Transportation Plan
NCHRP	National Cooperative Highway Research Program
NHB	Non-Home-Based
RMSE	Root Mean Squared Error

%RMSE	Percent Root Mean Squared Error
TAZ	traffic analysis zone
TDM	travel demand model
Univ	university
VMT	vehicle-miles traveled
VHT	vehicle-hours traveled
TIP	Transportation Improvement Program

1. INTRODUCTION

1.1 BACKGROUND

A Metropolitan Transportation Plan (MTP) is a plan that identifies a vision and addresses all transportation needs of a region. It is recommended that an MTP be updated every five years. It usually covers a minimum 20-year planning horizon and should be fiscally constrained. An MTP should include current and projected transportation demands and existing and proposed transportation facilities that should function as an integrated regional transportation system. It also requires the region to evaluate the condition and performance of the transportation system. For those regions developing multiple scenarios, an analysis of how the preferred scenario has improved the conditions and performance of the transportation system should also be included. Among all the tools helping the regions meet the requirements, the Travel Demand Model (TDM) is a state-of-the-art tool to forecast transportation demands and assess the performance measures of the transportation system.

The Hinesville Area Metropolitan Planning Organization (HAMPO) Metropolitan Transportation Plan (MTP) was last updated in 2019. An updated MTP is essential for identifying new transportation challenges and opportunities over the next 30 years. A key aspect of this update involves making informed decisions regarding various improvements to the transportation system. The TDM is one of many planning tools that help HAMPO understand the impacts of their decisions. In this cycle, the TDM has been updated to a 2020 base year and a 2050 future year to reflect existing transportation conditions in 2019 to avoid the impacts of COVID and future transportation needs in 2050. The purpose of this document is to provide an overview of the HAMPO TDM update that has been used as a tool for the development of the 2050 MTP.

1.2 TRAVEL DEMAND MODEL INTRODUCTION

1.2.1 What is a Travel Demand Model?

Travel Demand Modeling is an essential component of planning for regional infrastructure improvements. TDMs can replicate the existing travel demand, forecast future travel demand, identify transportation network deficiencies, prioritize projects, and analyze the benefits of transportation improvements. The critical questions surrounding any transportation investment include not only “Where is a facility needed?” but also “When and why is a facility needed?” These questions can be answered from the perspective provided by regional TDMs. The travel demand forecasting process uses what is known about the existing world to predict what conditions will be like in the future. It is a projection based on empirical data and foreseeable circumstances.

In the broadest sense, the HAMPO TDM consists of three elements: 1) model inputs, 2) a series of models conducting mathematical procedures, and 3) model outputs. More details on each are provided below.

1.2.1.1 Model Inputs

The model inputs are based on the roadway system, land use, and demographic or socioeconomic (SE) data, including population, household, employment by type, college enrollment, K-12 enrollment, and median household income. The future year projections of SE data are based on existing land uses, including land development, as well as region-wide forecasts of population, household, and employment. The forecasts for the future also consider planned major transportation improvements. In this area of TDM development, land use, and community planning are connected to the transportation planning process. SE data and the highway network serve as the basic inputs to the TDM.

1.2.1.2 A Series of Mathematical Procedures

The typical 4-step TDM forecasts travel demands based on the following steps: 1) trip generation, 2) trip distribution, 3) mode choice, and 4) trip assignment. The first step, trip generation, estimates how many trips each household produces for each trip purpose (work, shopping, etc.) and how many trips are attracted to each location (workplaces, shopping centers, other activity areas, etc.). The second step, trip distribution, determines where the generated trips go (i.e. their origin and destination). The third step, mode choice, determines what modes will be utilized (i.e. passenger vehicles, transit, etc.). The fourth step, trip assignment, determines the routes taken to get from travelers' origin to destination. **Figure 1-1** illustrates the structure of a TDM and its purpose.

Figure 1-1: TDM Structure

1.2.1.3 Model Outputs

The outputs of the TDM forecast traffic volumes and other metrics (e.g., travel speeds, travel time, congestion levels, etc.) of the transportation network. These metrics can help identify transportation system deficiencies. TDMs are also often used to assist in prioritizing transportation projects.

1.2.2 What the MPO's Regional TDM Can and Can Not Provide

TDMs across the country were developed at the regional and statewide levels. Their respective capabilities in forecasting traffic vary depending on the model's features. The model developed for large metropolitan areas may include time-of-day, transit, and freight components. A few even include components for non-motorized trips (bicycle, pedestrian, etc.). The regional TDMs in Georgia, outside of Metro Atlanta, generally provide users with forecasted roadway volumes with the functional classification as collectors and above. The volumes are typically average daily volumes for long-range forecasts with a 20 to 30-year horizon.

The HAMPO TDM can help identify roadway deficiencies where daily volumes exceed the roadway capacities, evaluate the impacts of major highway improvements, and evaluate transportation system performance for the purpose of the MTP.

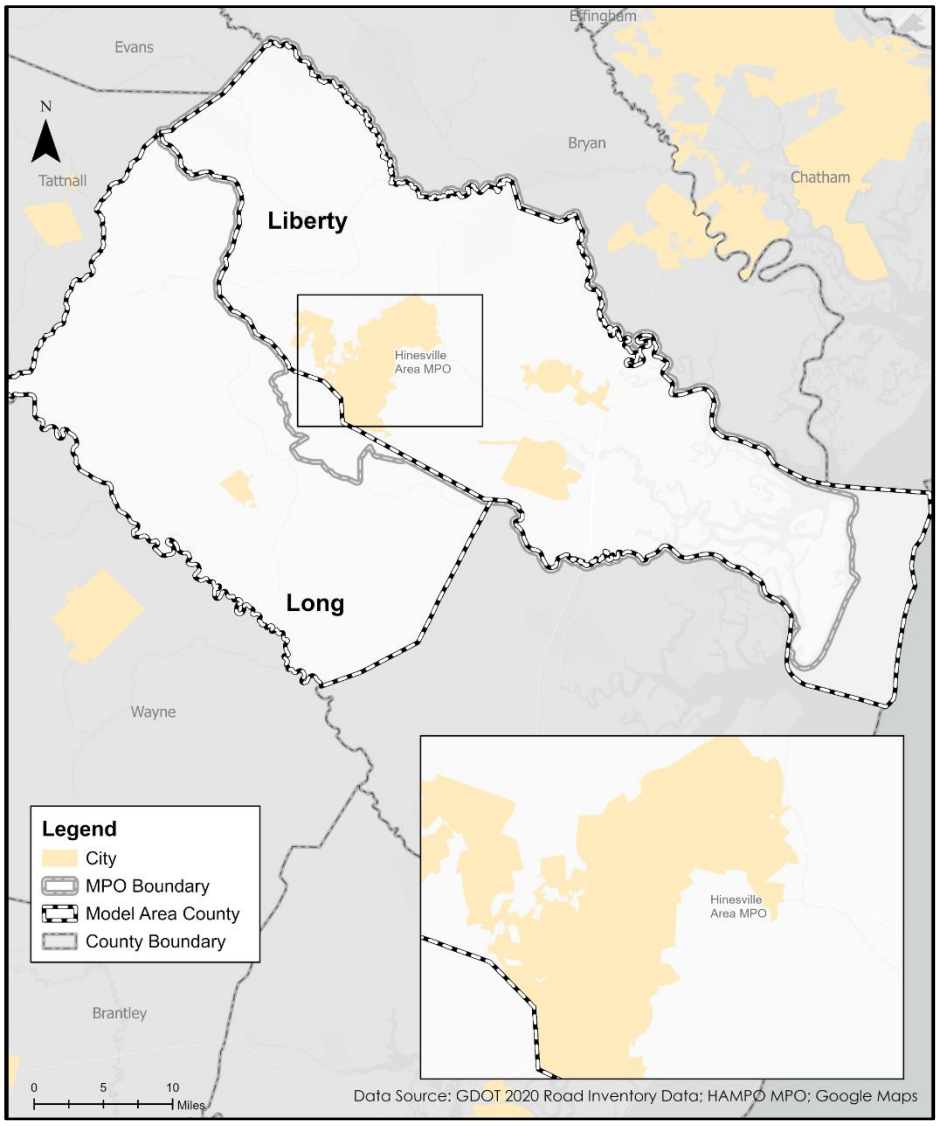
Due to their aggregate nature and regional scope, these TDMs are not intended to forecast the following metrics:

- The peak hour or peak period travel demands.
- The freight demand.
- The number of bicycling and walking trips.
- The logical termini determination.

1.2.3 Modeling Area

The modeling area is all of Liberty and Long County. **Figure 1-2** illustrates the modeling area for the HAMPO.

Figure 1-2 HAMPO Modeling Area



2. 2020 BASE YEAR MODEL UPDATE

2.1 WHAT HAS BEEN UPDATED?

To update the base year model to 2020 in support of the HAMPO 2050 MTP update, the following changes were:

- Modified TAZ boundaries and renumbered TAZs:
- Updated 2020 SE Data
- Update 2020 Base Year Highway Network:
- Updated 2020 Base Year Model Validation Components:
- Developed 2050 Scenarios based on projects provided by MPO.

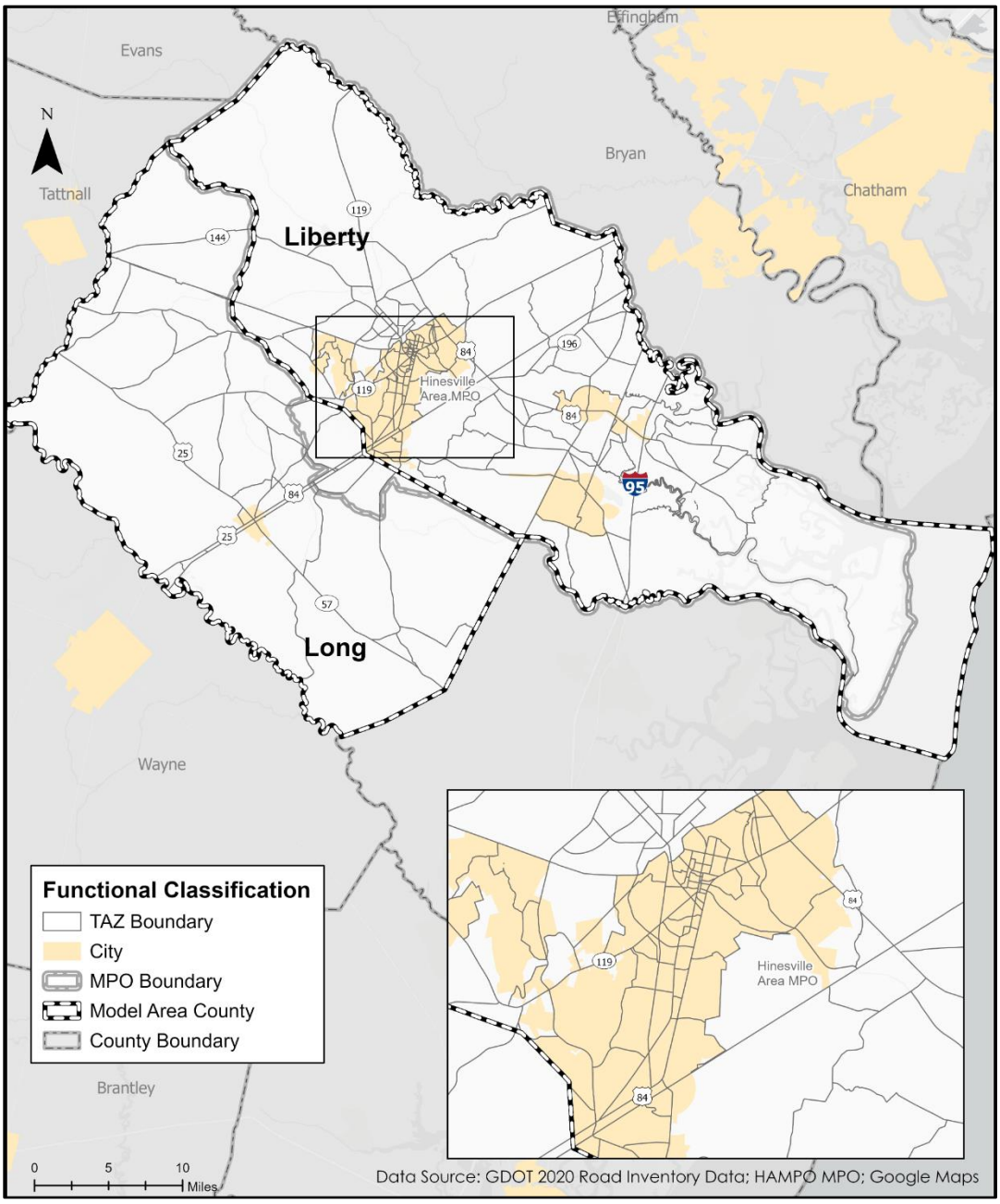
2.2 MODEL UPDATE

The following sections describe the details of the model updates, as well as each principal model element.

2.2.1 Traffic Analysis Zone Boundary Changes

The study area includes 221 internal TAZs within HAMPO. TAZ boundaries have been updated to align with the boundaries of census tracts and census blocks, as well as the highway network with functional classification as collectors and above**. Figure 2-1** shows the TAZs within HAMPO.

Figure 2-1 HAMPO TAZs



2.2.2 Model Inputs – 2020 SE Data Summary

The 2020 Base Year SE Data was developed for the model. The development memorandum for the SE data is included in **Appendices A-1**Error! Reference source not found.. For 221 TAZs, the variables listed below were developed for the trip generation model.

- **Population:** The total number of individuals that are residing in a given TAZ;
- **Households:** The total number of occupied households in a given TAZ;
- **Total Employment:** The total number of employed people that are working in a given TAZ;
- **Manufacturing, Transportation, Communication, Utilities, Warehousing (MTCUW) Employment**: The number of employees working for manufacturing-based, transportation-based, communication-based, utility-based, and warehousing-based businesses in a given TAZ where the business is located;
- **Service Employment:** The number of employees working for service-based businesses in a given TAZ where the business is located;
- **Retail Employment:** The number of employees working for retail-based businesses in a given TAZ where the business is located;
- **Agriculture, Mining, Construction (AMC) Employment:** The number of employees working for agriculture-based, mining-based, and construction-based businesses in a given TAZ where the business is located;
- **Median Income:** The median household income in a given TAZ in 2020 dollars;
- **School Enrollment:** The total number of K-12 enrolled students in a given TAZ at educational facilities; and
- **College Students:** The total number of enrolled college students in a given TAZ with college or university-level facilities.

Table 2-1 shows the summary of 2020 SE data provided by the MPO, by the variables mentioned above.

Table 2-1 Summary of 2020 SE Data

SE Variable	MPO Total
Population	83,993
Household	37,867
Total Employment	19,245
MTCUW Employment	2,109
Service Employment	12,636
Retail Employment	3,789
AMC Employment	711
School Enrollment	14,440
College Students	2,056
Acreage	662,417

2.2.3 Model Inputs - 2020 Network Update

In this effort, the following features were updated:

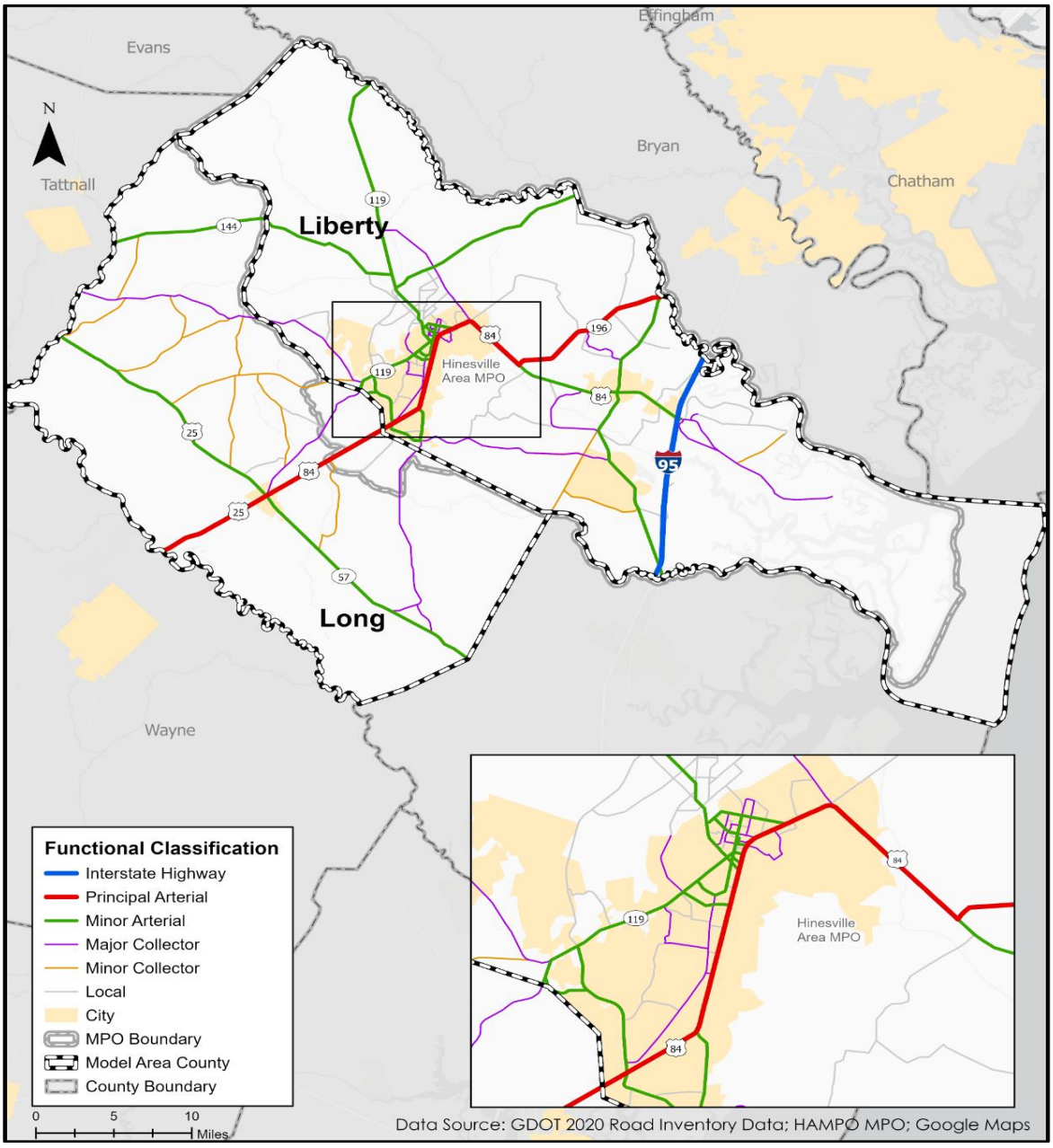
1. Functional Classification
2. Facility Type and Area Type
3. Number of Lanes
4. Capacity
5. Speeds
6. Traffic Count Location

The details of the update for the external stations and traffic are provided in the following sections.

2.2.3.1 Functional Classification

The road network by functional classification categories was updated using the Georgia Department of Transportation's (GDOT) Roadway inventory data. **Figure 2-2** shows the functional classification of roadways within HAMPO.

Figure 2-2 HAMPO Road Functional Classification



The transportation infrastructure can be classified by facility type such as interstates, freeways, arterials, etc. Similarly, service areas can be classified as urban, suburban, rural, etc. The characteristics of a facility, such as free flow speed and capacity, vary by the facility and area type. Hence, the facility types together with area types provide the framework for organizing the network into sub-groups where free-flow speeds and capacities can be assigned. In combination with the length and number of lanes, these attributes constitute the base layer of highway network data that needs to be updated and applied to the TDM. The facility type and area type definitions used in the highway network and modeling process are shown in **Table 2-2** and **Table 2-3** . The facility types were coded based on the designated functional classification of each roadway. The area types were defined based on the geographic distribution of the SE data.

Table 2-2 Facility Types

Code	Facility Type
1	Interstate
2	Freeway
3	Expressway
4	Parkway
6	Freeway to Freeway Ramp
7	Freeway Entrance Ramp
8	Freeway Exit Ramp
11	Principal Arterial – Class I
12	Principal Arterial – Class II

Code	Facility Type
13	Minor Arterial – Class I
14	Minor Arterial – Class II
15	One Way Arterial
21	Major Collector
22	Minor Collector
23	One Way Collector
30	Local Road
32	Centroid Connector

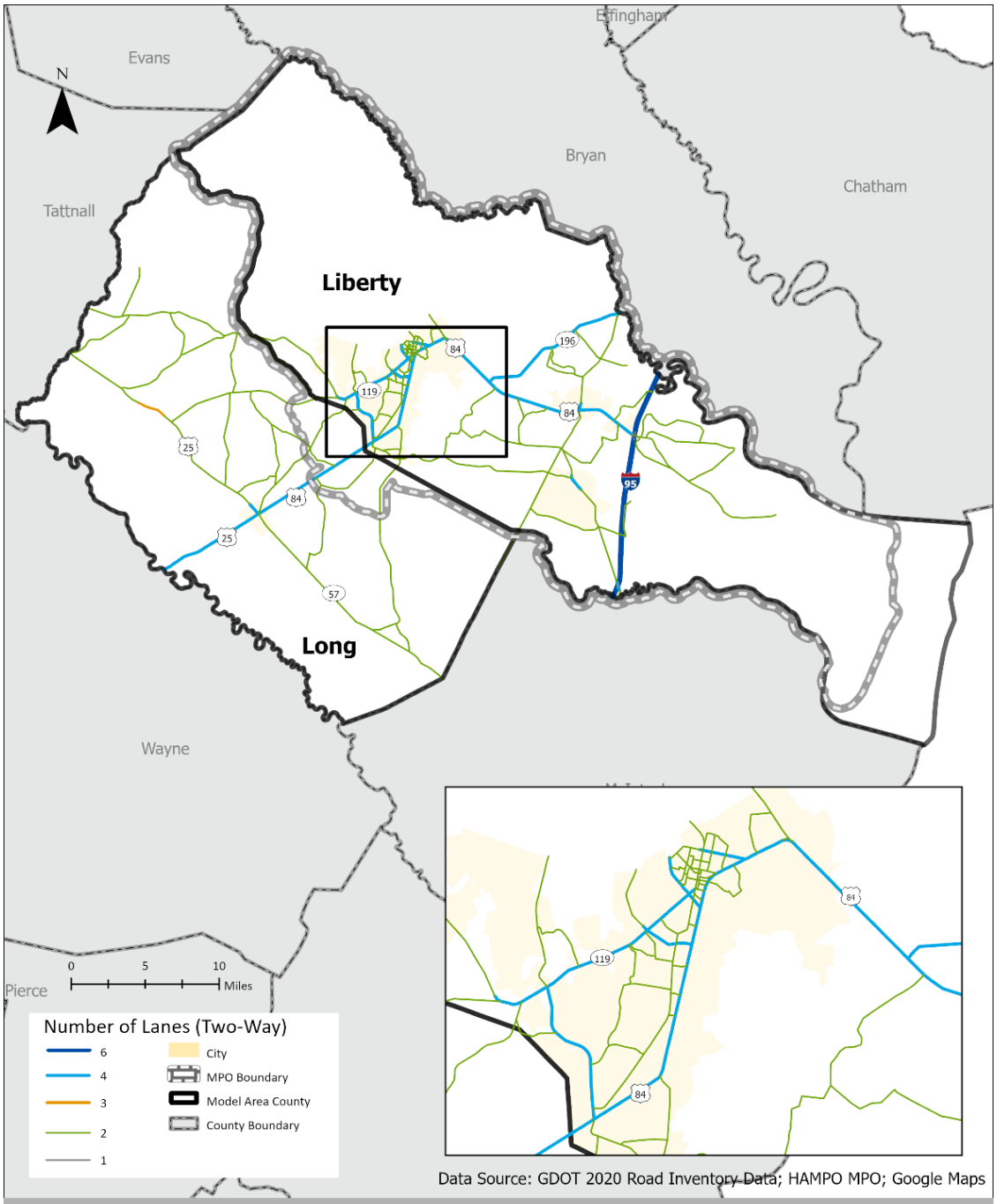
Table 2-3 Area Types

Code	Area Type
1	High Density Urban
2	High Density Urban Commercial
3	Urban Residential
4	Suburban Commercial
5	Suburban Residential
6	Exurban
7	Rural

2.2.3.2 Number of Lanes

The number of lanes on each roadway link was updated using GDOT's Roadway Inventory Data and checked against Google Earth Imagery to ensure the accuracy of 2020 base year conditions. **Figure 2-3** illustrates the total number of lanes in both directions on roadways within the HAMPO area.

Figure 2-3 Number of Lanes



2.2.3.3 Traffic Count Locations

A total of 98 traffic count stations were coded in the HAMPO TDM network after updating the information and adding new stations in the study area, referencing the online traffic data provided by GDOT. The count stations were updated with 2019 count information to assist the model validation. Please note that the base year model is validated to 2019 traffic conditions to avoid the impact of COVID.

2.2.3.4 External Stations and Traffic

The external trip locations were updated in the 2020 input network. The 2020/2050 model has 12 external stations. The external stations in the HAMPO TDM have been expanded to include the Fort Stewart Area. The 2019 available traffic count data, including Annual Average Daily Traffic (AADT) and truck percents at or near the external stations, were obtained and coded for each external station. If external stations had no traffic counts available, appropriate daily volume estimations were made based on the best knowledge and professional judgment. The External-External (E-E) trip and truck percentages were estimated based on the functional classification of the external station facilities.

2.2.3.5 Network Attributes Summary

Table 2-4 lists the key attributes coded in the 2020 input network with their description.

Table 2-4 Link Attributes

Attribute Name	Description/Coding System
COUNTY	County FIPS Code
ROAD_NAME	Roadway Name
FTYPE	Facility Type
TOTAL_LANE	Number of Lanes for Each Direction
STATIONID	2020 Traffic Count Station Number
GDOT_PI	GDOT Project Identification Number
LOCAL_PI	Local Project Identification Number
DISTANCE	Roadway Link Length in miles
MPO	1 – In HAMPO; 0 – Outside of HAMPO
TCOUNT20	2020 AADT – Both Directions
COUNT20	2020 AADT – Each Direction
FC2020	The updated HPMS Functional Classification Codes (7 Categories)

2.2.4 Modeling Procedures

2.2.4.1 Trip Generation

Trip generation is the first step in the four-step modeling process. It estimates the number of trips that will start and end in each Traffic Analysis Zone (TAZ). These are referred to as “trip ends.” Trip ends generated by households are referred to as productions. Trip ends calculated from employment or school enrollment figures are referred to as attractions. This process is accomplished by establishing relationships between trips and SE variables. This process estimates the number of trip ends (i.e.

productions and attractions) by various trip purposes for each TAZ. Trip generation does not determine the origin and destination of each trip, whereas this step only estimates the total trips produced and attracted by the SE characteristics of each TAZ.

In 2017, GDOT purchased add-on data from National Household Travel Survey (NHTS) and this data is used to update trip generation models in the HAMPO TDM. The trip generation process includes trip production and trip attraction sub-models. The trip production sub-model applies trip rates through a household stratification model for trips with both “trip ends” in the modeling area and applies regression equations for Internal-External Passenger Car (IEPC) and Internal-External Truck (IETRK) trips. The trip attraction sub-model applies regression equations for all trip purposes.

There were eight trip purposes that were included in the trip generation process. These purposes are summarized below:

- **Home-Based Work (HBW)**: Includes all travel made for the purpose of work that begins or ends at the traveler’s home;
- **Home-Based Other (HBO)**: Includes any trip made with one end at the home except those for the purpose of work or shopping;
- **Home-Based Shopping (HBS)**: Includes travel made for the purpose of shopping, and which begins or ends at the traveler’s home;
- **Non-Home-Based (NHB)**: Includes any trip that neither begins nor ends at home;
- **University (Univ)**: Includes travel made for a university which begins and ends at the traveler’s residence;
- **Internal-Internal Truck (IITRK)**: Includes internal trips made by commercial vehicles;
- **Internal-External Passenger Car (IEPC)**: Includes internal trips beginning or ending outside the modeled area, excluding trucks; and

  Internal-External Truck (IETRK): Includes internal truck trips beginning or ending outside the modeled area.

Household Stratification Model

The household stratification model subdivides the total number of households by TAZ into 16 household strata defined by household size and the number of automobiles available. The stratification uses zonal income, socioeconomic data, and information from the 2020 US Census and the American Community Survey (ACS). The model distributes the total number of households in a TAZ to each cross-classification cell by calculating the relative probability that a household will be a particular size with a particular number of automobiles.

The estimate of the number of households in a particular cross-classification cell is then calculated by multiplying the total number of households in the TAZ by the corresponding relative probability. The final number of households in each cross-classification cell is calculated by applying an adjustment

factor to each calculated value. The adjustment factor is applied to ensure that the sum of the resulting disaggregated households equals the original aggregate number of households.

Trip Productions

The routine for computing trip productions uses cross-classified data from the household stratification model and applies trip rates to calculate HBW, HBO, HBS, and NHB trips. The trip rates for each purpose used the updated GDOT Daily Trip Production Rates, which are based on the 2017 NHTS, as the initial trip generation rate. Then, further adjustments were applied to the initial trip production results during the validation and calibration process.

Trip Attractions

The trip attraction estimates the demand for traveling to each TAZ based on its socioeconomic factors. Regression equations are used to compute the estimated number of trips attracted to each TAZ. Different parameters and socioeconomic factors are used for different types of trips, including HBW, HBO, HBS, NHB, University, Internal Truck trips, and Internal-External (I-E) trips.

Balancing Productions and Attractions

For most trip purposes in the HAMPO TDM, production and attraction trip ends are computed separately using 2020 SE data. Therefore, the sum of productions across all zones does not necessarily equal the sum of attractions. In reality, each trip has two ends, where one is a production or origin, and the other is an attraction or destination. Hence, it makes sense to equalize the sum of productions with the attractions across all zones. This, in effect, “balances” the two types of trip ends.

Internal and External Trips

The total number of I-E trips for each external station is calculated by subtracting the estimated number of E-E trips, based on an assumed percentage of the station’s daily traffic volumes. Then the total I-E trips are separated into I-E truck trips and other I-E trips based on an assumed truck percentage at each external station. The same applies to the E-E trips.

2.2.4.2 Trip Distribution

Trip distribution is the second major step in the TDM process. Trip distribution is the modeling process that calculates the trip interchanges between each zone pair that eventually have to be accommodated by the transportation system. The gravity model, the most widely used method for trip distribution, is adopted to distribute trips among TAZs in the HAMPO TDM. It predicts that the relative number of trips made between two TAZs is directly proportional to the number of trip ends (productions or attractions)

in each TAZ and inversely proportional to the function of the spatial separation between those two areas.

There are various measures of impedance that can be used in a gravity model, including travel time, travel distance, and travel cost. Impedance functions that can be used to assess the relative attractiveness of each TAZ include: (1) exponential, (2) inverse power, and (3) gamma functions. The HAMPO TDM utilizes exponential functions to calculate travel impedance based on travel time. The impedance function, also known as the friction factor, is illustrated below:

$$f(d_{ij}) = e^{-c(d_{ij})}$$

Where, d_{ij} is the distance between TAZ *i* and TAZ *j* and where, *c* is a parameter that needs to be calibrated based on observed data. The calibration of *c* requires that model estimated trip length frequency distributions match the observed or target trip length frequency distributions for each trip purpose. In this study, the average trip length is used as the criterion.

2.2.4.3 Mode Split

The mode choice process determines what mode of travel will be used to make the trips between zones. Federal Highway Administration's (FHWA) National Cooperative Highway Research Program (NCHRP) 255 Calibration and Adjustment of Systems Planning Models, (FHWA-ED-90-015), acknowledges that in small or medium urban areas, transit patronage may be too insignificant to warrant an adjustment of person trips to transit trips. The full mode choice step was omitted from the model.

The trip generation process estimates person trips for internal trip purposes (HBW, HBO, HBS and NHB). With this consideration, it is necessary to convert person trips to vehicle trips before trip assignment. The average auto occupancy rates by purpose are used to do this. The average auto occupancy rates by purpose from various sources such as U.S. Census Journey-to-Work Data and National Travel Surveys (e.g., NHTS), NCHRP Report 365 and NCHRP Report 716 were used to estimate the HAMPO TDM average auto occupancy rate. The other trip tables, including those for internal truck and I-E and E-E passenger car and truck trips, were calculated in terms of vehicle trips at their inception. The conversion to a vehicle trip table enables comparison to vehicle counts and capacity analyses.

2.2.4.4 Trip Assignment

The last step in the modeling sequence is the assignment of the trip tables created in previous steps to logical routes in the highway network. Trip assignment for HAMPO TDM was accomplished using the

equilibrium assignment technique. The trip assignment algorithm is iterative, running through successive applications until equilibrium occurs. Equilibrium occurs when no trip can be made by an alternate path without increasing the total travel time of all trips in the network. The equilibrium assignment is an iterative process that reflects travel demand assigned to minimum time paths as well as the effects of congestion. In each iteration, traffic volumes are loaded onto network links and travel times are adjusted in response to the volume-to-capacity relationships. The final assigned volumes are derived by summing a percentage of the loadings from each iteration. The percentages reflect congested conditions that usually influence motorists' path selection for a portion of the day, not the entire day.

Output Network Attributes

The model run has additional network link attributes that are attached to the input network. These store the values used in trip assignments as well as the assignment results. These additional attributes provide volumes and travel time for each link. These attributes can be used to summarize network-wide link statistics such as Vehicle Miles Travelled (VMT) and Vehicle Hours Travelled (VHT). The list of these attributes is shown in **Table 2-5.**

Table 2-5 HAMPO TDM Output Network Attributes

Attribute Name	Description
TAZ	Nearest TAZ ID
CAPACITY	Daily Capacity (Vehicles per Day)
SPEED	Free Flow Speed (Miles per Hour)
TIME_FF	Free Flow Travel Time (Minutes)
V_1	Daily Volume (Each Direction)
TIME_1	Congested Link Travel Time
VC_1	Daily Volume Capacity Ratio
CGTSPEED	Congested Speed (Miles per Hour)
VHT_1	Vehicle Hours of Travel
VT_1	Daily Volume (Both Direction)

Attribute Name	Description
VT_TRK	Daily Volume (Trucks)
VMT_1	Daily Vehicle Miles Traveled (VMT)
TTI	Daily Travel Time Index

3. 2020 BASE YEAR MODEL VALIDATION

GDOT recommends refinements to various model parameters until the base year model sufficiently replicates the observed base year travel patterns and conditions. To avoid the impact of COVID on the traffic condition and future forecast of the HAMPO TDM, the base year model was validated to 2019 traffic conditions. The base year model was checked for accuracy under each of the major steps in the TDM process, starting from trip generation to trip assignment. The inputs and outputs were checked for accuracy and reasonableness via review of the transportation network and attributes, trip generation and distribution parameters, vehicle-miles traveled statistics, and percent root mean squared error. The results from each of these validation steps are presented in the following sections.

3.1 TRIP GENERATION

The trip generation process primarily uses parameters from NHTS and the U.S. Census. The national data sources are used as reasonable checks for trip generation results. The comparison between target ranges of calibration measures and modeled results for trip generation is summarized in **Table 3-1.** The trip generation measures are within the target ranges.

Table 3-1 Trip Generation Model Reasonableness Checks

	Target Range / Value[1]		
Calibration Measures	**Min**	**Max**	**Model Results**
SE Data			
Persons / Household	2	3	2.2
Workers / Household	1	3	0.5
School / Population	0.2	0.2	0.2
Trip Generation			
Person Trips Per Household	8.5	9.2	7.2
Person Trips Per Person	3	4	3.2

[1] *Source:* General Summary of Recommended Travel Demand Model Development Procedures for Consultants, MPOs and Modelers*, GDOT, May 2013.*

Calibration Measures	Target Range / Value[1] Min	Max	Model Results
HBW Trips / Employee	0	2	2.1
Shopping Trips / Retail Employment			19.1
P/A Ratio Before Balancing (HBW)	0.9	1.1	1.0
P/A Ratio Before Balancing (HBO)	0.9	1.1	1.0
P/A Ratio Before Balancing (HBS)	0.9	1.1	0.9
P/A Ratio Before Balancing (NHB)	0.9	1.1	1.0

3.2 TRIP DISTRIBUTION

The trip distribution parameters are calibrated to produce reasonable ratios for auto trips by purpose. The expected trip ratios by purpose were estimated from 2017 NHTS add-on data purchased and provided by GDOT. Average trip lengths were calculated from 2017 NHTS data, 2019 ACS 5-yr estimates of work travel time, and the population and geographic size of the modeled area. The travel times from trip assignment were used as input for trip distribution (i.e., feedback), which strengthens the validity of the modeled trip lengths. The comparisons between the target trip lengths and modeled trip lengths are summarized in **Table 3-2**.

Table 3-2 HAMPO 2020 TDM Targeted Average Trip Lengths

Trip Purpose	Targeted Trip Lengths (mins)	Average Trip Lengths (mins)
Home-Based Work	18.2	21.4
Home-Based Other	16.4	18.82
Home-Based Shopping	16.0	19.2
Non-Home-Based	13.4	16.2

3.3 TRIP ASSIGNMENT

The trip assignment validation process includes the comparison of the model outputs to observed targets. The following documents serve as the primary sources for checking the reasonableness of model parameters and results:

- *Model Validation and Reasonableness Checking Manual*, Travel Model Improvement Program (TMIP), FHWA, 2010;
- *NCHRP Report 716 Travel Demand Forecasting: Parameters and Techniques,* Transportation Research Board, 2012*; and*
- *Calibration and Adjustment of System Planning Models*, USDOT, FHWA, 1990.

The primary targets used for validating the trip assignment process are outlined in **Table 3-3**. In this model, GDOT 2019 VMT and traffic counts were used to validate the traffic conditions. This was completed to reflect traffic conditions prior to COVID-19 to avoid the impact. The HAMPO TDM validation results are described in the following sections.

Table 3-3: Trip Assignment Validation Measure Targets

Validation Measures	Target Range/Value
VMT (based on GDOT 445 reports)	
VMT - Interstates	Less than 6% - 7%
VMT – Principal Arterials	Less than 10% - 15%
VMT – Minor Arterials	Less than 10% - 15%
VMT – Collectors	Less than 15% - 25%
VMT – Total	Less than 5%
Volumes for Individual Links	
Volumes to Count Deviation	Less than Maximum Desirable Deviation (NCHRP Report 255)
Volume root mean squared error (RMSE)	
Volume Group: 0 – 5,000	Less than 100%
Volume Group: 5,001 – 10,000	Less than 75%
Volume Group: 10,001 – 15,000	Less than 50%
Volume Group: 15,001 – 20,000	Less than 30%
Volume Group: 20,001 – 30,000	Less than 30%
Volume Group: >30,001	Less than 30%
System Total	Less than 35%

3.3.1 Vehicle-Miles Traveled Summary

The daily regional VMT is calculated by multiplying the amount of daily traffic on a roadway segment by its length, then summing the VMT for all roadway segments to give a total for a geographical area of concern.

The comparison of model VMT and observed VMT by functional classification is shown in **Table 3-4** below. The total model VMT has an approximate percent difference of 1 percent compared to the observed VMT. For each functional classification, the model VMT matches the observed roadway VMT closely, and the difference is within GDOT's recommended measures.

Table 3-4 HAMPO 2020 TDM VMT

Functional Classification	Mileage (miles)		VMT (1,000s, miles)		VMT Distribution			
	Observed[2]	Model	Observed	Model	Observed	Model	Difference	% Difference
Interstates	13	13	728,848	725,238	29.7%	29.8%	3,610	0.5%
Principal Arterial	35	34	665,734	706,250	27.1%	29.0%	-40,516	-6.1%
Minor Arterial	120	120	718,409	673,184	29.3%	27.6%	45,225	6.3%
Collectors	147	143	340,907	330,879	13.9%	13.6%	10,028	2.9%
Total	**315**	**311**	**2,453,898**	**2,435,551**	**100%**	**100%**	**18,347**	**0.7%**

3.3.2 Modeled Volume Summary

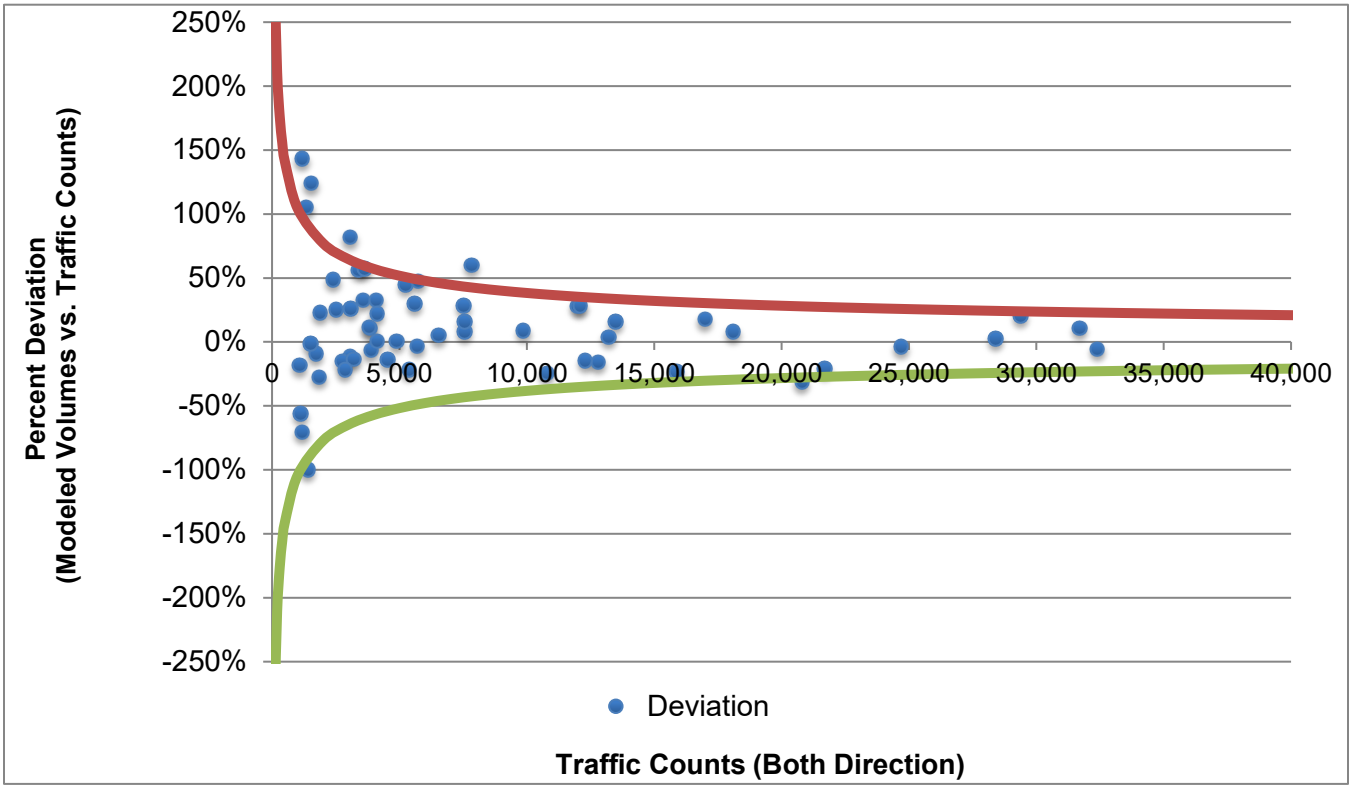
3.3.2.1 Link Volume Percent Deviation

The percent deviation is described in *Calibration and Adjustment of System Planning Models*. This method is used to calibrate a model for system-wide studies. It is based on the expectation that the TDM should accurately predict the number of through-lanes required to provide a specific level of service (LOS) for a given facility. The trip assignment deviation should not result in a design deviation of more than one highway travel lane. Therefore, the expected accuracy of the model increases as the AADT on a facility increases.

[2] *Source:* 2019 GDOT VMT – Mileage by Route and Road System Report 445, *GDOT*

Figure 3-1 shows the deviation between the 2020 base year volumes assigned by the TDM and observed traffic counts. Most link-level deviation points are concentrated between the maximum desirable deviation positive line and the maximum desirable deviation negative line. It could be concluded that most modeled highway links were assigned volumes that were in reasonable agreement with the traffic counts.

Figure 3-1 HAMPO 2020 TDM Link Volume Percent Deviation

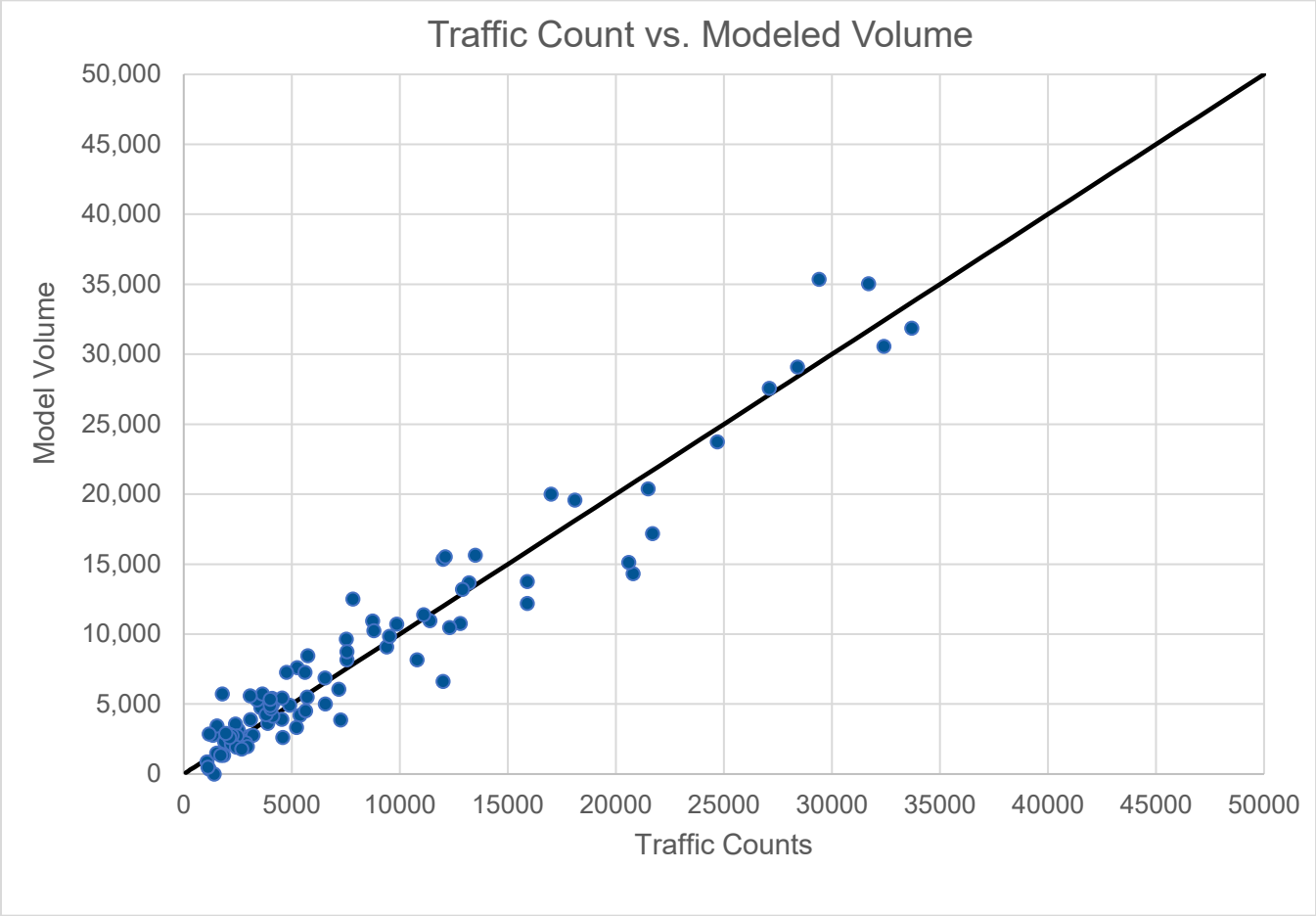


3.3.2.2 Correlation / Scatter Plot

The correlation coefficient shows the strength and direction of a linear relationship between two variables – our modeled traffic volume and the observed traffic counts. The correlation coefficient takes values from -1 to +1, where +1 indicates the strongest positive correlation, -1 indicates the strongest negative correlation, and 0 indicates no correlation. The HAMPO TDM achieves a correlation coefficient of 0.94, indicating that the modeled traffic volumes have a close positive correlation with the observed traffic counts.

The scatter plot of modeled volumes versus traffic counts helps identify outliers. **Figure 3-2** indicates that modeled volumes are clustered within the 45-degree line.

Figure 3-2 HAMPO TDM Link Volume Scatter Plot



3.3.2.3 **Percent Root Mean Square Error**

Percent RMSE (%RMSE) is a measure of the average deviation between the base year actual counts and the modeled volumes. It is another indicator to illustrate how closely the model volumes match the traffic counts. The %RMSE is calculated as follows:

$$\%RMSE = \frac{\sqrt{\sum_i \frac{(V_i - C_i)^2}{(N-1)}}}{\frac{\sum_i C_i}{N}} \times 100$$

where,

Vi = model volume at link *i*;

Ci = traffic count at link *i*;

N = number of count stations

The HAMPO 2020 TDM achieved an overall %RMSE of 29%, which is lower than GDOT's target of 35 percent. Low %RMSEs were also observed for links by volume groups, as shown in **Table 3-5**.

Table 3-5 HAMPO 2020 Model %RMSE

Volume Group	HAMPO 2020 TDM	Target Range
1,000 – 5,000	44%	<100%
5,001 – 10,000	28%	<75%
10,001 – 15,000	22%	<50%
15,001 – 20,000	19%	<30%
20,001 – 30,000	20%	<30%
> 30,000	8%	<30%
System Total	**26%**	**<35%**

4. 2020 BASE YEAR LEVEL OF SERVICE

The purpose of TDM development is to assist in the evaluation of future travel conditions and deficiency analysis in the study area. Besides the traffic volumes, another key output from the TDM is the daily volume-to-capacity ratio for each roadway segment. The volume-to-capacity ratio corresponds to LOS based on accepted methodologies. LOS is a qualitative measure of traffic flow describing operating conditions. There are six LOS defined by the FHWA in the *Highway Capacity Manual* for use in evaluating roadway operating conditions. They are given letter designations from A to F, with LOS A representing the best operating conditions and LOS F representing the worst operating conditions. A facility may operate at a range of service levels depending on the time of day, day of the week, or period of the year. A qualitative description and depiction of the different levels of service is provided in **Figure 4-1**. **Figure 4-2** illustrates the 2020 LOS for the HAMPO TDM highway network.

Figure 4-1 Level of Service Depiction

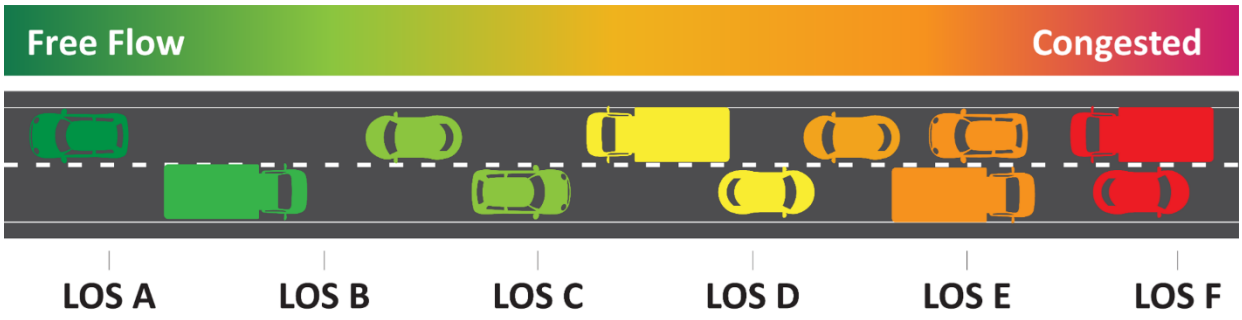
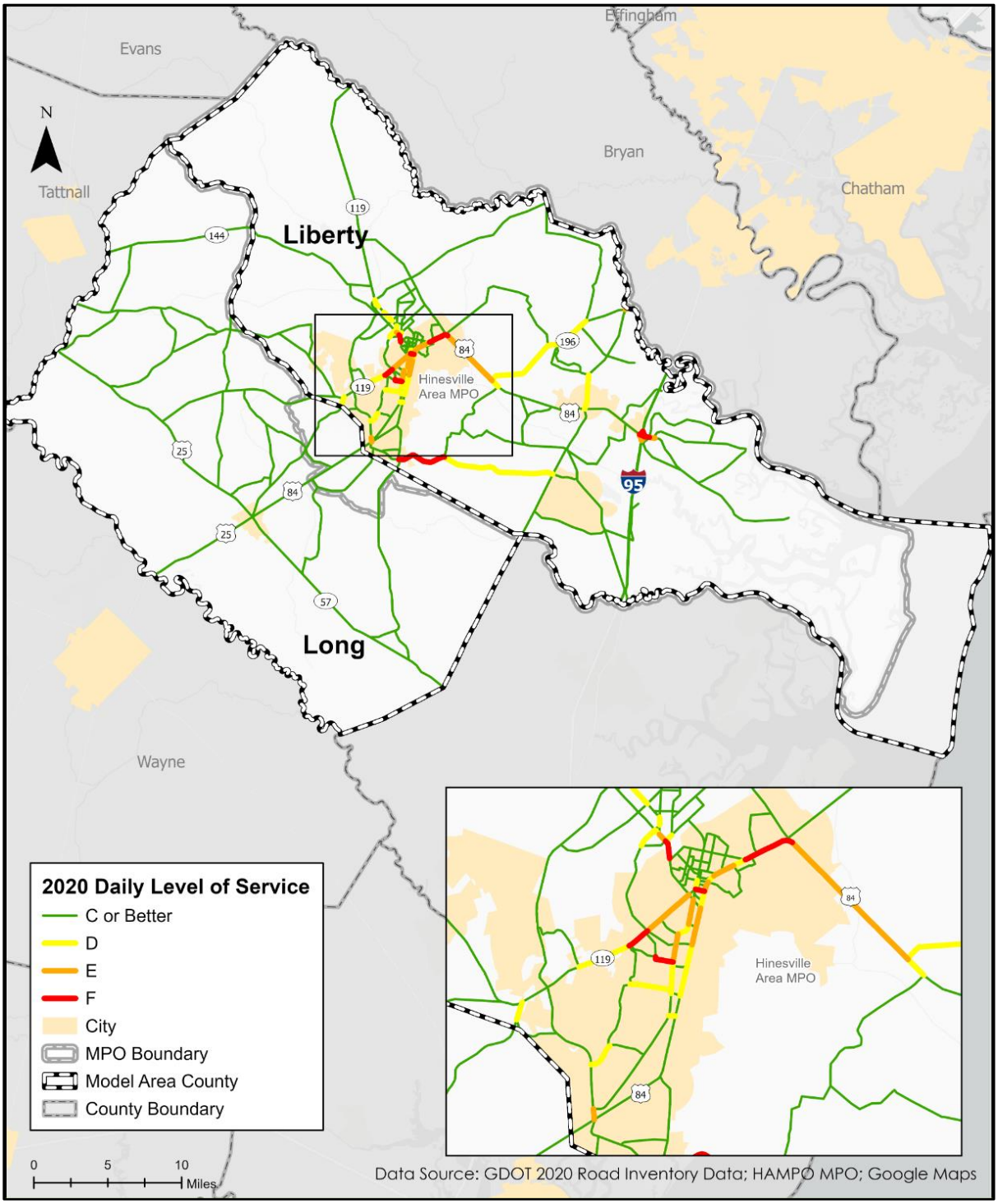


Figure 4-2 2020 Daily LOS for HAMPO



5. 2050 TRAVEL DEMAND MODELS

5.1 2050 LONG-RANGE TRANSPORTATION PLAN NETWORKS

After the 2020 base year, TDM was calibrated and validated, and the model was used to forecast the traffic conditions for the future year 2050. To simulate the future travel demand, the following information was updated based on the information provided by HAMPO :

- 2050 Highway Network;
- 2050 SE Data; and
- External Station Traffic Forecasting.

The 2050 HAMPO networks include scenarios based on the inputs from HAMPO and their MTP. The model considered five future networks.

- **The 2nd Network—Do-Nothing: The 2020 base year network plus any projects that** have opened to traffic since 2020 or are currently under construction.
- **The 3rd Network – Existing + Committed Projects Network:** Do-Nothing network plus any projects with construction (CST) funded in the Statewide Transportation Improvement Program (STIP) years 2024-2027 plus any local projects with CST funded in the MPO's current Transportation Improvement Program.
- **The 4th Network – TIP Projects Network**: E+C Network plus any projects with preliminary engineering (PE) or right-of-way (ROW) funded in the TIP years 2024-2027 plus any local projects with PE or ROW funded in the MPO's current TIP.
- **The 5th Network – MTP Projects:** TIP network plus all projects to address future transportation needs identified through the MTP.
- **The 6th Network – MTP Financially Constrained Projects:** TIP network plus all financially constrained projects identified through the MTP process.

5.2 2050 SOCIOECONOMIC DATA PROJECTIONS

The 2050 SE data was used as input into the TDM to forecast the number of future year trips. For a more in-depth analysis of the 2050 socio-economic trends, refer to **Appendix A-2**: 2050 SOCIOECONOMIC DATA REVIEW MEMO. **Table 5-1** shows SE data comparison between 2020 and 2050 for the entire TDM area.

Table 5-1 SE Data Comparison between 2020 and 2050

	2020	2050	% Overall Growth	% Annual Growth Rate
Population	83,993	101,267	21%	0.6%
Household	37,867	46,015	22%	0.7%
Total Employment	19,245	22,181	15%	0.5%
AMC Employment	3,789	4,655	23%	0.1%
MTCUW Employment	12,636	14,680	16%	0.7%
Service Employment	711	737	4%	0.5%
Retail Employment	2,109	2,109	0%	0.0%
K-12 Enrollment	14,440	17,801	23%	0.7%
College Students	2,056	2,535	23%	0.7%

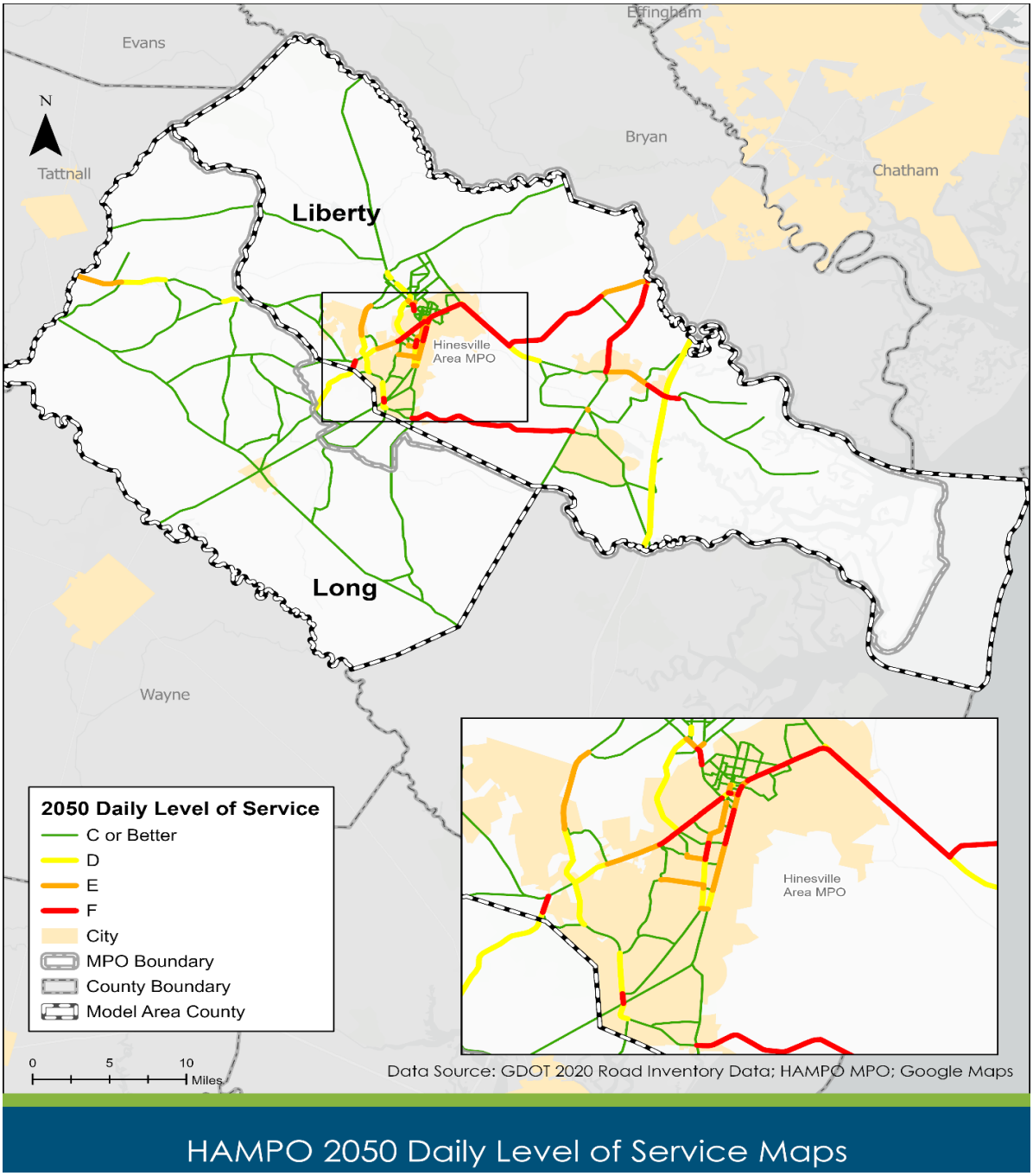
5.3 EXTERNAL STATION TRAFFIC

Year 2050 external station traffic was estimated based on historic AADT trends at the external stations where traffic count data was available and growth rates of surrounding TAZs. Professional judgment was also used during the estimation process. **Figure 5-1** through **Figure 5-4** illustrates the LOS estimated for each 2050 network. These maps were provided to the HAMPO after each model network scenario was run and were used to develop their project lists for the subsequent scenarios.

No new projects were identified for the 2050 Do-Nothing Network. Furthermore, no additional projects were added between the Existing and Committed (E+C) network model and the STIP network model; as a result, the STIP network model was not analyzed. For future reference, the STIP and E+C networks can be used interchangeably.

5.4 MODEL OUTPUT - LOS

Figure 5-1 The 2nd Network - 2050 Do-Nothing



HAMPO 2050 Daily Level of Service Maps

Figure 5-2 The 3rd Network - 2050 E+C Network

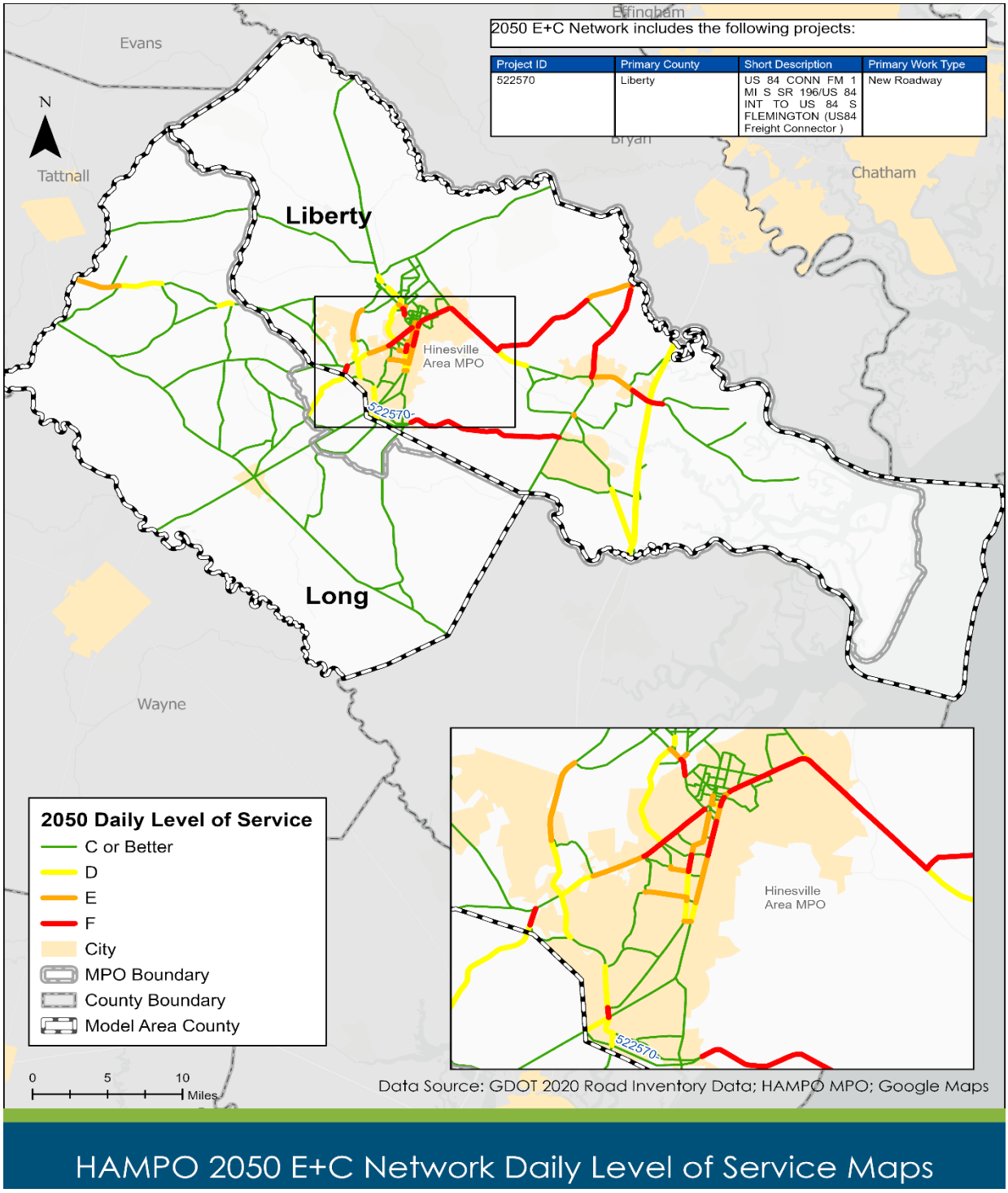
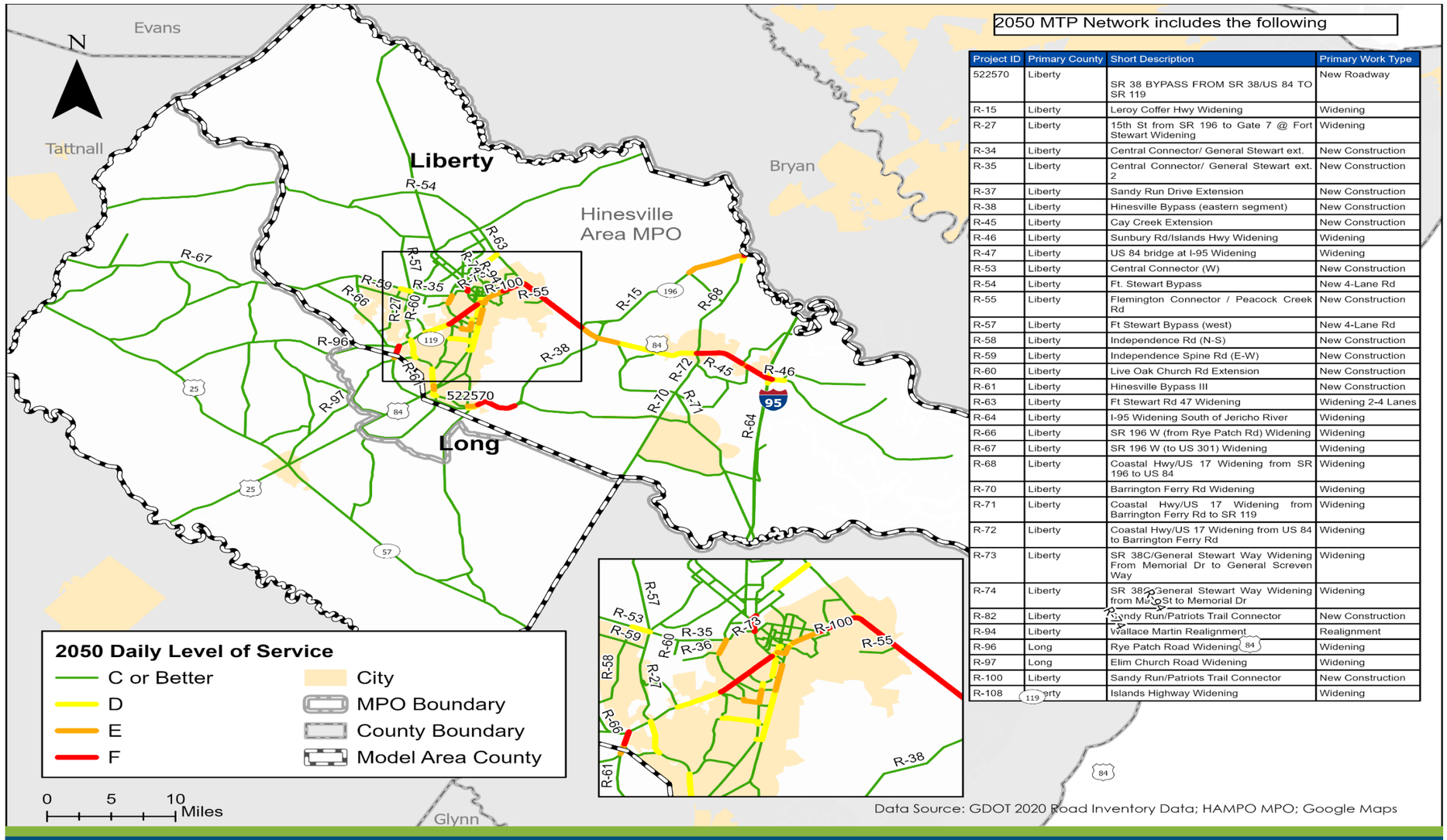


Figure 5-3 The 5th Network - 2050 MTP Network

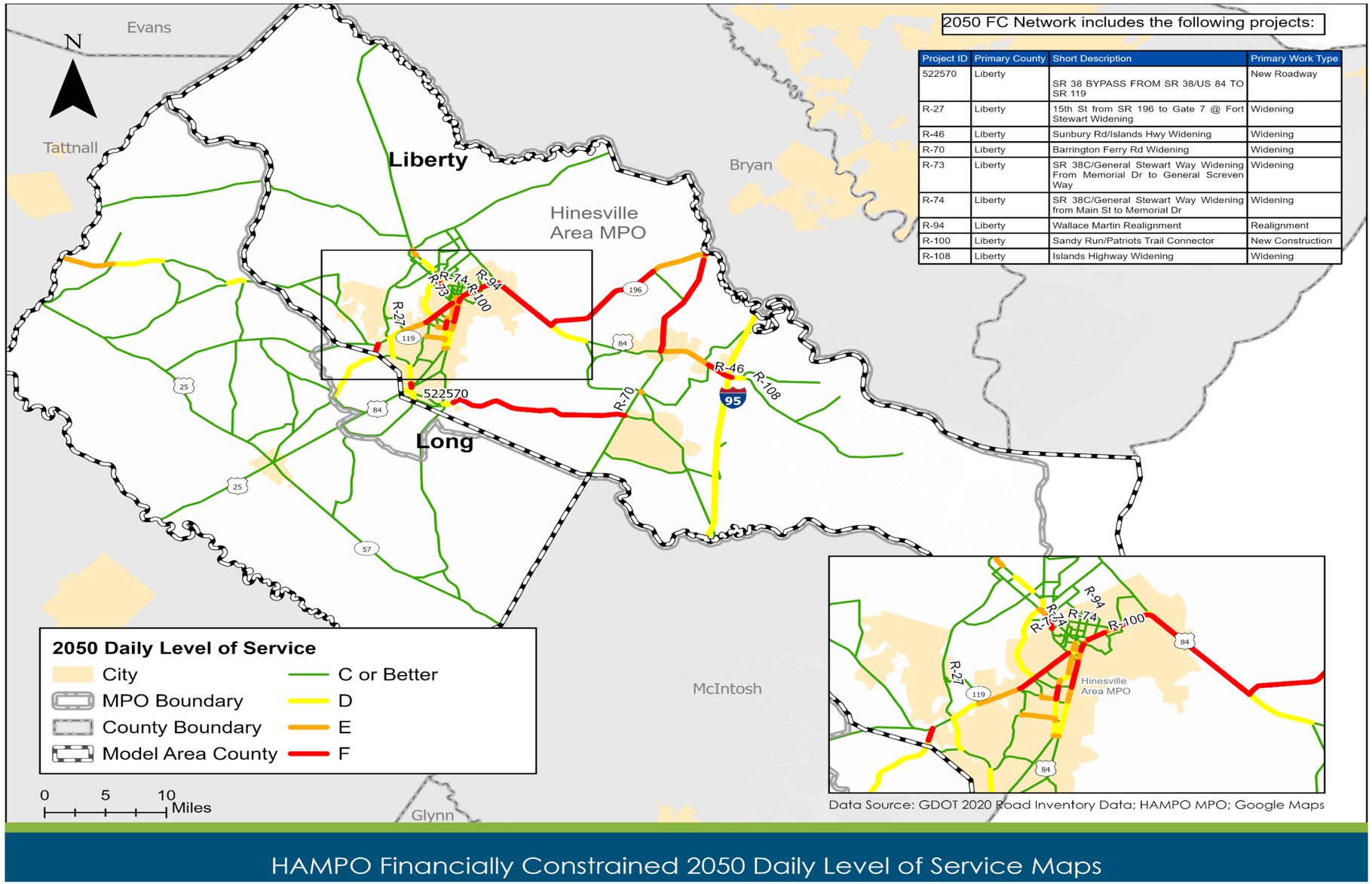


2050 MTP Network includes the following

Project ID	Primary County	Short Description	Primary Work Type
522570	Liberty	SR 38 BYPASS FROM SR 38/US 84 TO SR 119	New Roadway
R-15	Liberty	Leroy Coffer Hwy Widening	Widening
R-27	Liberty	15th St from SR 196 to Gate 7 @ Fort Stewart Widening	Widening
R-34	Liberty	Central Connector/ General Stewart ext.	New Construction
R-35	Liberty	Central Connector/ General Stewart ext. 2	New Construction
R-37	Liberty	Sandy Run Drive Extension	New Construction
R-38	Liberty	Hinesville Bypass (eastern segment)	New Construction
R-45	Liberty	Cay Creek Extension	New Construction
R-46	Liberty	Sunbury Rd/Islands Hwy Widening	Widening
R-47	Liberty	US 84 bridge at I-95 Widening	Widening
R-53	Liberty	Central Connector (W)	New Construction
R-54	Liberty	Ft. Stewart Bypass	New 4-Lane Rd
R-55	Liberty	Flemington Connector / Peacock Creek Rd	New Construction
R-57	Liberty	Ft Stewart Bypass (west)	New 4-Lane Rd
R-58	Liberty	Independence Rd (N-S)	New Construction
R-59	Liberty	Independence Spine Rd (E-W)	New Construction
R-60	Liberty	Live Oak Church Rd Extension	New Construction
R-61	Liberty	Hinesville Bypass III	New Construction
R-63	Liberty	Ft Stewart Rd 47 Widening	Widening 2-4 Lanes
R-64	Liberty	I-95 Widening South of Jericho River	Widening
R-66	Liberty	SR 196 W (from Rye Patch Rd) Widening	Widening
R-67	Liberty	SR 196 W (to US 301) Widening	Widening
R-68	Liberty	Coastal Hwy/US 17 Widening from SR 196 to US 84	Widening
R-70	Liberty	Barrington Ferry Rd Widening	Widening
R-71	Liberty	Coastal Hwy/US 17 Widening from Barrington Ferry Rd to SR 119	Widening
R-72	Liberty	Coastal Hwy/US 17 Widening from US 84 to Barrington Ferry Rd	Widening
R-73	Liberty	SR 38C/General Stewart Way Widening From Memorial Dr to General Screven Way	Widening
R-74	Liberty	SR 38C/General Stewart Way Widening from Main St to Memorial Dr	Widening
R-82	Liberty	Sandy Run/Patriots Trail Connector	New Construction
R-94	Liberty	Wallace Martin Realignment	Realignment
R-96	Long	Rye Patch Road Widening	Widening
R-97	Long	Elim Church Road Widening	Widening
R-100	Liberty	Sandy Run/Patriots Trail Connector	New Construction
R-108	Liberty	Islands Highway Widening	Widening

HAMPO MTP 2050 Daily Level of Service Maps

Figure 5-4 The 6th Network Financially Constrained



HAMPO Financially Constrained 2050 Daily Level of Service Maps

6. APPENDIX

A-1: 2020 SOCIOECONOMIC DATA REVIEW MEMO

Introduction

The following section includes the review and observations of the Hinesville Area Metropolitan Planning organization (HAMPO) SE data for the year 2020 input into the travel demand model (TDM). The SE data was reviewed at two geographic levels: the aggregated TDM region and individual traffic analysis zones (TAZs).

The **regional level** review included a summary overview of:

1. 2020 Total Population;
2. 2020 Total Households;
3. 2020 Total Employees and Employees by Category;
4. 2020 Total Students;
5. Density Ratios.

The **individual TAZ-level** review included a reasonableness check on:

1. TAZs with No 2020 SE data;
2. 2020 Persons per Household Ratio;
3. 2020 Household Density;
4. 2020 Population Density;
5. 2020 Student to Service Employment Ratio;
6. 2020 Employment Relative to Acres; and
7. 2020 School Enrollment.

Absent local development knowledge, the review was conducted purely based on the existing 2020 SE data provided and *GDOT's Georgia MPO Travel Demand Models Socio-Economic Data Development Guide (2022)* (abbreviated as *"GDOT's SE Data Guide"* hereafter). This document offers the observed facts that need attention and confirmation. The observations do not necessarily suggest any revisions if the SE data reasonably reflects the region's approved development plans.

Regional Level SE Data Review

Table 6-1 provides a summary of the 2020 SE data in the TDM area of HAMPO, including the entire Liberty and Long County. Based on the SE data provided, the sum of total employment doesn't equal the sum of four types of employment. In the review memo, the sum of four employment types was used as total employment for consistency.

Table 6-1 TDM Area 2020 SE Data Summary

SE Variable	Total
Population	71,863
Households	30,222
Total Employment	14,946
Manufacturing, Transportation, Communication, Utilities, Warehousing	3,576
Service	8,875
Retail	2,055
Agriculture, Mining, Construction	440
Students	14,440
University Enrollment	2,056

Table 6-2 represents some commonly used ratios to check the SE data. At the regional level, the person per household ratio, the school enrollment to population ratio, population density, and household density appear to be within reasonable limits compared to GDOT standards. However, the employees per household ratio is 0.49, which is under the GDOT's recommended range of 1.00-3.00, and the MPO will need to double-check it.

Table 6-2 Commonly Used Ratios of Density

Variable	2020	GDOT's Recommended Range
Persons per Household	2.38	2.00 - 3.00
Employees per Household	0.49	1.00 - 3.00
Proportion of Population Enrolled in K12 Schools	20.09%	Around 20%
Persons per Acre	0.14	< 10.00
Households per Acre	0.06	< 6.00

Traffic Analysis Zone (TAZ) Level SE Data Review

A TAZ-level review was conducted following *GDOT's Model Guidelines* to ensure the existing estimations are consistent with reasonable changes.

As indicated in **Table 6-3**, there are 2 TAZs with zero total population, households, and employment; 14 TAZs with zero total population and households, but have employment; and 45 TAZs with population and households but no employment. These values need to be rechecked and confirmed.

Table 6-3 TAZs with No SE Data

Zero Value Field	TAZ ID
Population, Households, and Employment	103, 214
Population and Households Only	12, 21, 24, 25, 26, 30, 34, 35, 109, 112, 135, 136, 138, 321
Employment Only	7, 14, 15, 19, 43, 45, 56, 57, 60, 61, 68, 77, 79, 81, 82, 86, 87, 95, 96, 97, 99, 101, 105, 107, 113, 117, 119, 127, 134, 182, 302, 306, 307, 312, 314, 318, 320, 325, 326, 327, 329, 332, 333, 334, 336

According to GDOT's SE Data Guide, the ratio of person per household should range between 1 and 7. The population per household ratio should not be less than 1 as a household is an occupied housing unit. Values exceeding 7 should correspond to some form of group housing within the TAZ. This ratio for most TAZs in the HAMPO model falls within range as shown in **Table 6-4**. Among 193 TAZs, 6 TAZs have a persons per household ratio above 7 or below 1.

Table 6-4 TAZs with 2020 Persons per Household Ratio > 7 or <1

TAZ ID	Population	Household	Person per Household Ratio
28	8	1	8
41	16	1	16
56	9	1	9
82	36	3	12
127	8	1	8
326	16	1	16

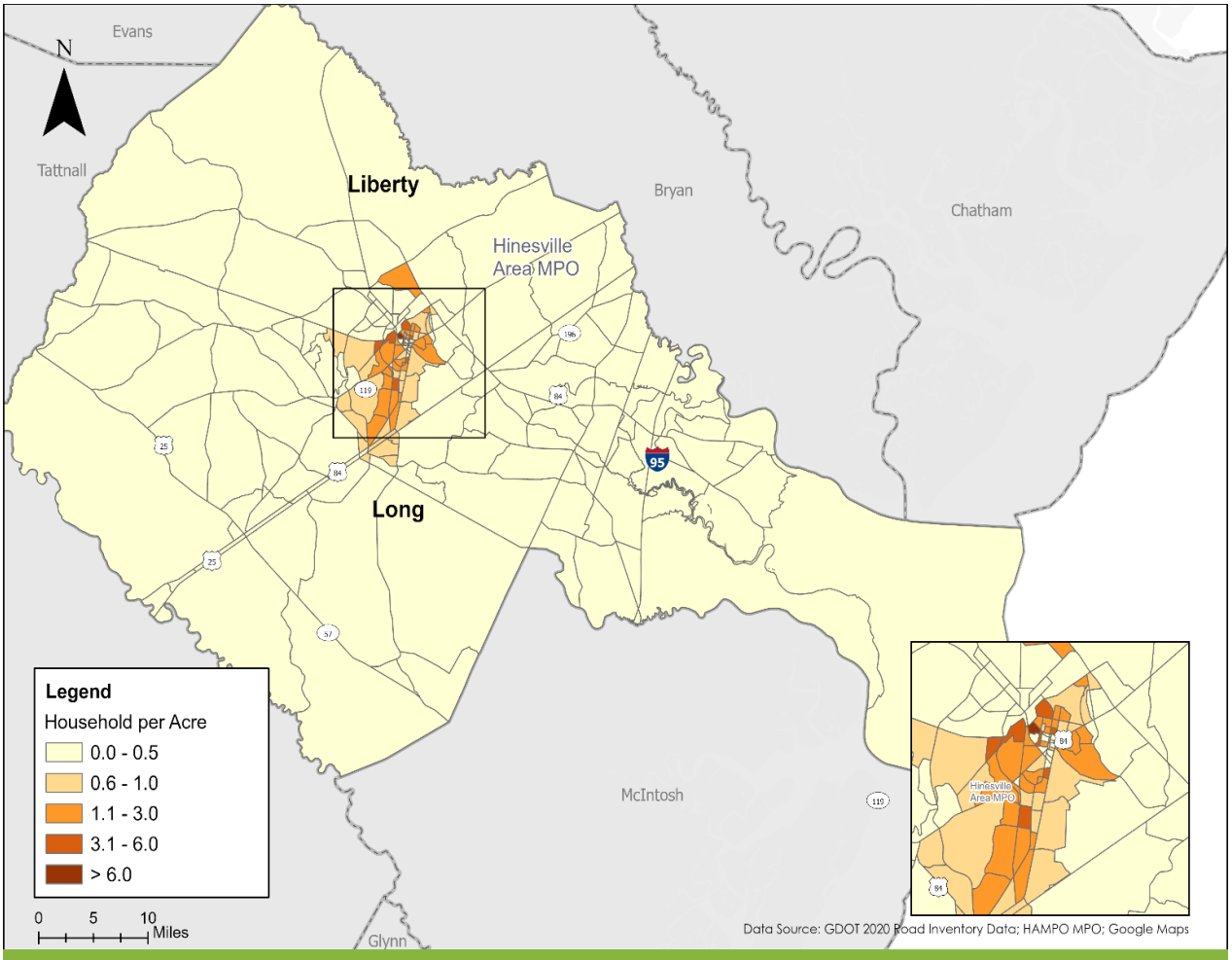
Household Density

According to *GDOT's SE Data Guide,* the number of households per acre in most TAZs should be no more than 6. A value of 6 typically corresponds to a three-story multi-family building. Values exceeding 6 should correspond to larger or denser multi-family housing.

There is one TAZ with HH/acre greater than 6, which is TAZ 13 with a HH/acre of 6.55

A household density map was prepared and reviewed based on SE data provided by the MPO**. Figure 6-1** on next page illustrates the household density by TAZ for the HAMPO TDM region.

Figure 6-1 2020 Household Density per TAZ



HAMPO 2020 Household Density

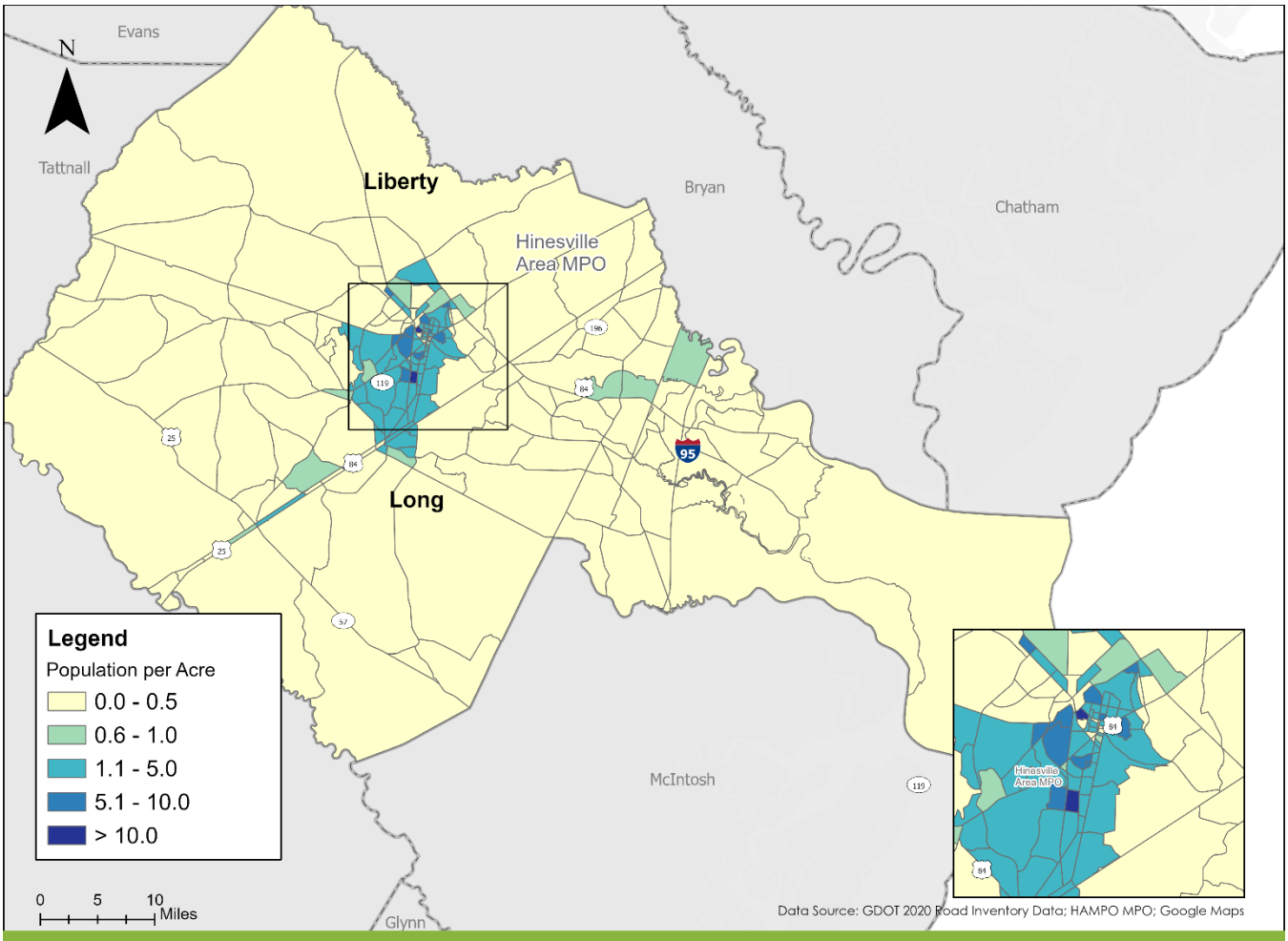
Population Density

According to *GDOT's SE Data Guide,* the ratio of population to acres should not exceed 10. TAZs with persons per acre higher than 10 are generally identified as multi-family or group housing land use.

There were 2 TAZs with pop/acre greater than 10 which were TAZs 13 and 44 and should be rechecked.

A population density map was prepared and reviewed based on SE data provided by the MPO. **Figure 6-2** illustrates the population density by TAZ for the HAMPO region. All TAZs fall under the GDOT recommended range for populations per acre.

Figure 6-2 2020 Population Density per TAZ



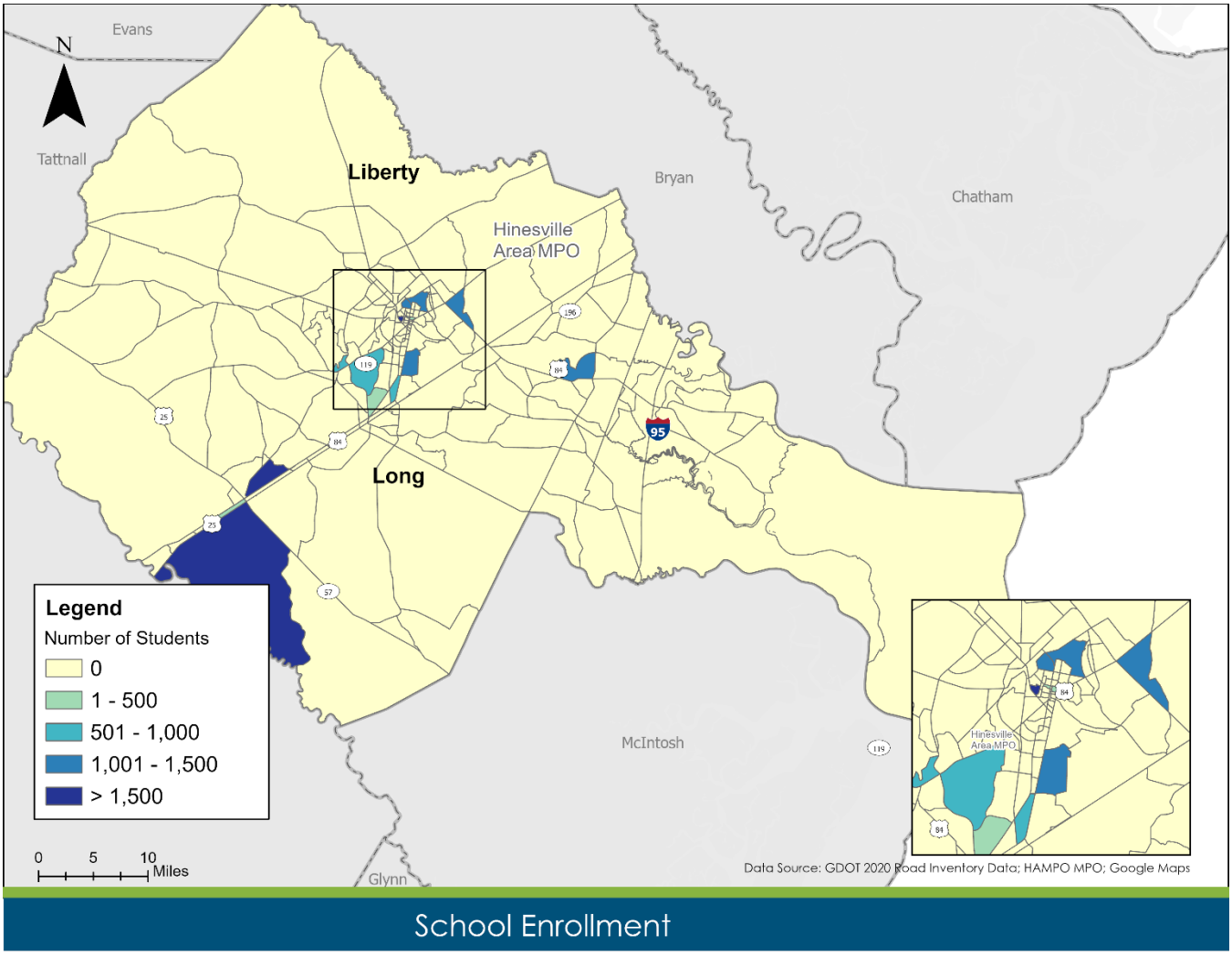
Service Employment

In TAZs that have school enrollments, there is typically one service employee to every 12 students. If the student to service employee ratio is significantly higher than 12, those TAZs should be confirmed that unique or atypical schools exist. All TAZs fall under the recommended student to service employment ratio.

School and University Enrollment

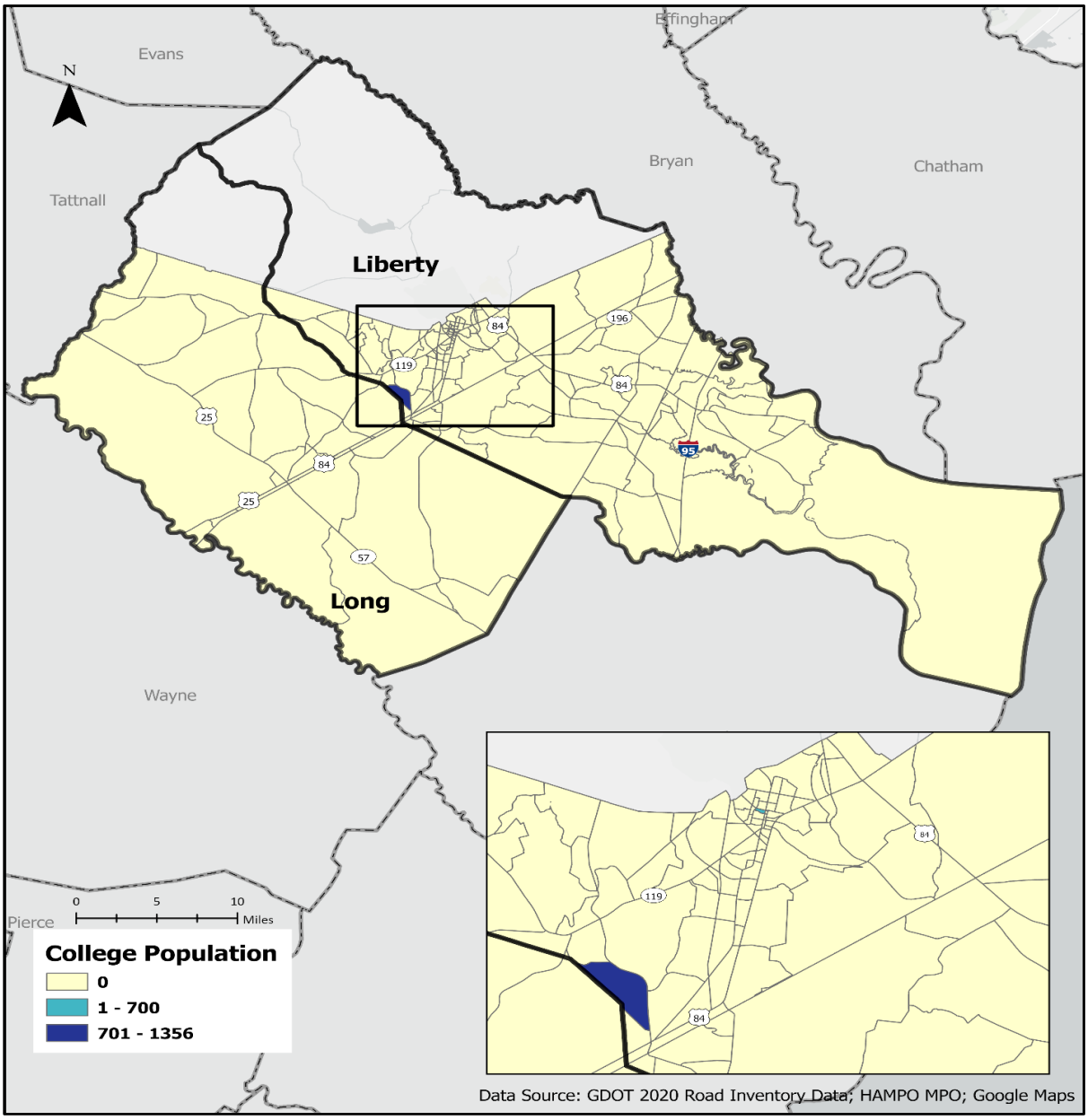
Overall, the ratio of K12 school enrollment to total population is 20.09% in 2020. There are 15 TAZs that include school enrollment. **Figure 6-3** illustrates the K12 school locations.

Figure 6-3: 2020 School Enrollment per TAZ



There is a total of 2 TAZs with a college population in Liberty and Long County. TAZ 50 and TAZ 21 correspond to Savannah Technical College and Georgia Southern University, respectively. These TAZs are shown in **Figure 6-4**.

Figure 6-4 2020 College Locations



Median Income

If detailed income data is not available for smaller geographic areas, TAZ income data can be estimated from its associated census tracts (or block groups) data. Income should be reported in 2020 dollars. TAZ income data should not be blank if the TAZ has household data. All TAZs with households have income data.

Conclusions

Overall, the methodology and assumptions used in the SE data preparation are sound and in-line with best practices. However, it is recommended the MPO review and confirm the following:

- Check the Employment/Household Ratio, it is currently below the GDOT recommended range of 1.00-3.00.
- Check the population, household, and employment values for TAZs listed **Table 6-3**. These TAZs have zero values for population, household, and/or employment.There are 2 TAZs with zero total population, households, and employment; 14TAZs with zero total population and households but has employment; and 45 TAZs with population and households but no employment.
- Check the population and household value, and the housing types, of TAZs listed below. All the cases should be verified by the MPO.
    - **Table 6-4** shows the TAZ with persons per household ratio > 7 or <1. There are 6 TAZs with person per household ratio > 7 and should be doublechecked.
    - There is one TAZ with HH/acre greater than 6 which is TAZ 13 with a HH/acre of 6.55
    - There were 2 TAZs with pop/acre greater than 10 which were TAZs 13 and 44 and should be rechecked.

A-2: 2050 SOCIOECONOMIC DATA REVIEW MEMO

Introduction

The following section includes the review and observations of the Hinesville Area Metropolitan Planning Organization (HAMPO) socio-economic (SE) data for the year 2050 input into the travel demand model (TDM). The SE data was reviewed at two geographic levels: the aggregated TDM region and individual traffic analysis zones (TAZs).

The **regional level** review included a summary overview of:

6. 2050 Total Population;
7. 2050 Total Households;
8. 2050 Total Employees and Employees by Category;
9. 2050 Total Students;
10. Density Ratios.

The **individual TAZ-level** review included a reasonableness check on:

8. TAZs with No 2050 SE data;
9. Growth Rates between 2020 and 2050 SE Data;
10. 2050 Persons per Household Ratio;
11. 2050 Household Density;
12. 2050 Population Density;
13. 2050 Student to Service Employment Ratio; and
14. 2050 School Enrollment.

Absent local development knowledge, the review was conducted based on the 2050 SE data provided and *GDOT's Georgia MPO Travel Demand Models Socio-Economic Data Development Guide (2022)* (abbreviated as *"GDOT's SE Data Guide"* hereafter). This document offers the observed facts that need attention and confirmation. The observations do not necessarily suggest any revisions if the SE data reasonably reflects the region's approved development plans.

Regional Level SE Data Review

Table 6-5 provides a summary of the SE data in the TDM area for 2020 and 2050 and shows the growth in absolute and percentage terms by the overall TDM area. Between 2020 and 2050, the average annual growth rates are -0.63% for population, 0.65% for households, and 0.47% for employment, respectively. Among the four categories of employment, MTCUW has the highest average annual growth rate of 0.69%, and Retail has the lowest annual growth rate of 0.0%. The Service industry has the highest absolute growth with 1,608 additional jobs.

Table 6-5 TDM Area 2050 SE Data Summary

SE Variable	2020	2050	Absolute Growth	Growth Rate (2020 – 2050)	Average Annual Growth Rate (2020 - 2050)
Population	83,993	101,267	17,274	20.57%	0.63%
Households	37,867	46,015	8,148	21.52%	0.65%
Total Employment	19,245	22,181	2,936	15.26%	0.47%
Manufacturing, Transportation, Communication, Utilities, Warehousing	3,789	4,655	866	22.86%	0.69%
Service	12,636	14,680	2,044	16.18%	0.50%
Retail	2,109	2,109	0	0.00%	0.00%
Agriculture, Mining, Construction	711	737	26	3.66%	0.12%
K-12 Students	14,440	17,801	3,361	23.28%	0.70%
College Students	2,056	2,535	479	23.30%	0.70%

Table 6-6 applies some commonly used ratios to check the SE data. At the regional level, persons per household, the ratio of population to employment, population density, and household density in 2050 are within the GDOT's Recommended Ranges. The proportion of the population enrolled in K12 schools is 18.16%, slightly decreased from that ratio in 2020 but still in line with the GDOT recommended range. Additionally, the employees-to-household ratio is 0.46, which is considered low according to GDOT's Recommended Range of 1.00 – 3.00, but has increased from the ratio in 2020.

Table 6-6 Commonly Used Ratios of Density

Variable	2020	2050	Change (2020 - 2050)	GDOT's Recommended Range
Persons per Household	2.22	2.20	-0.02	2.00 - 3.00
Population to Employment	4.36	4.57	0.20	--
Employees per Household	0.51	0.48	-0.03	1.00 - 3.00
Proportion of Population Enrolled in K12 Schools	17.19%	17.58%	0.39%	Around 20%
Persons per Acre	0.13	0.16	0.03	< 10.00
Households per Acre	0.06	0.07	0.01	< 6.00

Traffic Analysis Zone (TAZ) Level SE Data Review

A TAZ-level review was conducted following *GDOT's SE Data Guide* to ensure the

Growth Rates between 2020 and 2050 SE Data

As per *GDOT's SE Data Guide,* TAZs with a 2050 population/household growth of more than 500% should be reviewed for any planned developments. **Table 6-7** shows that the population and household growth rates of TAZs 117, 155 and 180 are greater than 500%.

Table 6-7 TAZS WITH GROWTH GREATER THAN 500%

Growth Rate Greater than 500%	TAZ ID
Population	77, 83, 100, 332
Households	28,77,83,100,111,332

Persons per Household Ratio

According to *GDOT's SE Data Guide,* the ratio of persons per household should range between 1 and 7. Values exceeding 7 should correspond to some form of group housing within the TAZ. GDOT. **Table 6-8** shows that there are no TAZs with a ratio of persons per household lower than 1 or greater than 7.

Table 6-8 TAZs with Household Ratio outside of 1 and 7

	TAZ ID
Household Ratio not between 1 and 7	111

Household Density

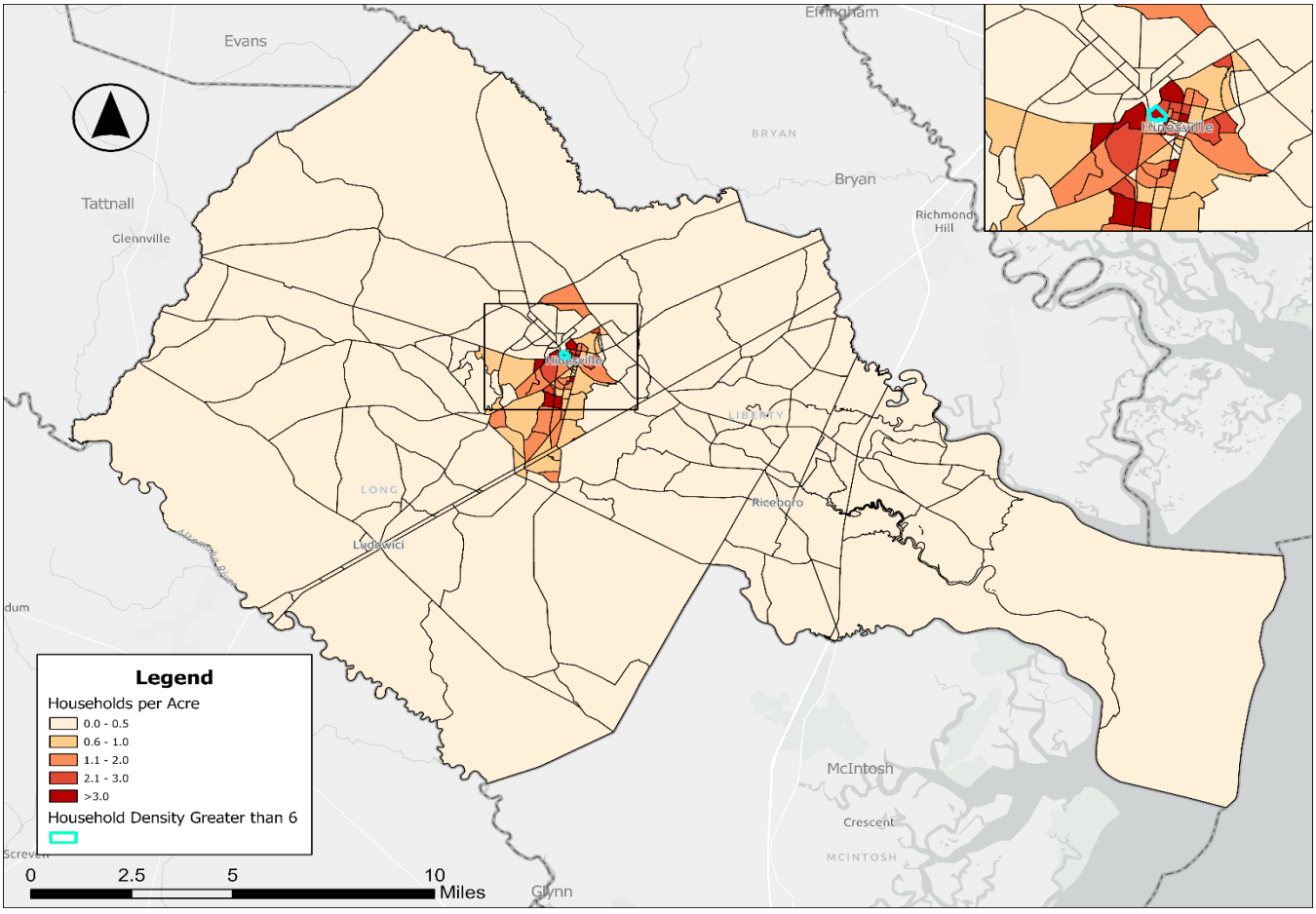
According to *GDOT's SE Data Guide,* the number of households per acre in most TAZs should be less than 6. A value of 6 typically corresponds to a multi-family building or group home. Values exceeding 6 should correspond to larger or denser multi-family housing.

A household density map was prepared and reviewed based on SE data provided by the MPO. Figure 1 illustrates the household density by TAZ for the HAMPO MPO region. Among 220 TAZs, 1 of those have household density greater than 6. **Table 6-9** lists the TAZ with households per acre ratio greater than 6 for the year 2050 and 2020. With the slightly higher ratio in 2020, the 2050 ratio seems reasonable.

Table 6-9 TAZs With 2050 Households Per Acre Greater Than 6

TAZ ID	Households/Acre in 2020	Households/Acre in 2050
13	7.57	7.82
16	6.34	6.62

Figure 6-5 2050 Household Density per TAZ



Population Density

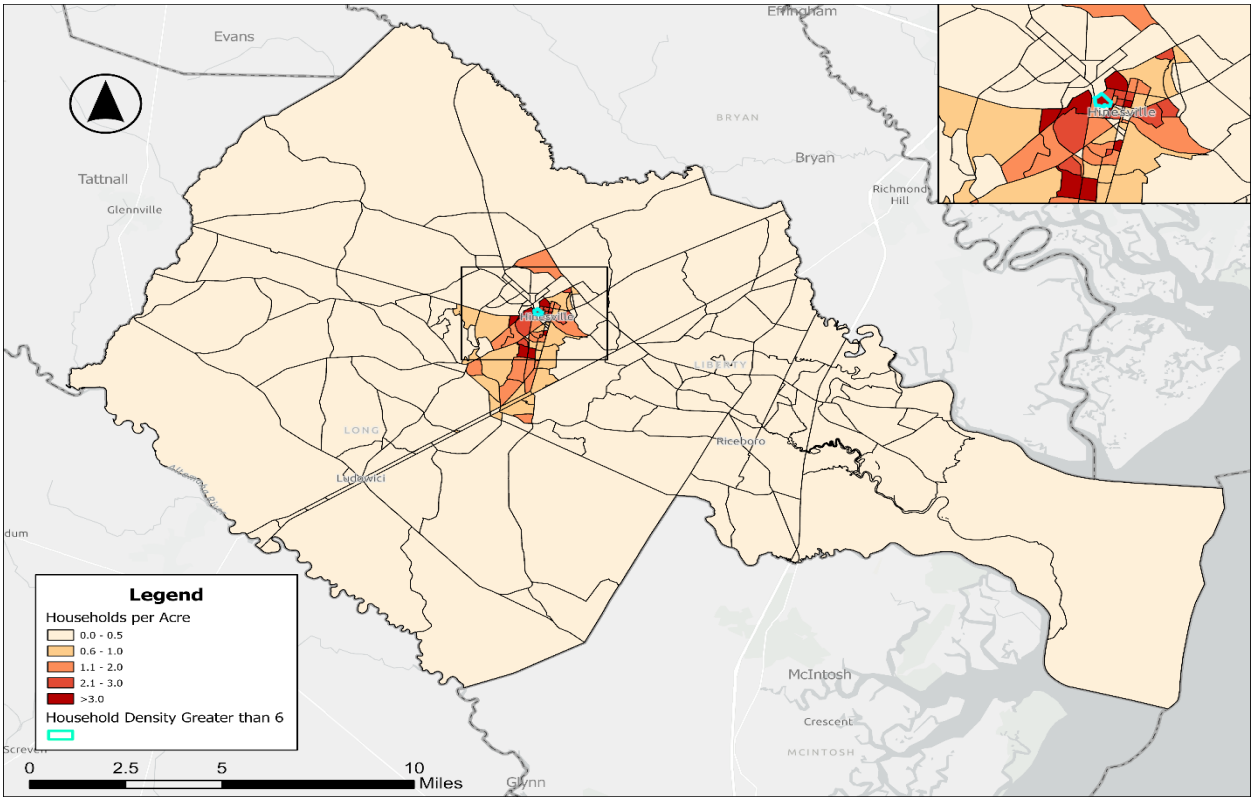
According to *GDOT's SE Data Guide,* the ratio of population to acres should not exceed 10. TAZs with a population per acre higher than 10 are generally identified as multi-story residential, multi-family, or group housing land uses. Based on SE data provided by the MPO, a population density map was prepared and reviewed. **Figure 6-6** illustrates the population density by TAZ for the HAMPO MPO region. Out of 220 TAZs, 3 TAZs have a population density greater than 10.

Table 6-10 lists TAZs with population per acre greater than 10 in order of ascending population/acre ratios. These TAZs are also highlighted in light blue in **Figure 6-6**The TAZs with a population per acre greater than 10 in 2050 will also have a high population density in 2020, which seems reasonable.

Table 6-10 TAZs With 2050 Population Per Acre Greater Than 10

TAZ ID	Population/Acre in 2020	Population/Acre in 2050
13	11.61	12.15
16	9.79	10.36
44	10.91	11

Figure 6-6 2050 Population Density per TAZ



Service Employment

For TAZs that contain schools, there is typically one service employee for every 12 students. If the ratio of students to service employees is significantly higher than 12, those TAZs should be confirmed to ensure that unique or atypical schools exist or are planned. In the 2050 SE data, there are no TAZs with a student-to-service employee ratio greater than 12.

School and University Enrollment

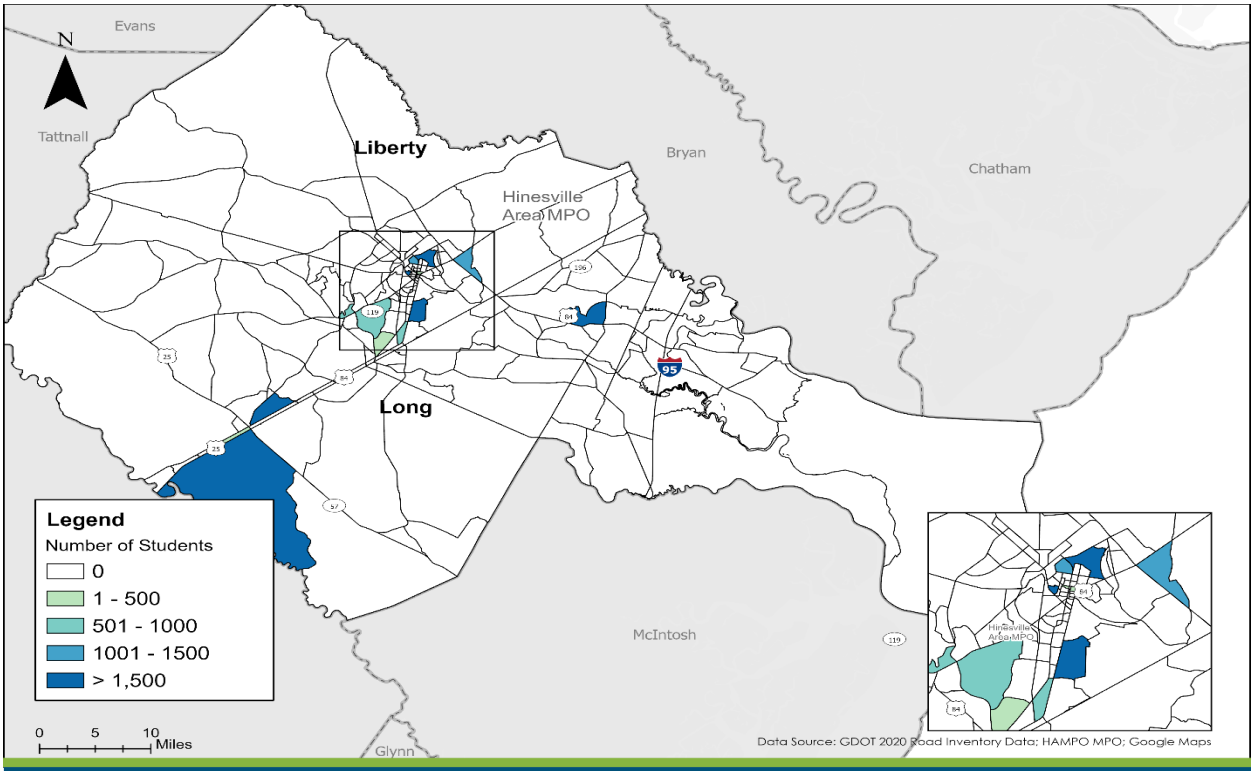
Overall, the ratio of K12 school enrollment to total population in 2050 is 18.16%. There are 15 TAZs that include K12 school enrollment.

There have been changes in college development, which are shown in **Table 6-11**. The absolute growth in college students is 479, with an average annual growth of .70% between 2020 and 2050.

Table 6-11 Net Changes in College Development(2020-2050)

College Student(2020)	College Student (2050)
2,056	2,535

Figure 6-7 2050 School Locations



Median Income

If detailed income data is not available for smaller geographic areas, TAZ income data can be estimated from its associated census tracts (or block groups) data. 2050 income is consistent with 2020 median income.

Conclusions

Overall, the methodology and assumptions used in the SE data preparation and forecasts are sound and in-line with best practices. However, it is recommended the MPO review and confirm the following:

- Based on **Table 6-7**, TAZs with household and population growth greater than 500% between 2020 and 2050 should be double checked. These include TAZs 28, 100,111, and 332B
- Based on **Table 6-8**, 1 TAZ has a person to household ratio outside of 1 and 7
- Based on **Table 6-9** , TAZ 13 and 16 has households per acre greater than 6 for the year 2050.
  Based on **Table 6-10**, TAZ 13,16, and 44 have populations per acre greater than 10 for the year 2050.