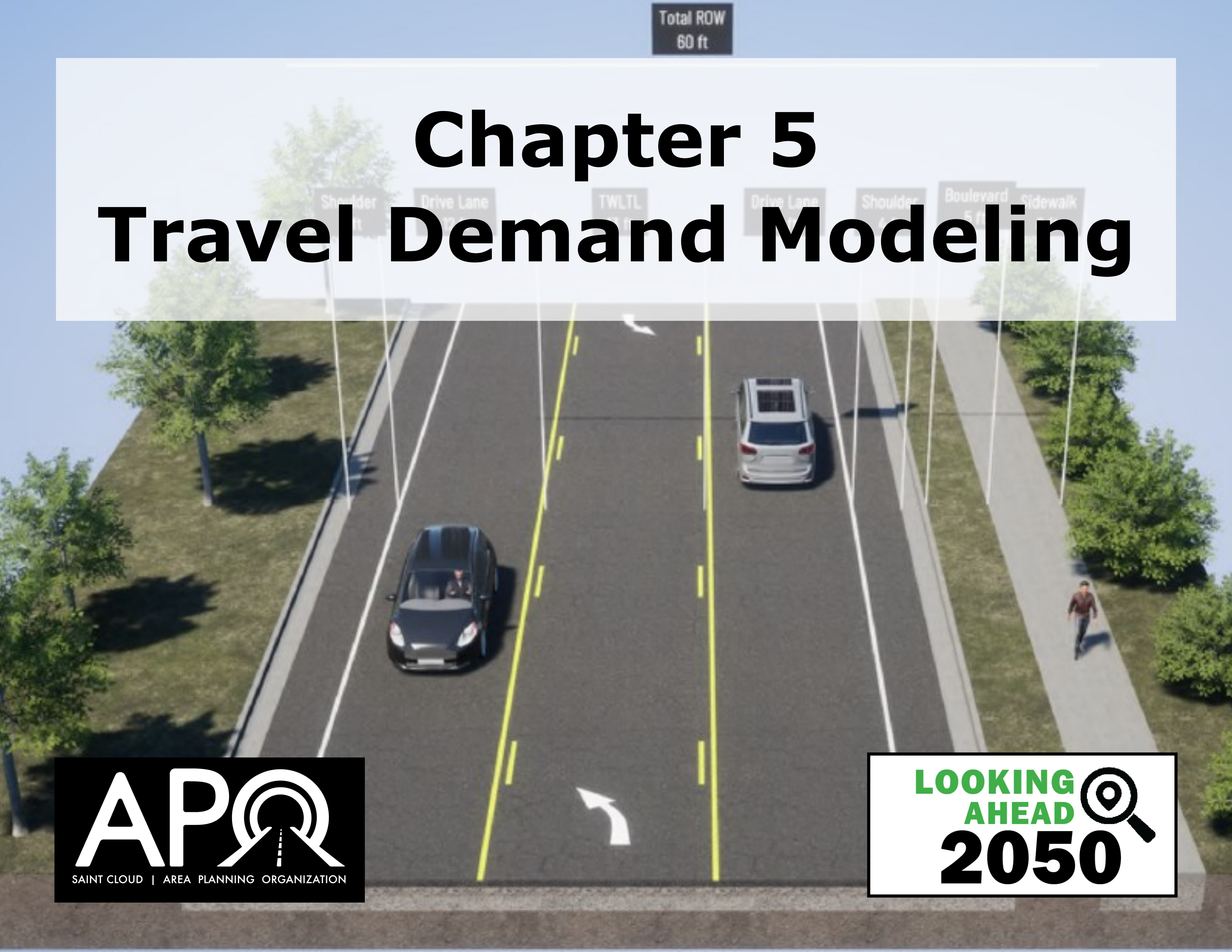
Chapter 5
Travel Demand Modeling



APO
SAINT CLOUD | AREA PLANNING ORGANIZATION

LOOKING AHEAD 2050

Chapter 5: Travel Demand Modeling Contents

Introduction

Federal regulations require the APO's MTP include a "projected transportation demand of persons and goods in the metropolitan planning area over the period of the transportation plan." One of the primary techniques the APO utilizes to fulfill this requirement is through the Travel Demand Model (TDM).

As stated in the Existing Conditions, the TDM is a tool used to understand trip generation and attraction information to distribute travel on a roadway network (trip assignment). Using a computer-based modeling software – the APO model is built and maintained in CUBE – we are not only able to understand our current system, but we are also able to reasonably forecast travel patterns based on future population growth and land use.

What is CUBE?

CUBE is a predictive modeling and transportation simulation software. Agencies, like the Saint Cloud APO, use CUBE as a way to analyze the effects of new projects and policies on the region's transportation network, land use, and population.

Information courtesy of Bentley.

Figure 5.1: *Infographic describing CUBE software.*

This chapter focuses on the use of the APO's TDM to forecast future travel patterns. After providing a cursory overview of the model calibration process, this section then moves into future scenario planning. Known as our 2050 No-Build Model, this model run is used to provide a basic understanding of our current system's performance if no additional capacity expansion improvements were made by 2050. Taken together, the 2020 base year model (as discussed in Chapter 2) and the 2050 No-Build Model can reasonably forecast operational/capacity concerns as well as assist APO member agencies/jurisdictions in identifying future areas for investment.

Model Calibration

Building a TDM is a mathematically complex process involving several steps. The text below outlines the general process used by modelers to build and manipulate the APO's TDM.

1. The urban area is subdivided into a set of Traffic Analysis Zones (TAZs) based on land use zoning, physical barriers (such as railroad tracks or rivers), and several other considerations.
2. Within each TAZ, certain demographic characteristics are measured such as the number of single-family houses; the number of apartments; the number of full-time equivalent employees (FTEs) for office, industrial, and retail employment; the number of students enrolled in any school within the TAZ (if any), and other characteristics that are related to the generation or attraction of transportation trips.
3. A model network of major roadways is constructed which includes a number of characteristics such as the number of through-lanes that are present for each roadway segment, speed limit, capacity, and length of roadway.
4. The software uses the TAZ data and some basic assumptions based on travel research to generate a number of trips originating from within each TAZ. In general, trips are generated by households and are attracted to other land use types such as commercial, office, industrial, and school properties. The model also assumes return trips back to the household.
5. The software then estimates the number of trips attracted to each TAZ, connecting the trip generations to the trip attractions. Known as a gravity model, this process assumes that the attractiveness of a destination is based on the distance and the "mass" (i.e., the number of jobs) at the destination. For example, a major shopping mall like Crossroads Center will attract many more trips and will attract trips from farther away than a small corner convenience store.
6. The software then assigns trips to the roadway network. In general, the TDM chooses the route that will minimize the travel time for each trip. This is a function of both the directness of the route, the posted speed limit on that route, and the available capacity on the route.
7. The estimated trips on each roadway segment are then compared to actual measured traffic volumes in order to test the reasonableness of how well the TDM is working. If necessary, adjustments are made to improve the reasonableness of the model output.
8. If the model appears to be reasonably estimating trips based on the known data (like data sourced for the APO's 2020 base year model), we make the assumption that it will also reasonably estimate trips if we start to adjust the TAZ data and/or the network characteristics.

Between the conclusion of the 2045 MTP and the drafting of the 2050 MTP, the APO's TDM underwent several updates to improve traffic forecasting for the region. This included a 2020 recommendation for several model improvements such as defining new model components, assumptions, and file structures as well as the 2021 Regional Household Travel Survey (RHTS).

As stated in the Existing Conditions (Chapter 2) the APO uses a three-step TDM process which accounts for trip generation, trip distribution, and trip assignment. While some transportation planning agencies incorporate a modal split into their TDMs (known as mode choice) to divide trips among the available modes of travel including public transit and active transportation, given the fact these trips make up a rather small proportion of all trips completed within the MPA, it would be cost prohibitive to both factor in the trips by mode and recalibrate the model.

More details on the APO's 2020 TDM improvements as well as an overview of the 2021 RHTS can be found in Appendices O and C, respectively.

2020 Base Year Model

Before we can forecast future travel demands on the transportation network, we need to be able to reasonably assume our model is able to replicate current travel conditions.

As stated in the Existing Conditions section, a base year model run was completed. However, calibrating and validating the 2020 base year model proved challenging due to the impacts of the COVID-19 global pandemic. Due to COVID, various data inputs (collected over three years) were used to program the model.

- Census household data was from April 2020 (during the full government-mandated shutdown).
- Employment data pre-dated the March 2020 pandemic shutdown.
- Data collected and inputted into the model from the RHTS was from late 2021 which reflected post-pandemic conditions.
- The roadway network used in the model was developed to mimic mid-2020 roadway physical characteristics.
- External trips using the transportation analytic platform StreetLight InSight were based on 2019 data.
- Traffic counts for both 2020 and 2021 were utilized to validate trip assignment – ultimately 2021 traffic counts were used due to the information more accurately reflecting travel patterns reported in the RHTS.

With the immediate impact COVID had on regional travel patterns, coupled with the uncertainties of the duration of those impacts (would 2020 be an outlier or the beginning of a change in travel behavior), modelers worked to replicate typical travel patterns for the MPA – being mindful of the challenges the pandemic presented.

Model Results

One of the main outputs of the initial model run was the determination of existing roadway capacity issues within the MPA. As stated in the Existing Conditions section, not all roadways are built to handle the same level of traffic. Roadways such as I-94 (Interstate) are designed to handle much more traffic than corridors such as 10^{th} Avenue N in Waite Park (minor arterial) or Heritage Drive in Sartell (major collector). Understanding the current volume-to-capacity (V/C) ratio of our existing system (and the related interpretative measurement Level of Service (LOS)) assists regional transportation planners and engineers in identifying areas/corridors in need of future investment. More information on V/C and LOS can be found in the Overall Network Performance section of Chapter 2.

Based on the results of the 2020 base year model, approximately 2.6% of the region's functionally classified roadway network lane miles are either approaching (LOS D or LOS E) or at/overcapacity conditions (LOS F). While low, given the overall number of functionally classified lane miles in the region, the impacted lane miles are primarily on the region's National Highway System (NHS) -- roadways designed to carry a significant amount of daily traffic. This includes the major north/south corridor of MN 15 and the major east/west corridor of MN 23.

Facility Type	Number of Lanes	LOS B	LOS C	LOS D	LOS E (Capacity)
Interstate Freeways & Expressways (Urban)	6	63,500	87,500	106,600	121,000
Interstate Freeways & Expressways (Urban)	4	42,300	58,300	71,100	80,700
Interstate Freeways & Expressways (Developing)	6	62,100	85,600	104,300	118,400
Interstate Freeways & Expressways (Developing)	4	41,400	57,000	69,500	78,900
Interstate Freeways & Expressways (Rural)	6	52,800	72,800	88,700	100,700
Interstate Freeways & Expressways (Rural)	4	35,200	48,500	59,100	67,100
Divided Arterials (Urban/Developing)	6	28,300	39,000	47,600	54,000
Divided Arterials (Urban/Developing)	4	18,800	25,900	31,500	35,800
Divided Arterials (Urban/Developing)	2	9,400	13,000	15,900	18,000
Divided Arterials (Rural)	6	25,500	35,100	42,800	48,600
Divided Arterials (Rural)	4	17,000	23,400	28,500	32,400
Divided Arterials (Rural)	2	8,500	11,700	14,300	16,200
Un-Divided Arterials (Urban/Developing)	4	17,900	24,700	30,100	34,200
Un-Divided Arterials (Urban/Developing)	2	9,000	12,400	15,100	17,100
Un-Divided Arterials (Rural)	4	16,200	22,300	27,100	30,800
Un-Divided Arterials (Rural)	2	8,100	11,100	13,600	15,400
Divided Collectors/Local Streets (Urban/Developing)	4	14,700	20,200	24,700	28,000
Divided Collectors/Local Streets (Urban/Developing)	2	7,200	10,000	12,200	13,800
Divided Collectors/Local Streets (Rural)	4	13,400	18,400	22,500	25,500
Divided Collectors/Local Streets (Rural)	2	6,700	9,200	11,200	12,700
Un-Divided Collectors/Local Streets (Urban/Developing)	4	13,800	19,000	23,200	26,300
Un-Divided Collectors/Local Streets (Urban/Developing)	2	7,000	9,600	11,700	13,300
Un-Divided Collectors/Local Streets (Rural)	4	12,700	17,600	21,400	24,300
Un-Divided Collectors/Local Streets (Rural)	2	6,400	8,800	10,700	12,200

Facility Type	Number of Lanes	LOS B	LOS C	LOS D	LOS E (Capacity)
V/C Ratio		**0.52**	**0.72**	**0.88**	**1.00**

Figure 5.2: *Estimated Volume to Capacity (V/C) ratio/Level of Service (LOS) by roadway type. Data courtesy of HFTE Inc. and KLJ.*

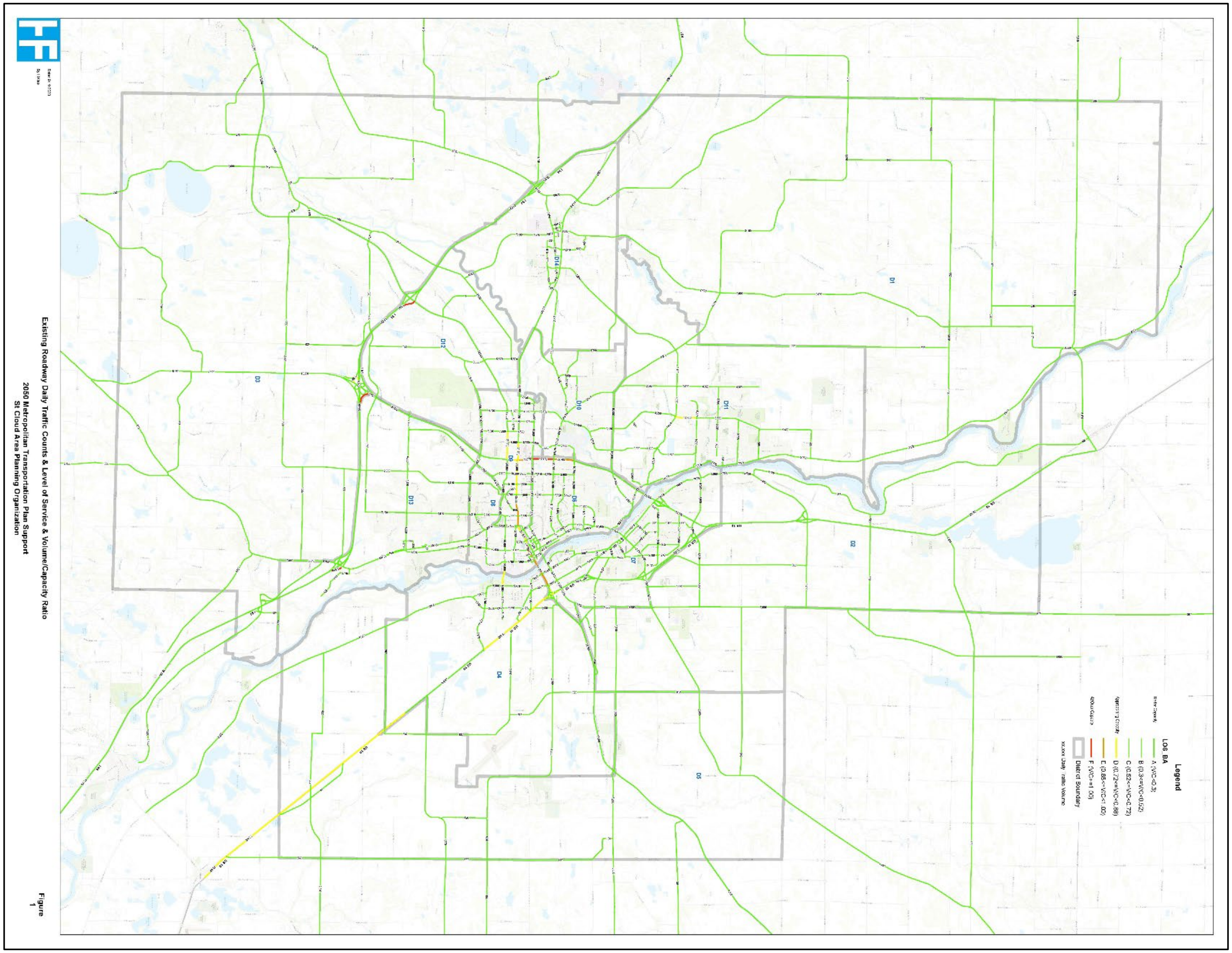


Figure 5.3: *2020 base year model results LOS map of the MPA.*
Data courtesy of KLJ.

In-Depth Model Results

To assist in understanding the 2020 base year model, consulting firm KLJ was able to further analyze the results using three additional metrics:

- Vehicle Miles Traveled (VMT).
- Vehicle Hours Traveled (VHT).
- Travel Delay.

Motorists will often make decisions on their preferred route to reach their destination based on travel time. Many will often drive more miles (VMT) if it shortens their travel time (VHT). The shortest distance route for the motorist may not be taken due to congestion (travel delay).

Vehicle Miles Traveled

Based on the model assumptions, a majority of the region's VMT is currently concentrated on the "other principal arterials" – MN 15, MN 23, and CSAH 75. This equates to nearly 40% of the region's total vehicle miles traveled – nearly double the VMT of minor arterials (23%), the next functionally classified roadway type most utilized.

Figure 5.4: *MN 15 at the intersection with Veterans Drive/CSAH 4 in Saint Cloud. This roadway, a four-lane divided arterial in an urban/developing area will be at capacity (a V/C ratio of 1.00) if the average annual daily traffic (AADT) exceeds 35,800 vehicles. Current AADT for this section of MN 15 is 32,700 vehicles (a V/C ratio of 0.91). meaning this portion of MN 15 has an LOS E rating. Photo courtesy of Saint Cloud APO.*

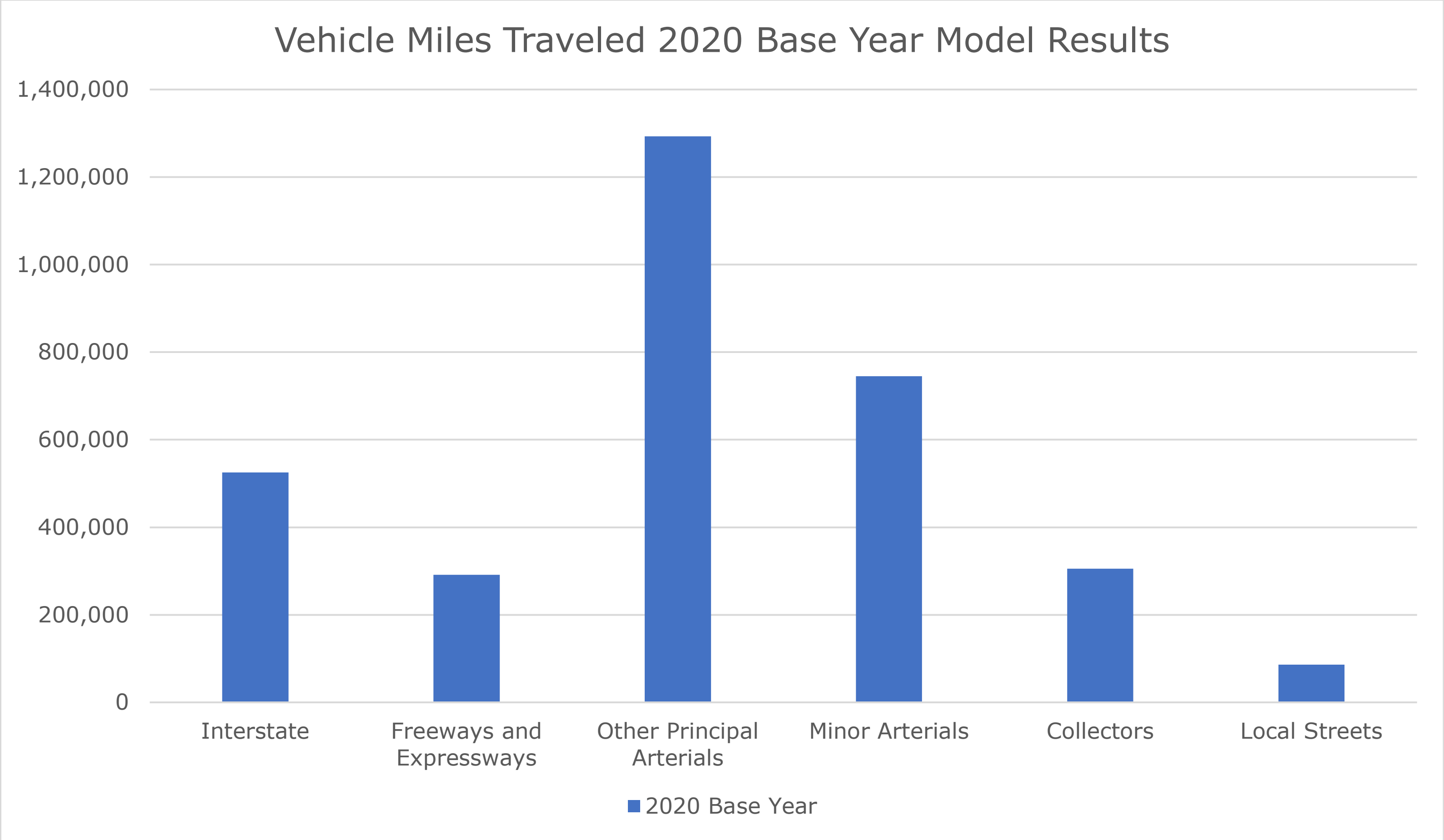


Figure 5.5: *Vehicle miles traveled by roadway functional classification for the 2020 Base Year model. Data courtesy of KLJ.*

Vehicle Hours Traveled

Similar to VMT, the majority of current vehicle hours traveled by motorists within the MPA are concentrated on the other principal arterials (40% of the region's total VHT) and the minor arterial system (28%).

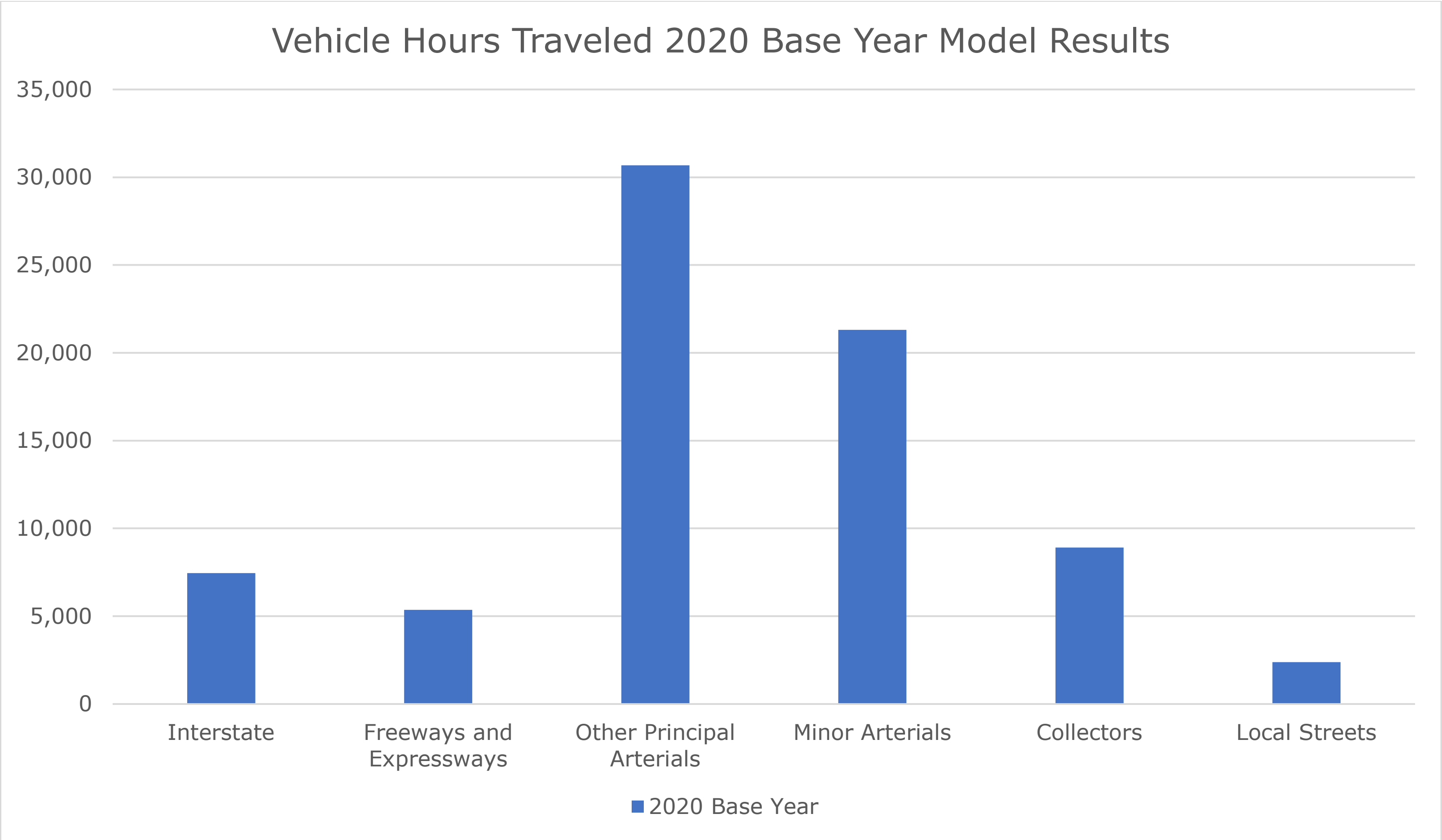


Figure 5.6: *Vehicle hours traveled by roadway functional classification for the 2020 Base Year model. Data courtesy of KLJ.*

Travel Delay

The travel delay metric measures approximately how much time people are sitting in traffic due to factors such as congestion. According to the 2020 Base Year model results, motorists within the MPA experience 4,638 hours of travel delay. Like VMT and VHT, a majority of travel delays experienced in the region are concentrated on the other principal arterials. The principal arterials system accounts for 72.5% of the total travel delay for the MPA as shown in Figure 5.7.

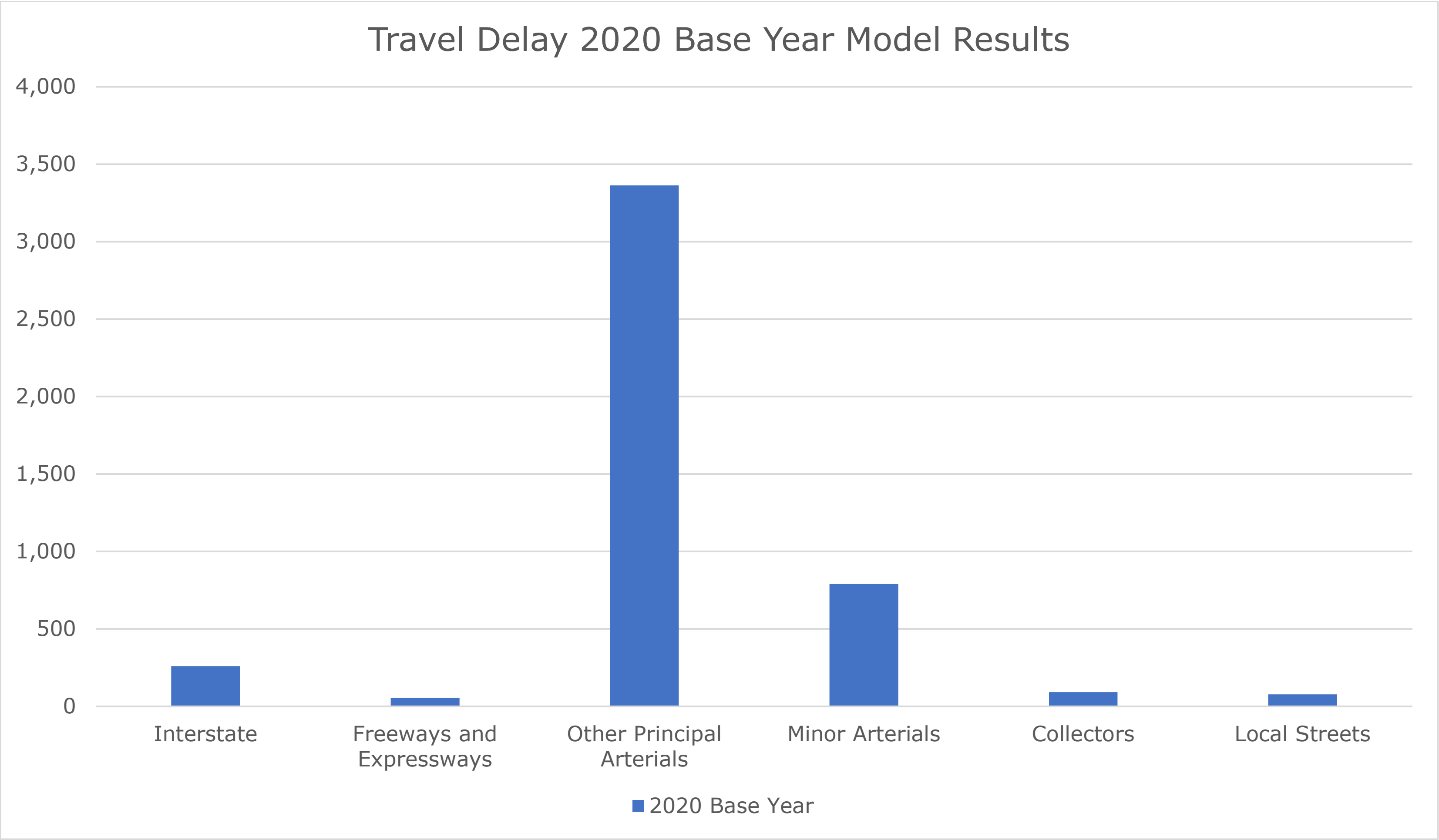


Figure 5.7: *Travel delay by roadway functional classification for the 2020 Base Year model. Data courtesy of KLJ.*

2050 No-Build Model

Once a valid base year TDM is achieved, we can be confident that if some data inputs are modified, the model will provide a reasonable assumption of traffic projections. Altering the data sets allows modelers to add forecasted projections (such as population) and changes (such as anticipated retail/office/industrial development expansion) to the base year model. This, in turn, allows regional planners and engineers to understand how various changes will impact the current transportation network.

Known as a "No-Build" model, this scenario hypothesizes how the regional transportation system will function in the event the region continues to grow/expand ***AND*** no additional roadway capacity is added to the network. The results of this model scenario are designed to highlight future problem areas and capacity constraints that may need to be addressed.

Calibrating the 2050 No-Build Model

Consulting firms SRF and Metro Analytics, in cooperation with staff from the APO and member jurisdictions, worked to update both the county/city population forecasts and the density distribution (households, retail employment, office employment, and industrial employment) to 2050. Working closely with jurisdictional staff, these anticipated changes were then assigned to individual TAZs.

Figure 5.8: *Construction of the new Chipotle along MN 15 near the intersection with Stearns CSAH 1 in the City of Sartell. Photo courtesy of Saint Cloud APO.*

2050 Forecasts "By the Numbers"

Technical staff from APO member jurisdictions, in conjunction with consulting firms SRF and Metro Analytics, worked to forecast socioeconomic data to 2050 for their respective city and/or county. Shown here are the combined regional results (projected to 2050) for population; households; and retail, office, and industrial employment.

32,008
the anticipated number of additional people living in the MPA by 2050 (22.9% increase).

6,900
the anticipated number of additional retail jobs to be created by 2050 (44.2% increase).

8,209
the anticipated number of additional office jobs to be created by 2050 (24.2% increase).

13,054
the anticipated number of additional households within the MPA by 2050 (22.8% increase).

2,958
the anticipated number of additional industrial jobs to be created by 2050 (16.5% increase).

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Figure 5.9: *2050 forecasts for population; households; and retail, industrial, and office jobs within the Saint Cloud MPA.*

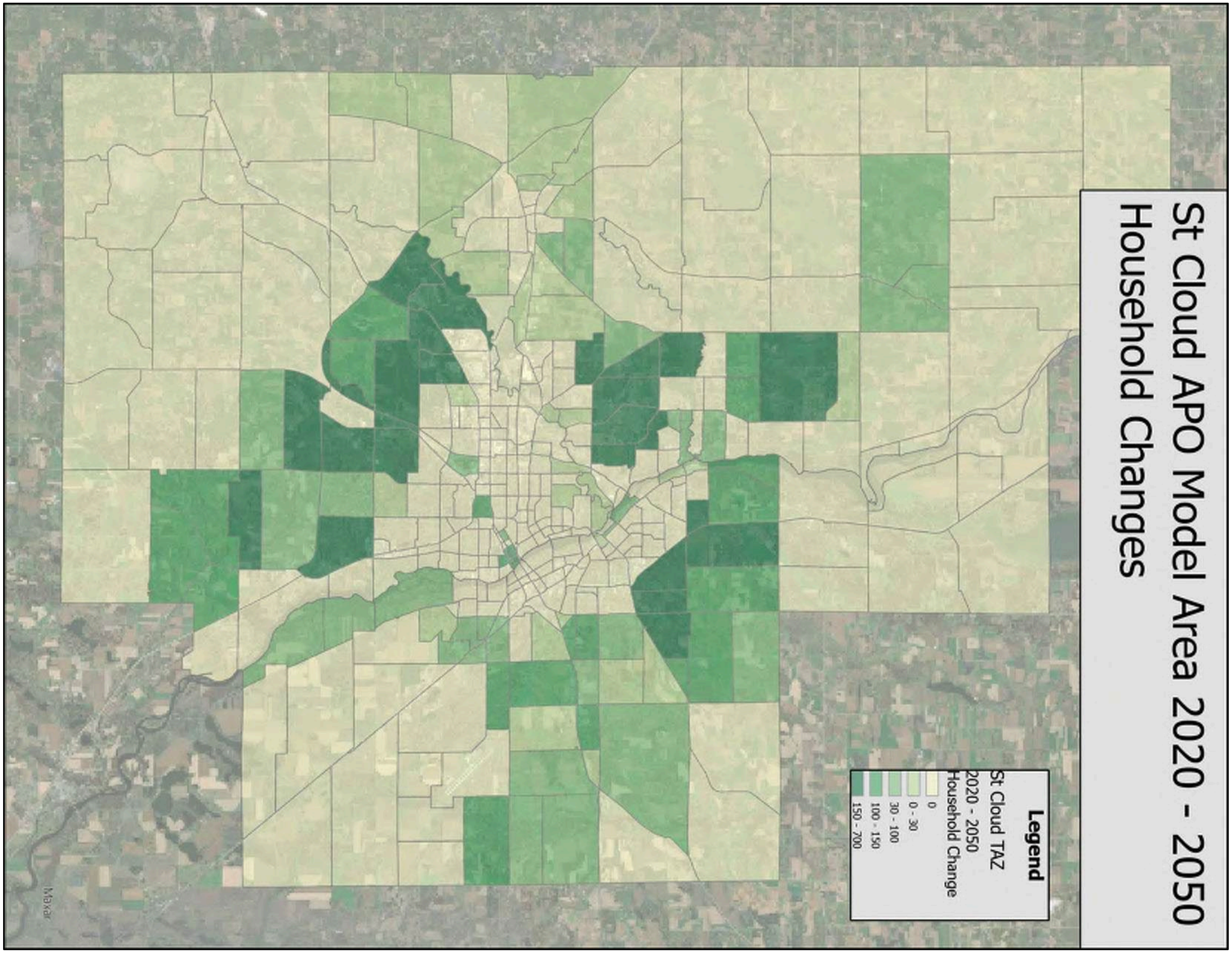

Figure 5.10: *Changes in the concentration of household density by TAZ from the current (2020) data to the 2050 forecasted data. Data courtesy of SRF and Metro Analytics.*

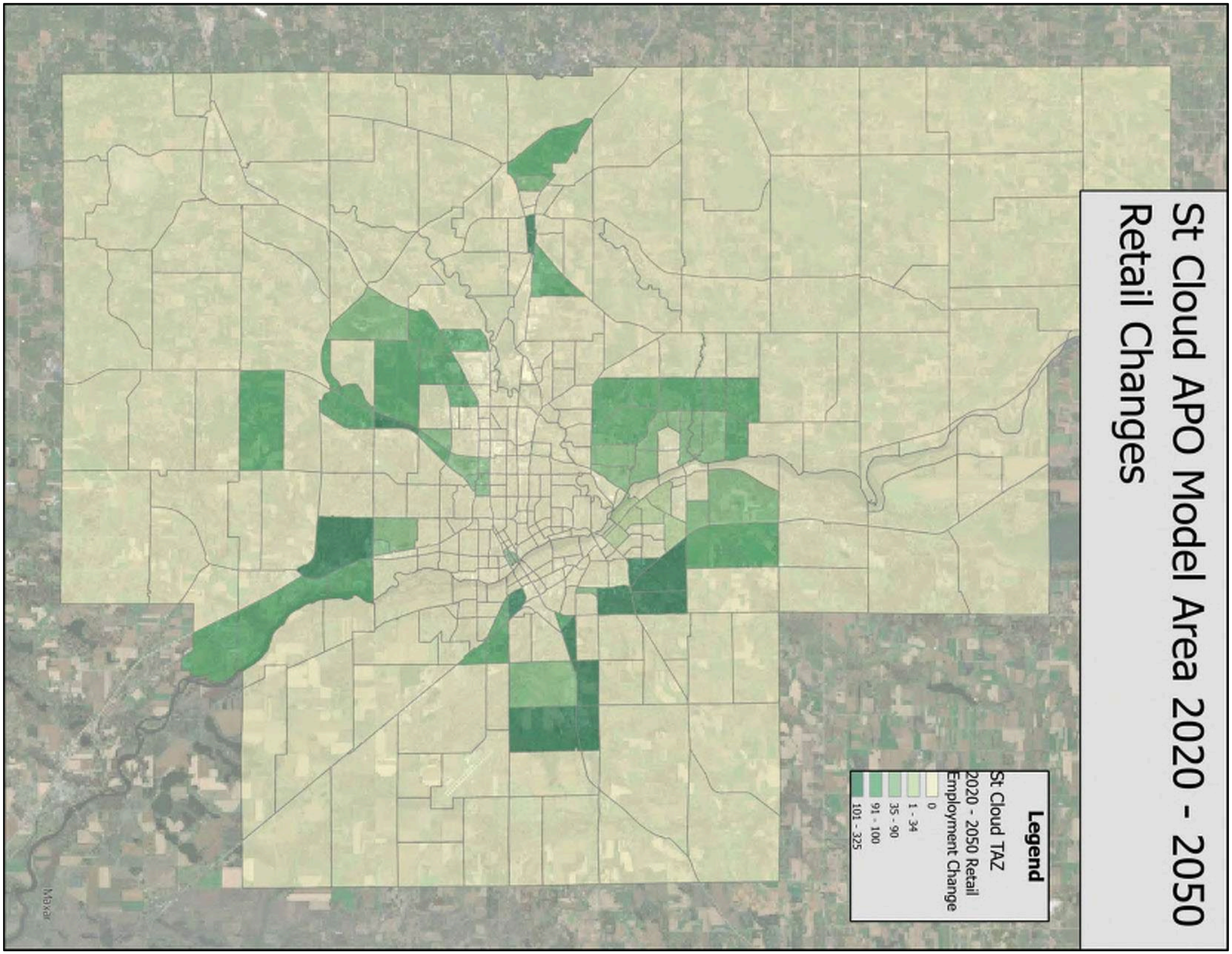

Figure 5.11: *Changes in the concentration of retail employment density by TAZ from the current (2020) data to the 2050 forecasted data. Data courtesy of SRF and Metro Analytics.*

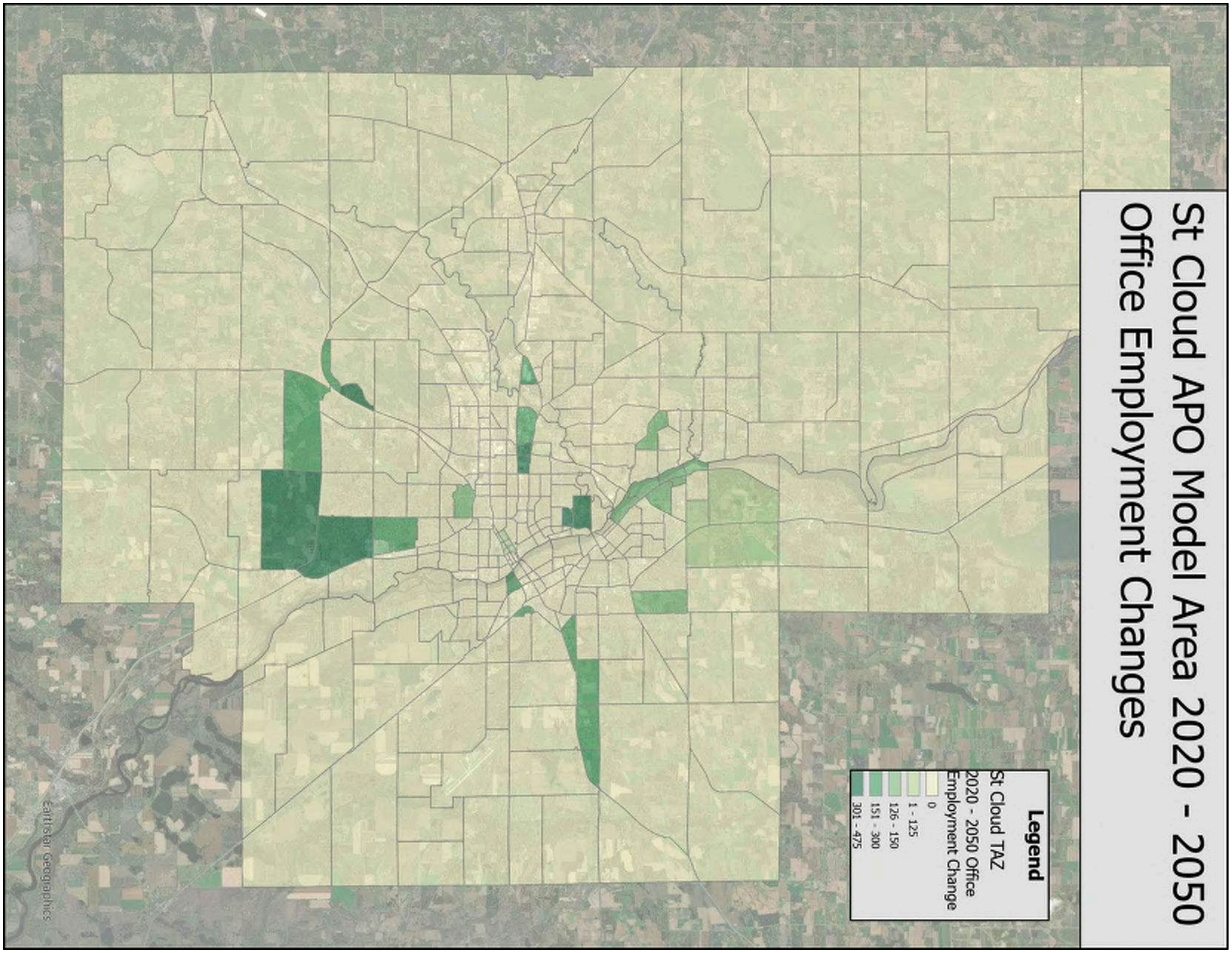

Figure 5.12: *Changes in the concentration of office employment density by TAZ from the current (2020) data to the 2050 forecasted data. Data courtesy of SRF and Metro Analytics.*

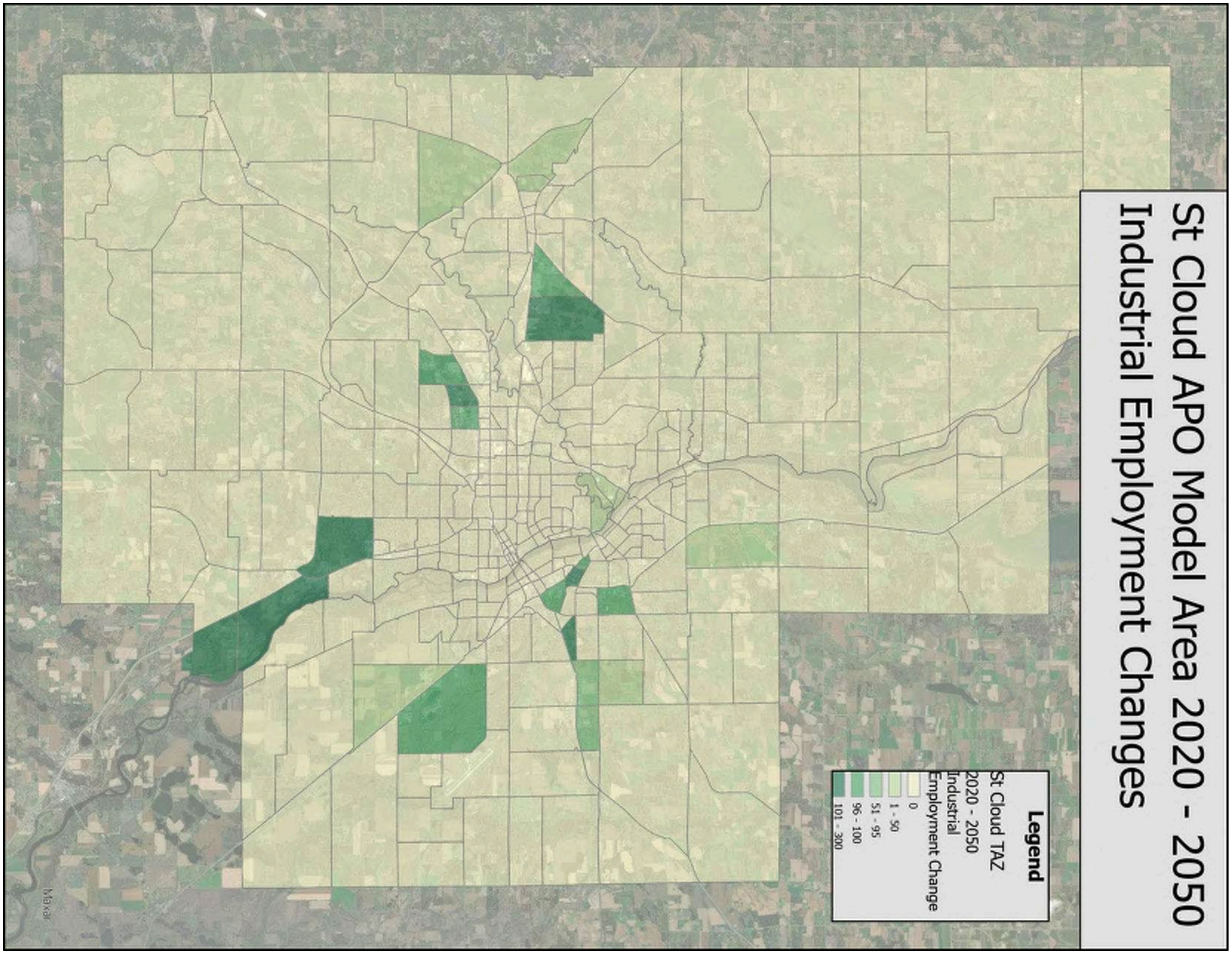

Figure 5.13: *Changes in the concentration of industrial employment density by TAZ from the current (2020) data to the 2050 forecasted data. Data courtesy of SRF and Metro Analytics.*

In addition to the changes in population growth and future development, the 2050 No-Build Model accounts for all capacity-changing projects completed (through 2020) and those committed to be completed by 2026. Because planning and securing funding for transportation infrastructure projects, especially capacity expansion and/or new alignments, can take years to complete, member agencies/jurisdictions already committed funds to complete some capacity expansion projects either during the development of this MTP or shortly after it has been completed.

As a result, the following roadway changes were added to the existing 2020 roadway network:

- City of Saint Cloud's 33rd Street S expansion from 26th Avenue S to Cooper Avenue S.
- City of Sartell's Scout Drive/Dehler Drive new alignment connection – from the end of Scout Drive near Pinecone Road to Connecticut Avenue's intersection with Dehler Drive.
- Stearns County's CSAH 133 expansion from CSAH 75 to 15th Avenue in the City of Saint Joseph.

These roadways account for approximately 3.9 lane miles added to the base year network.

2050 No-Build Model Results

As expected, the region's existing + committed roadway network will experience sizeable LOS changes if the MPA meets the population and development growth anticipated by 2050.

According to the 2050 No-Build Model results highlighted in Figure 5.14, the number of lane miles operating under capacity will decline by 9.6%. While this is not a major decline, it is far outpaced by the percentage increase of lane miles approaching or over capacity. Based on the 2050 No-Build Model scenario, 114.9 more lane miles of the region's network will be considered approaching capacity and 35.6 more lane miles will be considered over capacity. This is a 193.8% and 1,148.4% increase, respectively, over the 2020 Base Year Model results.

Network	Lane Miles Under Capacity (LOS A-C)	Lane Miles Approaching Capacity (LOS D & E)	Lane Miles Over Capacity (LOS F)	Total Lane Miles
Base Year (2020)	1,518.5	59.3	3.1	1,581.0
2050 No-Build Model	1,372.0	174.2	38.7	1,584.9
Change from Base Year to No-Build Model	**-146.5**	**+114.9**	**+35.6**	**+3.9**
Percent Change from Base Year to No-Build Model	**-9.6%**	**+193.8%**	**+1,148.4%**	**+0.2%**

Figure 5.14: *Lane mile capacity comparison between the base year (2020) model and the 2050 No-Build model. Data courtesy of KLJ.*

LOS Ranking	2050 No-Build Lane Miles	Percent of Lane Miles by LOS Ranking
A	811.0	51.2%
B	322.7	20.4%
C	238.3	15.0%
D	155.0	9.8%
E	19.2	1.2%
F	38.7	2.4%
Total	1584.9	100%

Figure 5.15: *The number and percentage of lane miles by LOS ranking for the 2050 No-Build model. Data courtesy of KLJ.*

Similar to the 2020 base year model, the corridors experiencing continued (or worsening) volume-to-capacity issues are concentrated on MN 15 and MN 23 throughout the region's core. Of note, in addition to the operational concerns forecasted for the NHS in the 2050 No-Build model, two of the six bridges crossing the Mississippi River within the Saint Cloud MPA are projected to be over capacity – creating potential bottlenecks for travelers needing to cross this waterway.

Roadway	Termini	LOS	Agency/Jurisdiction
MN 15	Third Street N to 12th Street N	F	MnDOT
MN 23	25th Avenue to Washington Memorial Drive	F	MnDOT
MN 23	12th Avenue S to Lincoln Avenue SE	F	MnDOT
University Drive	Fifth Avenue S to Kilian Boulevard SE	F	City of Saint Cloud
US 10	Halfway between 32nd Street SE/CSAH 3 and CR 65 to southern Haven Township border	F	MnDOT
CSAH 1	CR 120 to Ninth Avenue N	E	Stearns County
MN 15	Third Street N to MN 23/Second Street S	E	MnDOT
MN 23	MN 15 to 25th Avenue	E	MnDOT
MN 23	Washington Memorial Drive to 12th Avenue S	E	MnDOT
US 10	Halfway between 32nd Street SE/CSAH 3 and CR 65 to MN 301	E	MnDOT

Figure 5.16: *Roadway segments within the MPA with a LOS F or a LOS E based on the 2050 No-Build model results. Data courtesy of KLJ.*

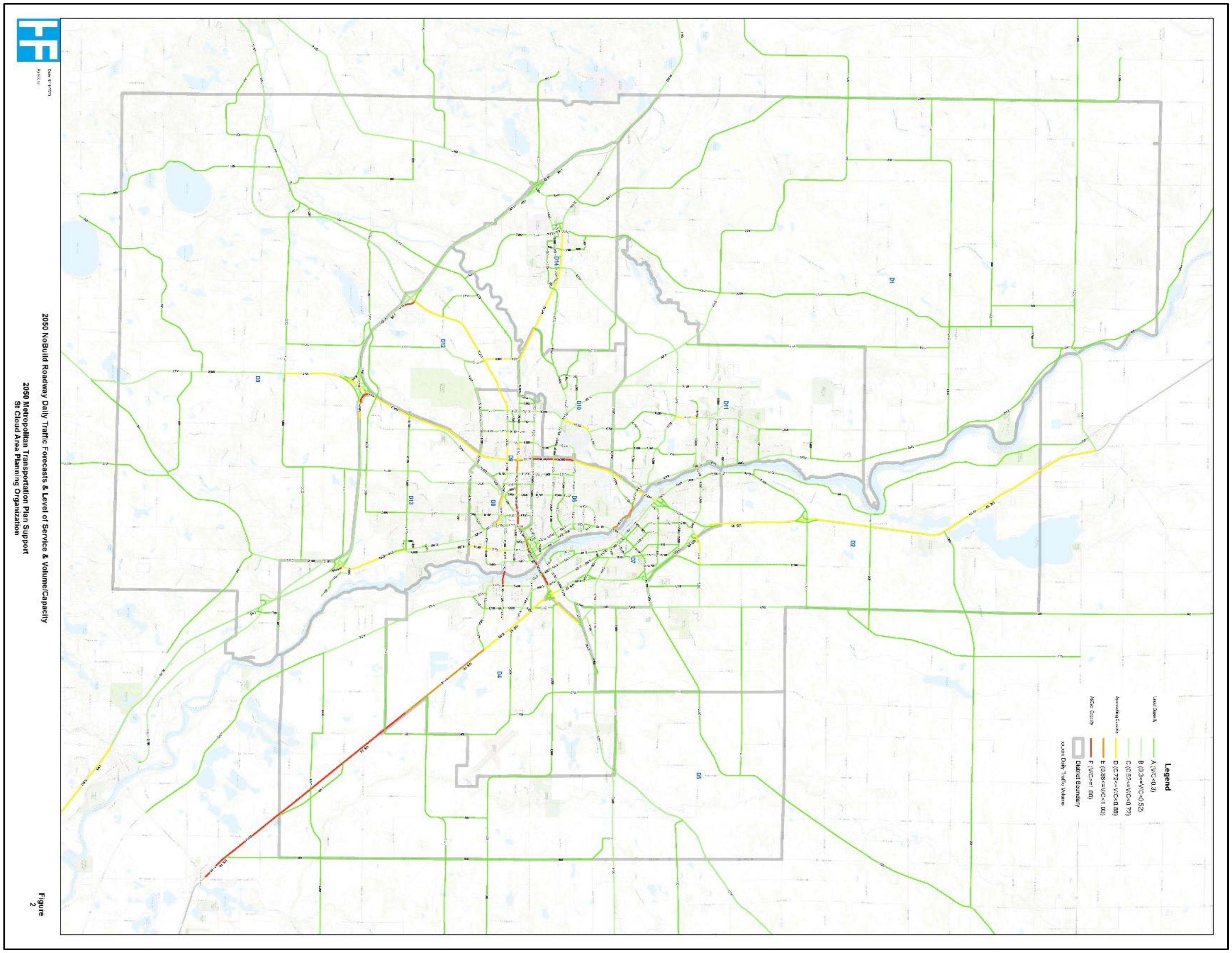

Figure 5.17: *2050 No-Build model results LOS map of the MPA.*
Data courtesy of KLJ.

In-Depth Model Comparisons

Consulting firm KLJ was able to provide further analysis of the 2050 No-Build model to compare the forecasted results to current conditions (2020 Base Year model). Using VMT, VHT, and Travel Delay, we can gain additional insights on the forecasted impacts on our current + committed transportation system if the region continues to grow and develop.

Vehicle Miles Traveled

VMT rates across the roadway network (existing + committed) are forecasted to increase by 2050. Roadways within the planning area that typically carry much of the region's traffic – other principal arterials – which were already operating near or at/over-capacity during the base year model run are anticipated to see a VMT increase of 19.1% by 2050. Further compounding the volume-to-capacity concerns are the sizeable VMT increases on the minor arterial system and the collector system which are anticipated to experience VMT increases of 30.0% and 45.1%, respectively.

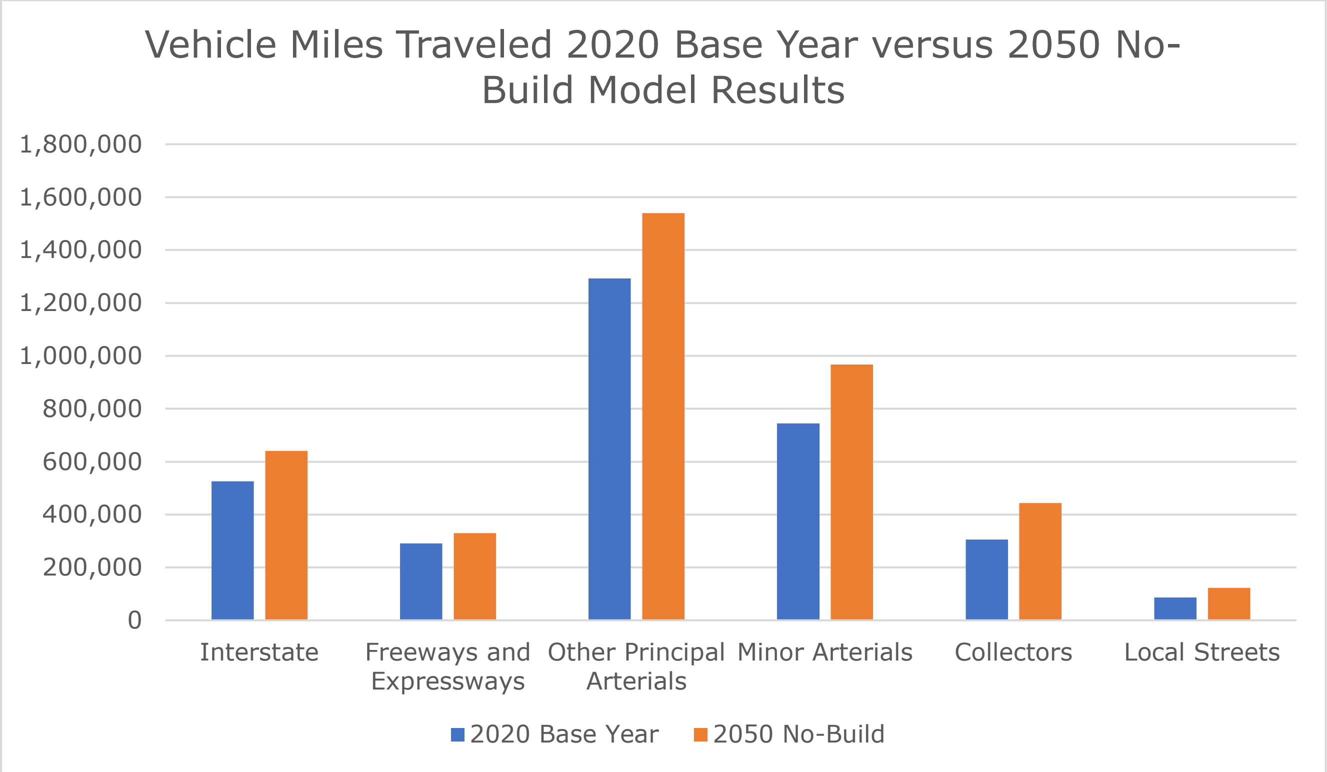

Figure 5.18: *Vehicle miles traveled comparisons between the 2020 base year and 2050 No-Build model. Data courtesy of KLJ.*

Vehicle Hours Traveled

Unsurprisingly, VHT increases were also experienced in comparing the 2020 base year and 2050 No-Build model scenarios. Most notable were the anticipated increases in VHT to be experienced by motorists using collector roadways. It is forecasted these roadways will experience a 45.6% increase in VHT by 2050 in comparison to current conditions. Sizeable VHT increases, once again, are anticipated to occur on the other principal arterial and minor arterial networks – a 23.3% and 31.6% increase respectively.

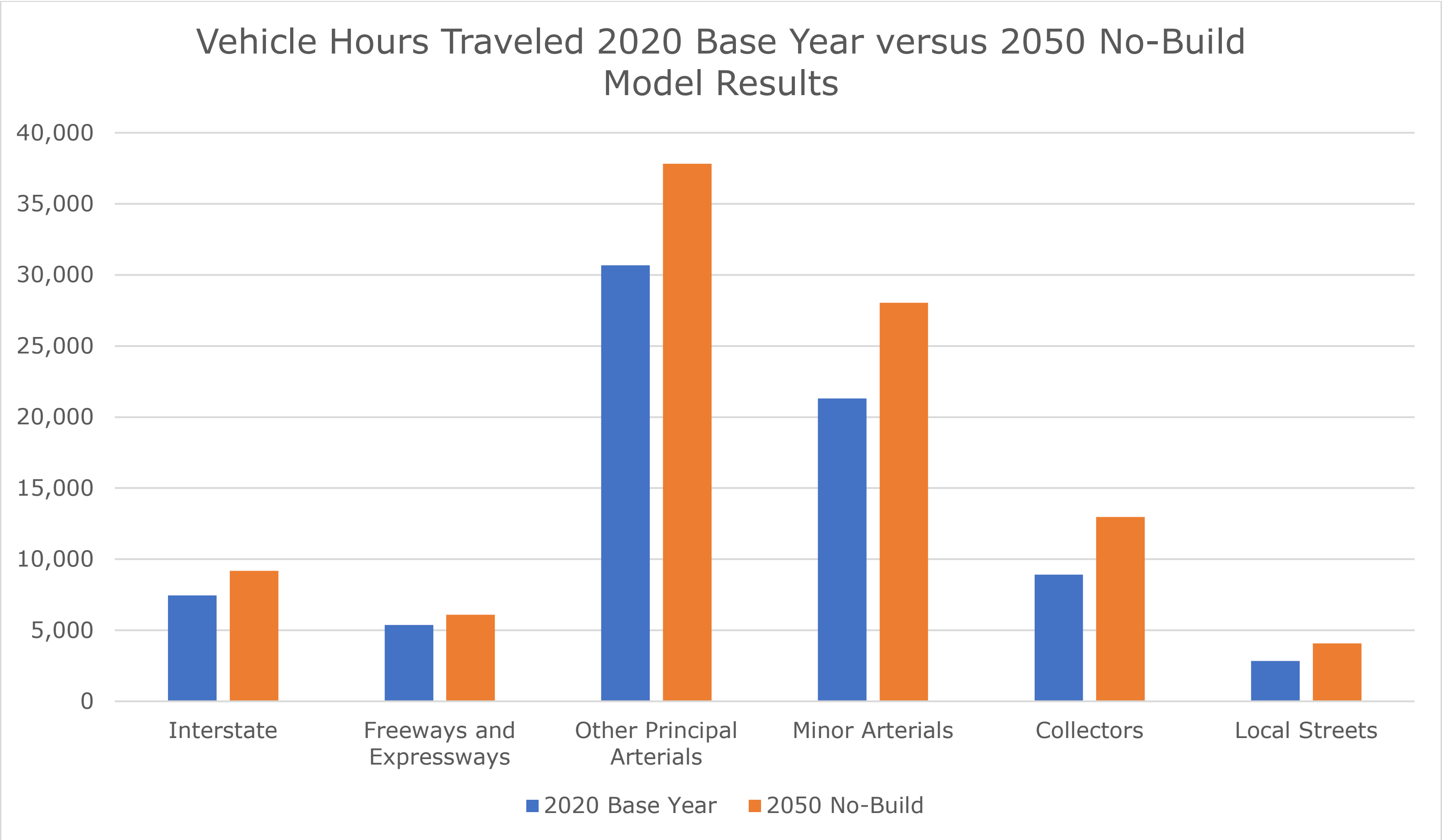

Figure 5.19: *Vehicle hours traveled comparisons between the 2020 base year and the 2050 No-Build model. Data courtesy of KLJ.*

Travel Delay

With increases to both VMT and VHT, travel delay is also anticipated to increase systemwide by 2050 based on anticipated population and development growth. In total, travel delay experienced across the region's transportation network is anticipated to more than double – from 4,638 hours of delay in the 2020 base year model to 9,472 hours of delay reflected in the 2050 No-Build model scenario. Similar to the 2020 base year model run, the brunt of the 2050 No-Build model travel delay is anticipated to be felt on the other principal arterials (67.9%).

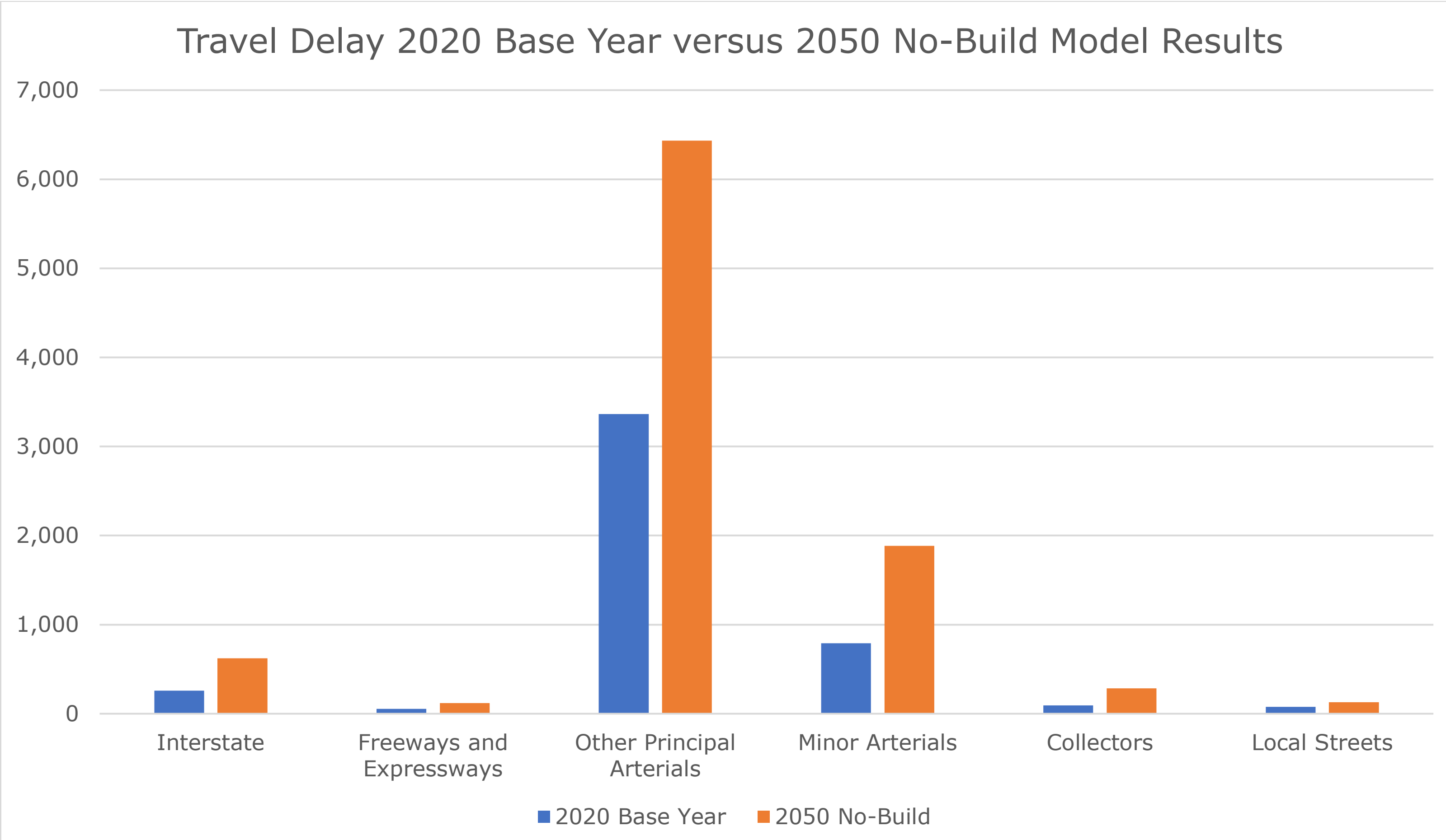

Figure 5.20: *Travel delay comparisons between the 2020 base year and 2050 No-Build model. Data courtesy of KLJ.*

Where Do We Go From Here?

The 2020 base year model scenario has indicated the region's overall transportation network is operating rather well. Aside from a few known problem areas – mainly the MN 15 north/south corridor and the MN 23 east/west corridor through the core – much of the system is currently under capacity.

However, while things may be functioning at a fairly high-level today, that may not be the case over the next few decades. If the current roadway network (with the addition of committed capacity expansion projects through 2026) is left unchanged and the region continues to grow, operational challenges will become more apparent. As the 2050 No-Build model results indicate, corridors currently approaching and/or over capacity will continue to face added capacity pressures further deteriorating their operational functions. Increases in VMT, VHT, and travel delay are also anticipated.

It is clear the roadway network will need a sizeable investment to address the impending congestion issues facing the Saint Cloud metro in the coming years.

However, it is important to note that capacity expansion alone will not be able to fully address the projected congestion issues within the MPA by 2050. Nor will simply "building our way out" help the region fully achieve its desired visions identified in Chapter 4. To adequately plan for future growth, the region's planners, engineers, and policymakers will need to rethink the role transportation plays in communities as well as explore other alternatives to traditional means of transportation (i.e., vehicle dependency).

As discussed in Chapter 3: Environmental Conditions, the transportation sector has a major impact on the natural and physical environment. By adding additional roadway capacity either through roadway expansion or the construction of new roadways, further impacts (mostly likely negative) to the environment are bound to occur. Care must be exercised in weighing the benefits capacity expansion for moving and/or connecting people and good versus the long-term consequences those corridors will have on the natural environment (i.e., air quality, water quality, soil health, wildlife and habitat destruction, and climate change). The APO is committed to furthering that understanding over the duration of this plan through the identification of several planning studies (including the continued monitoring the development of electric vehicle infrastructure and working to better understand the relationship between the environment and transportation) as listed in Chapter 10.

While the APO's TDM does not account for modal choices such as active transportation and transit, it has been well established that these forms of transportation are being used and have the potential to replace single occupancy vehicle (SOV) trips on our region's roadways in the future (See Chapter 2: Existing Conditions). Despite not being specifically identified in this long-range planning effort/analysis, work has been done by the APO (or by other agencies in coordination with the APO) to address the role alternative forms of transportation have on the region both today and in the future. In 2022, the APO completed the first regional Active Transportation Plan (https://tinyurl.com/5cfmetms) for the MPA which identified future locations for multimodal facilities. As part of this planning effort, APO staffers, along with regional planners and engineers, local policymakers, and community members, conducted a comprehensive review of existing active transportation facilities. This also included the identification of specific corridors – that once improved – would allow for safer connections to key destinations by active transportation means, further encouraging the replacement of vehicle trips with alternative modes.

Additionally, Saint Cloud Metro Bus is nearing completion of its long-range planning effort Metro Bus Forward. As part of this initiative, Metro Bus is preparing to restructure its existing (2024) service to better meet the needs of both its current ridership as well as potential future riders. By providing more frequent service to destinations most accessed by residents (like work, school, shopping, medical), it is the hope these improvements will entice more residents to replace some vehicle trips with mass transit.

Finally, other creative efforts, such as the exploration of a traffic management technology (such as adaptive signal control technology) or a more comprehensive review of the impacts of long-distance commuters on the region's transportation system have also been identified for future planning study consideration. See Chapter 10 for additional information.

As we dive into the final chapters of the MTP, we will explore how much available funding can be anticipated to address the transportation network. This, in turn, will allow us to understand what financially feasible improvements can realistically be made to the system by 2050.