MOBILITY PLAN 2045

Appendix I

Travel Demand Model Development

I. TRAVEL DEMAND MODEL DEVELOPMENT

KNOXVILLE REGIONAL TRAVEL MODEL 2018 BASE YEAR UPDATE AND SOCIOECONOMIC PROJECTION CONTROL TOTAL DEVELOPMENT DOCUMENTATION

INTRODUCTION

The purpose of this document is to provide details of the development of the latest planning assumptions and travel demand forecasting model that are required to support the overall Metropolitan Transportation Plan (MTP) for the Knoxville Regional TPO planning area, known as Mobility Plan 2045. These elements are integral to meeting federal transportation planning regulations (23 CFR 450.324) that state "In updating the transportation plan, the MPO shall base the update on the latest available estimates and assumptions for population, land use, etc." The regulations further require that MTPs be updated on a 4-year cycle (in air quality nonattainment/maintenance areas) in order "to confirm the transportation plan's validity and consistency with current and forecasted transportation and land use conditions and trends and to extend the forecast period to at least a 20-year planning horizon." The TPO uses the travel demand forecasting model to predict roadway network conditions (mainly congestion) into the future, and it requires its own particular set of specific inputs and assumptions that need to be updated regularly in order to stay current.

The remainder of this report is organized into two main sections: one covering the forecast of population, demographics and employment (collectively known as "socioeconomic characteristics") for the base year (2018) and the future year (2045); and the other section covering the travel demand forecasting model 2018 base year update and its validation against actual traffic counts.

SOCIOECONOMIC CHARACTERISTICS

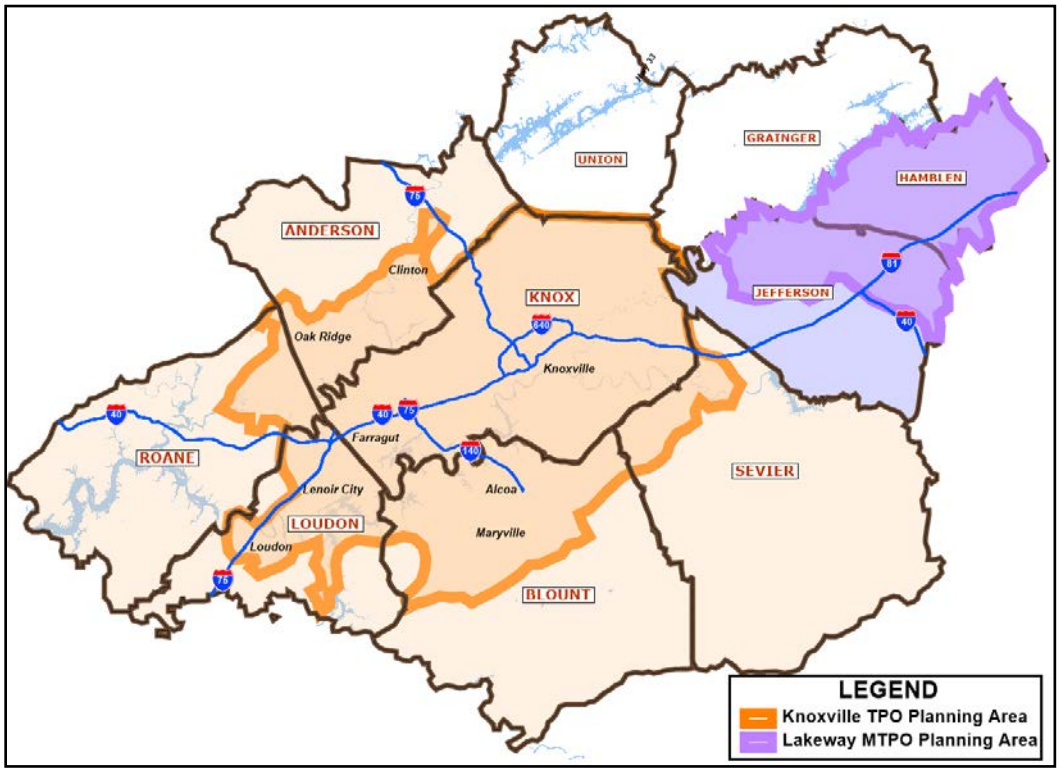
One of the key planning assumptions that goes into the development of the MTP is the forecast of the expected growth in population and employment, which are key drivers of transportation demand. With each update of the MTP, it is important to establish an updated base year in which all necessary data is available and to review previous population forecasts to ensure that they are: (1) still valid and relevant and (2) if they need to be extended further into the future to match the MTP's updated horizon year. In the case of Mobility Plan 2045, it was determined that 2018 should be the base year since that was the most recent year with full data availability when the MTP development started in late 2019, and that the population forecast would need to be extended out to 2045. The year 2045 was chosen in order to cover the minimum required 20-year horizon beyond the adoption date of the new MTP in 2021. In addition to simply extending the population forecast out, it was discovered that a foundational change in the rates of population growth had been occurring over the last decade that needed to be accounted for in the

updated projections. The remainder of this section of the report will cover separately the major socioeconomic characteristic inputs needed for Mobility Plan 2045 and specifically as inputs to the TPO Travel Demand Model, including population, employment, school enrollment and other demographic variables.

Population

The amount of travel activity in the Knoxville Region is directly related to the number of people living here, which is why it is important to establish the base year figures and future year population estimates as a first step in each major update of the MTP. The official planning area boundaries of the Knoxville Regional TPO include portions of six counties: Anderson, Blount, Knox, Loudon, Roane and Sevier. Additionally, the TPO's travel demand model includes four other counties – Grainger, Hamblen, Jefferson and Union – for which population data is required. The travel demand model is also used to support the MTP update for the separate Lakeway Area Metropolitan Transportation Planning Organization (LAMTPO) which includes all of Hamblen County and a portion of Jefferson County. The entire study area along with the planning area boundaries of the Knoxville Regional TPO and LAMTPO are shown in Figure I-1.

Figure I-1. Travel Demand Model Study Area



The population totals for each of the 10 counties were obtained for the base year 2018 from the U.S. Census "Population Estimates Program." These figures are released on an annual basis and represent the estimated county-level population as of July 1 for the reference year. The future year 2045 population forecast for each county were selected through a process of reviewing two primary sources of population projection data: "2018 – 2070 Projections" from the University of Tennessee (UT) Center for Business & Economic Research (CBER) and "2019 Regional Projections" from Woods & Poole, Inc. (W&P). Following the review of the two sources, the TPO staff recommended using the W&P source for the population forecasts as it is similar to CBER's forecast for population changes and it also provides projections for several other needed socioeconomic variables. The TPO Executive Board endorsed the staff recommendation of W&P as the source for future year county-level population forecasts at its February 26, 2020, meeting. Table I-1 below provides the 10-county population totals for the base year 2018 and future years of 2026, 2035 and 2045 to support the Mobility Plan 2045 development and travel demand model.

Table I-1. Population Forecasts

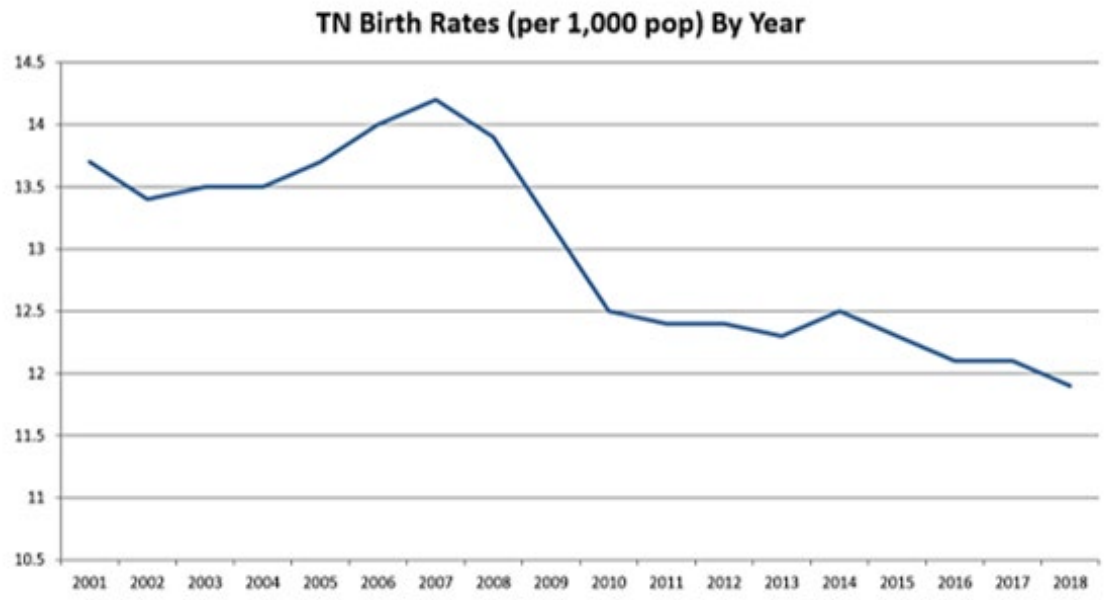
COUNTY	2018[1]	2026[2]	2035[2]	2045[2]
ANDERSON	76,482	79,239	81,472	82,896
BLOUNT	131,349	141,681	152,873	164,108
GRAINGER	23,145	24,095	25,086	26,234
HAMBLEN	64,569	67,598	70,344	72,535
JEFFERSON	54,012	58,627	63,211	67,800
KNOX	465,289	499,998	535,601	570,352
LOUDON	53,054	57,731	63,236	69,028
ROANE	53,140	54,460	55,334	55,563
SEVIER	97,892	110,029	122,690	136,609
UNION	19,688	20,155	20,895	21,749
TOTAL	**1,038,620**	**1,113,613**	**1,190,742**	**1,266,874**

1 - From Census Annual County Population Estimates data series, 2018 vintage (as of July 1, 2018)
2 - From Woods & Poole Economics, 2019 Regional Projections and Database

The population forecasts for Mobility Plan 2045 represent a fairly significant reduction in overall future population growth relative to the previous Mobility Plan 2040 forecasts that were based on projections developed in 2012. The primary reason for the reduction in population growth is related to the continuing decline in overall birth rates that began during the "Great Recession" period of 2007-2009. At first it was assumed that this represented a temporary decline and that birth rates would return to pre-recession

levels. However, as shown in Figure I-2 below for the Tennessee birth rates, they have continued to decline. Therefore, newer projection models account for this lower birth rate as a key component of population change.

Figure I-2. Tennessee Birth Rates



From CBER "Tennessee Population Projections and Underlying Influential Trends" Presentation, October 2019

The result of the lower birth rate assumption is reflected in how population projections have changed in our six-county region. The previous Mobility Plan population projection for those counties was 1,206,665 in 2040, while the new projection is 1,045,449, a decline of 13.4%.

Employment

Employment is another important variable influencing total travel and in particular the specific areas where travel occurs. Employment locations represent trip attractions for both the worker as well as locations where commerce or other necessary daily activities such as grocery shopping or attending medical appointments occur. The TPO travel demand model categorizes employment into four major types of: Basic (farming, construction), Industrial (manufacturing, wholesale trade), Service (professional, educational services) and Retail (shopping, accommodation, food services). Each type exhibits different characteristics in the type of trips generated. For example, retail employment tends to attract trips from workers as well as shoppers, whereas industrial employment will attract primarily worker trips as well as commercial vehicle trips to distribute finished or unfinished goods.

There is no a definitive source of the amount of employment in each county, as there is with population from the decennial Census. Two primary sources of employment data are the Bureau of Economic Analysis (BEA) and the Bureau of Labor Statistics (BLS). In general, the BEA estimate of employment produces a significantly higher number of jobs than the BLS estimate for the same county. The BLS employment estimates are lower in part because agricultural workers, the military, sole proprietors and other miscellaneous workers are excluded. The manner in which proprietorship employment is treated appears to account for the largest difference in terms of the BEA versus BLS estimates for the Knoxville Region since there are no large military bases or significant amount of farm employment. For example, the BEA (and W&P) employment estimates will double-count a person who has a full-time salary job and in their "spare" time (nights/weekends) runs a small business (proprietorship) from their home.

After reviewing the data sources, the TPO staff developed an "in-between" estimate of total county-level employment using the BLS estimate and adding the agricultural employment from BEA as well as "nonemployer" data from Census County Business Patterns (CBP) data. The CBP nonemployer data provided the number of businesses in each county that have no paid employees and annual business receipts of $1,000 or more. According to the Census Bureau, "most nonemployers are self-employed individuals operating very small unincorporated businesses." The county-level totals derived using this combination compared favorably with the summation of individual establishment-level employment data that was obtained through the Tennessee Department of Transportation (TDOT) from the company known as InfoGroup, which is described further in the travel demand model update section of this documentation. Since the base year 2018 employment derived by this method is lower than the W&P employment that is used to provide future-year employment projections, the TPO staff instead applied a growth factor from W&P to each of the future analysis years of 2026, 2035 and 2045 as shown in Table I-2. Additionally, Table I-3 shows the effects of the differing growth rates of employment by the major sectors – Basic, Industrial, Retail and Service – continuing the recent trends towards fewer manufacturing jobs compared with more jobs in the retail and service sectors.

Table I-2. Employment Forecasts

COUNTY, EMPLOYMENT	2018[1]	2026[2]	2035[2]	2045[2]
ANDERSON	44,399	47,425	50,274	52,536
BLOUNT	59,662	67,165	75,568	84,839
GRAINGER	6,432	6,750	7,022	7,275
HAMBLEN	35,495	37,283	38,895	40,059
JEFFERSON	17,371	19,650	22,404	25,773
KNOX	276,450	309,197	345,590	383,318
LOUDON	19,993	22,026	24,219	26,507
ROANE	21,755	23,154	24,497	25,638
SEVIER	55,952	64,365	74,448	86,823
UNION	4,102	4,423	4,750	5,095
TOTAL	**541,611**	**601,438**	**667,667**	**737,863**

1 - Developed from combining BLS employment data with farm employment from BEA and sole proprietorships from Census Nonemployer Statistics (NES)
2 - From Woods & Poole Economics, 2019 Regional Projections and Database - used percent growth to generate projection factor for 2018 base year

Table I-3. Employment Forecast by Sector

EMPLOYMENT SECTOR	2018	2026	2035	2045	GROWTH% (2018-2045)
BASIC	43,646	44,767	44,542	44,155	1%
INDUSTRIAL	90,695	91,990	93,605	94,848	5%
RETAIL	125,198	135,359	145,360	157,123	28%
SERVICE	282,072	329,322	384,160	441,737	53%
TOTAL	**541,611**	**601,438**	**667,667**	**737,863**	**36%**

School Enrollment

Updated school enrollment data for 2018 for both public and private schools throughout the 10-county travel demand model study area was obtained through the Tennessee Department of Education website. The enrollment data was compared against the year 2018 estimated school-age (5-17) population count from W&P, and the numbers were similar. Therefore, the growth rate from the projected W&P data was applied to 2018 base year enrollment in order to develop the future-year projections at the county level as shown in Table I-4:

Table I-4. School (K-12) Enrollment Forecasts

COUNTY, K-12 ENROLLMENT	2018[1]	2026[2]	2035[2]	2045[2]
ANDERSON	12,051	11,534	11,574	11,577
BLOUNT	18,858	18,233	19,556	21,425
GRAINGER	3,388	2,985	3,082	3,229
HAMBLEN	10,801	10,471	10,370	10,822
JEFFERSON	7,316	6,960	7,450	8,312
KNOX	67,664	70,838	77,963	83,952
LOUDON	7,329	7,482	7,636	8,439
ROANE	6,647	6,070	6,122	6,175
SEVIER	14,852	15,263	17,015	19,588
UNION	2,954	2,668	2,676	2,830
TOTAL	**151,860**	**152,502**	**163,444**	**176,349**

1 - Tennessee Department of Education
2 - Growth rates applied from Woods & Poole Economics, 2019 Regional Projections and Database

Demographic Variables

The regional travel demand model uses average socioeconomic and other demographic variables to inform some travel behavior characteristics that differentiate one household type from another. The key variables used in the model that have been found to have statistically significant effects on trip making either directly or indirectly are: Median Household Income, Percent Households with Seniors (age > 65), Workers per Household, Students per Household, and Vehicles per Household. These variables were all updated using the most recent available census information, primarily being the most current 5-year American Community Survey (ACS) data from 2014-2018, which is available at the block group level. (A Census block group is part of a Census tract and is made up of multiple Census blocks.)

The Census block groups are generally comparable with the travel demand model's Traffic Analysis Zones (TAZ). However, they are not at a 1 to 1 scale since there are a total of 1,173 TAZs and 593 Block Groups within the 10-county model region. The most common scenario is that multiple TAZs "nest" within a block group. There are also cases where block groups "nest" within TAZs, as well as cases where boundaries do not align at all. Another Census product known as the Census Transportation Planning Package (CTPP) provides a special tabulation of demographic variables at the "Census TAZ" level based on the 2012-2016 ACS. This was also used to assist in disaggregating this data to model TAZs since the Census TAZs are closer in alignment to our region's TAZs, with a total of 804 in the 10-county region.

These types of demographic variables can be extremely challenging to forecast at the sub-county level, and most are used in terms of percentages and ratios, so they do not represent a specific number. In keeping with past practice, the variables of Median Household Income and Vehicles per Household are left constant for all forecast years since these are relatively stable in terms of geographic distribution and, in the case of income, would be difficult to properly account for inflation effects. The variable of Percent Households with Seniors (age > 65) was also left constant because updated forecast data was not available. The remaining variables of Workers per Household and Students per Household were applied to TAZs at the county-level proportionally based on the particular county's rate of change from the W&P forecast data of the applicable age ranges (i.e., workers are made up of the age cohort from 20 to 64, and students the age cohort of 5 to 17). Table I-5 and Table I-6 show the forecast change in workers and students per household for each horizon year in the model.

Table I-5. Workers per Household Forecast

COUNTY, WORKERS PER HH	2018	2026	2035	2045
ANDERSON	1.15	1.07	1.04	1.04
BLOUNT	1.26	1.19	1.16	1.18
GRAINGER	1.15	1.11	1.07	1.08
HAMBLEN	1.16	1.13	1.13	1.14
JEFFERSON	1.22	1.17	1.15	1.16
KNOX	1.30	1.24	1.24	1.28
LOUDON	1.08	1.00	0.98	0.98
ROANE	1.10	1.02	0.98	0.99
SEVIER	1.33	1.25	1.23	1.26
UNION	1.11	1.02	1.00	1.01

Table I-6. Students per Household Forecast

COUNTY, STUDENTS PER HH	2018	2026	2035	2045
ANDERSON	0.39	0.36	0.36	0.36
BLOUNT	0.40	0.35	0.36	0.38
GRAINGER	0.41	0.35	0.35	0.36
HAMBLEN	0.45	0.41	0.41	0.42
JEFFERSON	0.42	0.36	0.37	0.40
KNOX	0.38	0.37	0.39	0.41
LOUDON	0.37	0.34	0.33	0.34
ROANE	0.37	0.32	0.33	0.33
SEVIER	0.41	0.37	0.38	0.40
UNION	0.44	0.38	0.37	0.38

TRAVEL DEMAND MODEL – 2018 UPDATE

Background

The TPO uses a computer-modeling tool known as a travel demand forecasting model to predict future conditions on our roadways. The Knoxville Regional Travel Demand Model (KRTM) is calibrated to closely replicate existing traffic patterns in the Knoxville Region to forecast future traffic volumes and resulting areas of potential congestion. It is also used to support the air quality conformity analysis that is required for the Knoxville Region, which is an air quality Maintenance Area for both Ozone and PM2.5. The model covers the primary roadway network in a 10-county area that includes Anderson, Blount, Grainger, Hamblen, Jefferson, Knox, Loudon, Roane, Sevier, and Union counties. To develop the model, mathematical relationships between travel activity and household socioeconomic characteristics were derived from extensive travel behavior surveys that were conducted in the years 2000 and 2008. In these surveys, approximately 3,000 households in the Knoxville Region were asked to record their travels in a one-day period including:

- Purpose of the trip
- Origin and destination of each trip
- Mode of transportation used
- Time of day trip was made

The model was developed based on the assumption that households with similar socio-economic characteristics such as household income, number of school-age children, and vehicle ownership would demonstrate similar travel activity. These household characteristics are available primarily from the U.S. Census Bureau as discussed in the prior section of this report and are input into the model based on their distribution across TAZs the Knoxville Region.

The current model has its origins back to 2012 when an update was completed to calibrate and validate the model using 2010 Decennial Census data. Since that time two minor updates have been completed – one for the prior Mobility Plan 2040 and one now for Mobility Plan 2045. In both updates the model has been validated against new base years of available data – 2014 and 2018 respectively. A major model update is being planned for the next Mobility Plan update since new 2020 Decennial Census data will become available in mid-2021 following the due date of this Plan. The remainder of this section provides more information about the current minor model update for three areas:

- Roadway Network and Traffic Analysis Zones
- Model Validation Statistics
- Existing and Committed Roadway Network

ROADWAY NETWORK & TRAFFIC ANALYSIS ZONES

As previously mentioned, the KRTM is a mathematical representation of reality and its key inputs are the roadway network attributes and the socioeconomic characteristics at the Traffic Analysis Zone (TAZ) level.

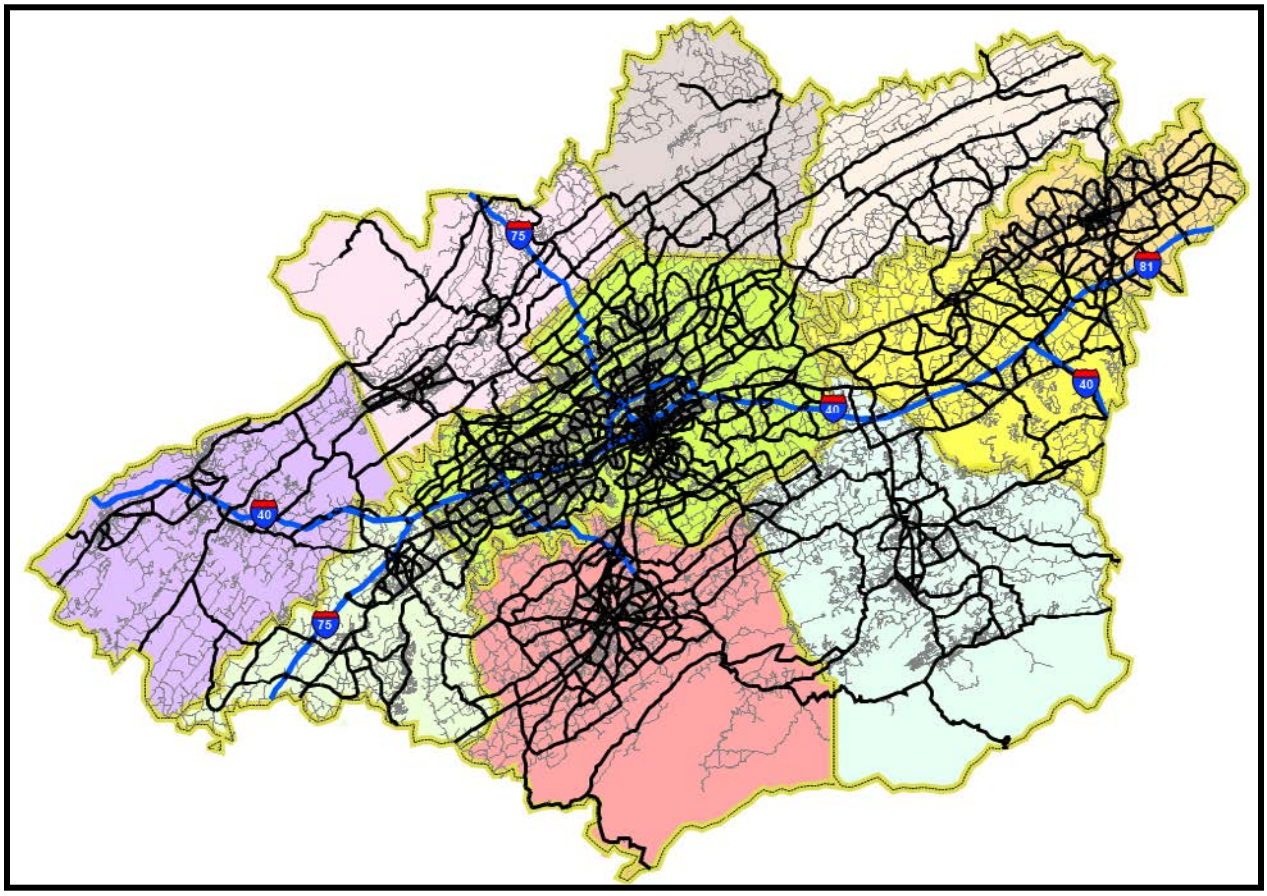
The roadway network is represented in a Geographic Information System (GIS) map as a system of links and nodes. The nodes represent intersections, locations of traffic signals, and places where roadway characteristics change in the middle of a segment (such as where a road narrows). Each link in the model represents a segment of roadway that is described by several attributes, including:

- Functional classification
- Speed limit
- Number of lanes
- Pavement width
- Level of access control
- Whether it is divided by a median

Roadway attributes are used to determine the capacity for motor vehicles and travel time along each link in the model network. The model can therefore be used to test alternative improvement strategies by changing attributes, such as increasing the number of lanes or adding a new link to represent construction of a new roadway.

The model primarily includes major roadways, ones that are functionally classified as collector and higher, since those are the facilities for which performance is of utmost importance. There are just over 3,250 centerline miles of roadways included in the KRTM network for the entire 10-county study area. Figure I-3 illustrates the model network in the dark black lines. The Interstate system is shown in blue. The “non-modeled” network is shown in light gray. In general, there is a denser network of modeled roadways within the core Knoxville TPO and Lakeway MTPO planning regions as compared with the other, more rural areas of the model study area.

Figure I-3. Travel Demand Model Roadway Network



The socioeconomic inputs that form the basis of the KRTM and how they were derived was documented in the first section of this report. That section focused on the county-level basis for the needed variables, which are called the "control totals." The KRTM needs inputs of these variables to be allocated to much smaller levels of geography known as Traffic Analysis Zones (TAZ). In general, the number of TAZs is directly proportional to the level of detail of the roadway network, as roadways generally form the boundaries of a TAZ. In this minor update of the KRTM, the number of TAZs was increased from 1,153 to 1,173 with the addition of greater roadway network detail in the LAMTPO Region of Hamblen and Jefferson counties. Knox County has the greatest number of TAZs at 508. In determining the size of TAZs, there are tradeoffs between the amount of confidence one can have in allocating future growth and the overall level of detail in the model. Smaller TAZs produce a more detailed model but result in less confidence in the estimates of where future population and job growth will occur.

In order to allocate the future growth of population and employment from the county control totals to the smaller TAZs, the TPO staff consulted with planning staffs and stakeholders from each jurisdiction

within the TPO and LAMTPO area. TPO staff obtained information on proposed developments and other likely development areas in the various jurisdictions to inform the allocation. Stakeholders reviewed the outputs to determine the overall reasonableness. This exercise is inherently challenging due to the unforeseen things that can influence development patterns, but provides a "best guess," and can be updated as needed to account for major changes with each subsequent Mobility Plan update. Table I-7 shows the amount of total population and employment increase for each county between 2018 and 2045 that must be allocated to the TAZs:

Table I-7. Increased Population and Employment Allocation by County

COUNTY, 2045 ALLOCATION	POPULATION	EMPLOYMENT
ANDERSON	6,414	8,137
BLOUNT	32,759	25,177
GRAINGER	3,089	843
HAMBLEN	7,966	4,564
JEFFERSON	13,788	8,692
KNOX	105,063	106,868
LOUDON	15,974	6,514
ROANE	2,423	3,883
SEVIER	38,717	30,871
UNION	2,061	993
TOTAL	**228,254**	**196,542**

Travel Demand Model Validation

The model uses the TAZ-level information on socioeconomic characteristics and the number of people and jobs to allocate trips via four steps:

1. Estimate the total trips that are generated each day per TAZ
2. Determine which mode of travel is most likely to be used
3. Identify the likely destination TAZ based on the trip type
4. Select the specific roadways that are traveled on in the case of motor vehicle trips.

Each step of the modeling process is calibrated independently, since errors in one step can propagate throughout the model and lead to problems in later steps. The calibration of each stage of the KRTM has

been previously documented and shown to be within acceptable tolerances based on national guidelines for model development. Since underlying travel behavior or network characteristics are not being adjusted with this update of the model, these calibration metrics will not be revisited in this report. Instead, the focus is to review the final output of the model and compare it with actual traffic count data collected by TDOT and local agencies. This determination of how well the model is replicating real-world traffic volumes is known as "model validation." The Federal Highway Administration (FHWA) has published guidelines on validation criteria that should be met to ensure the acceptability of the model. These guidelines formed the basis of recommended validation checks adopted for use specifically in Tennessee through the Tennessee Model Users Group (TNMUG).

The updated base year 2018 model outputs were compared against year 2018 traffic count data in order to determine how well the model is replicating actual traffic volumes. Validation criteria adopted by the TNMUG and documented in the "Minimum Travel Demand Model Calibration and Validation Guidelines for State of Tennessee" were used to demonstrate the performance of the model. Overall, the model performed very well in terms of meeting the validation criteria and overall % Root Mean Square Error (%RMSE) statistics were very good at 31.3%. The following tables show the TNMUG-required validation criteria and model performance. A separate table shows the vehicle miles traveled (VMT) comparison between model outputs and the 2018 VMT as developed by TDOT for the submittal to the FHWA's Highway Performance Monitoring System (HPMS). The tables demonstrate that the model meets the necessary criteria with the exception of one screenline for the KRTM, which is not missing the target by a wide margin and thus not a cause for concern about the overall performance.

The following tables and figures provide specific results of the KRTM 2018 base year validation tests. Table I-8 presents the seven TNMUG validation tests adopted for use in Tennessee and the KRTM performance for each. Figure I-4 is the scatter plot of modeled versus actual counts to determine the linear regression results and resulting coefficient of determination (R^2). Table I-9 shows the modeled VMT versus actual HPMS VMT and also indicates the comparison of modeled roadway mileage to actual roadway mileage. It is to be expected that model VMT will be much lower than actual VMT for less important roadways such as minor collectors and local roads since fewer of these are represented in the model. Finally, Figure I-5 shows the locations of the screenlines that were used.

Table I-8. Minimum Travel Demand Model Validation Standards for State of Tennessee

#1 - Percent Difference in value for screenlines	Standard	Model Value	Pass/Fail	Average Count	Average Modeled	Num Obs
External model cordon line	+/- 1%	-0.02%	Pass	9,678	9,676	33
Screenlines with greater than 70,000 AADT	+/- 10%					
Rivers	+/- 10%	10.04%	Pass	27,514	30,276	20
Inner Knoxville	+/- 10%	4.11%	Pass	25,777	26,836	19
East Counties	+/- 10%	-3.58%	Pass	7,699	7,424	9
West Counties	+/- 10%	15.12%	Fail	27,282	31,407	10
Northeast Counties	+/- 10%	8.14%	Pass	6,219	6,726	13
Screenlines with less than 35,000 AADT	+/- 20%					
North Counties	+/- 20%	8.12%	Pass	5,151	5,569	8
#2 - Percent Difference in volume by classification	**Standard**	**Model Value**	**Pass/Fail**	**Average Count**	**Average Modeled**	**Num Obs**
Freeway Volume-to-Count	+/- 7%	1.70%	Pass	28,866	29,355	450
Arterial Volume-to-Count	+/- 15%	-3.66%	Pass	14,866	14,322	563
Collector Volume-to-Count	+/- 25%	-8.98%	Pass	3,541	3,223	1051
#3 - Percent Difference in value for link volumes	**Standard**	**Model Value**	**Pass/Fail**	**Average Count**	**Average Modeled**	**Num Obs**
AADT < 1,000	+/- 200%	40.91%	Pass	629	887	177
AADT = 1,000 - 2,500	+/- 100%	8.80%	Pass	1,670	1,817	311
AADT = 2,500 - 5,000	+/- 50%	-3.93%	Pass	3,635	3,492	334
AADT = 5,000 - 10,000	+/- 25%	-1.18%	Pass	7,099	7,016	354
AADT = 10,000 - 25,000	+/- 20%	-1.43%	Pass	15,517	15,295	359
AADT = 25,000 - 50,000	+/- 15%	1.25%	Pass	36,574	37,030	134
AADT > 50,000	+/- 10%	-1.77%	Pass	90,453	88,850	100
#4 - Coefficient of Determination	**Standard**	**Model Value**	**Pass/Fail**	**Average Count**	**Average Modeled**	**Num Obs**
Coefficient of Determination (R^2)	> 0.88	0.94	Pass	13,504	13,408	1,768
#5 - Root mean square for link volumes	**Standard**	**Model Value**	**Pass/Fail**	**Average Count**	**Average Modeled**	**Num Obs**
AADT < 5,000	< 100%	65.68%	Pass	2,245	2,298	822
AADT = 5,000 - 9,999	< 45%	40.15%	Pass	7,099	7,016	354
AADT = 10,000 - 14,999	< 35%	27.09%	Pass	12,218	12,012	198
AADT = 15,000 - 19,999	< 30%	24.44%	Pass	17,329	17,604	103
AADT = 20,000 - 29,999	< 27%	22.48%	Pass	24,110	23,826	163
AADT = 30,000 - 49,999	< 25%	15.23%	Pass	41,157	42,403	103
AADT = 50,000 - 59,999	< 20%	6.83%	Pass	52,700	49,688	8
AADT > 60,000	< 19%	14.20%	Pass	104,788	102,891	72
Areawide	< 45%	31.27%	Pass	13,504	13,408	1768
#7 - (Option) Root mean square by functional class	**Standard**	**Model Value**	**Pass/Fail**	**Average Count**	**Average Modeled**	**Num Obs**
Freeways/Expressways	< 20%	16.69%	Pass	33,545	33,963	168
Principal Arterials	< 35%	19.94%	Pass	20,218	20,293	230
Minor Artrerials	< 50%	31.85%	Pass	10,413	9,607	337
Collectors	< 90%	54.57%	Pass	3,969	3,867	566

Figure I-4. KRTM Linear Regression Analysis, Daily Traffic Count vs Model Volume

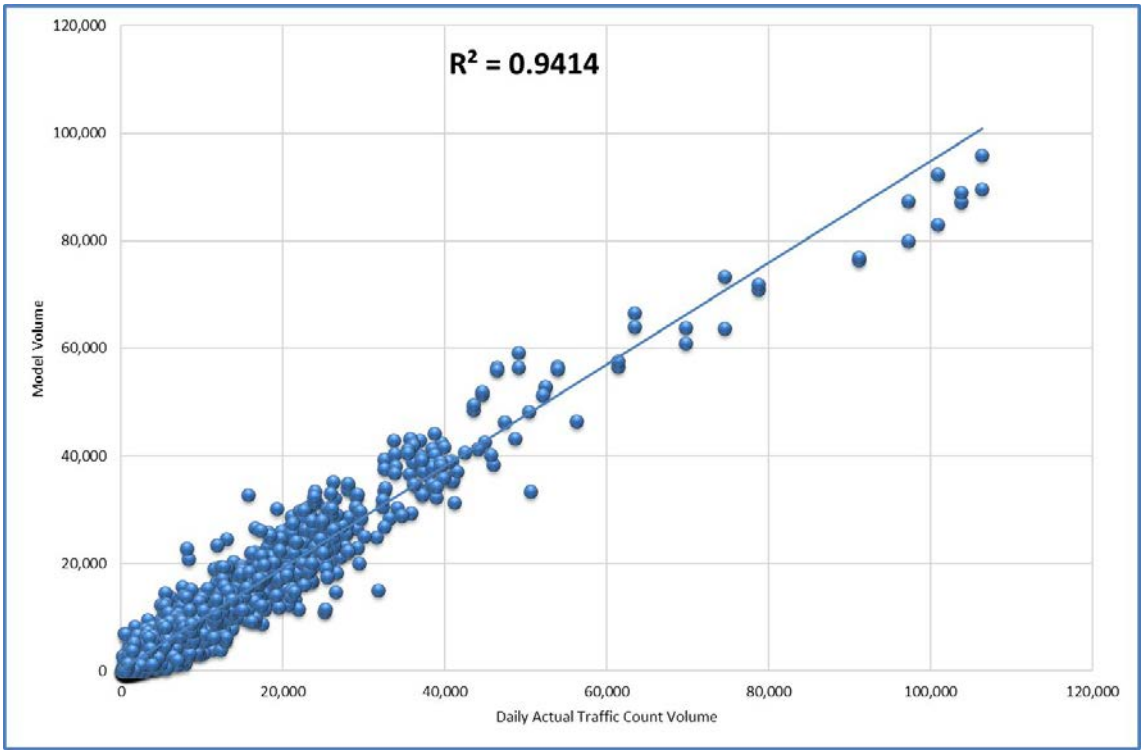
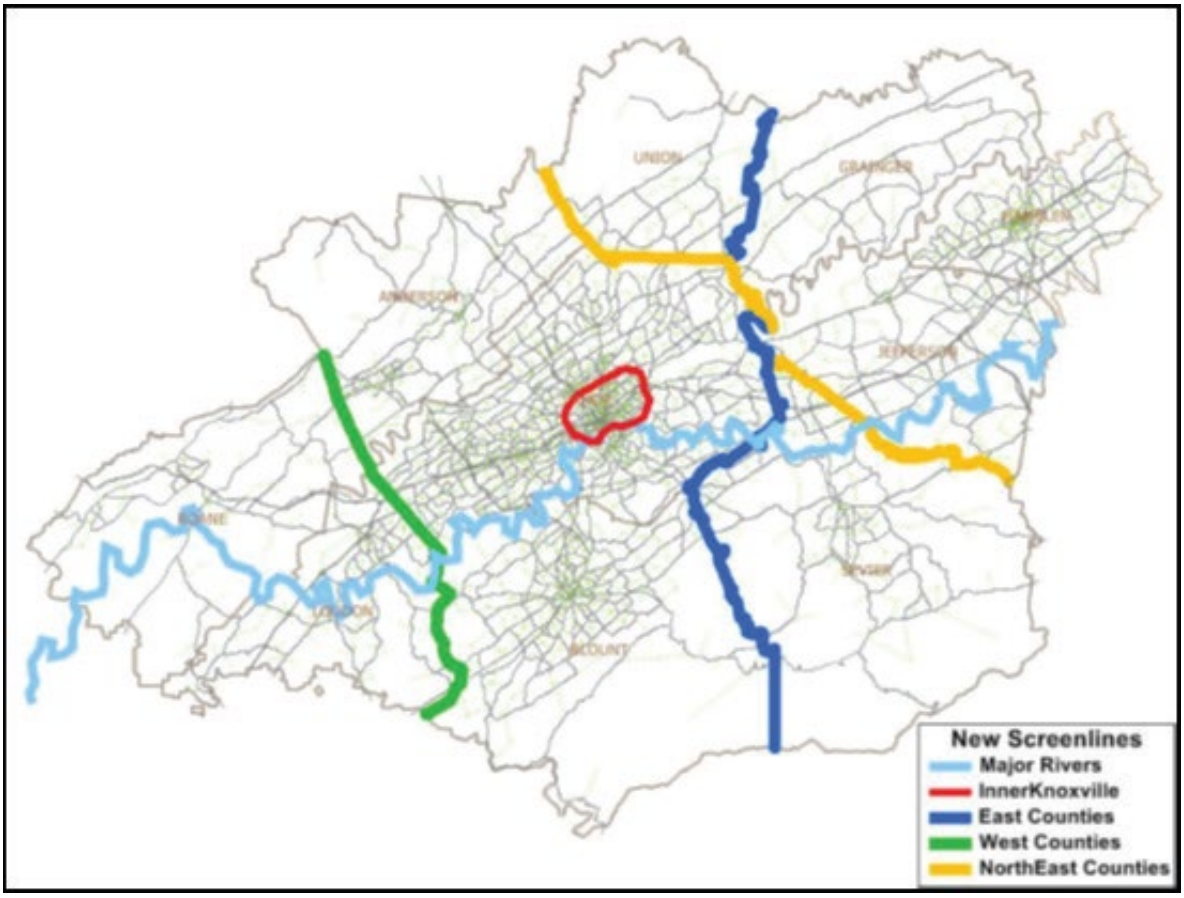


Table I-9. Model VMT versus HPMS VMT for Base Year 2018

	Rural Int	Rural Principal Arterial	Rural Minor Arterial	Rural Major Collector	Rural Minor Collector	Rural Local	Urban Int	Urban Freeway	Urban Principal Arterial	Urban Minor Arterial	Urban Major Collector	Urban Minor Collector	Urban Local	Total
ANDERSON HPMS	404,062	35,517	-	157,761	69,329	60,318	160,077	-	793,072	282,571	114,972	66,932	421,706	**2,566,317**
ANDERSON Model	472,022	31,621	-	141,096	11,269	6,069	154,106	-	737,178	266,665	80,675	34,825	16,636	**1,952,162**
HPMS Factor	0.86	1.12	N/A	1.12	6.15	9.94	1.04	N/A	1.08	1.06	1.43	1.92	25.35	**1.31**
BLOUNT HPMS	-	207,367	92,627	65,968	35,046	102,838	99,224	32,884	1,116,356	499,919	275,449	212,358	697,279	**3,437,315**
BLOUNT Model	-	230,383	95,403	66,948	23,638	15,435	95,025	42,291	1,087,823	460,910	185,302	156,991	20,474	**2,480,622**
HPMS Factor	N/A	0.90	0.97	0.99	1.48	6.66	1.04	0.78	1.03	1.08	1.49	1.35	34.06	**1.39**
HAMBLEN HPMS	301,182	872	-	64,996	39,896	48,855	30,632	-	778,487	251,872	149,726	31,082	259,973	**1,957,573**
HAMBLEN Model	360,364	1,892	-	59,870	16,097	2,776	24,524	-	688,782	201,299	110,449	12,587	14,442	**1,493,083**
HPMS Factor	0.84	0.46	N/A	1.09	2.48	17.60	1.25	N/A	1.13	1.25	1.36	2.47	18.00	**1.31**
JEFFERSON HPMS	1,381,120	-	315,331	221,288	125,190	137,492	25,060	-	168,927	84,606	19,903	6,862	40,525	**2,526,304**
JEFFERSON Model	1,612,519	-	399,160	296,728	90,562	11,285	41,798	-	191,792	89,837	15,074	5,084	2,921	**2,756,761**
HPMS Factor	0.86	N/A	0.79	0.75	1.38	12.18	0.60	N/A	0.88	0.94	1.32	1.35	13.87	**0.92**
KNOX HPMS	577,764	-	97,747	118,604	118,818	116,479	5,901,171	164,720	2,588,433	2,510,477	755,332	720,890	3,405,108	**17,075,543**
KNOX Model	648,903	-	100,701	102,934	98,352	21,290	5,268,112	98,995	2,445,573	2,137,807	656,678	572,720	250,823	**12,402,889**
HPMS Factor	0.89	N/A	0.97	1.15	1.21	5.47	1.12	1.66	1.06	1.17	1.15	1.26	13.58	**1.38**
LOUDON HPMS	433,441	135,412	68,056	44,803	72,874	51,662	757,321	-	318,900	217,896	67,801	62,344	189,571	**2,420,081**
LOUDON Model	476,558	167,067	78,398	60,413	22,005	-	849,612	-	288,078	226,304	37,197	23,603	297	**2,229,531**
HPMS Factor	0.91	0.81	0.87	0.74	3.31	N/A	0.89	N/A	1.11	0.96	1.82	2.64	638.91	**1.09**
ROANE HPMS	291,922	61,305	76,416	62,999	59,011	59,112	679,678	-	373,407	212,137	28,176	52,109	124,445	**2,080,717**
ROANE Model	337,576	66,671	72,343	54,601	10,865	-	691,289	-	411,226	168,469	19,795	25,688	20,532	**1,879,055**
HPMS Factor	0.86	0.92	1.06	1.15	5.43	N/A	0.98	N/A	0.91	1.26	1.42	2.03	6.06	**1.11**
SEVIER HPMS	-	259,823	531,610	175,693	140,021	466,921	354,829	-	1,107,780	365,420	253,920	38,782	631,188	**4,325,987**
SEVIER Model	-	216,335	520,123	177,889	46,703	51,703	367,754	-	999,139	313,835	175,321	26,236	35,535	**2,930,573**
HPMS Factor	N/A	1.20	1.02	0.99	3.00	9.03	0.96	N/A	1.11	1.16	1.45	1.48	17.76	**1.48**

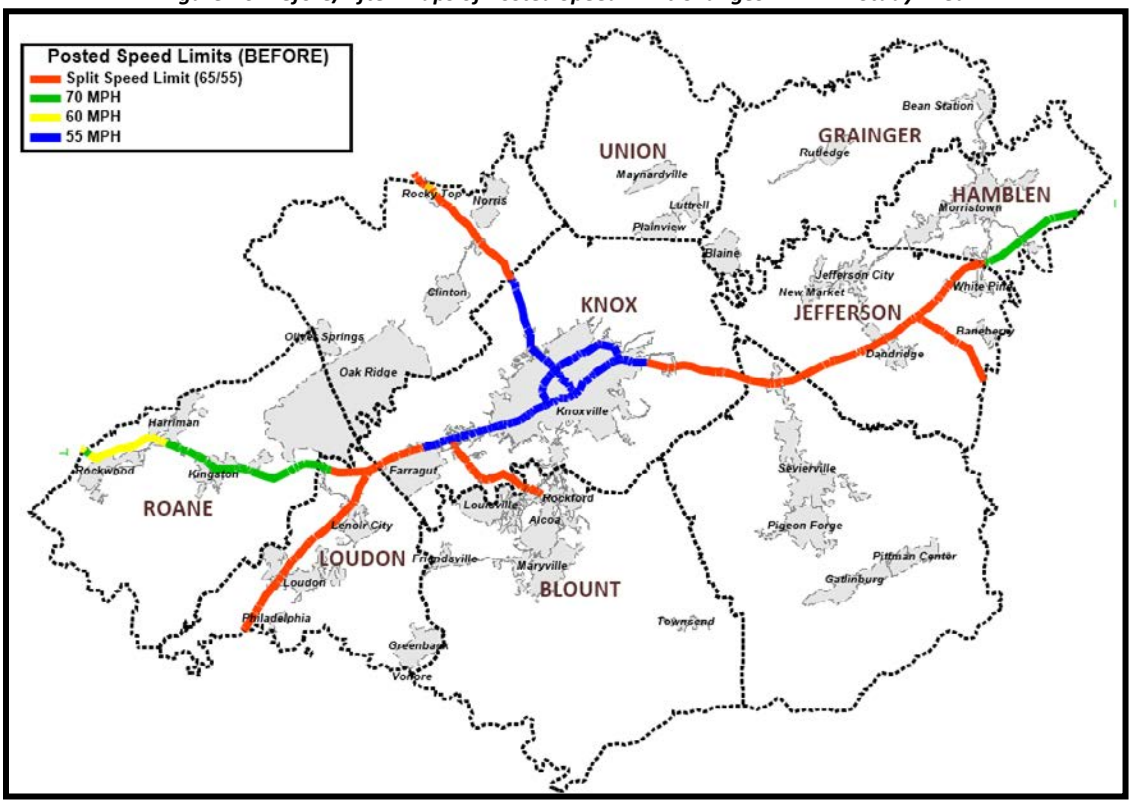
Figure I-5. Model Screenlines



Existing Plus Committed Roadway Network

The primary purpose of the model is to forecast needs and deficiencies for the roadway network, assuming that population and economic activity continue to grow, but no improvement projects are undertaken beyond what is known as the "existing plus committed" or E+C network. The model roadway network was first updated to account for changes that occurred after 2014 (the prior base year) and were completed before 2018 (the new base year for the model). This is known as the "existing" network. In addition to completed road projects, changes since 2014 include increased speed limits on several segments of interstate within the model study area. Figure I-6 shows before/after maps of the segments of Interstate where the speed limits have been increased. Table I-10 is a listing of major capacity-changing projects that were completed between 2014 and 2018.

Figure I-6. Before/After Maps of Posted Speed Limit Changes in KRTM Study Area



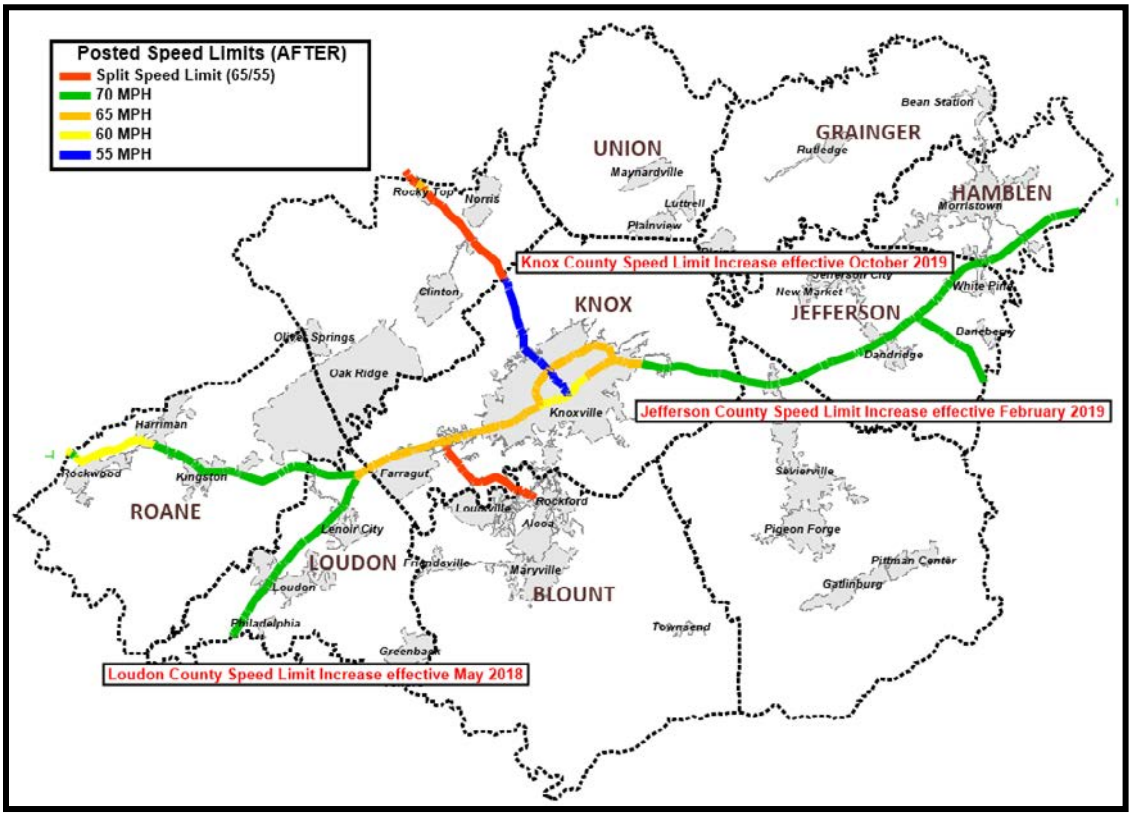


Table I-10. Major Capacity-Changing Projects Completed between 2014 and 2018

PROJECT NAME	KRMP ID	TERMINI	LENGTH (MILES)	PROJECT DESCRIPTION	STATUS
CUMBERLAND AVE ROAD DIET & STREETSCAPING	09-613b	22nd St to 16th St	0.5	Road diet and streetscape, reducing four lanes to two lanes with median and turn lanes	Completed in 2017
DIXIE LEE JUNCTION	09-406	Intersection of US 11 & US 70	0.2	Intersection Realignment & Signalization	Completed in 2018
FOOTHILLS PARKWAY	09-224	From U.S. 321 (SR-73) in Walland to U.S. 321 (SR-73) in Wears Valley	16	Construct a new 2-lane roadway	Completed in 2018
KARNS CONNECTOR	09-635	Oak Ridge Hwy to Westcott Blvd	0.8	Construct new 2-lane road with center turn lane	Completed in 2018
MAYNARDVILLE HWY	09-604	North of SR-71 to Union County Line	6.2	Widen from 2 to 4/5 lanes	Completed in 2017
NORTH CENTRAL STREET ROAD DIET AND STREETSCAPE	10-697	Woodland Ave to Depot St	1.2	Road diet and streetscape along North Central Street, reducing four lanes to two lanes with center turn lane	Completed in 2019
PARKSIDE DRIVE WIDENING	N/A	Mabry Hood Rd to Hayfield Rd		Widen from 2 to 5 lanes	Completed in 2017
WESTERN AVE (SR-62) WIDENING	09-612	Schaad Rd to I-640	3.9	Widen from 2 to 5 lanes	Completed in 2018

In addition to the projects and speed limit changes that were completed by 2018, other projects are labeled as “committed.” The definition of a “committed” project for the purposes of Mobility Plan 2045 is that the project is either under construction or construction funding is programmed in the TPO Fiscal Year 2020-2023 Transportation Improvement Program (TIP). An exception to this rule was made for two

phases of Alcoa Highway (US-129/SR-115) that are not currently programmed for construction, but are assumed to be committed since all other segments of Alcoa Highway are either under construction or programmed for construction by FY 2023. The E+C projects form the baseline network with which subsequent roadway deficiency analyses and the Congestion Management Process analysis is undertaken with; however, it should be noted that this network does not necessarily represent the first air quality conformity horizon year (2026) since some projects such as a few Alcoa Highway segments are not projected to be open to traffic by that year given their large magnitude and length of time it will take for construction to be completed. Table I-11 provides a listing of the Committed projects and their status (either under construction or funded for construction) as of May 2020:

Table I-11. Committed Project List

PROJECT NAME	KRMP ID	TERMINI	LENGTH (MILES)	PROJECT DESCRIPTION	STATUS AS OF MAY 2020
ALCOA HWY (SR-115/US-129)	09-627	Maloney Rd to Woodson Dr	1.4	Widen from 4-lane to 6-lane.	Under construction, completion target of 12/30/2020
ALCOA HWY (SR-115/US-129)	09-218	Hall Rd (SR-35) to proposed interchange at Tyson Blvd.	1.3	Widen from 4-lane divided to a 6-lane divided highway. Extend Tyson Boulevard under SR-115 and reconstruct Hunt Rd overpass.	Under construction, completion target of 11/30/2021
ALCOA HWY (SR-115/US-129) WIDENING	09-216	Pellissippi Pwy (SR-162) to Little River (Knox/Blount C.L.)	3.2	Widen 4-lane to 6-lane with frontage road system and new interchange at Topside Rd (SR-333). Reconfigure existing interchange at Pellissippi Pkwy (SR-162) and signalize ramps.	In ROW, no construction funds yet but entire Alcoa Hwy corridor considered as committed
ALCOA HWY (SR-115/US-129) WIDENING	09-628	North of Little River (Knox/Blount C.L.) to Maloney Rd	2.4	Widen from 4 to 6 lanes including pedestrian and bicycle facilities.	Under construction, completion target of 5/31/2023

PROJECT NAME	KRMP ID	TERMINI	LENGTH (MILES)	PROJECT DESCRIPTION	STATUS AS OF MAY 2020
ALCOA HWY (SR-115/US-129) WIDENING	09-653	Woodson Dr. to Cherokee Trail interchange	1.3	Widen 4-lane to 6-lane including pedestrian and bicycle facilities.	In ROW, construction programmed in FY 2020
RELOCATED ALCOA HWY (SR-115/US-129)	09-257	Proposed interchange at Tyson Blvd. to Pellissippi Pkwy (SR-162)	2.9	Construct new 4-lane divided highway with auxiliary lanes and new interchanges at McGhee Tyson Airport access, Wright Rd and Pellissippi Pkwy (SR-162).	In ROW, construction programmed for FY 2021
RELOCATED ALCOA HWY (SR-115/US-129)	09-258	Pellissippi Pkwy (SR-162) to South Singleton Station Rd	1.3	Construct new 4-lane divided highway with auxiliary lanes and new interchange at Singleton Station Rd.	In ROW, no construction funds yet but entire Alcoa Hwy corridor considered as committed
ASSOCIATES BOULEVARD EXTENSION, KNOWN AS MARCONI BLVD	13-206	Associates Blvd to East Edison St/Springbrook Rd (New Alignment)	0.8	Construct new 2-lane boulevard with bicycle/pedestrian facilities.	Out for construction bids
CHAPMAN HWY (US-441/SR-71)	09-626b	Evans Rd to Burnett Ln	0.9	Add center turn lane.	Under construction, completion target of 9/30/2020
CHAPMAN HWY (US-441/SR-71)	09-626d	Hendron Chapel Rd to Simpson Rd	0.9	Add center turn lane.	In ROW, construction likely by end of 2021
CHAPMAN HWY (US-441/SR-71) WIDENING	09-508	Boyds Creek Hwy (SR-338) to Macon Ln	1.2	Add center turn lane.	Under construction, completion target of 12/31/2020
CONCORD ROAD (SR-332) WIDENING	09-632	Turkey Creek Rd. to Northshore Dr. (SR-332)	0.8	Widen roadway from 2 to 4-lanes w/median and new bicycle/pedestrian facilities.	Under construction, completion target of 8/22/2021
FOOTHILLS MALL DRIVE EXTENSION TO FOCH STREET	13-211	US-129 Bypass (SR-115) to Foch St.	0.5	Construct new 2-lane road with center turn lane and sidewalks.	In ROW, construction programmed in FY 2020

PROJECT NAME	KRMP ID	TERMINI	LENGTH (MILES)	PROJECT DESCRIPTION	STATUS AS OF MAY 2020
I-275 INDUSTRIAL PARK ACCESS IMPROVEMENTS	09-618	Blackstock Ave: from W. Fifth Ave. to Bernard Ave., Marion St: from Bernard Ave. to Baxter Ave., Intersections of University Ave. with W. Fifth Ave. and Bernard Ave. Add greenway between W. Fifth Ave. and Baxter Ave.	0.5	Roadway and intersection improvements to enhance access to I-275 Business Park. Blackstock Ave: extend from Fifth Ave. to Bernard Ave.; Marion St: realign; University Ave: intersections with W Fifth Ave. and Bernard Ave.	Under construction, expected completion in Fall 2021
I-640 AT BROADWAY INTERCHANGE	09-611	I-640 at Broadway		Reconstruct and relocate ramps.	Under construction, Completion by end of 2020
MONTVALE RD (SR-336) WIDENING	09-262	Montvale Station Rd to Lamar Alexander Pkwy (US-321/SR-73)	0.6	Reconstruct 2-lane road with addition of continuous center turn lane and bicycle/pedestrian facilities.	In design, construction programmed in FY 2022
MORGANTON ROAD RECONSTRUCTION - PHASE 1	09-211	Foothills Mall Dr to William Blount Dr (SR-335)	2.2	Reconstruct 2-lane road with addition of turn lanes.	In NEPA, construction programmed for FY 2022
PELLISSIPPI PKWY (SR-162)/OAK RIDGE HWY INTERCHANGE	09-649	Interchange at Oak Ridge Hwy (SR-62)		Reconstruct interchange to provide ramp for westbound to southbound movement.	In design, construction programmed in FY 2023
PELLISSIPPI PKWY (SR-162/I-140) AND DUTCHTOWN RD INTERCHANGE	09-623	I-40 to Dutchtown Rd Interchange	0.4	Widen Pellissippi Pkwy from 1 to 2 lanes westbound and lengthen storage of westbound off-ramp at Dutchtown Road interchange.	Under construction, comp. target of 7/31/2020
PELLISSIPPI PKWY/HARDIN VALLEY INTERCHANGE	09-634	Interchange at Hardin Valley Rd		Reconfigure existing interchange to improve safety and operations. Add new northbound on-ramp in NE quadrant.	Under construction, comp. target of July 2021
ROBERT C. JACKSON DRIVE EXTENSION	09-238	Lamar Alexander Pkwy (US-321/SR-73) to Morganton Rd	1.2	Construct new 2-lane roadway with sidewalks.	Under construction, comp. target of Spring 2020

PROJECT NAME	KRMP ID	TERMINI	LENGTH (MILES)	PROJECT DESCRIPTION	STATUS AS OF MAY 2020
ROBERT C. JACKSON DRIVE SIA	NA	Lamar Alexander Pkwy (US-321/SR-73) to Middlesettlements Rd	1.2	Add center turn lane	Under construction, comp. target of June 2022
SCHAAD RD EXTENSION	09-605	Middlebrook Pk (SR-169) to W of Oak Ridge Hwy (SR-62)	4.6	Construct new 4-lane roadway with sidewalks	Construction beginning by Summer 2020
SCHAAD RD WIDENING	09-625	Oak Ridge Hwy. (SR-62) to Pleasant Ridge Rd.	1.5	Widen from 2 to 4 lanes with addition of sidewalks	In ROW, construction likely by end of 2021
SEVIERVILLE RD (SR-35/US-411) WIDENING	09-214	Washington St (SR-35) to Walnut St	0.4	Reconstruct 2-lane road with addition of continuous center turn lane and bicycle/pedestrian facilities	In NEPA, construction programmed for FY 2023
US 129 WIDENING	17-203	Foothills Mall Dr to Mall Rd	0.3	Intersection improvements at Foothills Mall Dr/Montgomery Ln and addition of turn lanes	In ROW, construction later in 2020
US 129 WIDENING	17-204	Mall Rd to Lamar Alexander Pkwy (US-321/SR-73)	0.7	Intersection improvements at W. Lamar Alexander Pkwy (US-321/SR-73) and addition of turn lanes	Under construction, completion target of 3/20/2020
US-321 (SR-73) WIDENING	09-423	E. Simpson Rd to north of SR-2 (US-11) in Lenoir City	1.4	Widen from 4 to 6 lanes	Under construction, comp. Soon
WESTERN AVE (SR-62) WIDENING	09-610	Texas Ave to Major Ave	0.8	Widen from 2 to 5 lanes	Under construction, comp. target of 6/7/2020