Tennessee Statewide Travel Demand Model Visualization

Forecasting Office of Long Range Planning Division

Tennessee Department of Transportation

ACKNOWLEDGEMENTS

Tennessee Department of Transportation

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INTRODUCTION

The RSG developed the Tennessee Statewide Model (TSM) to support a variety of studies across the State of Tennessee. The Forecasting Office of the Long Range Planning Division of the Tennessee Department of Transportation conducted in-depth review of the model input data, methodologies used for data processing, analysis, and modeling, and the obtained output. After undertaking several review and revise efforts, the current version of TSM is available and ready to use in different studies. However, it is necessary to identify the possible transportation problems in order to define study topics and new projects to address such issues. The goal of this project is to visualize the output of TSM for further analysis of the model results. This also includes combining other data sets, such as TRIMS tables for more in depth analysis.

METHODOLOGY

We categorize the road segments with respect to their functional class and posted speed limit, as follows:

- Interstates with speed limit greater than or equal to 65 mph
- Interstates with speed limit less than 65 mph
- Non-Interstates Rural with speed limit greater than or equal to 60 mph
- Non-Interstates Rural with speed limit greater than or equal to 40 and less than 60 mph
- Non-Interstates Rural with speed limit less than 40 mph

- Non-Interstates Urban with speed limit greater than or equal to 60 mph
- Non-Interstates Urban with speed limit greater than or equal to 40 and less than 60 mph
- Non-Interstates Urban with speed limit less than 40 mph
- Ramps and Roundabouts

Then, for each group of road segments we use the outputs of Tennessee Statewide Model (TSM) to define new variables and visualize the results. We do these calculations separately for Daily and Time-of-Day runs. Focusing on the daily model run scenarios, the following equations are used to calculate the percentage of MUTs, SUTs, Autos, and Trucks, as well as the V/C ratios for 2010 Base and 2040 E+C scenarios:

$$\text{Percentage of MUTs} = \frac{Tot\_MUT}{TotFlow} \times 100$$

$$\text{Percentage of SUTs} = \frac{Tot\_SUT}{TotFlow} \times 100$$

$$\text{Percentage of Trucks} = \frac{(Tot\_MUT + Tot\_SUT)}{TotFlow} \times 100$$

$$\text{Percentage of Autos} = \frac{Tot\_Auto}{TotFlow} \times 100$$

$$\text{Volume to Capacity Ratio} = \frac{TotFlow}{(AB\_DLYCap + BA\_DLYCap)} \times 100$$

Where:

Tot_MUT: Total MUT Volume

TotFlow: Total Traffic Volume

Tot_SUT: Total SUT Volume

Tot_Auto: Total Auto Volume

AB/BA_DLYCap: Daily Capacity

We also use the results obtained from Time-of-Day model runs to calculate the volume to capacity ratios for AM and PM peak hours, as follow:

$$\text{AM Peak Volume to Capacity Ratio} = \frac{AM\_TotFlow}{(AB\_AMCap + BA\_AMCap)} \times 100$$

$$\text{PM Peak Volume to Capacity Ratio} = \frac{PM\_TotFlow}{(AB\_PMCap + BA\_PMCap)} \times 100$$

Where:

AB/BA_AMCap: AM Period Capacity

AB/BA_PMCap: PM Period Capacity

Also, we look into a variety of TRIMS tables to visualize roadway system attributes in Tennessee. Next, we identified and visualized the critical road segments in Tennessee using a variety of different performance measures, such as volume to capacity ratio, delay, speed, crash, and fuel usage.

ROADWAY INFRASTRUCTURE IN TENNESSEE

In Tennessee, there are almost 28,000 miles of functionally classified roads that almost 70 % of them located in rural areas, as shown in Figure 1. Of the 166,826,911 daily vehicle miles traveled (DVMT) on Tennessee's roadways in 2012, 34% were traveled on Interstates (I-40, I-75, I-81, I-24, I-55, I-155, & I-65). There are 20,087 bridges on public roads within Tennessee that 42% (8,437) are State Maintained meaning that TDOT owns, operates, and maintains these structures. This section of the report presents and visualizes a number of attributes of road segment in Tennessee. The data were obtained from the Tennessee Roadway Information management System (TRIMS) and Tennessee Statewide Model (TSM).

Urban Boundary _Functional Classification System
Interstates & State Routes & Functional Routes - Statewide

Description	# of Miles	Percentage	Graph Reference
R / INTERSTATE	643.522	2.3%	A
R / OTH PRIN ART	1,784.301	6.4%	B
R / MIN ART	2,954.887	10.6%	C
R / MAJ COL	5,000.820	18.0%	D
R / MIN COL	9,644.070	34.6%	E
R / LOCAL	0.000	0.0%	F
U / INTERSTATE	557.774	2.0%	G
U / FWY OR EXP	177.662	0.6%	H
U OTH PRIN ART	1,909.945	6.9%	I
U / MIN ART	2,612.121	9.4%	J
U / COLL	2,561.127	9.2%	K
U / LOCAL	0.000	0.0%	L

Total Miles: 27,846.229

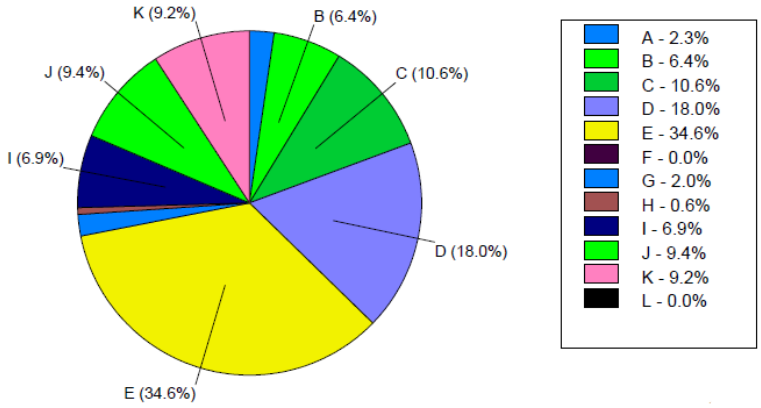

Figure 1: Urban vs Rural roadway functional classification system in Tennessee

Figure 2 to Figure 4 summarize Tennessee's classified roads based on their AADTs (Average Annual daily Traffic) respectively for Interstates, State Routes, and Functional Routes. AADTs on the majority of Interstates are higher than 25,000 vehicles. For State Routes and Fuctional Routes, most of roads experince AADTs less than 5,000 and 2,500 vehicles, respectively.

AADT
Interstates - Statewide

Description	# of Miles	Percentage	Graph Reference
>=0 AND <=2500	0.000	0.0%	A
>2500 AND <=5000	0.000	0.0%	B
>5000 AND <=10000	18.483	1.5%	C
>10000 AND <=15000	27.450	2.3%	D
>15000 AND <=20000	35.123	2.9%	E
>20000 AND <=25000	76.010	6.3%	F
AADT Greater than 25,000	1,043.770	86.9%	G
	Total Miles: 1,200.836		

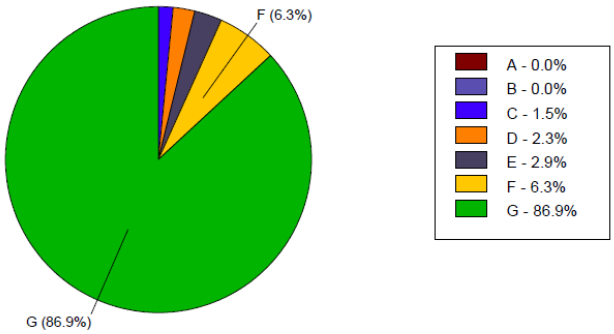

Figure 2: Summary of AADTs on Interstates in Tennessee

AADT
State Routes - Statewide

Description	# of Miles	Percentage	Graph Reference
>=0 AND <=2500	5,247.194	41.3%	A
>2500 AND <=5000	2,541.784	20.0%	B
>5000 AND <=10000	2,367.850	18.6%	C
>10000 AND <=15000	1,033.098	8.1%	D
>15000 AND <=20000	562.105	4.4%	E
>20000 AND <=25000	334.583	2.6%	F
AADT Greater than 25,000	609.844	4.8%	G

Total Miles: 12,696.458

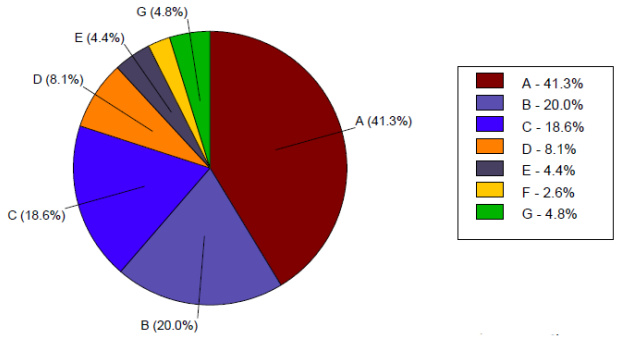

Figure 3: Summary of AADTs on State Routes in Tennessee

AADT
Functional Routes - Statewide

Description	# of Miles	Percentage	Graph Reference
>=0 AND <=2500	11,543.757	77.1%	A
>2500 AND <=5000	1,457.800	9.7%	B
>5000 AND <=10000	1,124.515	7.5%	C
>10000 AND <=15000	423.877	2.8%	D
>15000 AND <=20000	199.207	1.3%	E
>20000 AND <=25000	106.952	0.7%	F
AADT Greater than 25,000	112.642	0.8%	G

Total Miles: 14,968.750

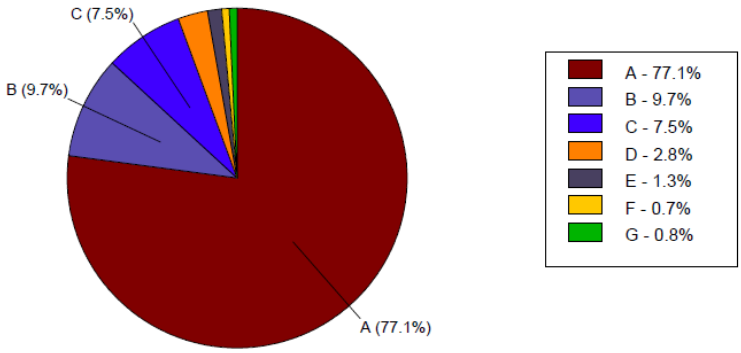

Figure 4: Summary of AADTs on Functional Routes in Tennessee

Figure 5 shows the road segments that are divided and Figure 6 demonstrates the road segments with median. As can be seen, most of divided road segments have medians.

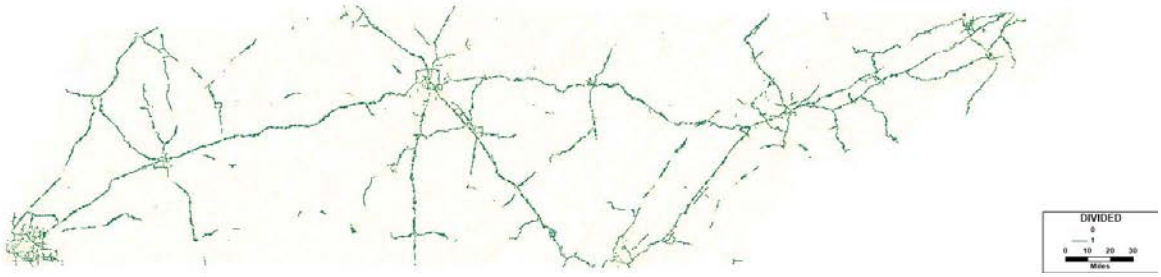

Figure 5: Divided Freeway or Multilane Identifier for road segments in Tennessee

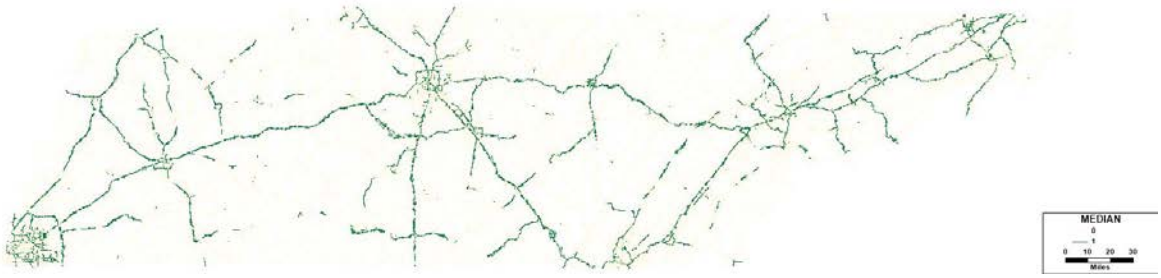

Figure 6: Median identifier for road segments in Tennessee

Figure 7 presents the TSM's roadway system with respect to the number of lanes that each road segment has. Figure 8 identifies the road segments having two-way center left turning lanes. We used the Tennessee Statewide Model input data to create Figure 5 to Figure 8.

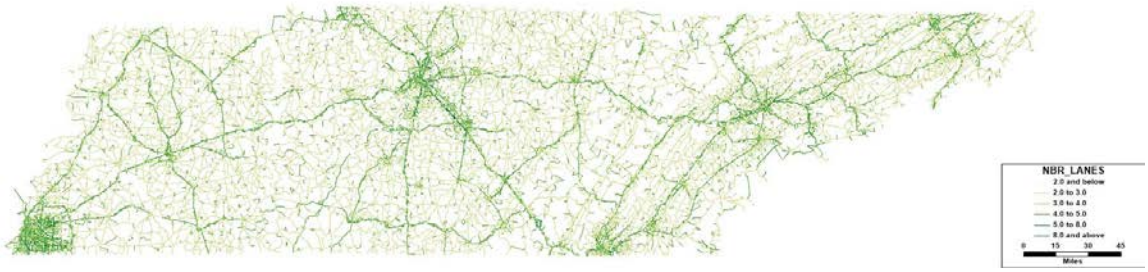

Figure 7: Number of Lanes for road segments in Tennessee

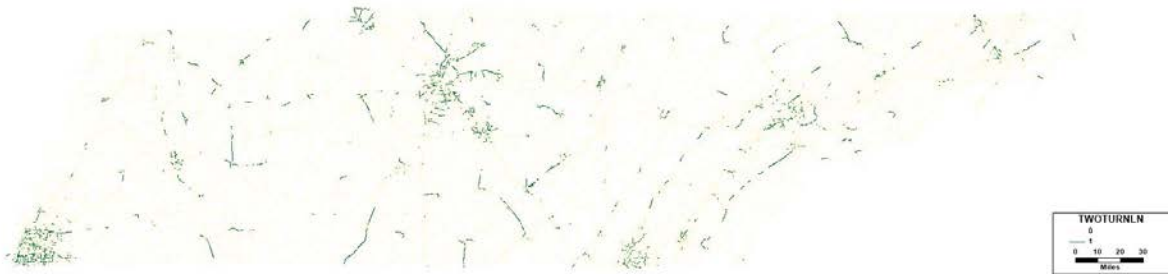

Figure 8: Two-Way Center Left Turning Lanes for road segments in Tennessee

There are a few road segments in Tennessee that truck movement are prohibited (Figure 9). Also, a number of road segments have truck speed limits (when different from automobiles) posted as shown in Figure 10.

Figure 9: Truck Prohibited road segments in Tennessee

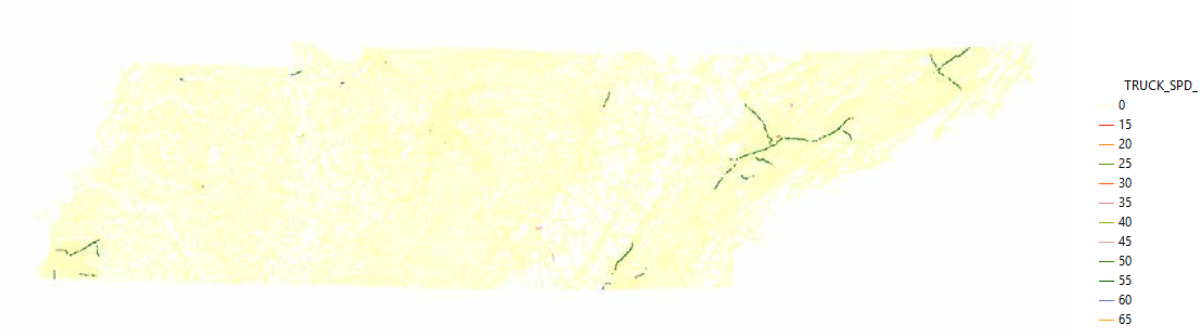

Figure 10: Posted truck speed limit on road segments in Tennessee (mph)

Figure 11 shows the land use surrounding the road segments across the state. According to TRIMS code book, these land use codings are based on a segment of roadway, not a parcel of land. The following is the definition of each land use type:

> 0: Rural – This is a general term for rural, agricultural and forest segments. They can be vacant and/or improved farmsteads.

1: Central Business District (CBD) – This includes the Central Business District (CBD) which embraces the office, retail, and commercial functions which serve the city/county/region. It is generally an urbanized population greater than 50,000.

2: Commercial – This includes a broad range of retail and wholesale sales of products, personal, and professional services. It shall include Regional/Community shopping and businesses on both sides of a street leading to the shopping center development, a nearby commercial strip mall, etc.

4: Fringe – This includes limited small-scale commercial development in close proximity to a neighborhood/residential area, providing goods and services to that neighborhood/residential market area.

5: Industrial – This includes a wide variety of manufacturing, warehousing, distribution or storage uses, research and development, processing, and industry related office and service activities.

7: Residential – This includes all residential developments including single family homes, patio or garden homes, duplex, townhouses, cluster houses and apartments.

9: Public – This includes public facilities along the roadway that provide a variety of services to the community such as government buildings, schools, colleges, libraries, fire and police stations, churches/religious facilities, cemeteries, utilities, hospitals, military, and transportation terminals.

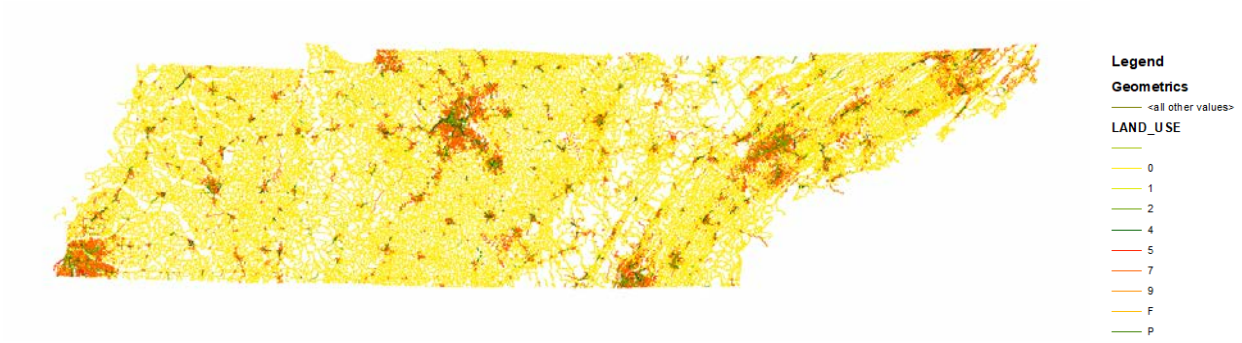

Figure 11: Land Use surronding road segment in Tennessee

Figure 12 to Figure 14 summarize the percentage of each type of land use surrounding the road segments in Tennessee. Most of all road functional classes are located in rural areas in Tennessee, as expected.

Land Use
Interstates - Statewide

Description	# of Miles	Percentage	Graph Reference
1-CBD	0.400	0.0%	A
2-HEAVY COM. (HIGH RISES, LG BUILDINGS)	116.070	9.7%	B
3-STRIP COMMERCIAL	0.000	0.0%	C
4-FRINGE (MIX RES. COMM.)	77.890	6.5%	D
5-INDUSTRIAL (FACTORIES, WAREHOUSES)	2.020	0.2%	E
6-LT. RESIDENTIAL (ACRE+)	0.000	0.0%	F
7-MED. RESIDENTIAL (1/4 - 1 ACRE)	11.640	1.0%	G
8-HEAVY RESIDENTIAL (APPT.)	0.000	0.0%	H
9-PUBLIC USE (PARKS, SCHOOLS)	0.000	0.0%	I
0-RURAL	993.276	82.7%	J
FERRY	0.000	0.0%	K
PROPOSED	0.000	0.0%	L
Is NULL	0.000	0.0%	M

Total Miles: 1,201.296

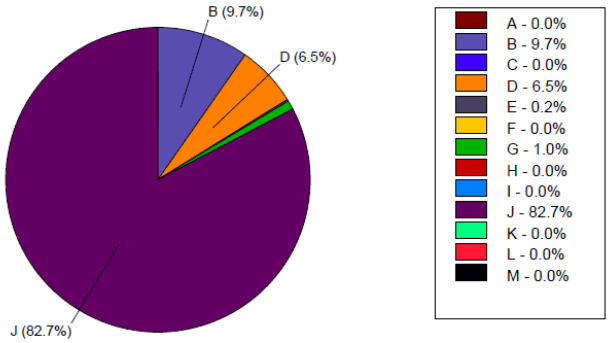

Figure 12: Miles of Interstates located in different types of land uses

Land Use
State Routes - Statewide

Description	# of Miles	Percentage	Graph Reference
1-CBD	1.940	0.0%	A
2-HEAVY COM. (HIGH RISES, LG BUILDINGS)	959.583	7.6%	B
3-STRIP COMMERCIAL	0.000	0.0%	C
4-FRINGE (MIX RES. COMM.)	1,069.681	8.4%	D
5-INDUSTRIAL (FACTORIES, WAREHOUSES)	32.319	0.3%	E
6-LT. RESIDENTIAL (ACRE+)	0.000	0.0%	F
7-MED. RESIDENTIAL (1/4 - 1 ACRE)	633.540	5.0%	G
8-HEAVY RESIDENTIAL (APPT.)	0.000	0.0%	H
9-PUBLIC USE (PARKS, SCHOOLS)	61.915	0.5%	I
0-RURAL	9,922.905	78.2%	J
FERRY	0.190	0.0%	K
PROPOSED	12.765	0.1%	L
Is NULL	1.620	0.0%	M

Total Miles: 12,696.458

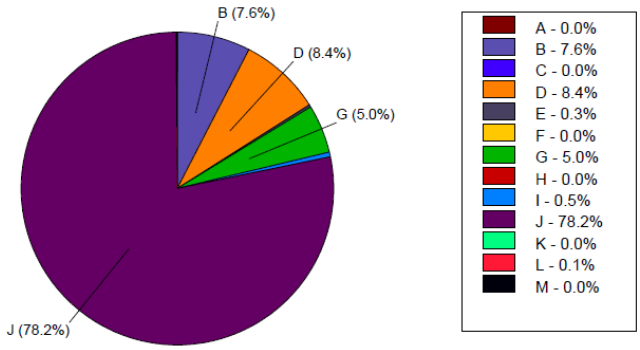

Figure 13: Miles of State Routes located in different types of land uses

Land Use
Functional Routes - Statewide

Description	# of Miles	Percentage	Graph Reference
1-CBD	1.660	0.0%	A
2-HEAVY COM. (HIGH RISES, LG BUILDINGS)	676.939	4.5%	B
3-STRIP COMMERCIAL	0.000	0.0%	C
4-FRINGE (MIX RES. COMM.)	480.231	3.2%	D
5-INDUSTRIAL (FACTORIES, WAREHOUSES)	168.501	1.1%	E
6-LT. RESIDENTIAL (ACRE+)	0.000	0.0%	F
7-MED. RESIDENTIAL (1/4 - 1 ACRE)	2,508.319	16.8%	G
8-HEAVY RESIDENTIAL (APPT.)	0.000	0.0%	H
9-PUBLIC USE (PARKS, SCHOOLS)	133.341	0.9%	I
0-RURAL	10,899.045	72.8%	J
FERRY	1.510	0.0%	K
PROPOSED	21.474	0.1%	L
Is NULL	78.450	0.5%	M
	Total Miles: 14,969.470		

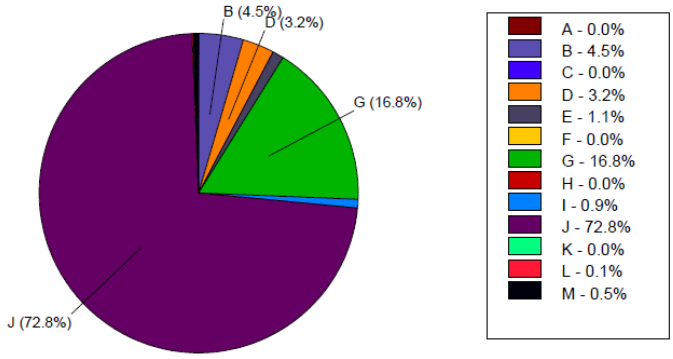

Figure 14: Miles of Functional Routes located in different types of land uses

Figure 15 presents the distribution of illumination on the road segments in Tennessee. As seen in the figure, a significant number of road segments accros the state are not illuminated, in particular road segments located in rural areas.

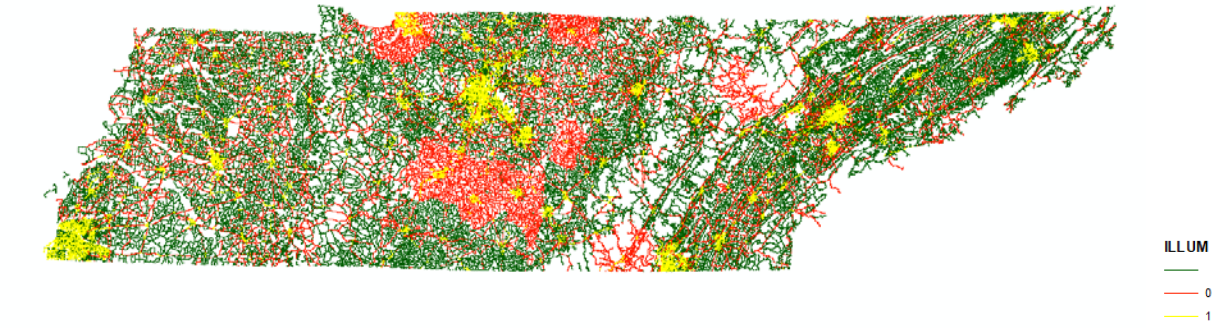

Figure 15: Illumination distribution for road segment in Tennessee

CRASH DATA

This section of the study examines the crashes occurred on Tennessee's roads. According to Figure 16, almost 91% of crashes on Interstates took place along the roadway. Focusing on State Routes, 97.5% of crashes were occurred along the roadway or at an intersection (Figure 17). Also, Figure 18 shows that 98.2% of crashes on Functional Routes took place along the roadway or at an intersection.

Crash by Location1
Interstates - Statewide
2009 - 2018

Description	# of Points	Percentage	Graph Reference
ALONG ROADWAY	177,629	90.8%	A
AT AN INTERSECTION	870	0.4%	B
R.R. GRADE CROSSING	5	0.0%	C
BRIDGE	1,362	0.7%	D
UNDERPASS	618	0.3%	E
RAMP	14,823	7.6%	F
PRIVATE PROPERTY	249	0.1%	G

Total Records: 195,556

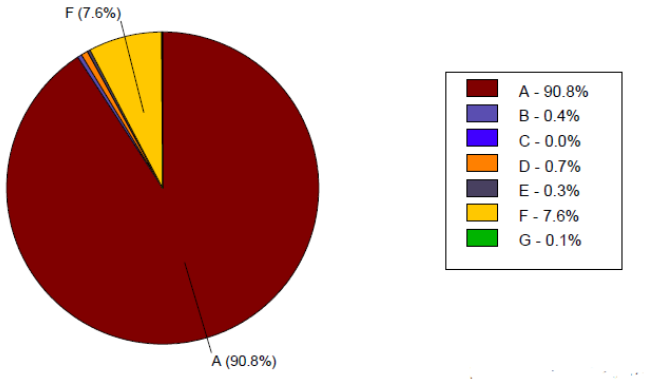

Figure 16: Location of crashes on Interstates in Tennessee

Crash by Location1
State Routes - Statewide
2009 - 2018

Description	# of Points	Percentage	Graph Reference
ALONG ROADWAY	403,389	49.1%	A
AT AN INTERSECTION	397,912	48.4%	B
R.R. GRADE CROSSING	255	0.0%	C
BRIDGE	2,125	0.3%	D
UNDERPASS	570	0.1%	E
RAMP	18,114	2.2%	F
PRIVATE PROPERTY	4	0.0%	G

Total Records: 822,369

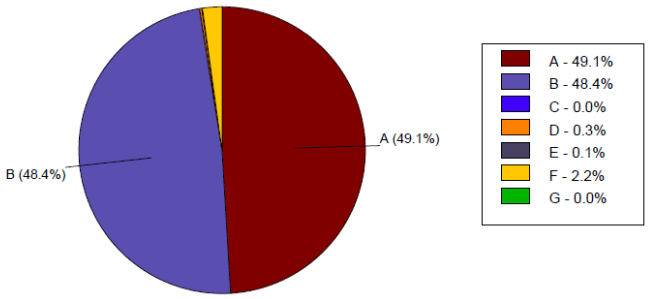

Figure 17: Location of crashes on State Routes in Tennessee

Crash by Location1
Functional Routes - Statewide
2009 - 2018

Description	# of Points	Percentage	Graph Reference
ALONG ROADWAY	258,841	52.4%	A
AT AN INTERSECTION	225,871	45.8%	B
R.R. GRADE CROSSING	544	0.1%	C
BRIDGE	784	0.2%	D
UNDERPASS	339	0.1%	E
RAMP	7,124	1.4%	F
PRIVATE PROPERTY	5	0.0%	G

Total Records: 493,508

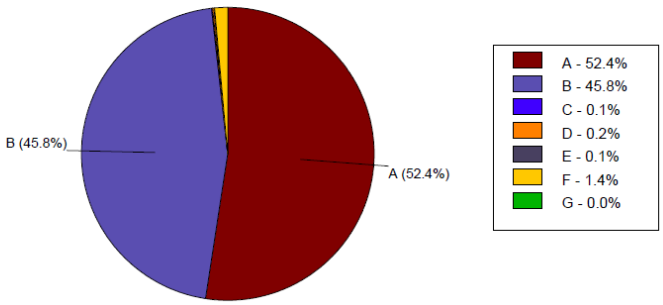

Figure 18: Location of crashes on Functional Routes in Tennessee

Figure 19 and Figure 20 show the location of crashes occurred in Tennessee in 2016, 2017, and 2018. As seen in the figure, a significant number of crashes are fatalities. Figure 21 presents the number and percentage of crashes by crash type. As seen in the figure, high property damage crashes contribute to lamost 70% of crashes in Tennessee.

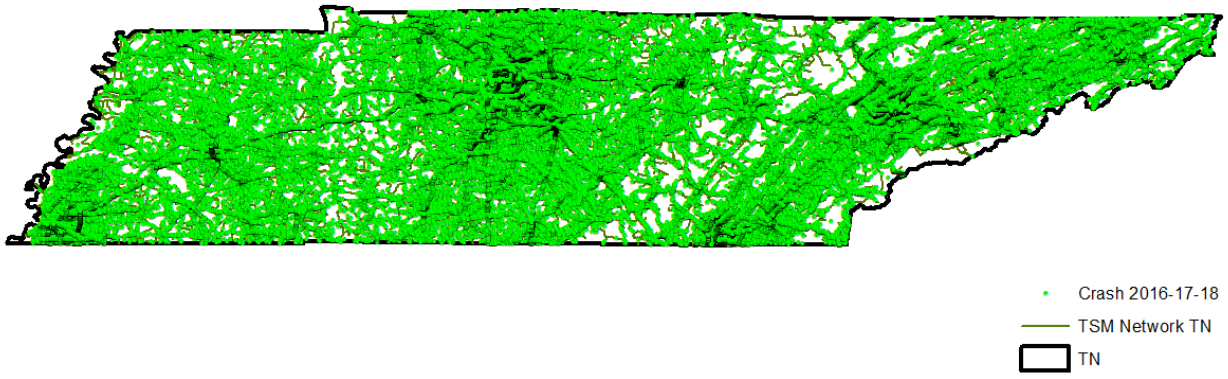

Figure 19: Crashes occurred on Tennessee's roads in 2016 to 2018

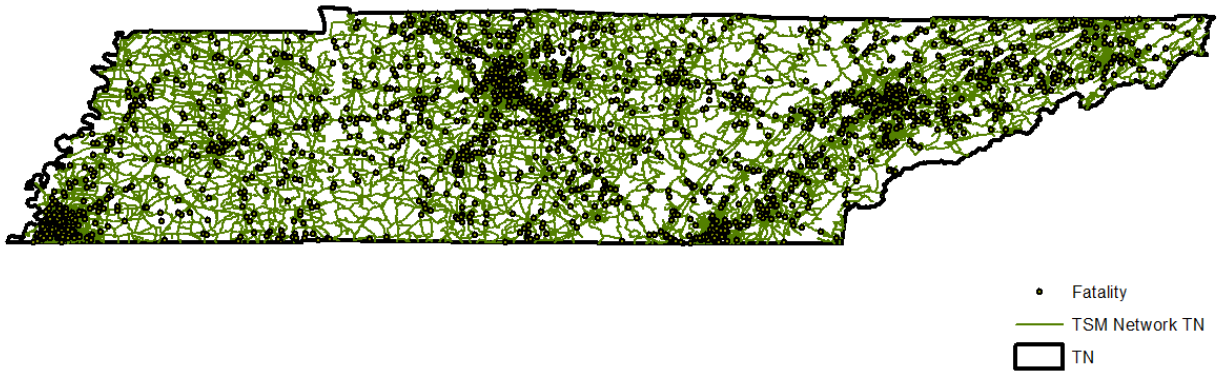

Figure 20: Fatal crashes occurred on Tennessee's roads in 2016 to 2018

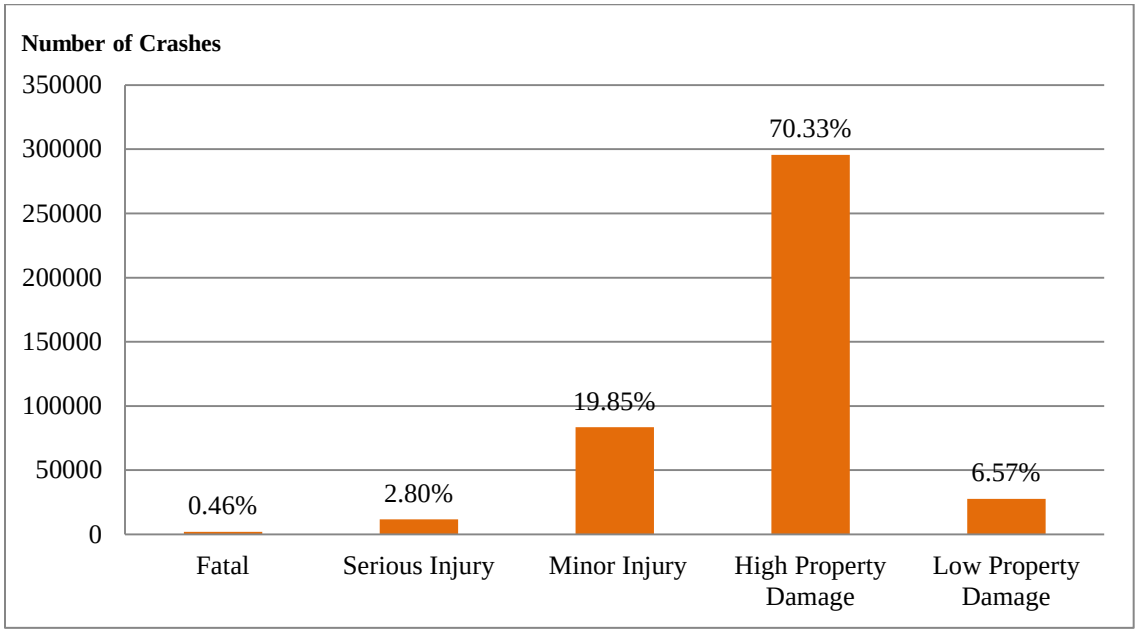

Figure 21: Summary of crashes occurred on Tennessee's roads in 2016 to 2018 by crash type

As Figure 22 shows, the majority of crashes in Tennessee occurred in day time, almost 69% of total crashes. It was supposed that day time starts at 6:00 am and finishes at 6:00 pm. The rest of time considered as night time. Table 1 summarizes the number of crashes by time of day. To have a better sense of the number of crashes by time of day, Figure 23 was created. From 3:00 pm through 6:00 pm was shown to be the most critical time of day in terms of the high number of crash occurance. Additionally, Table 2 demonstrates the number of crashes by county in which the crash occurred. Davidson, Shelby, Knox, Hamilton, and Rutherford exhibits the hieghst rate of crashes where, respectively, 17.8%, 12.7%, 7.4%, 6.7%, and 5.3% of Tennessee's crashes occuer in these counties. Also, Figure 24 provides the summary of crashes by region. As expected, Region 3 exhibits the highest number of crashes, followed by Region 1 and Region 4.

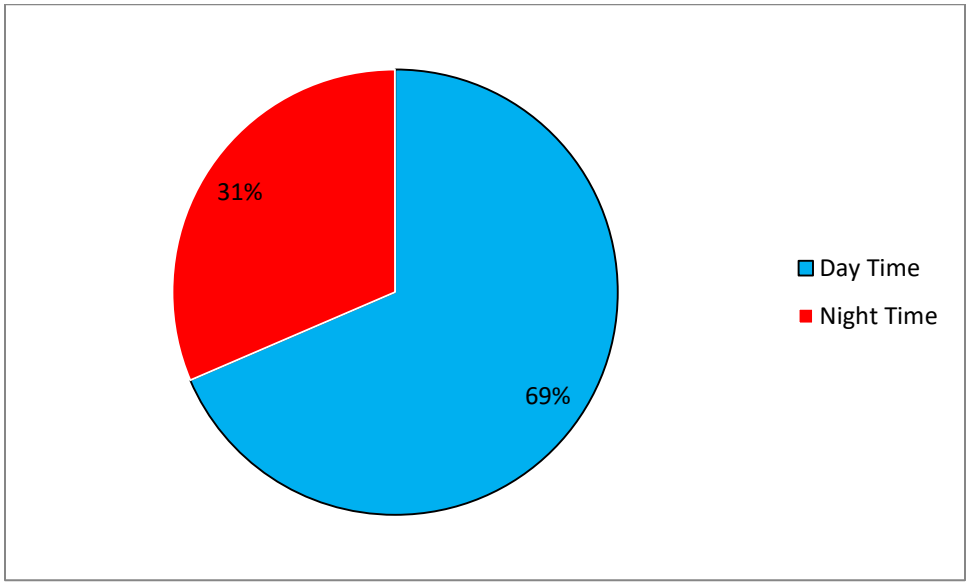

Figure 22: Summary of crashes occurred on Tennessee's roads in 2016 to 2018, Day vs. Night

Table 1: Summary of crashes occurred on Tennessee's roads in 2016 to 2018 by time of the day

Time of Day	Number of Crashes
0-1	24,262
1-2	4473
2-3	3,989
3-4	3,817
4-5	3,765
5-6	6,235
6-7	12,501
7-8	24,049
8-9	19,595
9-10	15,775
10-11	16,722
11-12	19,745
12-13	23,657
13-14	24,087
14-15	26,888
15-16	34,205
16-17	34,434
17-18	36,396
18-19	25,263
19-20	16,763
20-21	13,825
21-22	12,331
22-23	9,975
23-24	7,567
Total	**420,319**

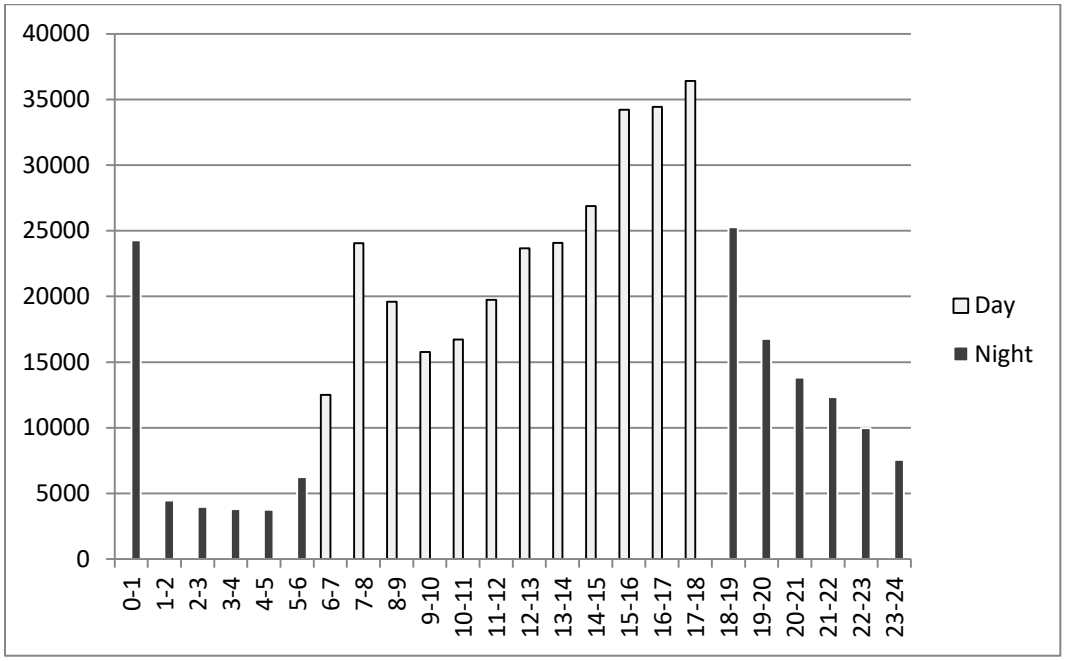

Figure 23: Number of crashes occurred on Tennessee's roads in 2016 to 2018 by time

Table 2: Summary of crashes occurred on Tennessee's roads in 2016 to 2018 by County

County Number	County Name	Region	Number of Crashes
1	Anderson	1	4472
2	Bedford	3	2849
3	Benton	4	865
4	Bledsoe	2	226
5	Blount	1	5985
6	Bradley	2	6966
7	Campbell	1	2606
8	Cannon	2	747
9	Carroll	4	1027
10	Carter	1	2871
11	Cheatham	3	2335
12	Chester	4	781
13	Claiborne	1	858
14	Clay	2	245
15	Cocke	1	2638
16	Coffee	2	3469
17	Crockett	4	568

18	Cumberland	2	3481
19	Davidson	3	74660
20	Decatur	4	593
21	Dekalb	2	851
22	Dickson	3	3649
23	Dyer	4	1885
24	Fayette	4	1277
25	Fentress	2	758
26	Franklin	2	1835
27	Gibson	4	1614
28	Giles	3	2106
29	Grainger	1	760
30	Greene	1	4299
31	Grundy	2	648
32	Hamblen	1	3766
33	Hamilton	2	28352
34	Hancock	1	202
35	Hardeman	4	1134
36	Hardin	4	1684
37	Hawkins	1	2294
38	Haywood	4	1382
39	Henderson	4	1883
40	Henry	4	1152
41	Hickman	3	1325
42	Houston	3	330
43	Humphreys	3	919
44	Jackson	2	312
45	Jefferson	1	1585
46	Johnson	1	956
47	Knox	1	30986
48	Lake	4	129
49	Lauderdale	4	1043
50	Lawrence	3	1923
51	Lewis	3	418
52	Lincoln	3	2018
53	Loudon	1	2824
54	Mcminn	2	2741
55	Mcnairy	4	1243

56	Macon	3	782
57	Madison	4	8555
58	Marion	2	1597
59	Marshall	3	1894
60	Maury	3	6951
61	Meigs	2	457
62	Monroe	1	1916
63	Montgomery	3	10711
64	Moore	3	335
65	Morgan	1	459
66	Obion	4	1431
67	Overton	2	1113
68	Perry	3	244
69	Pickett	2	155
70	Polk	2	740
71	Putnam	2	6674
72	Rhea	2	1329
73	Roane	1	3138
74	Robertson	3	3825
75	Rutherford	3	22126
76	Scott	1	430
77	Sequatchie	2	537
78	Sevier	1	8068
79	Shelby	4	53292
80	Smith	3	1454
81	Stewart	3	566
82	Sullivan	1	7569
83	Sumner	3	8378
84	Tipton	4	2282
85	Trousdale	3	588
86	Unicoi	1	801
87	Union	1	340
88	Van Buren	2	356
89	Warren	2	2165
90	Washington	1	6398
91	Wayne	3	707
92	Weakley	4	1033
93	White	2	1205

94	Williamson	3	13122
95	Wilson	3	8071

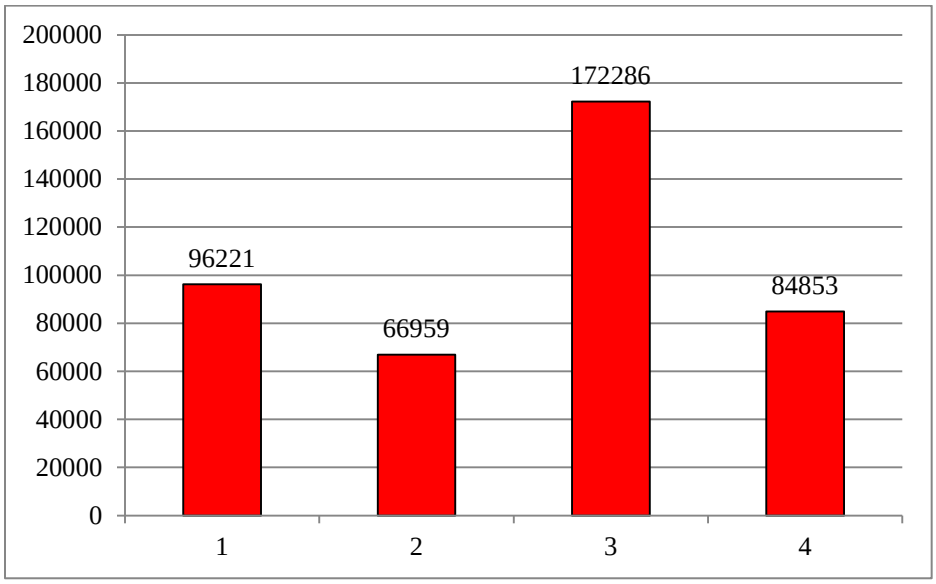

Figure 24: Number of crashes occurred on Tennessee's roads in 2016 to 2018 by time

TSM OUTPUT 2010

This section of the report provides readers with the results obtained from running TSM for the base year. Figure 25 to Figure 28 present traffic flow on roadways in Tennssee by vehicle type (MUT, SUT, Auto, and Total Flow).

Figure 25: MUTs' traffic volume on Tennssee's roads (2010)

Figure 26: SUTs' traffic volume on Tennssee's roads (2010)

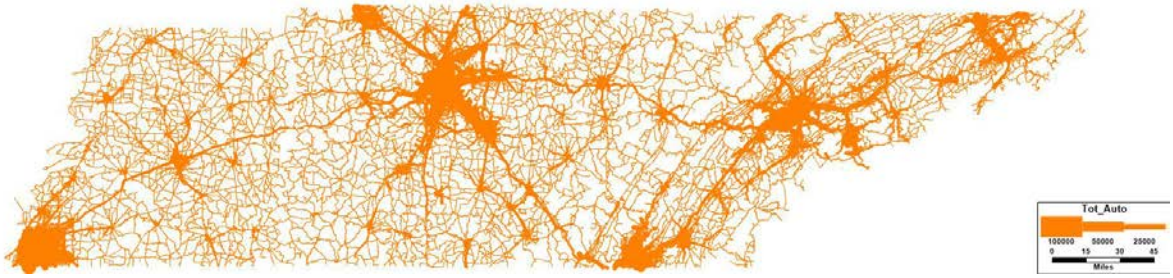

Figure 27: Autos' traffic volume on Tennssee's roads (2010)

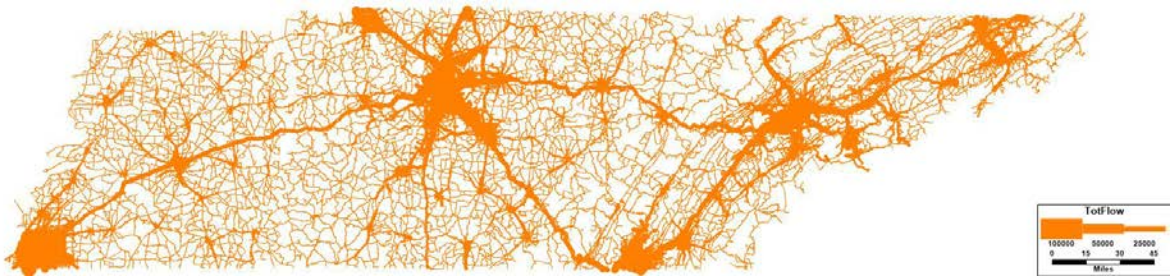

Figure 28: Total traffic volume on Tennssee's roads (2010)

Figure 29 to Figure 32 show the percentage of MUTs, SUTs, Trcuks, and Autos on Tennessee's roads, resepectively. Also, Figure 33 to Figure 35 demonstrate the Volume to Capacity ratios on the road segments for Daily, AM Peak, and PM Peak hours. The rest of this section discusses the rsults in more-details. As mentioned earlier, the road segments were categorized with respect to their functional class and posted speed limit.

Figure 29: Percentage of MUTs for Tennessee's roads (2010)

Figure 30: Percentage of SUTs for Tennessee's roads (2010)

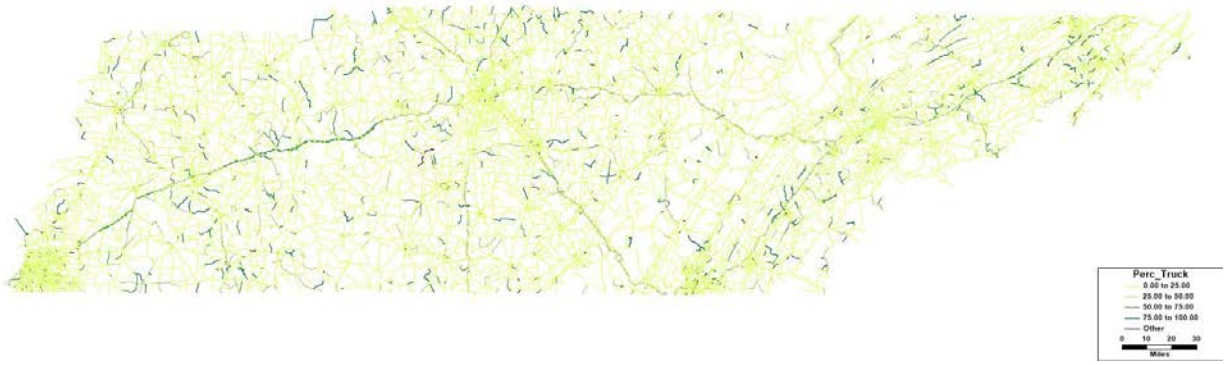

Figure 31: Percentage of Trucks for Tennessee's roads (2010)

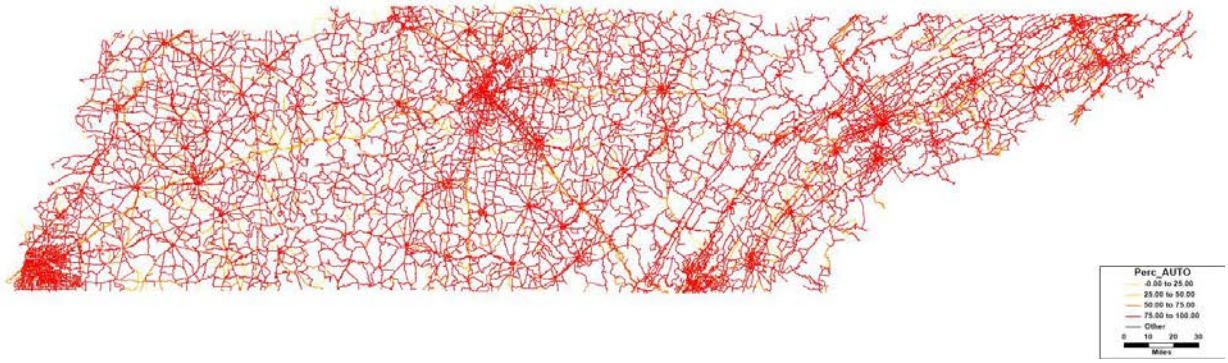

Figure 32: Percentage of Autos for Tennessee's roads (2010)

Figure 33: Daily Volume to Capacity Ratio for Tennessee's roads (2010)

Figure 34: AM Peak Volume to Capacity Ratio for Tennessee's roads (2010)

Figure 35: PM Peak Volume to Capacity Ratio for Tennessee's roads (2010)

Interstate – Speed Limit ≥ 65

In the Tennnessee Statewide Model, Rural Interstates and Urban Intestates were respectively classified as Functional Class 1 and 11. Figure 36 to Figure 40 show the percentages of MUTs, SUTs, Trucks, and Autos, as well as Volume to Capcity Ratios for Interstates with speed limit greater than or equl to 65 mph. The results obtained from running TSM for Base year daily scenario. For most road segments of Intestates, autos contribute to more than fifty percent of traffic flow compared to trucks. However, in some sections of I-40 and I-65, the percentage of trucks is more than autos. The reason for this is the high number of MUTs driving on these road segments. As shown in Figure 40, V/C ratios in 2010 for Interstates with speed limit greater than or equl to 65 mph were less than 0.5.

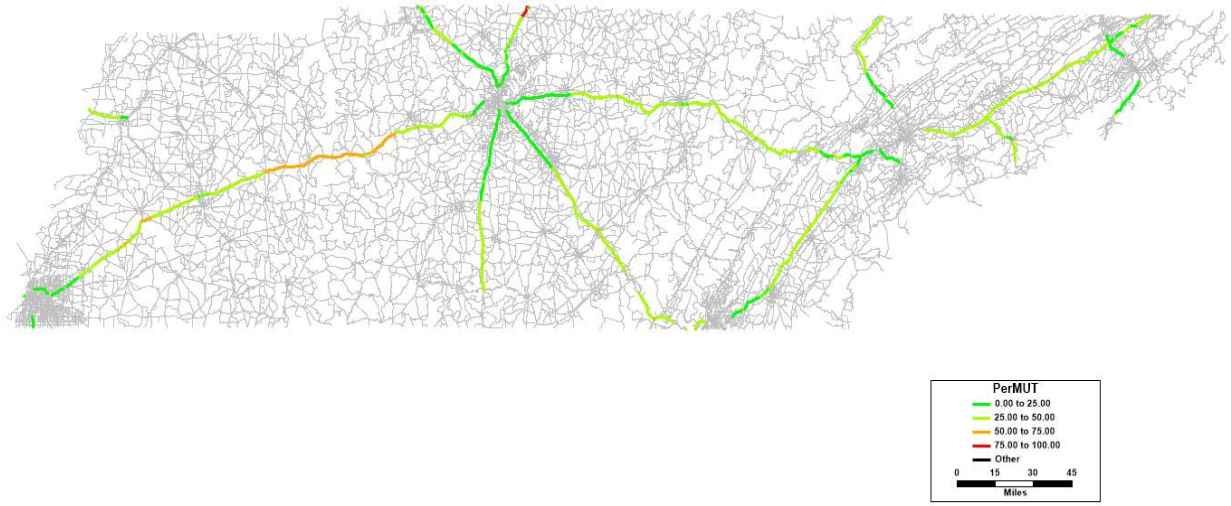

Figure 36: Percentage of MUTs for Interstates with Speed Limit greater than or equal to 65 mph (2010)

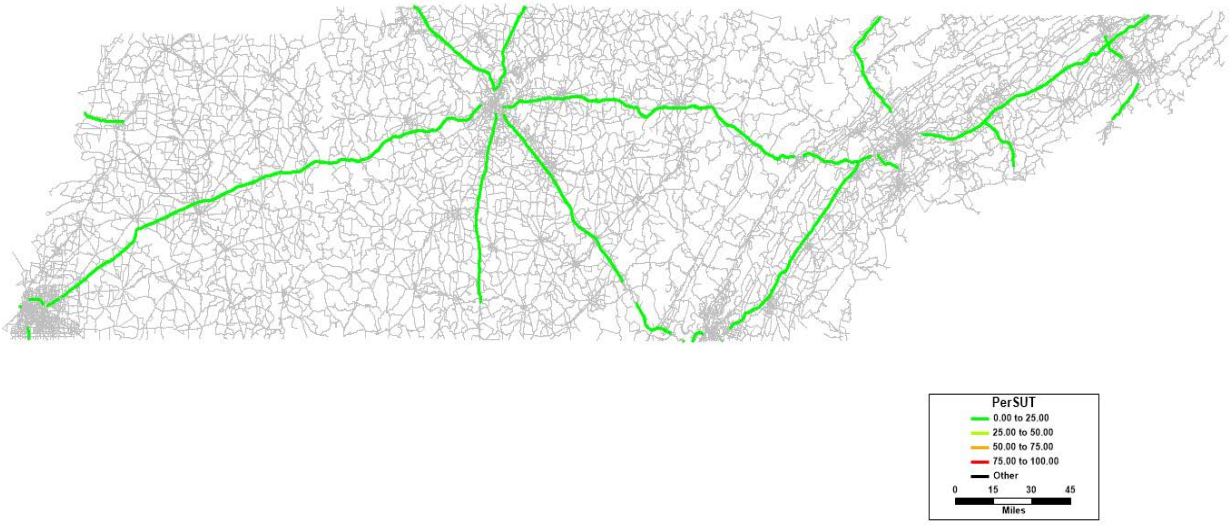

Figure 37: Percentage of SUTs for Interstates with Speed Limit greater than or equal to 65 mph (2010)

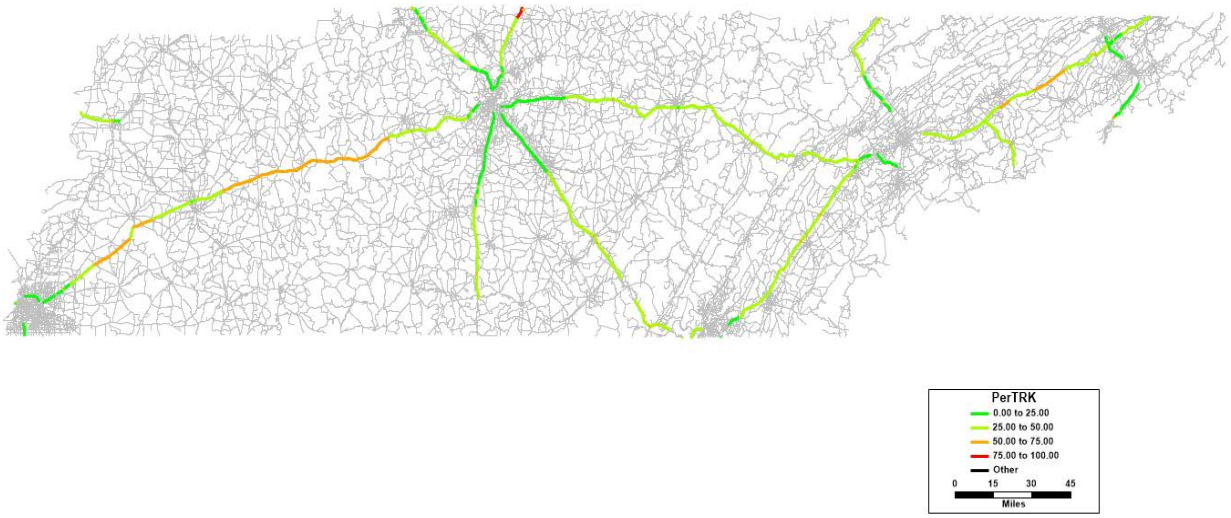

Figure 38: Percentage of Trucks for Interstates with Speed Limit greater than or equal to 65 mph (2010)

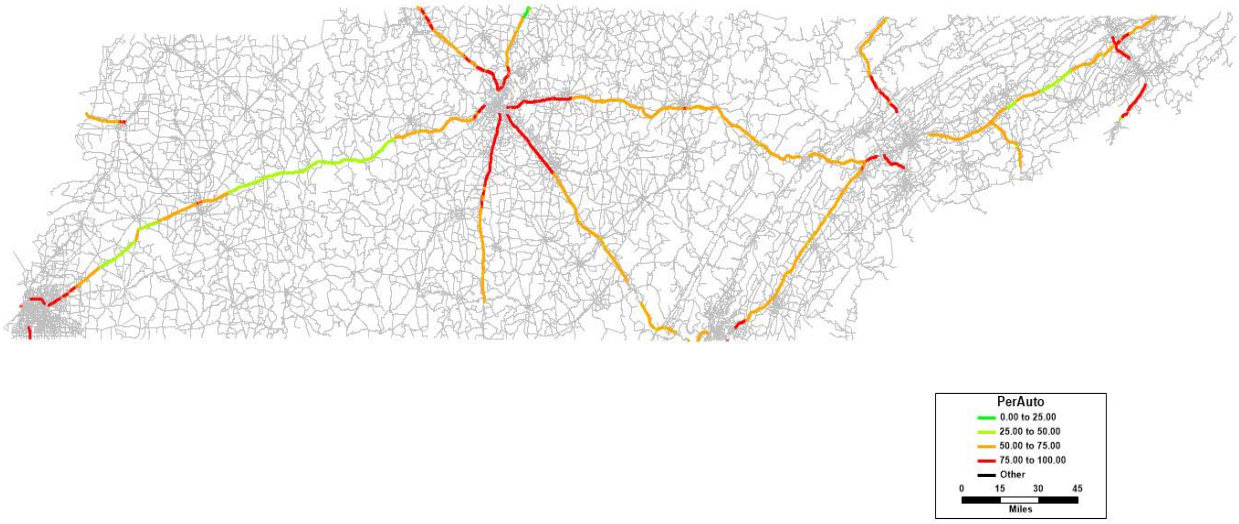

Figure 39: Percentage of Autos for Interstates with Speed Limit greater than or equal to 65 mph (2010)

Figure 40: Volume to Capacity Ratio for Interstates with Speed Limit greater than or equal to 65 mph (2010)

Interstate – Speed Limit < 65

Figure 41 to Figure 45 present the percentages of MUTs, SUTs, Trucks, and Autos, as well as Volume to Capcity Ratios for Interstates with speed limit less than 65 mph. For almost all road segments of Intestates with speed limit less than 65 mph, autos are the major contributer to traffic flow. This maybe a reflection of the fact that these Interstate segments are located in Urban areas. Some segments of interstates also exhibited critical V/C ratios in 2010.

Figure 41: Percentage of MUTs for Interstates with Speed Limit less than 65 mph (2010)

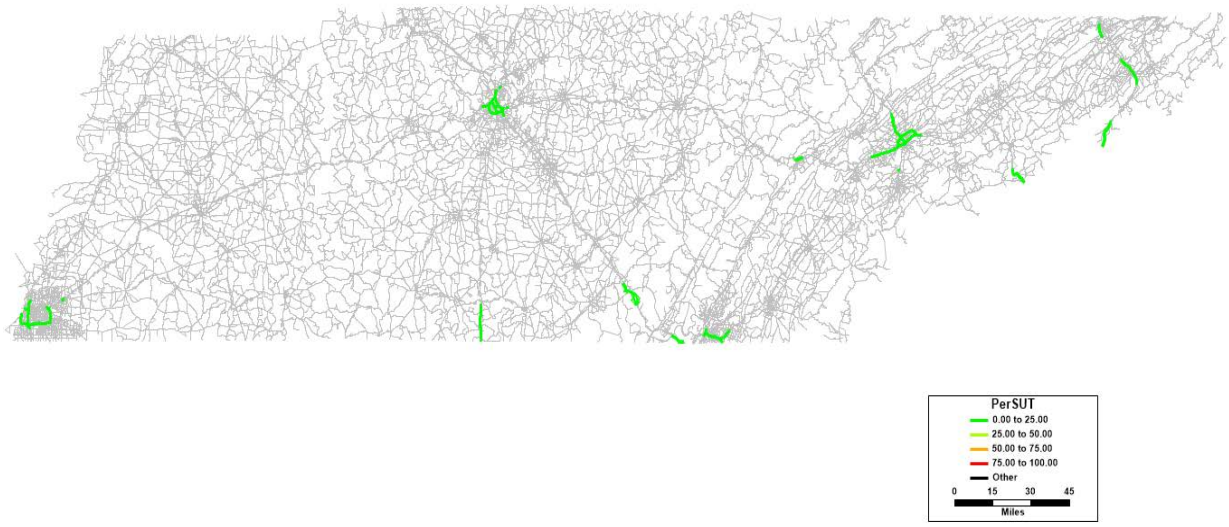

Figure 42: Percentage of SUTs for Interstates with Speed Limit less than 65 mph (2010)

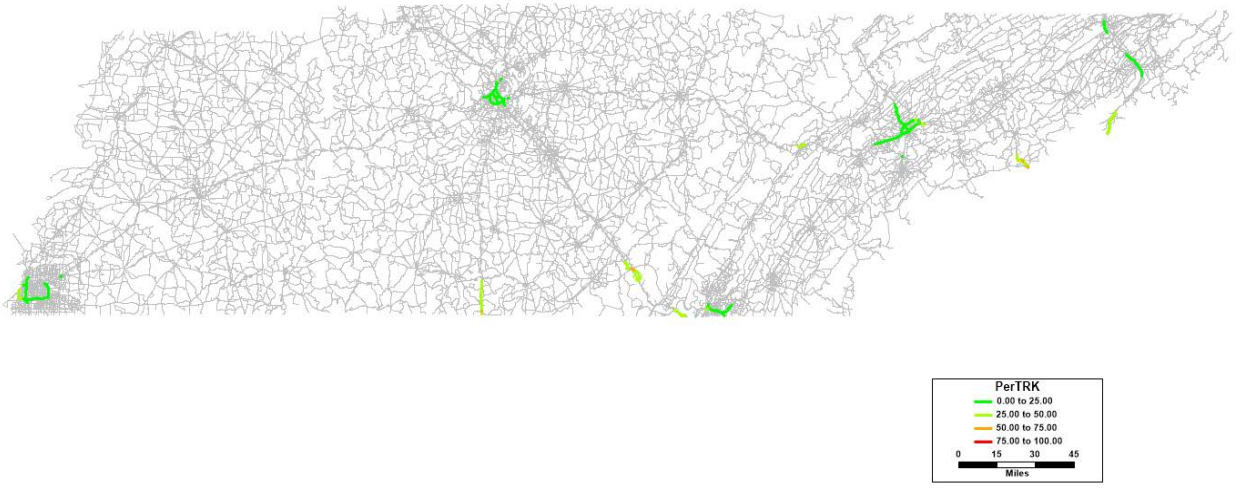

Figure 43: Percentage of Trucks for Interstates with Speed Limit less than 65 mph (2010)

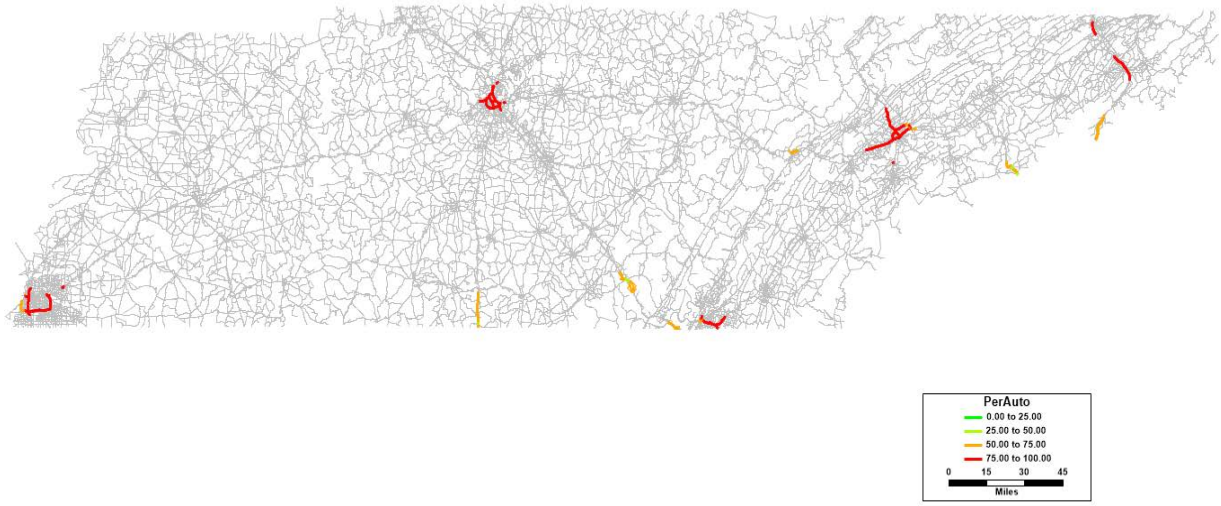

Figure 44: Percentage of Autos for Interstates with Speed Limit less than 65 mph (2010)

Figure 45: Volume to Capacity Ratio for Interstates with Speed Limit less than 65 mph (2010)

Non-Interstate – Rural – Speed Limit ≥ 60

This category includes rural principal arterials (other than Interstates), minor arterials, major and minor collectors, and local roads (Functional Class 2, 6, 7, 8, and 9). Figure 46 to Figure 50 show the percentages of MUTs, SUTs, Trucks, and Autos, as well as Volume to Capcity Ratios for Non-Interstates with speed limit greater than or equal to 60 mph. For these road segments, autos contrubute to more than fifty percent of traffic flow. No critical volume to capacity ratios were observed between this group of road segments.

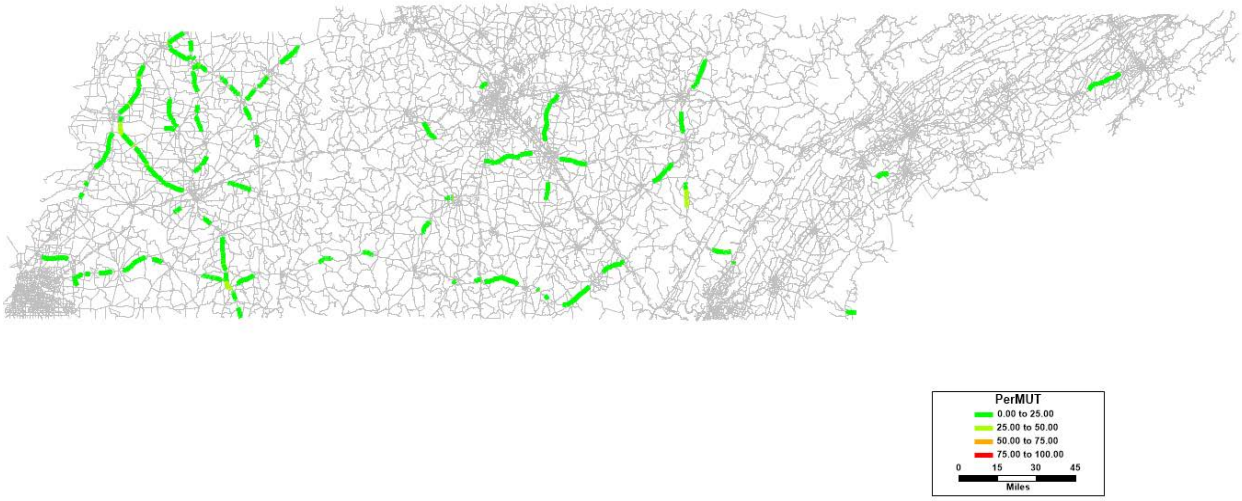

Figure 46: Percentage of MUTs for Non-Interstate Rural Roads with Speed Limit greater than or equal to 60 mph (2010)

Figure 47: Percentage of SUTs for Non-Interstate Rural Roads with Speed Limit greater than or equal to 60 mph (2010)

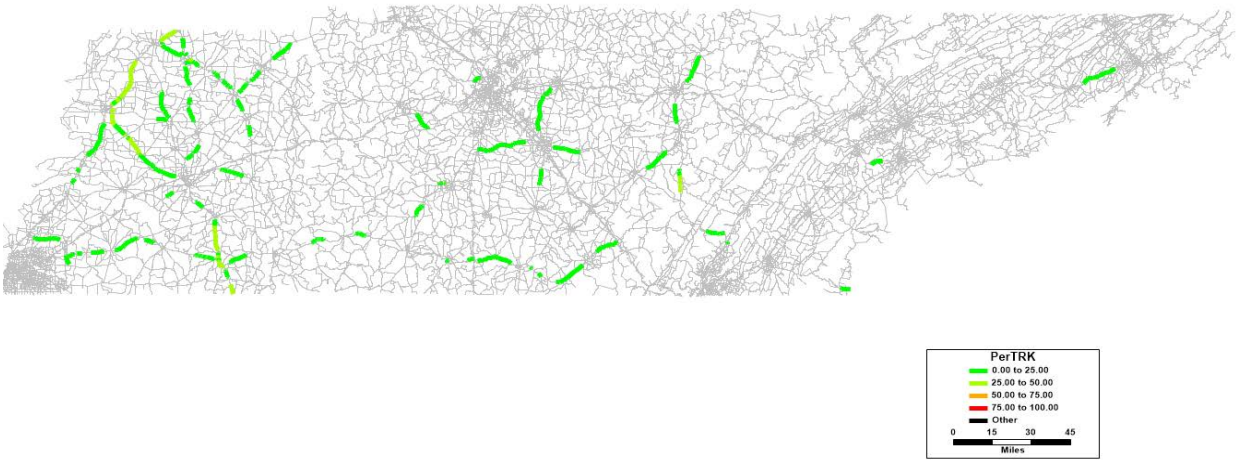

Figure 48: Percentage of Trucks for Non-Interstate Rural Roads with Speed Limit greater than or equal to 60 mph (2010)

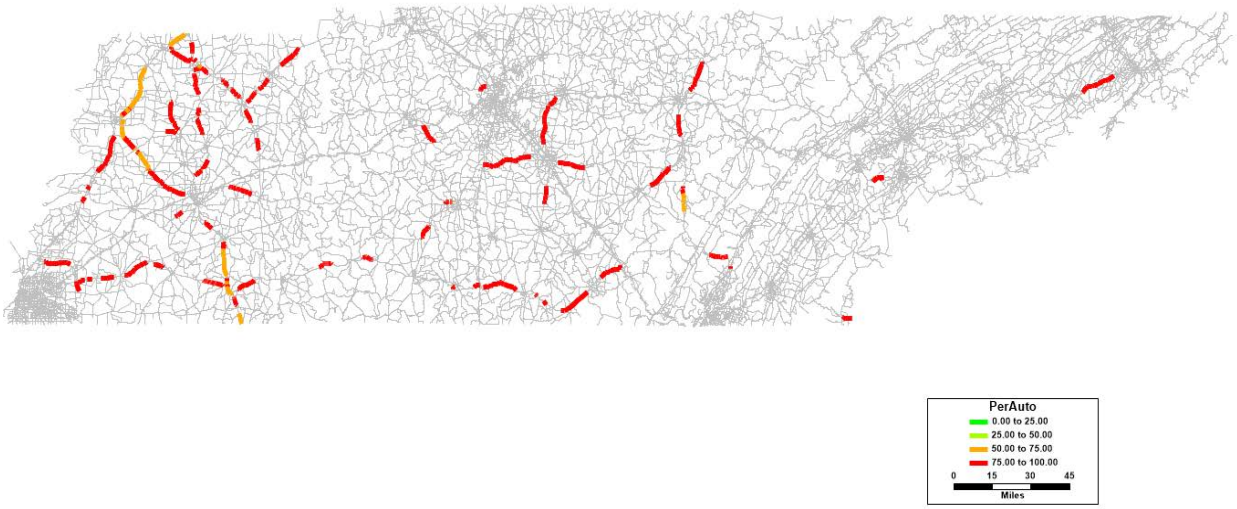

Figure 49: Percentage of Autos for Non-Interstate Rural Roads with Speed Limit greater than or equal to 60 mph (2010)

Figure 50: Volume to Capacity Ratio for Non-Interstate Rural Roads with Speed Limit greater than or equal to 60 mph (2010)

Non-Interstate – Rural – 40 ≤ Speed Limit < 60

As shown in Figure 51 to Figure 55, in most Non-Interstate road segments with speed limit between 40 and 60 mph, the percentage of autos driving on roads is more than percentage of trucks. However, some segments exhibited higher percentage of trucks mostly because of high number of SUTs on those roads. Volume to capacity ratios seem not to be critical for this group of road segments.

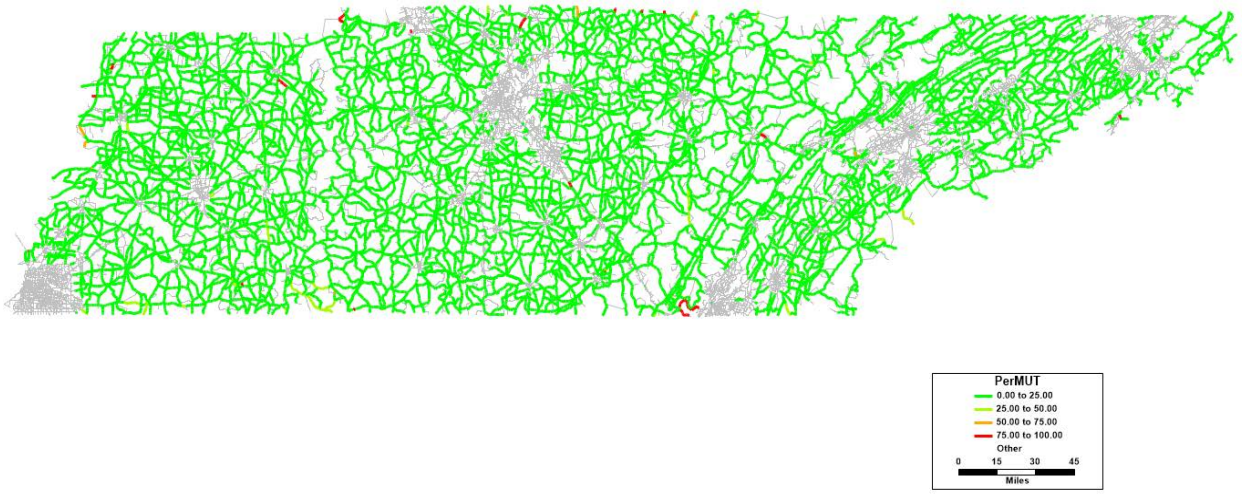

Figure 51: Percentage of MUTs for Non-Interstate Rural Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2010)

Figure 52: Percentage of SUTs for Non-Interstate Rural Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2010)

Figure 53: Percentage of Trucks for Non-Interstate Rural Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2010)

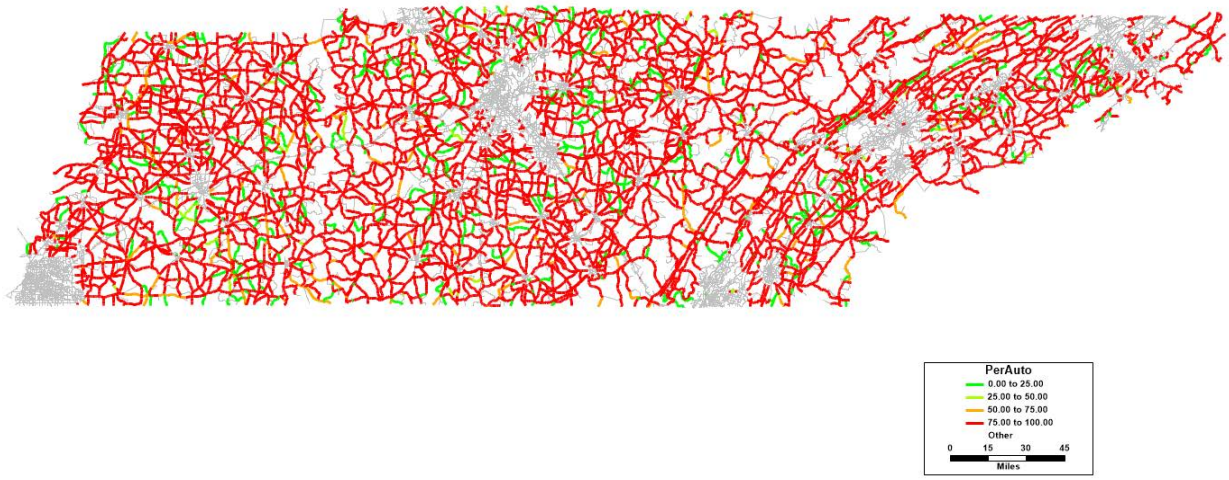

Figure 54: Percentage of Autos for Non-Interstate Rural Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2010)

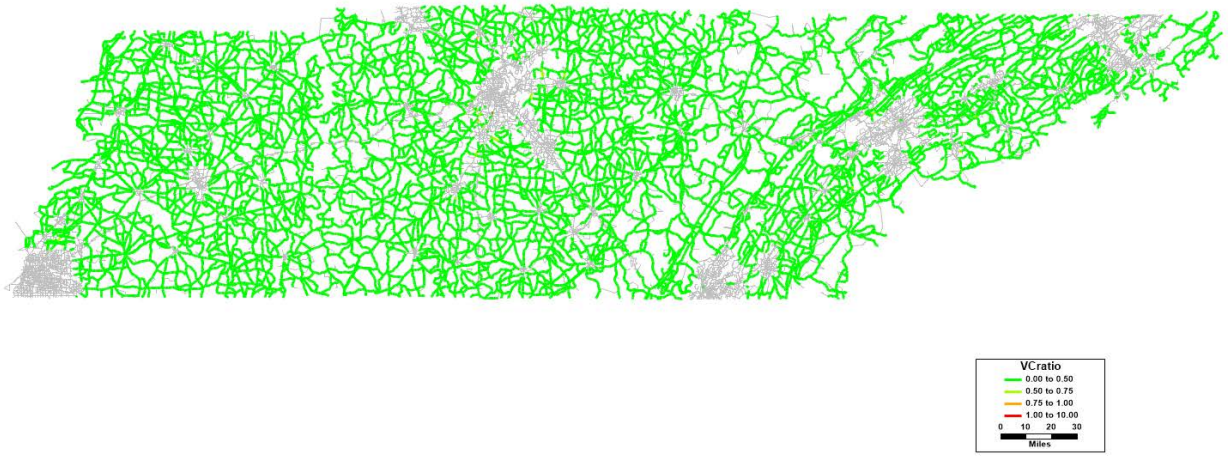

Figure 55: Volume to Capacity Ratio for Non-Interstate Rural Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2010)

Non-Interstate – Rural – Speed Limit < 40

Figure 56 to Figure 60 show the percentages of MUTs, SUTs, Trucks, and Autos, as well as Volume to Capcity Ratios for Non-Interstates with speed limit less 40 mph. Again, the autos are the main contibuters to traffic flow on these roads. However, some segments exhibited higher percentage of trucks mostly because of high number of SUTs on those roads. No critical volume to capacity ratios were observed between this group of road segments.

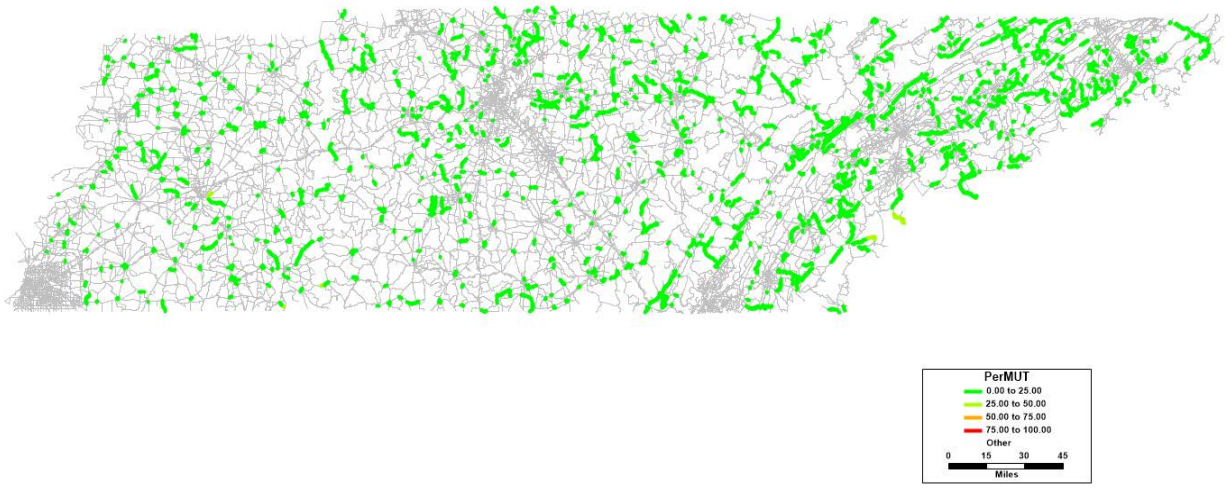

Figure 56: Percentage of MUTs for Non-Interstate Rural Roads with Speed Limit less than 40 mph (2010)

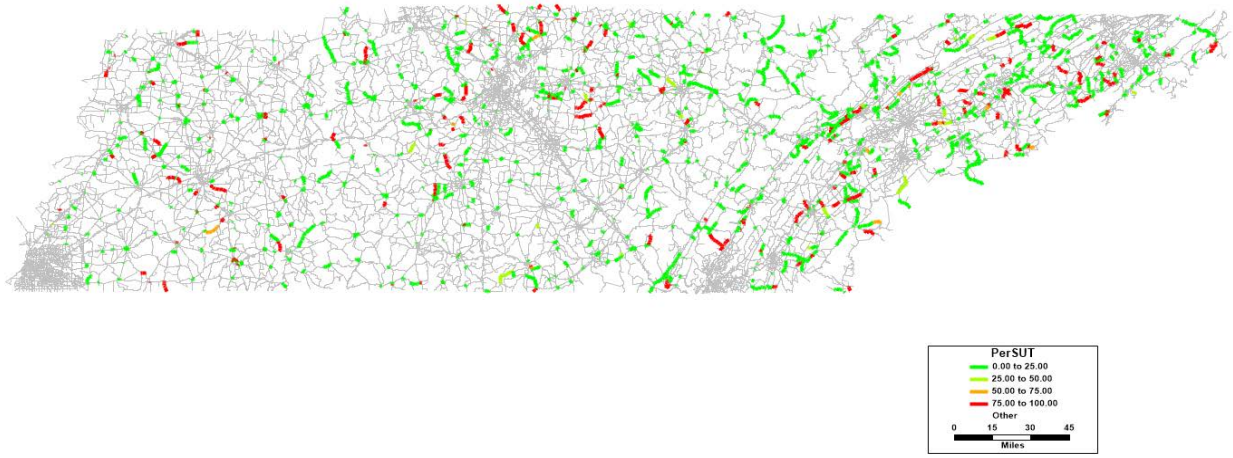

Figure 57: Percentage of SUTs for Non-Interstate Rural Roads with Speed Limit less than 40 mph (2010)

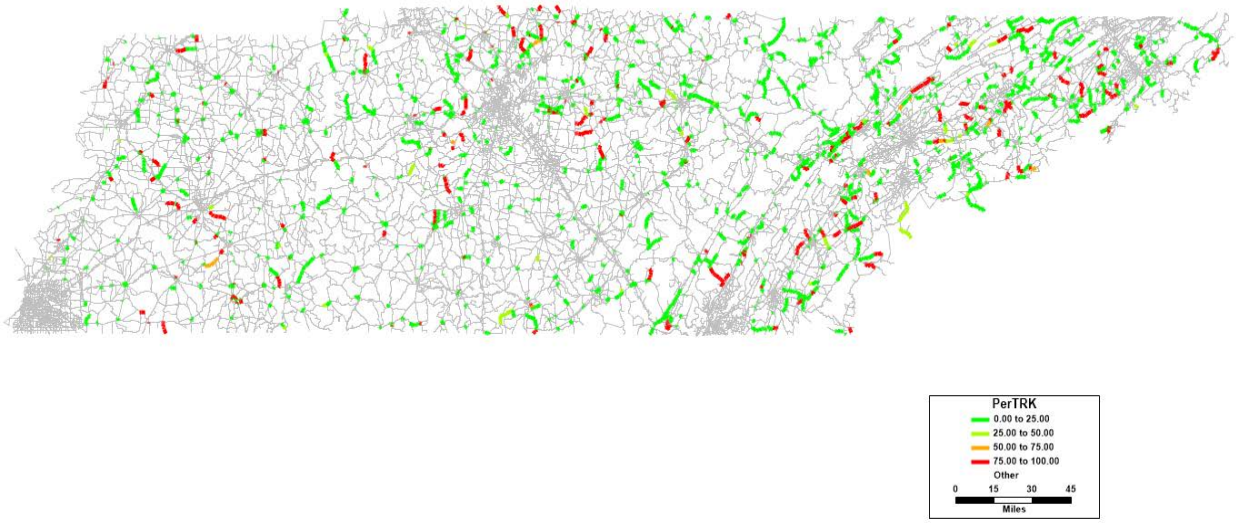

Figure 58: Percentage of Trucks for Non-Interstate Rural Roads with Speed Limit less than 40 mph (2010)

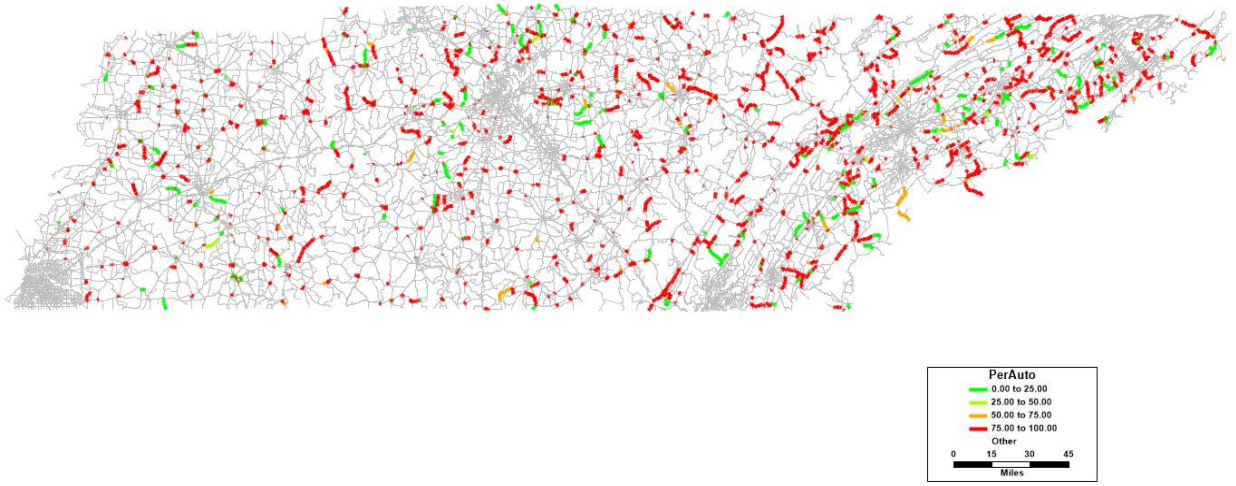

Figure 59: Percentage of Autos for Non-Interstate Rural Roads with Speed Limit less than 40 mph (2010)

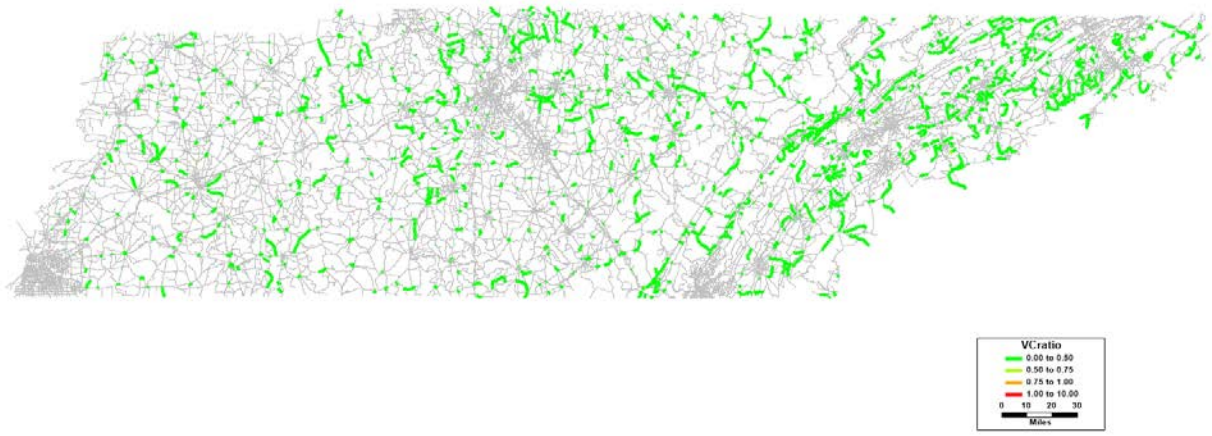

Figure 60: Volume to Capacity Ratio for Non-Interstate Rural Roads with Speed Limit less than 40 mph (2010)

Non-Interstate – Urban – Speed Limit ≥ 60

This category includes urban principal arterials (other than Interstates), minor arterials, collectors, and local roads (Functional Class 12, 14, 16, 17, and 19). Figure 61 to Figure 65 show the percentages of MUTs, SUTs, Trucks, and Autos, as well as Volume to Capcity Ratios for Non-Interstates with speed limit greater than or equal to 60 mph. The number of such road segments in Tennesse are limited. For these road segments, autos contribute to more than fifty percent of traffic flow. No critical volume to capacity ratios were observed between this group of road segments.

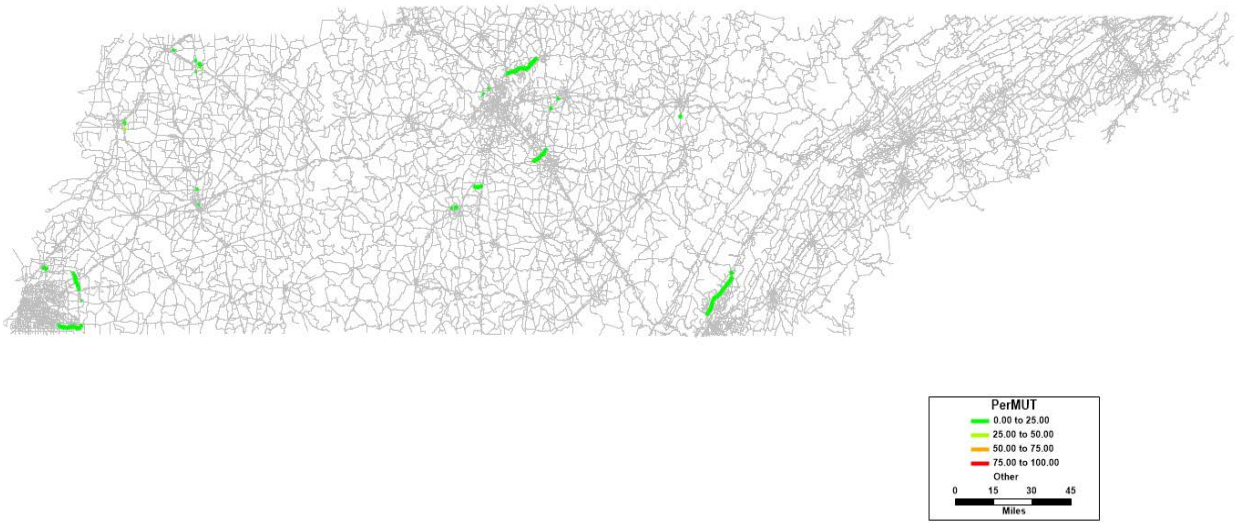

Figure 61: Percentage of MUTs for Non-Interstate Urban Roads with Speed Limit greater than or equal to 60 mph (2010)

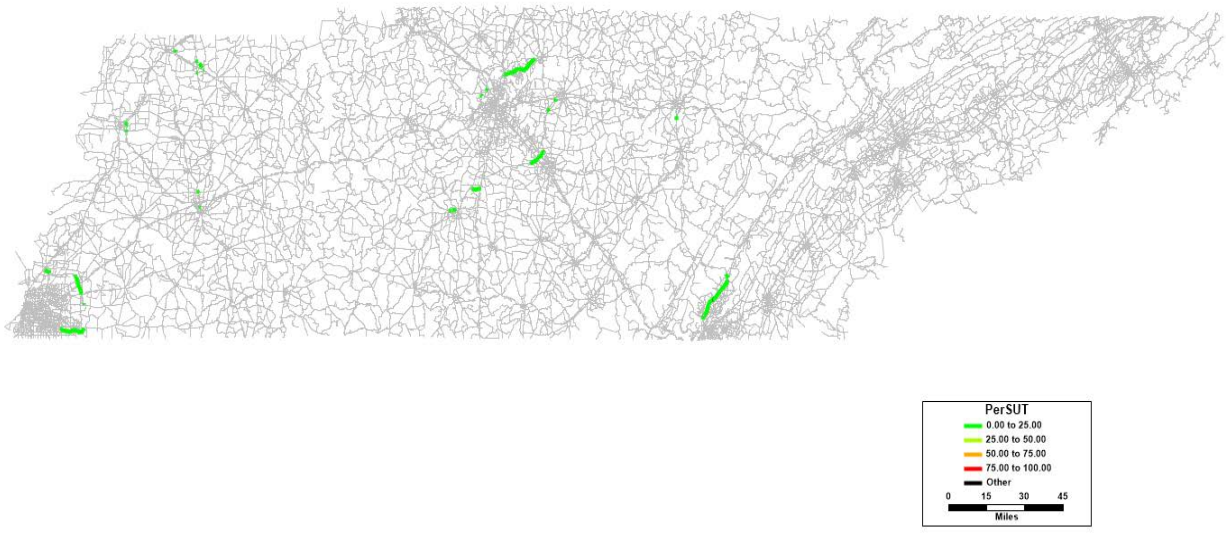

Figure 62: Percentage of SUTs for Non-Interstate Urban Roads with Speed Limit greater than or equal to 60 mph (2010)

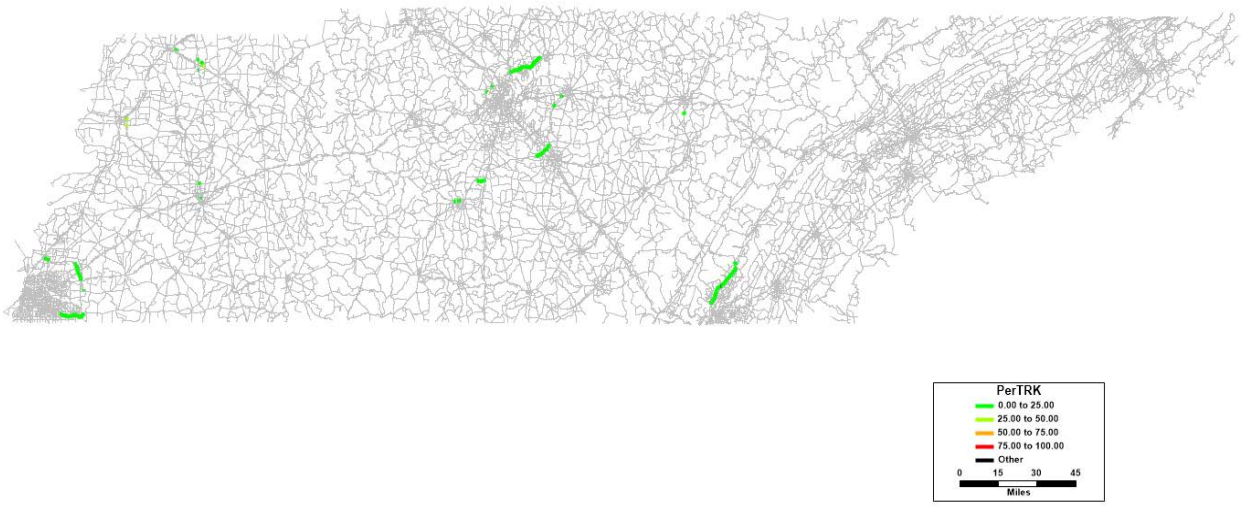

Figure 63: Percentage of Trucks for Non-Interstate Urban Roads with Speed Limit greater than or equal to 60 mph (2010)

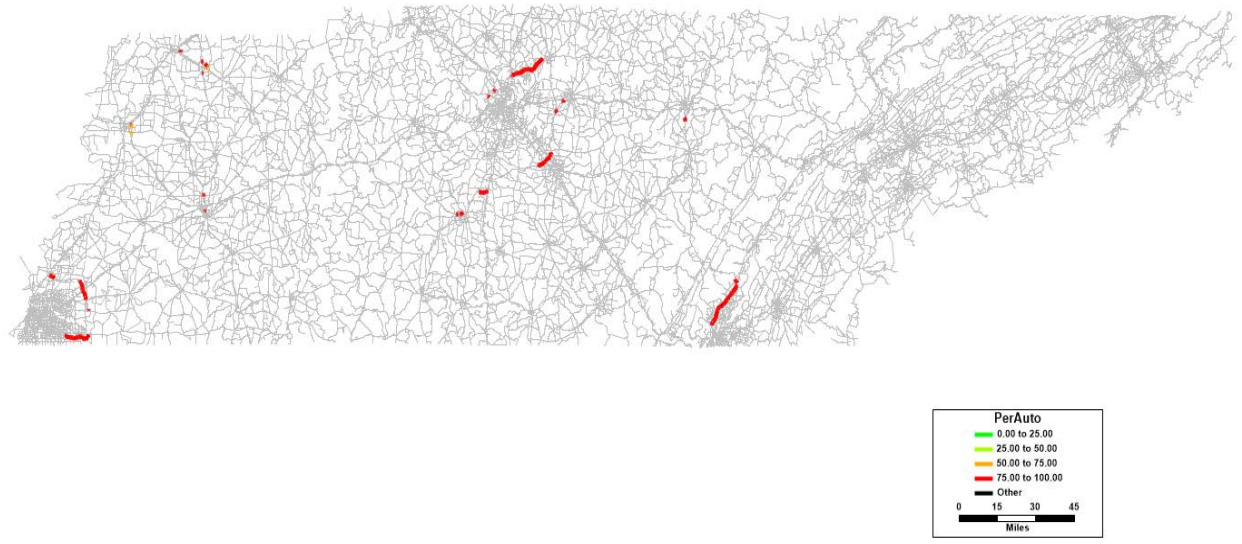

Figure 64: Percentage of Autos for Non-Interstate Urban Roads with Speed Limit greater than or equal to 60 mph (2010)

Figure 65: Volume to Capacity Ratio for Non-Interstate Urban Roads with Speed Limit greater than or equal to 60 mph (2010)

Non- Interstate – Urban – 40 ≤ Speed Limit < 60

As shown in Figure 66 to Figure 70, in most Non-Interstate road segments with speed limit between 40 and 60 mph, the percentage of autos driving on roads is more than percentage of trucks. However, some segments exhibited higher percentage of trucks mostly because of high number of SUTs on those roads. Volume to capacity ratios seem not to be critical for this group of road segments.

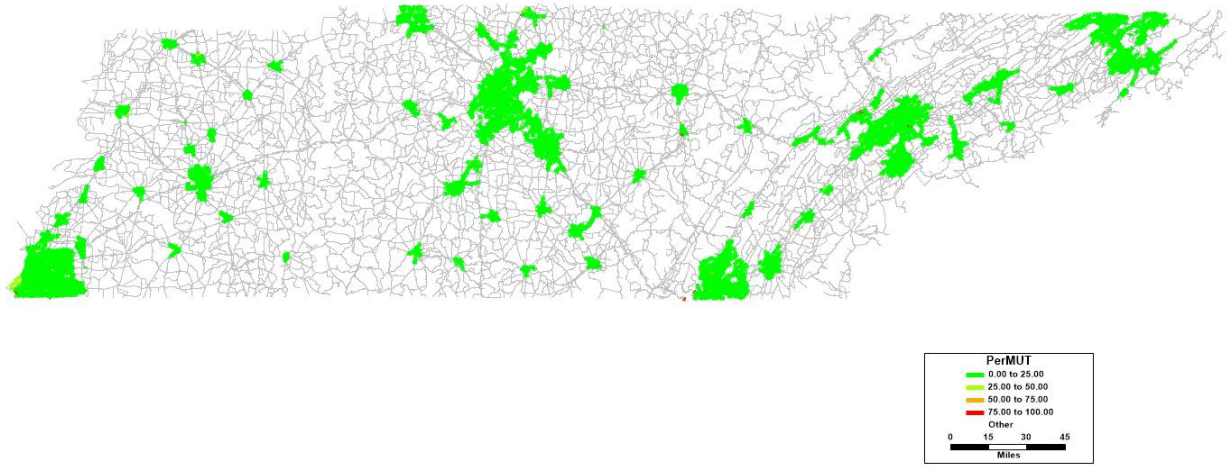

Figure 66: Percentage of MUTs for Non-Interstate Urban Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2010)

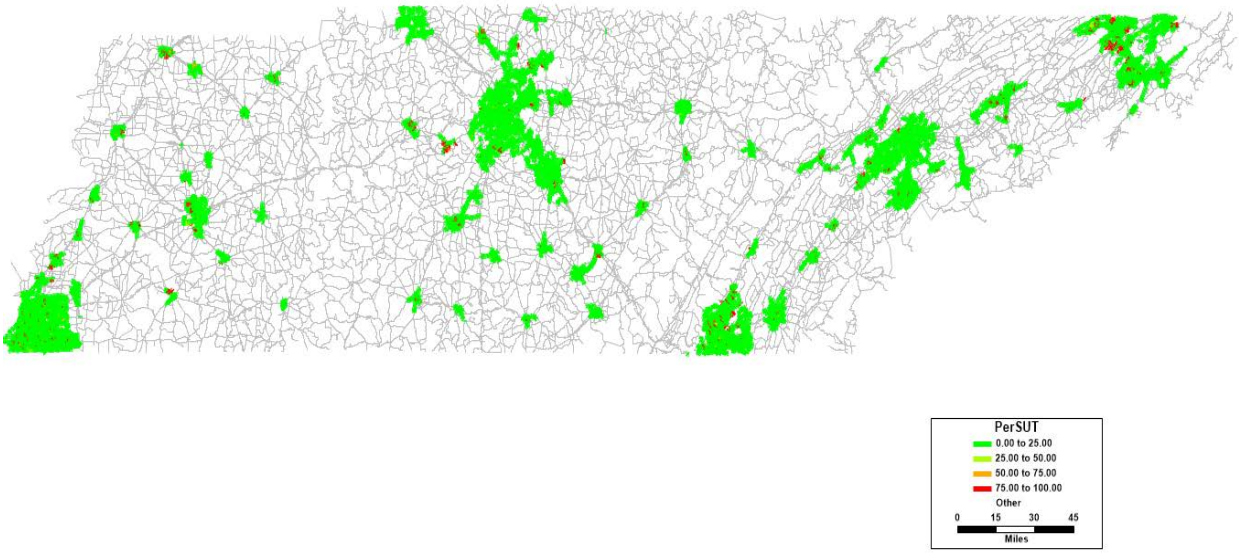

Figure 67: Percentage of SUTs for Non-Interstate Urban Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2010)

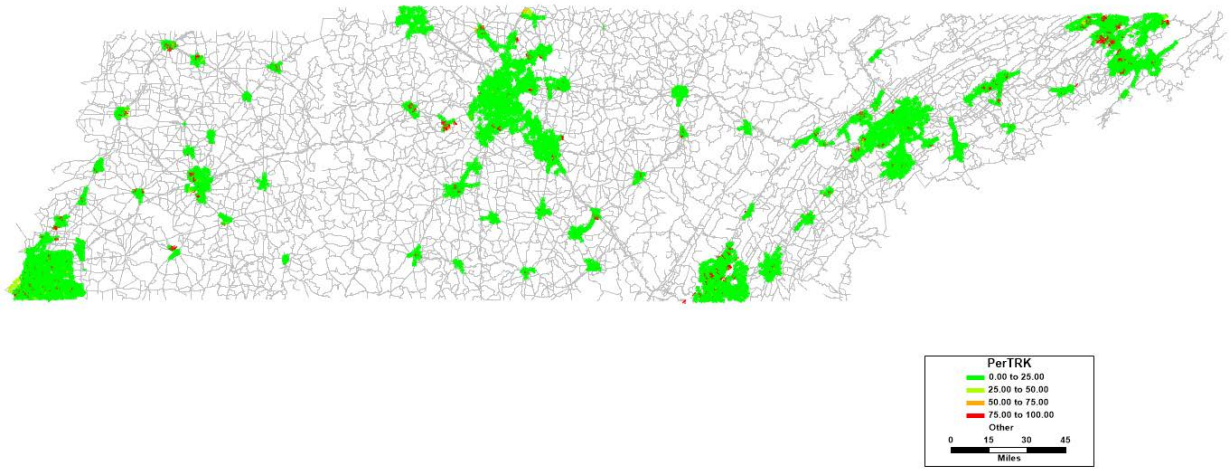

Figure 68: Percentage of Trucks for Non-Interstate Urban Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2010)

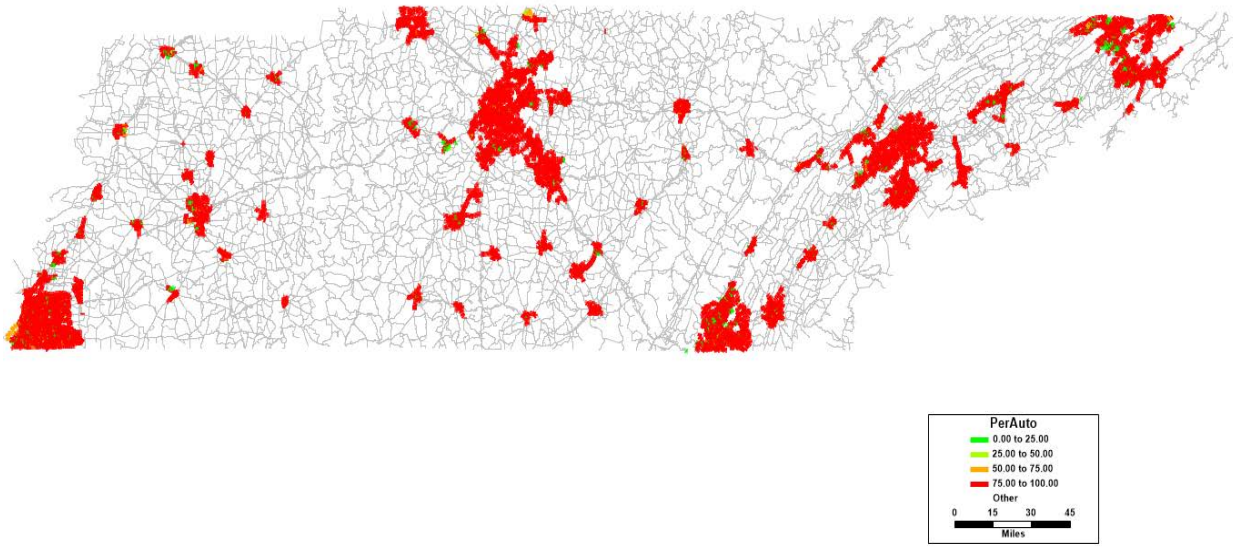

Figure 69: Percentage of Autos for Non-Interstate Urban Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2010)

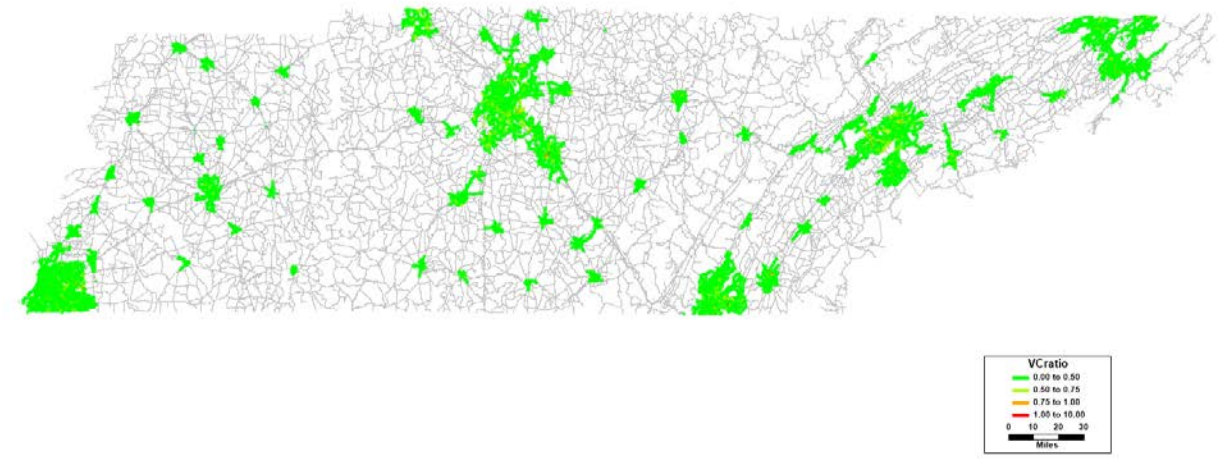

Figure 70: Volume to Capacity Ratio for Non-Interstate Urban Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2010)

Non- Interstate – Urban – Speed Limit < 40

Figure 71 to Figure 75 show the percentages of MUTs, SUTs, Trucks, and Autos, as well as Volume to Capcity Ratios for Non-Interstates with speed limit less 40 mph. Again, the autos are the main contibuters to traffic flow on these roads. However, some segments exhibited higher percentage of trucks mostly because of high number of SUTs on those roads. No critical volume to capacity ratios were observed between this group of road segments.

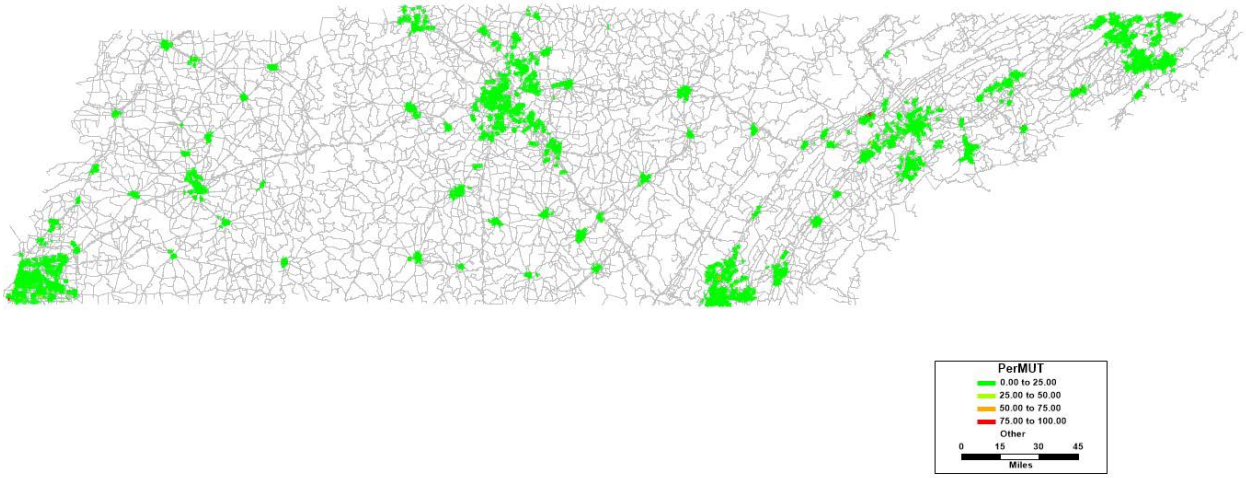

Figure 71: Percentage of MUTs for Non-Interstate Urban Roads with Speed Limit less than 40 mph (2010)

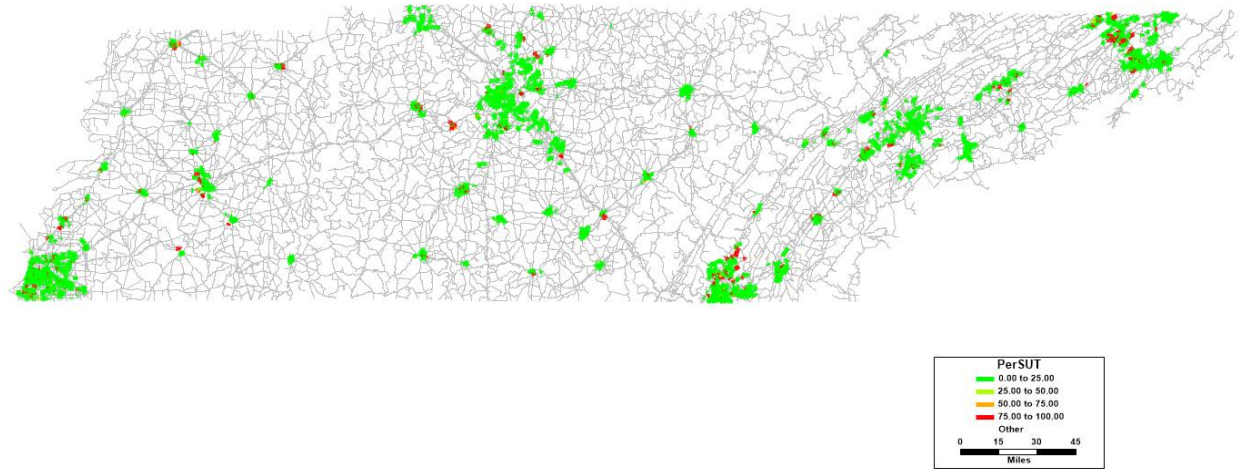

Figure 72: Percentage of SUTs for Non-Interstate Urban Roads with Speed Limit less than 40 mph (2010)

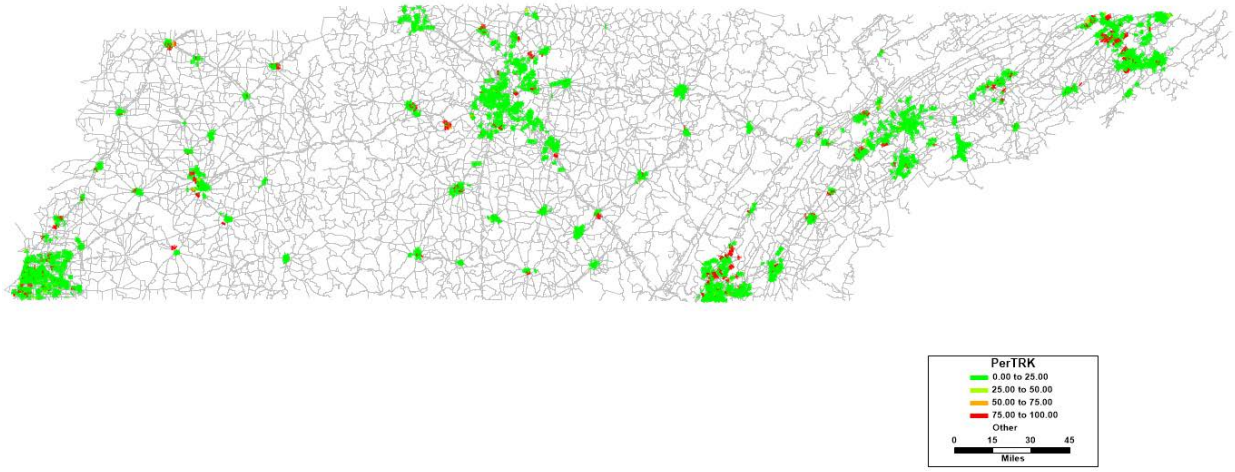

Figure 73: Percentage of Trucks for Non-Interstate Urban Roads with Speed Limit less than 40 mph (2010)

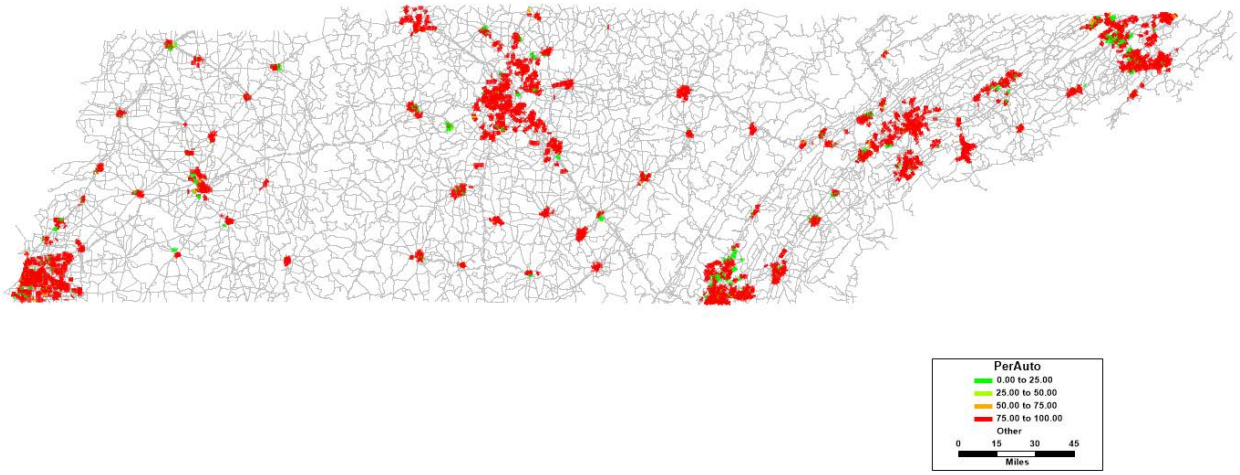

Figure 74: Percentage of Autos for Non-Interstate Urban Roads with Speed Limit less than 40 mph (2010)

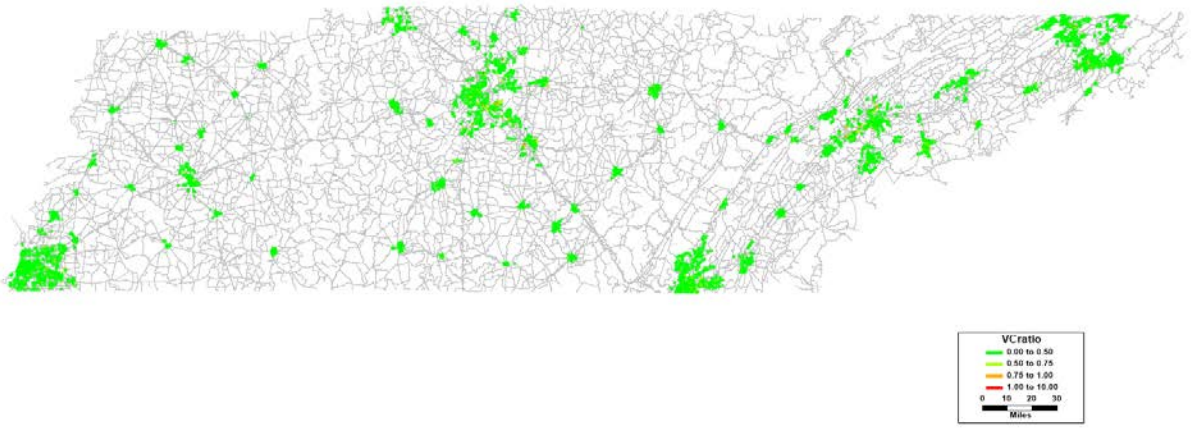

Figure 75: Volume to Capacity Ratio for Non-Interstate Urban Roads with Speed Limit less than 40 mph (2010)

Ramps and Roundabouts

We also created maps of the percentages of MUTs, SUTs, Trucks, and Autos, as well as Volume to Capcity Ratios for ramps and roundabouts (functional class 10, 20, 91, and 92). Again, the autos are the main contibuters to traffic flow on ramps and roundabouts. However, some of them exhibited higher percentage of trucks than autos as can be seen in Figure 76 to Figure 79. Almost no critical V/C ratios were observed on ramps and roundabouts (Figure 80).

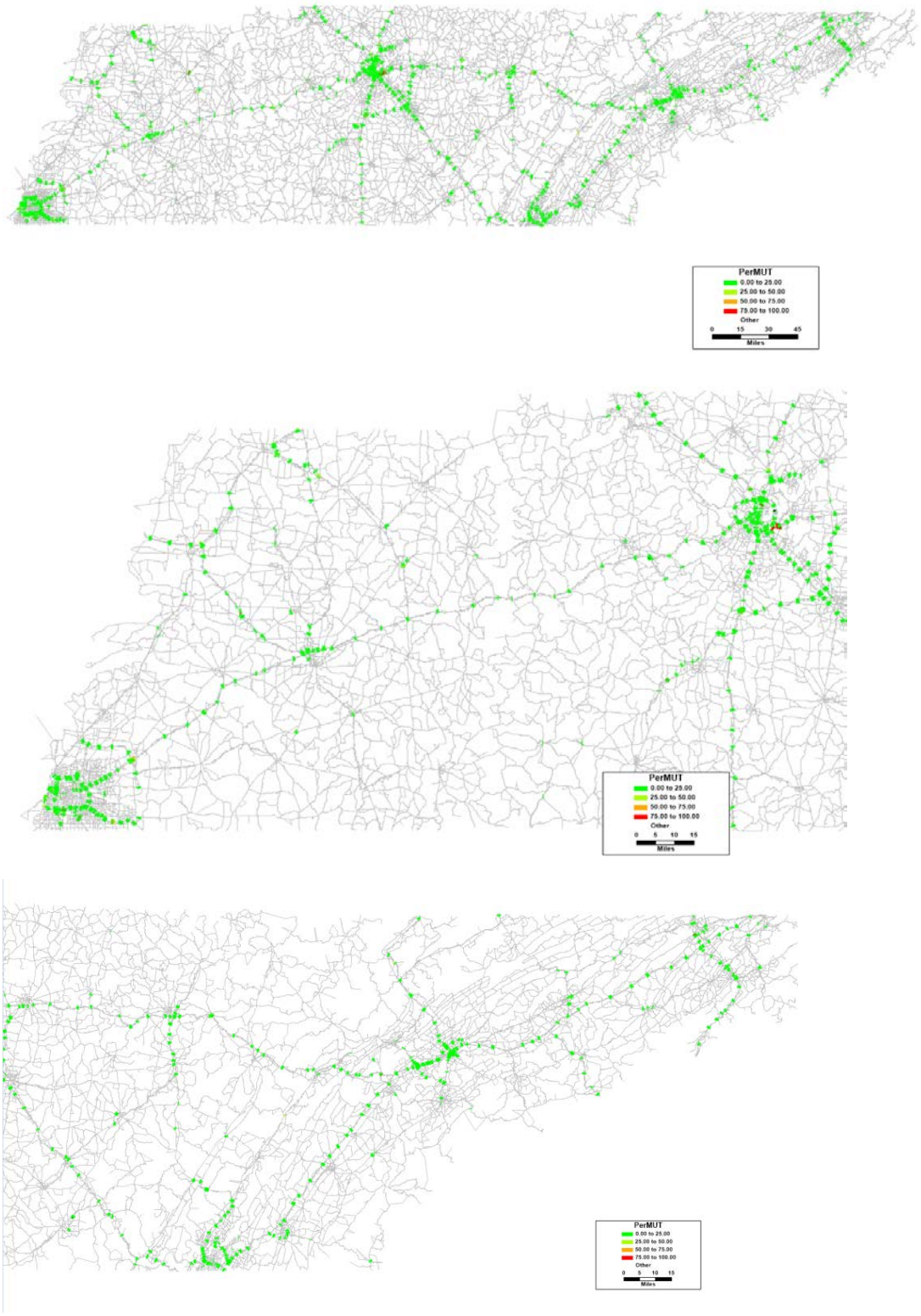

Figure 76: Percentage of MUTs for Ramps and Roundabouts (2010)

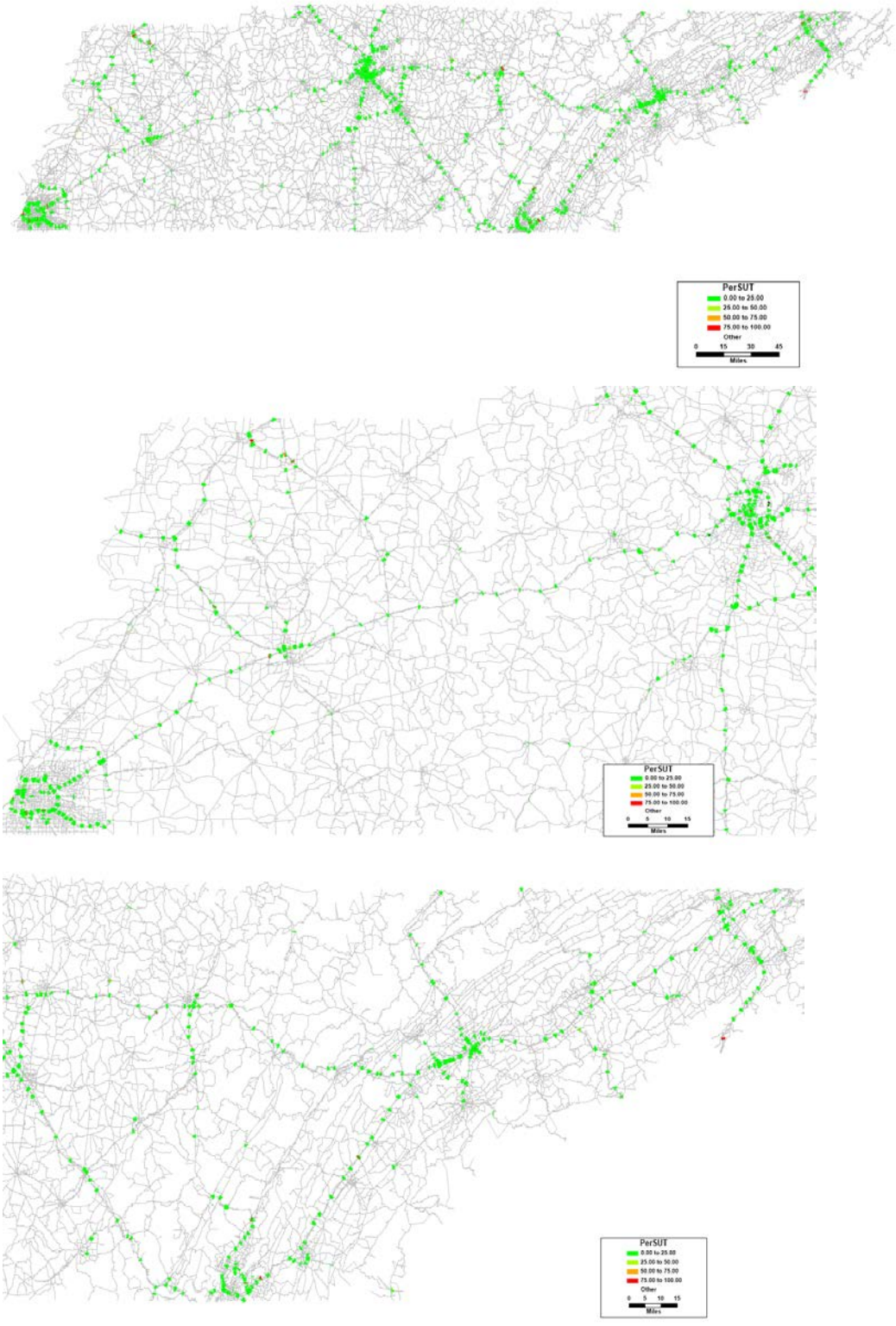

Figure 77: Percentage of SUTs for Ramps and Roundabouts (2010)

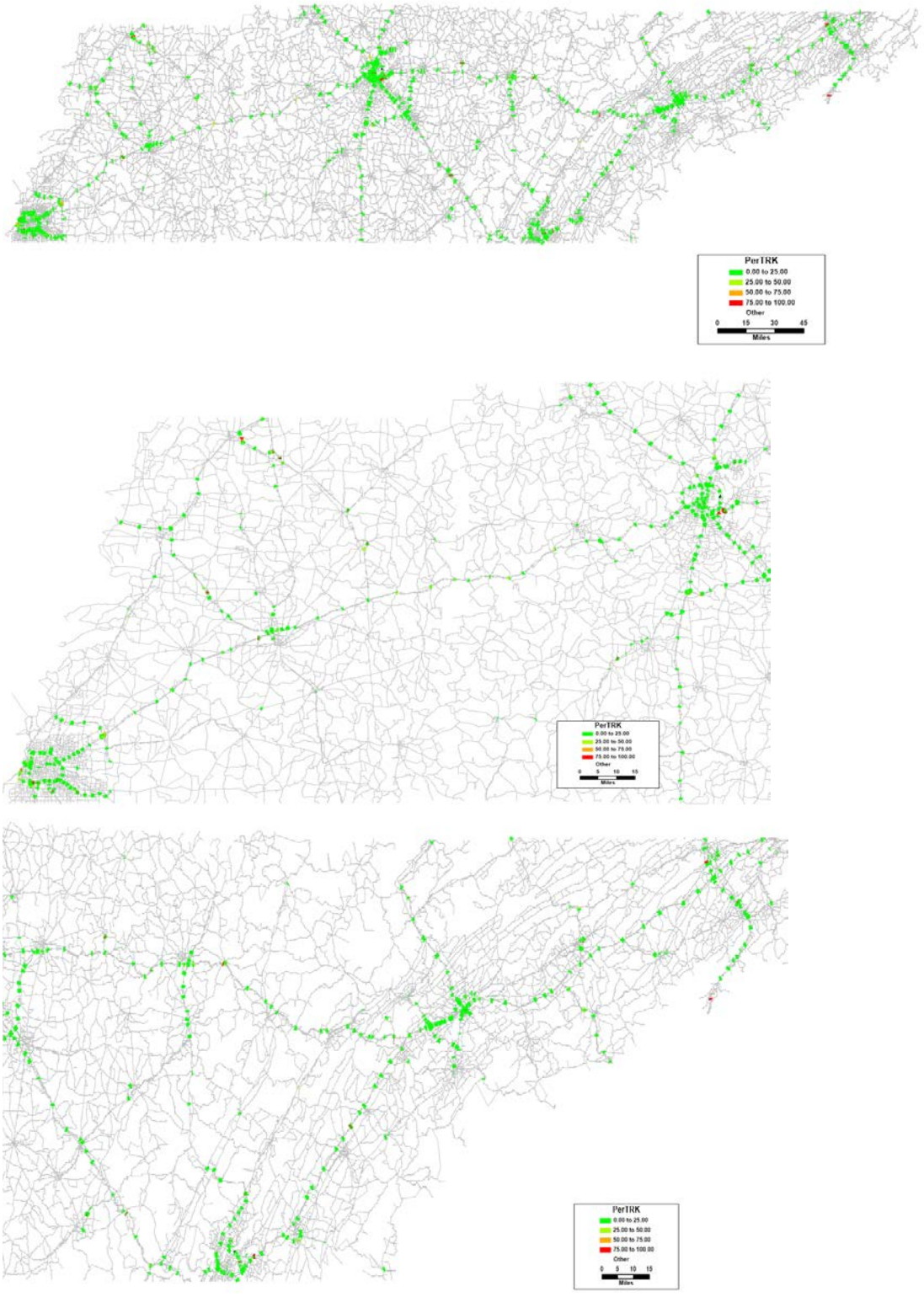

Figure 78: Percentage of Trucks for Ramps and Roundabouts (2010)

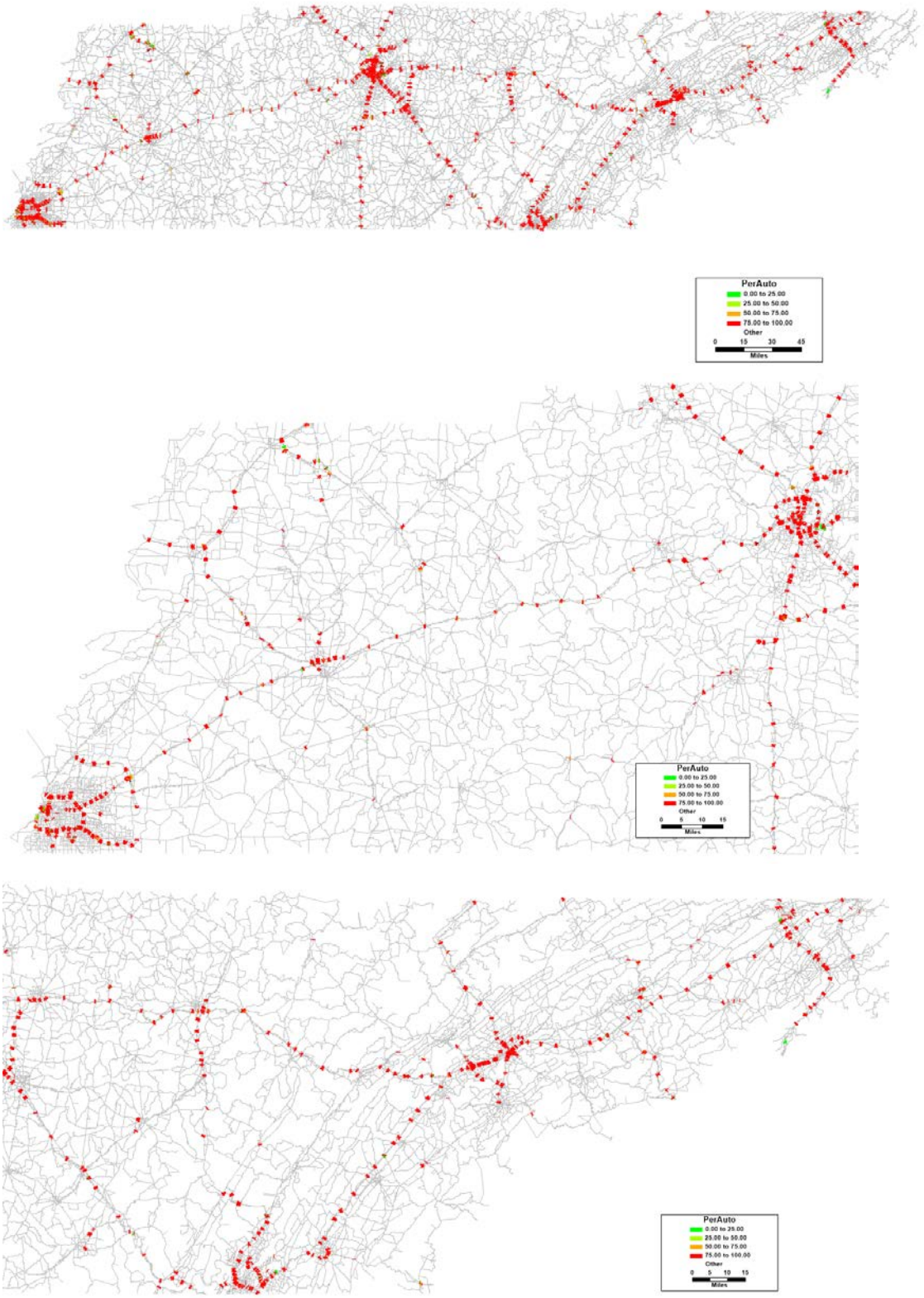

Figure 79: Percentage of Autos for Ramps and Roundabouts (2010)

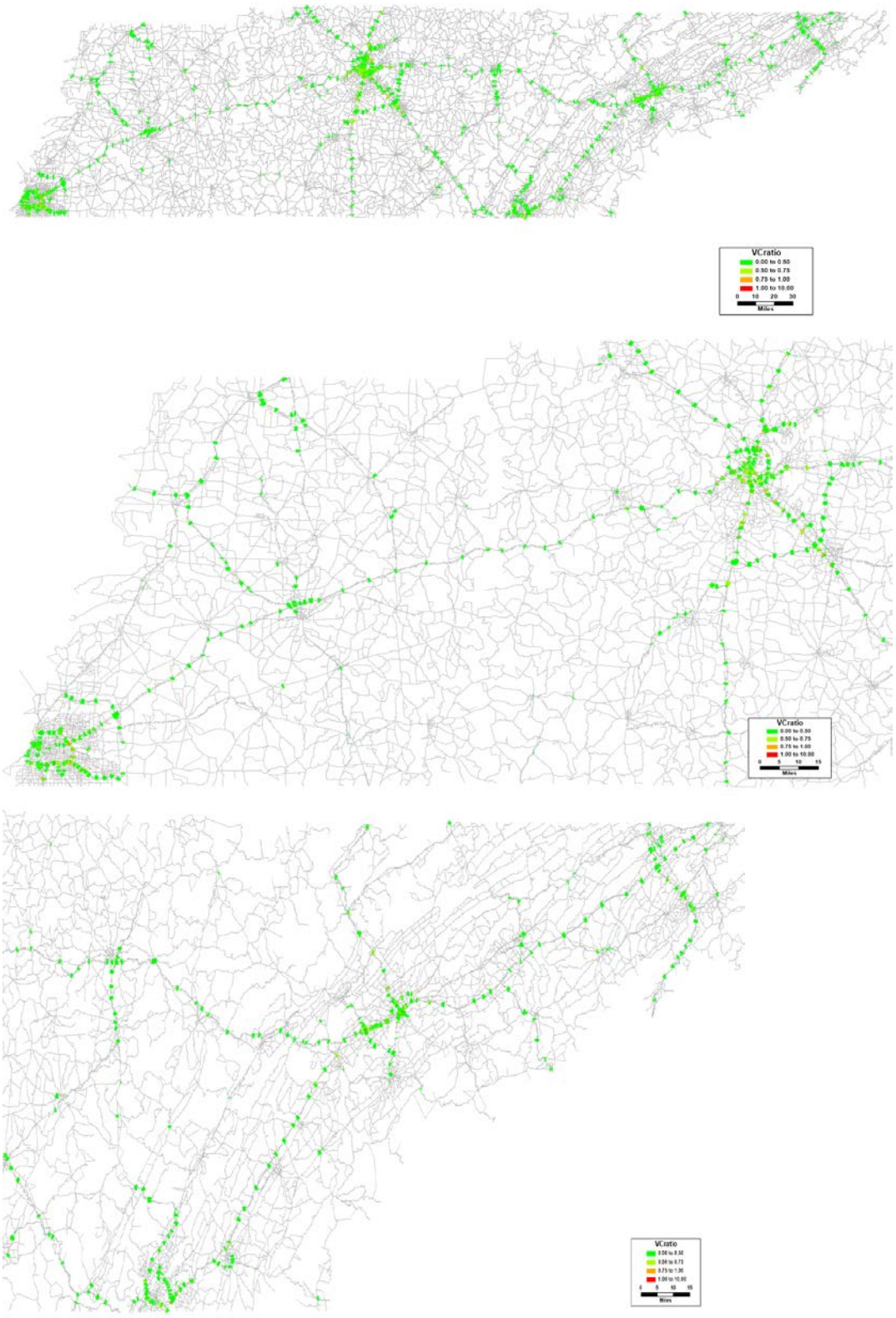

Figure 80: Volume to Capacity Ratio for Ramps and Roundabouts (2010)

TSM OUTPUT 2040

The results obtained from running TSM for the future year are shown in the following sub-sections. As ame as 2010 results, the road segments were categorized with respect to their functional class and posted speed limit. Figure 81 to Figure 84 present traffic flow on roadways in Tennssee by vehicle type (MUT, SUT, Auto, and Total Flow).

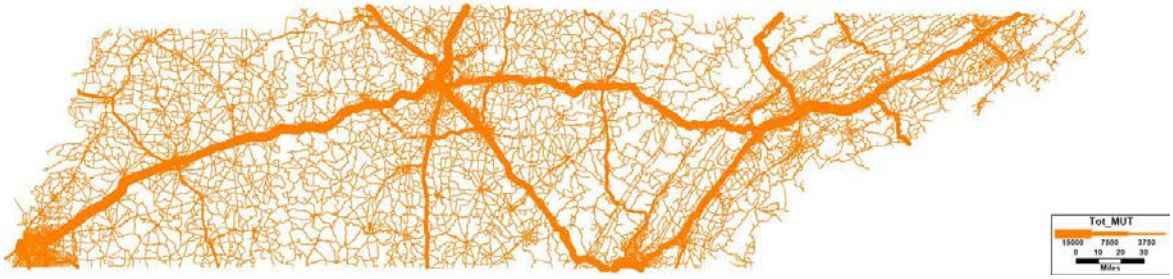

Figure 81: MUT's traffic volume on Tennessee's roads (2040)

Figure 82: SUT's traffic volume on Tennessee's roads (2040)

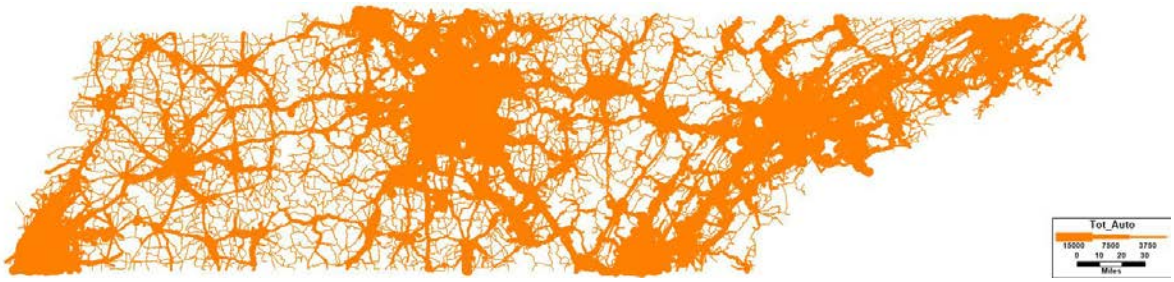

Figure 83: Auto's traffic volume on Tennessee's roads (2040)

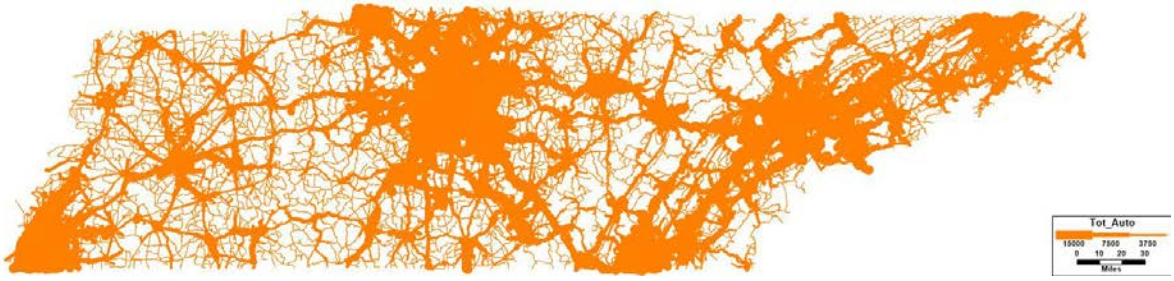

Figure 84: Total traffic volume on Tennessee's roads (2040)

Figure 85 to Figure 88 show the percentage of MUTs, SUTs, Trcuks, and Autos on Tennessee's roads in 2040, resepectively. Also, Figure 89 to Figure 91 demonstrate the Volume to Capacity ratios on the road segments for Daily, AM Peak, and PM Peak hours. The rest of this section discusses the rsults in more-details. As mentioned earlier, the road segments were categorized with respect to their functional class and posted speed limit.

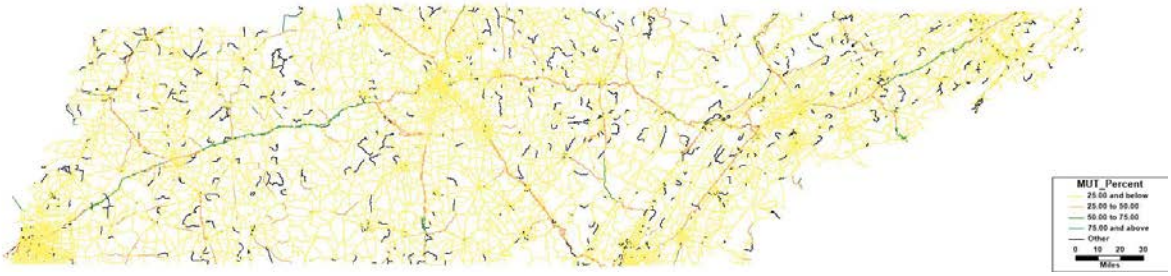

Figure 85: Percentage of MUTs for Tennessee's roads (2040)

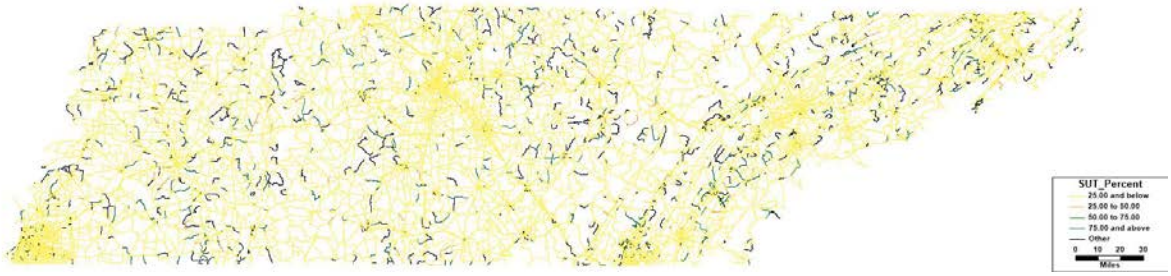

Figure 86: Percentage of SUTs for Tennessee's roads (2040)

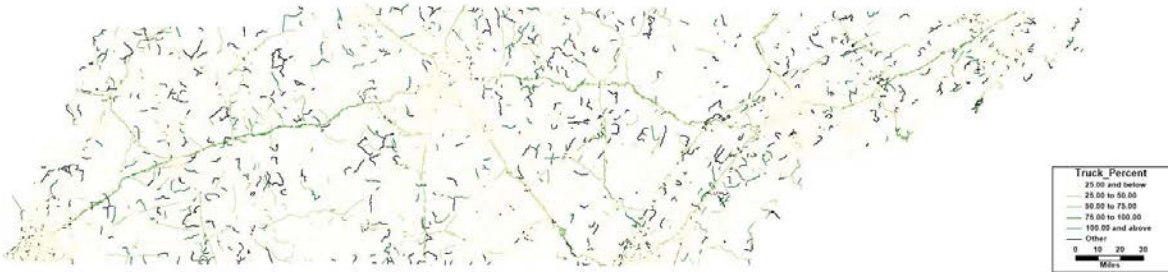

Figure 87: Percentage of Trucks for Tennessee's roads (2040)

Figure 88: Percentage of Autos for Tennessee's roads (2040)

Figure 89: Daily Volume to Capacity Ratio for Tennessee's roads (2040)

Figure 90: AM Peak Volume to Capacity Ratio for Tennessee's roads (2040)

Figure 91: PM Peak Volume to Capacity Ratio for Tennessee's roads (2040)

Interstate – Speed Limit ≥ 65

Figure 92 to Figure 96 show the percentages of MUTs, SUTs, Trucks, and Autos, as well as Volume to Capcity Ratios for Interstates with speed limit greater than or equl to 65 mph in 2040. The results obtained from running TSM for the future year daily scenario. The number of road segments experiencing a higher percentage of trucks than autos are significant, specifically on I-40. Both MUTs and SUTs contrubite to this high truck volume. As shown in Figure 96, some segments of Interstates with speed limit greater than or equl to 65 mph experince V/C ratios close to one in 2040.

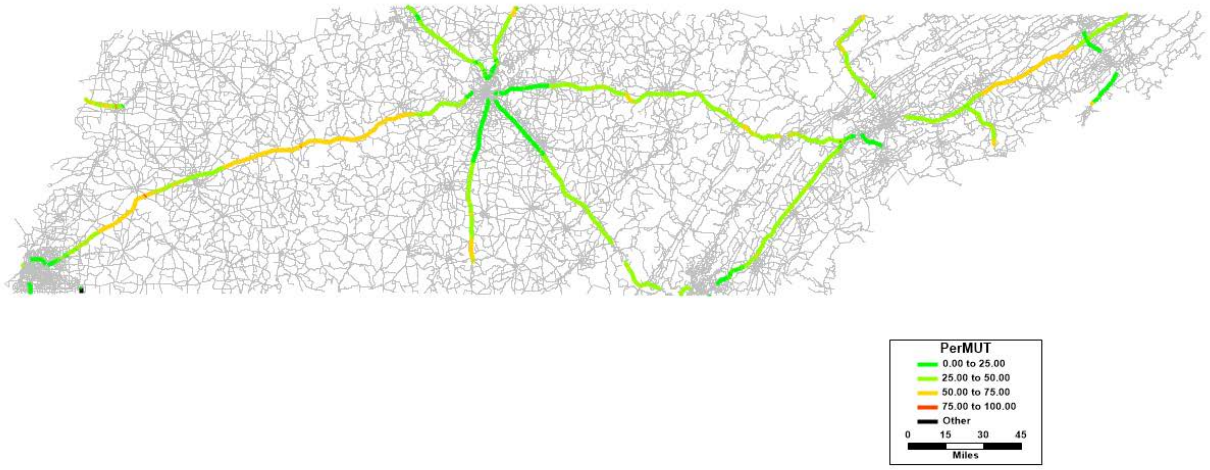

Figure 92: Percentage of MUTs for Interstates with Speed Limit greater than or equal to 65 mph (2040)

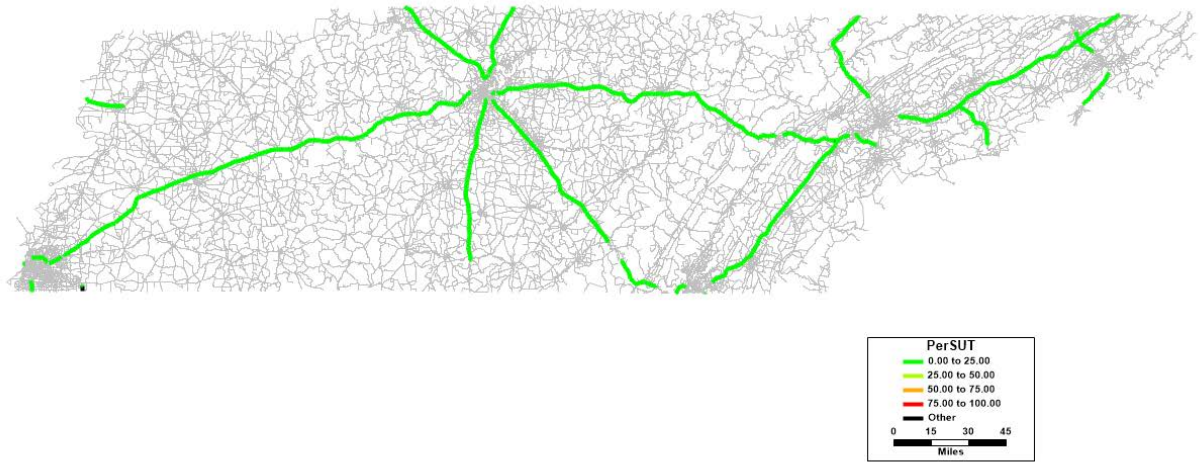

Figure 93: Percentage of SUTs for Interstates with Speed Limit greater than or equal to 65 mph (2040)

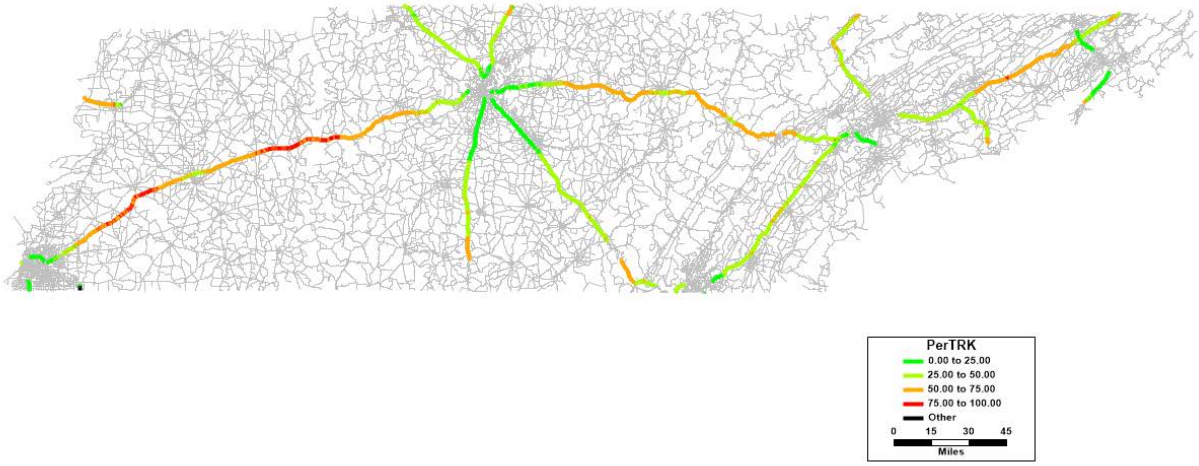

Figure 94: Percentage of Trucks for Interstates with Speed Limit greater than or equal to 65 mph (2040)

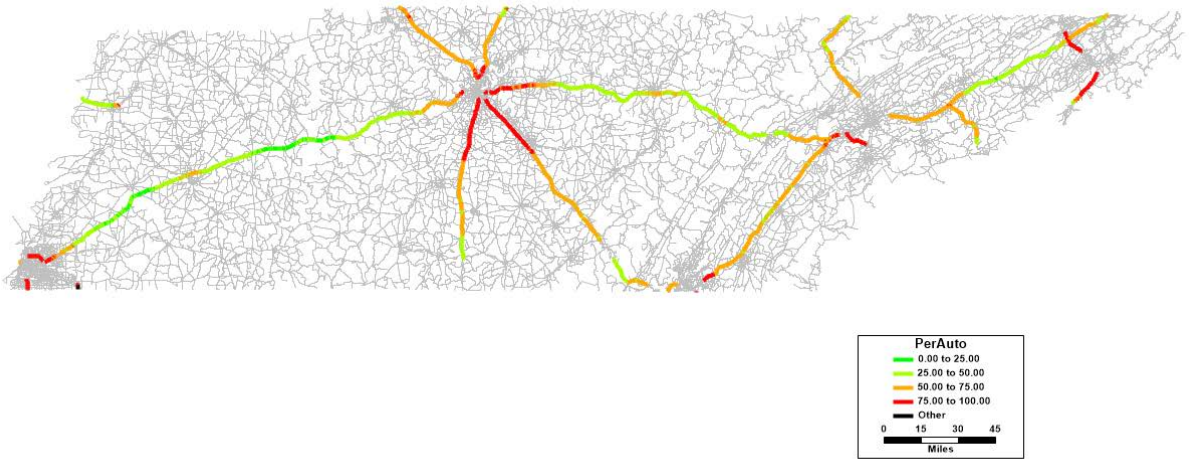

Figure 95: Percentage of Autos for Interstates with Speed Limit greater than or equal to 65 mph (2040)

Figure 96: Volume to Capacity Ratio for Interstates with Speed Limit greater than or equal to 65 mph (2040)

Interstate – Speed Limit < 65

Figure 97 to Figure 101 present the percentages of MUTs, SUTs, Trucks, and Autos, as well as Volume to Capcity Ratios for Interstates with speed limit less than 65 mph in 2040. In majority of road segments of Intestates with speed limit less than 65 mph, autos are the major contributer to traffic flow. Some segments of interstates also exhibited critical V/C ratios in 2040.

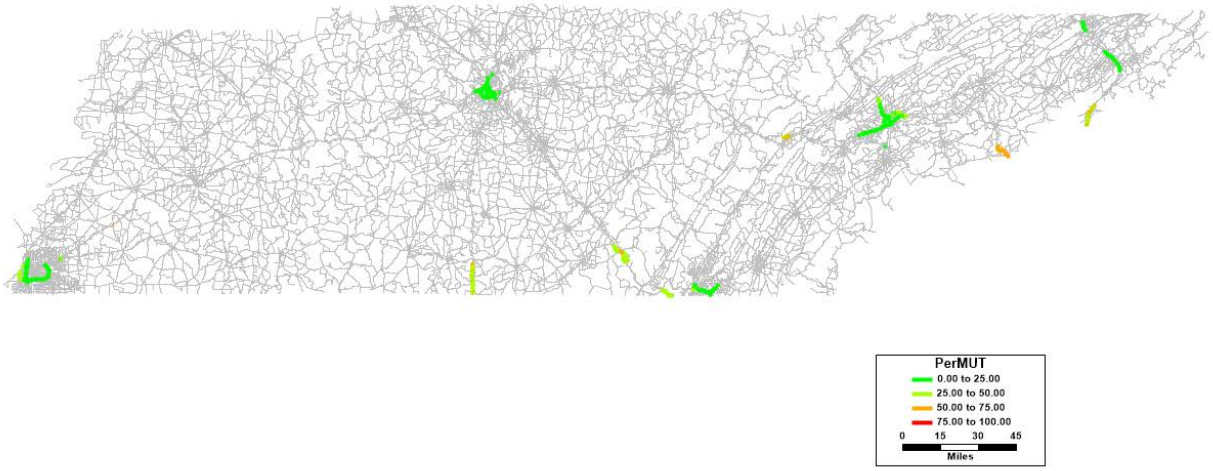

Figure 97: Percentage of MUTs for Interstates with Speed Limit less than 65 mph (2040)

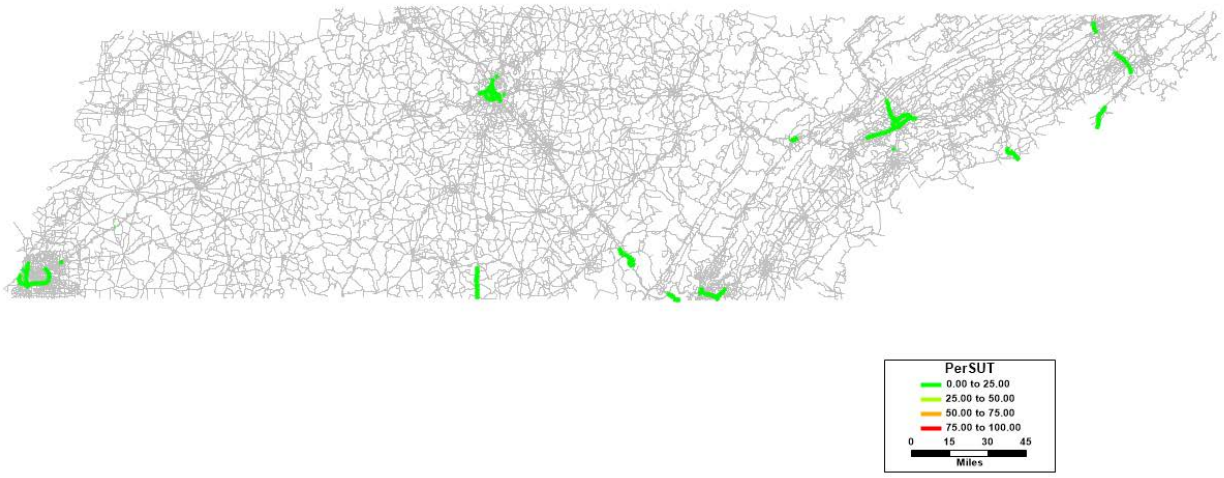

Figure 98: Percentage of SUTs for Interstates with Speed Limit less than 65 mph (2040)

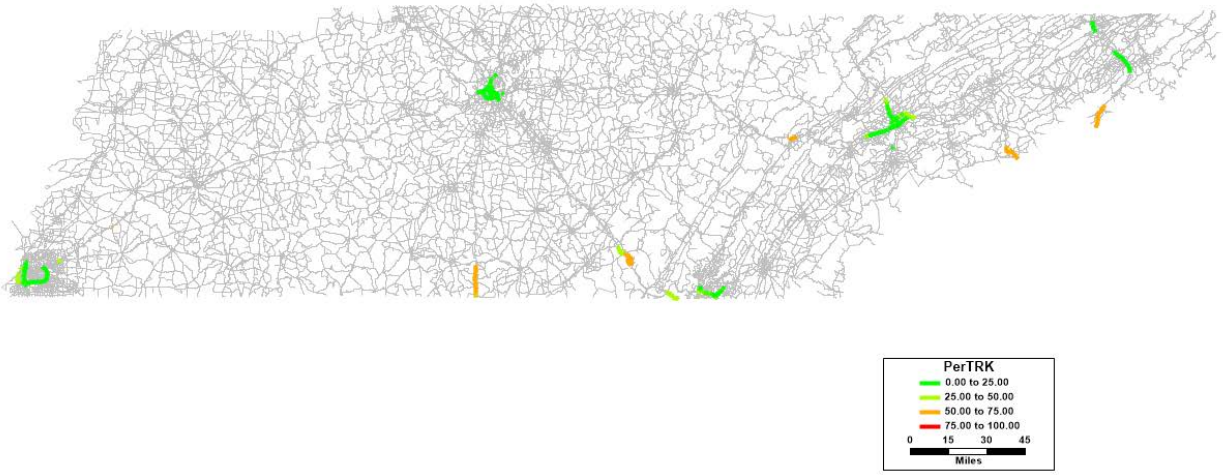

Figure 99: Percentage of Trucks for Interstates with Speed Limit less than 65 mph (2040)

Figure 100: Percentage of Autos for Interstates with Speed Limit less than 65 mph (2040)

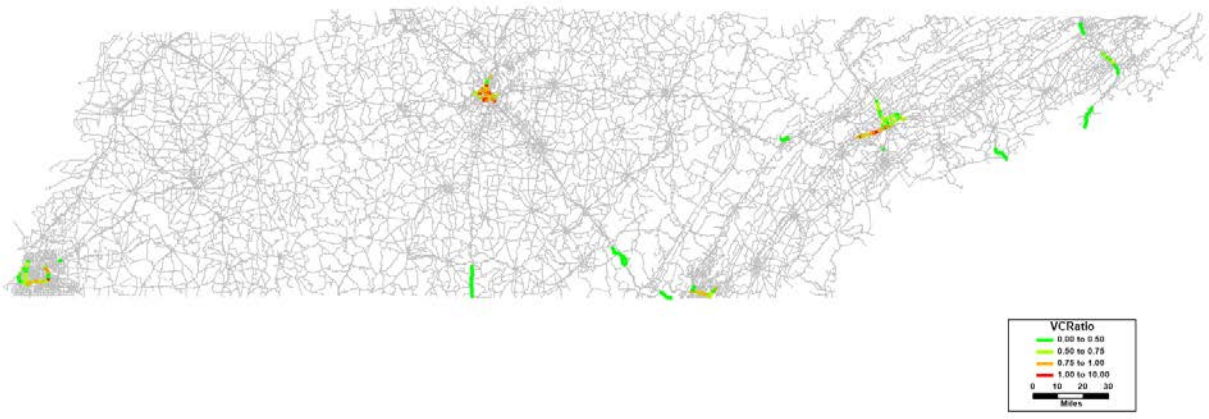

Figure 101: Volume to Capacity Ratio for Interstates with Speed Limit less than 65 mph (2040)

Non-Interstate – Rural – Speed Limit ≥ 60

Figure 102 to Figure 106 show the percentages of MUTs, SUTs, Trucks, and Autos, as well as Volume to Capcity Ratios for Non-Interstates with speed limit greater than or equal to 60 mph in 2040. For majority of these road segments, autos contribute to more than fifty percent of traffic flow. No critical volume to capacity ratios were observed between this group of road segments.

Figure 102: Percentage of MUTs for Non-Interstate Rural Roads with Speed Limit greater than or equal to 60 mph (2040)

Figure 103: Percentage of SUTs for Non-Interstate Rural Roads with Speed Limit greater than or equal to 60 mph (2040)

Figure 104: Percentage of Trucks for Non-Interstate Rural Roads with Speed Limit greater than or equal to 60 mph (2040)

Figure 105: Percentage of Autos for Non-Interstate Rural Roads with Speed Limit greater than or equal to 60 mph (2040)

Figure 106: Volume to Capacity Ratio for Non-Interstate Rural Roads with Speed Limit greater than or equal to 60 mph (2040)

Non-Interstate – Rural – 40 ≤ Speed Limit < 60

As shown in Figure 107 to Figure 111, in most Non-Interstate road segments with speed limit between 40 and 60 mph, the percentage of autos driving on roads is more than percentage of trucks. However, some segments exhibited higher percentage of trucks mostly because of high number of SUTs on those roads. Also, a few number of critical volume to capacity ratios were observed among this group of road segments.

Figure 107: Percentage of MUTs for Non-Interstate Rural Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2040)

Figure 108: Percentage of SUTs for Non-Interstate Rural Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2040)

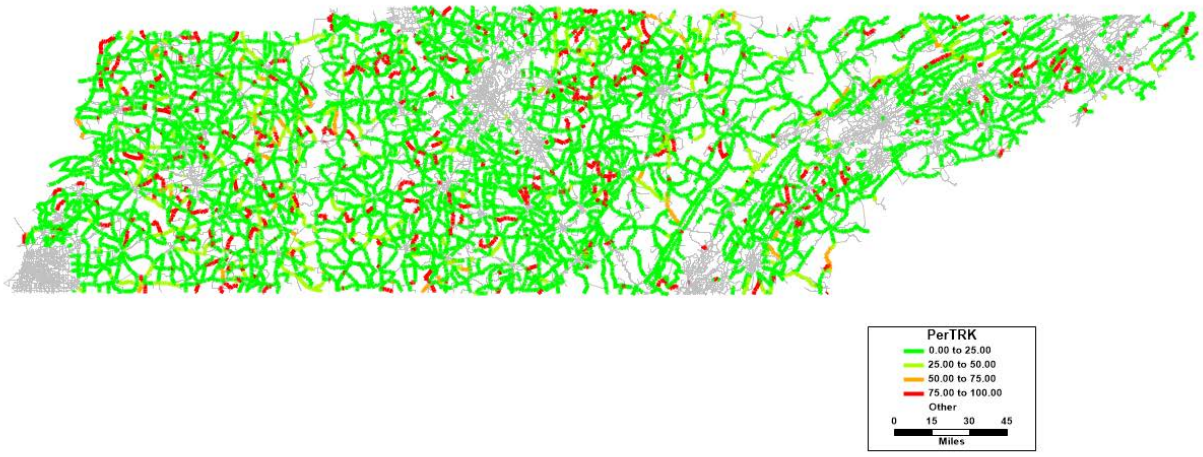

Figure 109: Percentage of Trucks for Non-Interstate Rural Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2040)

Figure 110: Percentage of Autos for Non-Interstate Rural Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2040)

Figure 111: Volume to Capacity Ratio for Non-Interstate Rural Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2040)

Non-Interstate – Rural – Speed Limit < 40

Figure 112 to Figure 116 show the percentages of MUTs, SUTs, Trucks, and Autos, as well as Volume to Capcity Ratios for Non-Interstates with speed limit less 40 mph in 2040. Again, the autos are the main contibuters to traffic flow on these roads. However, some segments exhibited higher percentage of trucks mostly because of high number of SUTs on those roads. No critical daily volume to capacity ratios were observed between this group of road segments.

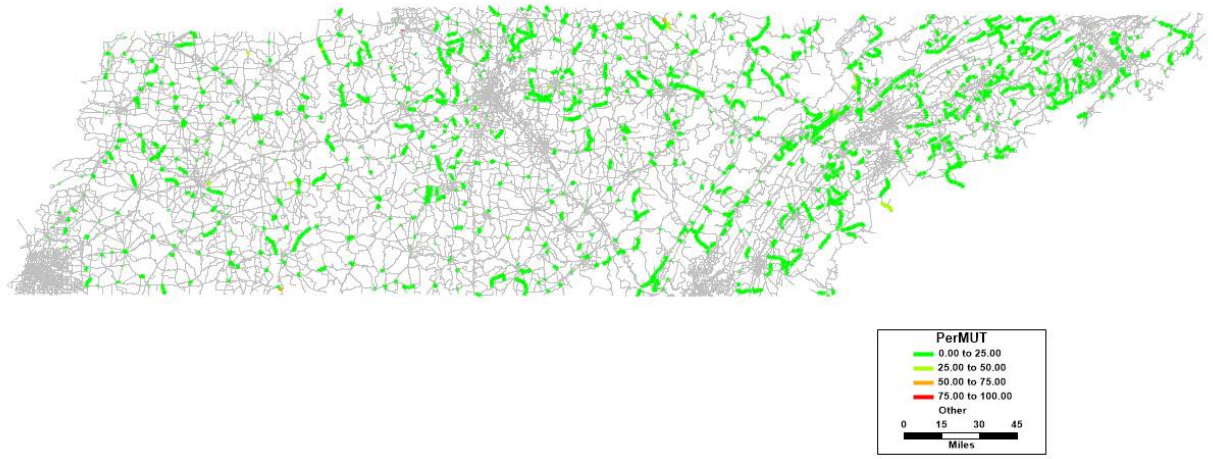

Figure 112: Percentage of MUTs for Non-Interstate Rural Roads with Speed Limit less than 40 mph (2040)

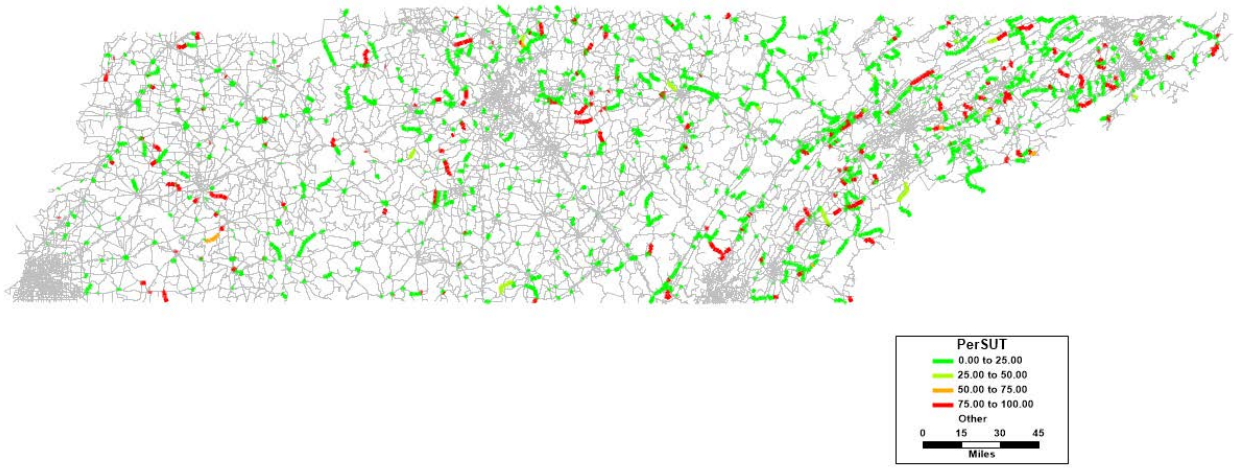

Figure 113: Percentage of SUTs for Non-Interstate Rural Roads with Speed Limit less than 40 mph (2040)

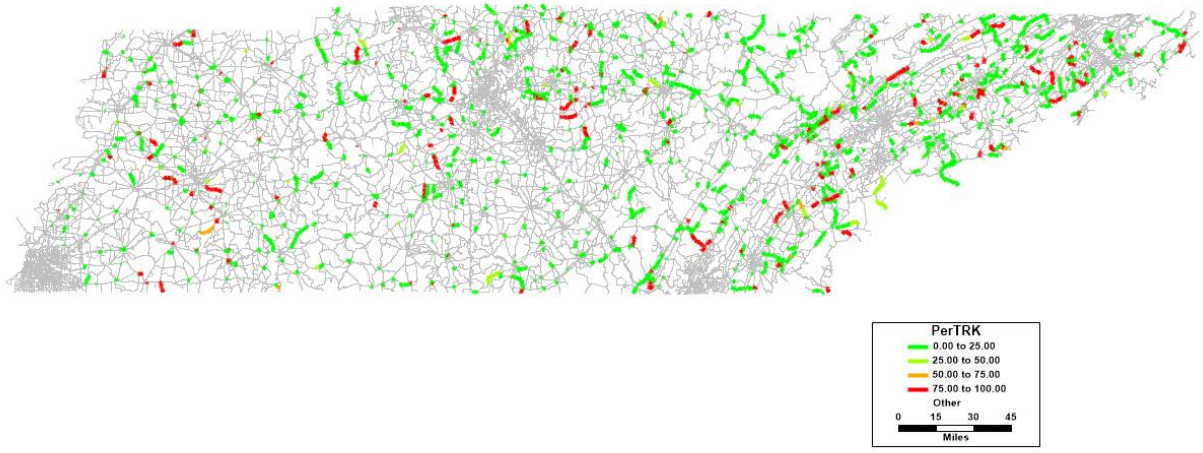

Figure 114: Percentage of Trucks for Non-Interstate Rural Roads with Speed Limit less than 40 mph (2040)

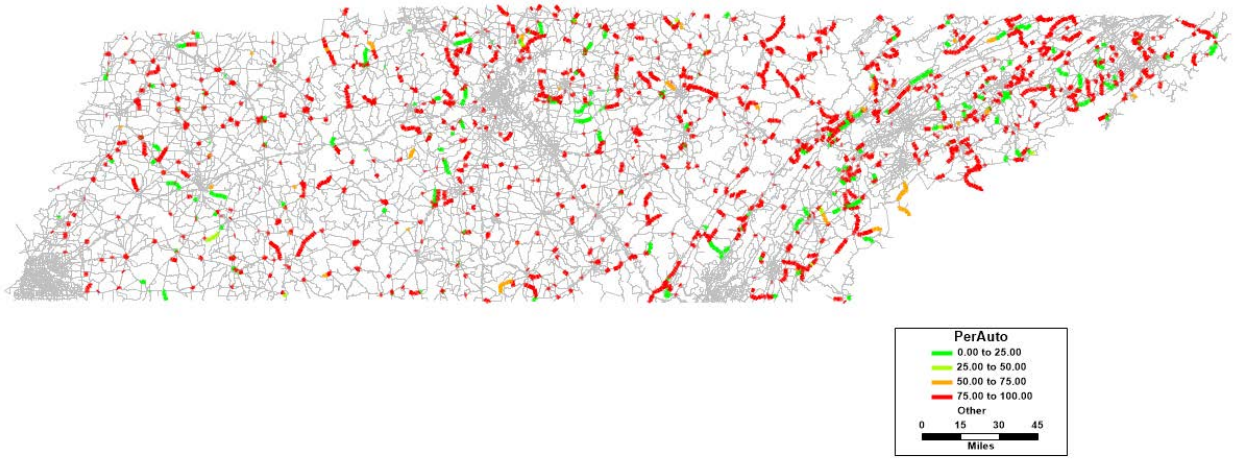

Figure 115: Percentage of Autos for Non-Interstate Rural Roads with Speed Limit less than 40 mph (2040)

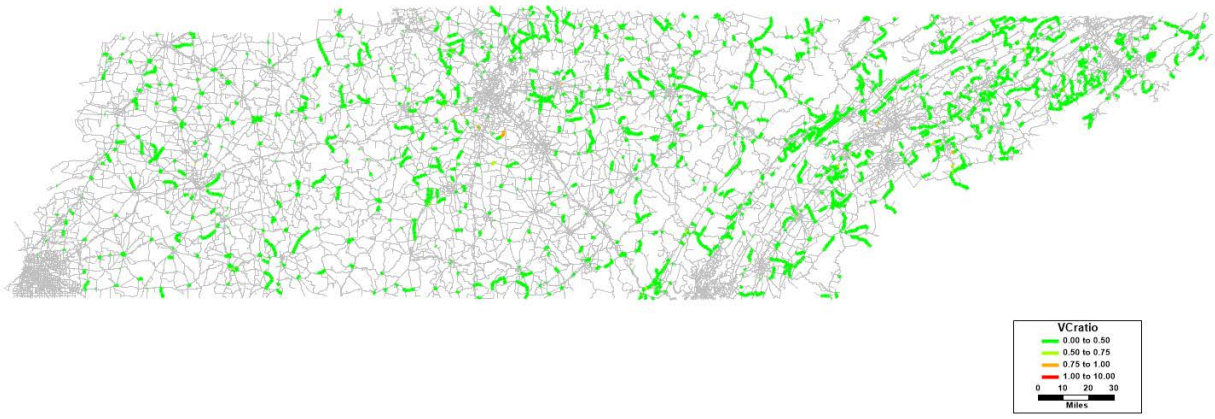

Figure 116: Volume to Capacity Ratio for Non-Interstate Rural Roads with Speed Limit less than 40 mph (2040)

Non-Interstate – Urban – Speed Limit ≥ 60

Figure 117 to Figure 121 show the percentages of MUTs, SUTs, Trucks, and Autos, as well as Volume to Capcity Ratios for Non-Interstates with speed limit greater than or equal to 60 mph in 2040. For these road segments, autos contribute to more than fifty percent of traffic flow. No critical volume to capacity ratios were observed between this group of road segments.

Figure 117: Percentage of MUTs for Non-Interstate Urban Roads with Speed Limit greater than or equal to 60 mph (2040)

Figure 118: Percentage of SUTs for Non-Interstate Urban Roads with Speed Limit greater than or equal to 60 mph (2040)

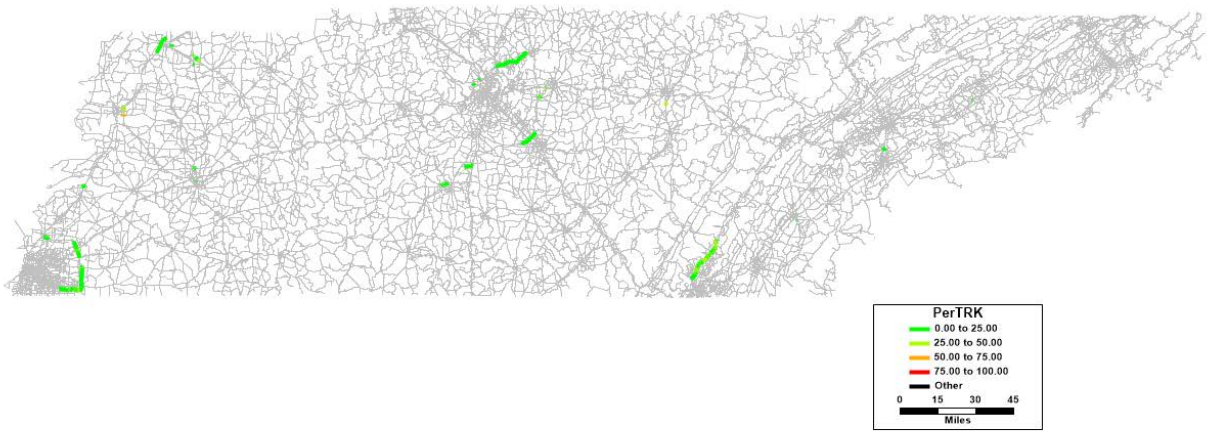

Figure 119 Percentage of Trucks for Non-Interstate Urban Roads with Speed Limit greater than or equal to 60 mph (2040)

Figure 120: Percentage of Autos for Non-Interstate Urban Roads with Speed Limit greater than or equal to 60 mph (2040)

Figure 121: Volume to Capacity Ratio for Non-Interstate Urban Roads with Speed Limit greater than or equal to 60 mph (2040)

Non-Interstate – Urban – 40 ≤ Speed Limit < 60

As shown in Figure 122 to Figure 126, in most Non-Interstate road segments with speed limit between 40 and 60 mph, the percentage of autos driving on roads is more than percentage of trucks. However, few segments exhibited higher percentage of trucks mostly because of high number of SUTs on those roads. A number of such road segments exhibit critical volume to capacity ratios in 2040.

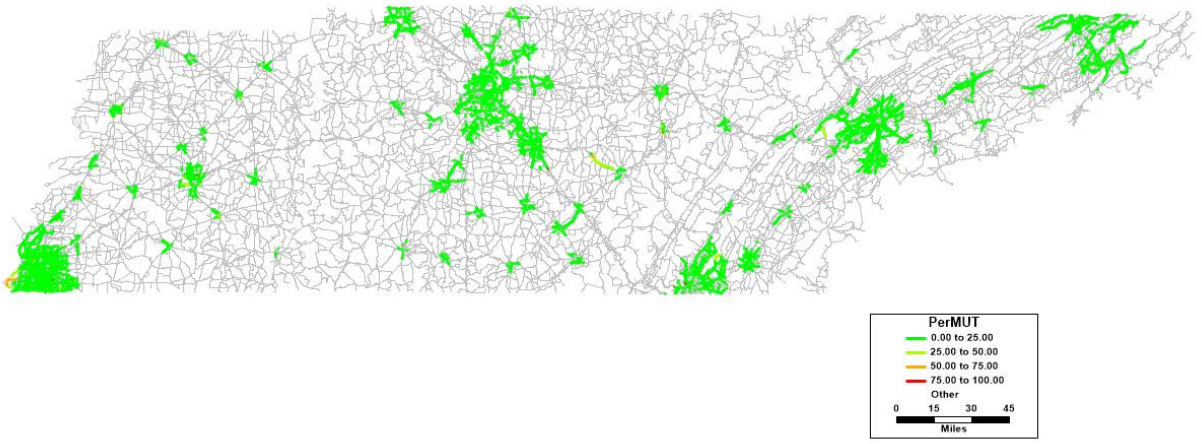

Figure 122: Percentage of MUTs for Non-Interstate Urban Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2040)

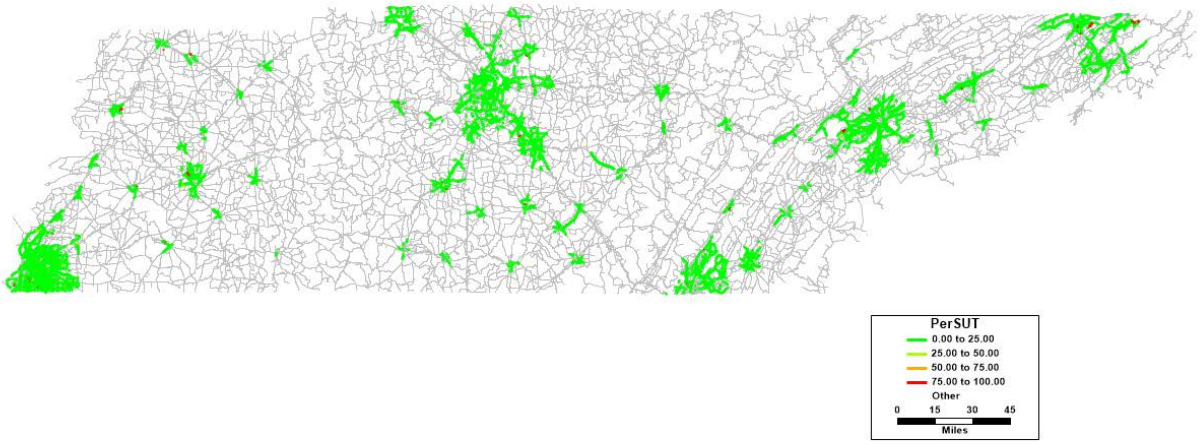

Figure 123: Percentage of SUTs for Non-Interstate Urban Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2040)

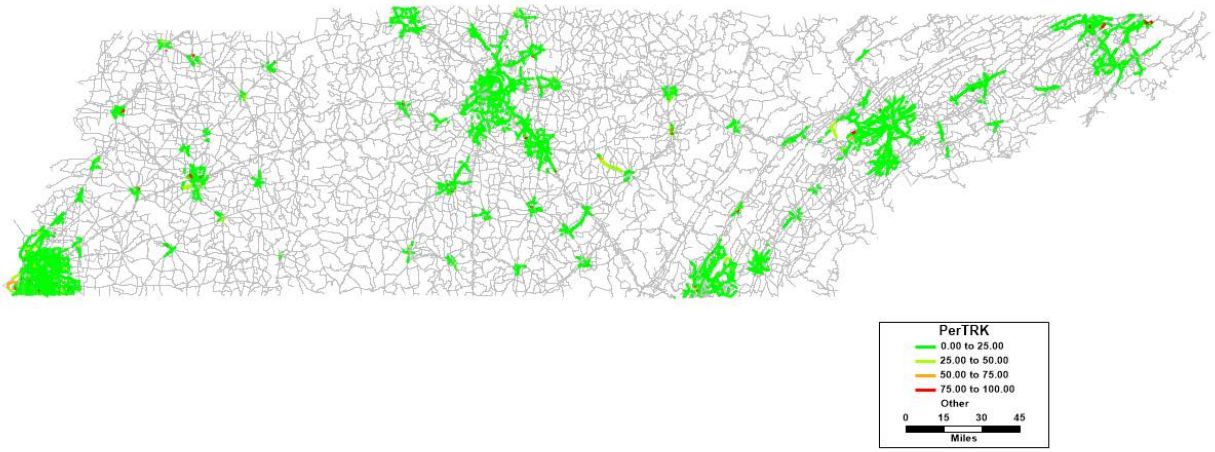

Figure 124: Percentage of Trucks for Non-Interstate Urban Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2040)

Figure 125: Percentage of Autos for Non-Interstate Urban Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2040)

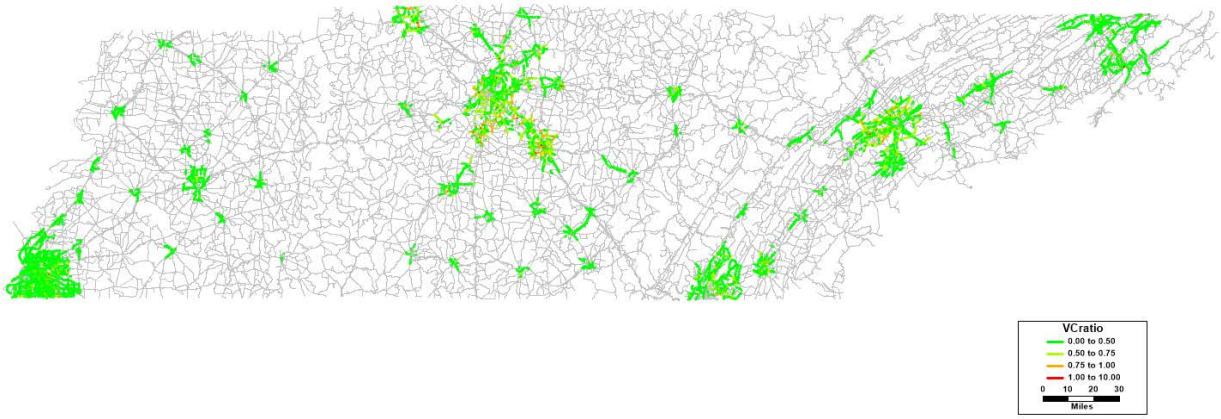

Figure 126: Volume to Capacity Ratio for Non-Interstate Urban Roads with Speed Limit greater than or equal to 40 and less than 60 mph (2040)

Non-Interstate – Urban – Speed Limit < 40

Figure 127 to Figure 131 show the percentages of MUTs, SUTs, Trucks, and Autos, as well as Volume to Capcity Ratios for Non-Interstates with speed limit less 40 mph in 2040. Again, the autos are the main contibuters to traffic flow on these roads. However, some segments exhibited higher percentage of trucks mostly because of high number of SUTs on those roads. No critical volume to capacity ratios were observed between this group of road segments.

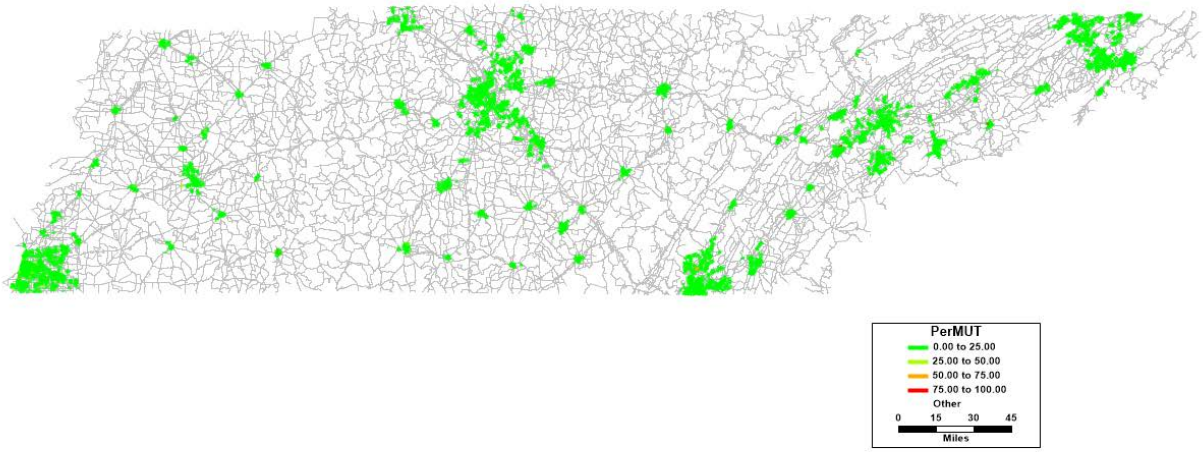

Figure 127: Percentage of MUTs for Non-Interstate Urban Roads with Speed Limit less than 40 mph (2040)

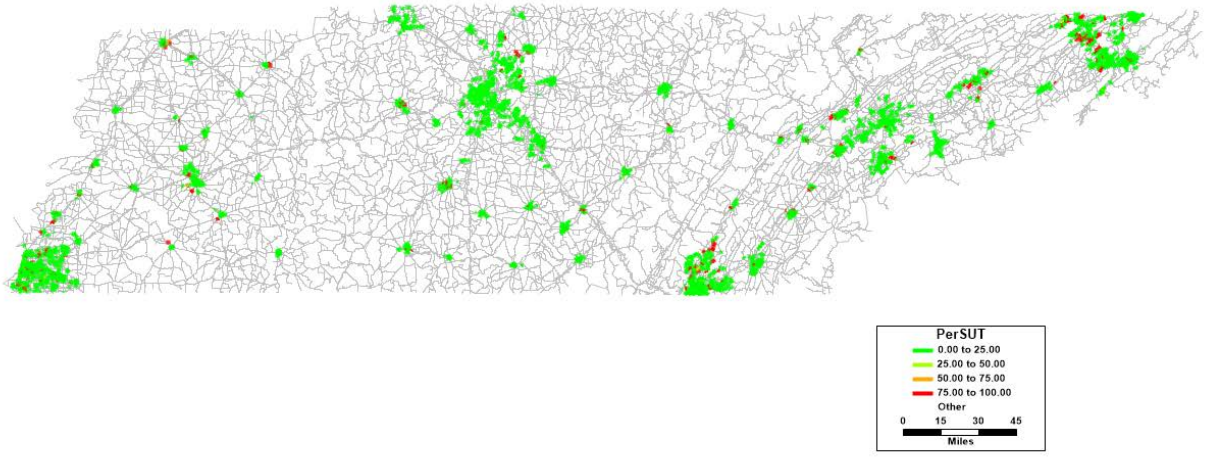

Figure 128: Percentage of SUTs for Non-Interstate Urban Roads with Speed Limit less than 40 mph (2040)

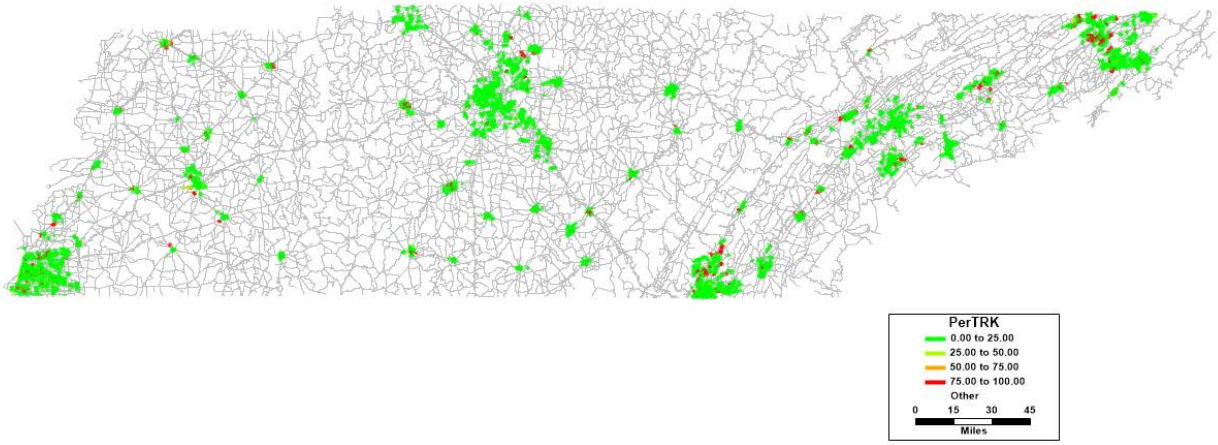

Figure 129: Percentage of Trucks for Non-Interstate Urban Roads with Speed Limit less than 40 mph (2040)

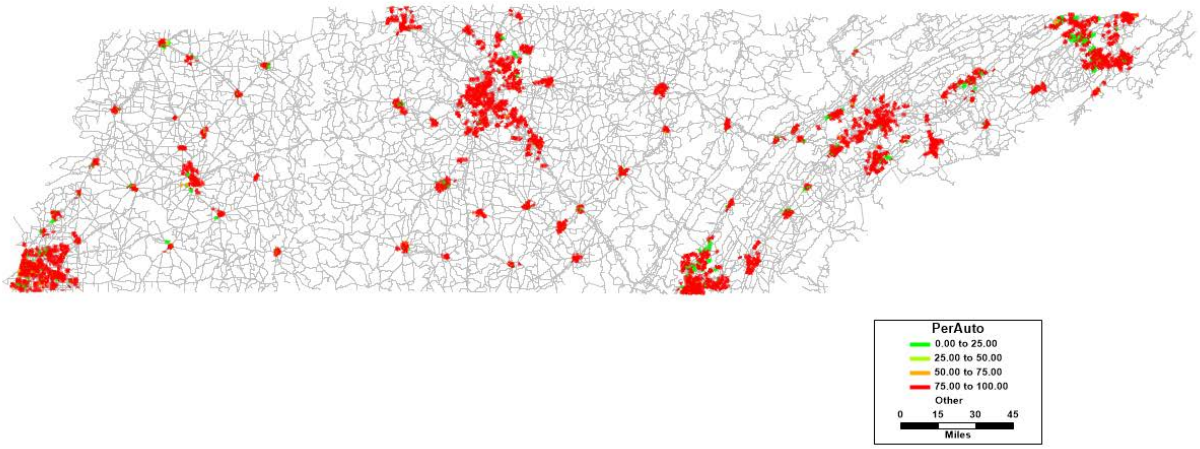

Figure 130: Percentage of Autos for Non-Interstate Urban Roads with Speed Limit less than 40 mph (2040)

Figure 131: Volume to Capacity Ratio for Non-Interstate Urban Roads with Speed Limit less than 40 mph (2040)

Ramps and Roundabouts

We also created maps of the percentages of MUTs, SUTs, Trucks, and Autos, as well as Volume to Capcity Ratios for ramps and roundabouts for 2040. Again, the autos are the main contibuters to traffic flow on ramps and roundabouts. However, a number of road segments exhibited higher percentage of trucks than autos as can be seen in Figure 132 to Figure 135. Also, critival V/C ratios were observed on ramps and roundabouts in 2040 (Figure 136).

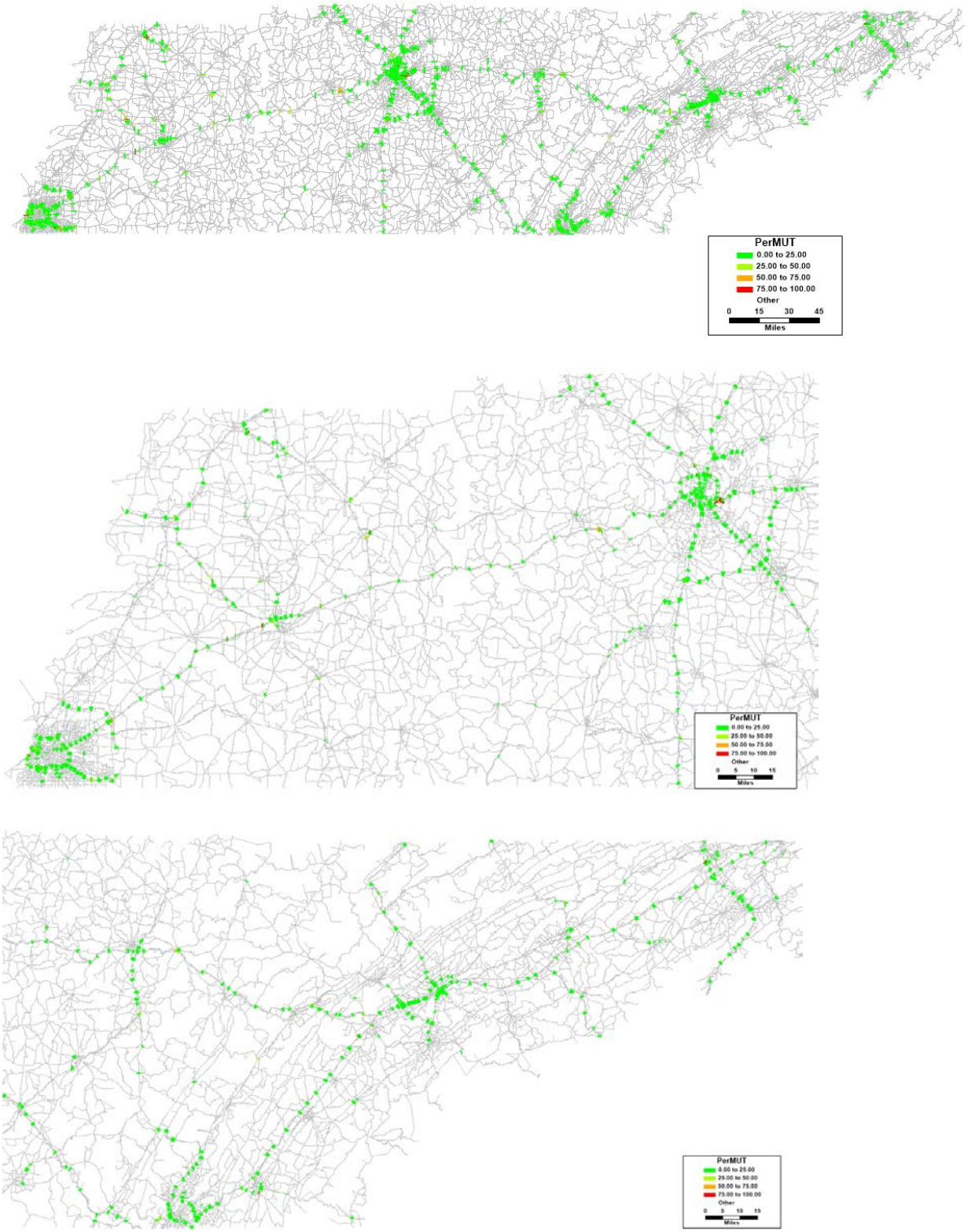

Figure 132: Percentage of MUTs for Ramps and Roundabouts (2040)

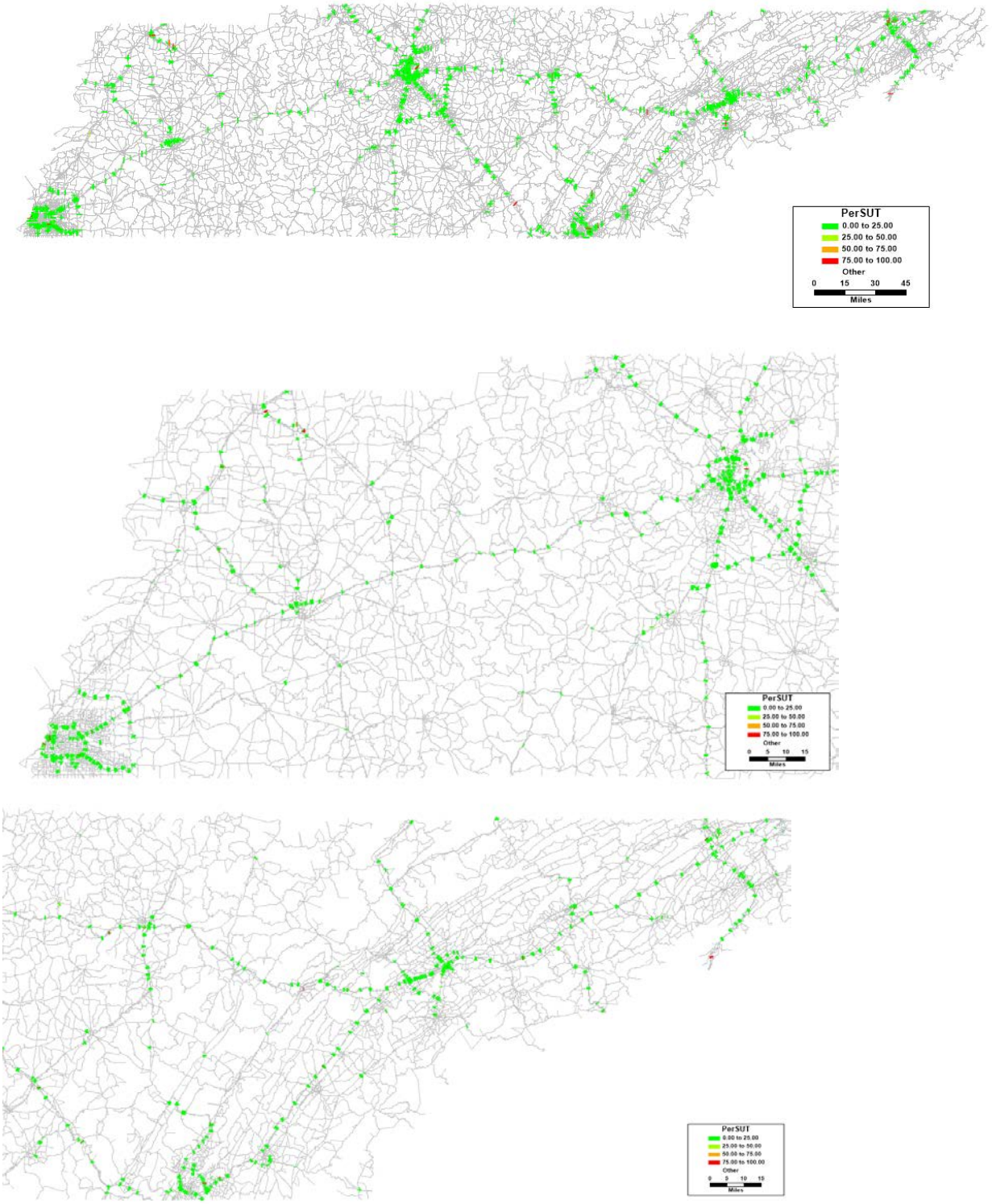

Figure 133: Percentage of SUTs for Ramps and Roundabouts (2040)

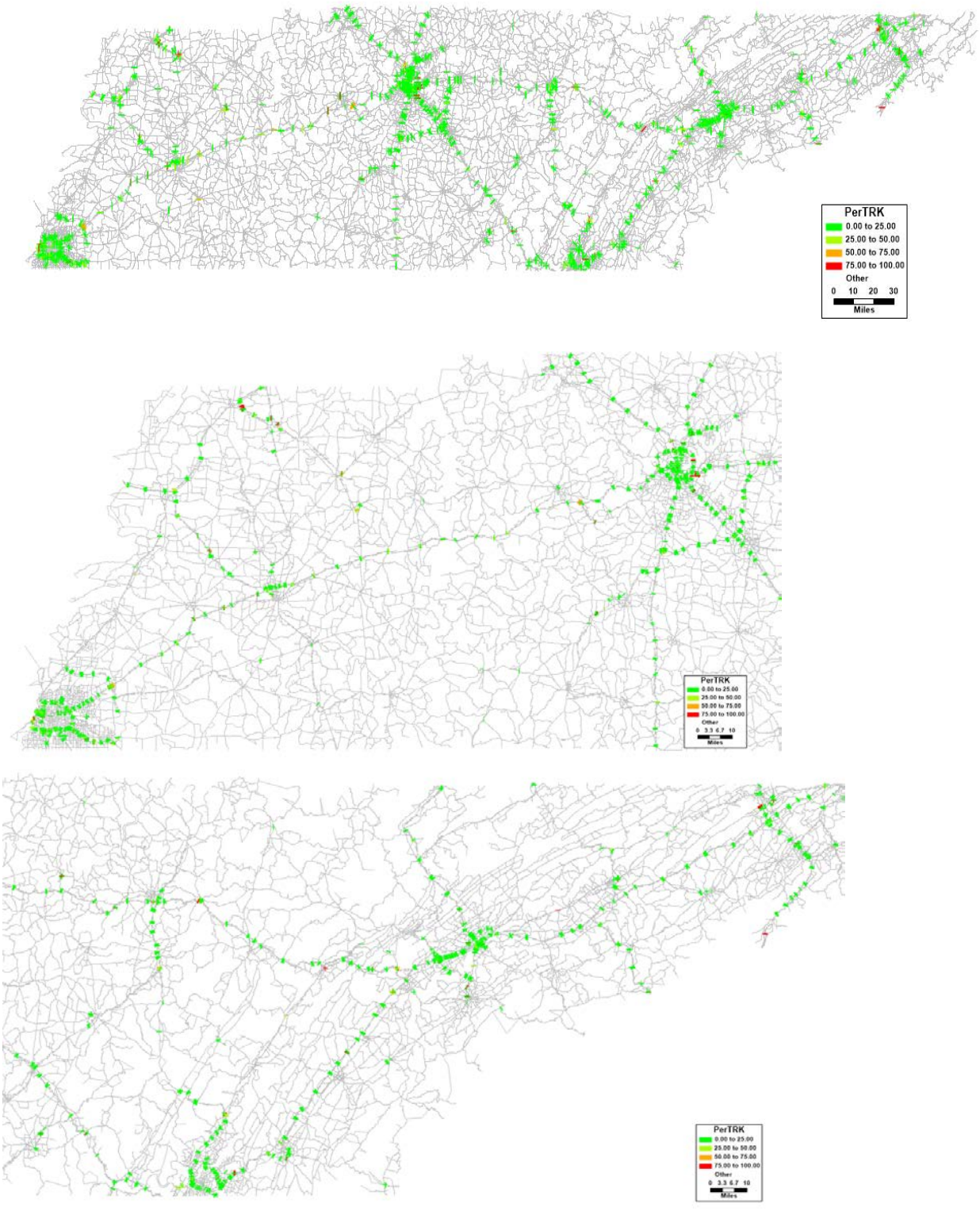

Figure 134: Percentage of Trucks for Ramps and Roundabouts (2040)

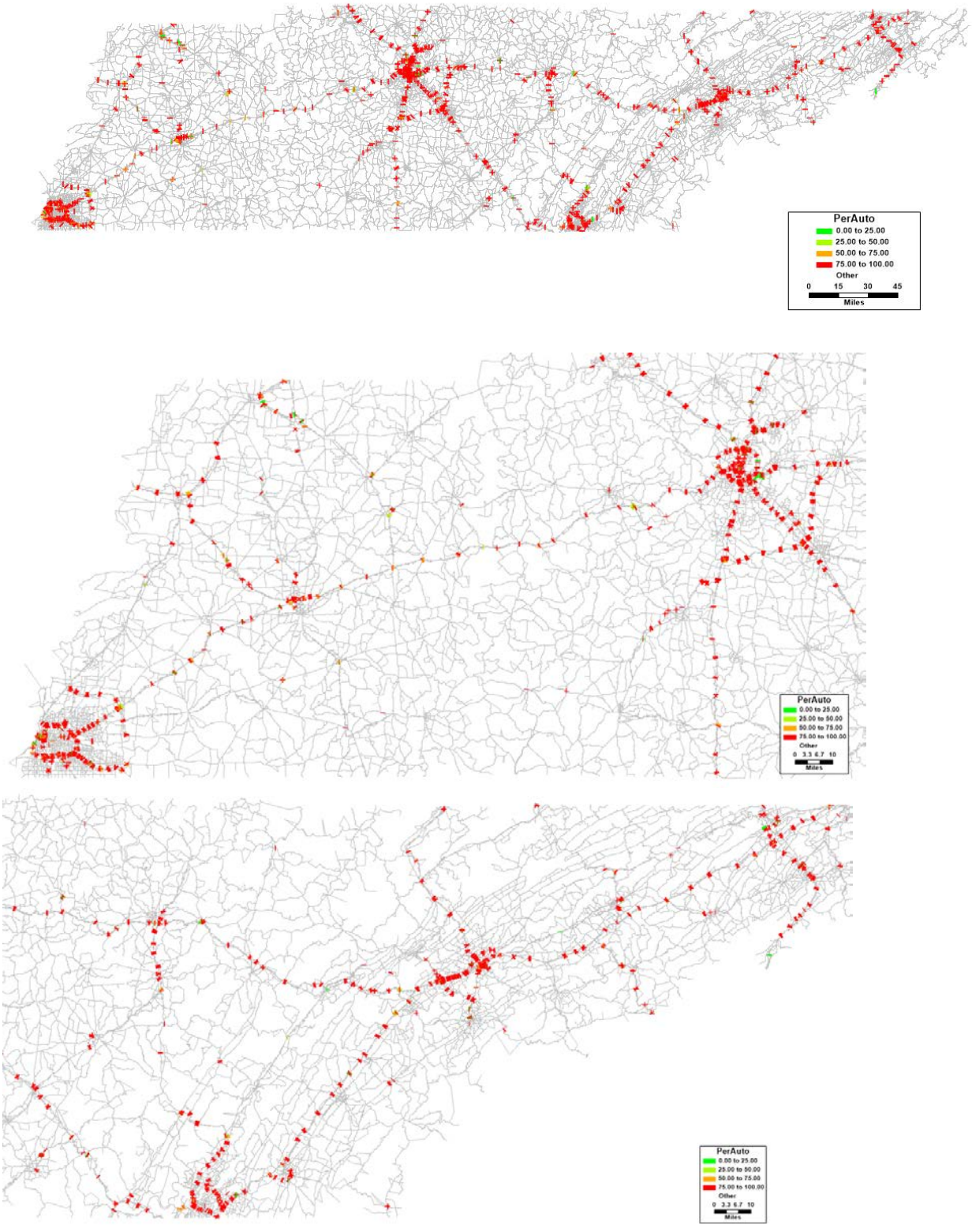

Figure 135: Percentage of Autos for Ramps and Roundabouts (2040)

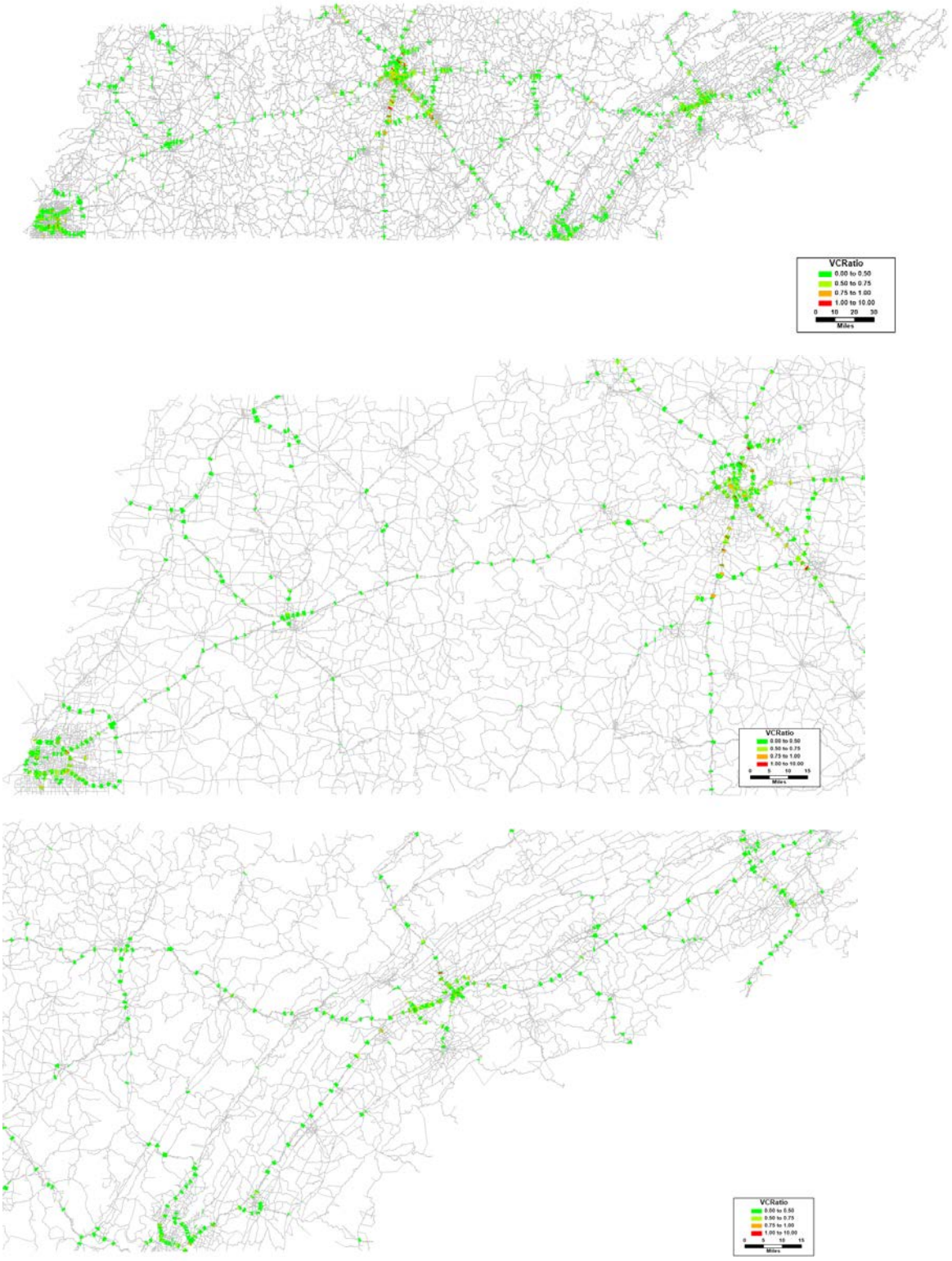

Figure 136: Volume to Capacity Ratio for Ramps and Roundabouts (2040)

CRITICAL ROAD SEGMENTS

To identify the critical road segments, a number of different metrics were used, such as V/C ratio, level of service, speed, number of crashes, and emissions. To do this, the 2040 post processed model results were joined to the master network first. Then, multiple metrics were taken into account to identify the critical projects, as follwos:

Peak Hours Volume to Capacity Ratio

In this section of the report, the 2040 AM and PM Peak V/C ratios for Interstate and Arterials are presented. Also, separate maps are provided for four major metropolitan areas in Tennessee. The areas are categorized into three different groups based on their V/C ratio, as follows:

- Highly Congested Areas: V/C ratio greater than 0.95
- Congested Areas: V/C ratio between 0.75 and 0.94
- Uncongested Areas: V/C ratio less than 0.75

Figure 137 to Figure 141 are related to PM Peak hours, while Figure 142 to Figure 146 present the AM Peaks.

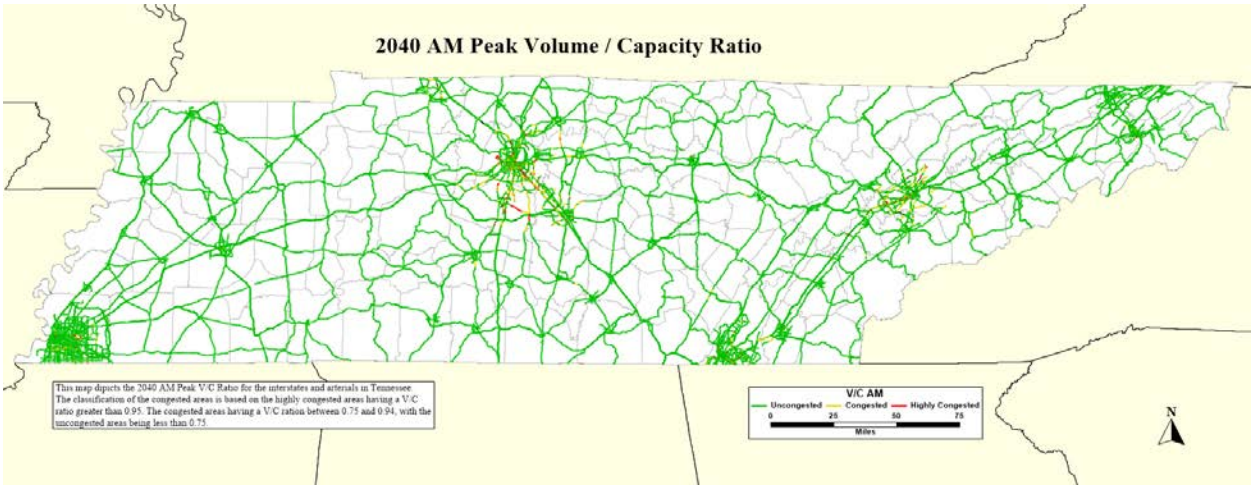

Figure 137: AM Peak Volume to Capacity Ratio for Interstate and Arterials (2040)

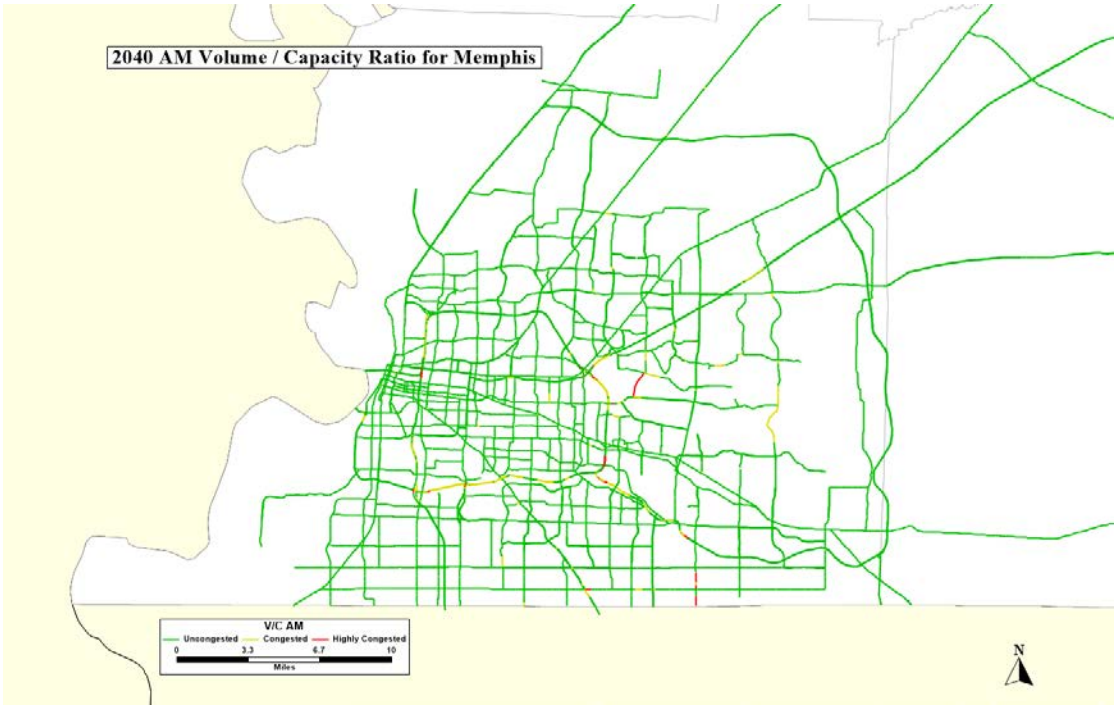

Figure 138: AM Peak Volume to Capacity Ratio for Interstate and Arterials in Memphis (2040)

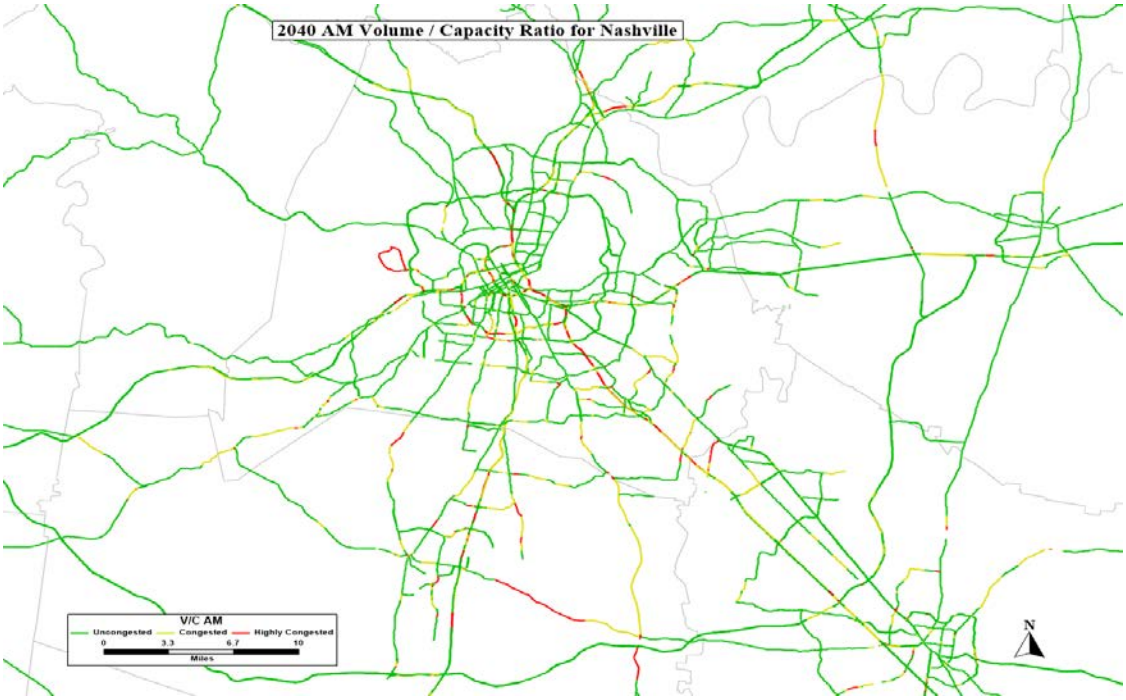

Figure 139: AM Peak Volume to Capacity Ratio for Interstate and Arterials in Nashville (2040)

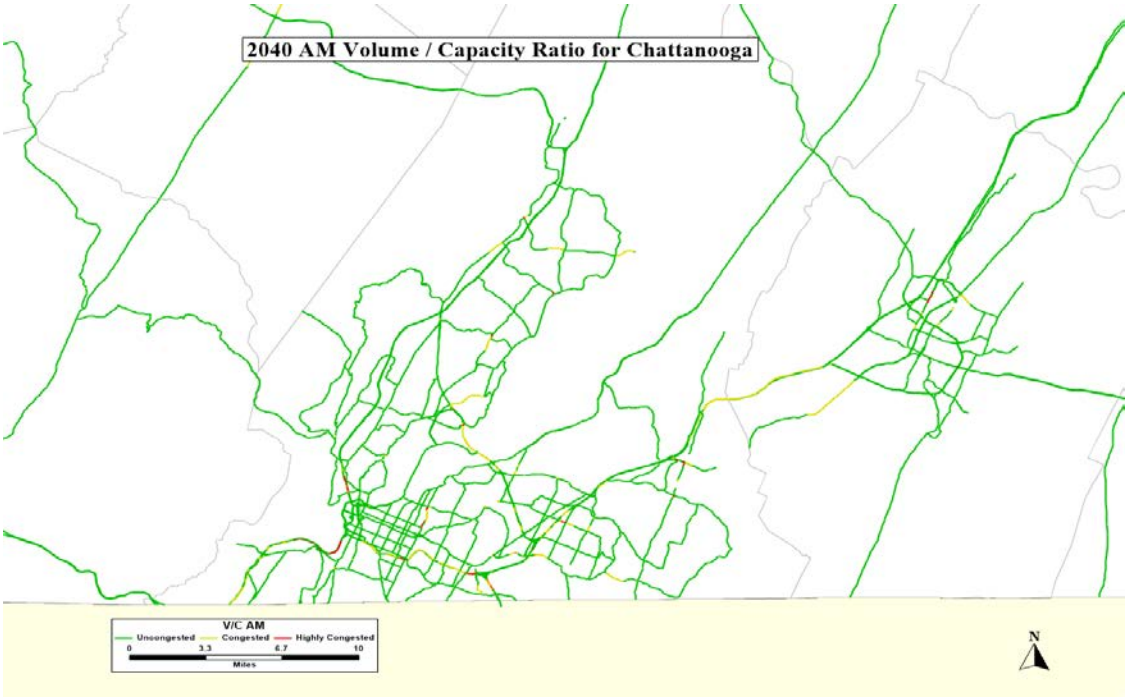

Figure 140: AM Peak Volume to Capacity Ratio for Interstate and Arterials in Chattanooga (2040)

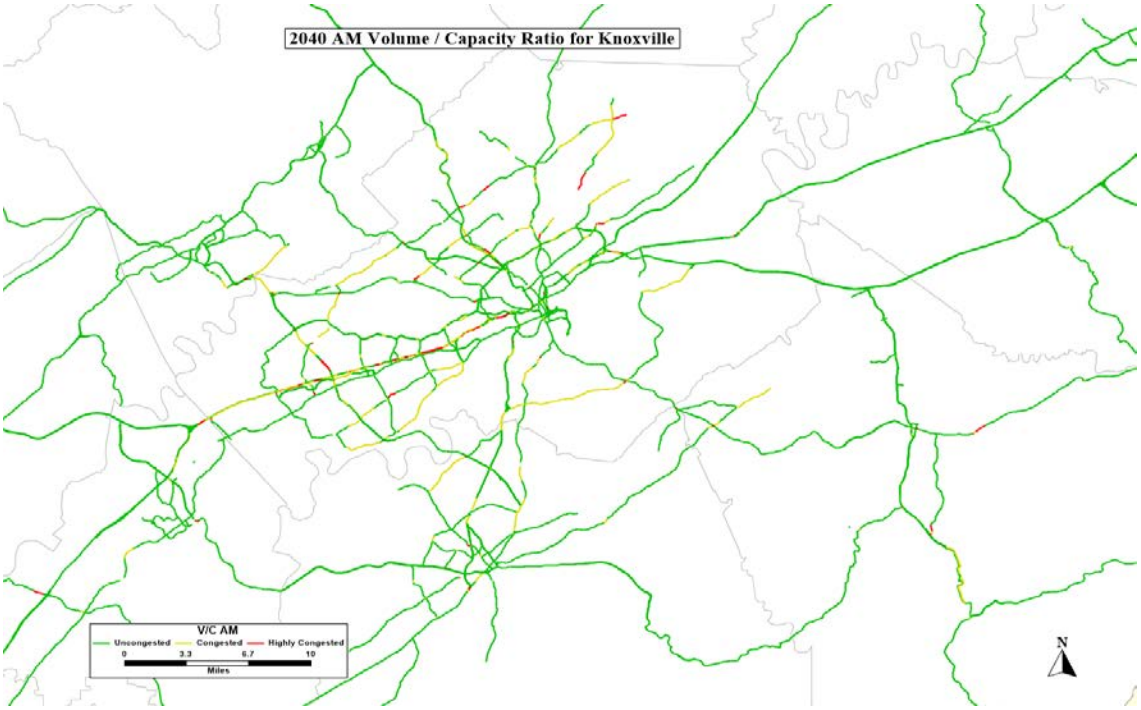

Figure 141: AM Peak Volume to Capacity Ratio for Interstate and Arterials in Knoxville (2040)

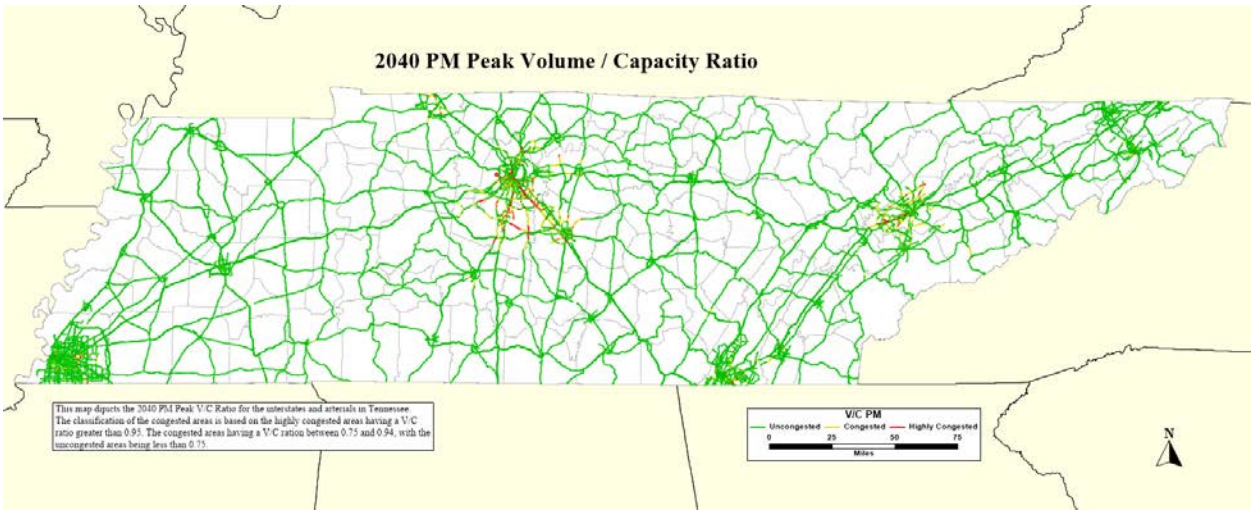

Figure 142: PM Peak Volume to Capacity Ratio for Interstate and Arterials (2040)

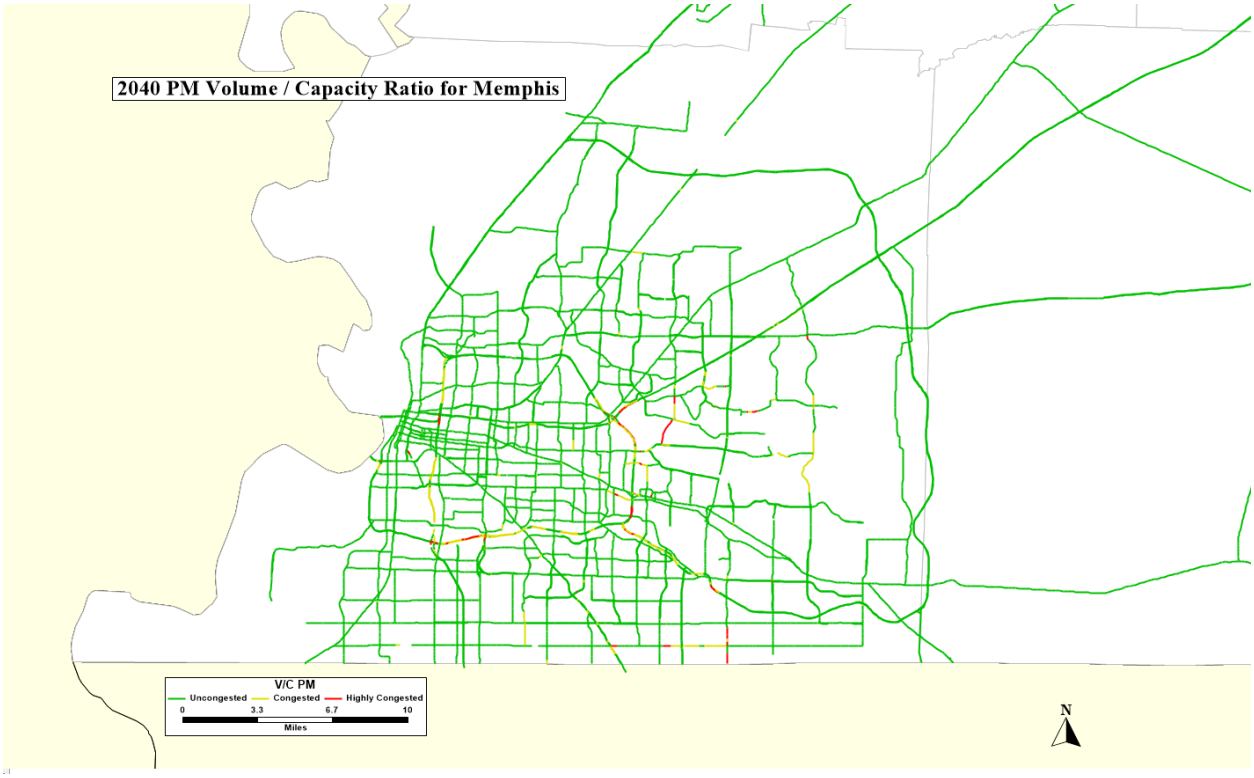

Figure 143: PM Peak Volume to Capacity Ratio for Interstate and Arterials in Memphis (2040)

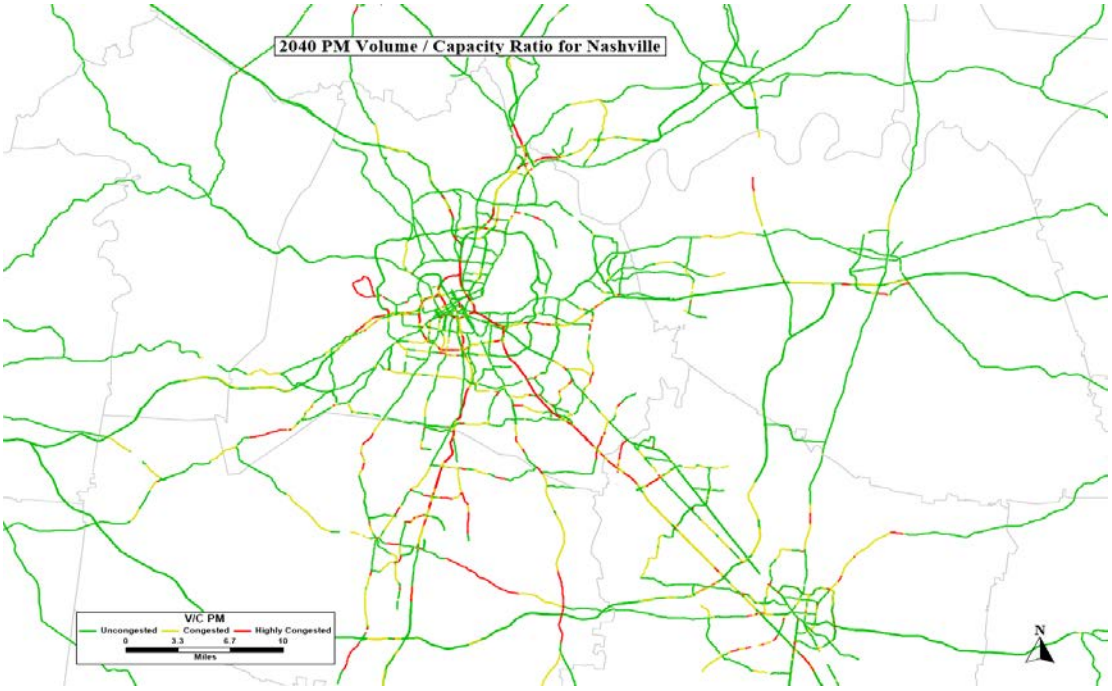

Figure 144: PM Peak Volume to Capacity Ratio for Interstate and Arterials in Nashville (2040)

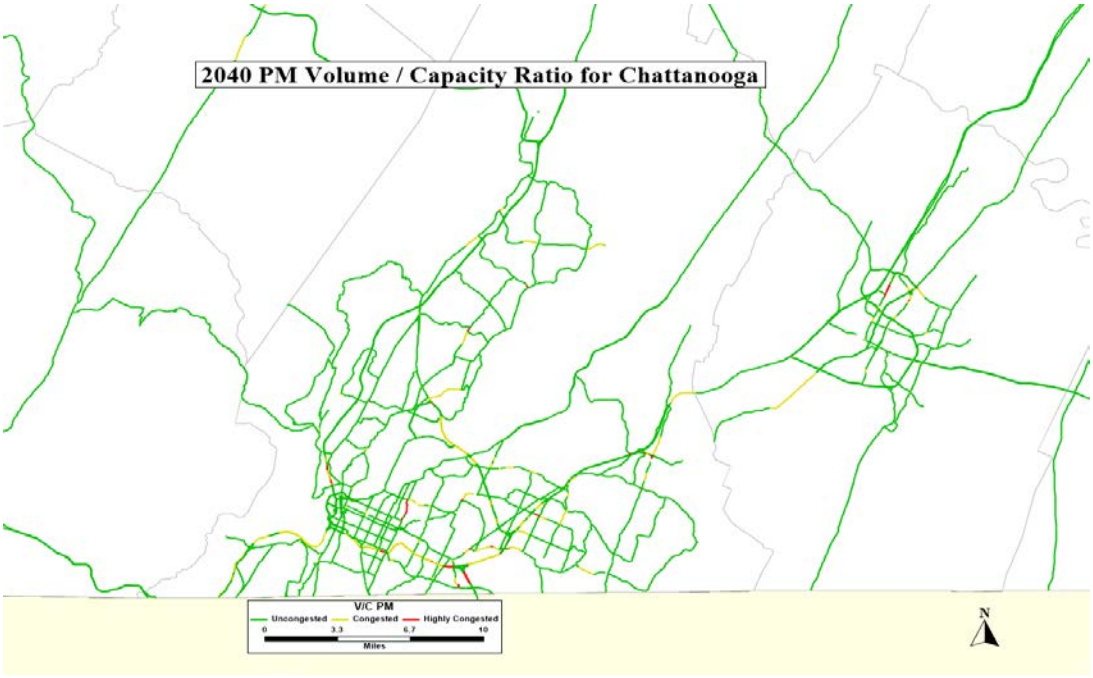

Figure 145: PM Peak Volume to Capacity Ratio for Interstate and Arterials in Chattanooga (2040)

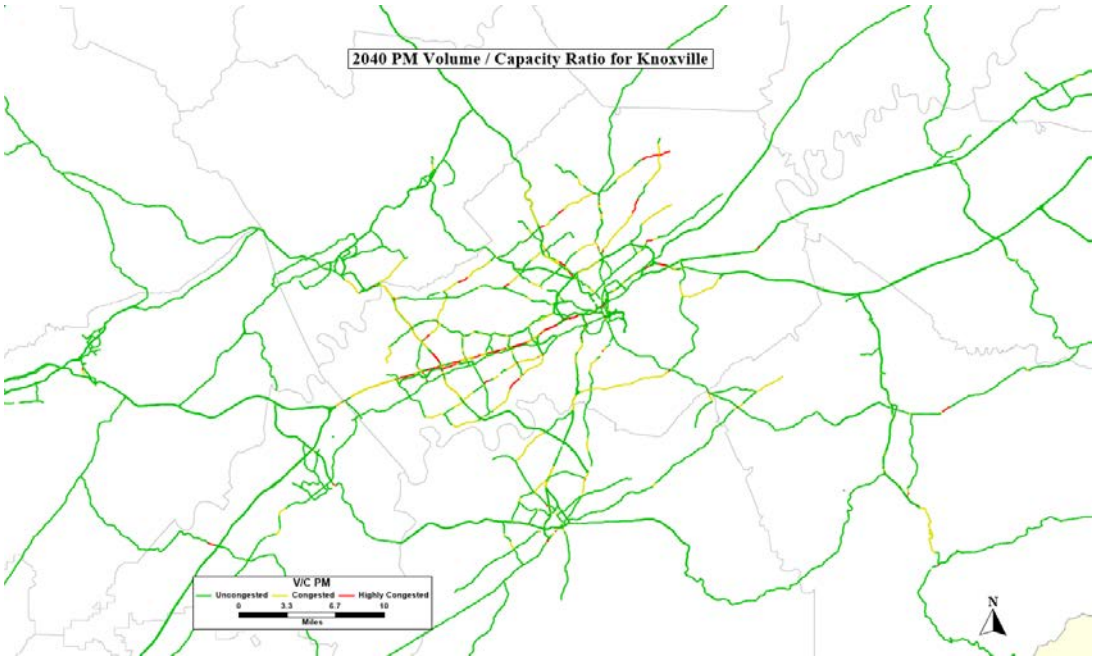

Figure 146: PM Peak Volume to Capacity Ratio for Interstate and Arterials in Knoxville (2040)

Level of Service

Figure 147 demonstrates Tennessee's road segments exhibiting Level of Services "E" or "F" in 2040. As seen in the figure, most of these group of road segments are located in uraban araes.

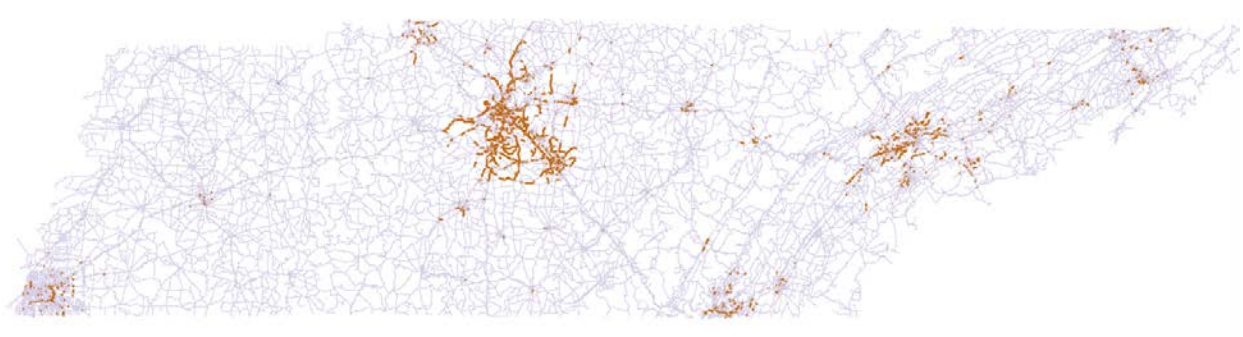

Figure 147: Tennessee's Road Segments with LOS E or F (2040)

Peak Hour Speed

To compare the peak hour speed values with the posted speed limits on the road, the following map was created (Figure 148). This map presents all of the road segments with the peak hour speed higher than or eqal to the posted speed limit.

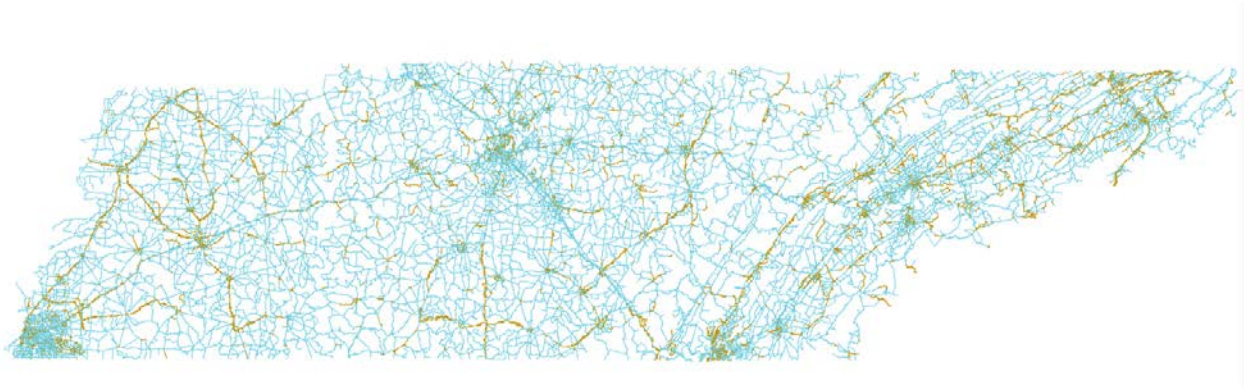

Figure 148: Tennessee's Road Segments with Peak Hour Speed ≥ Speed Limit (2040)

Delay

Figure 149 and Figure 150 show the road segments in Tennessee that drivers experience delays greater than or equal to 5 and 10 minutes on them, respectively. High congested roads are most located near urban areas, in particular Nashville. Such maps were also created for trucks (Figure 151 and Figure 152). For truck drivers, Interstates are most congested roads.

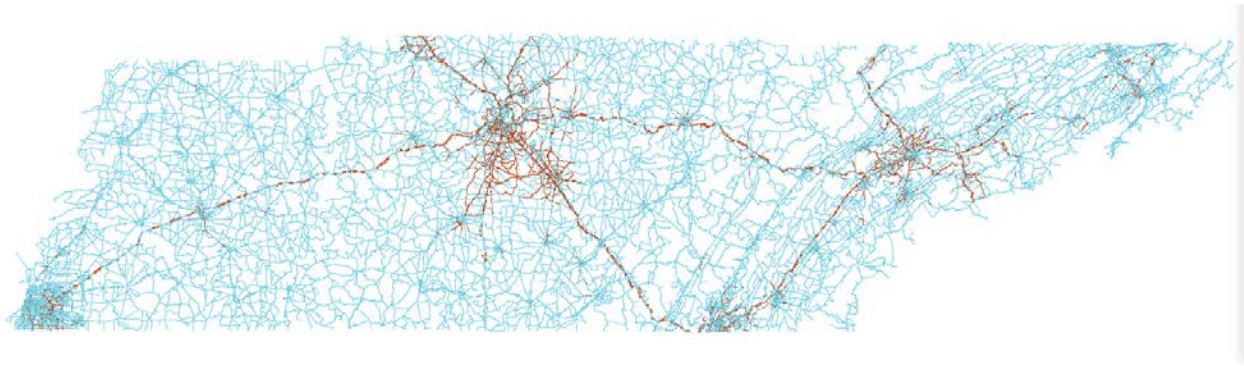

Figure 149: Tennessee's Road Segments with Car Delay ≥ 5 minutes (2040)

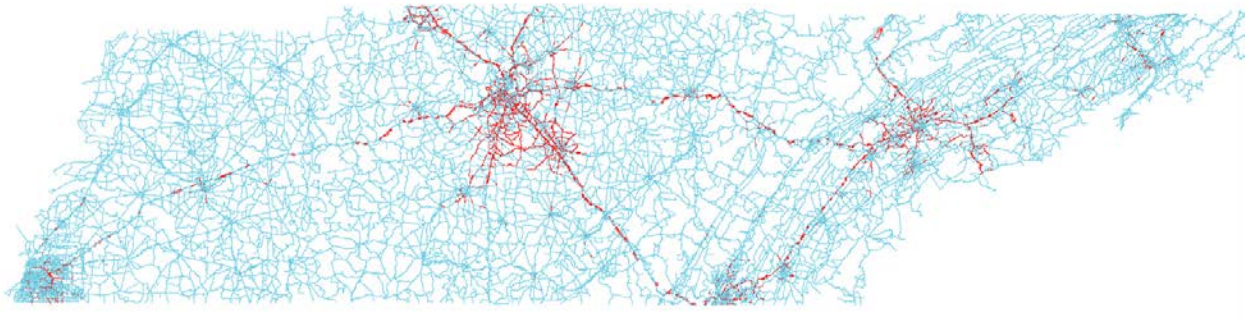

Figure 150: Tennessee's Road Segments with Car Delay ≥ 10 minutes (2040)

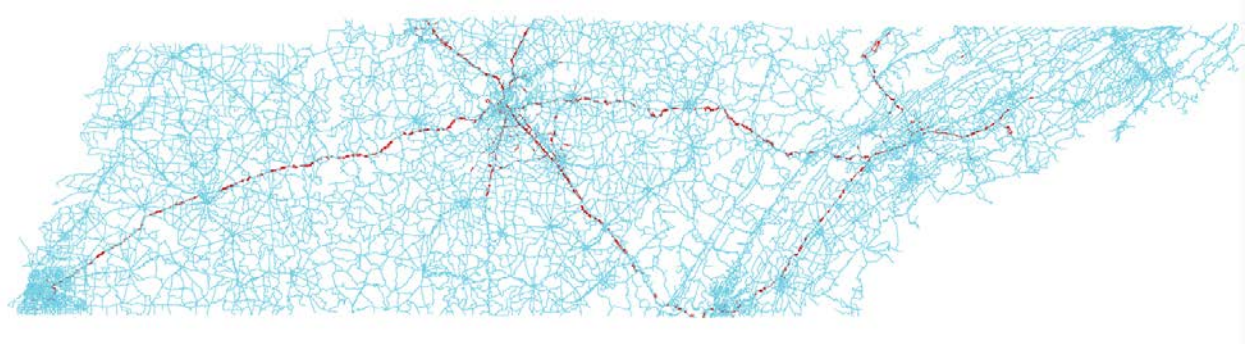

Figure 151: Tennessee's Road Segments with Truck Delay ≥ 5 minutes (2040)

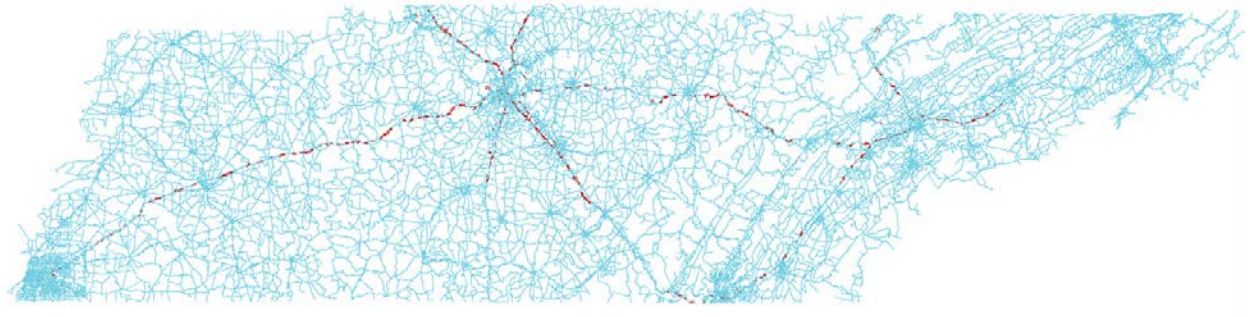

Figure 152: Tennessee's Road Segments with Truck Delay ≥ 10 minutes (2040)

Fuel Usage

Using the vehicle operating fuel cost ($1.8 for autos and $2.55 for trucks), the value of fuel consumption by vehicle type onFatatl each link can be calculated. Figure 153 presents the fuel usage in Tennessee.

Figure 153: Fuel usage on Tennessee's roads (2040)

Crash

To peresent and identify road segments with citical safety condition, the number of crashes were divided by the length of the road to calculate the rate of crash for each road segment. The crash rates were calculated for total crashes, fatal crashes, and injury crashes. Figure 154 shows all of the road segments with total crash rate greater than one. Figure 155 and Figure 156 demonstrate segments with total crash rate greater than 10 and 100, respectively.

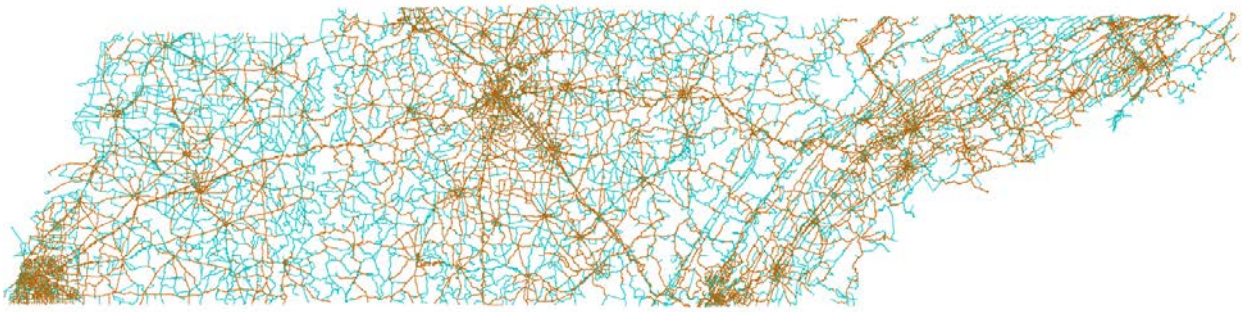

Figure 154: Tennessee's Road Segments with total crash rate greater than one (2040)

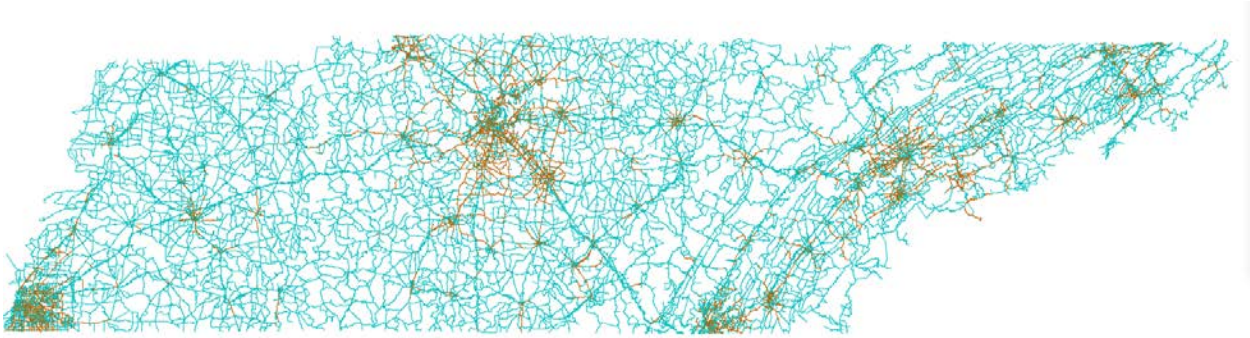

Figure 155: Tennessee's Road Segments with total crash rate greater than ten (2040)

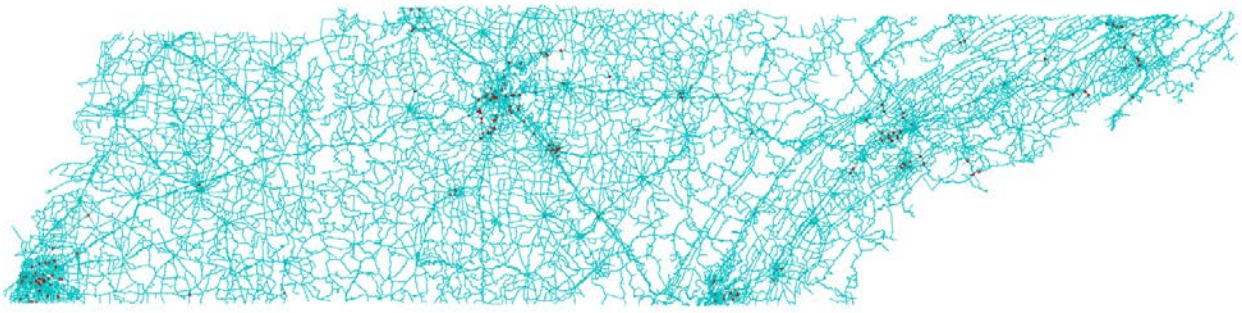

Figure 156: Tennessee's Road Segments with total crash rate greater than one hundred (2040)

Figure 157 and Figure 158 present segments with injury crash rate greater than or eqal to 1 and 10, respectively. Also, Figure 159 shows Tennessee's road segments exhibiting fatal crash rates greater than or eqal to 1.

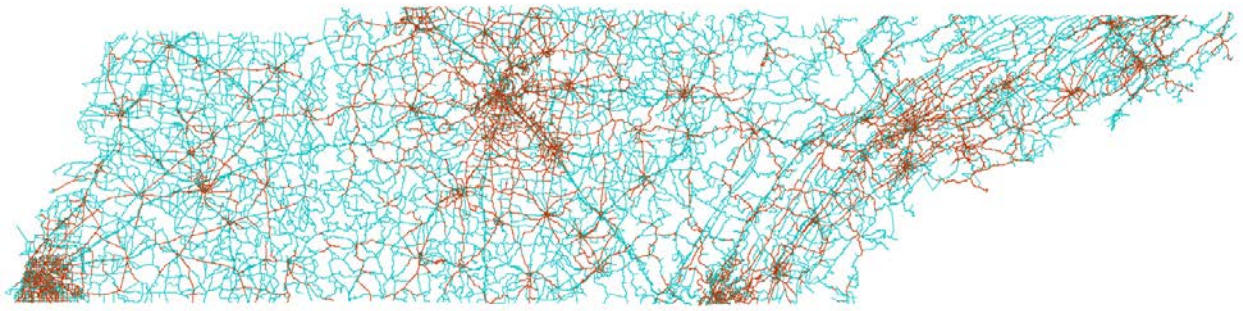

Figure 157: : Tennessee's Road Segments with injury crash rate greater than or equal to one (2040)

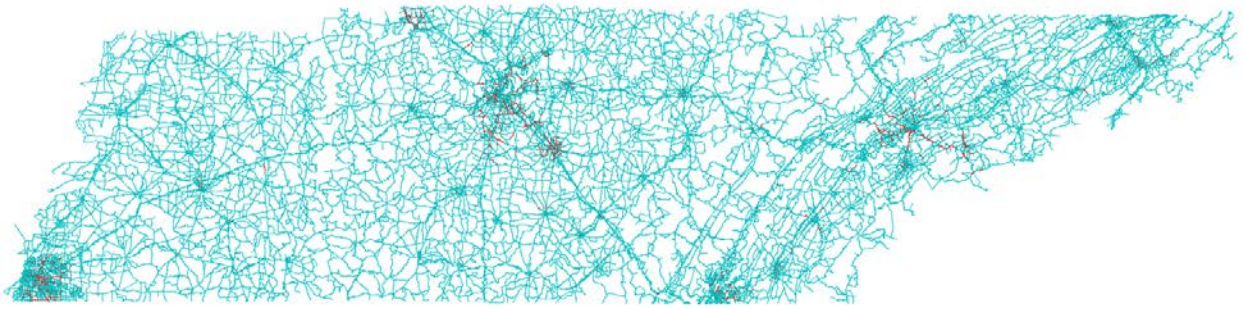

Figure 158: Tennessee's Road Segments with injury crash rate greater than or equal to ten (2040)

Figure 159: Tennessee's Road Segments with fatal crash rate greater than or equal to one (2040)

SUMMARY

This study aimed to visualize the output of TSM for further analysis of the model results. This included combining a variety of data sets with TSM's output. Also, further maps were created to present and identify the most critical projects across the state. To do this, a number of performance measures were taken into account, such as volume to capacity ratio, delay, speed, crashes, and fuel usage. This study provides policy makers with essential information regarding the current and future traffic and safety condition of Tennessee's roads helping them make long range plans for the state and make informed decisions.