CONNECTING Ouachita 2045

TECHNICAL REPORT #1

Transportation Modeling and Forecasting

September 2020

Prepared for:

OCOG Ouachita Council of Governments

Prepared by:

NEEL-SCHAFFER

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1.0 Introduction and Model Overview

1.1 Introduction

This report includes a description of the procedures used in developing the demographics and travel estimates used in the 2045 Metropolitan Transportation Plan (MTP) for the Monroe Metropolitan Planning Organization (MPO). It also describes the relationship between planning data and trip making, and the calibration and testing of the model. This report does not include how to operate the model.

1.2 Model Overview

The Monroe MPO Travel Demand Model (TDM) was updated for use in the MPO's new 2045 MTP. The model was calibrated and validated to meet the requirements established by the Federal Highway Administration (FHWA) and uses the calibration and validation parameters described in the latest *Minimum Travel Demand Model Calibration and Validation Guidelines for State of Tennessee*[1].

The TDM was updated to use a 2018 base year and contains:

- a master roadway network,
- socioeconomic data and corresponding trips rates,
- turn penalties and trip prohibitions,
- time penalties,
- new time-of-day modeling,
- new capacity factors, and
- external trip data

[1] http://tnmug.utk.edu/wp-content/uploads/sites/47/2017/06/MinimumTravelDemandModel2016.pdf

Introduction

The Monroe MPO TDM is based upon the conventional trip-based four-step modeling approach.

Broadly, the main model components fall within the following four categories:

Trip Generation

- The process of estimating trip productions and attractions at each TAZ

Trip Distribution

- The process of linking trip productions to trip attractions for each TAZ pair.

Mode Choice

- The process of estimating the number of trips by mode for each TAZ pair.
- This process allows the model to calculate transit trips.

Trip Assignment

- The process of assigning auto and truck trips onto specific highway facilities in the region.

The TDM's focus is on the region's highway network due to a limited number of transit trips. As a result, a transit element has not been included, eliminating the Mode Choice step. The TDM was developed in TransCAD 8.0 travel demand forecasting software and the model interface was developed using GISDK macros.

2.0 Traffic Analysis Zones and Socioeconomic Data

2.1 Study Area and Traffic Analysis Zones

The accuracy necessary for generating trips from planning data requires it to be aggregated by small geographic areas. These areas are called Traffic Analysis Zones (TAZs).

TAZs are generally homogeneous areas and were delineated based on:

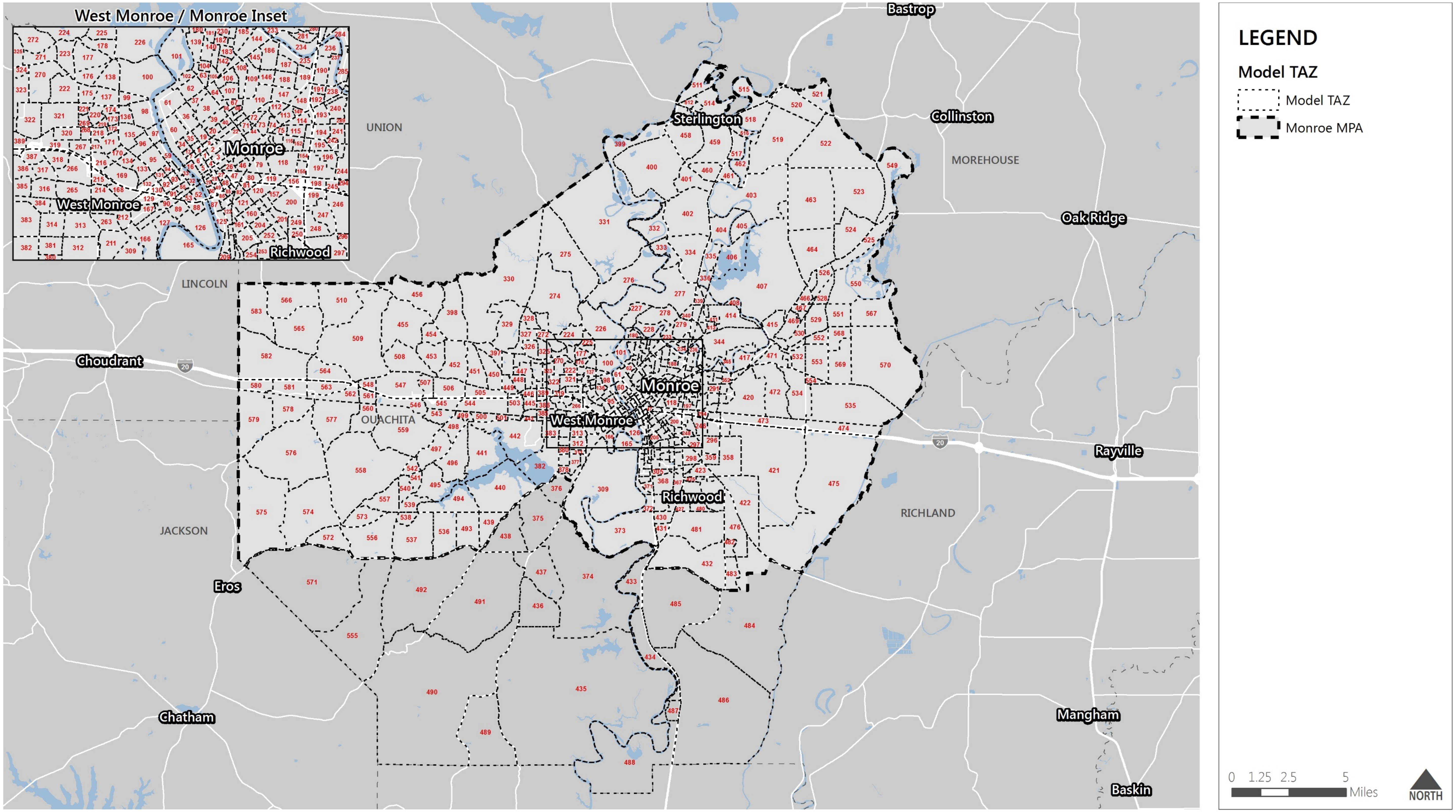
- population,
- land use,
- census geography,
- physical landmarks, and
- governmental jurisdictions.

The MTP 2045 study area is the same as the previous MTP and uses the TAZ structure developed for the MTP 2040. The MTP 2045 study area was divided into 583 TAZs. Additionally, there are 18 external stations. A map of the TAZs is shown in Figure 2.1.

All of the local governments in the MPA, including the Parish government, are members of the MPO. This includes:

- The City of Monroe,
- the City of West Monroe,
- the Town of Richwood,
- the Town of Sterlington, and
- the Ouachita Parish Police Jury.

Figure 2.1: MPO Study Area



Data Source: Census Bureau; Monroe MPO

Disclaimer: This map is for planning purposes only.

2.2 Base Year (2018) Model Socioeconomic Data

This MTP effort uses a 2018 base year with housing, income, employment, and school attendance data as model inputs. This section describes the procedures used to create the model files and base year socioeconomic data.

Household Data Development

The population growth analysis for Ouachita Parish was conducted based on data obtained from the Census Bureau for 2010 and the American Community Survey (ACS) for 2018. Based on this analysis, a control total for 2018 population was developed and TAZ-level housing data was developed. The following steps were used to obtain the 2018 housing data:

- Estimated a total population size for year 2018 based on 5-year averages from the American Community Survey (ACS) dataset, with household data adjusted during model calibration to account for discrepancies.
- Categorized each TAZ into one of two categories “Built Out” and “Growth Potential” based on aerial analysis, historical growth, and local knowledge.
    - Built out – This TAZ has no available land and cannot gain any new dwelling units or employment.
    - Growth Potential – This TAZ has available land and could experience growth.
- Calculated the 2010 total household population in both the Growth Potential TAZ and Built Out groups.
    - This corresponds to 30,758 persons in the Built-out TAZs and 117,428 persons in the Growth Potential TAZs.
- For each TAZ, computed the ratio of household population to total household population of its assigned group, based on the 2010 data.
    - Example: TAZ 10 is categorized as Growth Potential, so its growth ratio was computed as 65/117428 = 0.05 percent of the available growth
- Year 2010 population was held constant in 2018 for all TAZs that are Built Out.
- Computed the total growth available by subtracting 2010 population totals from 2018 study area control totals.
- Distributed the potential growth proportionally based on the developed TAZ ratios calculated earlier. This growth was then added to the existing year 2010 population data producing year 2018 population.
    - One percent of this growth was reserved for TAZs categorized as Growth Potential but with no 2010 population.

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  - For example, the household population of TAZ 10 was 65 for 2010 and the resulting value after multiplication of the ratio with the available growth was 1. The final household population the TAZ in 2018 was 65 + 1 = 66.
  - There were 31 TAZs found to have no 2010 population but had growth potential. Their 2018 population was estimated as: 0 + (1201/31) = 39

- Group quarters population remained unchanged from 2010 through 2018.
- Households in 2018 were developed based on year 2018 TAZ population using existing year 2010 population per household ratios.

Table 2.1 displays the estimated 2018 household data within the study area.

Table 2.1: Study Area Households and Population, Base Year 2018

Variable	Total
Total Population	155,866
Household Population	150,332
Households	59,570

Source: Census 2010; NSI, 2020

Employment Data Development

The initial InfoUSA employment layer from the MTP 2040 was used to locate the employers within the study area; however, it required updating to the base year. A point layer showing new business locations since the MTP 2040, and number of employees at them, was created based on data obtained from several sources, including the Louisiana Workforce Commission (LWC) and Google searches. The two layers were merged to create the 2018 employment layer, with the following adjustments made to employment to meet the established employment control total, which was developed based on the data obtained from the LWC:

- Added employment for the new IBM facility and expansion of Century Link in Monroe.
- Added seven (7) percent growth to the ULM employment based to match the school enrollment growth.
- Adjusted employment at Delta Community College to reflect the campus expansion.
- Added one (1) percent growth to businesses in areas with an attraction ratio, based on spacial analysis conducted as part of the study, greater than 0.5.
- Distributed the remaining employee growth numbers uniformly among the different businesses in Ouachita Parish.

After updating employer data, these jobs were organized by NAICS category into five categories:

- Agriculture, Mining and Construction (NAICS 11, 21, 23)
- Manufacturing, Transportation/Communications/Utilities, and Wholesale Trade (NAICS 31-33, 48-49, 22, 42)
- Retail Trade (NAICS 44-45, NAICS 72)
- Government, Office, and Services (NAICS 51-56, 61, 62, 71, 81, 92)
- Other Employment (NAICS 99)

Table 2.2 displays the study area employment by type.

Table 2.2: Study Area Households and Population, Base Year 2018

Variable	Description	Total
TOT_EMP	Total Employment	79,101
AMC_EMP	Agriculture, Mining and Construction Employment	4,207
MTCUW_EMP	Manufacturing, Transportation/Communications/Utilities and Wholesale Trade Employment	13,762
RET_EMP	Retail Employment	17,546
OS_EMP	Government, Office and Services Employment	42,962
OTH_EMP	Other Employment	624

Source: InfoUSA; NSI, 2020

School Enrollment Data Development

The MTP 2045 school enrollment uses data received from the National Center for Education Statistics. This data was used to geocode and assign schools to the TAZs in the TDM, along with each school's total enrollment. School attendance figures include public and private elementary, middle, and high schools; colleges; universities; vocational and business schools. Total school attendance in the study area in 2018 was 44,150 students. For modeling purposes, the school attendance is measured by the number of students attending a school in a traffic zone and *not* by the number of students residing in a traffic zone.

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3.0 Roadway Network

3.1 Network Line Layer

The simulation of travel patterns in a computer model requires a representation of the street and highway system in digital format. The TransCAD model creates such a network from a geographic line layer in GIS. The line layer dataview records contain descriptive information for each link and its properties. Restricted turning movements, called turn prohibitors in the model, are also coded into the network at locations where certain movements are not allowed or physically cannot be made.

Adjustments were made to the model network to update the base year for accuracy.

This network includes:

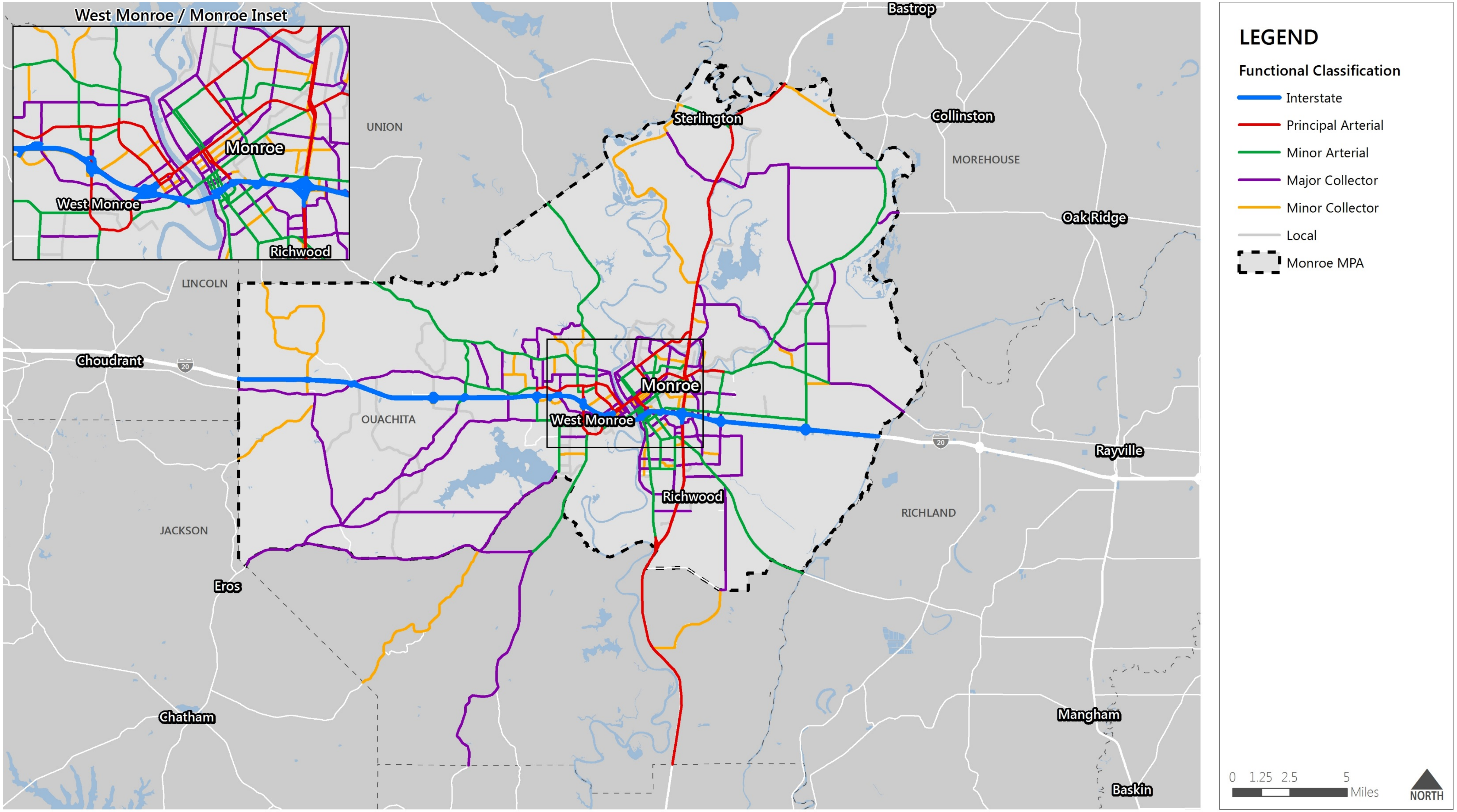
- number of travel lanes and/or turn lanes,
- posted speeds and model speeds,
- functional classification to the most up-to-date data,
- roadway capacities,
- volume-delay function parameters (alpha and beta values), and
- daily traffic counts and traffic stations (where necessary).

The TDM uses a master network in the model's setup folder. This line layer contains the records for all roadway links used in the TDM process. The master network contains the data for the base year, Existing Plus Committed network, and all roadway test projects. Figure 3.1 displays the base year roadway network and link functional classifications used in the TDM.

3.2 Functional Classification

Each link in the model's roadway network was assigned a functional classification based on the system maintained by the Louisiana Department of Transportation and Development (LADOTD). The functional classifications used in the TDM are shown in Table 3.1.

Figure 3.1: Roadway Network and Functional Classification, Base Year



Data Source: LADOTD

Disclaimer: This map is for planning purposes only.

Table 3.1: Functional Classification Used in MPO Model

FHWA Functional Classification		Description	LADOTD Functional Classification Number
Rural	01	Interstate	1
	02	Other Principal Arterial	2
	06	Minor Arterial	6
	07	Major Collector	7
	08	Minor Collector	8
	09	Local	9
	N/A	Ramp	**
Urban	11	Interstate	11
	12	Freeway/Expressway	12
	14	Principal Arterial	14
	16	Minor Arterial	16
	17	Collector	17
	19	Local	19
	N/A	Ramp	**
Other	N/A	System Ramp	**
	N/A	Centroid Collector	0

**NOTE: Ramps follow the same functional classification as the primary roadway they connect to.

Source: FHWA, LADOTD

3.3 Model Link Speeds and Capacities

Roadway speeds and capacities are important inputs for the TDM that affect the traffic assignment model. The posted speed, which is assumed to be the free flow speed, for each roadway link is contained in the network database. The model uses capacity factors based on several inputs, which are shown in Figure 3.2. The capacity inputs consider factors such as:

- Roadway functional classification
- Lane and shoulder widths
- Location of roadway in an urban or rural area
- Number of lanes
- Presence of a median or dividing feature
- Presence and width of shoulder on roadway

Figure 3.2: Model Capacity Factors

Link Capacity (LOS D)

Vehicles per lane per hour - vphpl

Functional Class		vphpl Directional
All Interstate		
2 Lanes		2,300
>2 Lanes		2,400
Principal Arterial		
Rural	Divided	1,700
Rural	Undivided	1,500
Urban	Divided	1,500
Urban	Undivided	1,300
Minor Arterial		
Rural	Divided	1,600
Rural	Undivided	1,350
Urban	Divided	1,400
Urban	Undivided	1,150
Collector		
Rural	Divided	1,350
Rural	Undivided	1,150
Urban	Divided	1,150
Urban	Undivided	950
Local		
Rural	2 Lane	900
Rural	>2 Lane	1,000
Urban	2 Lane	800
Urban	>2 Lane	900
Ramps		1,000
Centroid Connectors		9,999

SF = c x N x Fw x Fhv x Fp x Fe x Fd x Fctl x Fpark X (V/C)i

SF = Model vphpl for desired level of service
c = Ideal vphpl
N = Number of Lanes
(V/C)I = Rate of service flow for level of service D

Adjustment Factors

Acronym	Name	Facility Type	Lane	Shoulder	Factor
Fw	Lane & Shoulder Width	Interstate & Sys Ramp	<=10'	0-<2'	0.78
		Interstate & Sys Ramp	<=10'	2'-5'	0.83
		Interstate & Sys Ramp	<=10'	>5'	0.88
		Interstate & Sys Ramp	>10'	0-<2'	0.90
		Interstate & Sys Ramp	>10'	2'-5'	0.95
		Interstate & Sys Ramp	>10'	>5'	1.00
		Principal Arterial Div	<=10'	0-<2'	0.78
		Principal Arterial Div	<=10'	2'-5'	0.83
		Principal Arterial Div	<=10'	>5'	0.88
		Principal Arterial Div	>10'	0-<2'	0.92
		Principal Arterial Div	>10'	2'-5'	0.96
		Principal Arterial Div	>10'	>5'	1.00
		Principal Arterial Undiv	<=10'	0-<2'	0.78
		Principal Arterial Undiv	<=10'	2'-5'	0.82
		Principal Arterial Undiv	<=10'	>5'	0.86
		Principal Arterial Undiv	>10'	0-<2'	0.90
		Principal Arterial Undiv	>10'	2'-5'	0.95
		Principal Arterial Undiv	>10'	>5'	1.00
		Minor Arterial Div	<=9'	0-<2'	0.81
		Minor Arterial Div	<=9'	2'-5'	0.86
		Minor Arterial Div	<=9'	>5'	0.93
		Minor Arterial Div	>9'	0-<2'	0.94
		Minor Arterial Div	>9'	2'-5'	1.00
		Minor Arterial Div	>9'	>5'	1.05
		Minor Arterial Undiv	<=9'	0-<2'	0.77
		Minor Arterial Undiv	<=9'	2'-5'	0.83
		Minor Arterial Undiv	<=9'	>5'	0.88
		Minor Arterial Undiv	>9'	0-<2'	0.89
		Minor Arterial Undiv	>9'	2'-5'	0.95
		Minor Arterial Undiv	>9'	>5'	1.00
		Collector Div	<=9'	0-<2'	0.81
		Collector Div	<=9'	2'-5'	0.86
		Collector Div	<=9'	>5'	0.93
		Collector Div	>9'	0-<2'	0.96
		Collector Div	>9'	2'-5'	1.00
		Collector Div	>9'	>5'	1.05
		Collector Undiv	<=9'	0-<2'	0.81
		Collector Undiv	<=9'	2'-5'	0.85
		Collector Undiv	<=9'	>5'	0.90
		Collector Undiv	>9'	0-<2'	0.94
		Collector Undiv	>9'	2'-5'	1.00
		Collector Undiv	>9'	>5'	1.04
		Local 2 Lane	<=9'	0-<2'	0.65
		Local 2 Lane	<=9'	2'-5'	0.78
		Local 2 Lane	<=9'	>5'	0.90
		Local 2 Lane	>9'	0-<2'	0.85
		Local 2 Lane	>9'	2'-5'	1.00
		Local 2 Lane	>9'	>5'	1.04
		Local >2 Lane	<=9'	0-<2'	0.81
		Local >2 Lane	<=9'	2'-5'	0.85
		Local >2 Lane	<=9'	>5'	0.92
		Local >2 Lane	>9'	0-<2'	0.96
		Local >2 Lane	>9'	2'-5'	1.00
		Local >2 Lane	>9'	>5'	1.10
Fhv	Heavy Vehicle	Interstate			0.88
		Principal Arterial			0.90
		Minor Arterial			0.90
		Collector			0.92
		Local			0.97
Fp	Driver Population	Rural Interstate			0.90
		Urban Interstate			0.92
		System Ramp			0.92
		Principal Arterial			0.95
		Minor Arterial			0.98
		Collector			NA
		Local			NA
Fe	Driving Environment	Interstate			NA
		Rural Prin Art	Divided		1.00
		Rural Prin Art	Undivided		0.90
		Urban Prin Art	Divided		0.90
		Urban Prin Art	Undivided		0.80
		Rural Minor Art	Divided		1.00
		Rural Minor Art	Undivided		0.90
		Urban Minor Art	Divided		0.90
		Urban Minor Art	Undivided		0.80
		Rural Collector	Divided		1.00
		Rural Collector	Undivided		0.90
		Urban Collector	Divided		0.90
		Urban Collector	Undivided		0.80
		Rural Local	2 Lane		0.90
		Rural Local	>2 Lane		0.90
		Urban Local	2 Lane		0.80
		Urban Local	>2 Lane		0.80
Fd	Directional Distribution (Local only)	2 Lane	Divided		0.94
		>2 Lane	Divided		1.16
		2 Lane	Undivided		0.94
		>2 Lane	Undivided		1.10
Fctl	Center Turn Lane	Interstate			NA
		All Other			1.08
Fpark	On Street Parking	Any			0.95

Source: Nashville Model

3.4 Centroid Connectors

Centroid connectors are imaginary roadway network links that connect a TAZ's centroid to the adjacent roadway network at nodes. These links represent the local streets on the street and highway system that are not in the model network. Centroid connectors provide the model the ability to move trips generated from individual TAZs to the roadway network. Where centroid connectors access the model network is based on features such as neighborhood roadway entrances, driveways, and parking lots.

During the TDM update, the centroid connectors were adjusted to match locations where traffic is most likely to access the model's roadways. This was accomplished by relocating the centroid for the TAZ to reflect the "center of mass" of developed land and/or moving the centroid connector roadway network access points to a location where trips generally enter or leave the TAZ. This changes the length of the centroid connectors and the travel times on the links to encourage modeled traffic to use certain access points to reflect the observed traffic.

3.5 Traffic Counts

The TDM contains traffic volumes received from LADOTD and reflect the 2018 base year volumes. The model calibration and validation process included the verification of count stations upon the existing TDM links and ensuring that the ADTs are assigned to the correct link, with adjustments made as necessary.

3.6 Network Attributes

Table 3.2 displays the network attributes used on the links in the TDM.

Table 3.2: Model Link Attributes

Attribute Name	Description	Input Type
LENGTH	Real (4 bytes) Segment length in miles	Automatic
DIR	Integer (2 Bytes) 0 = Two way link 1 = one way link, AB fields will be used -1 = one way link, BA fields will be used.	Automatic but user can override.
FULL_NAME	Character Street Name	User
ADT_18	Integer (4 bytes) 2018 Daily Traffic Count	User

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DIR_18	Integer (2 Bytes) 2018 Link Direction 0 = Two way link 1 = one way link, AB fields will be used -1 = one way link, BA fields will be used.	User
NETWORK_18	Integer (2 bytes) 1= Network Road link 2= Centroid connector 0 or null= Link will not be included in the model run	User*
AB_DOTD_FC_18	Integer (4 bytes) Refer to Table 3.1	User
BA_DOTD_FC_18	Integer (4 bytes) Refer to Table 3.1	User
DOTD_FC_DESC_18	Character Refer to Table 3.1	User
MODEL_FC_18	Integer (4 bytes) Model functional classification code	User*
MODEL_FC_DESC_18	Character Model functional classification description	User
AB_CLASS_18	Integer (4 bytes) Field denoting number of lanes and configuration in AB direction	User
BA_CLASS_18	Integer (4 bytes) Field denoting number of lanes and configuration in BA direction	User
POSTED_SPEED_18	Integer (4 bytes) Posted Link Speed (mph)	User
AB_SPEED_18	Real (8 bytes) Link speed (mph) in AB direction	User*
BA_SPEED_18	Real (8 bytes) Link speed (mph) in BA direction	User*
LANES_18	Integer (4 bytes) Number of lanes for the roadway	User
AB_LANES_18	Integer (4 bytes) Number of lanes in AB direction	User*
BA_LANES_18	Integer (4 bytes)	User*

	Number of lanes in BA direction	
ALPHA_18	Real (8 bytes) BPR Function Parameter	User*
BETA_18	Real (8 bytes) BPR Function Parameter	User*
AB_TT_18	Real (8 bytes) Link travel time in AB direction	Model
BA_TT_18	Real (8 bytes) Link travel time in BA direction	Model
AB_AM_TT_18	Real (4 bytes) Morning link travel time in AB direction	Model
BA_AM_TT_18	Real (4 bytes) Morning link travel time in BA direction	Model
AB_MD_TT_18	Real (4 bytes) Midday link travel time in AB direction	Model
BA_MD_TT_18	Real (4 bytes) Midday link travel time in BA direction	Model
AB_PM_TT_18	Real (4 bytes) Afternoon link travel time in AB direction	Model
BA_PM_TT_18	Real (4 bytes) Afternoon link travel time in BA direction	Model
AB_NT_TT_18	Real (4 bytes) Night-time link travel time in AB direction	Model
BA_NT_TT_18	Real (4 bytes) Night-time link travel time in BA direction	Model
OP_COST_18	Real (4 bytes) Operating cost	User
TOLL_COST_18	Real (4 bytes) Toll cost	User
Fw_18	Real (8 bytes) Capacity factor for lane and shoulder width	User
Fhv_18	Real (8 bytes) Capacity factor for heavy vehicles	User
Fp_18	Real (8 bytes) Capacity factor for driver population	User

Fe_18	Real (8 bytes) Capacity factor for driving environment	User
Fd_18	Real (8 bytes) Capacity factor for directional distribution	User
Fctl_18	Real (8 bytes) Capacity factor for center turn lanes	User
Fpark_18	Real (8 bytes) Capacity factor for on street parking	User
Fall_18	Real (8 bytes) Overall capacity factor	User
IDEAL_VPHPL_18	Real (8 bytes) Maximum capacity in vehicles/hour/lane	User
AB_VPHPL_18	Real (8 bytes) Capacity in AB direction in vehicles/hour/lane	User
BA_VPHPL_18	Real (8 bytes) Capacity in AB direction in vehicles/hour/lane	User
IS_MANUAL_CAP_18	Integer (2 bytes) 0 or null= Model calculates the link capacity Any other value= Link capacity value input by User will be retained	User*
AB_CAPACITY_18	Integer (4 bytes) Capacity in AB direction	Model
BA_CAPACITY_18	Integer (4 bytes) Capacity in BA direction	Model
AB_CAP_AM_18	Integer (4 bytes) Morning capacity in AB direction	Model
BA_CAP_AM_18	Integer (4 bytes) Morning capacity in BA direction	Model
AB_CAP_MD_18	Integer (4 bytes) Mid-day capacity in AB direction	Model
BA_CAP_MD_18	Integer (4 bytes) Mid-day capacity in BA direction	Model
AB_CAP_PM_18	Integer (4 bytes) Afternoon capacity in AB direction	Model
BA_CAP_PM_18	Integer (4 bytes) Afternoon capacity in BA direction	Model
AB_CAP_NT_18	Integer (4 bytes)	Model

	Night time capacity in AB direction	
BA_CAP_NT_18	Integer (4 bytes) Night time capacity in BA direction	Model
DAILY_FLOW	Real (8 bytes) Total daily model volume	Model
AB_DAILY_FLOW	Real (8 bytes) AB directional daily model volume	Model
BA_DAILY_FLOW	Real (8 bytes) BA directional daily model volume	Model
DAILY_TOT_VMT	Real (8 bytes) Total daily vehicle miles travelled	Model
DAILY_AB_VMT	Real (8 bytes) AB directional daily vehicle miles travelled	Model
DAILY_BA_VMT	Real (8 bytes) BA directional daily vehicle miles travelled	Model
DAILY_TOT_VHT	Real (8 bytes) Total daily vehicle hours travelled	Model
DAILY_AB_VHT	Real (8 bytes) AB directional daily vehicle hours travelled	Model
DAILY_BA_VHT	Real (8 bytes) BA directional daily vehicle hours travelled	Model
DAILY_TOT_VHD	Real (8 bytes) Total daily vehicle hours delay	Model
DAILY_AB_VHD	Real (8 bytes) AB directional daily vehicle hours delay	Model
DAILY_BA_VHD	Real (8 bytes) BA directional daily vehicle hours delay	Model
DAILY_AB_VOC	Real (8 bytes) AB directional volume/capacity	Model
DAILY_BA_VOC	Real (8 bytes) BA directional volume/capacity	Model
DAILY_MAX_VOC	Real (8 bytes) Higher of AB and BA volume/capacity	Model
DAILY_TRK_FLOW	Real (8 bytes) Total daily model truck volume	Model
AB_DAILY_TRK_FLOW	Real (8 bytes) AB directional daily model truck volume	Model

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BA_DAILY_TRK_FLOW	Real (8 bytes) AB directional daily model truck volume	Model
Note: *: These fields must be filled in within the network for the model scenario to function. 1. Each of the suffix "18" fields should be repeated for EC, VIS, and SCE suffixes as well. 2. Volume-delay function parameter fields ALPHA_18 and BETA_18 are based on BPR function. 3. In addition to the base year fields, each planned year should have a field called "PROJECT_[suffix]" of type Integer. This field should have a unique project number for each committed or planned project.		

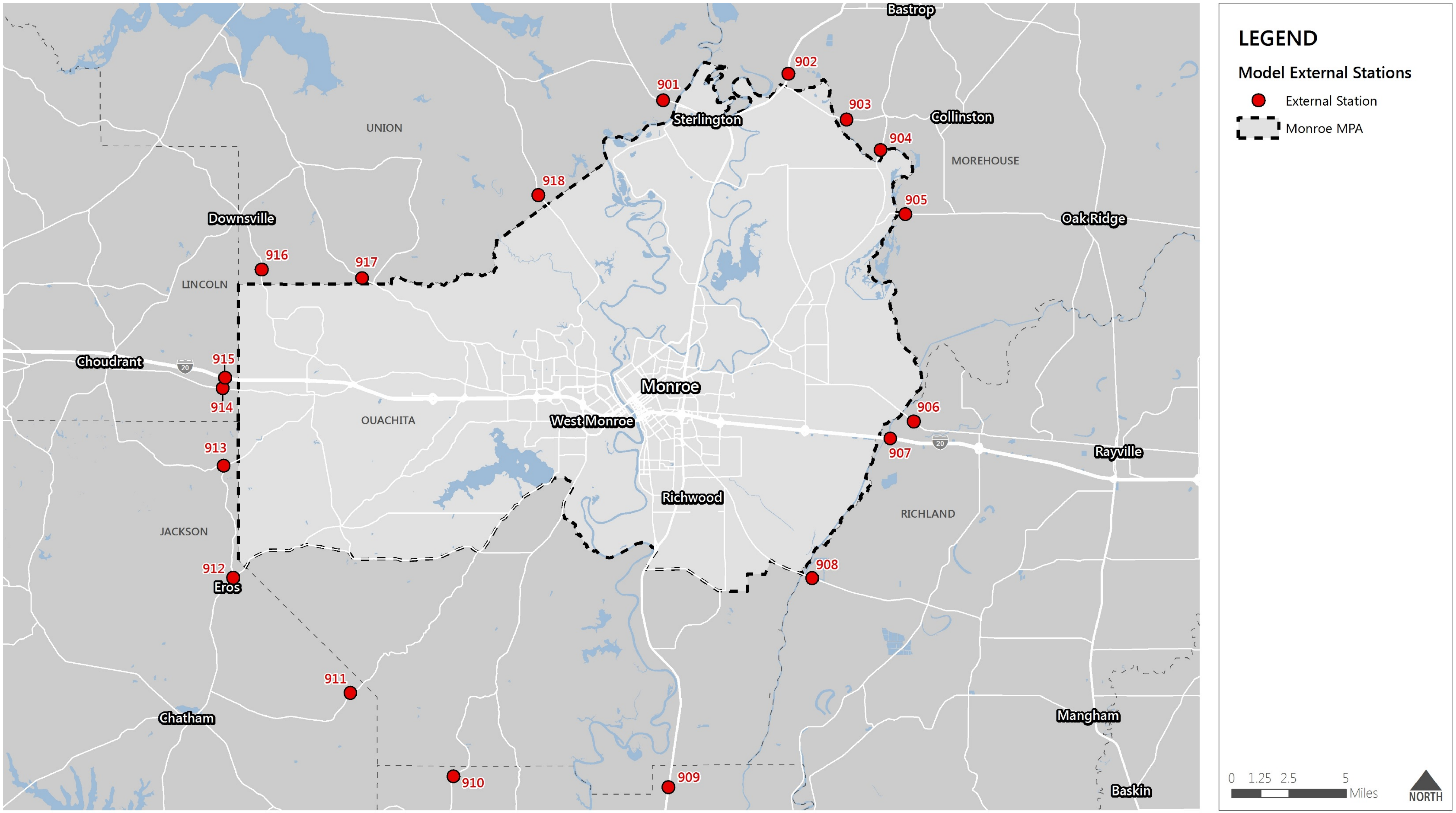
Source: NSI, 2020

4.0 External Travel

There are two (2) types of external travel trips: external-internal (EI) trips and external-external (EE) trips. EI trips have one (1) end of the trip inside the study area, and the other outside. EE trips pass through the study area, but have no origin or destination within the study area itself. Both trip types are assigned at external stations located on significant roadways that are at the study area's periphery. These stations represent most of the trips that are crossing the study area boundary. The locations of the TDM's external stations are shown in Figure 4.1.

External trips in the model are divided into auto trips (AUTO) and truck (TRK) trips. Auto trips are those that are made in a personal vehicle. While not actually an auto trip, commercial vehicle (CMVEH) trips are included in AUTO trips for the purposes of external trips and represent four-tire commercial vehicles. Commercial vehicles include delivery and service vehicles. Truck trips represent single-unit with six or more tires and multi-unit with three-plus axle combination trucks.

Figure 4.1: Model External Stations



Data Source: Monroe MPO

Disclaimer: This map is for planning purposes only.

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4.1 External-External Trips

The MTP 2045 TDM uses the same distribution of external-external trip matrices that were used in the MTP 2040, but updated with the most recent traffic counts. The Fratar procedure was used to obtain balanced trips crossing the study area boundary. Table 4.1 displays the expanded 24 hour EE trip table for all vehicles.

4.2 External-Internal Trips

During model development, EI trips were separated into auto and truck trips based on the vehicle classification counts at external stations.

The following EI attraction equations were used in the travel demand model for EIAUTO and EITRK trips.

EIAUTO Attractions = 0.1958 * (OCCDU) + 0.6561 * (RET_EMP + RET_EMP2) +

0.1989 * (AMC_EMP + MTCUW_EMP + OS_EMP + OTH_EMP)

EITRK Attractions = 0.1160 * (RET_EMP + RET_EMP2) +

0.0930 * (AMC_EMP + MTCUW_EMP)

Note: RET_EMP2 is not used in the Monroe TDM.

Descriptions of the variables used in the equations were included in Tables 2.1 and 2.2. Table 4.2 displays the EI trips at each external station.

Table 4.1: Expanded 24-Hour EE Trip Table for All Vehicles

TAZ	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	Total
901	0.0	210.6	0.0	0.0	0.0	0.0	45.4	23.4	30.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	309.6
902	210.6	0.0	0.0	0.0	0.0	61.5	97.3	12.4	202.7	0.7	1.3	27.9	13.8	56.7	1,402.0	0.0	0.0	20.7	2,107.6
903	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
904	0.0	0.0	0.0	0.0	0.0	0.0	37.7	0.0	0.0	0.0	0.0	0.0	0.3	0.0	128.7	0.0	0.0	0.0	166.7
905	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.1	0.0	0.0	32.6	0.0	0.0	0.0	34.7
906	0.0	61.5	0.0	0.0	0.0	0.0	140.5	0.0	35.3	0.0	0.0	0.0	0.0	0.0	41.6	0.0	0.0	0.0	279.1
907	45.4	97.3	0.0	37.7	0.0	140.5	0.0	38.2	227.5	1.2	4.6	58.6	61.9	204.7	7,969.4	50.3	75.9	182.5	9,195.5
908	23.4	12.4	0.0	0.0	0.0	0.0	38.2	0.0	18.3	0.0	0.0	0.0	0.0	0.0	85.3	0.3	6.4	0.0	184.3
909	30.3	202.7	0.0	0.0	1.9	35.3	227.5	18.3	0.0	0.1	0.0	38.2	0.0	25.5	867.2	6.8	0.0	0.0	1,453.6
910	0.0	0.7	0.0	0.0	0.0	0.0	1.2	0.0	0.1	0.0	0.0	0.0	0.0	0.1	4.5	0.0	0.1	0.0	6.7
911	0.0	1.3	0.0	0.0	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9
912	0.0	27.9	0.0	0.0	0.1	0.0	58.6	0.0	38.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	124.8
913	0.0	13.8	0.0	0.3	0.0	0.0	61.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	76.0
914	0.0	56.7	0.0	0.0	0.0	0.0	204.7	0.0	25.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	287.0
915	0.0	1,402.0	0.0	128.7	32.6	41.6	7,969.4	85.3	867.2	4.5	0.0	0.0	0.0	0.0	0.0	0.0	135.7	0.0	10,667.0
916	0.0	0.0	0.0	0.0	0.0	0.0	50.3	0.3	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.4
917	0.0	0.0	0.0	0.0	0.0	0.0	75.9	6.4	0.0	0.1	0.0	0.0	0.0	0.0	135.7	0.0	0.0	0.0	218.2
918	0.0	20.7	0.0	0.0	0.0	0.0	182.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	203.2
Total	309.6	2,107.6	0.0	166.7	34.7	279.1	9,195.5	184.3	1,453.6	6.7	5.9	124.8	76.0	287.0	10,667.0	57.4	218.2	203.2	25,377.3

Source: NSI, 2020

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Table 4.2: External Station EI Data

Station Number	Description	EI AUTO Trips	EI TRK Trips
901	LA 2	4,997	263
902	US 165 N	5,233	918
903	LA 554	523	28
904	LA 139	4,072	214
905	LA 134	1,265	67
906	US 80 E	873	46
907	1-20 E	14,731	4,867
908	LA 15 S	2,228	117
909	US 165 S	4,607	70
910	LA 557	214	11
911	LA 548	126	7
912	LA 34	3,003	158
913	LA 144	1,993	105
914	US 80 W	2,180	115
915	I-20 W	11,200	3,783
916	LA 151	695	37
917	LA 15 N	3,057	161
918	LA 143	4,092	216

Source: NSI, 2020

5.0 Trip Generation

This section describes the procedures used to determine the number of trips that begin or end in a given traffic zone. Trip generation is the estimation of the amount of person trips that are produced and attracted to each TAZ. Trip rates for the various types of trips are based upon the land use properties and demographic characteristics of each TAZ.

The model considers the following internal trip purposes:

- Home-based Work (HBW)
- Home-based Other (HBO)
- Non-home-based (NHB)
- Commercial Vehicle (CMVEH)
- Truck (TRK)

Home-based trips are those that have one (1) trip end located at the traveler's household. Examples of home-based trips include travel from home to work, shopping, or other personal business. Non-home-based trips include travel to and from any location that does not involve the traveler's household. Examples of these trips can include travel from work to shopping, from school to daycare, and from work to a lunch location.

5.1 Internal Travel Model

For home-based trips, the productions refer to the home end, and the attractions refer to the non-home end of the trip. For NHB, CMVEH, and TRK trips, productions and attractions refer to the origin and destination respectively.

The model uses cross-classification trip production models for the home-based and non-home-based trip purposes. This means that trip rates that vary by household type are applied at the zonal level. The trip attraction models are linear regression equations that relate zonal employment, school enrollment, and households to trip attractions. For the commercial vehicle and freight vehicle trip purposes, the model applies a linear regression equation that relates zonal employment and households to trip productions and attractions. These equations are based on the Quick Response Freight Manual II.

The trip production and attraction models used in the MTP 2040 were checked and adjusted for reasonableness to create the MTP 2045 trip models. The final trip generation production and attraction models for HBW, HBO, and NHB trips are shown in Tables 5.1 and 5.2 respectively. The final trip generation production and attraction models for CMVEH and TRK trips are shown in Tables 5.3 and 5.4 respectively.

Table 5.1: HBW, HBO, and NHB Trip Production Rates

Trip Purpose	Number of Vehicles	Household Size				
		HHS1	HHS2	HHS3	HHS4	HHS5P
HBW	VEH0	0.5809	1.1800	1.5711	1.9523	2.1269
	VEH1	0.8938	1.6465	1.9523	2.4411	2.6017
	VEH2	0.8938	1.9914	2.2498	2.8237	3.1715
	VEH3P	0.8938	2.0640	2.5263	3.2050	3.4186
HBO	VEH0	1.2152	2.2443	3.4595	4.3003	5.2353
	VEH1	1.8699	3.1316	4.3003	5.3760	6.4040
	VEH2	1.8699	3.7863	4.9550	6.2179	7.8064
	VEH3P	1.8699	3.9270	5.5632	7.0587	8.4145
NHB	VEH0	0.8111	1.3823	2.2190	2.5383	2.8217
	VEH1	1.2474	1.9281	2.7587	3.1725	3.4514
	VEH2	1.2474	2.3314	3.1785	3.6688	4.2070
	VEH3P	1.2474	2.4184	3.5683	4.1650	4.5339

Source: NSI, 2020

Table 5.2: HBW, HBO, and NHB Trip Attraction Rates

	OCCDU	RET_EMP	RET_EMP2	OS_EMP	OTH_EMP	AMC_EMP	MTCUW_EMP	SCHATT
HBW	0.0000	1.4981	1.4981	1.4981	1.4981	1.4981	1.4981	0.0000
HBO	0.6928	6.9277	6.9277	1.3086	0.3849	0.3849	0.3849	0.5062
NHB	0.4326	3.5475	3.5475	1.0383	0.4326	0.4326	0.4326	0.2221

Source: NSI, 2020

Table 5.3: CMVEH and TRK Trip Production Rates

	OCCDU	RET_EMP	RET_EMP2	OS_EMP	OTH_EMP	AMC_EMP	MTCUW_EMP
CMVEH	0.1632	0.5772	0.5772	0.2841	0.2841	0.7215	0.6097
TRK	0.0501	0.1163	0.1163	0.0282	0.0282	0.1693	0.1265

Source: NSI, 2020

Table 5.4: CMVEH and TRK Trip Attraction Rates

	OCCDU	RET_EMP	RET_EMP2	OS_EMP	OTH_EMP	AMC_EMP	MTCUW_EMP
CMVEH	0.1632	0.5772	0.5772	0.2841	0.2841	0.7215	0.6097
TRK	0.0501	0.1163	0.1163	0.0282	0.0282	0.1693	0.1265

Source: NSI, 2020

5.2 Special Generators

A special generator is a land use with unusually low or high trip generation characteristics when compared to the established trip generation rates. For the Monroe TDM there were no special generators included.

5.3 Balancing Productions and Attractions

Productions and attractions are balanced at the study area level for all trip purposes. This means that the area-wide trip attractions match the amount of area-wide trip productions. HBW, HBO, and TRK trips are balanced by holding the productions as a constant. The NHB and CMVEH trips are balanced by holding the attractions as a constant. This reflects that the trips produced at the households or trip origins must be equal to the total number of trips attracted to the non-home ends or destinations. Table 5.5 shows the daily trips by trip purpose before and after balancing.

Table 5.5: Balanced Productions and Attractions

Trip Purpose	Before Balancing		After Balancing	
	Productions	Attractions	Productions	Attractions
HBW	114,749	118,501	114,749	114,749
HBO	245,039	248,549	245,039	245,039
NHB	149,049	150,471	150,471	150,471
CMVEH	43,658	43,658	43,658	43,658
TRK	8,707	8,704	8,707	8,707

Source: NSI, 2020

5.4 Summary

Two separate documents were used in the calibration and validation of the Monroe MPO TDM. The first is the *Minimum Travel Demand Model Calibration and Validation Guidelines for State of Tennessee*, which was last updated in 2016. The second is the *Travel Model Validation and Reasonableness Checking Manual, 2nd Edition*.[2] Using these guidelines, several key statistics for trip generation were monitored. Those key statistics are shown in Table 5.6.

Table 5.6: Modeled vs Benchmark Trip Rates

Trip Rate	Modeled	Low Benchmark	High Benchmark
Person Trips per Person	3.8	3.3	4.0
Person Trips per Household	9.7	8.0	10.0
HBW Trips	22.9%	12.0%	24.0%
HBO Trips	49.0%	45.0%	60.0%
NHB Trips	28.1%	20.0%	33.0%

Source: Minimum Travel Demand Model Calibration and Validation Guidelines for State of Tennessee; NSI, 2020

These statistics are within the reasonable limits established by the Tennessee Model User's Group (TNMUG) guidance. No further adjustments were made since the model was performing well within all other benchmark ranges.

5.5 Time of Day

The speed feedback loop implemented within the TDM requires that the production and attractions are split into four different time periods during Trip Generation. This time of day split is based on factors derived from data obtained from StreetLight. The time of day factors are shown in Table 5.7. The four assignment time periods are:

- AM Peak Period: 6:00 AM to 9:00 AM
- Mid-Day: 9:00 AM to 3:00 PM
- PM Peak Period: 3:00 PM to 6:00 PM
- Night: 6:00 PM to 6:00 AM

[2] Travel Model Validation and Reasonableness Checking Manual, 2nd Edition. Travel Model Improvement Program.

Table 5.7: Trip Generation Time of Day Factors

	HBW	HBO	NHB	CMVEH	TRK	EIAUTO	EITRK
AM	0.3413	0.1232	0.1168	0.1168	0.1540	0.2373	0.1352
MD	0.2459	0.2815	0.4953	0.4953	0.3960	0.3410	0.3442
PM	0.2445	0.2667	0.2392	0.2392	0.1440	0.2274	0.1570
NIGHT	0.1683	0.3286	0.1487	0.1487	0.3060	0.1943	0.3636

Source: NSI, 2020

6.0 Trip Distribution

The next step in travel demand modeling is the trip distribution process. This function determines the destinations of trips produced in the trip generation model, and conversely, where the attracted trips originated.

6.1 Gravity Model

Many models are available for this process; however, the TDM effort used the traditional gravity model.

This model employs two relationships, the first of which is indirect:

> The shorter the travel time to the destination zone, the greater the number of trips will be distributed to it from the origin zone.

The second relationship is direct:

> The more attractions there are in a destination zone, the more trips will be distributed to it from the origin zone.

The generalized equation for this model is:

$$T_{ij} = \frac{(P_i)(A_j)(F_{ij})}{\sum_{j=1}^{n}(A_j)(F_{ij})(K_{ij})}$$

Where:

T_{ij} = Trips distributed between zones i and j

P_i = Trips produced at zone i

A_j = Trips attracted to zone j

F_{ij} = Relative distribution rate (friction factors or impedance function) reflecting impedance between zone i and zone j

K_{ij} = Calibration parameter

n = Total number of zones in study area

6.2 Shortest Path Matrix

The TDM uses a travel time impedance matrix for each zonal pairing within the study area. This matrix traced the shortest free-flow travel time path from zone i (the start of the trip) to zone j (the end of the trip). These values are used in the calculation of F_{ij} as described in Section 6.1.

6.3 Friction Factors

Friction factors are another input used to calculate F_{ij}. This is the first relationship that was mentioned for the gravity model. These factors measure the probability of trip making at one-minute increments of travel time. Friction factors in the gravity model are an inverse function of travel time and each unique trip purpose has its own friction factors. The TDM's friction factor values can be found in the model's FF.bin file.

6.4 Terminal Times

Terminal times reflect additional travel that is associated with a trip. These can be events such as parking or walking to vehicles and/or facilities. This factor was added to the beginning and end of each trip and is stored in a matrix used by the model. The TDM effort uses a one (1) minute terminal time at the beginning and end of each trip.

6.5 Trip Length Frequency Distribution

As mentioned previously, the gravity model develops friction factors in one-minute increments and accommodates various trip lengths. The average trip lengths obtained from the model are displayed in Table 6.1. Figures 6.1 through 6.3 show the modeled trip length frequency distribution for HBW, HBO, and NHB trips.

Table 6.1: Average Trip Length by Trip Purpose

Trip Purpose	2018 Model Average Trip Length (min)	2018 StreetLight Average Trip Length (min)
HBO	16.81	15.45
HBW	14.47	13.88
NHB	11.87	12.18
EI	26.97	25.48

Source: NSI, 2020

Figure 6.1: Modeled HBW Trip Length Frequency Distribution

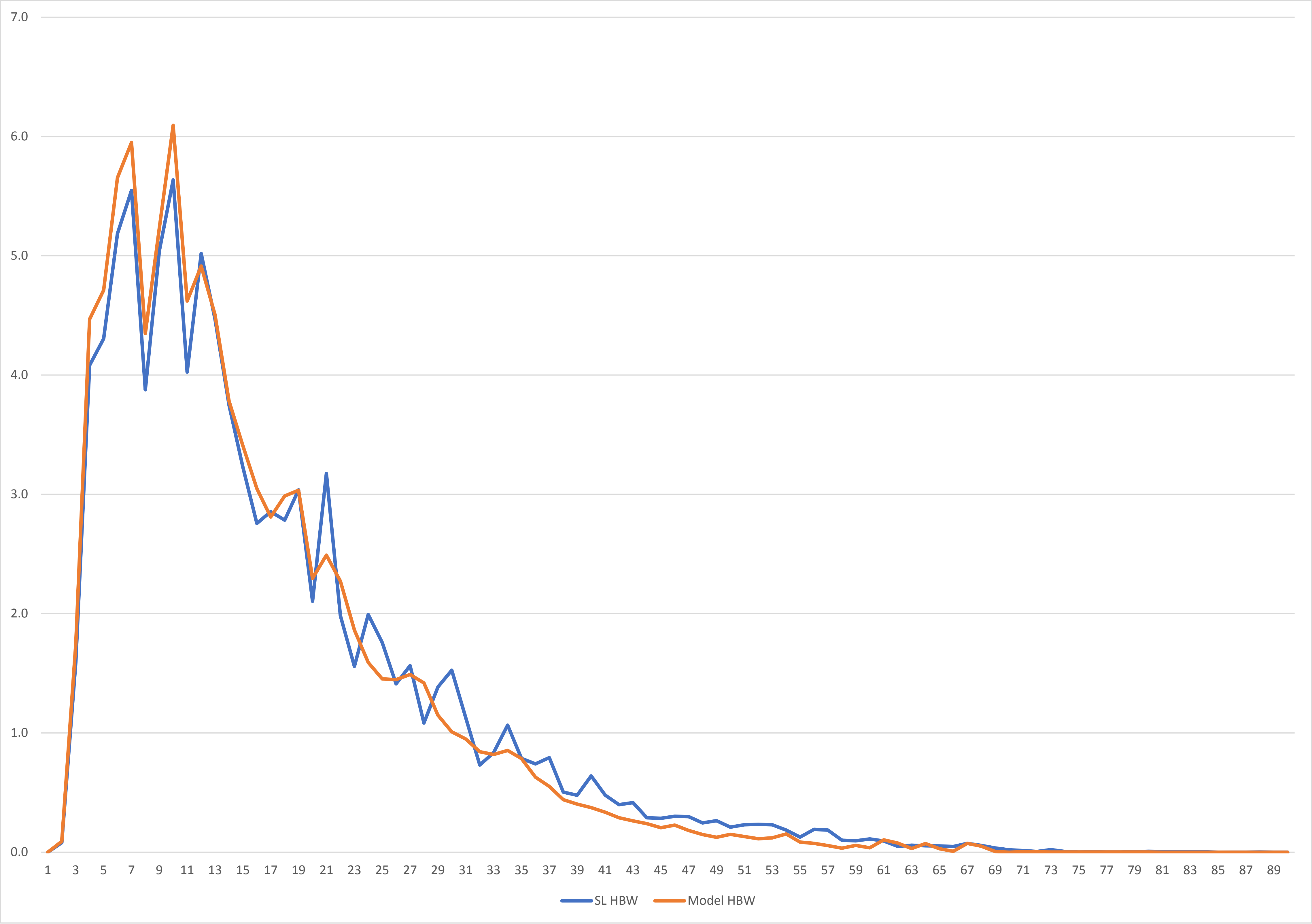


Figure 6.2: Modeled HBO Trip Length Frequency Distribution

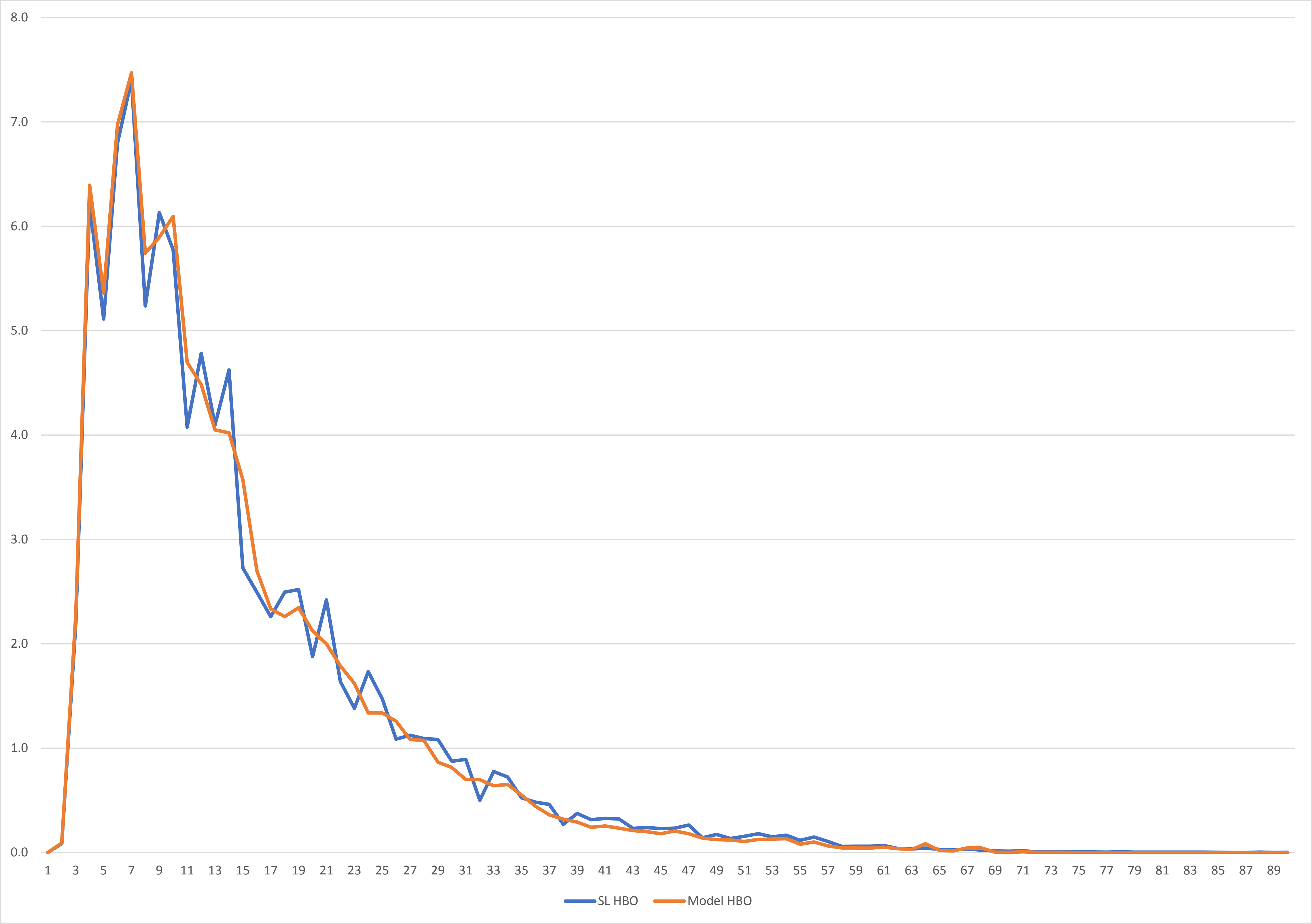


Figure 6.3: Modeled NHB Trip Length Frequency Distribution

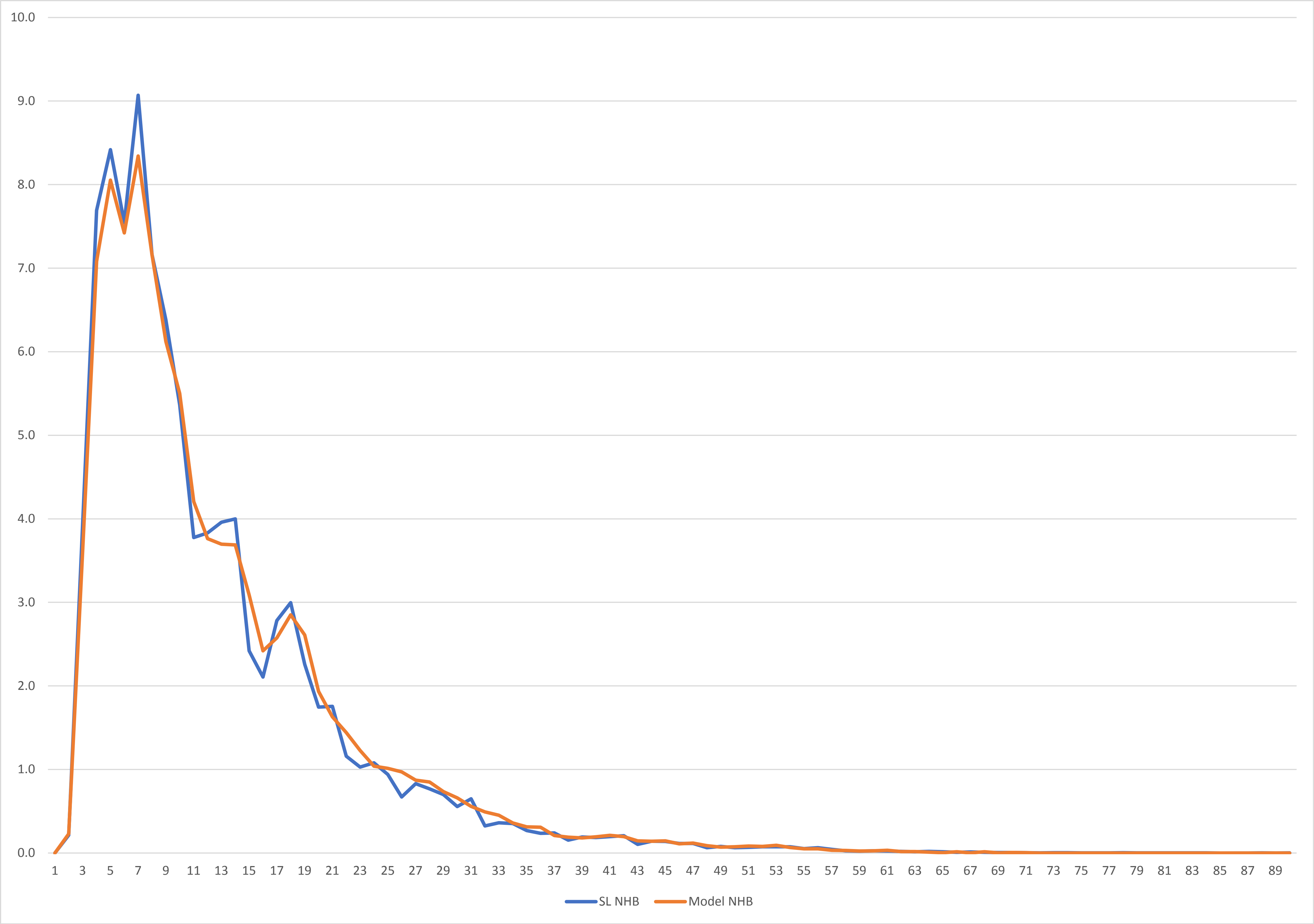
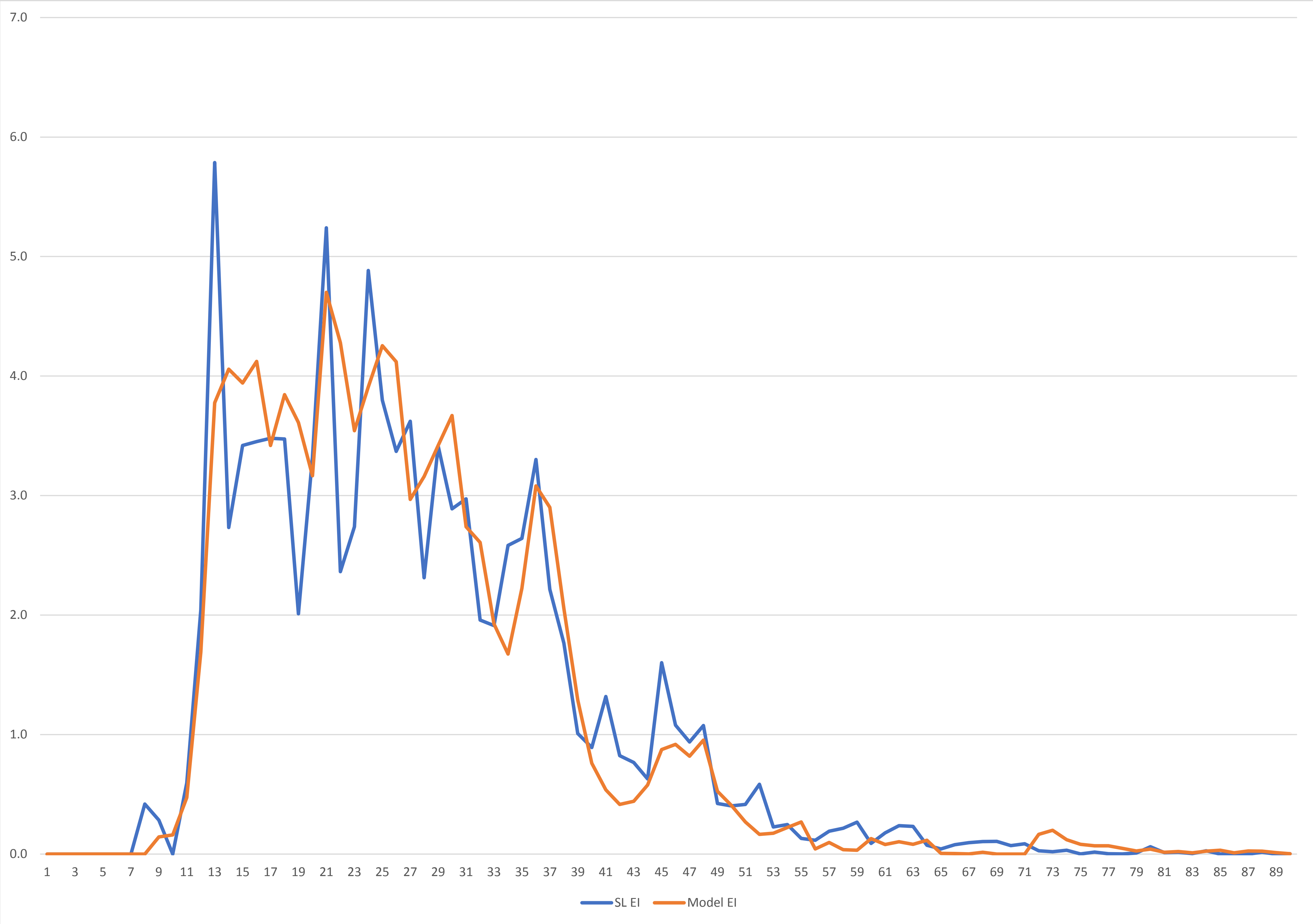


Figure 6.4: Modeled EI Trip Length Frequency Distribution



6.6 Auto Occupancy Rates

The trip rates calculated in the Trip Generation step for HBW, HBO, and NHB trips are in person trips. In order for the TDM to assign vehicles to the roadway network, the amount of trips assigned must be in vehicle trips. This process is done using auto occupancy factors. It divides the amount of person trips by the corresponding occupancy factors shown in Table 6.2.

Table 6.2: Model Auto Occupancy Factors

Trip Purpose	Auto Occupancy Factor
HBW	1.12
HBO	1.92
NHB	1.68
CMVEH	1.00
TRK	1.00

Source: NSI, 2020

7.0 Trip Assignment

Trip assignment is the final step in the traditional four step planning model.

> Traffic assignment models are used to estimate the traffic flows on a network.

The main input to these models is a matrix of flows that indicate the volume of traffic between origin-destination (O-D) pairs. The other inputs to these models are network topology, link characteristics, and link performance functions.

The trips between each O-D pair are loaded onto the network based on the travel time or impedance of the alternative paths that could carry this traffic. The MTP 2045 model is a user equilibrium model with a generalized cost assignment that uses travel time as the cost.

7.1 BPR Volume-Delay Functions

The TDM link travel time was estimated by the Bureau of Public Roads (BPR) Volume-Delay function. The values that were used in the BPR formula are determined by facility type. The TDM uses alpha and beta values assigned by a roadway's functional classification. The assignment process used in the TDM analyzes link and intersection delay. As traffic volume increases on a roadway and approaches its maximum capacity, the average speed on the roadway declines. After a point, the roadway speed declines past that of the free flow speed and indicates congestion.

The generalized equation for the BPR formula is:

$$T = T_0 * (1 + \alpha * (\frac{v}{c})^{\beta})$$

Where: T = Congested travel time

T_0 = Free flow travel time

v = Assigned link volume

c = Capacity

α, β= BRP coefficients

This allows for the calculation of the roadway's peak hour travel:

$$\text{Peak Hour Travel Speed} = (\text{Free Flow Speed})/(1+\alpha*(\frac{v}{c})^{\beta}$$

The BPR coefficients used in the TDM are shown in Table 7.1.

Table 7.1: BPR Volume-Delay Function Parameters

Model Functional Classification	Alpha	Beta
Rural Interstate	0.71	2.10
Rural Principal Arterial	0.71	2.10
Rural Minor Arterial	0.71	2.10
Rural Major Collector	0.60	1.60
Rural Minor Collector	0.60	1.60
Rural Local	0.60	1.60
Rural Other	0.60	1.60
Rural On/Off Ramp	0.56	3.60
Urban Interstate	0.71	2.10
Urban Expressway	0.71	2.10
Urban Principal Arterial	0.71	2.10
Urban Minor Arterial	0.71	2.10
Urban Collector	0.60	1.60
Urban Local	0.60	1.60
Urban Other	0.60	1.60
Urban On/Off Ramp	0.56	3.60
System Ramp	0.71	2.10
Centroid Connector	0.15	4.00

Source: NSI, 2020

8.0 Model Validation

The purpose of model validation is to make the adjustments necessary to replicate the base-year traffic conditions as closely as possible.

In practice, this means making the link assignment volumes approximate the traffic estimates, based on actual counts, within acceptable limits of deviation. Generally speaking, the lower the volume, the greater the relative deviation that is acceptable. Conversely, the greater the amount of traffic, the greater the degree of accuracy required. This is because the ultimate purpose of the model is to determine whether additional vehicular capacity will be needed on any given roadway at a designated future date.

Where existing volumes are low, the model assignment may deviate from actual conditions by 40 or 50 percent without affecting the projected need for additional capacity. In the case of a heavily traveled route, such as an Interstate, a deviation of 20 percent may be significant (i.e., alter the projection of required capacity). The validation process is intended to ensure that the model is performing within the limits that define acceptable ranges of deviation from observed "real-world" values.

As stated previously, this modeling effort uses the *Minimum Travel Demand Model Calibration and Validation Guidelines for State of Tennessee* and the *Travel Model Validation and Reasonableness Checking Manual, 2nd Edition*, as guidelines for the validation of TDMs.

The following criteria were used to validate the Monroe TDM:

- Percent Root Mean Square Error (RMSE) by ADT Group
- Percent RMSE by Roadway Functional Classification
- Percent Error/Deviation by ADT Group
- Percent Error/Deviation by Functional Classification

8.1 Percent RMSE

The RMSE measure was chosen because when comparing model flows versus counts, sometimes a direct aggregate sum by link group can be misleading. The sum of all traffic counts for a particular link group may be close to the sum of the corresponding traffic flows, but individual link flows may still be very different than their corresponding link count. However, the RMSE statistic does not convey information about the magnitude of the error relative to that of the counts. Therefore, the Percent Root Mean Square Error (Percent RMSE or % RMSE) is often computed. This measure expresses the RMSE as a percentage of the average count value. The Percent RMSE is defined below:

$$\%RMSE = \frac{\sqrt{\sum_j (Model_j - Count_j)^2 / (Numberofcounts)}}{\left(\sum_j Count_j \middle/ Numberofcounts \right)} * 100$$

Validation results by ADT group and functional class are shown in Table 8.1 and Table 8.2 respectively.

Table 8.1: RMSE by ADT Group

ADT Range	Number of Observations	Total Count	Total Model Volume	% RMSE	% RMSE Limit[1]
ADT < 5,000	51	132,042	161,360	53.3	45.0 - 100.0
5,000 ≥ ADT < 10,000	32	230,550	254,249	28.6	35.0 - 45.0
10,000 ≥ ADT < 15,000	24	302,814	314,928	18.8	27.0 - 35.0
15,000 ≥ ADT < 20,000	14	237,111	244,746	18.5	25.0 - 30.0
20,000 ≥ ADT < 30,000	19	458,899	419,650	11.2	15.0 - 27.0
ADT>=30,000	19	727,926	733,577	5.6	15.0 - 25.0
Areawide	159	2,089,342	2,128,511	16.3	35.0 - 45.0

Source: Minimum Travel Demand Model Calibration and Validation Guidelines for State of Tennessee; NSI, 2020

Table 8.2: RMSE by Functional Classification

Functional Classification	Number of Observations	Total Count	Total Model Volume	% RMSE	% RMSE Limit[1]
Interstate	24	852,020	840,170	5.5	20
Principal Arterial	48	744,598	756,883	16.3	30
Minor Arterial	49	377,753	392,967	27.6	40
Collector	35	106,745	130,174	58.9	70
Local	3	8,226	8,315	2.8	N/A
Areawide	159	2,089,342	2,128,511	16.3	35.0 - 45.0

Source: Minimum Travel Demand Model Calibration and Validation Guidelines for State of Tennessee; NSI, 2020

(1) % RMSE Limit is the maximum acceptable magnitude of the error relative to that of the counts conducted by LADOTD

8.2 Percent Error

The next measure of model validation is the percent error, or percent deviation, of the model's assigned traffic volumes to the observed traffic counts. Tables 8.3 and 8.4 display the validation results by ADT group and by facility category respectively.

Table 8.3: Percent Deviation by ADT Group

ADT Range	Number of Observations	Total Count	Total Model Volume	% Deviation	% Deviation Limit[1]
ADT < 1,000	8	4,393	7,528	71.4	200.0
1,000 ≥ ADT < 2,500	16	28,130	40,733	44.8	100.0
2,500 ≥ ADT < 5,000	27	99,519	113,099	13.6	50.0
5,000 ≥ ADT < 10,000	32	230,550	254,249	10.3	25.0
10,000 ≥ ADT < 25,000	50	812,151	809,439	-0.3	20.0
ADT>=25,000	26	914,599	903,463	-1.2	15.0
Areawide	159	2,089,342	2,128,511	1.9	5.0

Source: Minimum Travel Demand Model Calibration and Validation Guidelines for State of Tennessee; NSI, 2020

Table 8.4: Percent Deviation by Functional Classification

Functional Classification	Number of Observations	Total Count	Total Model Volume	% Deviation	% Deviation Limit[1]
Interstate	24	852,020	840,170	-1.4	+/- 7.0
Principal Arterial	48	744,598	756,883	1.6	+/- 15.0
Minor Arterial	49	377,753	392,967	4.0	+/- 15.0
Collector	35	106,745	130,174	21.9	+/- 25.0
Local	3	8,226	8,315	1.1	N/A
Areawide	159	2,089,342	2,128,511	1.9	+/- 5.0

Source: Minimum Travel Demand Model Calibration and Validation Guidelines for State of Tennessee; NSI, 2020

(1) % Deviation Limit is the maximum acceptable magnitude of the error relative to that of the counts conducted by LADOTD

The validation effort concluded that the Monroe study area travel demand forecasting model performs within the established limits of acceptable deviation from base year estimated volumes.

9.0 Future Year Model Development

Future year models were developed to forecast traffic that the study area will experience based on its anticipated growth. This includes forecast socioeconomic data, external travel, and special generator data. Forecast models also require updates to the roadway network based on projects that are expected to occur or have allocated funding in the near future.

9.1 Future Year Socioeconomic Data Development

To adequately forecast future transportation system needs, future projections of demographic variables were developed for each Traffic Analysis Zone (TAZ).

Population and Employment Growth

The following steps summarize the overall procedure that was followed to estimate population and employment growth for TAZs within the Monroe planning area.

1.) Developed Parish level control totals based on stakeholder input and third party estimates.
2.) Identified development status and land availability for each TAZ in the study area.
3.) Identified planned and proposed developments.
4.) Identified TAZ growth types based on Steps 2 and 3:
    a.) Minimal/no growth.
    b.) Low Growth Potential.
    c.) Moderate Growth Potential.
    d.) High Growth Potential.
    e.) Planned Developments Identified.
5.) Determined what type of growth was likely to occur within TAZs with growth potential.
    a.) Residential
    b.) Commercial
    c.) Industrial
6.) Conducted a capacity analysis to determine that maximum populations and jobs that could be added to a TAZ based on land use and availability.
7.) Allocated growth from 2018 to 2045 to individual TAZs based on Steps 4 through 6.
    a.) Minimal/no growth areas received no additional population or employment.
    b.) Those TAZs with identified developments received the specified growth.
    c.) Ten percent of the total population or employment growth was distributed to "Low Growth Potential" TAZs
    d.) Thirty percent of the total population or employment growth was distributed to "Moderate Growth Potential" TAZs

e.) Sixty percent of the total population or employment growth was distributed to "High Growth Potential" TAZs

Following these procedures, a manual check of each TAZ was performed to ensure that the initial projected growth did not exceed the capacities previously calculated. The difference between 2045 and 2018 data was calculated for each TAZ and compared to maximum growth capacities. TAZs with growth beyond this level were redistributed to the next largest TAZ that had not reached its capacity. Note, that this process was not done for TAZs with identified proposed plans.

Finally, the estimates for 2025 and 2035 were derived by applying growth ratios to each TAZ. The ratios were derived by interpolation based on 2018 and 2045 estimates.

School Enrollment Growth

Enrollment at colleges and universities fluctuates more than the overall population and employment of an area, as it is more affected by internal and external trends, such as the competitiveness of an institution or overall state of the economy.

Because no existing enrollment projections or policies were identified for the major colleges or universities in the area, it is assumed that college and university enrollment at each institution will grow at rate that is twice as fast as the overall population of the parish. This rate was selected because it is in line with recent trends and stakeholder expectations and allows for gradual deceleration over time as the state and other areas see the growth of the student age population slow.

In addition to the existing colleges and universities in 2018, a new college plans to open in the fall semester of 2020 – the Louisiana campus of the Edward via College of Osteopathic Medicine (VCOM). VCOM plans to enroll 160 students each year until reaching 640 students after four years. VCOM is located on the University of Louisiana Monroe (ULM) campus at 4408 Bon Aire Drive Monroe, LA 71203.

Enrollment at primary and secondary schools generally follows population trends, though it is likely to be somewhat slower given the aging population and lower fertility rates/smaller family sizes.

To forecast K-12 enrollment in the parish, growth rates for the school-age population from the Third Party projections were applied to existing public and private school enrollment data. Third Party projection data was used to be consistent across all forecast variables (population, employment, and school attendance).

Table 9.1: Population and Households by Year

Variable	2018	2025	2035	2045
Total Population	155,866	159,635	163,434	164,956
Household Population	150,332	154,101	157,900	159,422
Households	59,570	60,991	62,424	62,998
School Enrollment	44,150	46,367	47,441	47,517

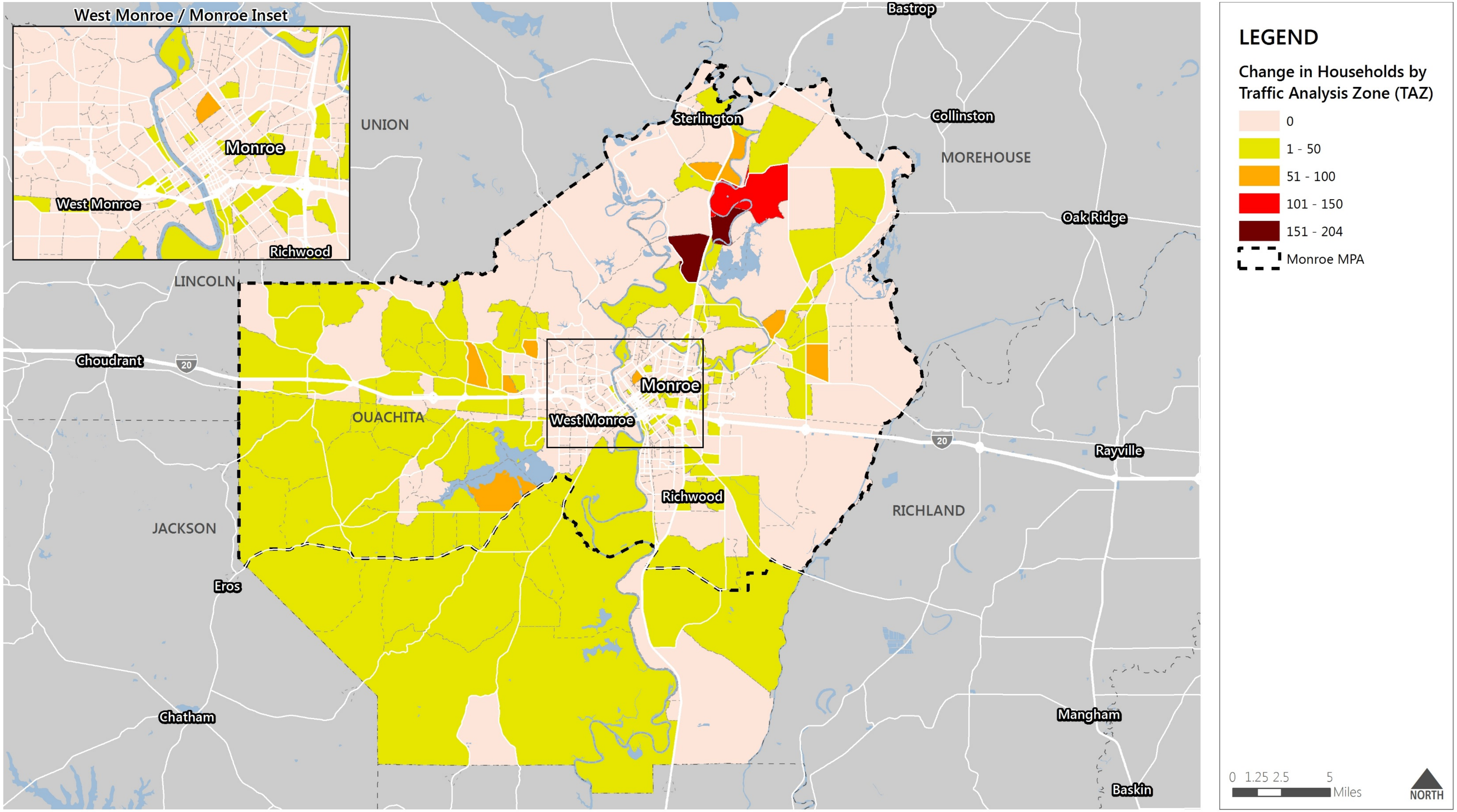
Source: NSI, 2020

Table 9.2: Employment by Year

Variable	2018	2025	2035	2045
TOT_EMP	79,101	84,902	91,932	96,639
AMC_EMP	4,207	4,495	4,853	5,367
MTCUW_EMP	13,762	13,858	13,969	14,036
RET_EMP	17,546	18,669	19,795	20,676
OS_EMP	42,962	47,255	52,690	55,936
OTH_EMP	624	624	624	624

Source: NSI, 2020

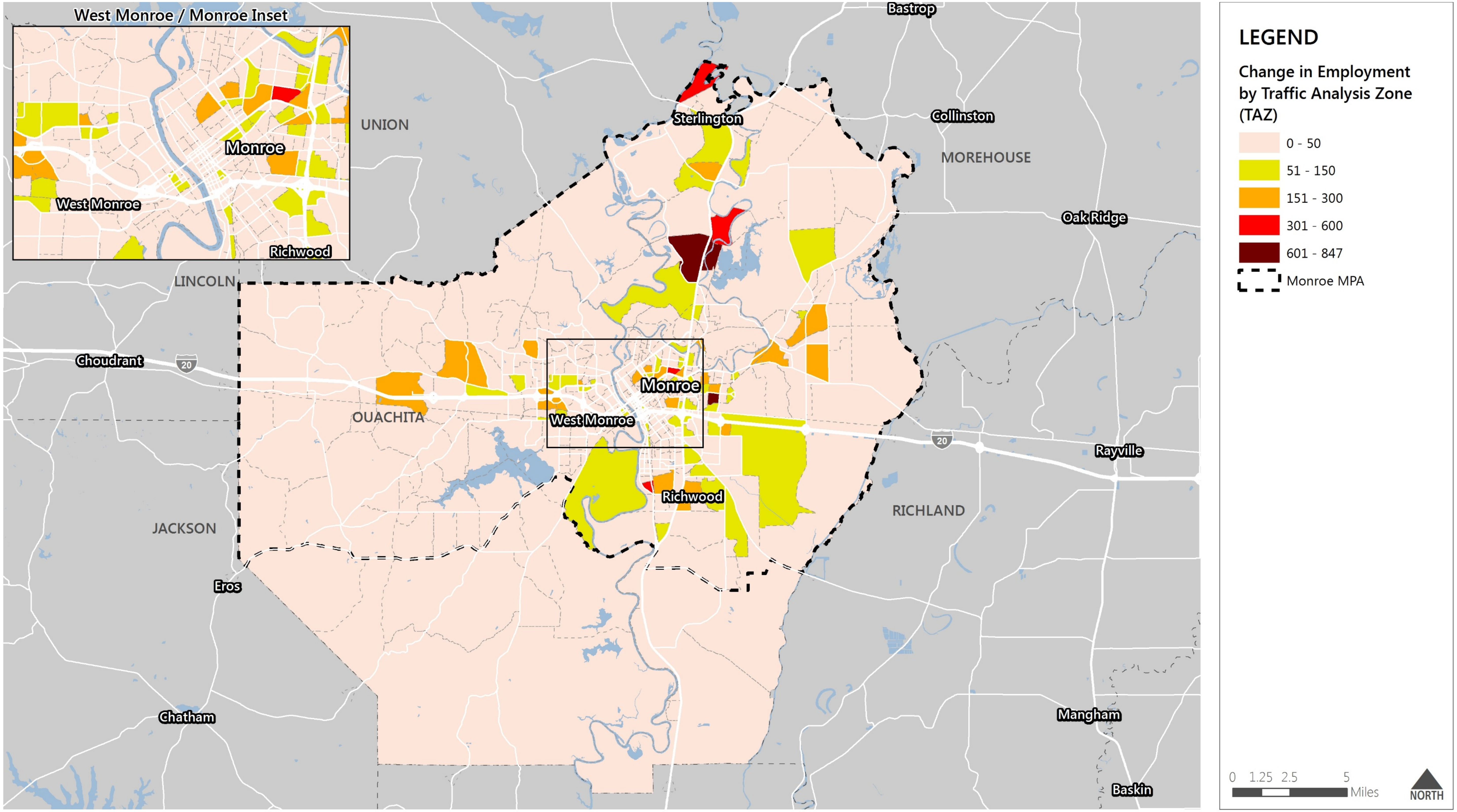
Figure 9.1: Household Growth, 2019-2045



Data Source: Neel-Schaffer, Inc.

Disclaimer: This map is for planning purposes only.

Figure 9.2: Employment Growth, 2019-2045



Data Source: Neel-Schaffer, Inc.

Disclaimer: This map is for planning purposes only.

9.2 Existing Plus Committed (E+C) Network

The base year network was defined as the street and highway system that existed in year 2019. Once the base year network was calibrated, the E+C network was developed which included committed projects.

Committed projects are those improvements for which:

- construction was either completed or had begun since 2019,
- a contract for construction has been awarded,
- have completed the National Environmental Policy Act (NEPA) phase, or
- have funding for right-of-way and/or construction programmed in the MPO's Transportation Improvement Program

Committed projects were added to the base network using the following procedure:

- New routes were coded with the proposed number of lanes, and with the posted speed and volume-delay function attributes that reflect the project's functional classification.
- Widened roadways change the number of lanes to the appropriate amount in each direction as well as the lane configuration field required by the network.
- All E+C projects were flagged in the 'PROJECT_EC' field using a unique project ID.

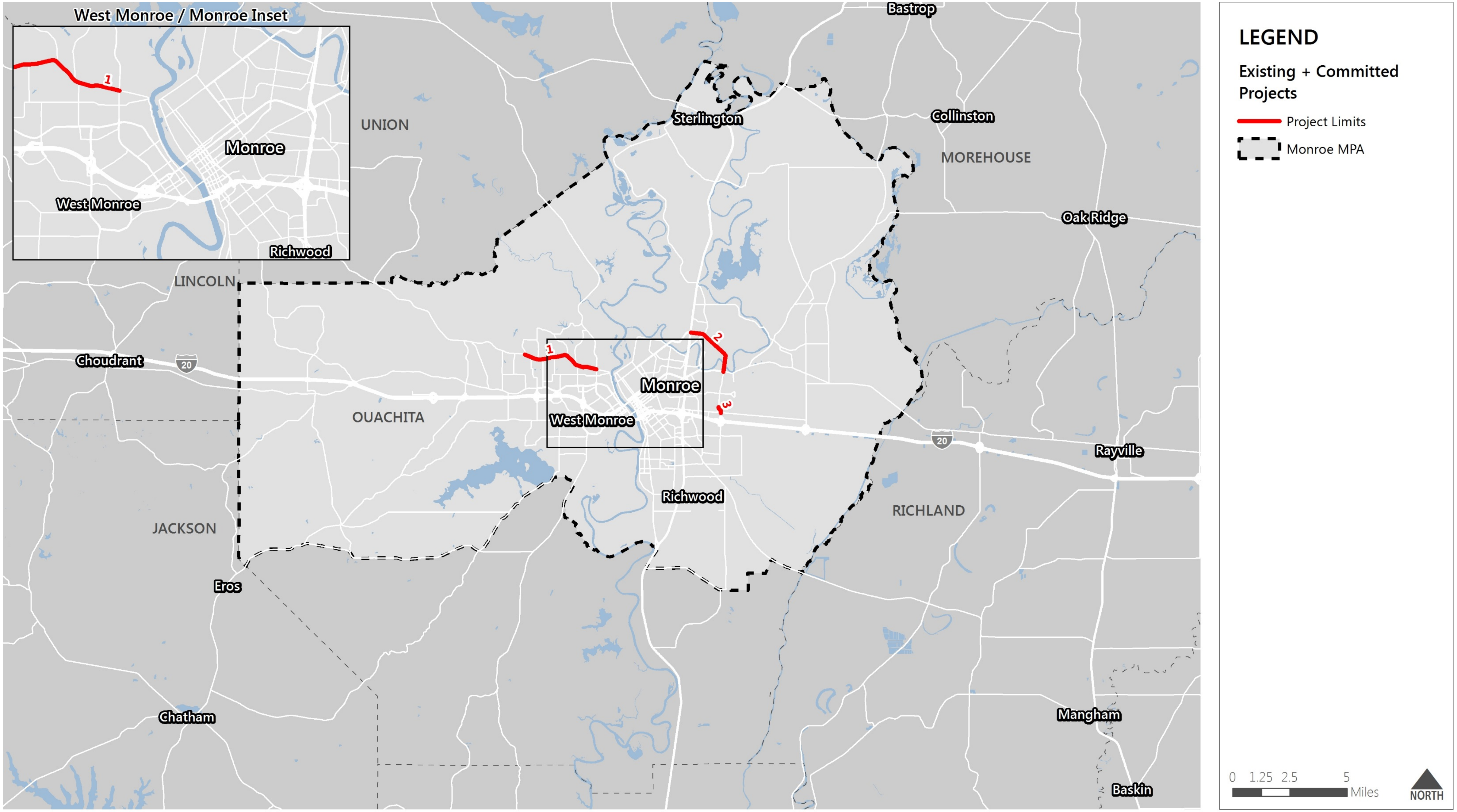
The committed projects are listed in Table 9.3 and shown in Figure 9.3.

Table 9.3: Existing + Committed Projects

Project ID	Roadway	Location	Improvement
1	Arkansas Rd	Caldwell Rd to LA 143	Widen to 5 Lanes and Realignment
2	Kansas Ln Extension	US 80 (Desiard St) to US 165 (Sterlington Rd)	New 4 Lane Roadway
3	Kansas Ln to Garrett Rd Connector	Kansas Ln to Garret Rd	New 4 Lane Roadway

Source: MPO, LADOTD

Figure 9.3: Existing + Committed Projects



Data Source: Monroe MPO; LADOTD

Disclaimer: This map is for planning purposes only.

9.3 External Station Growth

The base year traffic counts at each external station were projected to 2025, 2035, and 2045 using growth factors developed based on historic traffic counts at the external stations. Development of the growth rates used the following methodology:

- Developed an average annual growth rate using historical traffic counts from 2013 through 2019.
- If the calculated average annual growth rate is less than one (1) percent, then the growth rate for that station was set at one (1) percent.
- If the calculated average annual growth rate is more than three (3) percent, then the growth rate for that station was set at three (3) percent.
- If the calculated average annual growth rate is between one (1) percent and three (3) percent, then the calculated average annual growth rate was used with no changes.
- If it was determined that a growth rate was not expected to be sustained for a long period of time it was adjusted to a reasonable rate.

The final forecast growth rates for each external station and comparison of external travel forecast for the base year and target years is shown in Table 9.4.

The total traffic at each station was then divided into EI and EE trips with the assumption that there would not be a significant change in the distribution from the base year. In addition, both EI and EE forecast trips were also separated into auto and truck trips.

Table 9.4: External Station Forecast Growth

External Station	Forecast Growth Rate	2018 Volume	2026 Volume	2036 Volume	2045 Volume
901	1.9%	5,880	7,087	8,543	10,297
902	1.0%	10,366	11,451	12,648	13,972
903	1.0%	551	609	672	743
904	2.0%	4,620	5,632	6,865	8,368
905	1.1%	1,401	1,559	1,734	1,930
906	1.0%	1,477	1,632	1,802	1,991
907	1.5%	37,989	44,088	51,166	59,380
908	2.1%	2,714	3,355	4,147	5,126
909	2.0%	7,584	9,245	11,269	13,737
910	1.0%	239	264	292	322
911	1.0%	144	159	176	194
912	3.0%	3,411	4,584	6,161	8,279
913	3.0%	2,250	3,024	4,064	5,461
914	3.0%	2,869	3,856	5,182	6,964
915	1.5%	36,317	42,147	48,914	56,766
916	1.0%	846	935	1,032	1,140
917	3.0%	3,654	4,911	6,600	8,869
918	3.0%	4,714	6,335	8,514	11,442

Source: MPO; NSI, 2020

9.4 Future Year Model Runs

The TDM was used to forecast traffic for the future years using the E+C network and forecast socioeconomic, external station, and special generator data. Interpolation was used where necessary to obtain a future year scenario that occurred between the base year (2018), interim years (2025 and 2035), or the horizon year (2045).