APPENDIX A: Simulation Model Calibration Technical Memorandum

Stantec

Memo

To:	Jay Balaji KYTC Division of Planning	From:	Mark Kranz Stantec Consulting Services, Inc.
File:	Newport US 27 Two-Way Study	Date:	February 7, 2024

Reference: Newport US 27 Two-Way Simulation Model Calibration Memo

INTRODUCTION

As part of the Newport US 27 Two-Way Study, Stantec has developed a simulation model representing existing peak hour conditions using Caliper's TransModeler (version 7.0) simulation package. This model will be used to analyze proposed alternatives for the 2035 design year. The study area consists of the one-way couplet of 4th Street and 5th Street between Central Avenue and Washington Avenue, the one-way couplet of Monmouth Street and York Street designated as US 27 between 3rd Street and 11th Street, and Saratoga Street between 3rd Street and 11th Street. This area is shown in **Figure 1.**

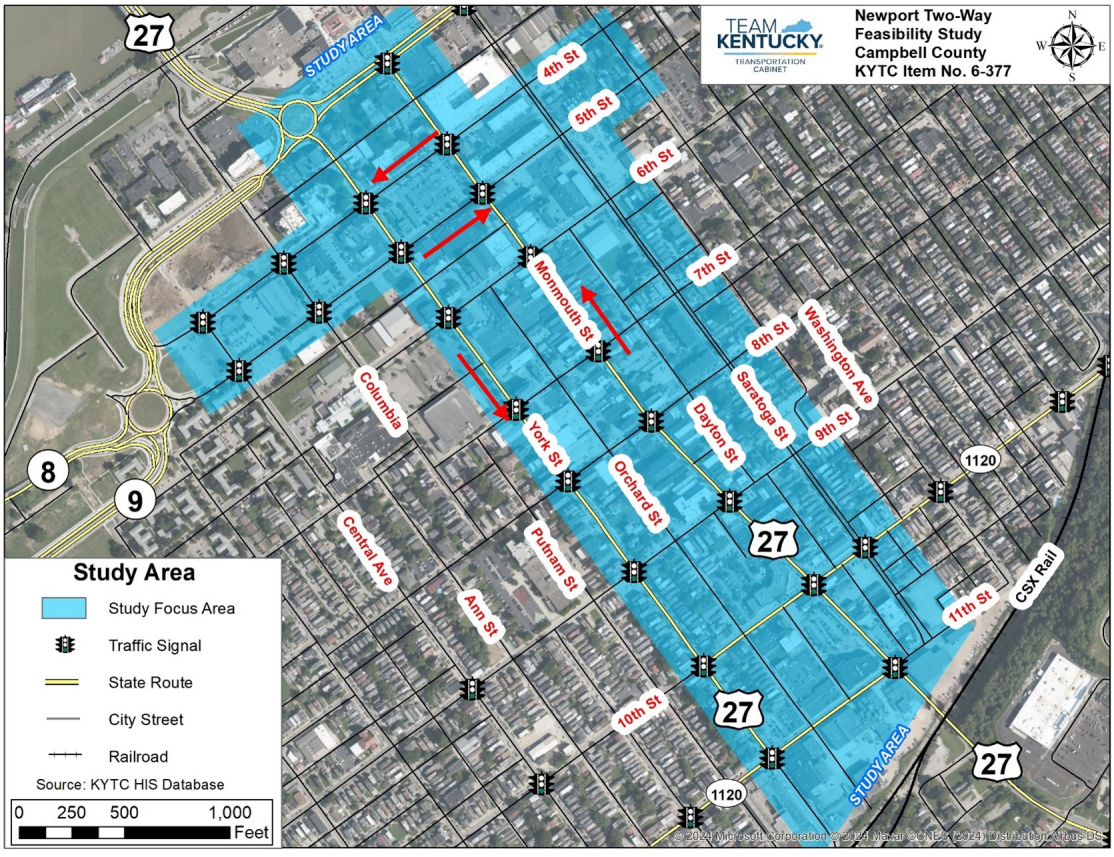

Figure 1: Study Area

Reference: **Newport US 27 Two-Way Simulation Model Calibration Memo**

MODEL DEVELOPMENT

The simulation model network was originally extracted from the Kentucky Statewide Traffic Model (KYSTM) and refined for the study's specific purposes. Turning Movement Counts (TMCs) were collected on Thursday, May 11, 2023, at the following locations and as shown in **Figure 2**:

- 3rd Street/KY-8 at Monmouth Street/US 27
- York Street/US 27 at 4th Street
- Monmouth Street/US 27 at 4th Street
- 4th Street at Saratoga Street
- 4th Street at Washington Avenue
- 4th Street at Central Avenue
- 4th Street at Columbia Street
- York Street/US 27 at 5th Street
- Monmouth Street/US 27 at 5th Street
- Saratoga Street at 5th Street
- 5th Street at Washington Avenue
- York Street/US 27 at 7th Street
- Monmouth Street/US 27 at 6th Street
- Saratoga Street at 7th Street
- York Street/US 27 at 8th Street
- Monmouth Street/US 27 at 9th Street
- Saratoga Street at 10th Street
- York Street/US 27 at 11th Street
- Monmouth Street/US 27 at 11th Street
- Saratoga Street at 11th Street

Additional TMCs from the Ovation Music Venue Traffic Impact Study were also analyzed. The study was dated March 29, 2020, and included counts recorded on Thursday, August 1, 2019. The TMCs used from this study were at the following locations:

- York Street/Taylor Southgate Bridge/US 27 at 3rd Street/KY-8 (roundabout)
- 4th Street at Central Avenue
- 4th Street at Columbia Street

AADT counts from the Kentucky Transportation Cabinet (KYTC) Traffic Database in the study area were also noted. Based on the entirety of TMC data, the study area peak hours were determined to be 7:30-8:30 AM and 4:45-5:45 PM. Locations of count stations are summarized in **Figure 3**.

Reference: **Newport US 27 Two-Way Simulation Model Calibration Memo**

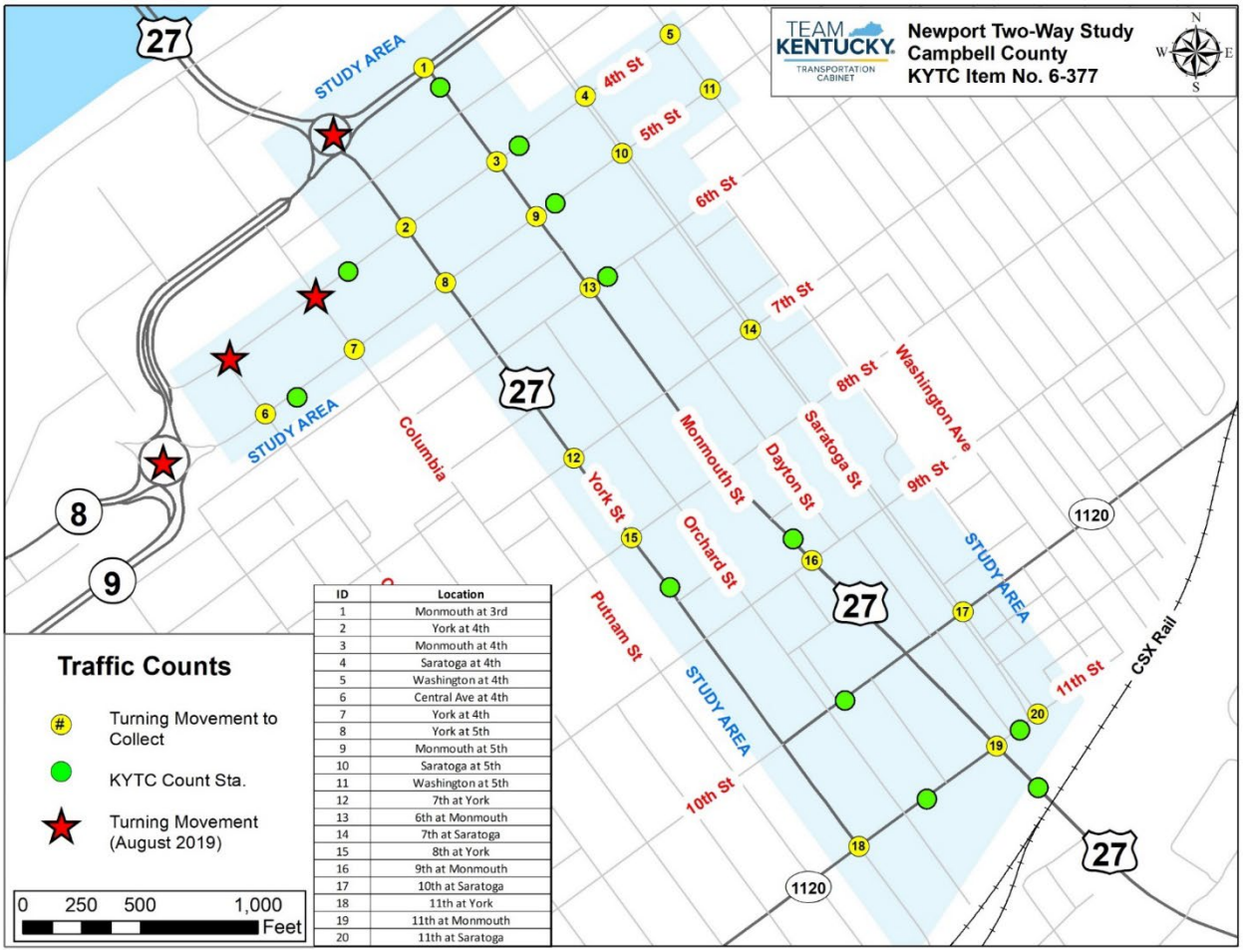

Figure 2: Turning Movement Count Locations

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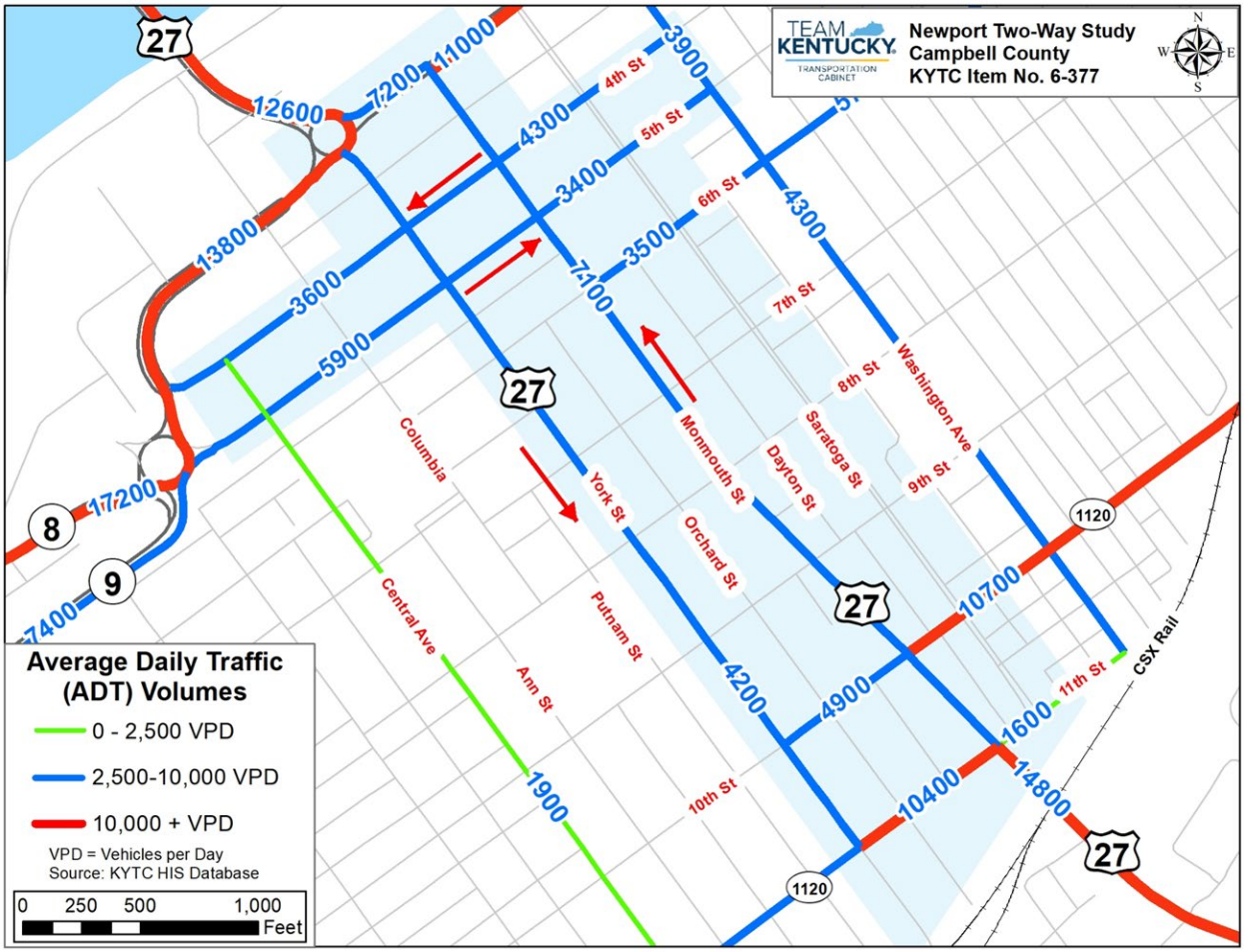

Figure 3: KYTC Average Daily Traffic (ADT) Volumes

MODEL TRIP TABLES

Trip tables for the AM and PM peak hours were developed for origin-destination matrices in the AM and PM peak hour for both automobiles and heavy trucks. AM and PM turning movement counts and seed matrices developed from aggregated Streetlight origin-destination data were used as inputs for TransModeler's origin-destination matrix estimation (ODME) procedure. The ODME procedure uses an iterative algorithm to estimate trip tables for the AM and PM peak hours that produce trip patterns that most closely match observed traffic counts.

The May 11, 2023, TMCs were also used to develop a time distribution curve to further refine the model's traffic demand throughout each peak hour. All counts were recorded in 15-minute increments, and total 15-minute volumes among all count locations were summed and proportioned within the peak hour. **Table 1** shows the time distribution curve used in the model.

Reference: **Newport US 27 Two-Way Simulation Model Calibration Memo**

Table 1: Peak Hour 15-Minute Time Distributions

AM Peak Hour			PM Peak Hour		
Time	Autos % of Total	Trucks % of Total	Time	Autos % of Total	Trucks % of Total
7:30	25.95%	29.41%	4:45	22.40%	21.24%
7:45	28.11%	16.34%	5:00	25.34%	20.35%
8:00	23.65%	22.88%	5:15	26.57%	34.51%
8:15	22.28%	31.37%	5:30	25.69%	23.89%

PARAMETERS & ROAD CLASS DEFINITIONS

The *KYTC Microsimulation Guidelines* provide a framework for conducting simulation analysis in Kentucky. KYTC's TransModeler Seed file, which includes a parameters file and a road class definition file, were used to revise default Caliper values for the following parameters:

- Time Headway
- Minimum Headway
- Standstill Distance
- Acceleration
- Deceleration
- Lane Change Distance
- Vehicle Speed Ranges
- Vehicle Classification
- Truck Weight/Power

VEHICLE FLEET

TransModeler's default vehicle fleet distribution was replaced with the fleet distribution from the *KYTC Microsimulation Guidelines* to better reflect Kentucky's higher proportion of pickups and SUVs. A matrix defining multi-unit truck trips was developed separately and not included in the general vehicle fleet mix. The vehicle fleet mix excluding multi-unit trucks used was:

- Car Low MPR (High performance passenger cars) – 5.40%
- Car Mid MPR (Middle performance passenger cars) – 21.70%
- Car High MPR (Low performance passenger cars) – 16.50%
- Pickup/SUV – 52.00%
- SU Truck – 3.90%
- Bus – 0.50%

MODEL VALIDATION

The criteria used to confirm that the simulation model has been sufficiently validation were taken from the Federal Highway Administration's (FHWA) *Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software, July 2004 (FHWA Publication No. FHWA-HRT-04-040).* The specific criteria, which were originally developed by the Wisconsin Department of Transportation, are found in Table 4

on page 64 of that document. The criteria consist of three general metrics: 1) visual audits, 2) traffic flow, and 3) travel speeds. Traffic flow and travel speeds are quantifiable based on observed data and the model output while the guidance says that visual audits are to be conducted to the "analyst's satisfaction."

Visual audits were performed throughout the calibration process. At the beginning of the process, areas with congestion were specifically targeted to ensure that these areas reflected existing traffic conditions.

To compare traffic flows, link-based trip volumes for five simulation runs were averaged and compiled for each direction of each link and validated to actual traffic counts on the segments. Some intersections in the model did not have observed TMCs and their modeled traffic demand was derived directly from the ODME procedure. Segments where this occurred were not included in the final validation statistics. Several statistical measures were used to measure model assignment volumes to matched observed counts. The most important of these measures is percent root-mean-square error (RMSE) with a target threshold of 20 percent or lower to confirm that model assignment volumes were sufficiently validated to match observed traffic volumes. **Table 2** presents the validation statistics for both the AM and PM models.

Table 1: Volume Validation Statistics

Total Volume to Count:	AM Peak	PM Peak
Target: within 5% of count		
Sum of assignment	26,221	39,022
Sum of counts	27,069	40,267
Percent Difference (within 5%)	3.13%	3.09%
Percent Root Mean Square Error		
Target: < 20.00%	11.87%	15.76%

Travel times and average speeds from the traffic model were compared with Google API data of travel times and average speeds by hour for Monmouth Street/US 27 and York Street/US 27 between 4th Street and 11th Street. Data was collected on weekdays between Wednesday, September 20, 2023, and Wednesday September 27, 2023. **Table 3** presents this data comparison. The largest difference between model and observed speeds is the average speed in the AM peak hour for York Street/US 27 at 6.0%. However, the corresponding difference for travel time on the same segment and period is only 0.9%. Otherwise, no discrepancy difference is greater than 3.8%.

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Table 2: Travel Time and Speed Comparison

Segment	Route	BMP	EMP	Metric	Measured Result	Modeled Result	% Diff.
Monmouth Street	NB US 27	21.463	22.086	AM Travel Time (min.)	2.03	2.10	3.4%
				AM Speed (mph)	18.30	18.44	0.8%
				PM Travel Time (min.)	2.16	2.18	0.9%
				PM Speed (mph)	17.20	17.65	2.6%
York Street	SB US 27	22.222	21.599	AM Travel Time (min.)	2.34	2.36	0.9%
				AM Speed (mph)	15.76	16.70	6.0%
				PM Travel Time (min.)	2.38	2.47	3.8%
				PM Speed (mph)	15.44	15.75	2.0%

NEXT STEPS

After calibration, the Newport US 27 Two-Way Study traffic model can be used to create future models for no-build conditions and proposed alternatives.

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