BRENT SPENCE
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BRENT SPENCE BRIDGE PROJECT

TRAFFIC COUNTS, MODELING, AND FORECAST REVIEW

DECEMBER 2019

STATE OF OHIO DEPARTMENT OF TRANSPORTATION

KENTUCKY TRANSPORTATION CABINET

HNTB

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1. INTRODUCTION

This memorandum presents a review of traffic counts, travel demand models, and forecasts completed since 2013 for the Brent Spence Bridge (BSB). Two primary studies were conducted since 2013: the Brent Spence Bridge Corridor study (BSBC Study) in 2013-2015, and the Eastern Bypass (EB) study in 2017. Both studies obtained traffic counts and used the OKI travel demand model to forecast traffic. Since the EB study in 2017, OKI has been developing an updated travel demand model (TDM) and established continuous traffic counters on the BSB.

The BSB traffic counts include:

- 2013 OKI Video Count – 1 month
- 2014 KTYC ATR Count – 6 days
- 2017 KYTC Video Counts – 1 week
- 2019 OKI ATR counts – 5 months

The OKI TDM assumptions and results are summarized for the 2 projects. Differences in the model networks and results are discussed. The models reviewed for each study include:

- BSBC Study – 2010 Existing, 2040 No Build, 2040 Build Toll Free, 2040 Build Tolled
- EB Study – 2015 Existing, 2040 No Build, 2040 Build Toll Free

OKI is currently developing an updated 2050 TDM. HNTB developed zonal growth factors to convert the 2040 model into a pseudo 2050 model. The traffic assignments from the 2050 model are compared to the previously completed 2040 models. The forecast implications of the 2050 model are discussed.

2. BRENT SPENCE TRAFFIC COUNTS

Traffic counts were taken on the Brent Spence Bridge at various times and by various methods by project stakeholders since 2013. The 2013 and 2014 counts were used for the ODOT certified traffic approved in 2015. The 2017 counts were used for the KYTC Eastern Bypass study. Since May 2019, OKI has set up continuous traffic counters on the Brent Spence Bridge and other nearby bridges over the Ohio River.

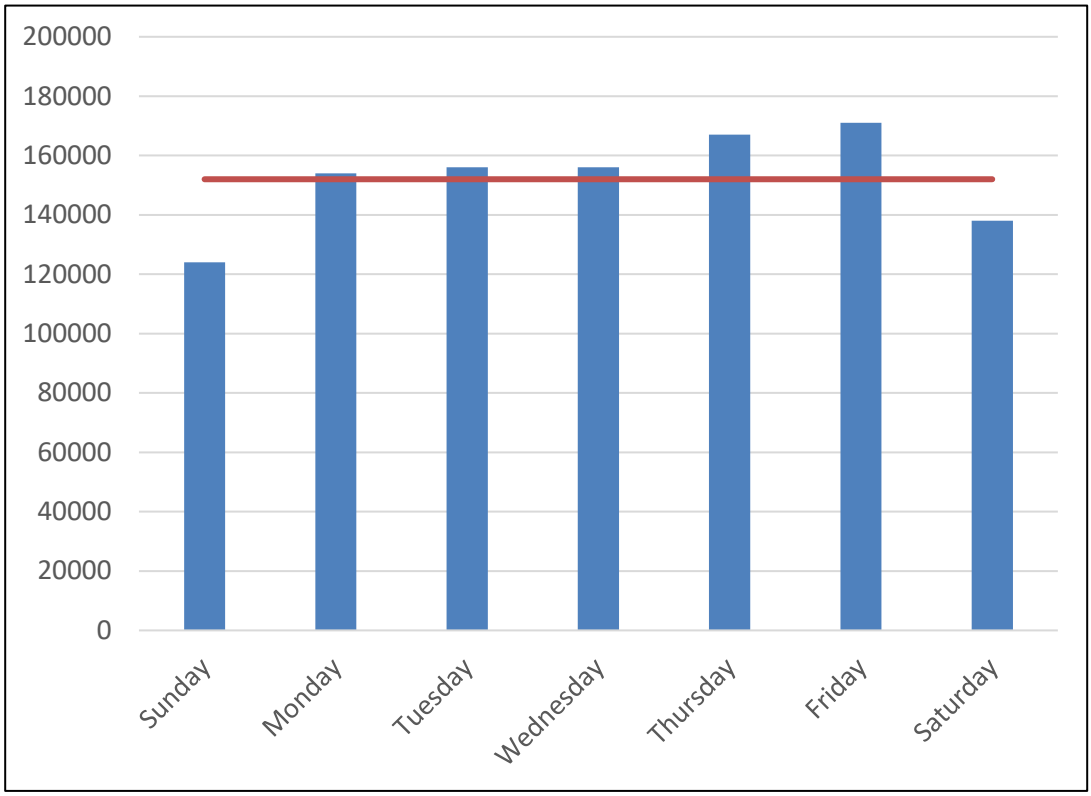
Each of the traffic counts collected since 2013 are summarized below. Additionally, the counting technology is identified for each traffic count. An overview of the count collection technology is provided in section 2.5.

2.1 2013 OKI VIDEO COUNTS

OKI arranged for video counts to be taken on the Brent Spence Bridge for one month in April/May 2013. Count data was collected from April 19 to May 19, 2013. The daily volumes are shown in the figure below:

Figure 2-1: 2013 OKI Video Count Daily Averages

Day of Week	ADT
Sunday	124,000
Monday	154,000
Tuesday	156,000
Wednesday	156,000
Thursday	167,000
Friday	171,000
Saturday	138,000
Average	**152,000**



Volumes on weekdays ranged from 149,200 to 177,800 and volumes on weekend days ranged from 113,000 to 142,900.

2.2 2014 KYTC ATR COUNTS

KYTC compiled counts from their ATR site 059014. The ATR site used permanent sensors in the pavement to collect the counts. The ATR location is milepost 191.3 on I-71/75 just south of the Brent Spence Bridge.

Figure 2-2: 2014 KYTC Video Count Locations

Date	Day of Week	ADT
8/7/2014	Thursday	192,800
8/8/2014	Friday	190,300
8/9/2014	Saturday	159,300
8/10/2014	Sunday	141,300
8/11/2014	Monday	173,300
8/12/2014	Tuesday	183,600
8/13/2014	Wednesday	153,800

2.3 2017 KYTC VIDEO COUNTS

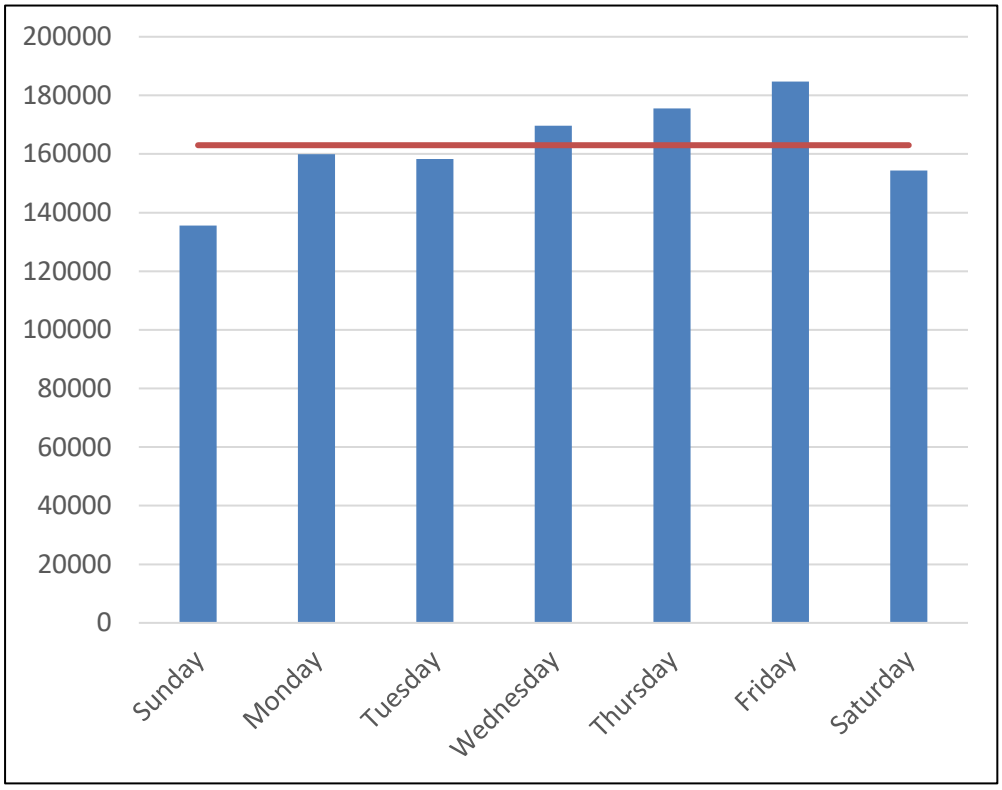
KYTC arranged for video counts to be taken at the south end of the Brent Spence Bridge. Mainline counts were taken from a camera located in the median just south of W. 5th street. The NB on-ramp from W. 4th Street and the SB off-ramp to W. 5th Street were also counted to capture all Brent Spence Bridge traffic. The count locations are shown in the figure below:

Figure 2-3: 2017 KYTC Video Count Locations

Count data was collected from March 6 to March 12, 2017. And the daily volumes are shown in the figure below:

Figure 2-4: 2017 KYTC Video Count Daily Volumes

Day of Week	ADT
Sunday	135,600
Monday	159,900
Tuesday	158,300
Wednesday	169,700
Thursday	175,500
Friday	184,700
Saturday	154,400
Average	**163,000**



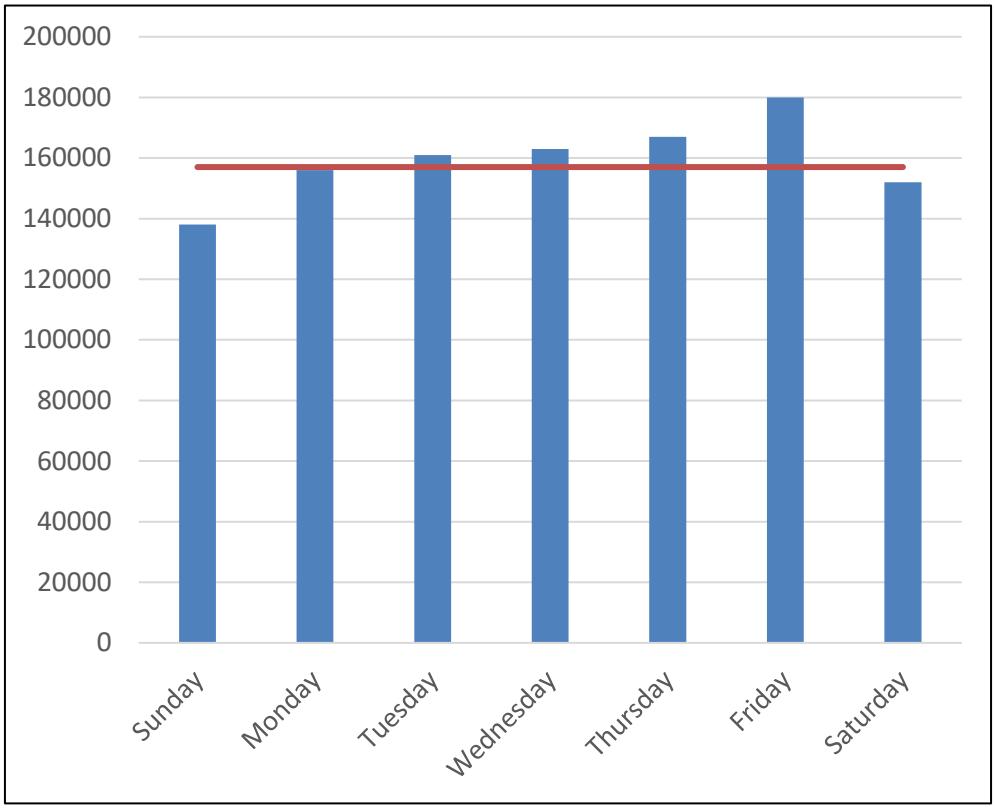
Volumes on weekdays ranged from 158,300 to 184,700 and volumes on weekends ranged from 135,600 to 154,400.

2.4 2019 OKI ATR COUNTS

OKI attached Image Sensing radar devices to overhead signing structures and are aimed downward toward the travel lanes of the Brent Spence Bridge. The overhead vantage point reduces the number of counting errors due to traffic blocking side-fire radar from sensing traffic in inside lanes. Traffic Data is being collected continuously since May 25, 2019. The data summarized here is from May 25 ,2019 to October 31, 2019.

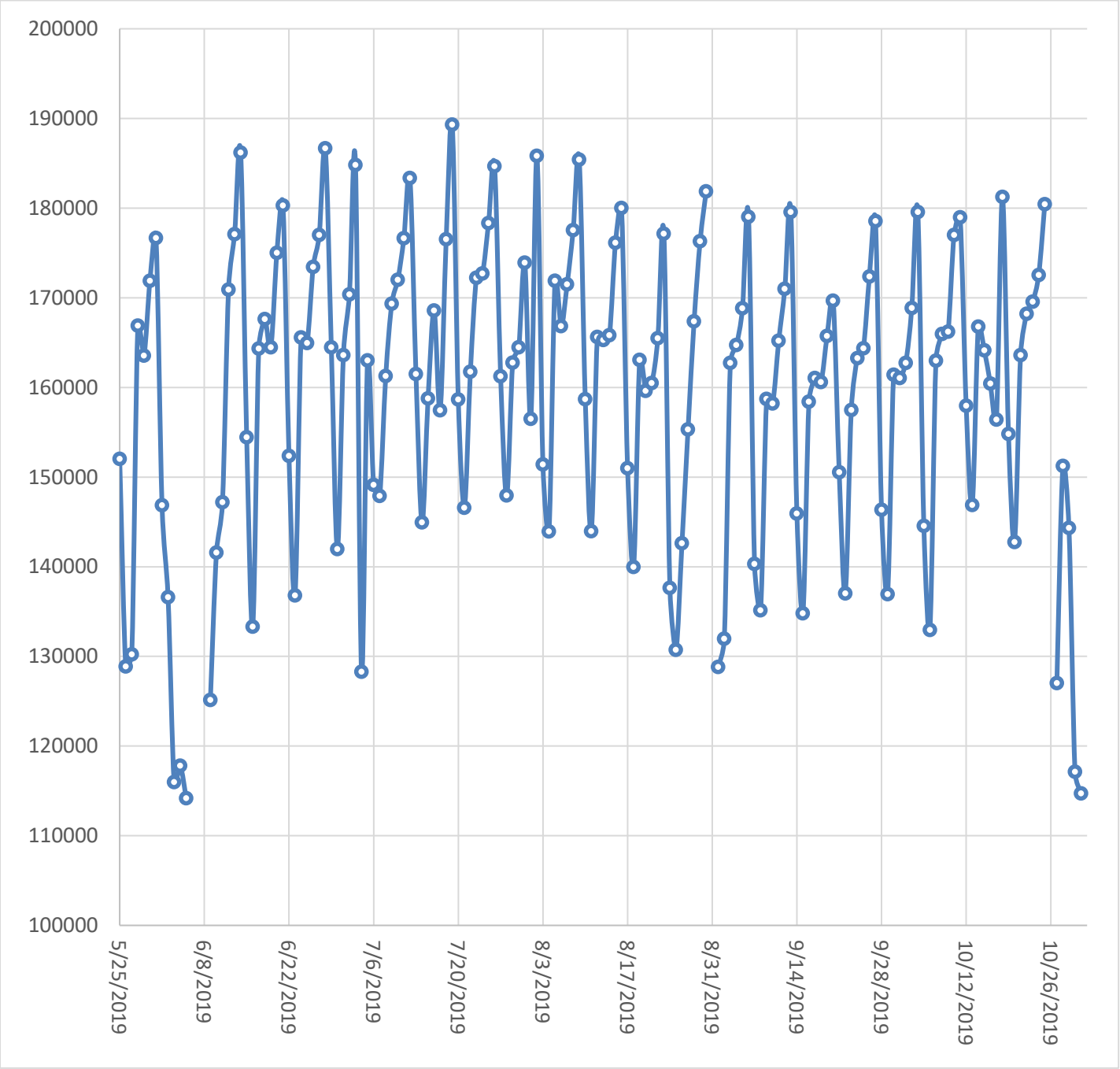
Figure 2-5: 2019 OKI Microwave Radar Count Daily Volumes

Day of Week	ADT
Sunday	138,000
Monday	156,000
Tuesday	161,000
Wednesday	163,000
Thursday	167,000
Friday	180,000
Saturday	152,000
Average	**159,000**



Volumes on weekdays ranged from 114,700 to 189,300 and volumes on weekends ranged from 125,300 to 164,500. The day-to-day variation in traffic counts on the Brent Spence Bridge is summarized in Figure 2-6, which shows the daily traffic volumes from May 25 to October 31, 2019.

Figure 2-6: Brent Spence Daily Traffic: May to October 2019



2.5 TRAFFIC COUNTING TECHNOLOGIES

The methods used to collect traffic data use different technologies to detect vehicles on the roadway and collect volume data. The technologies used for each of the counts are discussed below along with the advantages and disadvantages of each method.

Inductive Loop Detectors –Inductive Loop Detectors consists of: a wire loop (containing one or more turns of wire) embedded in the pavement, a lead-in wire running from the in-pavement loop to the detector unit, and the inductive loop detector unit. The detector unit is an electronic circuit on a card or device that processes the inducted voltages in the loop into count data. It can detect vehicle presence and passage. Advanced processing can be used to derive vehicle class characteristics.

Microwave Radar Sensors - Microwave Radar Sensors transmit electromagnetic energy from an antenna towards vehicle travelling on the roadway. When a vehicle passes through the antenna beam, a portion of the transmitted energy is reflected towards the antenna. The energy then enters a receiver where the detection is made and traffic flow data such as volume, speed, and vehicle length are calculated.

Video Detection Sensors – Video Detector Sensors consist of one or more cameras, a microprocessor-based computer for digitizing and analyzing the imagery, and software for interpreting the images and converting them into traffic flow data A video detection system can provide detection of vehicle across several lanes. The specific technology used in the 2013 and 2017 counts digitized the imagery onsite and then the imagery was sent to a central location for final processing.

Figure 2-7: Summary of Traffic Count Technology

Technology	Strengths	Weaknesses
Inductive Loop	• Flexible Design • Mature Technology • Large Experience Base • Provides basic traffic parameters • Insensitive to weather • Common standard for obtaining occupancy measurements • Advance signal processing can provide axel classification data	• Wire loops subject to stresses of traffic • Multiple loops are required to monitor a location • Detection accuracy may decrease when a large variety of classes is required • Does not detect axels in commonly used configuration.
Microwave Radar Sensors	• Typically insensitive to weather • Direct Measurement of speed • Multiple lane operation • Detects stopped and slow-moving vehicles • Lane assignments can be accommodated for on location.	• Detector can miss occasional vehicle traveling side-by-side • Calibration and sensor placement are crucial to proper operation • Does not detect axles.
Video Detection sensors	• Monitors multiple lanes and multiple detection zones per lane • Easy to add and modify detection zones • Vast array of data available • Generally, cost effective when multiple zones are capture by a single camera or specialized data is required.	• Installation and Maintenance including periodic lens cleaning • Performance affected by weather, vehicle shadows, vehicle projection into adjacent lanes, occlusion day-to-night transition, vehicle/road contrast, and dirty lenses • Night time operation requires illumination • Does not detect axles. • Some models susceptible to camera motion due to strong winds or vibration

2.6 BRENT SPENCE HOURLY TRAFFIC

The Brent Spence Bridge peaks for the northbound direction in the AM and southbound direction in the PM. The hourly midweek traffic volumes derived from the 2019 OKI counts are shown in Figure 2-8. The Friday profile, Figure 2-9, has similar peaks as the midweek but higher traffic volumes are sustained through the middle of the day.

Figure 2-8: Brent Spence Bridge - 2019 Midweek – Hourly Traffic Flow

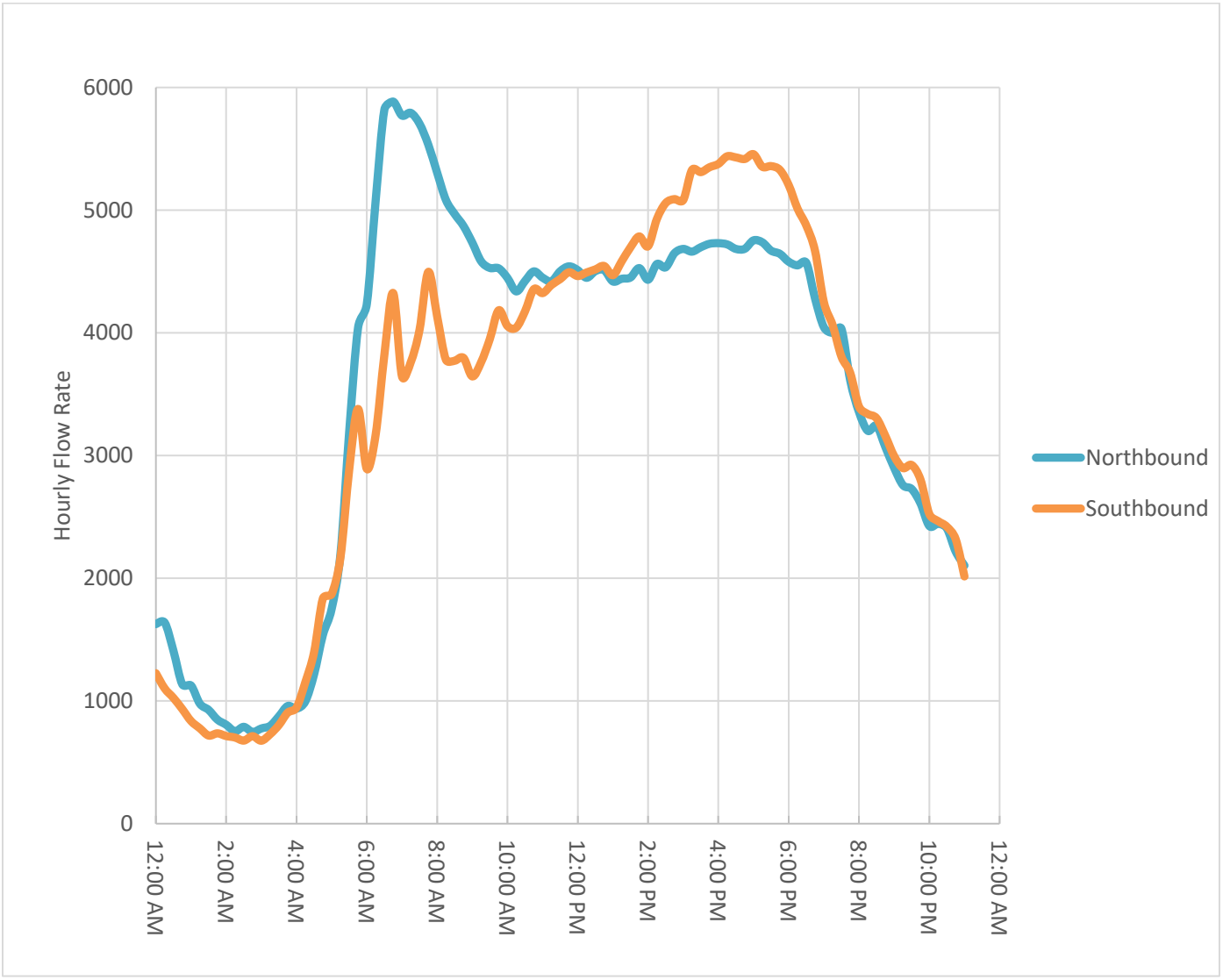
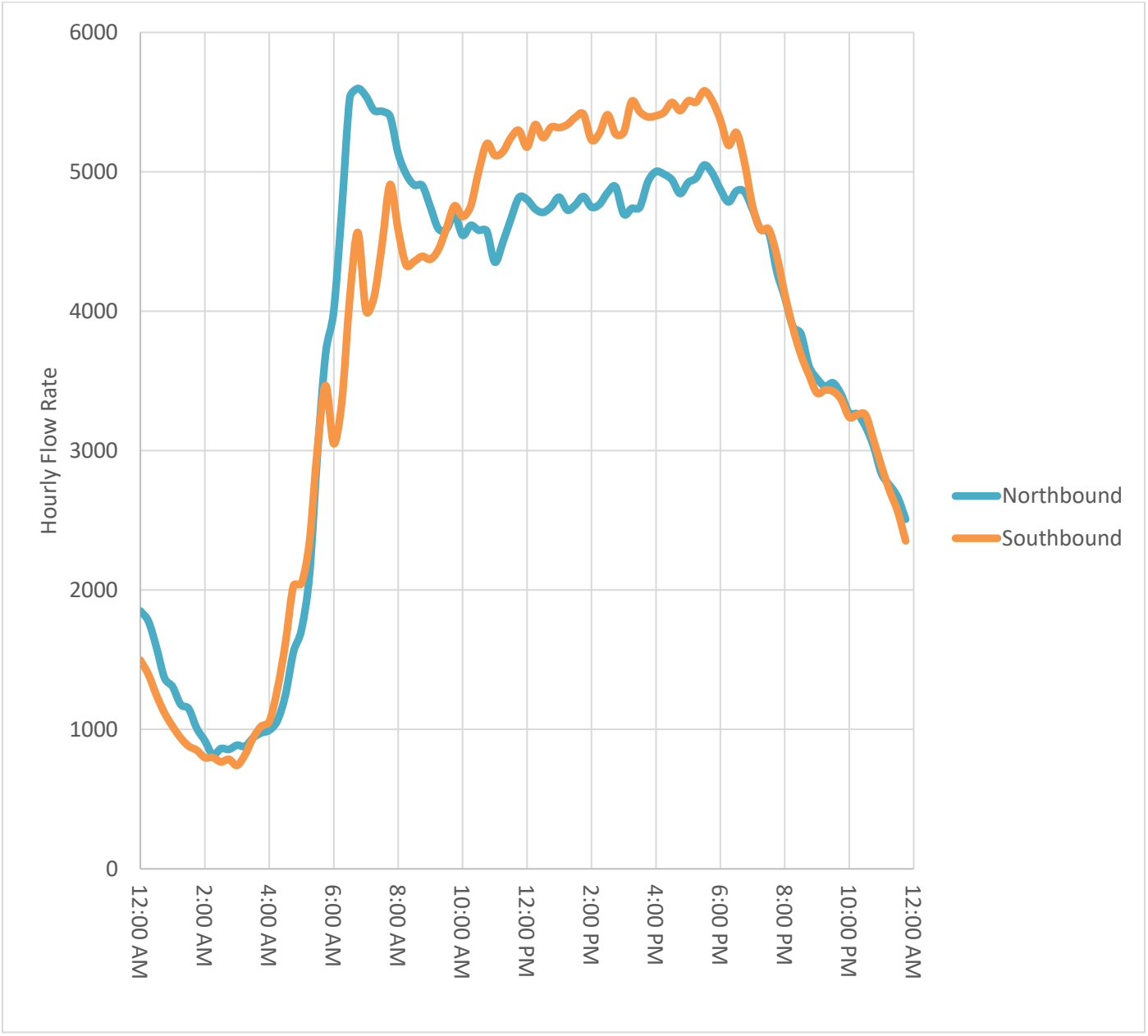


Figure 2-9: Brent Spence Bridge – 2019 Friday – Hourly Traffic Flow



3. TRAVEL DEMAND MODEL COMPARISION

Travel Demand Model forecasts were completed for the Brent Spence Bridge as part of the Brent Spence Bridge Corridor study in 2015 and the Eastern Bypass study in 2017. The OKI TDM traffic assignments and model assumptions are compared for these studies.

3.1 TRAFFIC ASSIGNMENT

The OKI travel demand model was used to forecast traffic volumes for both the Brent Spence Bridge Corridor Study and the Eastern Bypass Study. The traffic assignment from these two studies are summarized in the table below. The Build model for the BSB Corridor Study represents Alternative I. The Eastern Bypass Study Build model includes capacity improvements on the Brent Spence Bridge and I-75 in Ohio. Details of the Build model networks are covered in section 3.2.

Figure 3-1: Daily Traffic Assignment

OKI Model Scenario	BSB Corridor Study	Eastern Bypass Study
2010 Existing	141,900	-
2017 Existing	-	159,300
2040 No Build	173,700	174,400
2040 Build Toll Free	228,000	174,200
2040 Build Tolled ($2)	165,500	-

3.2 MODEL ASSUMPTIONS

The OKI TDM network is compared for the two Brent Spence Bridge studies. The comparison of the Build models from the two studies reveals similar network assumptions on I-75 from the BSB north into Ohio. The significant difference between these models, as it relates to the BSB, is the capacity assumption on I-71/75 in Kentucky. The BSBC study assumes I-71/75 capacity expansion in Kentucky, as shown in Alternative I, while the EB study assumes existing capacity on I-71/75. This difference is the primary contributor in the traffic assignment differences between the two studies (228,000 verse 174,200).

The OKI TDM lanes and traffic assignments for the BSB and I-71/75 in Kentucky are shown in the following figures.

Figure 3-2: OKI TDM Lanes on Brent Spence Bridge

Build (BSB Corridor Study) *No Build (Eastern Bypass Study)* *Build (Eastern Bypass Study)*

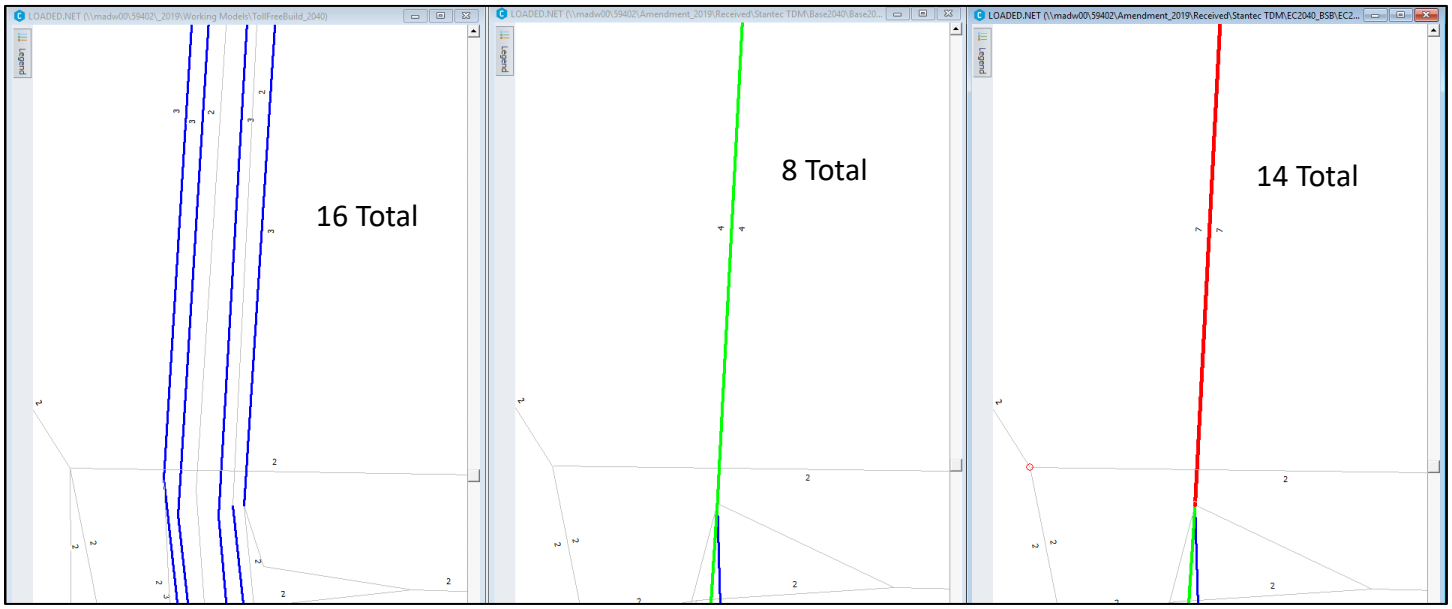


Figure 3-3: OKI TDM Lanes on I-71/75 in Kentucky

Build (BSB Corridor Study) *No Build (Eastern Bypass Study)* *Build (Eastern Bypass Study)*

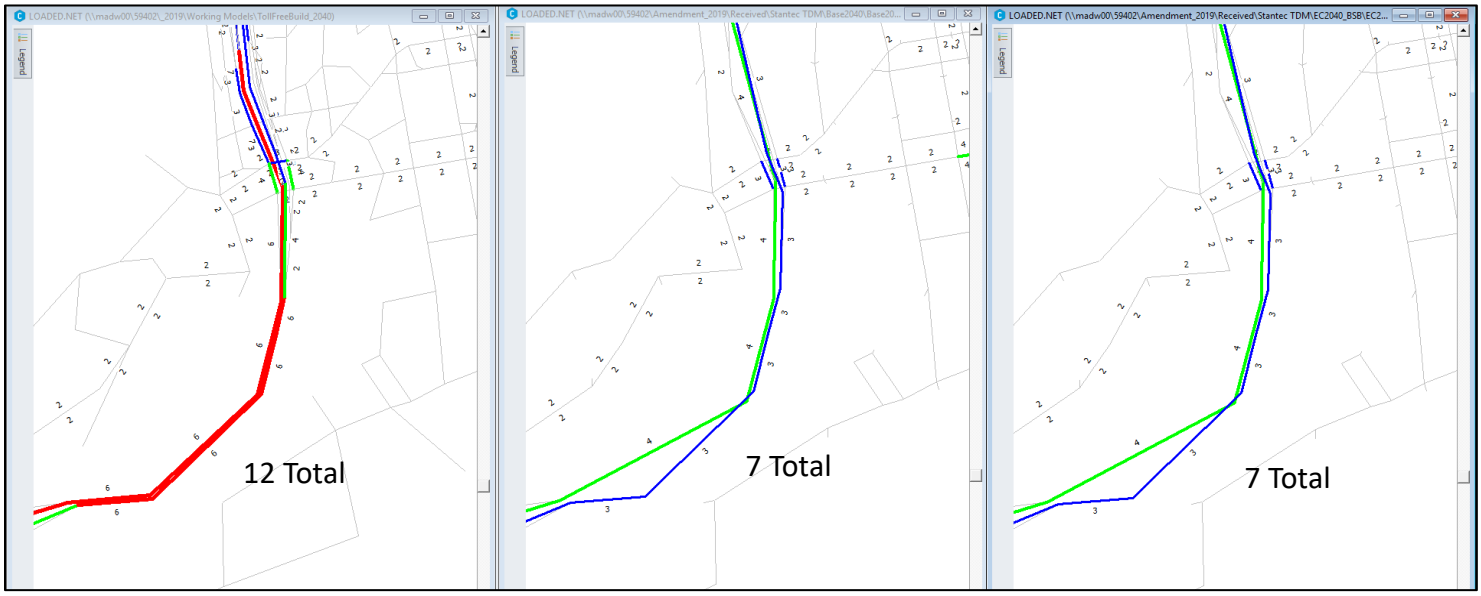


Figure 3-4: OKI TDM Traffic Assignment on Brent Spence Bridge

Build (BSB Corridor Study) *No Build (Eastern Bypass Study)* *Build (Eastern Bypass Study)*

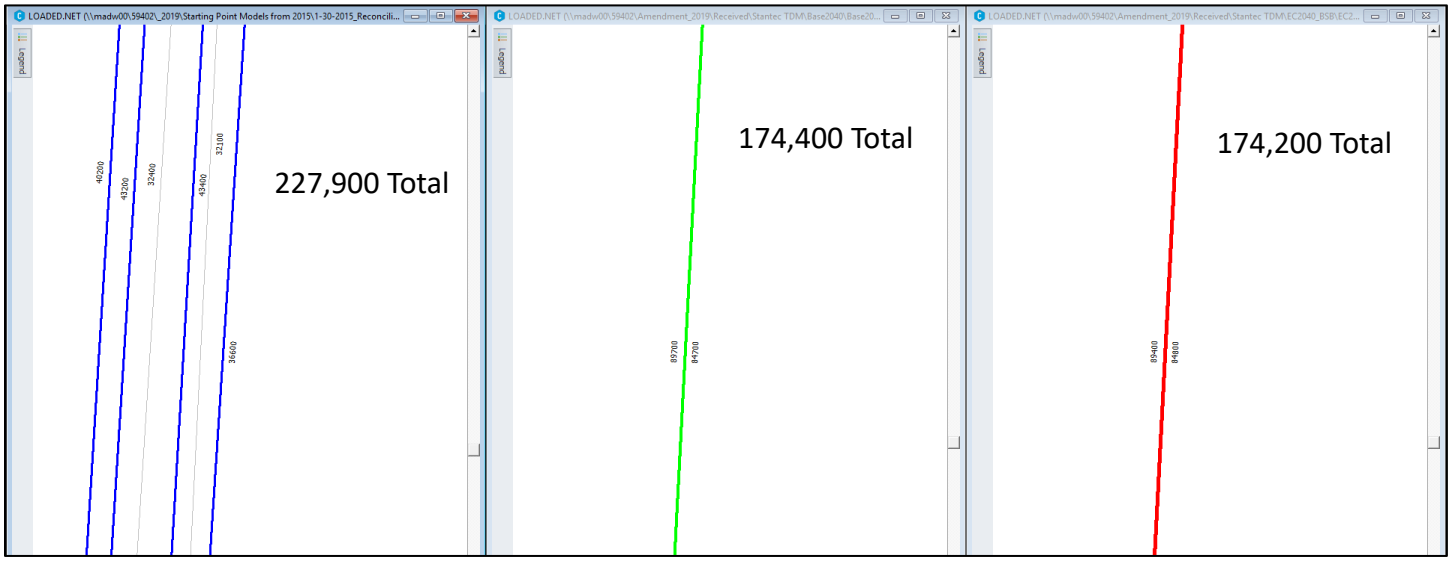
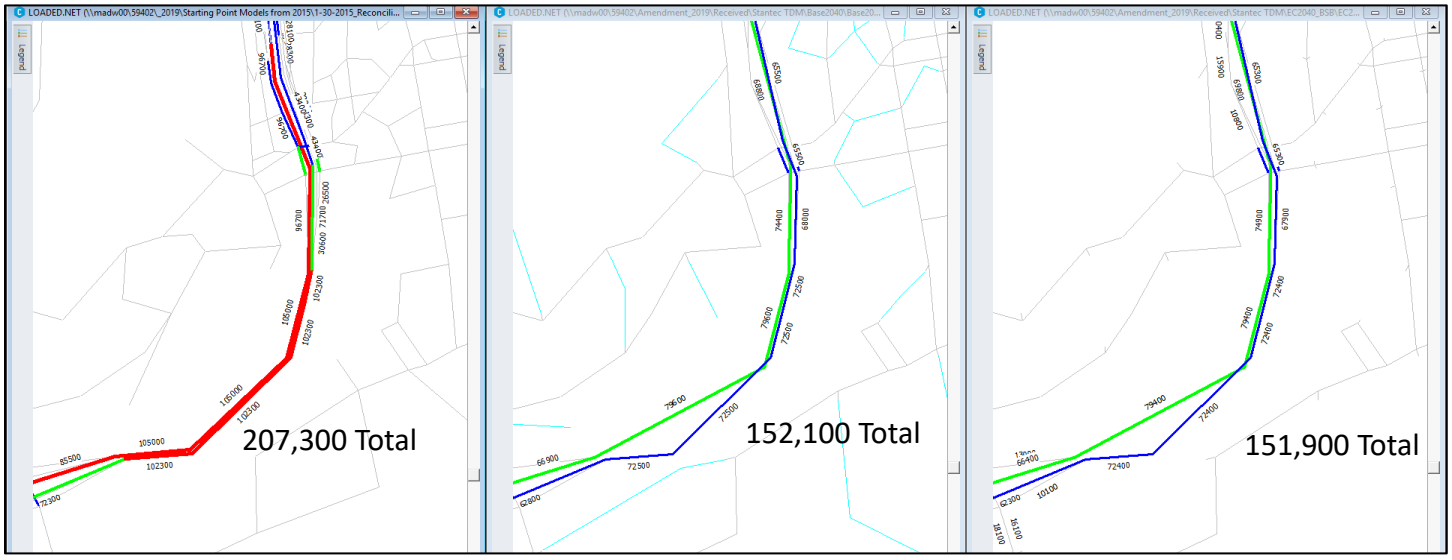


Figure 3-5: OKI TDM Traffic Assignment on I-71/75 in Kentucky

Build (BSB Corridor Study) *No Build (Eastern Bypass Study)* *Build (Eastern Bypass Study)*



4. PSEUDO 2050 TRAVEL DEMAND MODEL

The Brent Spence Bridge Corridor study and Eastern Bypass study models have a horizon year of 2040. At the time of this memorandum, OKI is developing an updated model for horizon year 2050. The purpose of this modeling exercise is to evaluate the anticipated impacts of the updated 2050 socio-economic data.

4.1 2050 TDM METHODOLGY

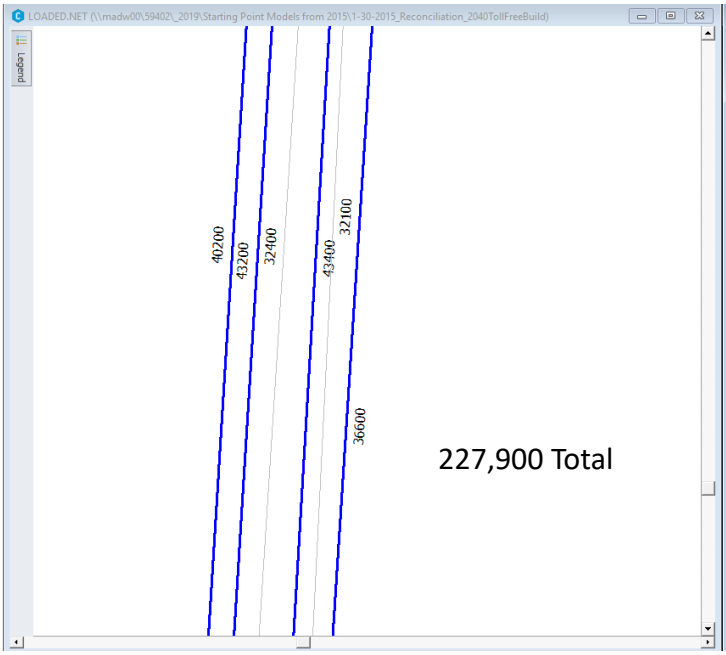
The pseudo 2050 TDM model is developed using the 2040 Build model from the BSBC study. 2040 to 2050 growth factor are developed by comparing the 2040 and 2050 socio-economic data. The derived zonal growth factors are applied to the 2040 trip tables. On average, the region-wide trip tables showed approximately 6 percent more trips in the 2050 tables compared to the 2040 tables. The derived 2050 trip tables where then assigned to the BSBC study No Build and Build models.

4.2 2050 MODEL RESULTS

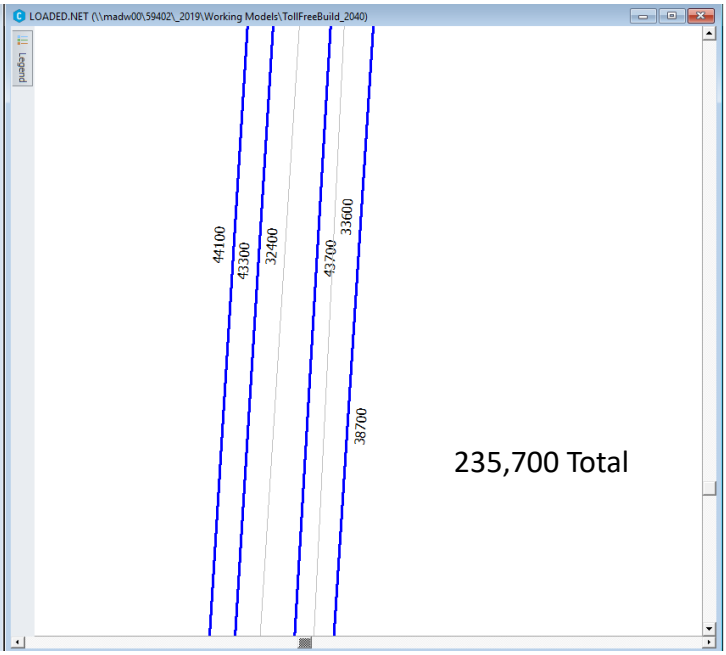
The BSB Build traffic assignments increased by 3.4% from 2040 to 2050. The traffic assignment of BSB are shown in the figure below.

Figure 4-1: Brent Spence Traffic Assignment 2040 & 2050

2040 Build (BSB Corridor Study)



2050 "pseudo" Build



5. TRAFFIC FORECASTS

ODOT certified 2040 AM, PM, and Daily forecasts during the BSBC study. The project team reviewed the forecasting methodology used in the BSBC study and estimated a 2050 forecast using the updated 2015 and 2050 travel demand models.

5.1 2050 DAILY FORECASTS (ESTIMATE)

The 2040 forecasts from the BSBC study were derived using 2010 AADT (traffic counts), 2010 TDM, and 2040 TDM. The 2050 forecasts are estimated using a 2019 AADT, 2015 TDM, and 2050 TDM. The existing data for both 2040 and 2050 forecasts are listed below.

- 2010 AADT: 154,300
- 2010 Assignment: 141,800
- 2015 Assignment: 142,700
- 2019 AADT (estimate from OKI counts): 159,000

The 2010 AADT increases at an annual rate of 0.1% from 2010 to 2019. The traffic assignment increases by 0.6% from 2010 to 2015, or 0.1% annually.

The future traffic assignments and growth rates are:

- 2040 Build Toll Free Assignment: 227,900
    - 2.02% annual growth rate from 2010 assignment
- 2050 Build Toll Free Assignment: 235,700
    - 1.86% annual growth rate from 2015 assignment

Although the 2050 traffic assignment increases from 2040, the growth rate from the base year is lower for 2050 due to the higher base year assignment in 2015 and the longer duration over which the growth is spread.

If the 1.86% growth rate is applied to the 2019 AADT, the 2050 forecast for the BSB is estimated as 250,700. This is only 3 percent higher than the 2040 forecasts of 242,700.

Because of the similarity between the 2040 forecast previously derived and the 2050 forecast estimate, the project team decided to use the 2040 certified forecasts for the current traffic analysis.

5.2 2040 PEAK HOUR FORECAST

The AM and PM peak design hour forecasts developed as part of the Brent Spence Bridge Study and certified by ODOT are compared against various traffic counts and the method forecasts (reflective of typical weekday peak) developed during the BSB study. This summary is in Table 5-1.

Table 5-1: Brent Spence Bridge - Peak Hour Counts and Forecasts

Count/Forecast	AM – Northbound	PM - Southbound
2013 Count (T-Th April/May OKI)	6,000	5,800
2014 Count (T-Th August KYTC)	5,500	6,300
2017 Count (T-Th Jan/March KYTC)	5,900	6,100
2019 Count (T-Th June-Oct OKI)	5,800	5,500
2010 Balanced Peak Hour	5,200	5,100
2040 No Build Method Forecast	6,200	6,200
2040 No Build Design Hour Forecast	7,800	7,800
2040 Toll Free Method Forecast	8,600	8,700
2040 Toll Free Design Hour Forecast	10,600	10,900

6. SUMMARY

Traffic counts, travel demand modeling, and forecasts completed during and since the Brent Spence Bridge Corridor and Eastern Bypass studies were reviewed.

6.1 TRAFFIC COUNTS

Brent Spence Bridge traffic counts were collected in 2013, 2014, 2017, and 2019. The daily counts vary from about 130,000 to 180,000 with the lowest volumes observed on Sunday and highest on Friday. The counts were collected using video, radar, and inductive loops. Each method has its advantages and disadvantages, but the counts appear to be consistent between the count sources.

6.2 2040 BUILD TRAVEL DEMAND MODEL COMPARISON

The OKI Travel Demand Model was used for the Brent Spend Bridge and Eastern Bypass studies. The Build models (assuming additional capacity on Brent Spence Bridge) from the two studies were compared. The models were consistent on the Brent Spence Bridge and I-75 in Ohio. The Brent Spence Bridge study model included capacity expansion on I-71/75 south of the Brent Spence Bridge while the Eastern Bypass model represents existing conditions. This difference in "Build" assumptions creates the large differences in traffic assignments on the Brent Spence Bridge.

6.3 2050 MODEL REVIEW

The socio-economic data anticipated for the 2050 OKI model was compared to the 2040 data. Zonal growth factors were created to grow the 2040 model, used in the BSBC study, to a pseudo 2050 model. The 2050 model assignments were compared to the 2040 model. The BSB assignments for the Build Toll Free scenario increased by 3.4%.

6.4 FORECAST REVIEW

ODOT Certified 2040 AM, PM, and Daily forecasts were established during the BSBC study. The 2019 AADT (estimate), 2015 model assignments, and 2050 model assignments were used to approximate a 2050 daily forecast. The forecast revealed only a 3.29% increase from the 2040 forecast. Due to the minimum differences between forecasts, the project team decided to use the 2040 certified traffic for the current traffic analysis.

6.5 FUTURE ACTIONS

The project team should work with OKI to incorporate the newest version of the OKI travel demand model into future forecasting efforts.

The project team should compile the continuous traffic count data currently being collected on the BSB facility and along the parallel facilities across the Ohio River in the downtown Cincinnati area. This continuous count data should be analyzed to develop BSB-specific traffic count factors to be used during future traffic forecasting efforts. Currently both ODOT and KYTC have statewide traffic count factors based on their respective state's traffic data, resulting in the BSB facility having different traffic count factors being applied on either side of the state line.