

# Final Report Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



September 2019



Prepared for



North Carolina  
Department of Transportation



**CDM  
Smith**



77 Hartland Street, Suite 201  
East Hartford, Connecticut 06108  
tel: 860 529-7615

September 27, 2019

Mr. David Roy  
Director of Finance and Budget  
North Carolina Turnpike Authority  
1 South Wilmington Street  
1578 Mail Service Center  
Raleigh, NC 27601

**Subject: NCTA Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study**

Dear Mr. Roy:

CDM Smith is pleased to provide the ***Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study*** report dated September 2019 (T&R Study). It is our understanding that this letter and corresponding T&R Study are intended to support upcoming financing of the Triangle Expressway system including Complete 540 Phase 1.

The purpose of the study was to develop 40-year annual traffic and toll revenue forecasts for the following two scenarios:

**Scenario 1:** Triangle Expressway assuming Complete 540 is not constructed.

**Scenario 2:** Triangle Expressway assuming the planned Complete 540 Phase 1 is constructed. Complete 540 Phase 1 will extend the Triangle Expressway from its southern terminus at the NC 55 Bypass to Interstate 40 and US 70 (the Clayton Bypass).

The T&R Study was substantially complete in draft form in September 2018 and utilized the most recent available tools and data at that time. The T&R Study utilized the Triangle Regional Model version 6 (TRMv6), released May 2018. That model was reviewed and refined to better reflect actual traffic conditions in the study corridor. Key components of the work effort included calibration of the model with traffic counts, travel time data, motorists' value-of-time, trip characteristics, and an independent evaluation of the socioeconomic forecasts. The model reflected the most recently approved transportation improvement plans identified at that time. Other key inputs included historical Triangle Expressway transactions and revenue through June 2018, and assumed future toll rate adjustments developed in coordination with North Carolina Turnpike Authority (NCTA) staff. Motorists value-of-time in the study area was estimated via a stated preference survey conducted by Resource Systems Group, Inc. (RSG). TRMv6 socioeconomic forecasts were independently reviewed and adjusted where appropriate by Dr. Stephen Appold, an economist with local expertise.





Mr. David Roy  
September 27, 2019  
Page 2

### **Key Project Assumptions**

Subsequent to the substantial completion of the T&R Study in draft form in September 2018, based on executed construction contracts, the anticipated opening date for Complete 540 Phase 1 was revised from January 1, 2024 to July 1, 2023. Correspondingly, the anticipated opening date for the planned relocation of existing Triangle Expressway ramp toll zones at Hopson Road and U.S. 64 to adjacent mainline segments was also assumed to change from January 1, 2024 to July 1, 2023. The traffic and revenue forecasts included in the T&R Study reflect this six-month advance in anticipated opening dates.

### **Forecast Review**

Since substantial completion of the T&R Study in draft form in September 2018 an additional 12 months ending June 30, 2019 (FY 2019) of Triangle Expressway historical traffic and revenue data has become available. CDM Smith conducted a review of the forecasts in the T&R Study report taking into consideration actual FY 2019 Triangle Expressway transactions and revenue. Triangle Expressway FY 2019 historical data was used to analyze average weekday traffic growth by toll zone, method of payment distribution, processing fee revenue generation, annualization factors, and weather events.

The forecast review also included identifying changes to NCTA's planned roadway improvements on the Triangle Expressway. One notable change resulting from this review is a revised opening date for the planned Morrisville Parkway interchange with the Triangle Expressway. The new interchange was previously expected to be open to traffic on January 1, 2020 but is now expected to open no later than May 1, 2020.

We have assessed the potential impacts of the changes and information mentioned above and have concluded that the net overall effect of these changes on toll revenue would not be material to the Triangle Expressway and Complete 540 Phase 1 traffic and revenue estimates included in the T&R Study report. Therefore, the Triangle Expressway and Complete 540 Phase 1 traffic and revenue forecasts included in the T&R Study are appropriate for use in the support of project financing.

Sincerely,

A handwritten signature in black ink that reads "Scott A. Allaire". The signature is written in a cursive, flowing style.

Scott Allaire  
Vice President  
CDM Smith Inc.





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# Chapter 1

## Introduction

This report documents the ***Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study*** conducted for the North Carolina Turnpike Authority (NCTA) and the North Carolina Department of Transportation (NCDOT). The purpose of the study was to develop a 40-year (fiscal years 2019 through 2058) annual traffic and toll revenue forecast for the following two scenarios:

**Scenario 1:** Triangle Expressway assuming Complete 540 Phase 1 is not constructed. This scenario will also be called the **Triangle Expressway Scenario** or forecast in this report. The Triangle Expressway is an existing toll road consisting of Toll NC 540 and Toll NC 147.

**Scenario 2:** Triangle Expressway assuming the proposed Complete 540 Phase 1. Phase 1 would extend the Triangle Expressway from its southern terminus at the NC 55 Bypass to Interstate 40 (I-40) and US 70 (the Clayton Bypass). This scenario will also be called the **Complete 540 Scenario** or forecast in this report. This study assumes that Complete 540 Phase 1 would open on July 1, 2023. In this report, the term Complete 540 always refers to Complete 540 Phase 1.

The traffic and toll revenue forecasts presented in this study for the two scenarios described above are suitable for use in support of project financing.

**Figure 1.1** shows the location of the existing Triangle Expressway and the proposed Complete 540 Phase 1 within North Carolina and the connecting roadway system. The Triangle Expressway and Complete 540 are located in the greater Raleigh area. The completion of Complete 540 Phase 1 would substantially complete the 540 Outer Loop, which would consist of Interstate 540, the Triangle Expressway and Complete 540, also known as the Southeast Extension. Interstate 540, on the northern side of Raleigh is a toll-free roadway, while the Triangle Expressway is a toll road that opened in its entirety in early 2013. Complete 540 Phase 1 is planned as a toll road.

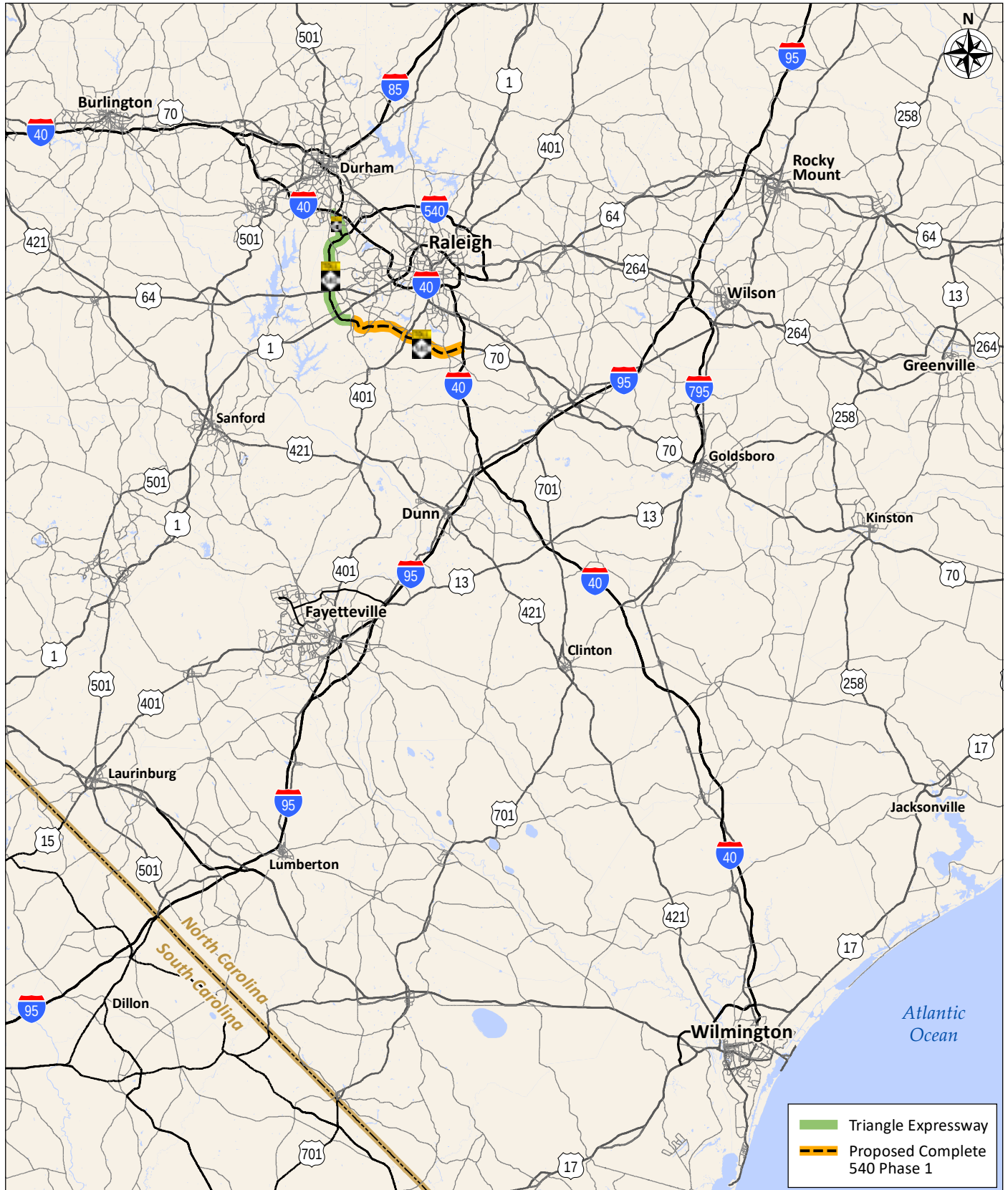
Complete 540 Phase 1 would extend the Triangle Expressway by about 17.1 miles from its current southern terminus at the NC 55 Bypass in Apex, NC to I-40 and US 70, south of Raleigh. Complete 540 Phase 1 is assumed to open on July 1, 2023. In central and eastern North Carolina, I-40 is an important road that connects inland communities such as Winston-Salem, Greensboro, Durham, and Raleigh, to shore points, including Wilmington and numerous recreational areas in southwestern NC. Upon completion, the Triangle Expressway and Complete 540 Phase 1 would provide an alternative route for longer-distance trips, avoiding the more congested sections of I-40 serving local movements in the Raleigh area. Complete 540 Phase 1 would provide more connectivity for local residents, including those in Apex, Holly Springs, Williams Crossroads and Clayton.

The NCDOT lists two Complete 540 Phase 1 construction Segments in the ***State Transportation Improvement Program*** (STIP):

- Segment 1: **NC 55 Bypass to U.S. 401** (STIP# R-2721) – about 8.5 miles, and
- Segment 2: **U.S. 401 to I-40** (STIP# R-2828) – about 8.6 miles



# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



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As mentioned above, it is assumed that Complete 540 Phase 1 would open on July 1, 2023.

## 1.1 Project Description

**Figure 1.2** shows the general alignment of the existing Triangle Expressway and the proposed Complete 540 Phase 1. The Triangle Expressway is a 6-lane, 18.5-mile toll road, consisting of Toll NC 540 and Toll NC 147. Toll NC 147 is about 3.4 miles in length and terminates at I-40 in the north and Toll NC 540 to the south. Toll NC 540 is about 15.1 miles in length and terminates at NC 54 in the north and NC 55 Bypass in the south. The posted speed limit is 70 mph.

Complete 540 is planned as a 6-lane, limited-access toll road. Phase 1 would extend from its northern terminus at the NC 55 Bypass to its southern terminus at the I-40/US 70 interchange, a total distance of about 8.6 miles. Five intermediate interchanges would be provided between the NC 55 Bypass and I-40/US 70 interchanges. The speed limit would be posted at 70 mph on Complete 540 Phase 1.

Tolls are currently collected on the Triangle Expressway at toll zones sited on a mix of mainline and ramp locations, via an electronic toll collection (ETC) program named NC Quick Pass®, and a license plate image program named Bill by Mail (BBM). There are no physical toll booths on the Triangle Expressway; all tolls are collected via equipment located on overhead gantries at each toll zone. ETC transactions, including NC Quick Pass®, require motorists to have a transponder. The transponder automatically deducts tolls from a pre-paid account. Transponders from the following programs are all accepted on the Triangle Expressway:

- NC Quick Pass®
- Florida SunPass®
- Georgia Peach Pass®
- E-ZPass®

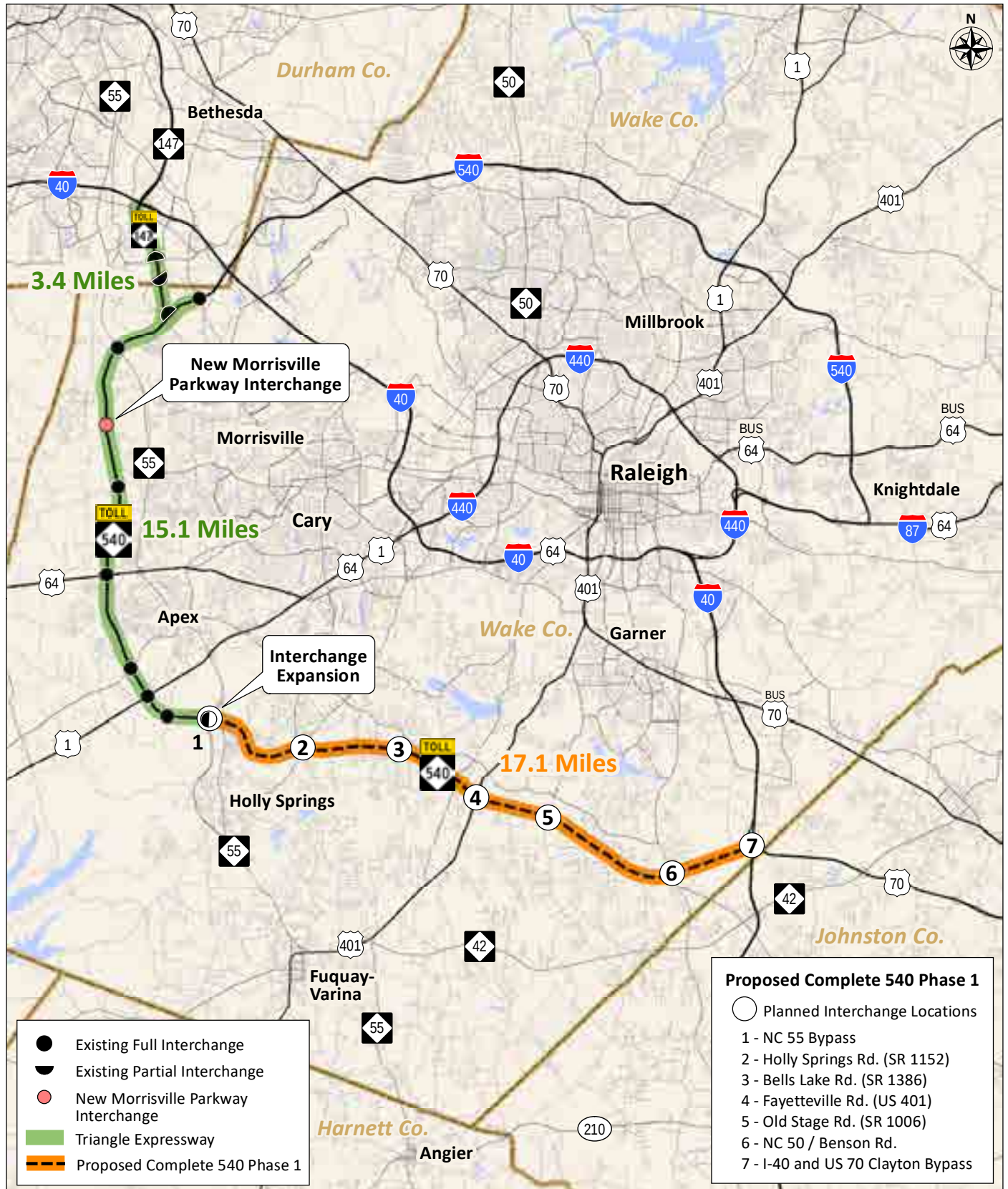
If a motorist doesn't have a transponder, high-speed cameras mounted on gantries record the license plate and an invoice is mailed to the registered owner through the BBM program. ETC transactions receive an automatic 35 percent discount from the BBM toll. No toll-free movements are available on the Triangle Expressway.

Complete 540 Phase 1 would utilize the same payment system as the Triangle Expressway, with toll zones located on each of the six mainline sections. No toll-free movements would be permitted on Complete 540.

There are planned improvements to the Triangle Expressway during the forecast period which are shown in **Figure 1.3**, along with the current and planned toll zone locations. NCTA toll zone IDs are shown at each toll zone. Figure 1.3 is a functional schematic, not drawn to scale, and does not portray the actual ramp configurations. The planned Triangle Expressway improvements include:

1. A new controlled-access interchange at Morrisville Parkway and Toll NC 540. The NCTA plans on opening the interchange in early 2020. This study assumes the opening date is January 1, 2020.

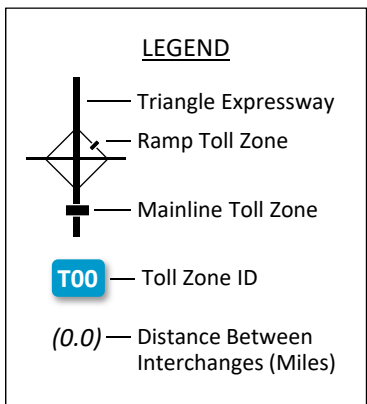
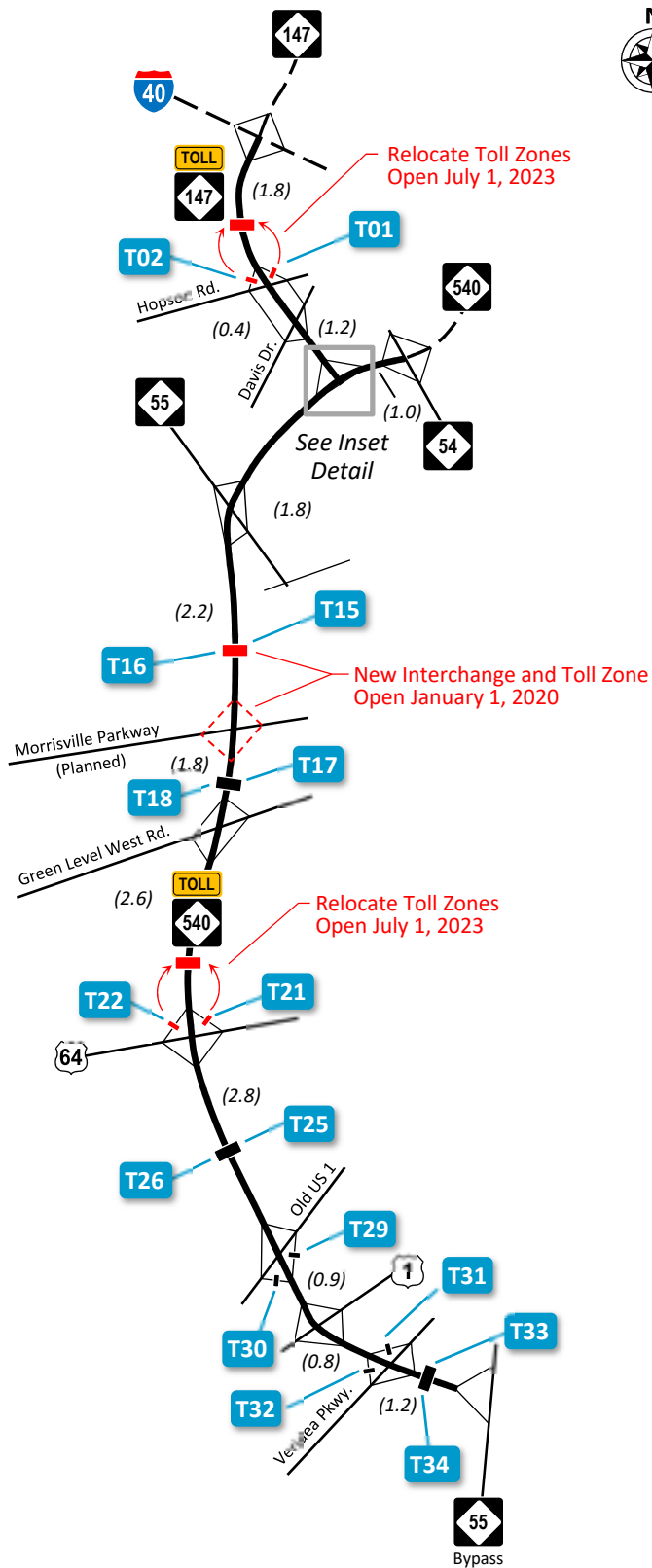
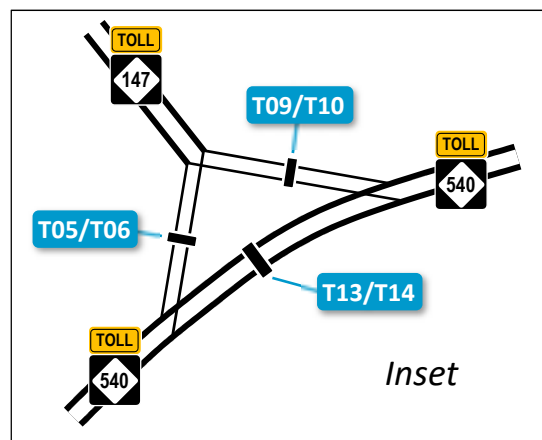
# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



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# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



**TRIANGLE EXPRESSWAY TOLL ZONES AND PLANNED MODIFICATIONS**

2. Existing ramp toll zones on Hopson Road (T01 and T02) and US 64 (T21 and T22) will be relocated to adjacent mainline sections. This change is assumed to occur on July 1, 2023, concurrent with the opening of Complete 540 Phase 1. The purpose of the change is to achieve greater toll equity among movements on the Triangle Expressway.

## 1.2 Prior Work

CDM Smith issued the ***Complete 540 Planning Level Traffic and Revenue Study*** on May 31, 2017. It provided traffic and toll revenue forecasts for the existing Triangle Expressway and for three scenarios that included various assumptions regarding Complete 540 Phase 1 and Phase 2 (a completion of Complete 540 from I-40/U.S. 70 to U.S. 64/U.S. 264 Bypass). The traffic and revenue forecasts were intended for planning purposes and were not suitable for project financing. A substantial amount of data was collected for the Planning Level Study, including traffic counts, travel-speed data, travel-pattern data from StreetLight Data, Inc., historical traffic and toll revenue on the Triangle Expressway, and planned roadway improvements in the study area. The traffic and revenue projections were based on the Triangle Regional Model version 5 (TRMv5), including its assumptions regarding growth and location of future population, households and employment.

This ***Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study*** used the data collected for the Planning Level Study, as well as additional traffic counts, updated travel-time data, updated historical Triangle Expressway traffic and toll revenue and updated plans for roadway improvements. In addition, this current study used the new version 6 of the Triangle Regional Model (TRMv6); engaged an independent economist to review and adjust forecasted socioeconomic variables assumed in the TRMv6; and had stated preference (SP) surveys conducted to estimate motorist values-of-time.

The following are other pertinent studies conducted by CDM Smith relating to the Triangle Expressway and Complete 540, listed in reverse chronological order (most recent first).

**November 2018: *Triangle Expressway 2018 Traffic and Revenue Study***

Provided a 40-year annual traffic and revenue forecast for the Triangle Expressway, from fiscal year (FY) 2019 through 2058. The forecast included a new planned interchange with Morrisville Parkway, and the relocation of ramp toll zones to mainline toll zones at the Hopson Road and U.S. 64 interchanges. The forecast was used for project financing.

**3/22/2017:** Revised transactions and toll revenue forecasts were prepared for the Triangle Expressway and for impacts due to the Veridea Parkway and Morrisville Parkway interchanges to reflect opening dates of April 1, 2017 and January 1, 2019, respectively. The revised transaction and revenue forecasts were used in the ***North Carolina Turnpike Authority Triangle Expressway Senior Lien Turnpike Revenue Refunding Bonds Official Statement***. The revised forecasts were based on the ***2009 Comprehensive Report***.

**03/31/2016: *Toll NC 540/Old Holly Springs-Apex Road Interchange Toll Schedule Recommendation***

Provided the recommended toll rate schedule for the Veridea Parkway Interchange (previously the Old Holly Springs-Apex Road Interchange). This toll rate schedule differed slightly from the assumed toll rates in the 9/9/2013 letter listed above. The recommended Veridea toll rate schedule was adopted by the NCTA.



**9/9/2013: Impact of Morrisville Parkway and Old Holly Springs Road Interchanges**

Revised traffic and toll revenue forecasts are provided for the Triangle Expressway without the proposed interchanges, with each individual interchange, and with both interchanges. The Old Holly Springs-Apex Road Interchange was the current name for the Veridea Parkway Interchange at the time of the study. The revisions of the Triangle Expressway included adjustments for actual experience, and some toll schedule adjustments that reflected actual phased openings. Both interchanges were assumed to open on January 1, 2016. The forecasts were based on the **2009 Comprehensive Report**.

**4/25/2012: Technical Memorandum – 24 Month Monthly Transactions and Gross Toll Revenue Estimates for the Triangle Expressway**

This document presents revised traffic and toll revenue estimates from January 2012 through December 2014 to reflect changes in the actual phased opening of the Triangle Expressway. The estimates were based on the **2009 Comprehensive Report**. The Veridea Parkway and Morrisville Parkway interchanges were not included in the forecasts.

**11/10/2011: Toll NC 147/McCrimmon Parkway Connector T&R Study**

This document presents planning level traffic and revenue estimates for the Toll NC 147 extension to McCrimmon Parkway. It was based on the **2009 Comprehensive Report** and did not assume the Veridea Parkway or Morrisville Parkway interchanges.

**December 2010: Morrisville Parkway Interchange Test**

This document presents planning level traffic and revenue estimates for the Morrisville Parkway Interchange. It was based on the **2009 Comprehensive Report**.

**October 2010: Triangle Expressway Veridea Interchange Test**

This document presents planning level traffic and revenue estimates for the Veridea Parkway Interchange. It was based on the **2009 Comprehensive Report**.

**4/6/2009: Triangle Expressway Comprehensive Traffic and Revenue Study (2009 Comprehensive Report)**

This report contains a certified forecast of Triangle Expressway traffic and toll revenue. It contains forecasts for fiscal years (FY) 2012 through 2051 and was prepared prior to the opening of the Triangle Expressway. The forecasts did not include the Veridea Parkway or Morrisville Parkway interchanges.

## 1.3 Work Scope

The work scope was comprised of the following tasks.

- Task 1: Data Collection and Summarization
- Task 2: Corridor Growth Analysis
- Task 3: Stated Preference Surveys
- Task 4: Triangle Regional Model Refinement and Calibration
- Task 5: Traffic and Toll Revenue Analysis
- Task 6: Traffic and Toll Revenue Sensitivity Tests

### Task 1: Data Collection and Summarization

CDM Smith used data collected for the *Complete 540 Planning Level Traffic and Revenue Study* and collected additional data.

#### Subtask 1.1: Obtain Available Traffic Counts and Toll Revenue Data

- CDM Smith obtained NCDOT traffic count data that was made available since the Planning Level Study was conducted.
- CDM Smith obtained updated toll transaction and revenue data for the Triangle Expressway from the NCTA. In addition, CDM Smith received data on leakage and fee revenue associated with BBM transactions on the Triangle Expressway.

#### Subtask 1.2: Conduct New Traffic Counts

- As part of the Planning Level Study, CDM Smith contracted The Traffic Group to conduct traffic counts at 63 locations. Traffic counts were conducted at 15 additional locations as part of the current study.

#### Subtask 1.3: HERE Travel Speed Data

- Updated travel speed data was obtained in the study area from HERE via the Regional Integrated Transportation Information System (RITIS) with the permission of the NCDOT.

#### Subtask 1.4: Future Roadway Improvements

- Future roadway improvement projects were reviewed and checked against assumed improvements in the TRMv6. The following sources were used to identify planned roadway improvements.
  - o *2018-2027 NC State Transportation Improvement Program (STIP)* and interactive map.
  - o NC Capital Area Metropolitan Planning Organization (CAMPO) and Durham - Chapel Hill – Carrboro Metropolitan Planning Organization (DCHC MPO) *Transportation Improvement Program (TIP)* and interactive map.

- o CAMPO and DCHC MPO long range plan – the 2045 ***Metropolitan Transportation Plan*** and interactive map.
- o Go Triangle ***Recommended Wake County Transit Plan***

CDM Smith coordinated with NCDOT/NCTA staff and/or MPO staff to identify needed changes to the TRMv6 model to reflect the current understanding of improvement completion dates or definitions.

## **Task 2: Corridor Growth Analysis**

Economic growth forecasts are one of the most important elements of a traffic and toll revenue forecast, particularly for new toll facilities. Traffic demand and travel patterns in regional models, such as the TRMv6, are based on forecasts of socioeconomic variables such as population, number of households, and employment. CDM Smith employed Dr. Steven Appold, an economist with local expertise, to conduct an independent analysis of the land-use and socioeconomic growth forecasts assumed in the TRMv6. Dr. Appold reviewed the forecasts and recommended adjustments where appropriate. The resulting revised socioeconomic forecasts were used in adjusting the TRMv6 trip tables to reflect the changed assumptions in variables such as population, households, and employment. The economic review focused on the Triangle Expressway and Complete 540 corridors. Chapter 3 in this report summarizes Dr. Appold's work and socioeconomic forecasts.

## **Task 3: Stated Preference Surveys**

Stated preference (SP) surveys are an integral part of investment-grade traffic and revenue studies to estimate motorists' willingness to pay tolls, or value of time (VOT), for different market segments. The surveys provide an important analytical tool in evaluating traffic and revenue potential and in enhancing the credibility of the study for presentation to the financial community. Past studies have shown that travelers' VOT are region-specific and depend in complex ways on characteristics of travelers and trip mix such as vehicle classification, personal incomes, trip purposes, and availability of discretionary time. These factors and others create wide variations in VOT among regions and facilities, and support the need for context-specific studies to accurately estimate these values.

CDM Smith contracted Resource Systems Group, Inc. (RSG) to conduct SP surveys to estimate VOT for motorists in the study area. Estimated VOT was developed for different market segments and geographic areas in the model area. This information was incorporated into the travel demand model to support the development of traffic and toll revenue forecasts.

## **Task 4: Triangle Regional Model Refinement and Calibration**

The TRMv6 was used to analyze the traffic and toll revenue potential of the Triangle Expressway and Complete 540. Model supported years included 2013, 2025, 2035, and 2045.

The TRMv6 model years were reviewed to identify necessary changes to improve network detail and more accurate route choice in the immediate project vicinity. These reviews included planned roadway improvements, the size of traffic analysis zones, centroid locations, road capacities, and speed limits.

Trip tables were modified to reflect socioeconomic adjustments recommended by Dr. Appold, the economist.

A 2016 model year was created by CDM Smith to use as a calibration year. Traffic assignments were calibrated to reflect actual ground conditions including traffic volumes, travel speeds, ETC market share, and trip distance at selected locations. Calibration adjustments were carried through to future year assignments.

### **Task 5: Traffic and Toll Revenue Analysis**

Traffic assignments were conducted using the refined and calibrated TRMv6, incorporating the adjusted trip tables, and using CDM Smith toll diversion algorithms. The assignments included model inputs developed by CDM Smith and RSG, including motorist VOTs, motor vehicle operating cost (VOC), toll rate schedules, and NC Quick Pass® and BBM market shares.

Annual traffic and gross toll revenue forecasts were developed for the model assignment years and the intermediate years. Net revenue was subsequently developed to incorporate adjustments reflecting expected toll-revenue leakage, and fee revenue. Estimated rates of revenue leakage and fee revenue were based on actual experience from the Triangle Expressway.

### **Task 6: Traffic and Toll Revenue Sensitivity Tests**

There is considerable uncertainty in traffic forecasts as they are dependent on many variables, particularly on new facilities. It is standard practice in investment-grade traffic and revenue studies to include traffic and toll revenue sensitivity testing. The purpose is to help financial analysts assess the potential risk associated with the Project's traffic and revenue forecasts by testing the impact of changes to key variables. Key variables tested include lower economic growth, lower motorist VOTs, higher fuel prices, longer ramp-up periods, and lower truck traffic. The results of the sensitivity tests are documented in Chapter 8.

## **1.4 Report Structure**

This report consists of eight chapters.

### **Chapter 1: Introduction**

Describes the purpose of the study; a description of the project and traffic and revenue scenarios; the work scope; and structure of the report.

### **Chapter 2: Existing Conditions**

Presents information regarding the existing conditions on the Triangle Expressway and other roads in the Complete 540 study area. Information provided for the Triangle Expressway includes its toll collection system and current toll schedule; historical traffic volumes and traffic characteristics; travel patterns; and historical transaction and toll revenue. Recent traffic volumes and travel times are provided for many area roads in the Triangle Expressway and Complete 540 study area.

### **Chapter 3: Independent Economic Review**

This chapter summarizes the work of the independent economist, Dr. Stephen Appold, who reviewed socioeconomic assumptions in the TRMv6, and created revised socioeconomic inputs, including population, number of households and employment, for each of the supported model years. The revised socioeconomic inputs to the TRMv6 are summarized; and the changes, compared to the original inputs, are quantified. In addition, Dr. Appold developed a set of socioeconomic inputs to the TRMv6 to create a model year 2016 for calibration purposes. This chapter describes the process Dr. Appold used to develop the 2016 socioeconomic dataset.

## Chapter 4: Stated Preference Survey

This chapter summarizes the Resource Systems Group (RSG) work in developing VOT for motorists in study area. RSG administered a SP survey, which is described, along with the survey analysis, and the resulting estimation of VOT by market segment.

## Chapter 5: Model Refinement

The TRMv6 is described. Also provided is a summary of modifications made to the model by CDM Smith; the model calibration process and calibration metrics.

## Chapter 6: Scenario 1: Triangle Expressway Traffic and Toll Revenue Forecast

Key inputs and assumptions are provided, including planned roadway improvements, toll schedules, and toll zone locations. A toll sensitivity curve is provided, demonstrating the revenue potential of the facility across various toll rate levels. The development of the traffic and toll revenue forecast is described, including how the model weekday traffic output is converted into annual traffic and toll revenue forecasts. Estimated annual toll transactions and toll revenue are provided from FY 2019 through FY 2058. Adjusted annual traffic and revenue forecasts are also provided that account for leakage and fee revenue associated with BBM transactions.

## Chapter 7: Scenario 2: Complete 540 Phase 1 Traffic and Toll Revenue Forecast

The development of the traffic and toll revenue forecast is described, including the assumed toll schedule and toll sensitivity curve. The traffic and toll revenue forecasts for gross toll revenue and adjusted toll revenue are provided. In addition, time-distance comparisons are provided for selected movements, comparing travel on the Triangle Expressway and/or Complete 540 Phase 1 with a trip using the best toll-free alternative route.

## Chapter 8: Sensitivity Tests

Six tests were conducted on Scenario 2 to determine the impact on forecast traffic and toll revenue if key assumptions were changed. All tests changed variables to negatively impact traffic and toll revenue. The five tests are:

1. Reduce the trip table by 30 percent to reflect lower economic growth.
2. Reduce the motorist VOT for all classes by 25 percent.
3. Increase fuel costs by 50 percent.
4. Reduce the truck market share by 25 percent. Total toll transactions are unchanged, but truck transactions are reduced by 25 percent and shifted into car transactions.
5. Assume a five-year ramp-up on Complete 540 Phase 1 instead of the three-year ramp-up assumed in Scenario 2.



## Chapter 2

### Existing Conditions

This Chapter describes existing and historical conditions on the Triangle Expressway, and in the Triangle Expressway and Complete 540 study area. Triangle Expressway traffic volumes, toll rates, toll revenue, travel patterns and other traffic characteristics are described. Traffic volumes and travel times by time period are described in the study corridor.

#### 2.1 The Triangle Expressway

The Triangle Expressway is a six-lane, 18.5-mile toll road, consisting of Toll NC 540 and Toll NC 147 (please refer to Figure 1.2 in Chapter 1). Toll NC 147 is about 3.4 miles in length and extends from I-40 in the north to Toll NC 540 in the south. Toll NC 540 is about 15.1 miles in length and extends from NC 54 in the north to NC 55 Bypass in the south. The speed limit is posted at 70 miles per hour (mph). The road provides a high-speed connection from communities to the south and west of Raleigh (such as Fuquay-Varina, Holly Springs and Apex), to Interstate 40 (I-40), Research Triangle Park (RTP) and the Raleigh-Durham International Airport. Toll NC 540 is part of the 540 Outer Loop.

The primary competing roadway to the Triangle Expressway is NC 55 and the NC 55 Bypass, which closely parallels the Triangle Expressway. NC 55 and the Bypass generally provide two through travel lanes per direction, with the intermittent provision of left, right and center turn lanes. There are some single-lane sections of NC 55. Posted speed limits range from 35 to 55 mph on NC 55 in the Triangle Expressway corridor. There are 13 signalized intersections on NC 55 and the Bypass between the southern end of Toll NC 540 and U.S. 64, another 13 between U.S. 64 and the interchange with Toll NC 540 near Morrisville, and 10 between the Toll NC 540 interchange and I-40 near Research Triangle Park.

The Triangle Expressway opened in three segments, as shown in **Table 2.1**. The entire project was opened to tolled traffic on January 2, 2013. The most recent improvement to the Triangle Expressway was the full-access interchange with Veridea Parkway which opened on April 4, 2017.

| <b>Table 2.1</b><br><b>Triangle Expressway Construction History</b> |                     |                      |                                                                                 |
|---------------------------------------------------------------------|---------------------|----------------------|---------------------------------------------------------------------------------|
| <b>Improvement</b>                                                  | <b>Opening Date</b> | <b>Tolling Began</b> | <b>Location</b>                                                                 |
| Segment 1                                                           | December 8, 2011    | January 3, 2012      | Toll NC 540 between NC 55 and NC 54<br>Toll NC 147 between I-40 and Toll NC 540 |
| Segment 2                                                           | August 1, 2012      | August 2, 2012       | Toll NC 540 between NC 55 and U.S. 64<br>in Apex                                |
| Segment 3                                                           | December 12, 2012   | January 2, 2013      | Toll NC 540 between U.S. 64 and<br>NC 55 Bypass near Holly Springs              |
| Veridea Parkway<br>Interchange                                      | April 4, 2017       | April 4, 2017        | Full access interchange at Toll NC 540<br>and Veridea Parkway                   |

### 2.1.1 Triangle Expressway Toll Collection, Toll Schedule and Historical Rate Increases

The Triangle Expressway features an all-electronic tolling system (AET), designed to reduce traffic delays and promote safety. This system allows motorists to pay their toll without stopping or slowing down. Tolls are collected via NC Quick Pass, NCTA's electronic toll collection (ETC) program, or by a video toll collection system named Bill by Mail (BBM). No conventional toll plazas are located on the Triangle Expressway; instead, toll collection equipment is located on overhead gantries.

The following describes the three toll classes on the Triangle Expressway:

- Class 1 (2-axle vehicles): includes all two-axle vehicles regardless of the number of tires.
- Class 2 (3-axle vehicles): includes all three-axle vehicles including two-axle vehicles towing a single-axle trailer.
- Class 3 (4-or-more axle vehicles): includes all vehicles with four-or-more axles (4+) including two-axle vehicles towing a dual-axle trailer.

Class 2 toll rates are twice the Class 1 toll rate, and Class 3 toll rates are four times the Class 1 toll rate.

Motorists who pay with NC Quick Pass (or E-ZPass, Florida SunPass, or Georgia Peach Pass) receive an automatic 35 percent discount from the BBM toll rates for all vehicle classes.

**Figure 2.1** illustrates all the states that have interoperable transponder programs with NC Quick Pass.

Beginning in August 2017, motorists were able to obtain a **NC Quick Pass Sticker Transponder** at no cost. It is accepted for toll-road payment in North Carolina, and where Florida SunPass and Georgia Peach Pass are accepted. For \$7.40 plus tax, motorists may obtain a **NC Quick Pass E-ZPass Interior Transponder** that is valid for toll-road payment in North Carolina and wherever E-ZPass, Florida SunPass or Georgia Peach Pass are accepted.

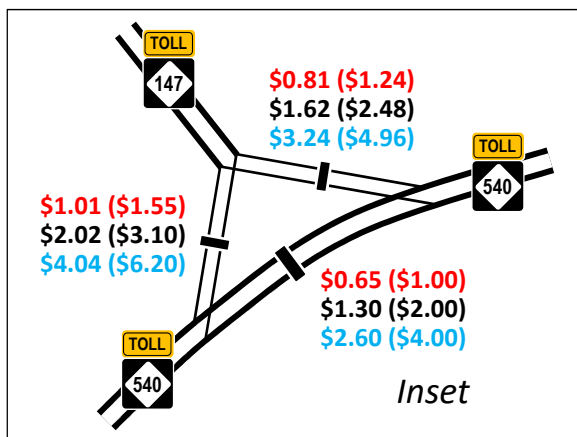
Triangle Expressway toll zones, and 2018 ETC and BBM toll rates are shown in **Figure 2.2**. A through trip on Toll NC 540 (15.1 miles between NC 55 Bypass and NC 54) in 2018 costs \$2.89 for a passenger car with a transponder, which is equal to \$0.191 per mile.

A 5-axle truck with a transponder, making the same trip, would pay \$11.56, or \$0.766 per mile.



Figure 2.1  
NC Quick Pass Interoperability

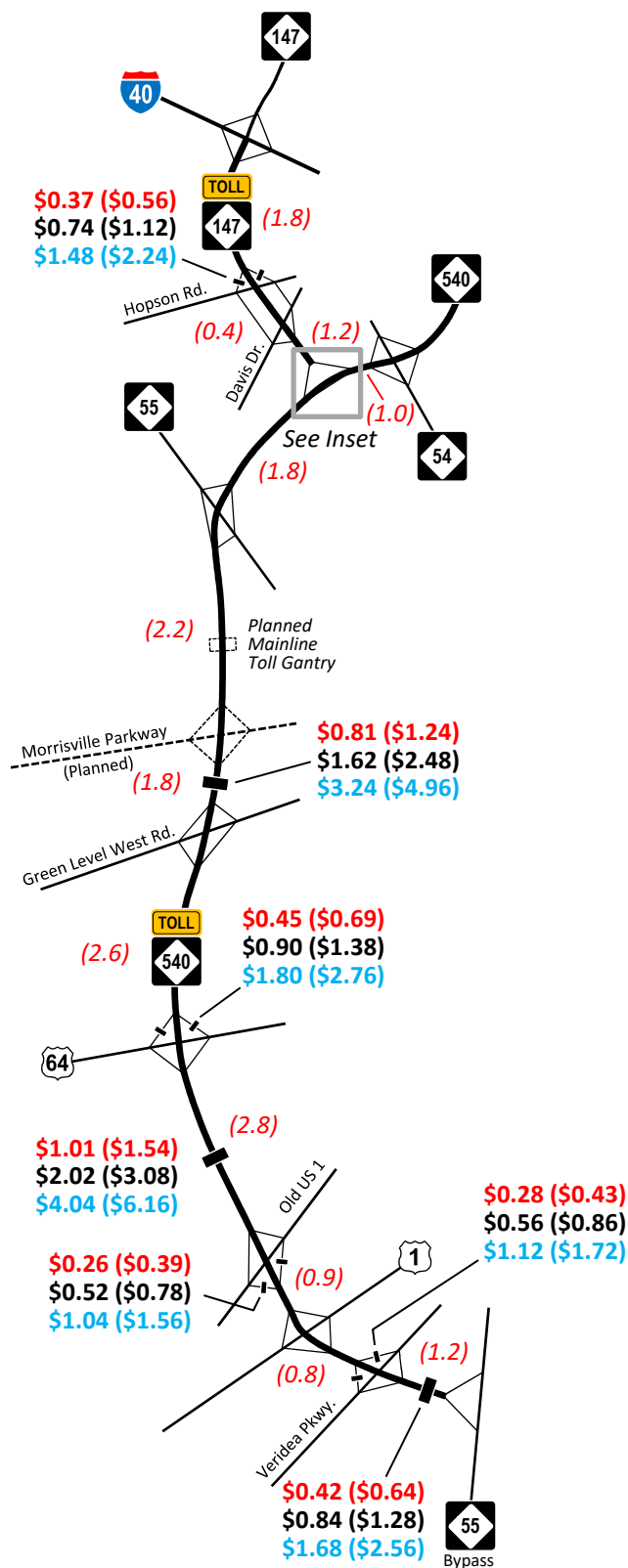
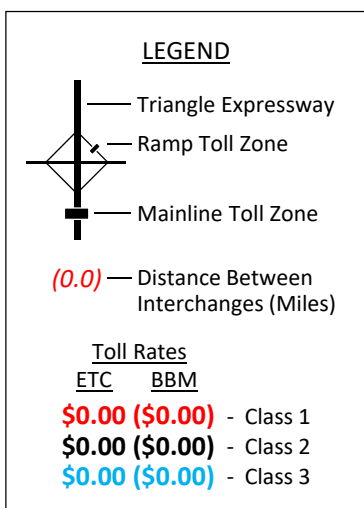
# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



## 2018 Through Trip ETC Toll Rates

Via Toll NC 540

| Vehicle Class | Toll    | Toll Per Mile |
|---------------|---------|---------------|
| Class 1       | \$2.89  | \$0.191       |
| Class 2       | \$5.78  | \$0.383       |
| Class 3       | \$11.56 | \$0.766       |



Toll rates increase annually in accordance with an approved toll schedule adopted by the NCTA Board of Directors. **Table 2.2** shows the annual historical toll rate increases on the Triangle Expressway from 2013 to 2018 for an ETC-equipped passenger car. It also shows the cost of a through trip on Toll NC 540 for an ETC-equipped passenger car, and the equivalent per-mile toll rate. A through trip on Toll NC 540 incurs tolls at four locations. Minor variations in the annual rate-of-increase of the through-trip toll between 2013 and 2018 result from rounding to the nearest penny at each of the four locations. Annual toll rate increases in future years are provided in Chapter 6.

### 2.1.2 Triangle Expressway Traffic Volumes and Characteristics

Based on data provided by NCTA, CDM Smith developed a balanced profile of 2016 and 2017 average weekday traffic on the Triangle Expressway. 2017 annual average weekday traffic (AAWDT) volumes are shown in **Figure 2.3**. Weekday traffic is important because about 83 percent of all Triangle Expressway toll transactions occur on weekdays. Traffic volumes build steadily from the south to the north on the Triangle Expressway, ranging from 19,000 vehicles per weekday at the southernmost mainline section to 49,000 on the mainline section between NC 55 and Toll NC 147.

Also shown in Figure 2.3 is the hourly weekday traffic distribution, by direction, at each of the four mainline toll-zone locations. The hourly traffic distributions are based on traffic data from Thursday, November 10, 2016. There is a sharp peaking characteristic to Triangle Expressway traffic, consistent with a commuter-based road. Northbound traffic peaks in the morning, while southbound traffic peaks in the afternoon. There is relatively low traffic demand during the midday.

Northbound traffic at the four selected mainline sections peaks between 7 AM and 9 AM, comprising from 32 to 37 percent of total weekday traffic volumes at each location. Northbound peak-hour (7 AM – 8 AM) traffic volumes comprise 15 to 20 percent of the total weekday volumes at each of the selected mainlines.

Southbound mainline traffic on the Triangle Expressway peaks sharply between 5 PM and 6 PM, comprising 16 to 22 percent of the weekday southbound traffic, as seen at the selected locations. PM peak-period traffic, between 4 PM and 7 PM in the southbound direction, accounts for 40 to 47 percent of weekday southbound traffic at these locations.

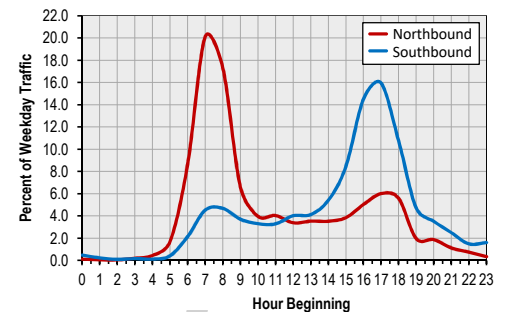
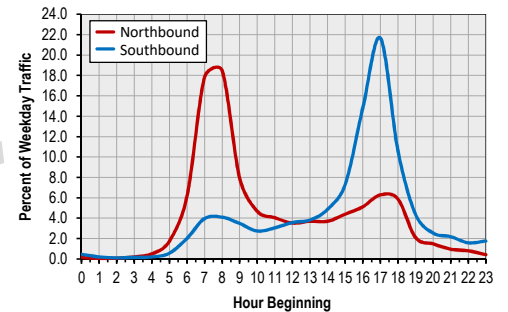
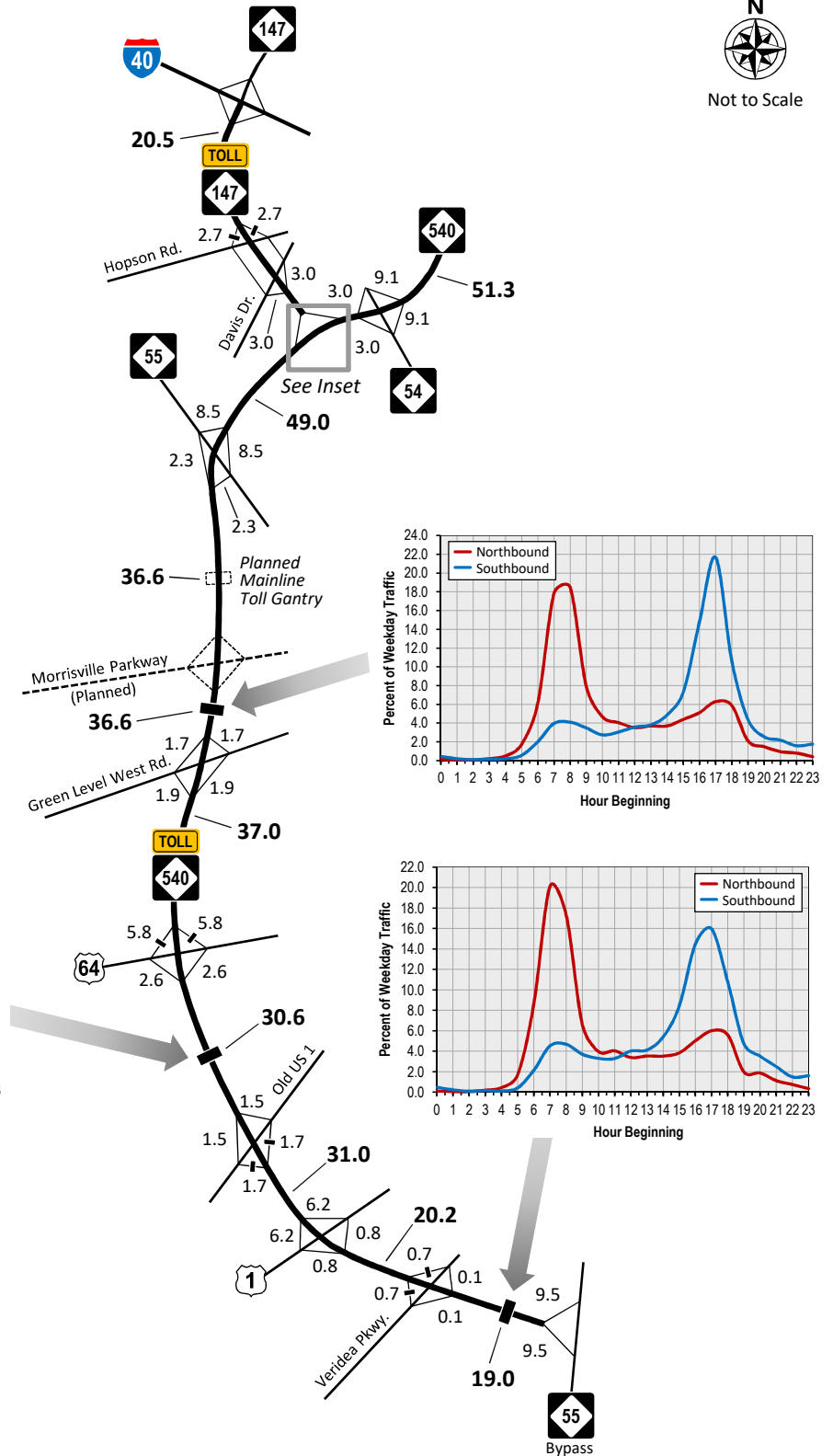
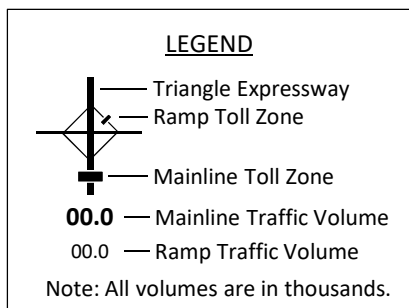
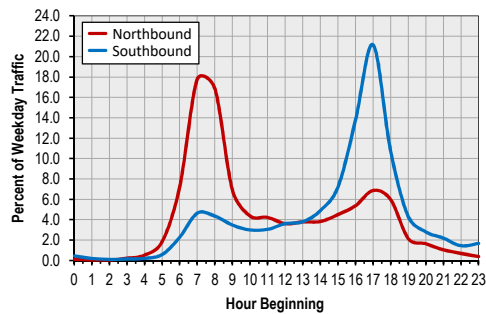
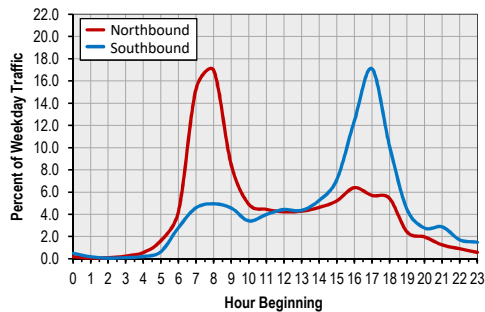
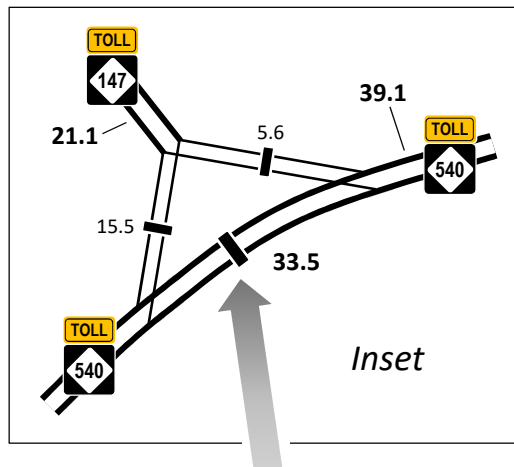
**Table 2.2**  
**Historical Toll Rate Increases**  
**on the Triangle Expressway (1)**

| Calendar<br>Year | Passenger-Car ETC<br>Through Trip Toll<br>on Toll NC 540 |                       | Percent<br>Annual<br>Toll<br>Increase |
|------------------|----------------------------------------------------------|-----------------------|---------------------------------------|
|                  | Toll (2)                                                 | Per-mile<br>Toll Rate |                                       |
| 2013             | \$ 2.34                                                  | \$ 0.155              |                                       |
| 2014             | 2.46                                                     | 0.163                 | 5.1 %                                 |
| 2015             | 2.59                                                     | 0.172                 | 5.3                                   |
| 2016             | 2.70                                                     | 0.179                 | 4.2                                   |
| 2017             | 2.78                                                     | 0.184                 | 3.0                                   |
| 2018             | 2.89                                                     | 0.191                 | 4.0                                   |

(1) Tolls increase on January 1st of each year.

(2) Class 1 Toll (2-axle vehicle) on the 15.1 mile  
Toll NC 540 portion of the Triangle Expressway.

# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



## TRIANGLE EXPRESSWAY: 2017 AVERAGE WEEKDAY TRAFFIC AND HOURLY DISTRIBUTION



Monthly traffic variations on the Triangle Expressway are shown in **Figure 2.4** and daily variations are shown in **Figure 2.5**. Cars and trucks show similar monthly patterns, with traffic volumes highest in the spring, summer and fall, and somewhat lower from December through February. Cars and trucks also have similar daily-variation patterns, with the highest traffic volumes occurring on Tuesdays, Wednesdays and Thursdays. Weekend traffic volumes for both passenger cars and trucks are lower than the weekday volumes.

**Table 2.3** shows the proportion of cars and trucks on the Triangle Expressway from 2013 through 2017. Passenger cars have consistently comprised 96 to 97 percent of total transactions. Truck transactions totaled approximately three percent in 2013, and approximately four percent in 2017. Large trucks (four-or-more axles) represented 65 percent of total truck transactions in 2013, and 68 percent in 2017.

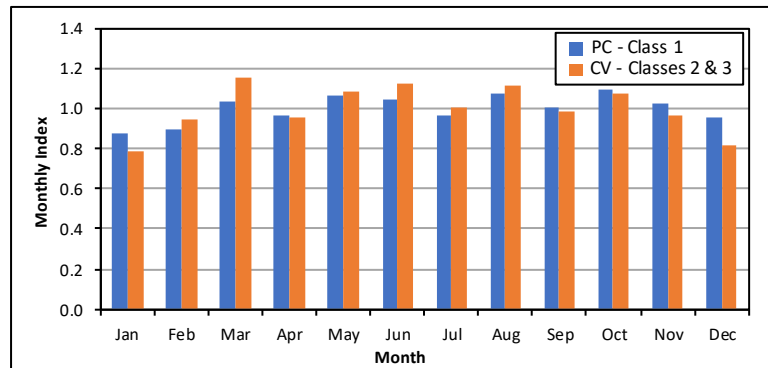


Figure 2.4  
Seasonal Variation of Toll Transactions  
on Triangle Expressway

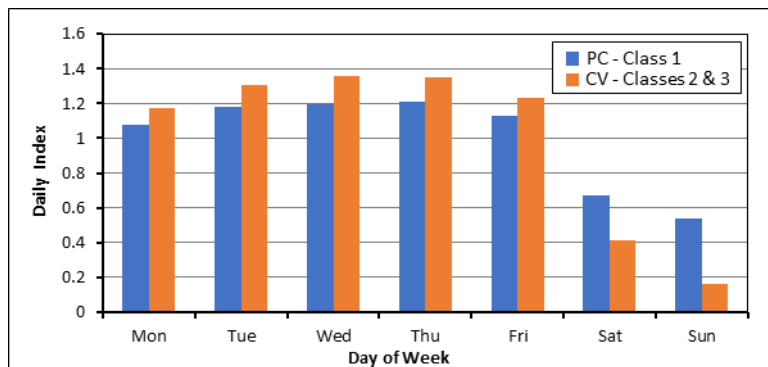


Figure 2.5  
Daily Variation of Toll Transactions  
on Triangle Expressway

**Table 2.3**  
Annual Vehicle Class Distribution on The Triangle Expressway by Toll Class  
(all transactions in thousands)

| Calendar Year | Passenger-Car Transactions |                   | Truck Transactions |                   |                         |                   | All Transactions |                   |          |                   |
|---------------|----------------------------|-------------------|--------------------|-------------------|-------------------------|-------------------|------------------|-------------------|----------|-------------------|
|               | Class 1                    | Percent           | Class 2            | Percent           | Class 3                 | Percent           | Class 2 & 3      | Percent           | All      | Percent           |
|               | 2-axle Vehicles            | of Total Vehicles | 3-axle Vehicles    | of Total Vehicles | 4 or-more Axle Vehicles | of Total Vehicles | All Trucks       | of Total Vehicles | Vehicles | of Total Vehicles |
| 2013          | 22,298                     | 96.7 %            | 268                | 1.2 %             | 493                     | 2.1 %             | 761              | 3.3 %             | 23,059   | 100.0 %           |
| 2014          | 29,641                     | 96.7              | 357                | 1.2               | 652                     | 2.1               | 1,010            | 3.3               | 30,650   | 100.0             |
| 2015          | 37,050                     | 96.7              | 427                | 1.1               | 842                     | 2.2               | 1,268            | 3.3               | 38,319   | 100.0             |
| 2016          | 43,568                     | 96.3              | 566                | 1.3               | 1,110                   | 2.5               | 1,676            | 3.7               | 45,244   | 100.0             |
| 2017          | 47,599                     | 96.2              | 602                | 1.2               | 1,258                   | 2.5               | 1,861            | 3.8               | 49,460   | 100.0             |

Source: NCTA

### 2.1.3 Travel Patterns on the Triangle Expressway

StreetLight Data, Inc. provided CDM Smith with a year of vehicle-matching data for 2016 at the 31 collection points shown in **Figure 2.6** and described in **Table 2.4**. The collection points were selected to obtain trip-distance and travel-pattern information on the Triangle Expressway, and to determine whether vehicles observed on roads intersecting the proposed Complete 540 were also identified on I-40, US 1, US 70, or the Triangle Expressway. This data provided insights into travel patterns and was available for discrete time periods as well as average days. Similar to license-plate matching surveys, geospatial information is gathered from sources such as mobile phones, GPS devices, connected cars and commercial vehicles. Unique identifiers are used to determine individual trips.

The StreetLight data helped determine what proportion of trips on the Triangle Expressway are either long-distance or through trips. **Figures 2.7 and 2.8** illustrate samples of the StreetLight data. The data is used in a similar manner to a “select link” analysis, where the selected link is identified by a star in each figure.

Figure 2.7 illustrates northbound Triangle Expressway travel patterns during an average weekday, based on all vehicles identified on the mainline section between the NC 55 Bypass and U.S. 1. This section of roadway has the lowest weekday traffic volume of any mainline section. Figure 2.7 shows the percent of all vehicles detected at the select link, at each of the mainline locations to the north of the select link. For example, 69.9 percent of all vehicles identified at the select link location were also identified on the mainline section between Green Level West Road and NC 55, and 30.6 percent were identified on the mainline section between Toll NC 147 and NC 54. Over half of the northbound vehicles (52.4 percent) detected on the southernmost section of the Triangle Expressway made a trip of approximately 15 miles, past the NC 55 interchange and continuing on either Toll NC 147 or Toll NC 540.

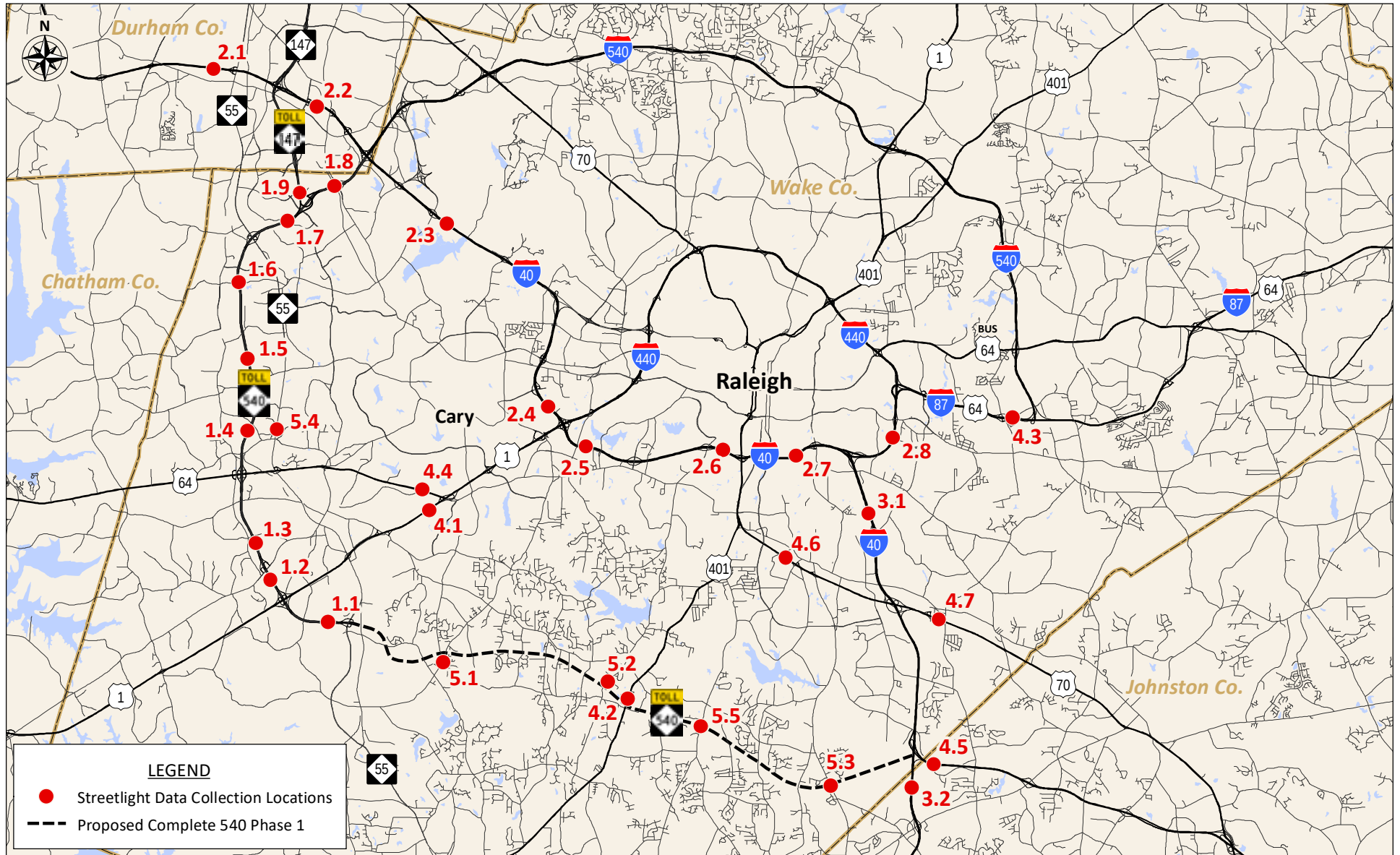
Figure 2.8 illustrates weekday travel patterns in the southbound direction from the select link location on Toll NC 540 between NC 54 and Toll NC 147. This point is marked by a star. This mainline section has the second highest weekday traffic volume on the Triangle Expressway. As shown, the majority of traffic identified at this location made short trips on the Triangle Expressway, with 54.7 percent of vehicles not traveling past the NC 55 interchange, and 8.3 percent of the trips traveling all the way to the southernmost mainline section.

The data provided by Streetlight assisted in identifying travel patterns but does not necessarily represent all vehicle trips. It is limited to the vehicles/motorists that are equipped with active devices that connect to cell towers or satellites.

### 2.1.4 Triangle Expressway Transactions and Toll Revenue

The Triangle Expressway opened in three phases to tolled traffic, with the final section opening to traffic on December 12, 2012. Tolling began on January 3, 2013, on the last section. Annual toll transactions and collected toll revenue from 2013 through 2017 are shown in **Table 2.5**. Strong growth in transactions and toll revenue occurred from 2013 through 2017. During this period transactions increased, on average, by 21.0 percent per year and collected toll revenue increased, on average, by 30.1 percent per year. Transactions increased quickly due to a long ramp-up period as motorists became familiar with the new road and its benefits, and to positive economic conditions.

# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study

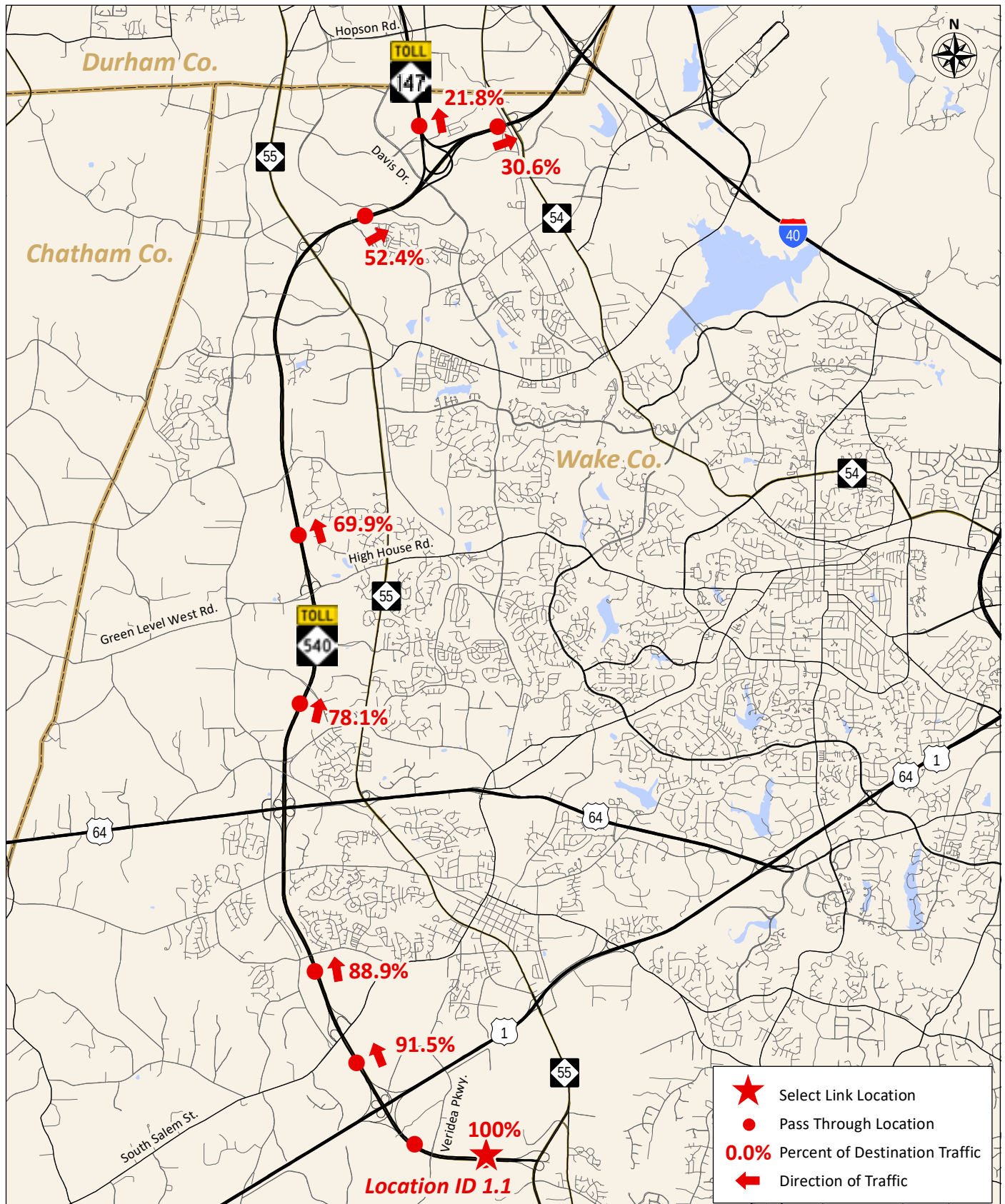


**Table 2.4**  
**StreetLight Data Collection Locations**

|                                       |           |                      | Data Collected Between These Crossroads |                        |
|---------------------------------------|-----------|----------------------|-----------------------------------------|------------------------|
| Location #                            | Direction | Roadway              | Crossroad 1                             | Crossroad 2            |
| Corridor 1: Triangle Expressway       |           |                      |                                         |                        |
| 1.1                                   | NB / SB   | Toll NC 540          | US 1                                    | NC 55 Bypass           |
| 1.2                                   | NB / SB   | Toll NC 540          | Old US Hwy 1                            | US 1                   |
| 1.3                                   | NB / SB   | Toll NC 540          | US Hwy 64                               | Old US Hwy 1           |
| 1.4                                   | NB / SB   | Toll NC 540          | Green Level Rd W                        | US Hwy 64              |
| 1.5                                   | NB / SB   | Toll NC 540          | Green Hope School Rd                    | Green Level Rd W       |
| 1.6                                   | NB / SB   | Toll NC 540          | NC 55                                   | Green Hope School Rd   |
| 1.7                                   | NB / SB   | Toll NC 540          | Toll NC 147                             | NC 55                  |
| 1.8                                   | NB / SB   | Toll NC 540          | NC 54                                   | Toll NC 147            |
| 1.9                                   | NB / SB   | Toll NC 147          | Davis Dr                                | I-540                  |
| Corridor 2: I-40 / I-440              |           |                      |                                         |                        |
| 2.1                                   | EB / WB   | I-40                 | NC 54                                   | NC 55                  |
| 2.2                                   | EB / WB   | I-40                 | Davis Dr                                | S Miami Blvd           |
| 2.3                                   | EB / WB   | I-40                 | Aviation Parkway                        | N Harrison Ave         |
| 2.4                                   | EB / WB   | I-40                 | Cary Towne Blvd                         | US 1 / I-440           |
| 2.5                                   | EB / WB   | I-40                 | US 1 / I-440                            | Gorman St              |
| 2.6                                   | EB / WB   | I-40                 | Lake Wheeler Rd                         | US 401 / S Saunders St |
| 2.7                                   | EB / WB   | I-40                 | Hammond Rd                              | Rock Quarry Rd         |
| 2.8                                   | EB / WB   | I-440                | Poole Rd                                | I-40                   |
| 3.1                                   | NB / SB   | I-40                 | Jones Sausage Rd                        | I-440                  |
| 3.2                                   | NB / SB   | I-40                 | NC 42                                   | US 70 Clayton Bypass   |
| Selected Bi-Directional Locations     |           |                      |                                         |                        |
| 4.1                                   | EB / WB   | US 1                 | Ten Ten Rd                              | US 64                  |
| 4.2                                   | NB / SB   | US 401               | Donny Brook Rd                          | Ten Ten Rd             |
| 4.3                                   | EB / WB   | US 64 Bypass         | Hodge Rd                                | I-540                  |
| 4.4                                   | EB / WB   | US 64                | Lake Pine Dr                            | US 1                   |
| 4.5                                   | EB / WB   | US 70 Clayton Bypass | I-40                                    | Cornwallis Rd          |
| 4.6                                   | EB / WB   | US 70                | Yeargan Rd                              | Vandora Springs Rd     |
| 4.7                                   | EB / WB   | US 70 Business       | I-40 / US 70                            | Auburn-Knightdale Rd   |
| Selected Combined Direction Locations |           |                      |                                         |                        |
| 5.1                                   | NB + SB   | Holly Springs Rd     | Sunset Lake Rd                          | Kildaire Farm          |
| 5.2                                   | NB + SB   | Lake Wheeler Rd      | Optimist Farm Rd                        | Ten Ten Rd             |
| 5.3                                   | NB + SB   | NC 50                | Cleveland School Rd                     | Ten Ten Rd             |
| 5.4                                   | NB + SB   | NC 55                | Jenks Rd                                | Green Level Rd W       |
| 5.5                                   | NB + SB   | Old Stage Rd         | Banks Rd                                | Ten Ten Rd             |



# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study

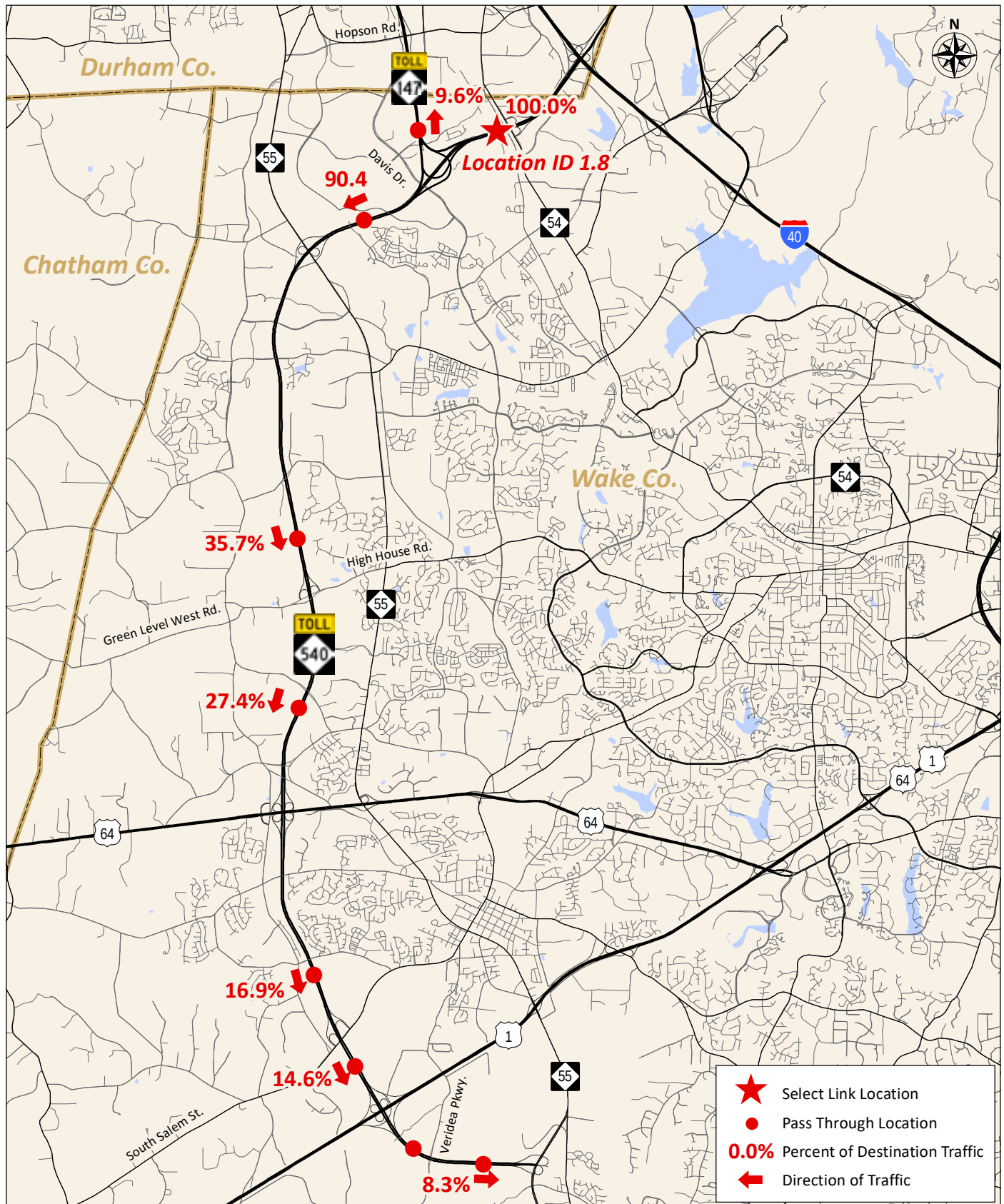


SOURCE: Streetlight Data, average 2016 all day Tuesday-Thursday traffic.

## WEEKDAY TRAVEL PATTERN DISTRIBUTION AT LOCATION 1.1 NB



# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



SOURCE: Streetlight Data, average 2016 all day Tuesday-Thursday traffic.

## WEEKDAY TRAVEL PATTERN DISTRIBUTION AT LOCATION 1.8 SB

FIGURE 2.8

Annual collected toll revenue increased at a faster rate than transactions in part due to programmed toll rate increases, and because the average weighted toll increased faster than the programmed toll rate increases. The average weighted toll is influenced each year by 1) the mix of ETC and BBM, 2) the mix of the vehicle classes, and 3) the average trip distance made on the Triangle Expressway.

**Table 2.5**  
**Triangle Expressway Annual Transactions and Collected Toll Revenue**  
(transactions and revenue in thousands)

| Calendar<br>Year              | Toll Transactions and<br>Year-over-Year<br>Percent Growth |        | Collected Toll Revenue<br>and Year-over-Year<br>Percent Growth (2) |        | Average Weighted<br>Toll Rate and<br>Year-over-Year<br>Percent Growth (1) |        | Percent<br>Annual<br>Toll<br>Increase |
|-------------------------------|-----------------------------------------------------------|--------|--------------------------------------------------------------------|--------|---------------------------------------------------------------------------|--------|---------------------------------------|
|                               | Transactions                                              | Growth | Revenue                                                            | Growth | Toll Rate                                                                 | Growth |                                       |
| 2013                          | 23,059                                                    |        | \$ 14,238                                                          |        | \$ 0.62                                                                   |        |                                       |
| 2014                          | 30,650                                                    | 32.9 % | 21,045                                                             | 47.8 % | 0.69                                                                      | 11.2 % | 5.3 %                                 |
| 2015                          | 38,319                                                    | 25.0   | 28,779                                                             | 36.7   | 0.75                                                                      | 9.4    | 4.2                                   |
| 2016                          | 45,244                                                    | 18.1   | 35,393                                                             | 23.0   | 0.78                                                                      | 4.2    | 3.0                                   |
| 2017                          | 49,460                                                    | 9.3    | 40,792                                                             | 15.3   | 0.82                                                                      | 5.4    | 4.0                                   |
| Average Annual Percent Change |                                                           |        |                                                                    |        |                                                                           |        |                                       |
| 2013-2017                     |                                                           | 21.0   |                                                                    | 30.1   |                                                                           | 7.5    | 4.4                                   |

(1) The average weighted toll rate is calculated by dividing total toll revenue for the year by total toll transactions for the year.

(2) This is toll revenue collected during the indicated year. It does not include fee revenue.

Source: NCTA

Monthly transactions and collected toll revenue are provided in **Table 2.6** from January 2013 through June 2018. In the first six months of 2018, passenger-car transactions and toll revenue increased by 7.3 percent and 11.7 percent respectively, compared to the same period in 2017. Truck transactions and toll revenue increased by 6.9 percent and 8.1 percent, respectively. In total, transactions in the first half of 2018 increased by 7.3 percent, and collected toll revenue increased by 11.4 percent compared to the first half of 2017.

**Table 2.7** shows the 2017 systemwide percent of transactions and collected toll revenue attributed to cars and trucks. Cars comprised 96.2 percent of total transactions, and 91.4 percent of toll revenue. Truck transactions totaled 3.8 percent of total transactions and 8.6 percent of total toll revenue.

**Table 2.6**  
**Triangle Expressway - Monthly Transaction and Collected Toll Revenue Trends**  
 (transactions and revenue in thousands)

| Passenger Cars (Class 1: 2-Axle Vehicles) |                          |       |        |       |                         |       |          |       |                         |       |          |       |
|-------------------------------------------|--------------------------|-------|--------|-------|-------------------------|-------|----------|-------|-------------------------|-------|----------|-------|
| Month                                     | Toll Transactions (000s) |       |        |       | Toll Revenue (000s) (1) |       |          |       | Toll Revenue (000s) (1) |       |          |       |
|                                           | 2013                     | % Chg | 2014   | % Chg | 2015                    | % Chg | 2016 (2) | % Chg | 2015                    | % Chg | 2016 (2) | % Chg |
| January                                   | 1,523                    | 28.9  | 1,964  | 34.0  | 2,632                   | 15.9  | 3,049    | 14.4  | 3,488                   | 5.1   | 3,665    | 5.1   |
| February                                  | 1,517                    | 24.2  | 1,884  | 19.1  | 2,244                   | 45.6  | 3,267    | 8.3   | 3,540                   | 8.5   | 3,840    | 8.5   |
| March                                     | 1,730                    | 31.3  | 2,271  | 30.3  | 2,959                   | 25.2  | 3,703    | 10.4  | 4,087                   | 5.2   | 4,298    | 5.2   |
| April                                     | 1,806                    | 32.1  | 2,387  | 28.1  | 3,057                   | 19.5  | 3,652    | 4.9   | 3,829                   | 10.7  | 4,239    | 10.7  |
| May                                       | 1,917                    | 34.8  | 2,585  | 21.4  | 3,138                   | 18.9  | 3,732    | 12.6  | 4,204                   | 8.5   | 4,560    | 8.5   |
| June                                      | 1,820                    | 40.6  | 2,559  | 25.3  | 3,207                   | 17.8  | 3,777    | 9.9   | 4,152                   | 6.2   | 4,409    | 6.2   |
| July                                      | 1,870                    | 36.3  | 2,549  | 25.7  | 3,205                   | 10.2  | 3,532    | 8.4   | 3,830                   |       |          |       |
| August                                    | 2,009                    | 31.1  | 2,634  | 25.0  | 3,293                   | 18.8  | 3,912    | 9.0   | 4,263                   |       |          |       |
| September                                 | 1,949                    | 37.9  | 2,687  | 21.2  | 3,257                   | 12.8  | 3,676    | 8.6   | 3,993                   |       |          |       |
| October                                   | 2,178                    | 33.8  | 2,915  | 20.8  | 3,522                   | 12.4  | 3,957    | 9.8   | 4,347                   |       |          |       |
| November                                  | 2,000                    | 27.7  | 2,555  | 26.1  | 3,221                   | 15.8  | 3,730    | 9.2   | 4,074                   |       |          |       |
| December                                  | 1,978                    | 34.1  | 2,652  | 25.0  | 3,316                   | 8.0   | 3,580    | 5.9   | 3,793                   |       |          |       |
| <b>Total Year</b>                         | 22,298                   | 32.9  | 29,641 | 25.0  | 37,050                  | 17.6  | 43,568   | 9.3   | 47,599                  |       |          |       |
| <b>Jan-June</b>                           | 10,314                   | 32.3  | 13,649 | 26.3  | 17,236                  | 22.9  | 21,181   | 10.0  | 23,300                  | 7.3   | 25,012   | 7.3   |

| Commercial Vehicles (Classes 2 and 3: 3-or-more Axle Vehicles) |                          |       |       |       |                         |       |          |       |                         |       |          |       |
|----------------------------------------------------------------|--------------------------|-------|-------|-------|-------------------------|-------|----------|-------|-------------------------|-------|----------|-------|
| Month                                                          | Toll Transactions (000s) |       |       |       | Toll Revenue (000s) (1) |       |          |       | Toll Revenue (000s) (1) |       |          |       |
|                                                                | 2013                     | % Chg | 2014  | % Chg | 2015                    | % Chg | 2016 (2) | % Chg | 2015                    | % Chg | 2016 (2) | % Chg |
| January                                                        | 37                       | 58.2  | 59    | 25.5  | 74                      | 37.4  | 102      | 20.0  | 122                     | 1.8   | 124      | 1.8   |
| February                                                       | 39                       | 44.6  | 57    | 4.5   | 59                      | 77.7  | 105      | 38.5  | 146                     | (2.7) | 142      | (2.7) |
| March                                                          | 57                       | 25.1  | 72    | 34.2  | 96                      | 49.3  | 143      | 24.3  | 178                     | (8.5) | 163      | (8.5) |
| April                                                          | 62                       | 41.0  | 87    | 24.3  | 109                     | 28.6  | 140      | 5.7   | 148                     | 20.7  | 178      | 20.7  |
| May                                                            | 66                       | 46.9  | 97    | 19.6  | 116                     | 20.8  | 140      | 20.2  | 168                     | 17.7  | 198      | 17.7  |
| June                                                           | 64                       | 47.7  | 95    | 27.6  | 121                     | 29.1  | 156      | 12.1  | 175                     | 12.1  | 196      | 12.1  |
| July                                                           | 69                       | 34.5  | 92    | 27.7  | 118                     | 20.3  | 142      | 9.1   | 155                     |       |          |       |
| August                                                         | 76                       | 23.4  | 94    | 27.3  | 120                     | 41.2  | 169      | 1.7   | 172                     |       |          |       |
| September                                                      | 78                       | 20.7  | 94    | 29.1  | 121                     | 14.9  | 139      | 10.1  | 153                     |       |          |       |
| October                                                        | 81                       | 27.4  | 104   | 18.3  | 123                     | 31.1  | 161      | 3.5   | 166                     |       |          |       |
| November                                                       | 68                       | 15.5  | 78    | 30.7  | 102                     | 43.5  | 147      | 2.4   | 150                     |       |          |       |
| December                                                       | 63                       | 28.2  | 81    | 35.2  | 110                     | 20.5  | 132      | (4.0) | 127                     |       |          |       |
| <b>Total Year</b>                                              | 761                      | 32.7  | 1,010 | 25.6  | 1,268                   | 32.2  | 1,676    | 11.0  | 1,861                   |       |          |       |
| <b>Jan-June</b>                                                | 326                      | 43.1  | 466   | 23.3  | 575                     | 36.8  | 786      | 19.2  | 937                     | 6.9   | 1,002    | 6.9   |

| Total Vehicles (Classes 1 through 3) |                          |       |        |       |                         |       |          |       |                         |       |          |       |
|--------------------------------------|--------------------------|-------|--------|-------|-------------------------|-------|----------|-------|-------------------------|-------|----------|-------|
| Month                                | Toll Transactions (000s) |       |        |       | Toll Revenue (000s) (1) |       |          |       | Toll Revenue (000s) (1) |       |          |       |
|                                      | 2013                     | % Chg | 2014   | % Chg | 2015                    | % Chg | 2016 (2) | % Chg | 2015                    | % Chg | 2016 (2) | % Chg |
| January                              | 1,561                    | 29.6  | 2,023  | 33.8  | 2,705                   | 16.5  | 3,151    | 14.6  | 3,610                   | 5.0   | 3,789    | 5.0   |
| February                             | 1,556                    | 24.7  | 1,941  | 18.7  | 2,303                   | 46.4  | 3,373    | 9.3   | 3,686                   | 8.0   | 3,982    | 8.0   |
| March                                | 1,787                    | 31.1  | 2,342  | 30.4  | 3,055                   | 25.9  | 3,847    | 10.9  | 4,265                   | 4.6   | 4,461    | 4.6   |
| April                                | 1,868                    | 32.4  | 2,474  | 27.9  | 3,165                   | 19.8  | 3,792    | 4.9   | 3,977                   | 11.1  | 4,417    | 11.1  |
| May                                  | 1,983                    | 35.2  | 2,682  | 21.3  | 3,254                   | 19.0  | 3,872    | 12.9  | 4,372                   | 8.8   | 4,758    | 8.8   |
| June                                 | 1,884                    | 40.8  | 2,654  | 25.4  | 3,328                   | 18.2  | 3,933    | 10.0  | 4,326                   | 6.4   | 4,605    | 6.4   |
| July                                 | 1,938                    | 36.3  | 2,642  | 25.8  | 3,323                   | 10.6  | 3,674    | 8.5   | 3,985                   |       |          |       |
| August                               | 2,086                    | 30.8  | 2,728  | 25.1  | 3,413                   | 19.6  | 4,081    | 8.7   | 4,435                   |       |          |       |
| September                            | 2,026                    | 37.2  | 2,781  | 21.5  | 3,378                   | 12.9  | 3,815    | 8.7   | 4,146                   |       |          |       |
| October                              | 2,260                    | 33.6  | 3,018  | 20.7  | 3,644                   | 13.0  | 4,118    | 9.6   | 4,513                   |       |          |       |
| November                             | 2,068                    | 27.3  | 2,633  | 26.2  | 3,324                   | 16.6  | 3,876    | 9.0   | 4,224                   |       |          |       |
| December                             | 2,041                    | 33.9  | 2,733  | 25.3  | 3,426                   | 8.4   | 3,712    | 5.6   | 3,920                   |       |          |       |
| <b>Total Year</b>                    | 23,059                   | 32.9  | 30,650 | 25.0  | 38,319                  | 18.1  | 45,244   | 9.3   | 49,460                  |       |          |       |
| <b>Jan-June</b>                      | 10,640                   | 32.7  | 14,115 | 26.2  | 17,811                  | 23.3  | 21,967   | 10.3  | 24,237                  | 7.3   | 26,013   | 7.3   |

(1) Programmed toll increases occurred every year on January 1st. Refer to Table 2.2 for details.

(2) Leap year occurred in 2016, resulting in negative traffic and toll revenue impacts in February 2017 compared to February 2016.

(3) A new interchange, Verdesa Parkway, opened in April 2017.

Source: NCTA

**Table 2.7**  
**2017 Annual Transactions and Collected Toll Revenue By Vehicle Class**  
 (traffic and revenue in thousands)

|                               | Cars     | Trucks  |         |             | Total Vehicles |
|-------------------------------|----------|---------|---------|-------------|----------------|
|                               | Class 1  | Class 2 | Class 3 | Class 2 & 3 |                |
| <b>Transactions</b>           | 47,599   | 602     | 1,258   | 1,861       | 49,460         |
| Percent of Total              | 96.2 %   | 1.2 %   | 2.5 %   | 3.8 %       | 100.0 %        |
| <b>Collected Toll Revenue</b> | \$37,275 | \$743   | \$2,774 | \$3,517     | \$40,792       |
| Percent of Total              | 91.4 %   | 1.8 %   | 6.8 %   | 8.6 %       | 100.0 %        |

Source: NCTA systemwide monthly transactions and revenue by toll class data

The percent of systemwide ETC transactions has been stable over the last five years, as shown in **Table 2.8**. Among passenger cars, ETC transactions ranged from 57.8 percent in 2013 to 59.1 percent in 2017. Truck ETC transactions averaged around 48 to 49 percent from 2013 to 2017.

**Table 2.8**  
**ETC Market Share on the Triangle Expressway**

| Calendar Year | Percent Transactions by Vehicle Type and Method of Payment |      |       |            |      |       |       |      |       |
|---------------|------------------------------------------------------------|------|-------|------------|------|-------|-------|------|-------|
|               | Cars                                                       |      |       | Trucks (2) |      |       | Total |      |       |
|               | ETC                                                        | BBM  | Total | ETC        | BBM  | Total | ETC   | BBM  | Total |
| 2013          | 57.8                                                       | 42.2 | 100.0 | 48.8       | 51.2 | 100.0 | 57.5  | 42.5 | 100.0 |
| 2014          | 58.4                                                       | 41.6 | 100.0 | 48.7       | 51.3 | 100.0 | 58.1  | 41.9 | 100.0 |
| 2015          | 58.0                                                       | 42.0 | 100.0 | 48.1       | 51.9 | 100.0 | 57.6  | 42.4 | 100.0 |
| 2016          | 58.6                                                       | 41.4 | 100.0 | 49.0       | 51.0 | 100.0 | 58.3  | 41.7 | 100.0 |
| 2017 (1)      | 59.1                                                       | 40.9 | 100.0 | 48.0       | 52.0 | 100.0 | 58.7  | 41.3 | 100.0 |

(1) NCTA began offering free NC Quick Pass sticker transponders August 30, 2017. Previously the cost was \$5.00.

(2) Cars are Toll Class 1 (2-axle vehicles).

Trucks are Toll Classes 2 and 3 (3-or-more axle vehicles).

Source: NCTA

It should be noted that transaction data by payment type (ETC and BBM) is based on information provided by NCTA that represents monthly transactions by vehicle class and payment type as detected at roadside. During the processing of detected roadside transactions, two issues occur that alter the distribution of transactions into ETC and BBM categories from that shown in Table 2.8.

First, some transactions recorded at roadside as BBM are later identified as NC Quick Pass or E-ZPass tag holders during the license plate image review. These transactions, called ITOLs, were recorded as BBM transactions in the data provided by NCTA when they were actually ETC transactions. After the image review process, the toll revenue associated with the ITOL transactions was reported as ETC toll revenue, but the transaction volumes were not adjusted to reflect the shift into ETC.

Second, interoperable ETC transactions with Florida SunPass and Georgia Peach Pass transponders are recorded as BBM in the data provided by NCTA. The agencies that issue these transponders provide license plate files to NCTA and upon image review the transactions are associated with the SunPass and Peach Pass accounts and the appropriate toll is charged. All toll revenue associated with SunPass and Peach Pass transponders is reported as Class 1 ETC toll revenue in the NCTA data.

NCTA monthly transaction data are not changed to account for the portion of transactions initially identified as BBM, but subsequently identified as ITOLs or interoperable ETC and reported as ETC revenue. Upon review of NCTA data on ITOL transactions, and SunPass and Peach Pass transactions, the percentage of Triangle Expressway transactions associated with ETC accounts, and paying ETC toll rates, is higher than reflected in the data provided by NCTA. In 2017, after accounting for ITOLs and interoperable ETC transactions, cars had an ETC market share of about 64.1 percent compared to the 59.1 percent calculated from NCTA monthly transaction data and shown in Table 2.8. Trucks had an ETC market share of about 54.9 percent compared to the 48.0 percent in Table 2.8.

## 2.2 Study Area Traffic Volumes and Travel Time

The following describes traffic volumes and travel times in the study area.

### 2.2.1 Traffic Volume Data Collection

CDM Smith collected a variety of traffic counts from different sources to validate TRMv6 assigned weekday traffic volumes at locations in the study area. The following sources of traffic counts were used in this study:

1. CDM Smith had The Traffic Group conduct traffic counts at 63 locations in the fall of 2016. In the fall of 2017, counts were conducted by The Traffic Group at an additional 15 locations.
2. Average annual daily traffic volumes were obtained from the NCDOT's Interactive Traffic Volume Map, located on the NCDOT website.
3. As described in Section 2.1.2, the NCTA provided CDM Smith with traffic volume data on the Triangle Expressway at tolled and non-tolled locations.

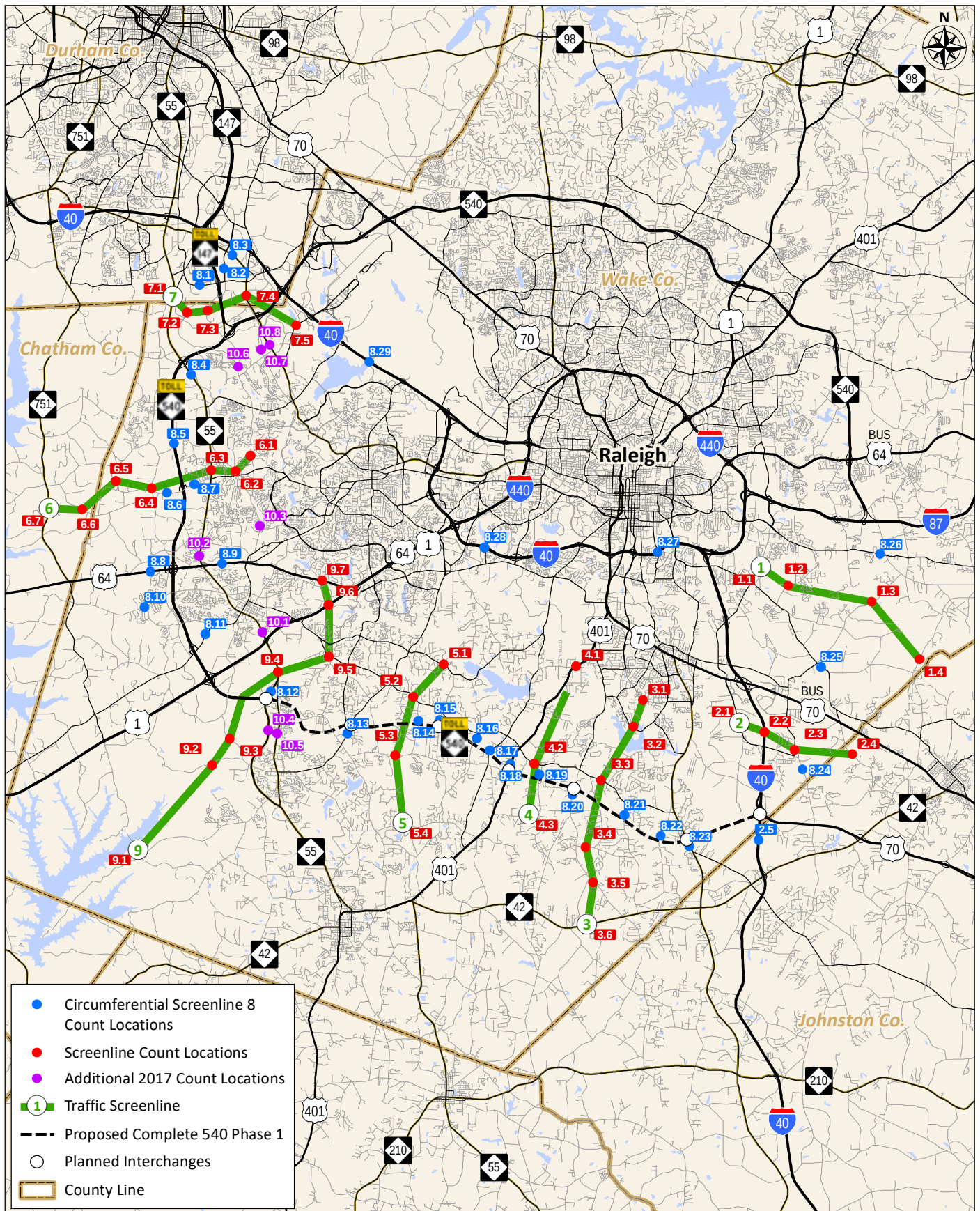
### 2.2.2 Traffic Counts Conducted by The Traffic Group

The Traffic Group conducted traffic counts at 63 locations in the fall of 2016, and an additional 15 locations in the fall of 2017. Counts were collected by direction in 15-minute increments via tubes or by Wavetronix radar detectors where tubes were not appropriate. Tube counts were collected by FHWA vehicle classifications. Wavetronix counts were collected by length categories. All counts were subsequently summarized into existing NCTA toll classes and TRMv6 time periods. Counts were conducted for at least three continuous weekdays (Tuesday, Wednesday and Thursday). At 12 locations, counts were conducted for seven consecutive days to obtain weekday and weekend-day traffic volumes.

All 78 traffic count locations are shown in **Figure 2.9** and **Table 2.9**. Traffic count locations that closely parallel either the Triangle Expressway or the proposed Complete 540 are grouped into screenlines, shown as green lines in Figure 2.9.



# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



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**Table 2.9 (Page 1 of 3)**  
**Summary of Weekday and Weekend-Day Traffic Volumes at Count Locations**  
**Based on Traffic Counts Conducted in the Fall of 2016**

| <b>Location #</b>                                                     | <b>Count Location</b>   | <b>Average<br/>Weekday<br/>Traffic (1)</b> | <b>Average<br/>Weekend<br/>Day<br/>Traffic (2)</b> | <b>Percent<br/>Trucks<br/>Weekday (3)</b> | <b>Percent<br/>Trucks<br/>Weekend<br/>Day (3)</b> |
|-----------------------------------------------------------------------|-------------------------|--------------------------------------------|----------------------------------------------------|-------------------------------------------|---------------------------------------------------|
| <b>Screenline 1: East Side of Raleigh, South of Poole Road</b>        |                         |                                            |                                                    |                                           |                                                   |
| 1.1                                                                   | S New Hope Rd           | 17,400                                     | --                                                 | 2.7%                                      | --                                                |
| 1.2                                                                   | Barwell Rd              | 6,000                                      | --                                                 | 0.5%                                      | --                                                |
| 1.3                                                                   | Auburn Knightdale Rd    | 2,900                                      | --                                                 | 2.3%                                      | --                                                |
| 1.4                                                                   | Mial Plantation Rd      | 4,600                                      | --                                                 | 1.1%                                      | --                                                |
| <b>Screenline 2: East side of Raleigh, South of Business 70</b>       |                         |                                            |                                                    |                                           |                                                   |
| 2.1                                                                   | White Oak Rd (NC 2547)  | 14,400                                     | --                                                 | 1.0%                                      | --                                                |
| 2.2                                                                   | Interstate 40           | 90,100                                     | 88,100                                             | 12.5%                                     | 5.8%                                              |
| 2.3                                                                   | Raynor Rd (NC 2555)     | 4,900                                      | --                                                 | 1.1%                                      | --                                                |
| 2.4                                                                   | Guy Rd (NC 2558)        | 7,600                                      | --                                                 | 0.8%                                      | --                                                |
| 2.5                                                                   | Interstate 40           | 67,000                                     | 64,900                                             | 14.5%                                     | 8.0%                                              |
| <b>Screenline 3: South of Raleigh, West of NC 50</b>                  |                         |                                            |                                                    |                                           |                                                   |
| 3.1                                                                   | Timber Dr.              | 18,400                                     | --                                                 | 0.4%                                      | --                                                |
| 3.2                                                                   | Buffalo Rd              | 2,900                                      | --                                                 | 0.1%                                      | --                                                |
| 3.3                                                                   | Ten Ten Rd              | 13,100                                     | --                                                 | 1.5%                                      | --                                                |
| 3.4                                                                   | Pagan Rd                | 1,700                                      | --                                                 | 0.3%                                      | --                                                |
| 3.5                                                                   | Rock Service Station Rd | 4,100                                      | --                                                 | 7.2%                                      | --                                                |
| 3.6                                                                   | NC 42                   | 10,400                                     | 8,800                                              | 2.9%                                      | 1.5%                                              |
| <b>Screenline 4: South of Raleigh, East of US 401</b>                 |                         |                                            |                                                    |                                           |                                                   |
| 4.1                                                                   | US 401                  | 36,500                                     | 24,300                                             | 2.2%                                      | 0.9%                                              |
| 4.2                                                                   | Ten Ten Rd              | 17,900                                     | --                                                 | 1.4%                                      | --                                                |
| 4.3                                                                   | Banks Rd                | 6,600                                      | --                                                 | 1.1%                                      | --                                                |
| <b>Screenline 5: Southwest of Raleigh, East of Holly Springs Road</b> |                         |                                            |                                                    |                                           |                                                   |
| 5.1                                                                   | Penny Rd                | 9,800                                      | --                                                 | 0.6%                                      | --                                                |
| 5.2                                                                   | Ten Ten Rd              | 19,400                                     | --                                                 | 1.7%                                      | --                                                |
| 5.3                                                                   | Optimist Farm Rd        | 9,600                                      | --                                                 | 0.3%                                      | --                                                |
| 5.4                                                                   | Hilltop Needmore Rd     | 9,300                                      | --                                                 | 2.0%                                      | --                                                |
| <b>Screenline 6: West of Raleigh, North of High House Road</b>        |                         |                                            |                                                    |                                           |                                                   |
| 6.1                                                                   | Davis Dr                | 30,600                                     | --                                                 | 1.0%                                      | --                                                |
| 6.2                                                                   | Louis Stephens Dr       | 3,400                                      | --                                                 | 0.0%                                      | --                                                |
| 6.3                                                                   | NC 55                   | 31,400                                     | 24,800                                             | 19.8%                                     | 13.0%                                             |
| 6.4                                                                   | Green Level Church Rd   | 8,900                                      | --                                                 | 0.8%                                      | --                                                |
| 6.5                                                                   | White Oak Church Rd     | 700                                        | --                                                 | 0.1%                                      | --                                                |
| 6.6                                                                   | Green Level Rd          | 1,200                                      | --                                                 | 1.6%                                      | --                                                |
| 6.7                                                                   | NC 751                  | 7,600                                      | --                                                 | 2.5%                                      | --                                                |

(Continued on next page)

**Table 2.9 (Page 2 of 3)**  
**Summary of Weekday and Weekend-Day Traffic Volumes at Count Locations**  
**Based on Traffic Counts Conducted in the Fall of 2016**

| <b>Location #</b>                                                             | <b>Count Location</b> | <b>Average Weekday Traffic (1)</b> | <b>Average Weekend Day Traffic (2)</b> | <b>Percent Trucks Weekday (3)</b> | <b>Percent Trucks Weekend Day (3)</b> |
|-------------------------------------------------------------------------------|-----------------------|------------------------------------|----------------------------------------|-----------------------------------|---------------------------------------|
| <b>Screenline 7: West of Raleigh, South of Interstate 40</b>                  |                       |                                    |                                        |                                   |                                       |
| 7.1                                                                           | NC 55 (Apex Highway)  | 24,100                             | 15,000                                 | 1.3%                              | 0.6%                                  |
| 7.2                                                                           | Louis Stephens Dr     | 5,400                              | --                                     | 0.1%                              | --                                    |
| 7.3                                                                           | Davis Dr              | 23,500                             | --                                     | 0.7%                              | --                                    |
| 7.4                                                                           | NC 54                 | 23,000                             | 11,900                                 | 1.2%                              | 0.7%                                  |
| 7.5                                                                           | Airport Blvd          | 24,200                             | --                                     | 2.6%                              | --                                    |
| <b>Screenline 8: Circumferential Locations Adjacent to Complete 540 Route</b> |                       |                                    |                                        |                                   |                                       |
| 8.1                                                                           | Hopson Rd.            | 10,600                             | --                                     | 0.4%                              | --                                    |
| 8.2                                                                           | Davis Dr              | 20,500                             | --                                     | 0.8%                              | --                                    |
| 8.3                                                                           | NC 54                 | 12,100                             | --                                     | 0.4%                              | --                                    |
| 8.4                                                                           | NC 55                 | 34,500                             | --                                     | 1.9%                              | --                                    |
| 8.5                                                                           | Green Hope School Rd  | 5,700                              | --                                     | 1.0%                              | --                                    |
| 8.6                                                                           | Green Level West Rd   | 6,500                              | --                                     | 1.9%                              | --                                    |
| 8.7                                                                           | Green Level West Rd   | 10,000                             | --                                     | 1.3%                              | --                                    |
| 8.8                                                                           | US 64                 | 27,100                             | --                                     | 6.3%                              | --                                    |
| 8.9                                                                           | US 64                 | 46,500                             | 37,700                                 | 2.5%                              | 1.0%                                  |
| 8.10                                                                          | Olive Chapel Rd       | 5,000                              | --                                     | 2.1%                              | --                                    |
| 8.11                                                                          | Old US Highway 1      | 7,400                              | --                                     | 5.2%                              | --                                    |
| 8.12                                                                          | NC 55                 | 31,000                             | 24,400                                 | 3.5%                              | 1.3%                                  |
| 8.13                                                                          | Holly Springs Rd      | 20,800                             | --                                     | 0.4%                              | --                                    |
| 8.14                                                                          | West Lake Rd          | 8,600                              | --                                     | 0.8%                              | --                                    |
| 8.15                                                                          | Bells Lake Rd         | 5,800                              | --                                     | 0.5%                              | --                                    |
| 8.16                                                                          | Johnson Pond Rd       | 4,000                              | --                                     | 0.7%                              | --                                    |
| 8.17                                                                          | Lake Wheeler Rd       | 7,700                              | --                                     | 0.7%                              | --                                    |
| 8.18                                                                          | US 401                | 26,000                             | 14,400                                 | 1.6%                              | 0.8%                                  |
| 8.19                                                                          | Fanny Brown Rd        | 4,700                              | --                                     | 0.3%                              | --                                    |
| 8.20                                                                          | Old Stage Rd          | 9,800                              | --                                     | 1.0%                              | --                                    |
| 8.21                                                                          | Sauls Rd              | 4,500                              | --                                     | 0.9%                              | --                                    |
| 8.22                                                                          | Jordan Rd             | 2,000                              | --                                     | 0.2%                              | --                                    |
| 8.23                                                                          | NC 50                 | 16,200                             | 14,700                                 | 1.2%                              | 0.7%                                  |
| 8.24                                                                          | White Oak Rd.         | 11,100                             | --                                     | 0.6%                              | --                                    |
| 8.25                                                                          | Rock Quarry Rd        | 5,200                              | --                                     | 1.8%                              | --                                    |
| 8.26                                                                          | Poole Rd (NC 2555)    | 9,900                              | --                                     | 1.4%                              | --                                    |
| 8.27                                                                          | Interstate 40         | 107,100                            | 72,900                                 | 8.5%                              | 2.6%                                  |
| 8.28                                                                          | Interstate 40         | 125,000                            | --                                     | 11.6%                             | --                                    |
| 8.29                                                                          | Interstate 40         | 185,600                            | --                                     | 13.3%                             | --                                    |

(Continued on next page)

**Table 2.9 (Page 3 of 3)**  
**Summary of Weekday and Weekend-Day Traffic Volumes at Count Locations**  
**Based on Traffic Counts Conducted in the Fall of 2017**

| <u>Location #</u>                  | <u>Count Location</u>       | <u>Average<br/>Weekday<br/>Traffic (1)</u> | <u>Average<br/>Weekend<br/>Day<br/>Traffic (2)</u> | <u>Percent<br/>Trucks<br/>Weekday (3)</u> | <u>Percent<br/>Trucks<br/>Weekend<br/>Day (3)</u> |
|------------------------------------|-----------------------------|--------------------------------------------|----------------------------------------------------|-------------------------------------------|---------------------------------------------------|
| <b>Screenline 9: South of US 1</b> |                             |                                            |                                                    |                                           |                                                   |
| 9.1                                | New Hill Holleman Road      | 5,900                                      | --                                                 | 4.2%                                      | --                                                |
| 9.2                                | Holly Springs New Hill Road | 2,400                                      | --                                                 | 1.2%                                      | --                                                |
| 9.3                                | Veridea Parkway             | 4,400                                      | --                                                 | 0.3%                                      | --                                                |
| 9.4                                | NC 55                       | 47,500                                     | --                                                 | 2.2%                                      | --                                                |
| 9.5                                | Ten Ten Road                | 26,000                                     | --                                                 | 1.5%                                      | --                                                |
| 9.6                                | US 1                        | 79,200                                     | --                                                 | 7.4%                                      | --                                                |
| 9.7                                | US 64                       | 54,300                                     | --                                                 | 2.6%                                      | --                                                |
| <b>Additional 2017 Counts</b>      |                             |                                            |                                                    |                                           |                                                   |
| 10.1                               | NC 55                       | 31,900                                     | --                                                 | 6.1%                                      | --                                                |
| 10.2                               | NC 55                       | 32,400                                     | --                                                 | 1.6%                                      | --                                                |
| 10.3                               | Davis Drive                 | 14,600                                     | --                                                 | 0.7%                                      | --                                                |
| 10.4                               | NC 55 Bypass                | 45,000                                     | --                                                 | 3.1%                                      | --                                                |
| 10.5                               | NC 55 - North of Easton St. | 15,100                                     | --                                                 | 0.5%                                      | --                                                |
| 10.6                               | Davis Drive                 | 25,700                                     | --                                                 | 0.4%                                      | --                                                |
| 10.7                               | Church Street               | 8,600                                      | --                                                 | 0.6%                                      | --                                                |
| 10.8                               | Chapel Hill Road            | 17,700                                     | --                                                 | 2.3%                                      | --                                                |

(1) Represents the average of Tuesday, Wednesday and Thursday traffic count volumes.

(2) Represents the average of Saturday and Sunday traffic count volumes.

(3) Trucks are defined as vehicles with three or more axles.

Source: Traffic counts were conducted by The Traffic Group

The traffic volumes in Table 2.9 include the average weekday traffic, the average weekend-day traffic, and the percent of trucks out of the average weekday or weekend-day traffic. Obtaining weekday traffic volumes by 15-minute increments was important in model calibration as the model represents weekday traffic and the small time-periods allowed for the aggregation of traffic into the model time periods.

### 2.2.3 Historical Traffic Growth in the Study Area

Traffic growth on I-40 and selected highways and arterials from 2009 to the most currently available year are shown in **Figure 2.10**. The traffic volumes are annual average daily traffic (AADT) volumes provided by the NCDOT Traffic Survey Group. Traffic volumes are shown on I-40, Davis Drive, NC 42, NC 55, and Ten Ten Road for 2009, 2011, 2013 and 2015. Volumes are also shown at 2016 levels on I-40 locations.

Several roadway improvements occurred between 2009 and 2016 that impacted traffic volumes on area roads. Segment 1 of the Triangle Expressway (Toll NC 147 and Toll NC 540 from NC 54 to NC 55 near Morrisville) opened in January 2012, and Segment 2 (Toll NC 540 from NC 55 near Morrisville to U.S. 64) opened in August 2012. In January 2013, the rest of the Triangle Expressway opened, from U.S. 64 to NC 55 Bypass near Holly Springs. It appears that the opening of the Triangle Expressway dampened traffic growth on Davis Drive and NC 55/NC 55 Bypass as evidenced by the 2013 AADTs.

In addition, Project Fortify I-40/I-440 was underway starting in early 2015. The project consisted of replacing the pavement on I-40 from U.S. 1/64 to the I-40/I-440 split. The work required the closing of one travel lane per direction during parts of 2015, all of 2016, and most of 2017. This work temporarily dampened traffic growth on sections of I-40 from 2015 through 2017. All travel lanes were re-opened by 2018, although some resurfacing and pavement work were completed in 2018.

### 2.2.4 Travel Times in the Study Area

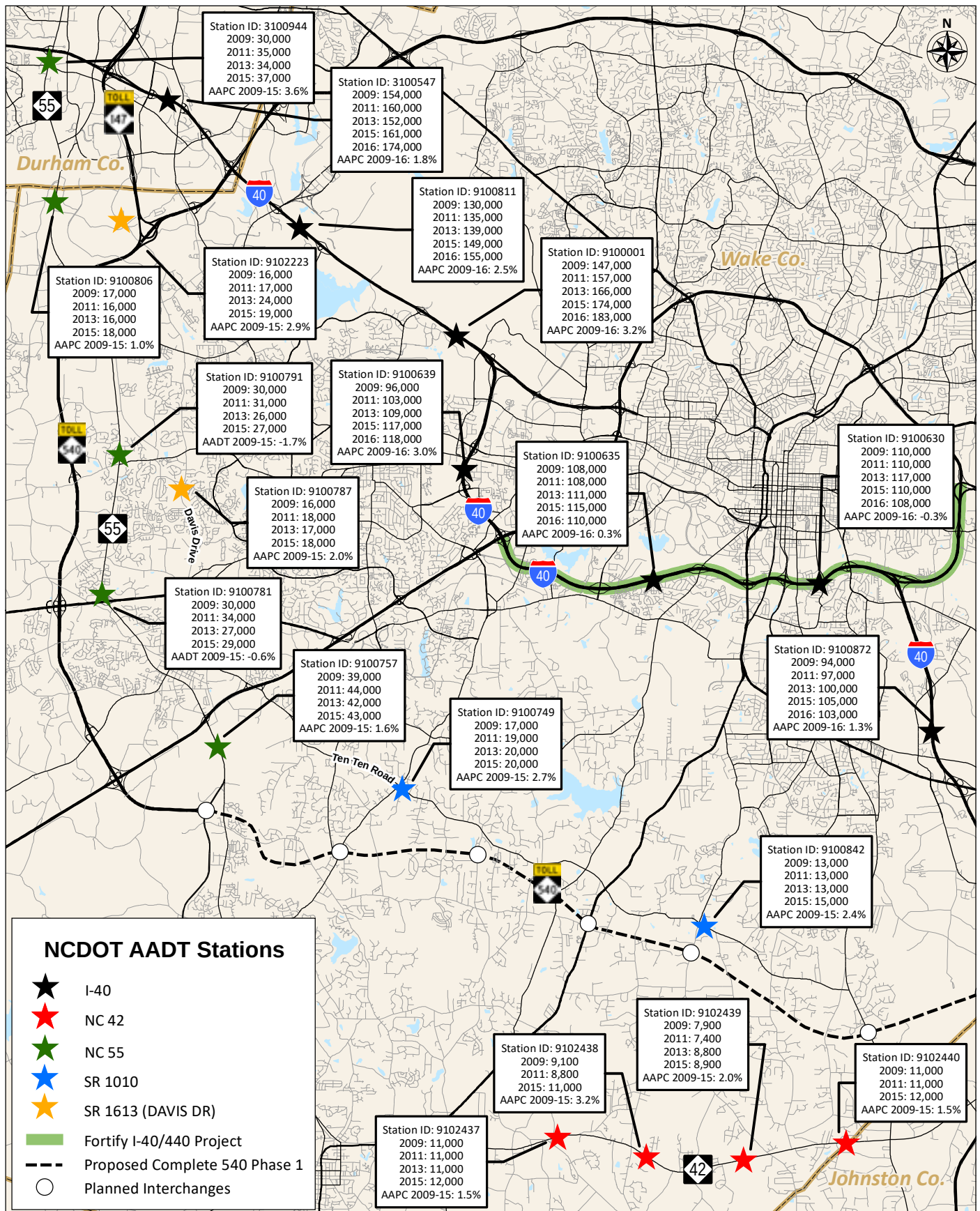
Travel speed data was obtained from HERE via Regional Integrated Transportation Information System (RITIS) with permission from NCDOT. Travel speed data was collected for the entire year of 2016. The data consisted of travel speeds and distance by roadway segment based on GPS data, from which travel time can be calculated. CDM Smith reviewed North Carolina-specific data validation reports produced for the I-95 Corridor Coalition for HERE. Based on that review, and prior experience using and validating INRIX data, CDM Smith found the HERE data to be an acceptable indicator of current travel speeds for this study.

CDM Smith compiled and summarized travel speeds for selected road segments in the study area and used that information to calculate travel times. **Figure 2.11** shows 2016 average free-flow travel times by segment and direction for a sampling of the selected routes. It should be noted that minor differences in free-flow travel time by direction on a given segment can be attributed to directional variances in the distances provided by HERE. For comparison purposes, **Figure 2.12** and **Figure 2.13** show 2016 average travel times by segment and direction for the same routes during the AM peak hour (7 AM – 8 AM) and the PM peak hour (5 PM – 6 PM). For example, northbound travel times on NC 55 between U.S. 64 and Toll NC 540 averaged 8.5 minutes under free-flow conditions, 9.7 minutes during the AM peak hour, and 10.5 minutes during the PM peak hour.

The travel times in Figures 2.11 through 2.13 are high-level summaries. For use in calibrating to 2016, travel times were available in smaller-distance segments.

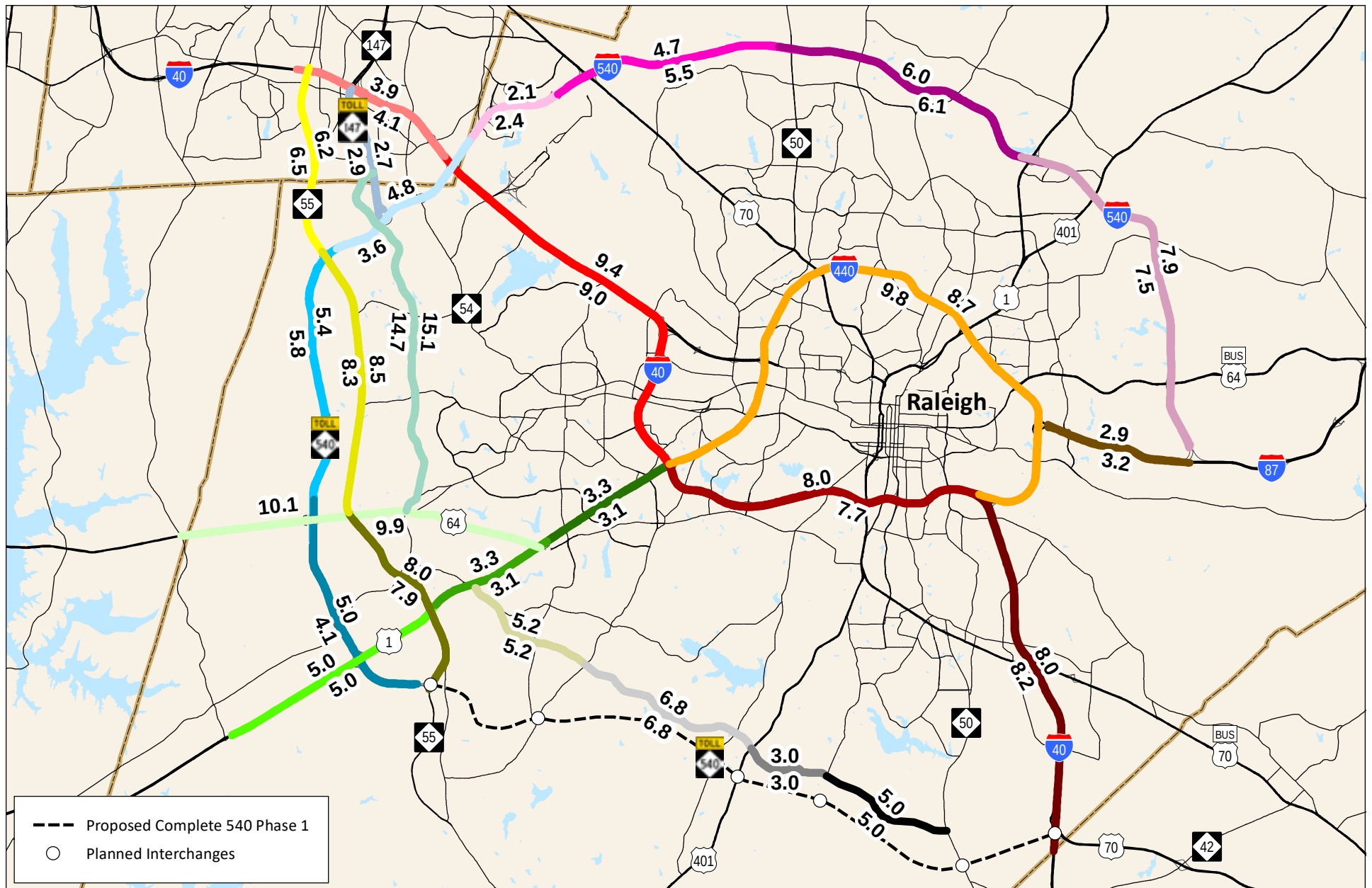


# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study

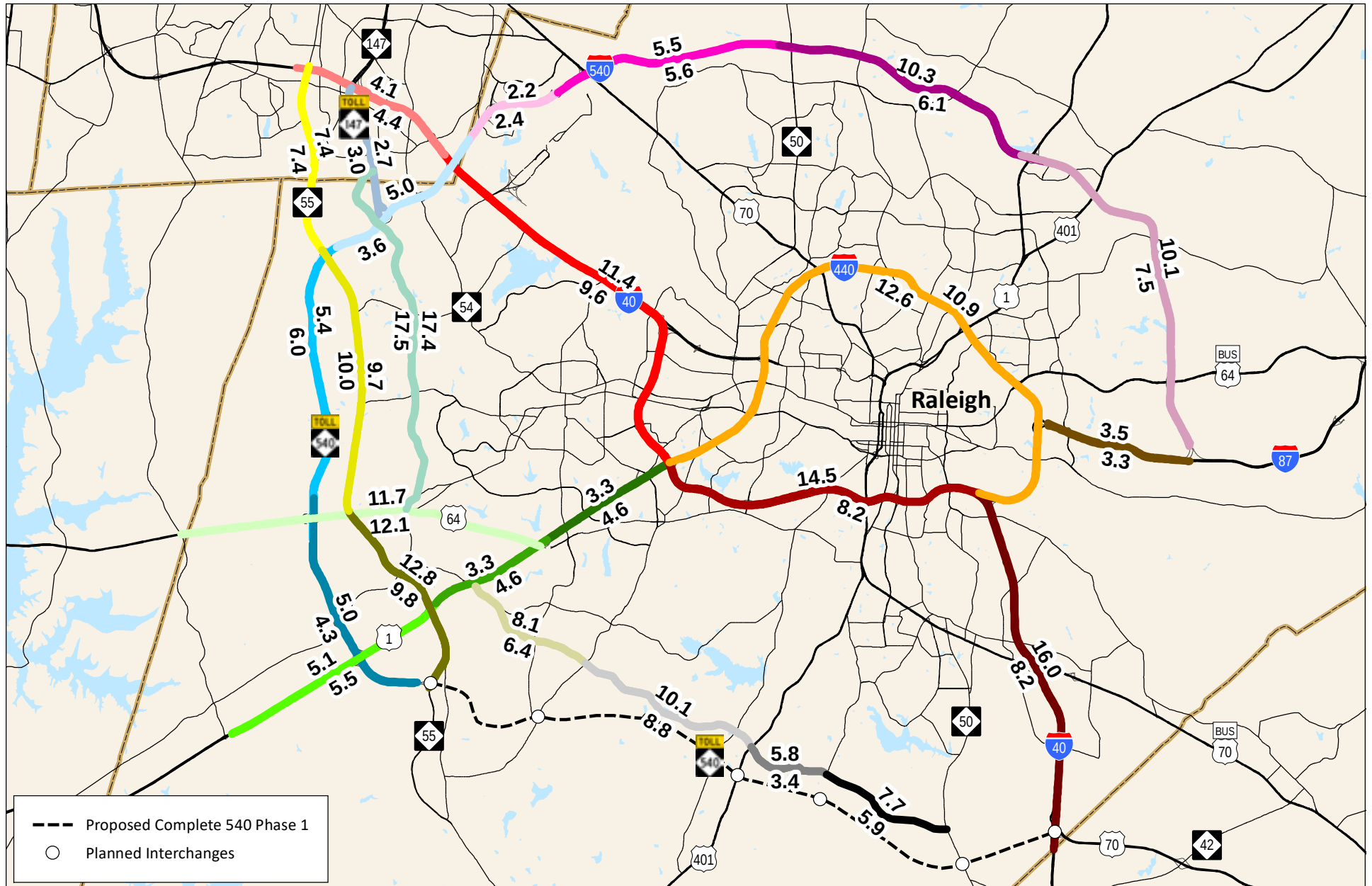


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# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



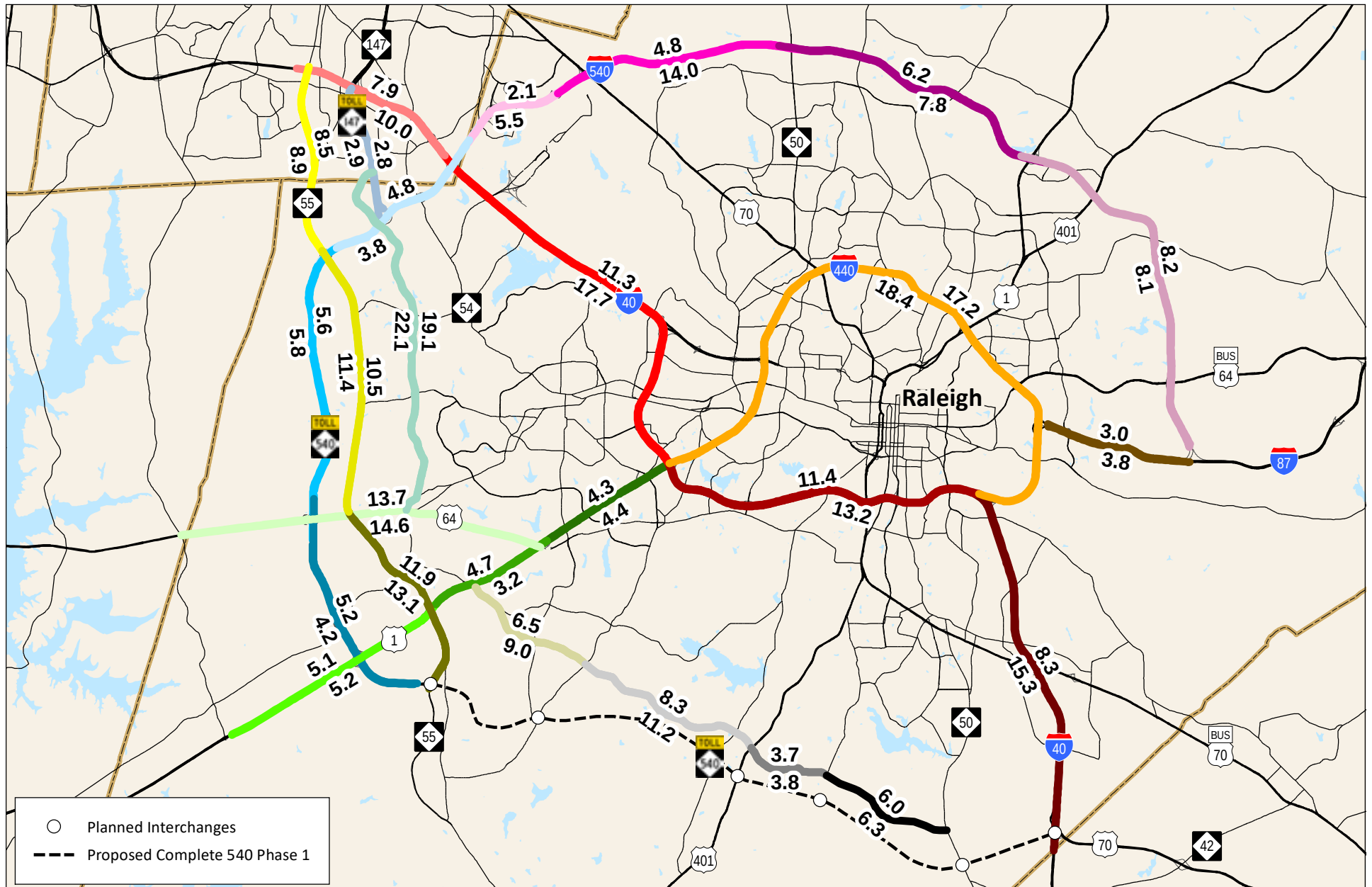
# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



**2016 AVERAGE WEEKDAY  
AM-PEAK HOUR TRAVEL TIMES (IN MINUTES)**



# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



**2016 AVERAGE WEEKDAY  
PM-PEAK HOUR TRAVEL TIMES (IN MINUTES)**

## Chapter 3

# Independent Economic Review

### 3.1 Introduction

Economic growth forecasts are one of the most critical elements of any traffic and revenue forecast. Because of the inherent uncertainty in the economic forecasting process, this has also become an area of considerable review and scrutiny by rating agencies and others in the financial community. As such, CDM Smith engaged Dr. Stephen J. Appold, an economist with local expertise, to conduct an independent analysis of the economic growth forecasts assumed in the Triangle Regional Model version 6 (TRMv6), a key tool for evaluating future travel demand in the region.

The goal of this effort was to evaluate the reasonableness of regional and corridor growth rates contained in the TRMv6 and to adjust where appropriate. In this process Dr. Appold identified and analyzed major employers, employment centers, housing developments, and commercial and retail developments in order to derive an understanding of the economic drivers of the region. He also conducted an analysis of regional and corridor growth rates based on the latest available historic trends and forecasts.

The TRMv6 model uses 2013 as its base year, and supports additional model years 2025, 2035 and 2045. Dr. Appold created forecasts for population, households, and employment for 2016, 2025, 2035 and 2045. CDM Smith requested 2016 socioeconomics to create a Base Year 2016 for model calibration. The resulting socioeconomic forecasts were used as input to the TRMv6 to develop revised trip tables for 2016 and the officially supported TRMv6 years of 2025, 2035 and 2045.

This chapter describes the socioeconomic projections assumed in the TRMv6 and the forecasts developed by Dr. Appold. The chapter also briefly describes Dr. Appold's process to create 2016 Base Year socioeconomic forecasts that were used by CDM Smith to develop a calibrated 2016 model.

CDM Smith reviewed Dr. Appold's methodology and forecasts and adopted his forecasts as input to the travel demand modeling conducted in support of this study. A detailed description of Dr. Appold's methodology and conclusions can be found in his July 2018 study titled, ***Evaluation of the Socioeconomic Conditions and Forecasts in the Complete 540 Study Area***.

### 3.2 Socioeconomics for Calibration Year 2016

The TRMv6 model uses 2013 as its base year for socioeconomic data inputs into the model. CDM Smith created a 2016 Base Year for model calibration, using socioeconomic inputs developed by Dr. Appold. The model required estimates of six subsets of socioeconomic data which are described in the following subsections. Dr. Appold developed these inputs to the model independently of the TRMv6 2013 datasets.



### 3.2.1 Households and Population

To estimate the number of households, Dr. Appold consulted 2010 Census data at the block level<sup>1</sup> and added the estimated number of housing units added between 2010 and 2016. The number of housing units added was estimated using Certificates of Occupancy data for Chatham, Durham, and Orange Counties; county parcel files for Harnett County; county parcel files augmented with supplemental information for Johnston and Wake Counties; and 2010 Census block-level household counts increased by a uniform overall county growth rate for the peripheral counties of Franklin, Granville, Nash, and Person.

After the block level estimates were calculated, the block-level data was allocated to the 2,857 Traffic Analysis Zones (TAZs) contained in the TRMv6. Most Census Blocks fell within a TAZ, but 265 Census Blocks were split into multiple TAZs. After the data was allocated to TAZs, all estimates were then rounded to the nearest whole number. The resulting estimate of 2016 households was then multiplied by the latest then-available (2011-2015) American Community Survey (ACS) estimates of housing occupancy rates and rounded to the nearest whole number to develop an estimated population.

### 3.2.2 Group Quarters Population

In 2010, approximately three percent of the population in the TRMv6 region lived in group quarters. Of those, 38 percent were in institutional quarters, mostly correctional facilities and nursing facilities. The institutionalized population does not contribute significantly to travel demand, and therefore, is not included in the population dataset. The other 62 percent, comprising less than two percent of the regional population, are not institutionalized and are represented by two group quarters fields included in the 2016 socioeconomic data set.

The first group, covering about 85 percent of the non-institutionalized group quarters population, are students living in public and private dormitories at each of the TRMv6 region's four major universities: North Carolina State University in Raleigh, the University of North Carolina at Chapel Hill, and Duke University and North Carolina Central University in Durham. The student population in the 2016 dataset was not changed from the TRMv6 2013 dataset, because the totals appear to remain relatively constant based on the available information.

The second group quarters field is for non-student, non-institutionalized population. Because a detailed categorization of group quarters population is only available in the decennial Census, the proportion of total block group population that lived in non-student, non-institutionalized group quarters was calculated, and that same proportion applied to the total 2016 block group population to estimate the number for 2016. This procedure assumes that the number of students living in group quarters has remained constant since 2013 but that the non-student, non-institutionalized group quarters population has grown.

### 3.2.3 Mean Household Income

Mean household income estimates were calculated for each TAZ in the model. This was accomplished by using Census Block data (number of households by income category) from the 2012-2016 ACS, aggregating this data into TAZs, and taking the household mean for each TAZ. The calculated 2016

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<sup>1</sup> Census blocks are the smallest geographic area from which the Census Bureau collects data, with a minimum size of 30,000 square feet (0.69 acres).

value was translated into 2013 dollars by using the Consumer Price Index Research Series Using Current Methods (CPI-U-RS) all-city average, as the TRMv6 model requires household income to be translated to 2013 dollars.

### 3.2.4 Employment

There are three components of TAZ-level employment estimates: county-level totals, sectoral distribution, and geographic distribution. Dr. Appold used the Quarterly Census of Employment and Wages (QCEW) to generate county-level totals and, following TRMv6 practice, adjusted by <sup>25</sup>/<sub>23</sub> (an approximately eight percent increase) to account for employment not covered by unemployment insurance in order to generate county control totals. Dr. Appold agrees that the adjustment is reasonable as the QCEW number is conservative compared to Bureau of Economic Analysis (BEA) employment estimates.

The TRMv6 data further classifies employment by five sectors: industry, office, high-volume service, low-volume service and retail. Employment is separated out by sectoral category because each is thought to have different propensities to generate customer (client) traffic. Dr. Appold distributed 2016 employment into the five sectors based on QCEW data for four-digit North American Industry Classification System (NAICS) codes at the county-level.

Geographic distribution is the most challenging portion of developing employment estimates, as there are few sources of data at the sub-county level. Dr. Appold based employment distribution on three sets of information, including 1) InfoUSA; 2) the 2013 TRMv6 geographic distributions of employment, and 3) block-level longitudinal employer-household dynamics (LEHD) origin-destination employment statistics (LODES) data.

Using the three sources generated realistic results which compared well with observation and with each other. The TAZ-level estimates of sector employment correlated moderately well, and all relationships are highly statistically significant.

### 3.2.5 Earnings

Besides the TAZ-level inputs of employment by the five employment sectors (industry, office, high-volume service, low-volume service and retail), the TRMv6 model requires an allocation of employment by sector into two earning categories, high and low-wage. Industry and office sectors were combined, as were the high-volume and low-volume service sectors. High and low-wage employment counts are split near the median salary point for each sector. TRMv6 estimated these values for their 2010 and 2013 estimates using the 2010 CTPP version of the ACS data. The 2016 data applied the same proportional TAZ-level split found in those earlier estimates to the 2016 employment estimates.

### 3.2.6 Enrollment

Pre-kindergarten through 12<sup>th</sup> grade student enrollment was estimated from two Department of Instruction reports: month two of the Principal's Monthly Reports for the 2016-2017 school year for public and charter school students and the North Carolina Directory of Non-Public Schools, Conventional Schools Edition, with information for the 2016-2017 school term. The separate enrollment estimates were aggregated and linked to TAZs using public and private school location data obtained from the North Carolina open data portal.

### 3.3 Socioeconomic Forecasts and Adjustments

This section describes the three principal socioeconomic inputs to the TRMv6 model that drive travel demand forecasts; population, households and employment. The forecasts assumed in the TRMv6 are described, along with the adopted forecasts used in this study. The adopted forecasts were developed by Dr. Appold. The socioeconomic forecasts are described by various geographic areas described in the following subsection.

#### 3.3.1 TRMv6 Model Area

The TRMv6 includes 10 North Carolina counties comprising 3,379 square miles: Chatham, Durham, Franklin, Graham, Harnett, Johnston, Nash, Orange, Person and Wake. Of the 10 counties, only Durham, Orange and Wake are fully contained within the model area; the other seven counties are only partially included. The area encompassed by the TRMv6 boundary, referred to as the “model area,” is shown in **Figure 3.1**. Year 2013 is the official base year. Future year socio-economic and land-use assumptions in the TRMv6 are forecasts.

The TRMv6 contains 2,857 geographic units called Traffic Analysis Zones (TAZs). CDM Smith identified 983 zones in the vicinity of the Triangle Expressway and the proposed Complete 540 as residing in the “Detailed Study Area” or “Study Area”. For purposes of summarization, TAZs in the Detailed Study Area were grouped into 43 Superzones and six Regions. **Figure 3.2** illustrates the Superzones and Regions within the Detailed Study Area. The Regions are identified by a color and name, while the Superzones are identified by a number. The following subsections describe the socioeconomic forecasts by County and Region, with figures provided at the Superzone level.

#### 3.3.2 Population Forecasts

**Table 3.1** presents TRMv6 population forecasts by county for each model year. The upper portion of Table 3.1 shows the original data set contained in the TRMv6. The lower portion shows the data set adjusted by Dr. Appold and adopted by CDM Smith for use in this study. Population growth rates for each ten-year interval are calculated using average annual percent change (AAPC).

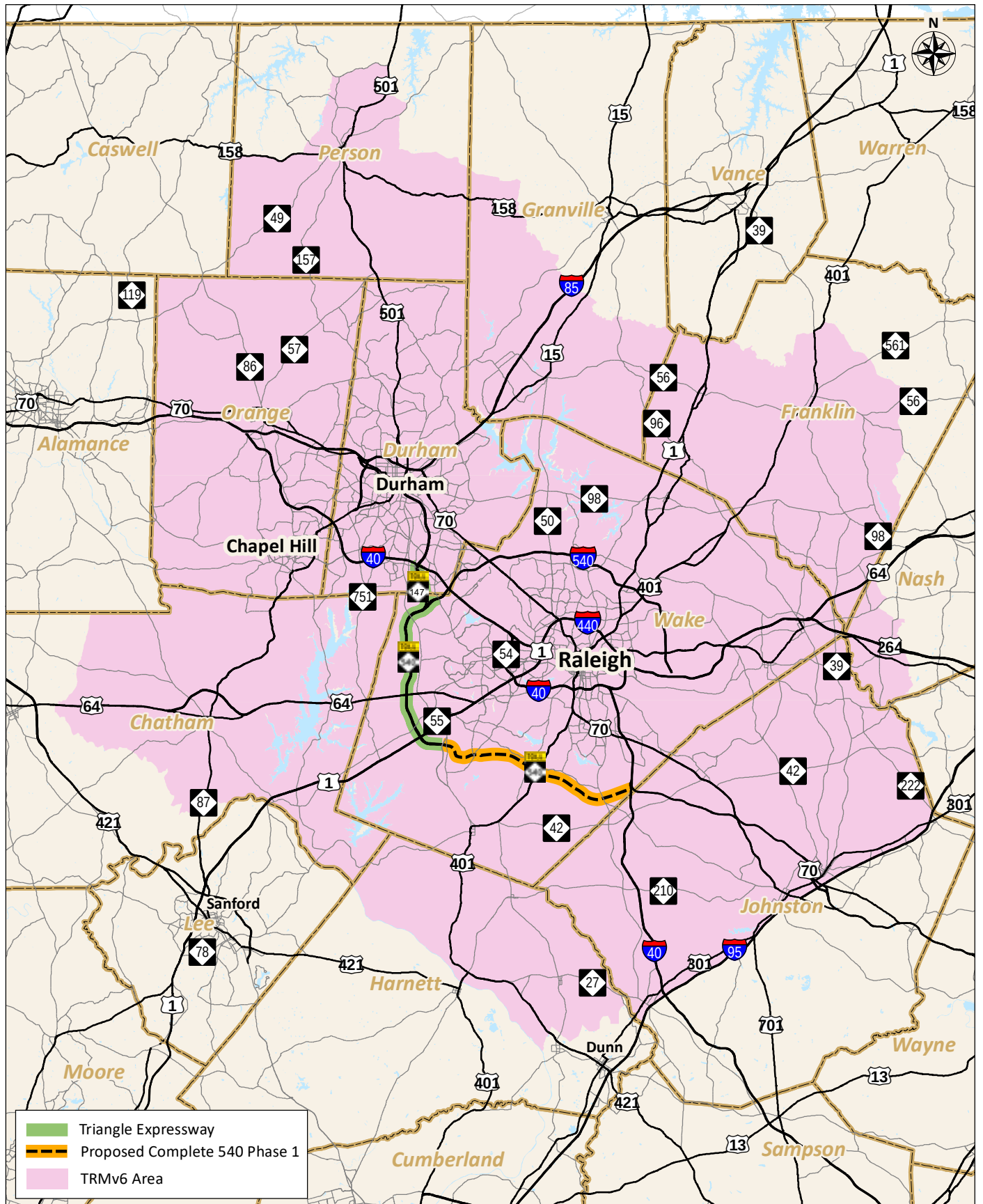
The official base year for the TRMv6 is 2013. CDM Smith created a 2016 model for calibration, and, as described in Section 3.2, asked Dr. Appold to develop the 2016 socioeconomic variables required by the model, including population, households and employment for each TAZ. The 2016 socioeconomic dataset developed by Dr. Appold is used as a common benchmark to measure growth for both the TRMv6 future-year socioeconomic forecasts and Dr. Appold’s.

The populations shown reflect the portions of the listed counties that are in the TRMv6 model area. Only Durham, Orange and Wake counties are included in their entirety in the TRMv6 model area. The Triangle Expressway is located in Wake County except for a small portion of Toll 147 that is located in southern Durham County. Complete 540 Phase 1 is located in southern Wake County, although the southeastern terminus of the road is very close to northern Johnston County.

Population growth rates are very similar, in total, between the TRMv6 and adopted forecasts. Compared to the TRMv6 forecasts, the annual rates of adopted population growth are lower in Wake and Durham counties for all model years and higher in Johnston County for all model years. Harnett County adopted population growth rates are higher than the original rates between 2016 and 2025.

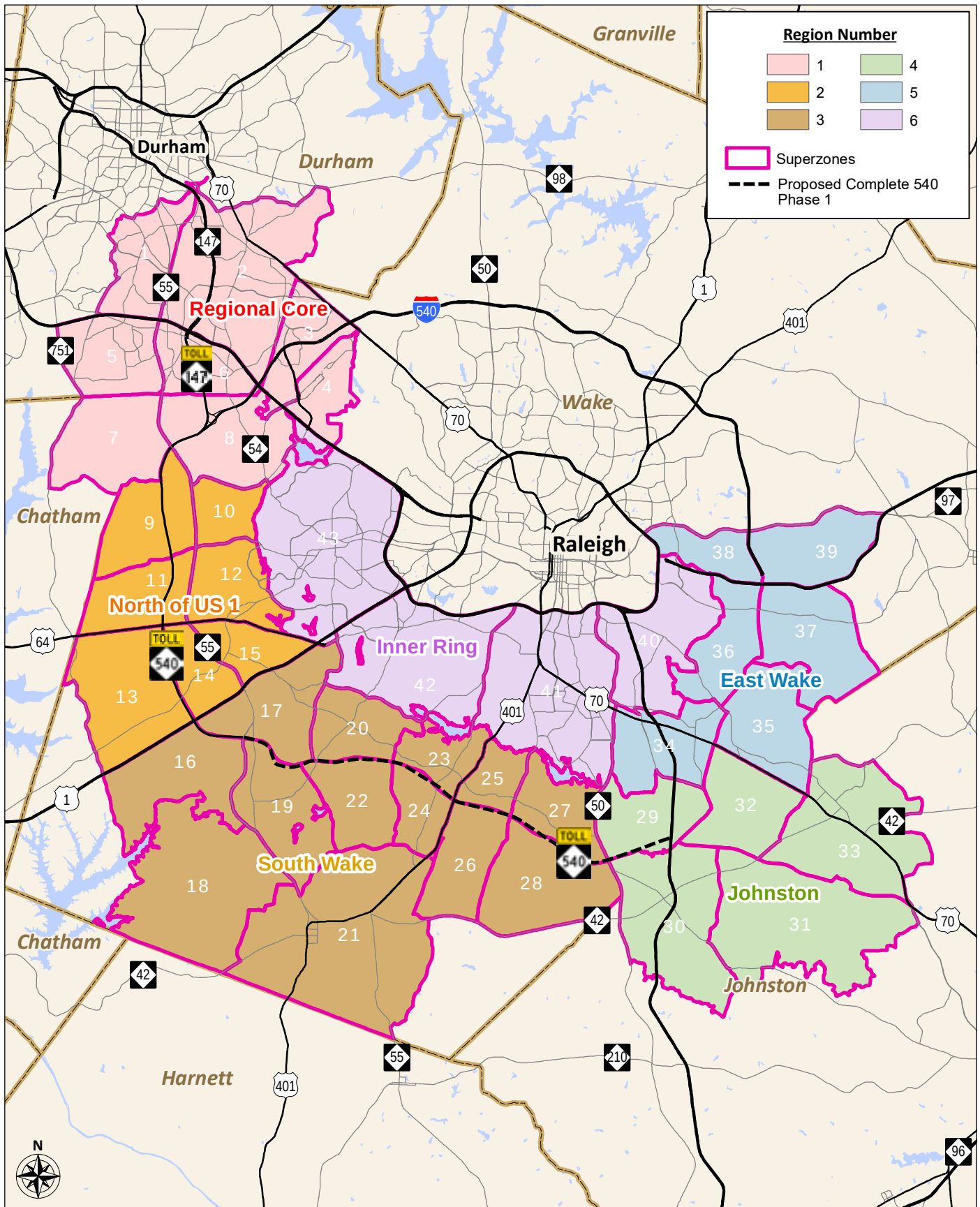
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# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



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**Table 3.1**  
**Model Area Population Forecasts by County - TRMv6 and Adopted Values**  
 (population in thousands)

| TRMv6 Values |                |                 |                |                 |                |                 |                |                 |
|--------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|
| County (1)   | 2016           | AAPC<br>2016-25 | 2025           | AAPC<br>2025-35 | 2035           | AAPC<br>2035-45 | 2045           | AAPC<br>2016-45 |
| Chatham      | 46.4           | 2.5 %           | 58.0           | 2.2 %           | 71.8           | 1.7 %           | 85.4           | 2.1 %           |
| Durham (1)   | 291.7          | 1.5             | 334.2          | 1.4             | 384.5          | 1.2             | 431.9          | 1.4             |
| Franklin     | 54.0           | 1.9             | 64.2           | 1.5             | 74.5           | 1.2             | 84.3           | 1.5             |
| Granville    | 31.2           | 1.4             | 35.4           | 1.3             | 40.3           | 1.1             | 44.8           | 1.3             |
| Harnett      | 39.4           | 1.4             | 44.8           | 1.7             | 53.0           | 1.4             | 60.7           | 1.5             |
| Johnston     | 159.9          | 3.0             | 208.8          | 2.3             | 262.3          | 1.8             | 313.1          | 2.3             |
| Nash         | 3.6            | 3.0             | 4.7            | 1.1             | 5.3            | 2.9             | 7.0            | 2.3             |
| Orange (1)   | 131.2          | 1.3             | 147.7          | 1.0             | 162.6          | 0.8             | 176.7          | 1.0             |
| Person       | 31.2           | 0.6             | 32.8           | 0.3             | 33.7           | 0.2             | 34.3           | 0.3             |
| Wake (1)     | <u>1,029.9</u> | 2.0             | <u>1,234.6</u> | 1.8             | <u>1,476.7</u> | 1.5             | <u>1,710.8</u> | 1.8             |
| Total        | 1,818.6        | 2.0             | 2,165.3        | 1.7             | 2,564.5        | 1.4             | 2,948.9        | 1.7             |

| Adopted Values |                |                 |                |                 |                |                 |                |                 |
|----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|
| County (1)     | 2016           | AAPC<br>2016-25 | 2025           | AAPC<br>2025-35 | 2035           | AAPC<br>2035-45 | 2045           | AAPC<br>2016-45 |
| Chatham        | 46.4           | 3.1 %           | 61.0           | 2.2 %           | 76.0           | 2.0 %           | 92.3           | 2.4 %           |
| Durham (1)     | 291.7          | 1.3             | 329.0          | 1.3             | 373.7          | 1.1             | 418.3          | 1.3             |
| Franklin       | 54.0           | 2.2             | 65.6           | 1.6             | 76.8           | 1.4             | 88.5           | 1.7             |
| Granville      | 31.2           | 3.2             | 41.4           | 1.8             | 49.6           | 1.7             | 58.6           | 2.2             |
| Harnett        | 39.4           | 2.2             | 47.7           | 1.6             | 56.0           | 1.4             | 64.6           | 1.7             |
| Johnston       | 159.9          | 3.3             | 214.4          | 2.5             | 274.4          | 2.1             | 338.5          | 2.6             |
| Nash           | 3.6            | 2.7             | 4.6            | 1.1             | 5.1            | 1.0             | 5.7            | 1.6             |
| Orange (1)     | 131.2          | 1.1             | 144.6          | 0.9             | 158.6          | 0.8             | 172.5          | 0.9             |
| Person         | 31.2           | 0.0             | 31.2           | 0.0             | 31.3           | 0.0             | 31.3           | 0.0             |
| Wake (1)       | <u>1,029.9</u> | 1.8             | <u>1,208.1</u> | 1.7             | <u>1,435.7</u> | 1.5             | <u>1,663.5</u> | 1.7             |
| Total          | 1,818.6        | 1.9             | 2,147.7        | 1.7             | 2,537.2        | 1.5             | 2,933.6        | 1.7             |

(1) Only Durham, Orange and Wake counties are entirely contained in the TRMv6 model area. The population in the remaining counties represents only the portion within the TRM model boundaries.

Note: AAPC is an abbreviation for Average Annual Percent Change

The adjustments to population forecasts at a county level are shown in **Table 3.2**. In the model area, total population was consistently adjusted downward by Dr. Appold, largely due to recent revisions of county-level population forecasts by the North Carolina Office of State Budget and Management (OSBM). Both the TRMv6 and adopted forecasts use OSBM projections as their basis for population projections. However, TRMv6 used OSBM figures dating from October 2015, while Dr. Appold used a more recent projection.

When compared with total model-area TRMv6 projections, the adopted population forecast shows approximately 17,600 fewer residents in 2025 and 15,400 fewer in 2045. These adjustments include lower population growth in the core counties (Durham, Orange and Wake) and more growth in the suburban counties over the next 20 years. Wake County adopted forecasts include approximately 26,500 fewer residents in 2025 and 47,400 fewer in 2045. Johnston County adopted forecasts in the model area include approximately 5,600 more residents in 2025 and 25,400 more in 2045.

**Table 3.2**  
**Model Area Population Adjustments by County**  
 (population in thousands)

| County (1) | 2025    |         |            | 2035    |         |            | 2045    |         |            |
|------------|---------|---------|------------|---------|---------|------------|---------|---------|------------|
|            | TRMv6   | Adopted | Adjustment | TRMv6   | Adopted | Adjustment | TRMv6   | Adopted | Adjustment |
| Chatham    | 58.0    | 61.0    | 3.1        | 71.8    | 76.0    | 4.2        | 85.4    | 92.3    | 6.9        |
| Durham (1) | 334.2   | 329.0   | (5.2)      | 384.5   | 373.7   | (10.8)     | 431.9   | 418.3   | (13.5)     |
| Franklin   | 64.2    | 65.6    | 1.3        | 74.5    | 76.8    | 2.3        | 84.3    | 88.5    | 4.2        |
| Granville  | 35.4    | 41.4    | 6.0        | 40.3    | 49.6    | 9.3        | 44.8    | 58.6    | 13.7       |
| Harnett    | 44.8    | 47.7    | 2.9        | 53.0    | 56.0    | 3.0        | 60.7    | 64.6    | 3.8        |
| Johnston   | 208.8   | 214.4   | 5.6        | 262.3   | 274.4   | 12.1       | 313.1   | 338.5   | 25.4       |
| Nash       | 4.7     | 4.6     | (0.1)      | 5.3     | 5.1     | (0.1)      | 7.0     | 5.7     | (1.3)      |
| Orange (1) | 147.7   | 144.6   | (3.1)      | 162.6   | 158.6   | (4.0)      | 176.7   | 172.5   | (4.3)      |
| Person     | 32.8    | 31.2    | (1.6)      | 33.7    | 31.3    | (2.5)      | 34.3    | 31.3    | (3.1)      |
| Wake (1)   | 1,234.6 | 1,208.1 | (26.5)     | 1,476.7 | 1,435.7 | (40.9)     | 1,710.8 | 1,663.5 | (47.4)     |
| Total      | 2,165.3 | 2,147.7 | (17.6)     | 2,564.5 | 2,537.2 | (27.3)     | 2,948.9 | 2,933.6 | (15.4)     |

(1) Only Durham, Orange and Wake counties are entirely contained in the TRMv6 model area. The population in the remaining counties represents only the portion within the TRM model boundaries.

Note: AAPC is an abbreviation for Average Annual Percent Change

The distribution of population growth by small geographic areas within the model area is very important, as population growth proximate to Complete 540 or the Triangle Expressway impacts potential travel more than population growth further away.

**Table 3.3** presents the population projections within the Detailed Study Area by region for each model year. The Detailed Study Area represents the geography that surrounds the Triangle Expressway and Complete 540 corridor (both Phase 1 and the potential future Phase 2). The upper portion of Table 3.3 shows the original TRMv6 data set. The lower portion shows the adopted data set.

Most notably, the adopted population growth rate was reduced in the adopted forecast for the South Wake region (which encompasses Complete 540 Phase 1) between 2016 and 2025. This resulted in a reduced population forecast in the South Wake region in 2025, 2035 and 2045 compared to the TRMv6 values. Adopted population growth rates were increased in the Johnston region between all model years, resulting in increased population forecasts.

The population adjustments in the Detailed Study Area between the TRMv6 and the adopted values are shown in **Table 3.4**. Population was reduced in the South Wake region by approximately 11,800 (6.0 percent) in 2025, 15,400 (6.0 percent) in 2035, and 18,900 (6.0 percent) in 2045. The Johnston region population was increased by approximately 3,500, 5,100 and 7,800 in 2025, 2035 and 2045 respectively compared to the TRMv6 values. These population increases represent an increase of 5.2 percent in 2025, 6.0 percent in 2035 and 7.5 percent in 2045.

**Table 3.3**  
**Detailed Study Area Population Forecasts by Region - TRMv6 and Adopted Values**  
 (population in thousands)

| Region Number<br>and Name | TRMv6 Values |         |       |         |       |         |         |         |
|---------------------------|--------------|---------|-------|---------|-------|---------|---------|---------|
|                           | AAPC         |         | AAPC  |         | AAPC  |         | AAPC    |         |
|                           | 2016         | 2016-25 | 2025  | 2025-35 | 2035  | 2035-45 | 2045    | 2016-45 |
| 1 Regional Core           | 116.7        | 0.5 %   | 122.0 | 1.2 %   | 137.9 | 1.1 %   | 153.7   | 1.0 %   |
| 2 North of US 1           | 104.8        | 0.6     | 110.6 | 1.3     | 125.4 | 1.1     | 140.1   | 1.0     |
| 3 South Wake              | 140.5        | 3.7     | 195.6 | 2.7     | 254.4 | 2.1     | 313.3   | 2.8     |
| 4 Johnston                | 53.3         | 2.6     | 67.4  | 2.4     | 85.6  | 2.0     | 103.9   | 2.3     |
| 5 East Wake               | 48.7         | 4.5     | 72.3  | 3.0     | 97.1  | 2.3     | 121.9   | 3.2     |
| 6 Inner Ring              | 171.0        | 1.0     | 186.2 | 1.2     | 210.4 | 1.1     | 234.6   | 1.1     |
| Total                     | 635.1        | 1.9     | 754.2 | 1.9     | 910.8 | 1.6     | 1,067.5 | 1.8     |

| Region Number<br>and Name | Adopted Values |         |       |         |       |         |         |         |
|---------------------------|----------------|---------|-------|---------|-------|---------|---------|---------|
|                           | AAPC           |         | AAPC  |         | AAPC  |         | AAPC    |         |
|                           | 2016           | 2016-25 | 2025  | 2025-35 | 2035  | 2035-45 | 2045    | 2016-45 |
| 1 Regional Core           | 116.7          | 1.1 %   | 128.7 | 1.1 %   | 143.1 | 1.0 %   | 157.6   | 1.0 %   |
| 2 North of US 1           | 104.8          | 1.1     | 115.7 | 1.1     | 129.6 | 1.0     | 143.5   | 1.1     |
| 3 South Wake              | 140.5          | 3.0     | 183.8 | 2.7     | 239.1 | 2.1     | 294.4   | 2.6     |
| 4 Johnston                | 53.3           | 3.2     | 70.9  | 2.5     | 90.7  | 2.1     | 111.7   | 2.6     |
| 5 East Wake               | 48.7           | 3.6     | 67.1  | 3.0     | 90.4  | 2.3     | 113.8   | 3.0     |
| 6 Inner Ring              | 171.0          | 1.1     | 188.8 | 1.1     | 211.5 | 1.0     | 234.3   | 1.1     |
| Total                     | 635.1          | 1.9     | 754.9 | 1.8     | 904.4 | 1.6     | 1,055.3 | 1.8     |

Note: TRMv6 is the Triangle Regional Model version 6  
 AAPC is an abbreviation for Average Annual Percent Change

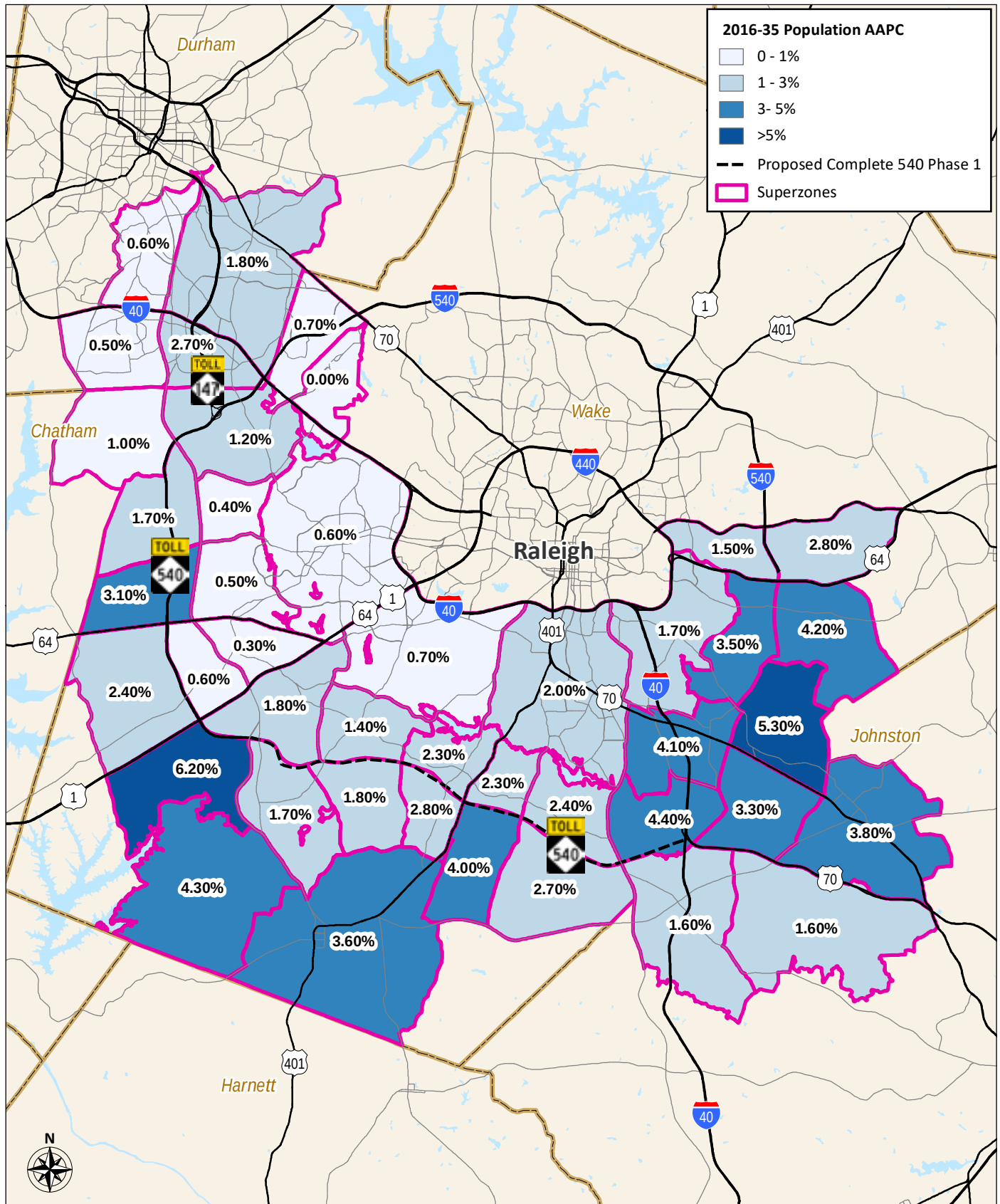
**Table 3.4**  
**Detailed Study Area Population Adjustments by Region**  
 (population in thousands)

| Region Number<br>and Name | 2025  |         |            | 2035  |         |            | 2045    |         |            |
|---------------------------|-------|---------|------------|-------|---------|------------|---------|---------|------------|
|                           | TRMv6 | Adopted | Adjustment | TRMv6 | Adopted | Adjustment | TRMv6   | Adopted | Adjustment |
| 1 Regional Core           | 122.0 | 128.7   | 6.6        | 137.9 | 143.1   | 5.2        | 153.7   | 157.6   | 3.9        |
| 2 North of US 1           | 110.6 | 115.7   | 5.1        | 125.4 | 129.6   | 4.2        | 140.1   | 143.5   | 3.3        |
| 3 South Wake              | 195.6 | 183.8   | (11.8)     | 254.4 | 239.1   | (15.4)     | 313.3   | 294.4   | (18.9)     |
| 4 Johnston                | 67.4  | 70.9    | 3.5        | 85.6  | 90.7    | 5.1        | 103.9   | 111.7   | 7.8        |
| 5 East Wake               | 72.3  | 67.1    | (5.3)      | 97.1  | 90.4    | (6.7)      | 121.9   | 113.8   | (8.1)      |
| 6 Inner Ring              | 186.2 | 188.8   | 2.6        | 210.4 | 211.5   | 1.1        | 234.6   | 234.3   | (0.3)      |
| Total                     | 754.2 | 754.9   | 0.7        | 910.8 | 904.4   | (6.4)      | 1,067.5 | 1,055.3 | (12.3)     |

Note: AAPC is an abbreviation for Average Annual Percent Change

**Figure 3.3** illustrates the adopted AAPC increase in population by superzone in the Detailed Study Area from 2016 to 2035. These years were selected to illustrate the growth in the near term, as opposed to growth through 2045. Recall the proposed Complete 540 Phase 1 is assumed to open in July 2023. The highest growth rates in population are forecast to occur in the southwestern superzones of Wake County, south of the proposed Complete 540, and in superzones located southeast of Raleigh in Wake and Johnston counties.

# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



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### 3.3.3 Household Forecasts

**Table 3.5** presents TRMv6 household forecasts by county for each model year. The upper portion of Table 3.5 shows the original data set contained in the TRMv6. The lower portion shows the data set adjusted by Dr. Appold and adopted by CDM Smith for use in this study. Household growth rates for each ten-year interval are calculated using average annual percent change (AAPC).

As seen in Table 3.5, there were nearly 714,000 households in the total model area in 2016 and about 66 percent of those households (472,800) are located in Wake County or in the portions of Johnston and Harnett counties in the model area.

In the adopted forecast (model years 2025, 2035 and 2045), household growth rates are higher in the total model area compared to the TRMv6 forecast. Adopted household growth rates in Wake County and in the portions of Johnston and Harnett counties in the model area are forecast to be higher compared to assumptions in the TRMv6, resulting in higher estimated numbers of households.

**Table 3.5**  
**Model Area Household Forecasts by County - TRMv6 and Adopted Values**  
(number of households in thousands)

| County (1) | TRMv6 Values |         |       |         |         |         |         |         |
|------------|--------------|---------|-------|---------|---------|---------|---------|---------|
|            | AAPC         |         | AAPC  |         | AAPC    |         | AAPC    |         |
|            | 2016         | 2016-25 | 2025  | 2025-35 | 2035    | 2035-45 | 2045    | 2016-45 |
| Chatham    | 19.4         | 2.6 %   | 24.5  | 2.0 %   | 30.0    | 1.7 %   | 35.5    | 2.1 %   |
| Durham (1) | 122.0        | 1.5     | 139.0 | 1.3     | 158.5   | 1.2     | 178.0   | 1.3     |
| Franklin   | 20.3         | 2.3     | 25.0  | 1.5     | 29.0    | 1.3     | 33.1    | 1.7     |
| Granville  | 11.5         | 1.8     | 13.5  | 1.3     | 15.3    | 1.1     | 17.0    | 1.4     |
| Harnett    | 14.3         | 1.9     | 16.9  | 1.6     | 19.8    | 1.4     | 22.7    | 1.6     |
| Johnston   | 58.6         | 2.9     | 76.0  | 2.2     | 94.9    | 1.8     | 113.8   | 2.3     |
| Nash       | 1.5          | 1.6     | 1.8   | 1.1     | 2.0     | 1.0     | 2.2     | 1.2     |
| Orange (1) | 53.5         | 1.4     | 60.9  | 1.0     | 67.0    | 0.9     | 73.2    | 1.1     |
| Person     | 12.8         | 0.5     | 13.4  | 0.2     | 13.7    | 0.2     | 14.0    | 0.3     |
| Wake (1)   | 399.9        | 2.0     | 479.3 | 1.8     | 570.3   | 1.5     | 661.3   | 1.7     |
| Total      | 713.8        | 2.0     | 850.3 | 1.6     | 1,000.5 | 1.4     | 1,150.7 | 1.7     |

| County (1) | Adopted Values |         |       |         |         |         |         |         |
|------------|----------------|---------|-------|---------|---------|---------|---------|---------|
|            | AAPC           |         | AAPC  |         | AAPC    |         | AAPC    |         |
|            | 2016           | 2016-25 | 2025  | 2025-35 | 2035    | 2035-45 | 2045    | 2016-45 |
| Chatham    | 19.4           | 4.1 %   | 27.8  | 2.4 %   | 35.3    | 2.3 %   | 44.4    | 2.9 %   |
| Durham (1) | 122.0          | 0.5     | 128.0 | 1.4     | 146.6   | 1.2     | 165.2   | 1.1     |
| Franklin   | 20.3           | 3.5     | 27.6  | 1.7     | 32.8    | 1.7     | 38.8    | 2.3     |
| Granville  | 11.5           | 5.6     | 18.8  | 2.0     | 22.8    | 2.0     | 27.7    | 3.1     |
| Harnett    | 14.3           | 2.6     | 18.0  | 1.8     | 21.5    | 1.6     | 25.2    | 2.0     |
| Johnston   | 58.6           | 4.2     | 84.5  | 2.6     | 109.3   | 2.3     | 137.7   | 3.0     |
| Nash       | 1.5            | 2.4     | 1.9   | 1.1     | 2.1     | 1.2     | 2.4     | 1.5     |
| Orange (1) | 53.5           | 1.5     | 61.2  | 1.1     | 68.5    | 1.2     | 77.0    | 1.3     |
| Person     | 12.8           | 0.0     | 12.8  | 0.0     | 12.8    | 0.0     | 12.9    | 0.0     |
| Wake (1)   | 399.9          | 2.1     | 483.9 | 2.0     | 591.2   | 1.8     | 707.2   | 2.0     |
| Total      | 713.8          | 2.1     | 864.4 | 1.9     | 1,043.1 | 1.7     | 1,238.4 | 1.9     |

(1) Only Durham, Orange and Wake counties are entirely contained in the TRMv6 model area. The population in the remaining counties represents only the portion within the TRM model boundaries.

Note: AAPC is an abbreviation for Average Annual Percent Change



The adjustments to the household forecasts at a county level are shown in **Table 3.6**. In total, the number of households was increased by about 14,100 in 2025, 42,600 in 2035 and 87,800 in 2045. The adopted forecast increased the households in Wake County by 4,600 (1.0 percent) in 2025, 20,900 (3.7 percent) in 2035 and 45,900 (6.9 percent) in 2045. Households in the Johnston County area were increased by 8,500 (11.2 percent) in 2025, 14,400 (15.2 percent) in 2035, and 24,000 (21.2 percent) in 2045 compared to the TRMv6 values.

| <b>County (1)</b> | <b>2025</b>  |              |             | <b>2035</b>    |                |             | <b>2045</b>    |                |             |
|-------------------|--------------|--------------|-------------|----------------|----------------|-------------|----------------|----------------|-------------|
|                   | TRMv6        | Adopted      | Adjustment  | TRMv6          | Adopted        | Adjustment  | TRMv6          | Adopted        | Adjustment  |
| Chatham           | 24.5         | 27.8         | 3.2         | 30.0           | 35.3           | 5.3         | 35.5           | 44.4           | 8.9         |
| Durham (1)        | 139.0        | 128.0        | (11.0)      | 158.5          | 146.6          | (11.9)      | 178.0          | 165.2          | (12.8)      |
| Franklin          | 25.0         | 27.6         | 2.6         | 29.0           | 32.8           | 3.8         | 33.1           | 38.8           | 5.7         |
| Granville         | 13.5         | 18.8         | 5.3         | 15.3           | 22.8           | 7.6         | 17.0           | 27.7           | 10.7        |
| Harnett           | 16.9         | 18.0         | 1.1         | 19.8           | 21.5           | 1.7         | 22.7           | 25.2           | 2.5         |
| Johnston          | 76.0         | 84.5         | 8.5         | 94.9           | 109.3          | 14.4        | 113.8          | 137.7          | 24.0        |
| Nash              | 1.8          | 1.9          | 0.1         | 2.0            | 2.1            | 0.2         | 2.2            | 2.4            | 0.2         |
| Orange (1)        | 60.9         | 61.2         | 0.3         | 67.0           | 68.5           | 1.5         | 73.2           | 77.0           | 3.9         |
| Person            | 13.4         | 12.8         | (0.6)       | 13.7           | 12.8           | (0.9)       | 14.0           | 12.9           | (1.2)       |
| Wake (1)          | 479.3        | 483.9        | 4.6         | 570.3          | 591.2          | 20.9        | 661.3          | 707.2          | 45.9        |
| <b>Total</b>      | <b>850.3</b> | <b>864.4</b> | <b>14.1</b> | <b>1,000.5</b> | <b>1,043.1</b> | <b>42.6</b> | <b>1,150.7</b> | <b>1,238.4</b> | <b>87.8</b> |

(1) Only Durham, Orange and Wake counties are entirely contained in the TRMv6 model area. The population in the remaining counties represents only the portion within the TRM model boundaries.

Note: AAPC is an abbreviation for Average Annual Percent Change

As discussed in Section 3.3.2, population estimates were adjusted downward in several counties or portions of counties in the model area. The downward adjustment in population occurred, particularly in Wake County, despite the number of households being adjusted upwards. This occurs because the TRMv6 model holds the population's age distribution constant to a 2010 distribution. Due to an expected aging of the population over time, household composition is also expected to change, resulting in a gradual lowering of average household size in Dr. Appold's adjustments. Both the TRMv6 model and Dr. Appold's projections use the same source information to calculate population estimates, which are then used to estimate the number of households. Because the adjusted numbers estimate a smaller household size as compared to TRMv6, the number of households must increase to reach the estimated population numbers.

**Table 3.7** presents the Detailed Study Area household projections by region for each model year. The upper portion of Table 3.7 shows the original data set. The lower portion shows the adjusted data set.

In the detailed study area, the adopted forecast has a higher rate of annual growth between all model years compared to the TRMv6 forecast. The higher rates of average annual growth are also seen in the South Wake region between 2025 and 2035 and between 2035 and 2045, and in the Johnston region between all model years.

**Table 3.7**  
**Detailed Study Area Household Forecasts by Region - TRMv6 and Adopted Values**  
 (number of households in thousands)

| Region<br>Number | TRMv6 Values |                 |       |                 |       |                 |       |                 |
|------------------|--------------|-----------------|-------|-----------------|-------|-----------------|-------|-----------------|
|                  | 2016         | AAPC<br>2016-25 | 2025  | AAPC<br>2025-35 | 2035  | AAPC<br>2035-45 | 2045  | AAPC<br>2016-45 |
| 1 Regional Core  | 48.2         | 0.5 %           | 50.6  | 1.3 %           | 56.6  | 1.1 %           | 62.7  | 0.9 %           |
| 2 North of US 1  | 36.3         | 0.9             | 39.2  | 1.5             | 44.6  | 1.3             | 50.0  | 1.1             |
| 3 South Wake     | 49.0         | 3.8             | 68.6  | 3.0             | 89.1  | 2.3             | 109.6 | 2.8             |
| 4 Johnston       | 18.9         | 2.9             | 24.5  | 2.7             | 31.0  | 2.1             | 37.5  | 2.4             |
| 5 East Wake      | 17.3         | 4.7             | 26.0  | 3.3             | 34.8  | 2.5             | 43.4  | 3.2             |
| 6 Inner Ring     | 66.1         | 1.2             | 73.9  | 1.3             | 83.2  | 1.2             | 92.6  | 1.2             |
| Total            | 235.7        | 2.0             | 282.7 | 2.0             | 339.3 | 1.7             | 395.8 | 1.8             |

| Region<br>Number | Adopted Values |                 |       |                 |       |                 |       |                 |
|------------------|----------------|-----------------|-------|-----------------|-------|-----------------|-------|-----------------|
|                  | 2016           | AAPC<br>2016-25 | 2025  | AAPC<br>2025-35 | 2035  | AAPC<br>2035-45 | 2045  | AAPC<br>2016-45 |
| 1 Regional Core  | 48.2           | 0.7 %           | 51.5  | 1.3 %           | 57.8  | 1.2 %           | 64.3  | 1.0 %           |
| 2 North of US 1  | 36.3           | 1.4             | 41.3  | 1.6             | 47.7  | 1.5             | 54.6  | 1.4             |
| 3 South Wake     | 49.0           | 3.7             | 67.9  | 3.4             | 92.1  | 2.8             | 118.2 | 3.1             |
| 4 Johnston       | 18.9           | 4.1             | 27.3  | 3.0             | 35.7  | 2.7             | 45.2  | 3.0             |
| 5 East Wake      | 17.3           | 4.3             | 25.4  | 3.9             | 35.6  | 3.1             | 46.8  | 3.5             |
| 6 Inner Ring     | 66.1           | 1.4             | 74.7  | 1.5             | 85.8  | 1.5             | 97.7  | 1.4             |
| Total            | 235.7          | 2.3             | 288.0 | 2.3             | 354.6 | 2.1             | 426.8 | 2.1             |

Note: AAPC is an abbreviation for Average Annual Percent Change

Adjustments made to the TRMv6 household forecasts in the Detailed Study Area are shown by region in **Table 3.8**. At a regional level, all household forecasts were adjusted upward, except for South Wake (Region 3) and East Wake (Region 5) in 2025, which both had slight downward adjustments. In 2035 and 2045, however, these regions had upward adjustments. Within the adjusted data set, the most notable changes were made to Region 4 (Johnston), at the east end of Complete 540 Phase 1, where household projections were adjusted upward by about 11.5 percent in 2025, 15.2 percent in 2035 and 20.5 percent in 2045. Household projections for all other regions stayed within 10 percent of the TRMv6 model.

**Table 3.8**  
**Detailed Study Area Household Adjustments by Region**  
 (number of households in thousands)

| Region Number<br>and Name | 2025  |         |            | 2035  |         |            | 2045  |         |            |
|---------------------------|-------|---------|------------|-------|---------|------------|-------|---------|------------|
|                           | TRMv6 | Adopted | Adjustment | TRMv6 | Adopted | Adjustment | TRMv6 | Adopted | Adjustment |
| 1 Regional Core           | 50.6  | 51.5    | 0.9        | 56.6  | 57.8    | 1.2        | 62.7  | 64.3    | 1.7        |
| 2 North of US 1           | 39.2  | 41.3    | 2.1        | 44.6  | 47.7    | 3.1        | 50.0  | 54.6    | 4.6        |
| 3 South Wake              | 68.6  | 67.9    | (0.7)      | 89.1  | 92.1    | 3.0        | 109.6 | 118.2   | 8.6        |
| 4 Johnston                | 24.5  | 27.3    | 2.8        | 31.0  | 35.7    | 4.7        | 37.5  | 45.2    | 7.7        |
| 5 East Wake               | 26.0  | 25.4    | (0.7)      | 34.8  | 35.6    | 0.9        | 43.4  | 46.8    | 3.3        |
| 6 Inner Ring              | 73.9  | 74.7    | 0.9        | 83.2  | 85.8    | 2.6        | 92.6  | 97.7    | 5.2        |
| Total                     | 282.7 | 288.0   | 5.3        | 339.3 | 354.6   | 15.4       | 395.8 | 426.8   | 31.0       |

Note: AAPC is an abbreviation for Average Annual Percent Change

**Figure 3.4** displays the forecasted average annual growth rate in households within the Detailed Study Area for the adopted data set between 2016 and 2035 by superzone. As with population, forecasted household growth rates are smallest in the northwest superzones, which is the portion of the study area that is already the most densely developed and populated. The highest annualized rates of growth are forecast to occur on the eastern and southern sides of the Detailed Study Area, in southern and southeastern Wake County and portions of northern Johnston County. Due to an anticipated decrease in average household size, households are forecasted to grow slightly faster than population in many of the superzones.

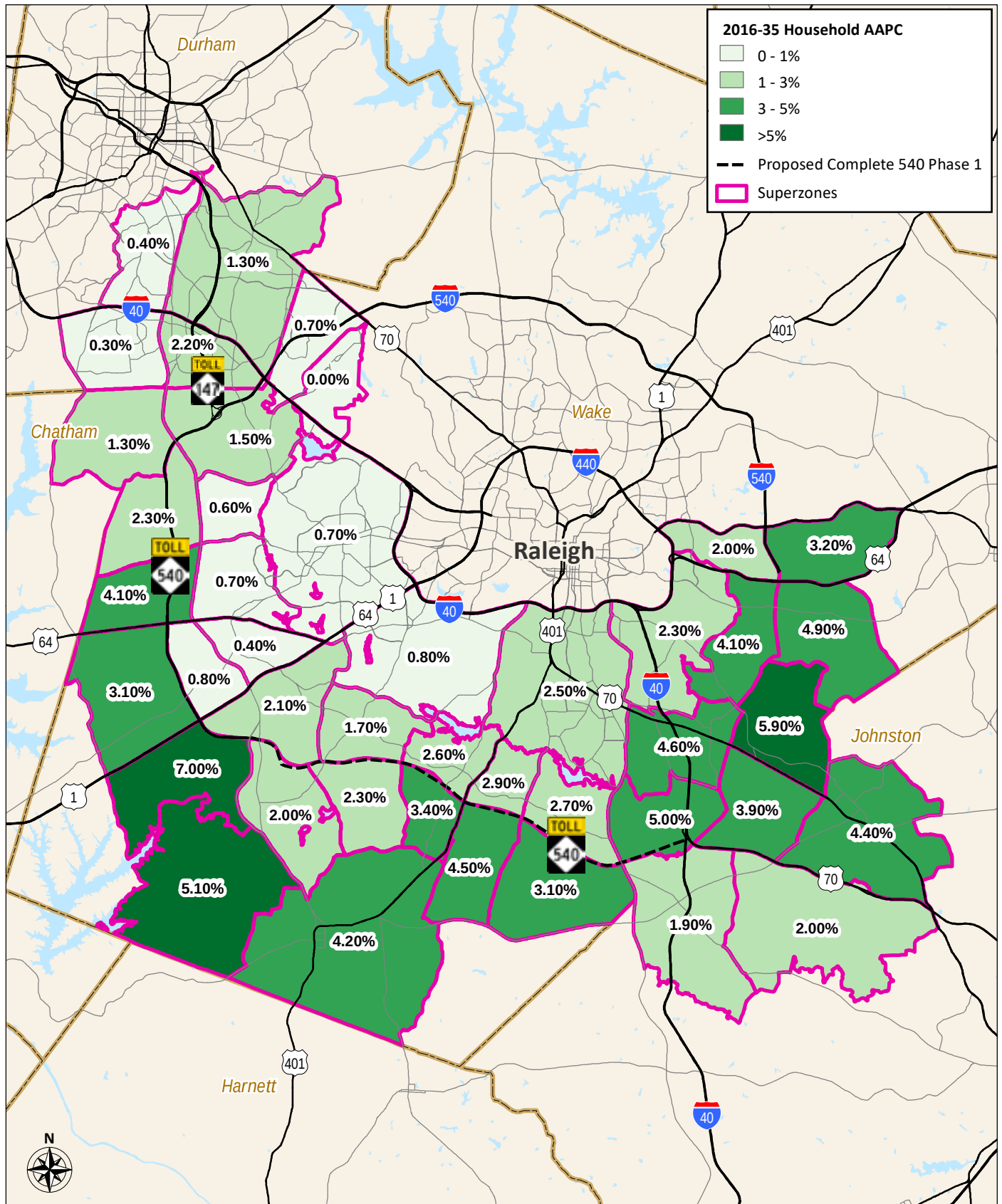
### 3.3.4 Employment Forecasts

**Table 3.9** presents TRMv6 employment projections by county for each model year. The upper portion of Table 3.9 shows the original data set. The lower portion shows the data set adjusted by Dr. Appold. Population growth rates for each ten-year interval are calculated using AAPC.

In total, employment forecasts were adjusted downward in each future year (2025, 2035 and 2045). The employment growth averaged 1.6 percent per year from 2016 to 2045 in the TRMv6 compared to the adopted 1.1 percent per year. The adopted employment forecast results in about 218,100 fewer employed people in 2045 compared to the original forecast. Rates of growth in employment were reduced in Wake County and increased in Johnston County.

The adjustments to employment made by Dr. Appold at the county level are shown in **Table 3.10**. Wake County employment was reduced by 100 in 2025; 54,100 in 2035; and 114,400 in 2045, representing decreases of about 0.0 percent, 6.7 percent, and 12.2 percent respectively compared to the TRMv6 values. In contrast, employment was adjusted upward in Johnston County (in the portion within the model), by 5,500 in 2015; 6,100 in 2035; and 7,000 in 2045. This represents increases of approximately 11 percent in each model year compared to the TRMv6 values.

# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



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**Table 3.9**  
**Model Area Employment Forecasts by County - TRMv6 and Adopted Values**  
**(employment in thousands)**

| TRMv6 Values |       |                 |         |                 |         |                 |         |                 |
|--------------|-------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|
| County (1)   | 2016  | AAPC<br>2016-25 | 2025    | AAPC<br>2025-35 | 2035    | AAPC<br>2035-45 | 2045    | AAPC<br>2016-45 |
| Chatham      | 9.8   | 2.8 %           | 12.6    | 2.2 %           | 15.2    | 1.8 %           | 17.9    | 2.1 %           |
| Durham (1)   | 212.6 | 1.8             | 249.2   | 1.9             | 296.2   | 1.6             | 343.1   | 1.7             |
| Franklin     | 12.1  | 3.6             | 16.5    | 1.8             | 19.5    | 1.6             | 22.5    | 2.2             |
| Granville    | 10.2  | (0.5)           | 9.8     | 1.2             | 10.9    | 1.1             | 12.0    | 0.6             |
| Harnett      | 7.5   | (0.3)           | 7.3     | 1.8             | 8.5     | 1.4             | 9.6     | 0.9             |
| Johnston     | 46.4  | 1.0             | 50.6    | 1.7             | 58.8    | 1.5             | 67.1    | 1.3             |
| Nash         | 0.8   | (8.7)           | 0.3     | 1.1             | 0.4     | 1.9             | 0.4     | (1.9)           |
| Orange (1)   | 76.3  | 0.6             | 80.3    | 1.7             | 93.7    | 1.5             | 107.1   | 1.2             |
| Person       | 10.2  | 0.4             | 10.6    | 0.5             | 11.2    | 0.5             | 11.7    | 0.5             |
| Wake (1)     | 576.6 | 1.7             | 668.6   | 2.1             | 804.1   | 1.7             | 939.5   | 1.7             |
| Total        | 962.5 | 1.6             | 1,105.8 | 2.0             | 1,318.5 | 1.7             | 1,530.9 | 1.6             |

| Adopted Values |       |                 |         |                 |         |                 |         |                 |
|----------------|-------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|
| County (1)     | 2016  | AAPC<br>2016-25 | 2025    | AAPC<br>2025-35 | 2035    | AAPC<br>2035-45 | 2045    | AAPC<br>2016-45 |
| Chatham        | 9.8   | 2.1 %           | 11.8    | 1.2 %           | 13.1    | 0.7 %           | 13.9    | 1.2 %           |
| Durham (1)     | 212.6 | 0.6             | 224.0   | 1.0             | 245.7   | 0.5             | 257.8   | 0.7             |
| Franklin       | 12.1  | 1.0             | 13.2    | 0.9             | 14.3    | 0.8             | 15.3    | 0.8             |
| Granville      | 10.2  | 0.1             | 10.3    | (0.0)           | 10.2    | 0.0             | 10.2    | 0.0             |
| Harnett        | 7.5   | 1.0             | 8.2     | 1.2             | 9.1     | 0.7             | 9.7     | 0.9             |
| Johnston       | 46.4  | 2.1             | 56.1    | 1.6             | 65.0    | 1.5             | 74.2    | 1.6             |
| Nash           | 0.8   | 0.3             | 0.8     | 0.3             | 0.8     | 0.3             | 0.8     | 0.3             |
| Orange (1)     | 76.3  | 0.8             | 81.7    | 0.8             | 88.0    | 0.8             | 94.2    | 0.7             |
| Person         | 10.2  | 0.8             | 10.9    | 0.4             | 11.3    | 0.4             | 11.7    | 0.5             |
| Wake (1)       | 576.6 | 1.7             | 668.5   | 1.3             | 750.0   | 1.1             | 825.0   | 1.2             |
| Total          | 962.5 | 1.3             | 1,085.5 | 1.2             | 1,207.5 | 0.9             | 1,312.8 | 1.1             |

(1) Only Durham, Orange and Wake counties are entirely contained in the TRMv6 model area. The population in the remaining counties represents only the portion within the TRM model boundaries.

Note: AAPC is an abbreviation for Average Annual Percent Change

Dr. Appold adjusted employment downward largely because of two characteristics of the TRMv6 model that he believed resulted in unrealistically high employment growth rates. First; the TRMv6 employment projections assume an employment growth rate based upon a data source with a higher population growth rate than used elsewhere in the model. Second, the TRMv6 model does not account for an aging population that will include fewer adults of prime working age and participating in the labor force. The adopted employment forecasts still assume employment growth but assume that the older population distribution will not require as many jobs as the younger population distribution



required in the TRMv6. Johnston County employment was adjusted upward because the TRMv6 uses an employment growth trajectory based on 2013 data. Johnston County was slow to recover from recession-based employment losses and had just returned to 2007 employment levels in 2013. Dr. Appold adjusted the Johnston County employment forecast to reflect anticipated continued employment growth.

**Table 3.10**  
**Model Area Employment Adjustments by County**  
(employment in thousands)

| County (1) | 2025    |         |            | 2035    |         |            | 2045    |         |            |
|------------|---------|---------|------------|---------|---------|------------|---------|---------|------------|
|            | TRMv6   | Adopted | Adjustment | TRMv6   | Adopted | Adjustment | TRMv6   | Adopted | Adjustment |
| Chatham    | 12.6    | 11.8    | (0.8)      | 15.2    | 13.1    | (2.1)      | 17.9    | 13.9    | (4.0)      |
| Durham (1) | 249.2   | 224.0   | (25.2)     | 296.2   | 245.7   | (50.5)     | 343.1   | 257.8   | (85.3)     |
| Franklin   | 16.5    | 13.2    | (3.3)      | 19.5    | 14.3    | (5.2)      | 22.5    | 15.3    | (7.1)      |
| Granville  | 9.8     | 10.3    | 0.5        | 10.9    | 10.2    | (0.7)      | 12.0    | 10.2    | (1.8)      |
| Harnett    | 7.3     | 8.2     | 0.9        | 8.5     | 9.1     | 0.6        | 9.6     | 9.7     | 0.0        |
| Johnston   | 50.6    | 56.1    | 5.5        | 58.8    | 65.0    | 6.1        | 67.1    | 74.2    | 7.0        |
| Nash       | 0.3     | 0.8     | 0.4        | 0.4     | 0.8     | 0.4        | 0.4     | 0.8     | 0.4        |
| Orange (1) | 80.3    | 81.7    | 1.4        | 93.7    | 88.0    | (5.7)      | 107.1   | 94.2    | (12.9)     |
| Person     | 10.6    | 10.9    | 0.3        | 11.2    | 11.3    | 0.2        | 11.7    | 11.7    | 0.0        |
| Wake (1)   | 668.6   | 668.5   | (0.1)      | 804.1   | 750.0   | (54.1)     | 939.5   | 825.0   | (114.4)    |
| Total      | 1,105.8 | 1,085.5 | (20.3)     | 1,318.5 | 1,207.5 | (111.1)    | 1,530.9 | 1,312.8 | (218.1)    |

(1) Only Durham, Orange and Wake counties are entirely contained in the TRMv6 model area. The population in the remaining counties represents only the portion within the TRM model boundaries.

Note: AAPC is an abbreviation for Average Annual Percent Change

**Table 3.11** presents the original and adopted employment growth forecasts by region in the Detailed Study Area, and **Table 3.12** shows the corresponding adjustments made to employment in the TRMv6. Employment forecasts were reduced in the total Detailed Study Area in each future model year. In the TRMv6, employment growth in the Detailed Study Area was forecast to average 2.0 percent per year from 2016 to 2045, while the adopted forecast assumes an average annual growth rate of 1.3 percent per year. In 2045 the reduced growth rates result in 92,800 fewer employed people, a 17.0 percent decrease compared to the TRMv6 values in the Detailed Study Area. The largest reductions occur in Region 1, the Regional Core, where the average annual employment growth was reduced from 2.0 percent from 2016 to 2045, to 1.0 percent in the adopted model.

Employment growth rate projections in the Detailed Study Area between 2016 and 2035 are shown by the 43 Superzones in **Figure 3.5**. The fastest rates of growth are projected to occur on the west side of the Triangle Expressway corridor, and in the area east of I-40 and south of downtown Raleigh.

**Table 3.11**  
**Detailed Study Area Employment Forecasts by Region - TRMv6 and Adopted Values**  
 (employment in thousands)

| Region Number<br>and Name | TRMv6 Values |                 |       |                 |       |                 |       |                 |
|---------------------------|--------------|-----------------|-------|-----------------|-------|-----------------|-------|-----------------|
|                           | 2016         | AAPC<br>2016-25 | 2025  | AAPC<br>2025-35 | 2035  | AAPC<br>2035-45 | 2045  | AAPC<br>2016-45 |
| 1 Regional Core           | 115.4        | 2.8 %           | 148.4 | 1.9 %           | 176.2 | 1.6 %           | 203.9 | 2.0 %           |
| 2 North of US 1           | 28.6         | 0.6             | 30.1  | 1.6             | 34.7  | 1.4             | 39.3  | 1.1             |
| 3 South Wake              | 39.9         | 2.7             | 50.7  | 2.3             | 62.4  | 1.9             | 74.1  | 2.2             |
| 4 Johnston                | 15.1         | 3.7             | 21.0  | 2.9             | 27.1  | 2.3             | 33.2  | 2.8             |
| 5 East Wake               | 13.1         | 6.2             | 22.6  | 3.9             | 31.9  | 2.9             | 41.1  | 4.0             |
| 6 Inner Ring              | 97.5         | 1.6             | 112.1 | 2.0             | 133.5 | 1.7             | 154.9 | 1.6             |
| Total                     | 309.6        | 2.4             | 384.9 | 2.1             | 465.8 | 1.8             | 546.6 | 2.0             |

| Region Number<br>and Name | Adopted Values |                 |       |                 |       |                 |       |                 |
|---------------------------|----------------|-----------------|-------|-----------------|-------|-----------------|-------|-----------------|
|                           | 2016           | AAPC<br>2016-25 | 2025  | AAPC<br>2025-35 | 2035  | AAPC<br>2035-45 | 2045  | AAPC<br>2016-45 |
| 1 Regional Core           | 115.4          | 1.1 %           | 127.4 | 1.2 %           | 142.0 | 0.8 %           | 152.8 | 1.0 %           |
| 2 North of US 1           | 28.6           | 1.1             | 31.7  | 0.9             | 34.5  | 0.8             | 37.0  | 0.9             |
| 3 South Wake              | 39.9           | 2.0             | 47.9  | 1.5             | 54.9  | 1.2             | 61.4  | 1.5             |
| 4 Johnston                | 15.1           | 4.4             | 22.3  | 2.9             | 28.8  | 2.4             | 35.6  | 3.0             |
| 5 East Wake               | 13.1           | 4.5             | 19.4  | 2.9             | 25.0  | 2.1             | 30.2  | 2.9             |
| 6 Inner Ring              | 97.5           | 1.6             | 112.0 | 1.2             | 124.9 | 1.0             | 136.8 | 1.2             |
| Total                     | 309.6          | 1.7             | 360.7 | 1.4             | 410.1 | 1.1             | 453.8 | 1.3             |

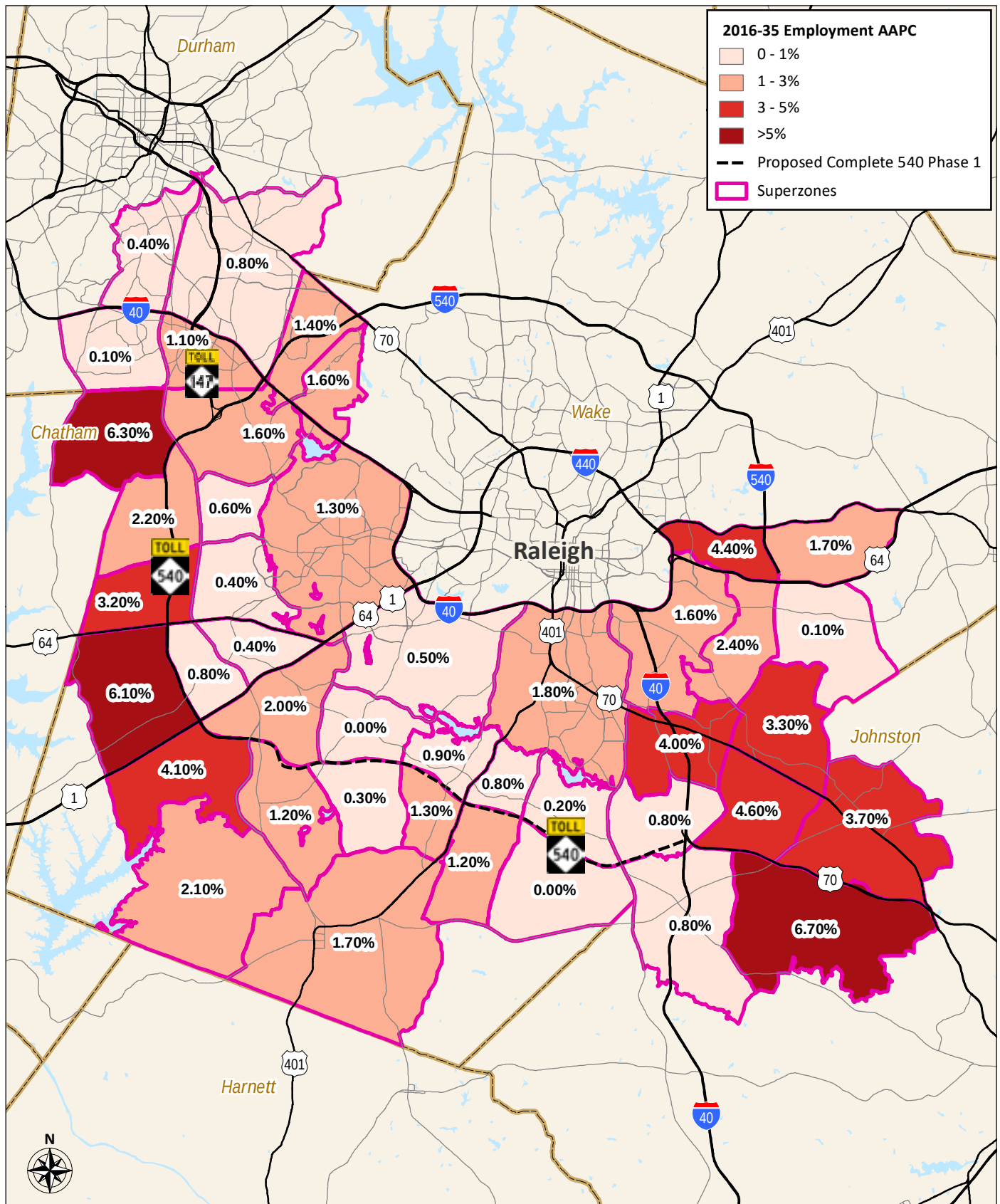
Note: AAPC is an abbreviation for Average Annual Percent Change

**Table 3.12**  
**Detailed Study Area Employment Adjustments by Region**  
 (employment in thousands)

| Region Number<br>and Name | 2025  |         |            | 2035  |         |            | 2045  |         |            |
|---------------------------|-------|---------|------------|-------|---------|------------|-------|---------|------------|
|                           | TRMv6 | Adopted | Adjustment | TRMv6 | Adopted | Adjustment | TRMv6 | Adopted | Adjustment |
| 1 Regional Core           | 148.4 | 127.4   | (21.0)     | 176.2 | 142.0   | (34.2)     | 203.9 | 152.8   | (51.2)     |
| 2 North of US 1           | 30.1  | 31.7    | 1.6        | 34.7  | 34.5    | (0.2)      | 39.3  | 37.0    | (2.3)      |
| 3 South Wake              | 50.7  | 47.9    | (2.8)      | 62.4  | 54.9    | (7.5)      | 74.1  | 61.4    | (12.7)     |
| 4 Johnston                | 21.0  | 22.3    | 1.3        | 27.1  | 28.8    | 1.7        | 33.2  | 35.6    | 2.4        |
| 5 East Wake               | 22.6  | 19.4    | (3.2)      | 31.9  | 25.0    | (6.9)      | 41.1  | 30.2    | (10.9)     |
| 6 Inner Ring              | 112.1 | 112.0   | (0.1)      | 133.5 | 124.9   | (8.6)      | 154.9 | 136.8   | (18.2)     |
| Total                     | 384.9 | 360.7   | (24.2)     | 465.8 | 410.1   | (55.7)     | 546.6 | 453.8   | (92.8)     |

Note: AAPC is an abbreviation for Average Annual Percent Change

# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



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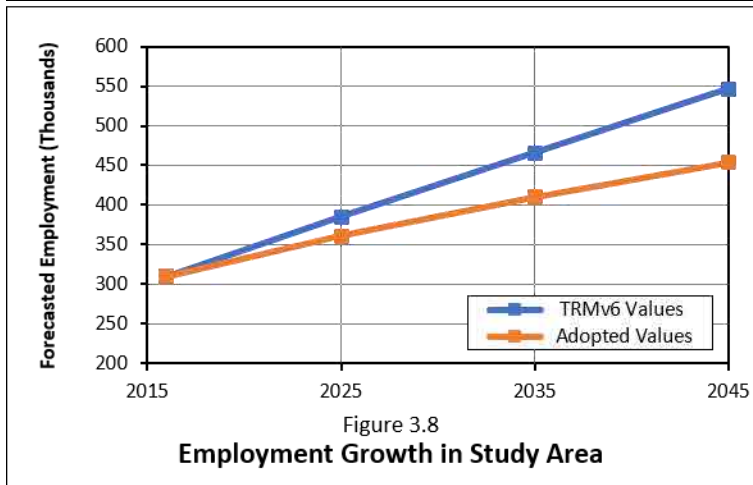
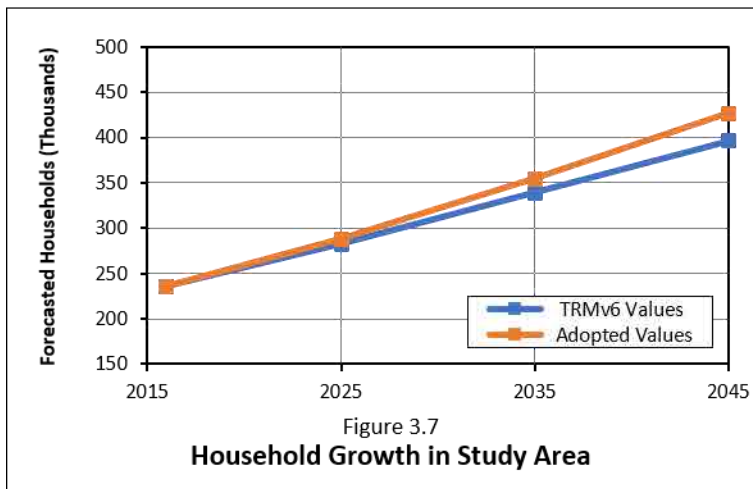
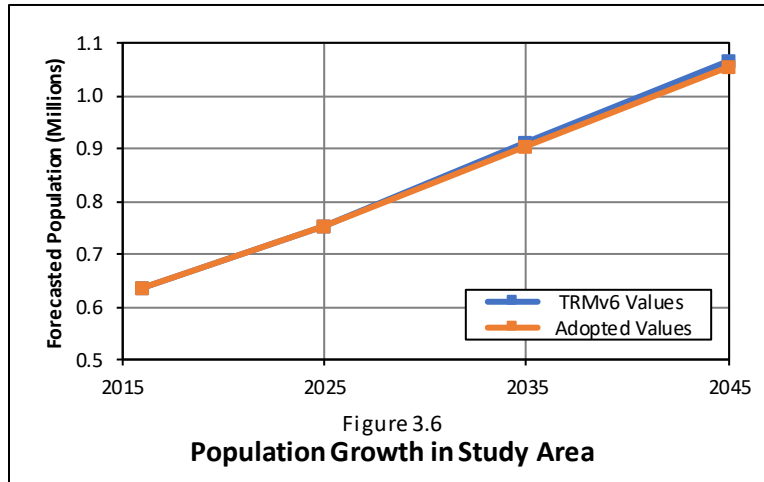
**2016 - 2035 AVERAGE ANNUAL PERCENT GROWTH IN EMPLOYMENT BY SUPERZONE (ADJUSTED FORECAST)**

### 3.3.5 Summary of Socioeconomic Forecasts and Adjustments

**Table 3.13** summarizes the TRMv6 and adopted socioeconomic forecasts by model year in the Detailed Study Area. The largest differences between the TRMv6 and adopted forecasts can be traced to the models' different age distribution of the population. TRMv6 holds age distribution constant at 2010 levels throughout the model period, while the adjusted numbers assume forecasts based on an aging population. This aging population results in an upward adjustment of the number of households from the TRMv6 model, while leaving forecasted population relatively unchanged. The aging population also accounts for the downward adjustments to employment, as the number of people of working age are expected to increase more slowly than the population as a whole. Therefore, the total employment within the study area was adjusted downward by 6.3 percent in 2025, 12.0 percent in 2035, and 17.0 percent in 2045.

| <b>Table 3.13</b><br><b>Detailed Study Area - Summary of Socioeconomic Adjustments</b><br><b>(Values in thousands)</b> |                      |             |             |             |                |                |                |                |
|------------------------------------------------------------------------------------------------------------------------|----------------------|-------------|-------------|-------------|----------------|----------------|----------------|----------------|
| <b>Economic Input</b>                                                                                                  | <b>Forecast Year</b> |             |             |             | <b>AAPC</b>    | <b>AAPC</b>    | <b>AAPC</b>    | <b>AAPC</b>    |
|                                                                                                                        | <b>2016</b>          | <b>2025</b> | <b>2035</b> | <b>2045</b> | <b>2016-25</b> | <b>2025-35</b> | <b>2035-45</b> | <b>2016-45</b> |
| <b><u>Population</u></b>                                                                                               |                      |             |             |             |                |                |                |                |
| TRMv6 Values                                                                                                           | 635.1                | 754.2       | 910.8       | 1067.5      | 1.9%           | 1.9%           | 1.6%           | 1.8%           |
| Adopted Values                                                                                                         | 635.1                | 754.9       | 904.4       | 1055.3      | 1.9%           | 1.8%           | 1.6%           | 1.8%           |
| Difference                                                                                                             | -                    | 0.7         | (6.4)       | (12.3)      |                |                |                |                |
| Percent Difference                                                                                                     | -                    | 0.1%        | -0.7%       | -1.2%       |                |                |                |                |
| <b><u>Households</u></b>                                                                                               |                      |             |             |             |                |                |                |                |
| TRMv6 Values                                                                                                           | 235.7                | 282.7       | 339.3       | 395.8       | 2.0%           | 1.8%           | 1.6%           | 1.8%           |
| Adopted Values                                                                                                         | 235.7                | 288.0       | 354.6       | 426.8       | 2.3%           | 2.1%           | 1.9%           | 2.1%           |
| Difference                                                                                                             | -                    | 5.3         | 15.4        | 31.0        |                |                |                |                |
| Percent Difference                                                                                                     | -                    | 1.9%        | 4.5%        | 7.8%        |                |                |                |                |
| <b><u>Employment</u></b>                                                                                               |                      |             |             |             |                |                |                |                |
| TRMv6 Values                                                                                                           | 309.6                | 384.9       | 465.8       | 546.6       | 2.4%           | 1.9%           | 1.6%           | 2.0%           |
| Adopted Values                                                                                                         | 309.6                | 360.7       | 410.1       | 453.8       | 1.7%           | 1.3%           | 1.0%           | 1.3%           |
| Difference                                                                                                             | -                    | (24.2)      | (55.7)      | (92.8)      |                |                |                |                |
| Percent Difference                                                                                                     | -                    | -6.3%       | -12.0%      | -17.0%      |                |                |                |                |
| Note: AAPC is an abbreviation for Average Annual Percent Change                                                        |                      |             |             |             |                |                |                |                |

A visual comparison of the population, household and employment forecasts is presented in **Figure 3.6**, **Figure 3.7** and **Figure 3.8**, between the TRMv6 and the adopted forecast. As shown the adopted forecasts contain small downward adjustment to population, upward adjustments to households, and downward adjustments to employment.





## Chapter 4

# Stated Preference Survey

Resource Systems Group, Inc. (RSG) conducted stated preference (SP) surveys in January and February of 2018 as part of the data collection effort for this traffic and revenue study. The data collected was used to estimate values of time for travelers that currently use or could potentially use the Triangle Expressway, as well as the proposed Complete 540 1. The estimated values of time were incorporated into the travel demand model to reflect the effects of tolls and road pricing.

This chapter summarizes the stated preference survey report provided by RSG, **Report: Complete 540 Stated Preference Survey (May 2018)**.

### 4.1 Survey Approach

The survey approach used a computer-assisted self-interview technique developed by RSG, and implemented within their proprietary software, rSurvey™. This software allowed the questionnaire to be customized for each respondent by modifying questions and language based on respondents' specific answers, allowing the presentation of realistic future conditions that correspond with the respondents' previous answers.

Respondents were recruited to take this online survey using multiple methods:

- Postcard invitations mailed to residents of ZIP codes in the study area;
- E-mail invitations sent to members of an online research panel residing in ZIP codes in the study area;
- In-person postcard invitation handout at the Raleigh-Durham International Airport (RDU);
- Invitations mailed with billing statements to NC Quick Pass Bill by Mail customers;
- Invitations mailed with Transponder Fulfillment packets to new NC Quick Pass transponder owners;
- Postcard invitations available at the NC Quick Pass customer service center in Morrisville, North Carolina; and
- Outreach to local businesses and organizations in the study area.

A total of 1,673 travelers completed the stated preference survey in total for all methods. After cleaning the dataset for outliers, completed surveys from 1,542 respondents were used for analysis. Data from these travelers were analyzed using accepted statistical methods to estimate travelers' sensitivity to travel time and toll cost, while considering other specific traveler characteristics.

### 4.2 Survey Questionnaire

RSG worked closely with NCTA and CDM Smith to develop a questionnaire to meet the objectives of this traffic and revenue study. The questionnaire collected data regarding current travel behaviors

and use (or not) of the Triangle Expressway for a recent trip, provided participants with information regarding the Complete 540 project, and used stated preference questions to estimate travelers' value of time and potential to use the proposed Complete 540 Phase 1.

#### 4.2.1 Introduction and Qualification Questions

All respondents were initially provided an introductory screen detailing the purpose of the study, the estimated time it will take to complete the survey, and instructions on how to navigate the online survey. Following the introduction, participants were shown trip qualification criteria to determine whether they were eligible to participate in the survey. Qualifying trips met the following conditions:

- Made within the past two months
- Traveled into, around, or through the highlighted area on a map of the Complete 540 Phase 1 corridor, including the existing Triangle Expressway
- Took at least 10 minutes in total door-to-door travel time
- Made on a weekday

To determine if participants' most recent trip was eligible for the survey, they were provided a map highlighting the study area and were asked to confirm if their trip occurred in this region. Respondents who indicated that they did not meet any of the criteria listed above were directed to the survey exit screen and thanked for their participation.

#### 4.2.2 Trip Characteristics and Travel Pattern Questions

Respondents were then asked to focus on this recent trip as they continued through the survey. This trip, also known as their reference trip, formed the basis for constructing the rest of the questions in the survey. Respondents were specifically asked to think about their most recent trip and not a typical or average trip that they might make to ensure that the sample included a diverse range of trip types and travel characteristics.

Respondents were asked a series of questions regarding the following characteristics of a one-way portion of their reference trip:

- Vehicle type and number of axles
- Roads used
- Day of week of travel
- Trip purpose
- Airport trip details (if applicable)
- Beginning and ending locations (home, work, or other)
- Trip origin and destination
- Start time of travel
- Triangle Expressway entrance and exit interchanges

- Travel time (trip duration)
- Delays encountered (and delay duration, if any)
- Perceived travel time if an alternative route was used
- Toll costs on the Triangle Expressway
- Vehicle occupancy
- Trip frequency
- Electronic Toll Collection (ETC) transponder ownership

The trip information was used to inform the details of the SP scenarios presented later in the survey.

#### 4.2.3 Stated Preference Questions

Participants were next provided a short description of the proposed Complete 540 project and brief instructions for the stated preference questions. The stated preference section involved eight exercises that provided respondents with two choices for making their reference trip again in the future under hypothetical conditions:

- Tolled Route Alternative using the Triangle Expressway, Complete 540, or both
- Toll-Free Route Alternative

In each of the eight SP exercises, travel times and toll costs were varied, and the respondent was asked to pick their preferred option. These exercises allowed RSG to collect quantitative data that can be used to estimate respondents' travel preferences and behavioral responses. An example of this stated preference screen is shown in **Figure 4.1**.

Based on your trip details, you could use part or all of the proposed Complete 540 for your trip.

Below are 2 different travel options for making your airport trip between your home and the place where your trip ended.

Imagine if the options below were the only options available for making your trip, even if they are not currently available. Which option would you most prefer?

*Highway information may have changed.*

| Use an alternate toll-free route           | Use the Triangle Expressway and partial of the Complete 540 |
|--------------------------------------------|-------------------------------------------------------------|
| Travel Time: 57 minutes                    | Travel Time: 38 minutes                                     |
| Toll Cost: No Toll                         | Toll Cost: \$1.50                                           |
| <input type="radio"/> I prefer this option | <input type="radio"/> I prefer this option                  |

(2 of 8)

« Previous Next »

© 2018 RSG | Resource Systems Group, Inc. | 1-800-441-4411 | [complete540@rsg.com](mailto:complete540@rsg.com)

Source: Resource Systems Group, Inc.

Figure 4.1

Sample Survey Screen – Stated Preference Question

The travel times presented in each exercise were varied around the user's reported travel time from their reference trip. The toll costs varied based on the user reported trip distance and vehicle axles. By varying the travel time and toll cost independently from each other in each experiment, the survey allowed respondents to demonstrate their travel preferences across a range of values of time.

#### 4.2.4 Debrief and Opinion Questions

After finishing the SP questions, respondents were asked to answer questions that will help assess the underlying rationale for their choices and to allow RSG to identify any potential strategic bias in their responses. These questions included asking respondents who never chose the tolled alternative for their primary reason, as well as asking respondents how they felt about the proposed Complete 540 project and why they felt that way. Respondents were also asked for their general attitudes on tolls and taxes for highway improvements. Additionally, questions related to the following demographic topics were asked: home ZIP code, gender, age, employment status, household size, household vehicle ownership, and 2017 household income before taxes.

Responses to these questions were used to confirm diversity of the sample respondents, as well as to classify and organize the data to identify any behavioral trends by population. Lastly, respondents were given opportunity to provide comments and feedback regarding the survey and the proposed project. The answers are provided in the full RSG report.

### 4.3 Survey Administration

RSG worked with CDM Smith and NCTA to develop a sampling plan that would produce a comprehensive sample of travelers in the Triangle region. The goal of this plan was to provide representation from different trip purposes, household incomes, and geographies, to accurately reflect behavioral differences. The project team recruited travelers to participate in the SP survey using the distribution methods highlighted in Section 4.1. The survey was administered online through RSG's proprietary software, rSurvey™, from January 17, 2018 through February 19, 2018, and yielded 1,673 completed surveys and 1,542 valid/usable surveys. **Table 4.1** below shows the breakdown of respondents by method of recruitment.

| <b>Administration Method</b>                    | <b>Completed Surveys</b> | <b>Invalid Surveys</b> | <b>Final Count</b> | <b>Percent</b> |
|-------------------------------------------------|--------------------------|------------------------|--------------------|----------------|
| Postcard invitations to area residents          | 965                      | 40                     | 925                | 60%            |
| Email invitations to online research panel      | 377                      | 55                     | 322                | 21%            |
| Postcard handout at RDU Airport                 | 236                      | 30                     | 206                | 13%            |
| Invitations to Bill by Mail customers           | 45                       | 5                      | 40                 | 3%             |
| Invitations in Transponder Fulfillment packets  | 17                       | 1                      | 16                 | 1%             |
| Postcard invitations at customer service center | 5                        | 0                      | 5                  | 0%             |
| Outreach to local businesses and organizations  | 28                       | 0                      | 28                 | 2%             |
| Total                                           | 1,673                    | 131                    | 1,542              | 100%           |

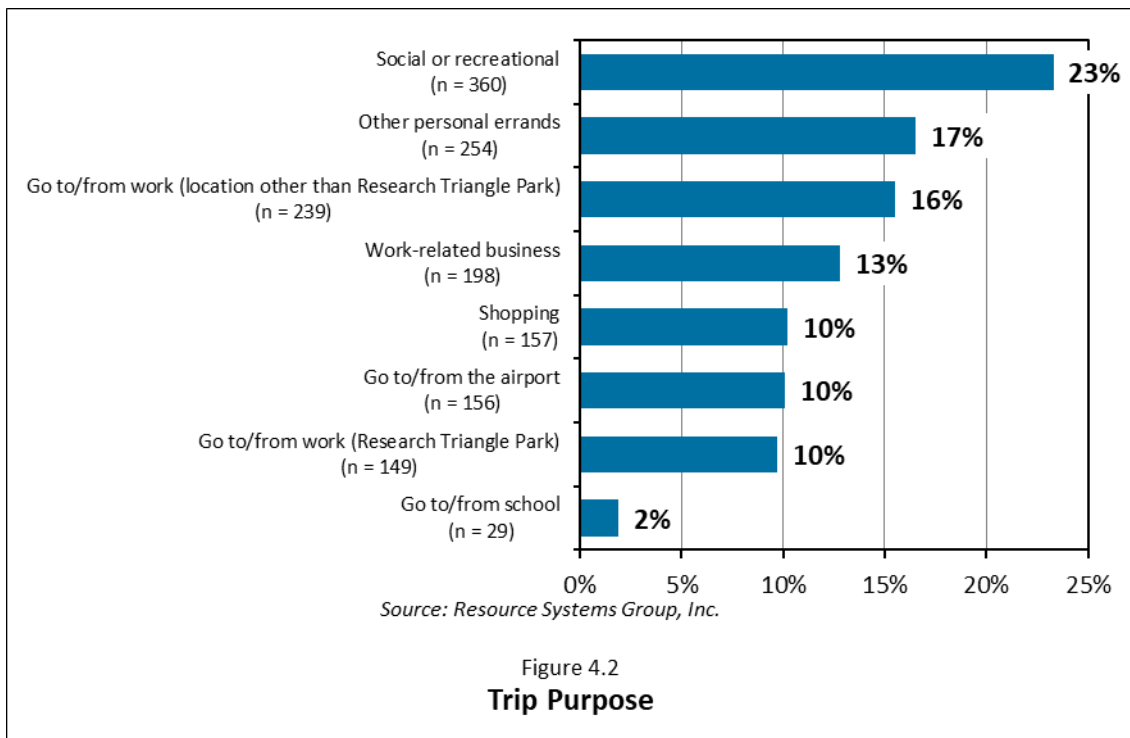
Postcard invitations to area residents generated the most responses, with 60 percent of the total 1,542 usable surveys, while postcard invitations at customer service centers generated the lowest responses with five usable surveys.

## 4.4 Trip Characteristic Analysis

**Table 4.2** shows the number of respondents who reported reference trips that used the Triangle Expressway and/or the proposed Complete 540 Phase 1, could have used the Triangle Expressway, or didn't use the Triangle Expressway but could use the Complete 540 project. More than half of all respondents (53 percent) completed their reference trip in the potential Complete 540 corridor only, while 40 percent used the Triangle Expressway at some point during their trip. Of the remaining 7 percent that could have used the Triangle Expressway but chose not to, a majority stated they did not want to pay a toll and a third reported that the toll on the Triangle Expressway was not worth the time savings for their trip.

| <b>User Type</b>                   | <b>Count</b> | <b>Percent</b> |
|------------------------------------|--------------|----------------|
| Triangle Expressway User           | 614          | 40%            |
| Potential Triangle Expressway User | 110          | 7%             |
| Potential Complete 540 User        | 818          | 53%            |
| <b>Total</b>                       | <b>1,542</b> | <b>100%</b>    |

Around a quarter of respondents reported their trip purpose was commuting for work (26 percent), with 10 percent traveling to Research Triangle Park (RTP) and 16 percent traveling to work outside RTP. The second most frequent trip purpose category was social or recreational trips, accounting for 23 percent of all trips surveyed. **Figure 4.2** provides a distribution for all trip purposes in detail. For the purposes of the value of time analysis, responses were divided into market segments representing work commute trips, work-related/business trips, airport trips, and other trips.



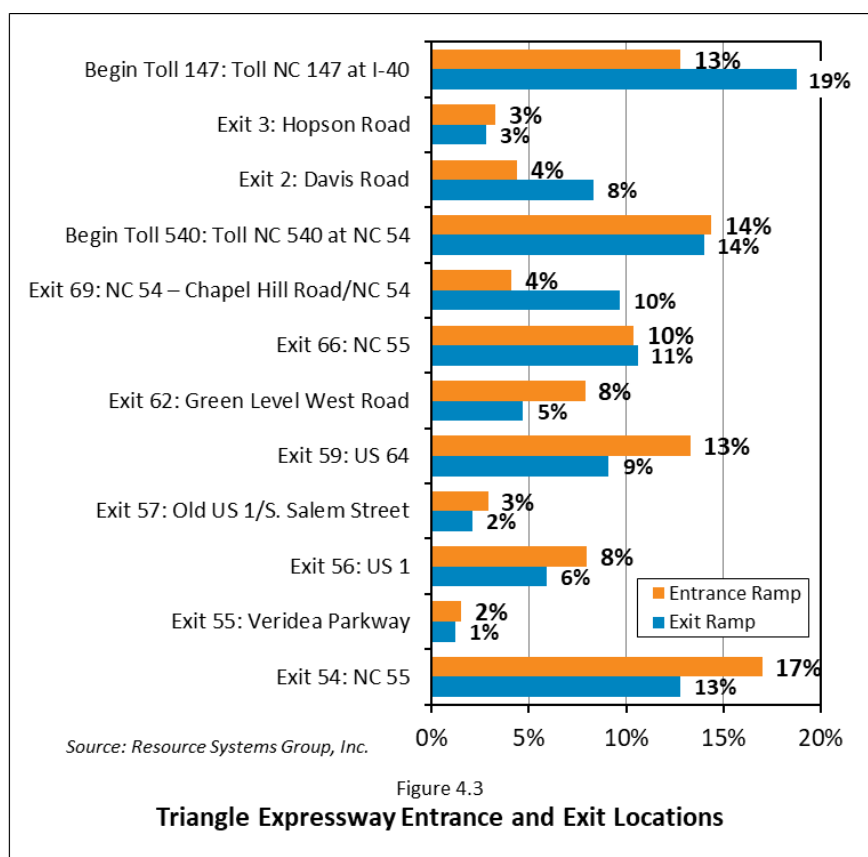


Using the latitude and longitude provided by respondents, estimated trip distances were calculated using a Google Maps route-planning algorithm. From this summary, the average calculated trip distance for all respondents was 25 miles, and the average reported travel time for all respondents was 42 minutes. **Table 4.3** shows the mean and median values for both distance and travel time for all respondents by market segment.

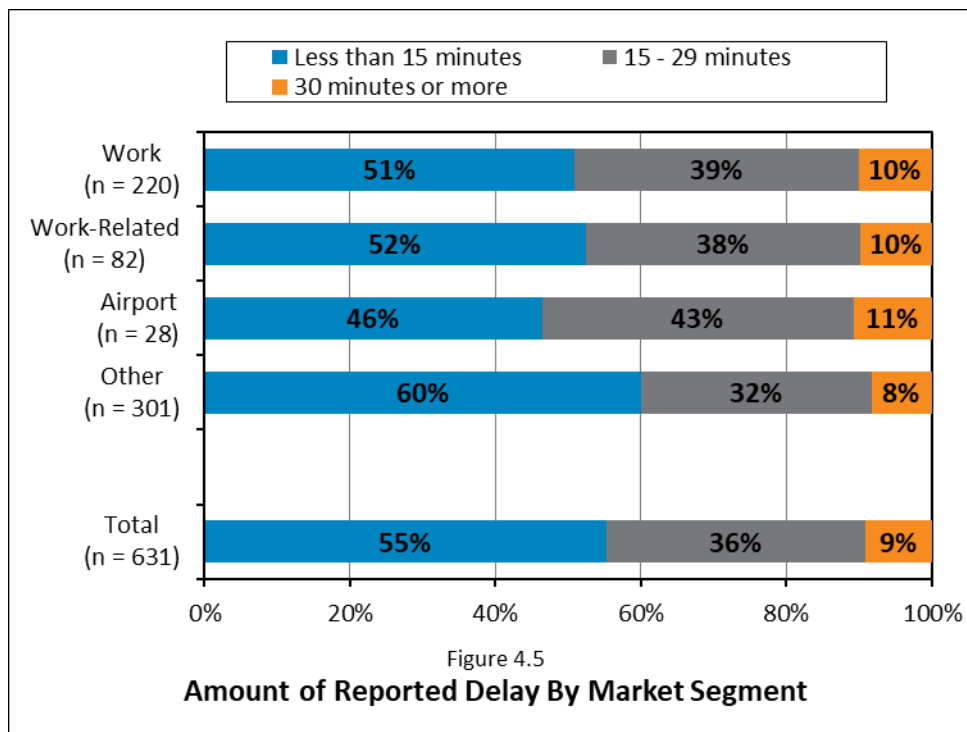
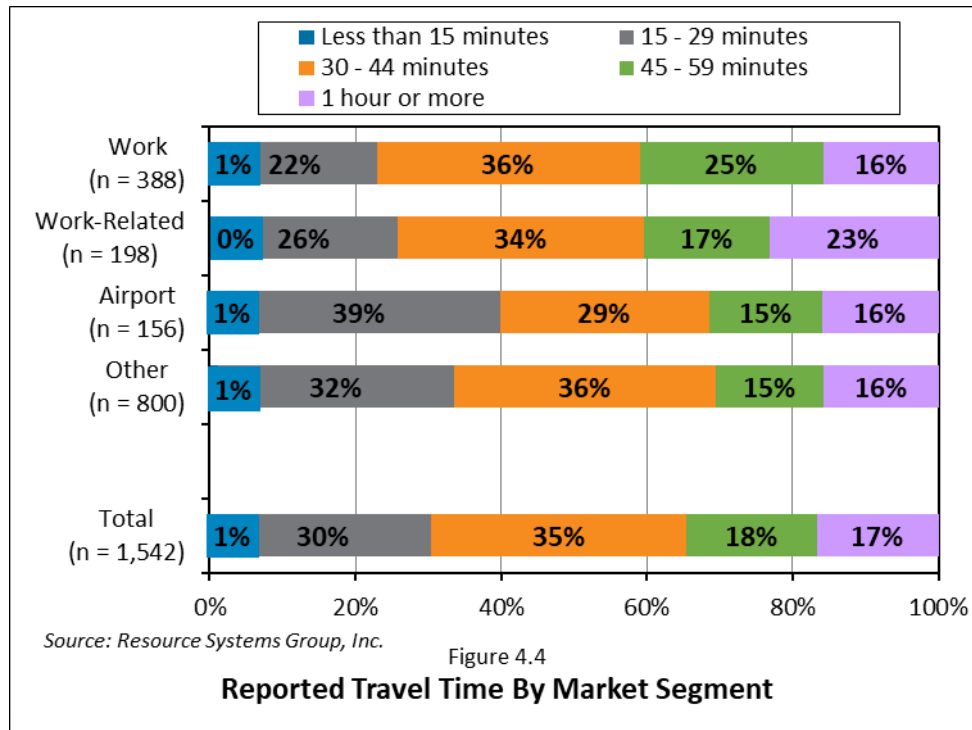
**Table 4.3**  
**Mean and Median Trip Distance and Reported Travel Time, By Market Segment**

| Market Segment | Distance<br>(miles) |        | Reported Travel Time<br>(minutes) |        |
|----------------|---------------------|--------|-----------------------------------|--------|
|                | Mean                | Median | Mean                              | Median |
| Work           | 24                  | 20     | 42                                | 40     |
| Work-Related   | 26                  | 21     | 46                                | 40     |
| Airport        | 26                  | 20     | 39                                | 30     |
| Other          | 25                  | 17     | 42                                | 35     |
| All            | 25                  | 19     | 42                                | 35     |

Respondents were asked to provide their entry and exit ramps on the Triangle Expressway, or the ramps they would have used, had they used the Triangle Expressway. **Figure 4.3** shows the distribution of trips to each interchange by entry and exit. The project termini, at NC 55 and at Toll NC 147/ I-40 were the most commonly used, accounting for 30 percent and 32 percent, respectively, of all entries or exits.

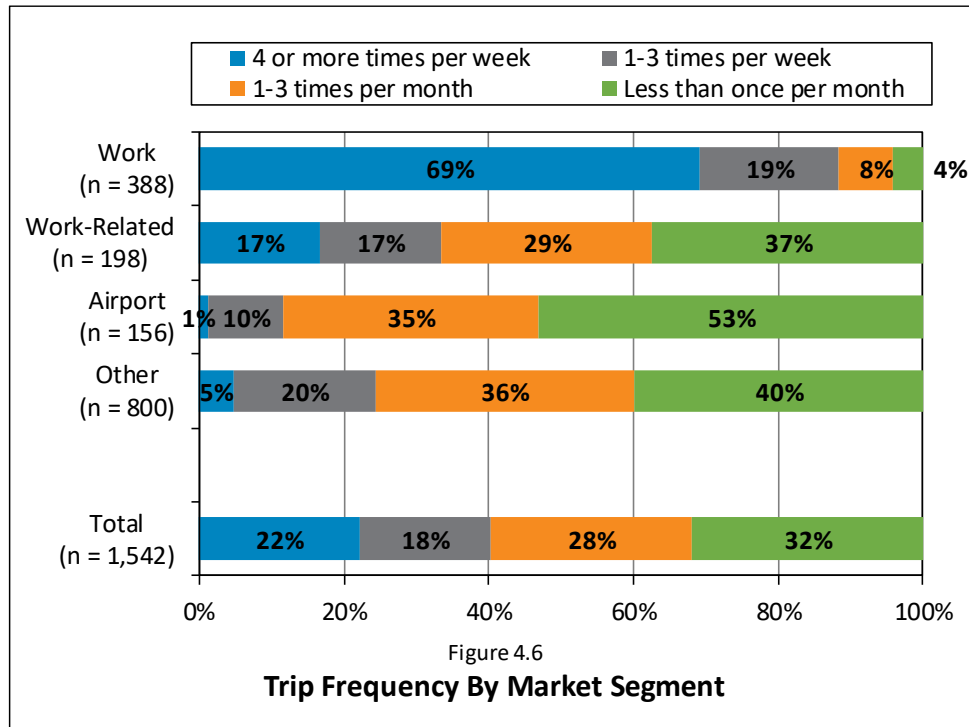


**Figure 4.4** and **Figure 4.5** provide the distribution of reported travel time and amount of perceived delay by market segment, respectively.



Work and work-related trips experienced the longest travel times with about 40 percent of each of these trips taking travelers 45 minutes or longer. These same market segments also reported the highest delay on their trip, with 57 percent of all work trips reporting delays.

**Figure 4.6** shows the trip frequency by market segment. Trip frequency had significant variation among the four market segments. As expected, work trips are made with the highest frequency, with 69 percent of all work respondents traveling the reference trip four or more times a week. Airport trips had the lowest frequency, with 53 percent traveling the reference trip less than once per month. Interestingly, work-related/business trips similar to the reference trip were made four or more times per week by 17 percent of the respondents in this category.



## 4.5 Debrief and Opinion Analysis

In the last section of the survey, respondents were asked to answer a series of debrief questions to provide insight on the underlying reasons for their choices in the SP question. Out of all the respondents, 491 (32 percent) never chose a tolled route for their trip. They were asked to identify their primary reason for never choosing a tolled route. **Table 4.4** provides a summary of their responses; about 44 percent said the time savings presented in the experiments were not worth the toll cost, while 31 percent were opposed to paying tolls.

| Reason                                                | Count | Percent |
|-------------------------------------------------------|-------|---------|
| Time savings not worth the toll cost                  | 219   | 44%     |
| Opposed to paying tolls                               | 153   | 31%     |
| Other                                                 | 46    | 9%      |
| Tolls presented were too high                         | 29    | 6%      |
| Current route is more convenient                      | 23    | 5%      |
| Opposed to toll roads for other reasons               | 14    | 3%      |
| Opposed to new roads (if potential Complete 540 user) | 4     | 1%      |
| Opposed to electronic payment                         | 3     | 1%      |
| Total                                                 | 491   | 100%    |

In response to the attitudinal question about whether they support or oppose the Complete 540 project, 61 percent said they somewhat favor or strongly favor the project (see **Table 4.5**). These respondents cited less congestion (44 percent) and shorter travel times (34 percent) as primary reasons for their support. The most common reason for those opposed to Complete 540 was general opposition to toll roads (53 percent).

## 4.6 Demographic Analysis

Of the 1,542 survey respondents, more than half of the respondents identified as male (56 percent), and the median age range was 45-54 years old. Most respondents were employed full-time (66 percent), less than half (43 percent) lived in a two-person household, and 52 percent had two household vehicles.

**Table 4.5**  
**Project Opinion**

| <b>Project Opinion</b> | <b>Count</b> | <b>Percent</b> |
|------------------------|--------------|----------------|
| Strongly favor         | 547          | 36%            |
| Somewhat favor         | 388          | 25%            |
| Neutral                | 400          | 26%            |
| Somewhat opposed       | 107          | 7%             |
| Strongly opposed       | 100          | 7%             |
| Total                  | 1,542        | 100%           |

**Table 4.6** provides the distribution of 2017 household income of respondents who chose to answer this question. The median income category of respondents for this survey was in the \$100,000 - \$124,999 range.

**Table 4.6**  
**Reported 2017 Annual Household Income**

| <b>Income Category</b> | <b>Count</b> | <b>Percent</b> |
|------------------------|--------------|----------------|
| Less than \$15,000     | 12           | 1%             |
| \$15,000-\$24,999      | 27           | 2%             |
| \$25,000-\$34,999      | 37           | 2%             |
| \$35,000-\$49,999      | 93           | 6%             |
| \$50,000-\$74,999      | 202          | 13%            |
| \$75,000-\$99,999      | 230          | 15%            |
| \$100,000-\$124,999    | 214          | 14%            |
| \$125,000-\$149,000    | 145          | 9%             |
| \$150,000-\$199,999    | 182          | 12%            |
| \$200,000 or more      | 155          | 10%            |
| Not provided           | 245          | 16%            |
| Total                  | 1,542        | 100%           |

## 4.7 Model Estimation for Value of Time

The primary purpose of this survey was to estimate value of time for travelers in the Triangle Expressway and Complete 540 corridors. RSG performed statistical analysis and discrete choice model estimation using the SP survey data. The statistical estimation and specification testing were completed using a conventional maximum likelihood procedure that estimated coefficients for a set of multinomial logit (MNL) models. The coefficients are a numerical representation of respondents' sensitivities to variables from the SP experiments (travel time and toll cost) and can be used to calculate value of time for travelers in the study corridor.

### 4.7.1 Specification and Segmentation

Respondents were presented with the following two options in the SP scenarios, based on the details of their reference trips:

- **Use a tolled route** (parts of Triangle Expressway or Complete 540 Phase 1 or both)
- **Use a toll-free route** (respondent's current route, or an alternate toll-free route if they used a toll route in their reference trip)

The MNL model estimates a choice probability for each alternative presented in the SP trade-off exercises. Several model forms were tested using different variables collected from the data. In addition to the travel times and toll costs presented in the SP experiments; trip characteristics, transponder ownership, attitudinal indicators, income, and demographic variables, among others, were tested to determine whether they influence respondents' choices in the SP scenarios. More details on the variables tested within the MNL model are provided in Sections 5.2 and 5.3 of the full RSG report

The final model specification was selected based on model fit, intuitiveness and reasonableness of the model coefficients, and the expected application of the model results. The data was divided into four market segments, to be carried forth into the traffic and revenue analysis: work commute, work-related, airport, or other. The interaction between toll cost and household income was significant. The relationship indicates that as household income increases, sensitivity to toll prices decreases, but at a rate that is not directly proportional.

### 4.7.2 Willingness to Pay for Travel Time Savings (Value of Time)

In economic theory, the marginal rate of substitution is the amount of one good (i.e., money) that a person would exchange for a second good (i.e., travel time) while maintaining the same level of utility, or satisfaction. The marginal rate of substitution of the travel time and toll cost coefficients from the MNL model provides the implied toll value that travelers would be willing to pay for a given amount of travel time savings.

The resulting value of time by market segment and income level are presented in **Table 4.7**. As expected, work-related/business trips had the highest value of time, followed by trips to/from the airport. Work commute trips have a higher value of time than trips for other purposes. At the survey sample median income of \$112,500, work-related trips have a value of time of \$24.70 per hour, while commute trips are valued at \$18.59 per hour, and trips for other purposes are valued at \$17.55.



**Table 4.7**  
**Value of Time, By Market Segment and Income**

| <b>Household<br/>Income</b> | <b>Work Commute<br/>Trips</b> | <b>Work-Related<br/>Trips</b> | <b>Airport<br/>Trips</b> | <b>Other<br/>Trips</b> |
|-----------------------------|-------------------------------|-------------------------------|--------------------------|------------------------|
| \$15,000                    | \$10.66                       | \$14.16                       | \$11.79                  | \$10.07                |
| \$20,000                    | \$11.79                       | \$15.67                       | \$13.04                  | \$11.13                |
| \$30,000                    | \$13.39                       | \$17.79                       | \$14.81                  | \$12.64                |
| \$42,500                    | \$14.76                       | \$19.61                       | \$16.32                  | \$13.94                |
| \$62,500                    | \$16.27                       | \$21.62                       | \$18.00                  | \$15.37                |
| \$87,500                    | \$17.60                       | \$23.38                       | \$19.47                  | \$16.62                |
| \$112,500                   | \$18.59                       | \$24.70                       | \$20.56                  | \$17.55                |
| \$137,500                   | \$19.38                       | \$25.75                       | \$21.43                  | \$18.30                |
| \$175,000                   | \$20.33                       | \$27.01                       | \$22.48                  | \$19.20                |
| \$200,000                   | \$20.85                       | \$27.71                       | \$23.07                  | \$19.69                |

## 4.8 Summary and Conclusions

An SP Survey was conducted to estimate value of time for drivers who currently travel in the Triangle region and could potentially use the Triangle Expressway or Phase 1 of the proposed Complete 540. The travel preferences from 1,542 drivers were used to develop models to produce estimates of value of time for four trip purpose market segments. The magnitude of the parameters of these models was reasonable, and their signs were intuitively correct. The value of time that was estimated is within the ranges found in other major metropolitan areas across the country, and similar to results from surveys conducted previously in Raleigh prior to the opening of Triangle Expressway and reported in the *Triangle Expressway Comprehensive Traffic and Revenue Study (2009)*.

RSG developed multinomial logit choice models using the survey data to generate value of time estimates by trip purpose. At the median income level of the sample (\$112,500), the value of time estimates were in the range of \$17.55 to \$24.70 per hour, depending on trip purpose.

## Chapter 5

# Model Calibration

CDM Smith received the latest version of the Triangle Regional Model (TRM v6) from the Institute of Transportation Research and Education (ITRE) at North Carolina State University for use in the traffic forecasting efforts of this study. The inputs to the model were adopted in April 2018, and the final components of the model were received in June 2018.

TRMv6 is a trip-based, four-step travel demand model that uses socioeconomic data and transportation network (roadway and transit) characteristics as primary inputs. The model was originally developed using population, housing, and employment data for 2010, but has been revalidated to a base year of 2013; future years that are supported by ITRE for the model are 2025, 2035, and 2045. CDM Smith and Dr. Steven Appold used this information as a starting point to develop the 2016 base year model and interim year 2020 used for this study. **Figure 5.1** outlines the steps used in refining the TRMv6 for the traffic and revenue study; the boxes shaded in gray describe the four-step modeling process used in TRMv6, while the blue boxes describe the specific steps used by CDM Smith to refine and run the model for the traffic and revenue study.

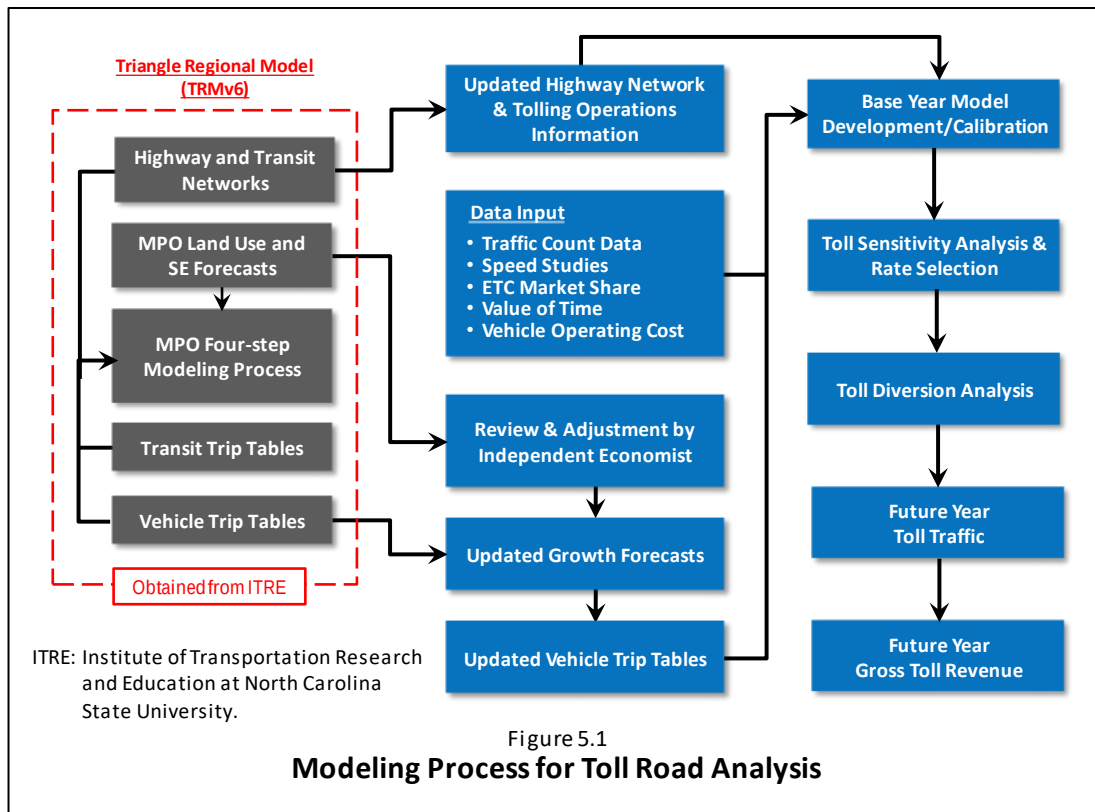
## 5.1 Refinements to Model Inputs

The independent economic forecast, including socioeconomic estimates for 2016, were input to the TRMv6 and revised future trip tables were developed for 2016, 2020, 2025, 2035 and 2045. The TRMv6 traffic assignment process was calibrated first against 2016 traffic volumes and then for observed travel speeds using data collected in 2016 and 2017. Calibration involves modifying the model parameters related to roadway capacity and speeds to reflect observed conditions.

Refinements to the highway network included the review and disaggregation of traffic analysis zones within the project study area, resulting in 30 additional traffic analysis zones; changes to zonal connectors to improve how traffic is loaded onto the roadway network from traffic analysis zones; and changes to the highway network to simulate 2016 roadway conditions, most notably reducing the number of lanes on I-40 between Lake Wheeler Road and Rock Quarry Road to three lanes in each direction to reflect the construction activity as part of the Fortify I-40/I-440 project as well as the addition of other minor roads within the project study area.

## 5.2 Calibration

The TRMv6 model was used with Dr. Steven Appold's estimates of socioeconomic data for 2016 to develop regional travel patterns at 2016 levels. Additional calibration efforts involving traffic assignments were then conducted. The calibration process involved adjustments to the model to confirm that it sufficiently represents observed traffic volumes, speeds, and origin-destination travel patterns, prior to being used to predict future traffic conditions.



In order to demonstrate that the 2016 base-year model sufficiently represents existing conditions, the following comparisons were made between model results and observed field data:

- Model traffic volume output compared to traffic counts at locations along nine screenlines;
- Model traffic volume output compared to existing traffic volumes on Triangle Expressway;
- Model travel speed output compared to observed 2016 HERE<sup>1</sup> travel speeds; and
- Model travel patterns compared to Streetlight data.

Details of the calibration results are provided below.

### 5.3 Traffic Volume Screenline Calibration Results

The goal of traffic volume calibration was to obtain model-estimated traffic volumes in the study area that match reasonably the actual ground counts on those roadways by direction and for weekday and peak vs. off-peak periods (AM, PM, Midday, and Overnight). In addition to adjustments to roadway network free-flow speeds and capacities, CDM Smith utilized a matrix adjustment procedure that adjusts the trip table in such a way to obtain model-estimated volumes closer to observed traffic counts. This process allowed the directional peaking patterns of individual links and screenlines to be adjusted to better match observations.

The traffic counts collected for this project are grouped into nine screenlines, depicted in Figure 2.9. Although the level of difference between counts and assigned volume may vary between individual

<sup>1</sup> HERE is geospatial travel time data obtained under NCDOT license.

links, if the total assigned volume crossing the screenline is close to actual counts, the general level of traffic and travel patterns is considered to be well represented by the model.

**Table 5.1** shows the volume calibration results at the weekday level for each screenline. **Table 5.2** shows the percent difference between model volumes and observed counts by time period for each of the screenlines. In total, the model volumes are within two percent of the counts at the weekday level, with all but one screenline varying by less than five percent. On a time period basis, most screenlines were calibrated to within five percent of counts. There was a 21 percent differential at screenline 1 during the midday period, but this on a fairly small base traffic volume. Traffic volume comparisons for individual links by time period and direction are included in **Appendix A**.

| Screenline | Number<br>of<br>Links | Observed<br>Count | Modeled Volume        |                       |                      |                       |
|------------|-----------------------|-------------------|-----------------------|-----------------------|----------------------|-----------------------|
|            |                       |                   | Before<br>Calibration | Percent<br>Difference | After<br>Calibration | Percent<br>Difference |
| 1          | 8                     | 30,947            | 28,712                | -7%                   | 33,032               | 7%                    |
| 2          | 10                    | 184,041           | 171,343               | -7%                   | 187,496              | 2%                    |
| 3          | 12                    | 50,369            | 40,649                | -19%                  | 48,511               | -4%                   |
| 4          | 6                     | 60,967            | 52,901                | -13%                  | 59,196               | -3%                   |
| 5          | 8                     | 48,087            | 49,686                | 3%                    | 49,992               | 4%                    |
| 6          | 12                    | 104,053           | 89,884                | -14%                  | 99,260               | -5%                   |
| 7          | 16                    | 116,979           | 97,592                | -17%                  | 117,864              | 1%                    |
| 8          | 12                    | 118,711           | 111,707               | -6%                   | 118,956              | 0%                    |
| 9          | 74                    | 929,872           | 812,982               | -13%                  | 901,140              | -3%                   |
| Total      | 158                   | 1,644,026         | 1,455,455             | -11%                  | 1,615,446            | -2%                   |

Source: Counts conducted by CDM Smith in 2016 and 2017 and travel demand model output.

| Screenline | Number<br>of<br>Links | AM                |                   |                       | PM                |                   |                       | MD                |                   |                       | NT                |                   |                       |
|------------|-----------------------|-------------------|-------------------|-----------------------|-------------------|-------------------|-----------------------|-------------------|-------------------|-----------------------|-------------------|-------------------|-----------------------|
|            |                       | Observed<br>Count | Modeled<br>Volume | Percent<br>Difference | Observed<br>Count | Modeled<br>Volume | Percent<br>Difference | Observed<br>Count | Modeled<br>Volume | Percent<br>Difference | Observed<br>Count | Modeled<br>Volume | Percent<br>Difference |
| 1          | 8                     | 8,310             | 8,696             | 5%                    | 10,056            | 10,115            | 1%                    | 7,648             | 9,254             | 21%                   | 4,933             | 4,967             | 1%                    |
| 2          | 10                    | 42,761            | 44,769            | 5%                    | 53,379            | 52,925            | -1%                   | 55,148            | 57,392            | 4%                    | 32,753            | 32,409            | -1%                   |
| 3          | 12                    | 12,723            | 12,176            | -4%                   | 16,340            | 15,008            | -8%                   | 14,728            | 14,616            | -1%                   | 6,578             | 6,712             | 2%                    |
| 4          | 6                     | 16,403            | 16,547            | 1%                    | 18,612            | 17,882            | -4%                   | 17,977            | 16,905            | -6%                   | 7,975             | 7,862             | -1%                   |
| 5          | 8                     | 12,824            | 13,623            | 6%                    | 15,607            | 15,551            | 0%                    | 14,056            | 14,732            | 5%                    | 5,600             | 6,086             | 9%                    |
| 6          | 12                    | 28,627            | 26,775            | -6%                   | 32,301            | 29,977            | -7%                   | 29,097            | 28,468            | -2%                   | 14,028            | 14,039            | 0%                    |
| 7          | 16                    | 32,817            | 32,755            | 0%                    | 40,330            | 37,153            | -8%                   | 30,342            | 33,461            | 10%                   | 13,490            | 14,495            | 7%                    |
| 8          | 12                    | 35,538            | 34,940            | -2%                   | 38,374            | 37,993            | -1%                   | 32,175            | 32,150            | 0%                    | 12,624            | 13,874            | 10%                   |
| 9          | 74                    | 248,364           | 235,448           | -5%                   | 278,612           | 260,104           | -7%                   | 276,643           | 273,945           | -1%                   | 126,253           | 131,643           | 4%                    |
| Total      | 158                   | 438,367           | 425,730           | -3%                   | 503,611           | 476,708           | -5%                   | 477,814           | 480,923           | 1%                    | 224,234           | 232,086           | 4%                    |

Source: Counts conducted by CDM Smith in 2016 and 2017 and TRMv6 output.

## 5.4 Triangle Expressway Traffic Volume Calibration Results

**Table 5.3** shows the traffic volumes (assigned vs. observed) on the existing Triangle Expressway toll facility by direction for an average weekday. As part of the calibration process, select link adjustments were made to the trip tables to better replicate traffic volumes on ramps and mainlines. Any remaining differences between modeled volumes and observed counts were used to develop adjustments that were applied to future year model output.

Table 5.3  
Volume Calibration Results by Time Period on Triangle Expressway

| Link Description                                              | Links              | Weekday        |                |                    |
|---------------------------------------------------------------|--------------------|----------------|----------------|--------------------|
|                                                               |                    | Observed Count | Modeled Volume | Percent Difference |
| NB On From NC 55 NB                                           | NB Ramp            | 8,088          | 8,653          | 7%                 |
| NB On From NC 55 SB                                           | NB Ramp            | 938            | 1,696          | 81%                |
| <b>NB Mainline Between NC 55 SB On and US 1 NB Off</b>        | <b>NB Mainline</b> | <b>9,026</b>   | <b>10,350</b>  | <b>15%</b>         |
| NB Off to US 1 NB                                             | NB Ramp            | 444            | 816            | 84%                |
| NB Off to US 1 SB                                             | NB Ramp            | 371            | 334            | -10%               |
| NB On From US 1 SB                                            | NB Ramp            | 2,217          | 2,016          | -9%                |
| NB On From US 1 NB                                            | NB Ramp            | 3,017          | 2,352          | -22%               |
| <b>NB Mainline Between US 1 On NB and S Salem St Off</b>      | <b>NB Mainline</b> | <b>13,445</b>  | <b>13,568</b>  | <b>1%</b>          |
| NB Off to S Salem St                                          | NB Ramp            | 1,454          | 1,450          | 0%                 |
| NB On From S Salem St                                         | NB Ramp            | 1,221          | 1,869          | 53%                |
| <b>NB Mainline Between Salem St NB On and US 64 NB Off</b>    | <b>NB Mainline</b> | <b>13,212</b>  | <b>13,987</b>  | <b>6%</b>          |
| NB Off to US 64 EB                                            | NB Ramp            | 857            | 1,377          | 61%                |
| NB On From US 64 EB                                           | NB Ramp            | 2,606          | 3,146          | 21%                |
| NB Off to US 64 WB                                            | NB Ramp            | 1,092          | 1,592          | 46%                |
| NB On From US 64 WB                                           | NB Ramp            | 2,554          | 3,039          | 19%                |
| <b>NB Mainline Between US 64 SB On and Green Level W Off</b>  | <b>NB Mainline</b> | <b>16,423</b>  | <b>17,204</b>  | <b>5%</b>          |
| NB Off to Green Level West                                    | NB Ramp            | 1,404          | 1,752          | 25%                |
| NB On From Green Level West                                   | NB Ramp            | 1,267          | 2,256          | 78%                |
| <b>NB Mainline Between Green Level W On and NC 55 Off NB</b>  | <b>NB Mainline</b> | <b>16,286</b>  | <b>17,707</b>  | <b>9%</b>          |
| NB Off to NC 55                                               | NB Ramp            | 284            | 111            | -61%               |
| NB Off to NC 55 - Loop                                        | NB Ramp            | 2,039          | 1,769          | -13%               |
| NB On From NC 55                                              | NB Ramp            | 8,874          | 7,295          | -18%               |
| <b>NB Mainline Between NC 55 On and Toll NC 147 Off</b>       | <b>NB Mainline</b> | <b>22,837</b>  | <b>23,121</b>  | <b>1%</b>          |
| NB Off to Toll NC 147                                         | NB Ramp            | 6,995          | 9,201          | 32%                |
| <b>NB Mainline Between Toll NC 147 Off and Toll NC 147 On</b> | <b>NB Mainline</b> | <b>15,842</b>  | <b>13,921</b>  | <b>-12%</b>        |
| NB On From Toll NC 147                                        | NB Ramp            | 2,687          | 3,434          | 28%                |
| <b>NB Mainline Between Toll NC 147 On and NC 54 Off</b>       | <b>NB Mainline</b> | <b>18,529</b>  | <b>17,354</b>  | <b>-6%</b>         |
| NB Off to NC 54                                               | NB Ramp            | 2,612          | 3,471          | 33%                |
| NB On From NC 54                                              | NB Ramp            | 9,830          | 12,071         | 23%                |
| NB North Of NC 54                                             | NB Ramp            | 25,747         | 25,954         | 1%                 |
| <b>NB Mainline Between NC 540 On and Davis Off</b>            | <b>NB Mainline</b> | <b>9,019</b>   | <b>12,421</b>  | <b>38%</b>         |
| NB Off to Davis Dr                                            | NB Ramp            | 2,415          | 3,635          | 51%                |
| NB On From Hopson Rd                                          | NB Ramp            | 2,589          | 2,901          | 12%                |
| NB Off to I-40 SB                                             | NB Ramp            | 179            | 0              | -100%              |
| NB Off to I-40 NB                                             | NB Ramp            | 2,398          | 3,168          | 32%                |
| <b>SB North Of NC 54</b>                                      | <b>SB Mainline</b> | <b>24,343</b>  | <b>23,135</b>  | <b>-5%</b>         |
| SB Off to NC 54                                               | SB Ramp            | 9,456          | 10,500         | 11%                |
| SB On From NC 54                                              | SB Ramp            | 2,924          | 3,402          | 16%                |
| <b>SB Mainline Between NC 54 On and Toll NC 147 Off</b>       | <b>SB Mainline</b> | <b>17,811</b>  | <b>16,037</b>  | <b>-10%</b>        |
| SB Off to Toll NC 147                                         | SB Ramp            | 2,024          | 3,221          | 59%                |
| <b>SB Mainline Between Toll NC 147 Off and Toll NC 147 On</b> | <b>SB Mainline</b> | <b>15,787</b>  | <b>12,816</b>  | <b>-19%</b>        |
| SB On From Toll NC 147                                        | SB Ramp            | 6,756          | 8,898          | 32%                |
| <b>SB Mainline Between Toll NC 147 On and NC 55 Off</b>       | <b>SB Mainline</b> | <b>22,543</b>  | <b>21,715</b>  | <b>-4%</b>         |
| SB Off to NC 55                                               | SB Ramp            | 3,602          | 3,630          | 1%                 |
| SB Off to NC 55 - Loop                                        | SB Ramp            | 4,255          | 2,822          | -34%               |
| SB On From NC 55                                              | SB Ramp            | 2,322          | 2,250          | -3%                |
| <b>SB Mainline Between NC 55 On and Green Level W Off</b>     | <b>SB Mainline</b> | <b>17,008</b>  | <b>17,513</b>  | <b>3%</b>          |
| SB Off to Green Level West                                    | SB Ramp            | 1,680          | 2,193          | 31%                |
| SB On From Green Level West                                   | SB Ramp            | 1,402          | 1,823          | 30%                |
| <b>SB Mainline Between Green Level W On and US 64 Off</b>     | <b>SB Mainline</b> | <b>16,730</b>  | <b>17,143</b>  | <b>2%</b>          |
| SB Off to US 64 WB                                            | SB Ramp            | 2,705          | 3,212          | 19%                |
| SB On From US 64 WB                                           | SB Ramp            | 835            | 1,752          | 110%               |
| SB Off to US 64 EB                                            | SB Ramp            | 2,701          | 3,101          | 15%                |
| SB On From US 64 EB                                           | SB Ramp            | 1,247          | 1,716          | 38%                |
| <b>SB Mainline Between US 64 NB On and S Salem St Off</b>     | <b>SB Mainline</b> | <b>13,406</b>  | <b>14,297</b>  | <b>7%</b>          |
| SB Off to S Salem St                                          | SB Ramp            | 1,350          | 1,929          | 43%                |
| SB On From S Salem St                                         | SB Ramp            | 1,551          | 1,718          | 11%                |
| <b>SB Mainline Between S Salem St On and US 1 Off SB</b>      | <b>SB Mainline</b> | <b>13,607</b>  | <b>14,086</b>  | <b>4%</b>          |
| SB Off to US 1 SB                                             | SB Ramp            | 2,941          | 2,654          | -10%               |
| SB On From US 1 SB                                            | SB Ramp            | 267            | 986            | 269%               |
| SB Off to US 1 NB                                             | SB Ramp            | 2,482          | 3,474          | 40%                |
| SB On From US 1 NB                                            | SB Ramp            | 351            | 436            | 24%                |
| <b>SB Mainline Between US 1 NB On and NC 55 SB Off</b>        | <b>SB Mainline</b> | <b>8,802</b>   | <b>9,381</b>   | <b>7%</b>          |
| SB Off to NC 55 SB                                            | SB Ramp            | 7,617          | 7,644          | 0%                 |
| SB Off to NC 55 NB                                            | SB Ramp            | 1,185          | 1,737          | 47%                |
| SB On From I-40 NB                                            | SB Ramp            | 139            | 0              | -100%              |
| SB On From I-40 SB                                            | SB Ramp            | 2,600          | 3,488          | 34%                |
| SB Off to Hopson Rd                                           | SB Ramp            | 2,348          | 2,961          | 26%                |
| SB On From Davis Dr                                           | SB Ramp            | 2,981          | 3,562          | 19%                |
| <b>SB Mainline Between Davis On and NC 540 Off</b>            | <b>SB Mainline</b> | <b>9,443</b>   | <b>12,332</b>  | <b>31%</b>         |
| Percent Root Mean Squared Error (%RMSE)                       |                    |                |                | 17%                |

Source: Counts conducted by CDM Smith in 2016 and 2017 and TRMv6 output.

## 5.5 Speed Calibration

The primary objective of speed calibration was to ensure that the speeds estimated by the travel demand model closely replicate the observed speeds and that the model exhibits congestion at locations where there is actual congestion, while not showing congestion where there is no congestion in the field. CDM Smith compiled observed directional travel speed data from HERE for the year 2016 along the major roadways in the study area and summarized it for the eight time periods in the model, by segment. The resulting speed profiles (color-coded “heat” maps) served as the basis for comparison with the model-estimated speeds.

In addition to changes in the free-flow speeds of selected roadways, adjustments were made to the volume-delay curves at key bottleneck locations to enable the model to better reflect the congestion on the roadways based on observed speed data from HERE. The model calibration process was an iterative process recognizing that adjustments to speed affected the assigned traffic volumes, and changes to assigned traffic volumes resulted in changes in speeds on roadways. The iterative process ensured that adjustments made to improve speeds were not detrimental to the estimated volumes. **Table 5.4** shows the results of the speed calibration by roadway by direction. In general, most of the model-estimated speeds are within five miles per hour (MPH) at the overall corridor level, although there were a few segments where this could not be achieved without considerably affecting the volume calibration.

## 5.6 Travel Pattern Validation

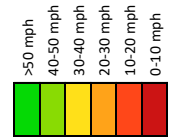
Once the model calibration to speeds and volumes was completed, a final check against the Streetlight travel pattern data was made. Two sample movements from the Streetlight data are shown in Figures 2.7 and 2.8. The observed share of trips that travel from the southern end of the existing Triangle Expressway to a point just north of NC 55 is about 50 percent in the case of both the Streetlight data and the model. The Streetlight data shows 31 percent of the trips from the southern end of the project travel to the northern end of Toll NC 540 (north of the Toll NC 147 interchange), while the model shows 19 percent. Similarly, in the southbound direction, **Table 5.5** shows a comparison from the link at the northern end of the Triangle Expressway to multiple points south. From this point, Streetlight data shows about 27 percent of the traffic travels as far as US 64 while the model shows 39 percent. Streetlight data shows about eight percent of the total traffic from the northern end of the Triangle Expressway travels to the southern end, the entire length of the project, while the model shows 11 percent make this movement.

These, and other comparisons, indicate that the travel patterns within the model for the study area zones reasonably replicate the travel patterns observed from the Streetlight data, and are within the tolerance limits of both the data and the model.



Table 5.4  
Speed Calibration Results by Roadway and Direction

| Road Name  | From                     | To                       | Dir. | Length<br>(miles) | Observed Speed (HERE) (1) |     |     |     |    |     |     |     | Modeled Speed (1) |     |     |     |    |     |     |     | Free<br>Flow | Speed Difference<br>(Modeled - Observed) (1) |     |     |     |    |     |     |     |
|------------|--------------------------|--------------------------|------|-------------------|---------------------------|-----|-----|-----|----|-----|-----|-----|-------------------|-----|-----|-----|----|-----|-----|-----|--------------|----------------------------------------------|-----|-----|-----|----|-----|-----|-----|
|            |                          |                          |      |                   | Free<br>Flow              | AM1 | AM2 | AM3 | MD | PM1 | PM2 | PM3 | Free<br>Flow      | AM1 | AM2 | AM3 | MD | PM1 | PM2 | PM3 |              | Free<br>Flow                                 | AM1 | AM2 | AM3 | MD | PM1 | PM2 | PM3 |
| US 64/US 1 | I-40                     | US 64/Tryon Rd/Exit 98   | WB   | 3.6               | 66                        | 66  | 65  | 64  | 65 | 62  | 50  | 58  | 66                | 63  | 62  | 62  | 55 | 55  | 60  | 0   | -3           | -3                                           | -2  | -3  | -7  | 5  | 3   |     |     |
| US 64/US 1 | I-40                     | US 64/Tryon Rd/Exit 98   | EB   | 3.3               | 65                        | 65  | 44  | 38  | 62 | 59  | 45  | 52  | 68                | 56  | 44  | 34  | 62 | 57  | 44  | 3   | -9           | 1                                            | -4  | 0   | -2  | -1 | 1   |     |     |
| US 64      | US 1/Tryon Rd            | NC 751/Chapel Rd         | WB   | 9.0               | 54                        | 51  | 46  | 44  | 46 | 45  | 40  | 43  | 57                | 52  | 47  | 49  | 50 | 42  | 43  | 4   | 1            | 1                                            | 4   | -2  | 3   | 5  |     |     |     |
| US 64      | NC 751/Chapel Rd         | US 1/Tryon Rd            | EB   | 9.0               | 55                        | 53  | 45  | 41  | 47 | 46  | 37  | 41  | 58                | 48  | 39  | 42  | 48 | 44  | 47  | 3   | -5           | -6                                           | 1   | 1   | -4  | 7  |     |     |     |
| US 401     | S Saunders St            | NC 55/NC 42              | SB   | 13.8              | 47                        | 43  | 40  | 38  | 40 | 37  | 33  | 36  | 48                | 46  | 45  | 45  | 44 | 33  | 26  | 40  | 1            | 3                                            | 6   | 4   | -5  | -7 |     |     |     |
| US 401     | NC 55/NC 42              | S Saunders St            | NB   | 13.1              | 48                        | 44  | 33  | 33  | 39 | 39  | 39  | 40  | 49                | 37  | 30  | 37  | 44 | 43  | 44  | 45  | 1            | -7                                           | -3  | 4   | 4   | 5  |     |     |     |
| US 1       | US 64/Tryon Rd/Exit 98   | New Hill/Exit 89         | SB   | 9.5               | 69                        | 69  | 69  | 68  | 68 | 65  | 59  | 65  | 71                | 69  | 68  | 69  | 68 | 61  | 62  | 66  | 2            | 0                                            | 0   | 1   | 1   | -4 |     |     |     |
| US 1       | New Hill/Exit 89         | US 64/Tryon Rd/Exit 98   | NB   | 9.4               | 70                        | 70  | 56  | 58  | 67 | 68  | 68  | 67  | 71                | 65  | 59  | 63  | 69 | 66  | 67  | 68  | 1            | -5                                           | 3   | 4   | 1   | -2 |     |     |     |
| Ten Ten Rd | Old Stage Rd             | US 1                     | WB   | 10.7              | 43                        | 36  | 27  | 28  | 36 | 35  | 35  | 36  | 39                | 29  | 26  | 29  | 35 | 33  | 33  | 35  | -4           | -7                                           | -1  | 1   | -2  |    |     |     |     |
| Ten Ten Rd | US 1                     | Old Stage Rd             | EB   | 8.5               | 43                        | 39  | 34  | 34  | 36 | 30  | 25  | 26  | 39                | 37  | 35  | 35  | 35 | 27  | 24  | 30  | -3           | -2                                           | 1   | 1   | -3  |    |     |     |     |
| NC 55 Byp  | NC 55 Byp/E Williams St  | NC 55/S Main St          | SB   | 4.4               | 51                        | 48  | 44  | 43  | 41 | 33  | 25  | 28  | 51                | 50  | 49  | 48  | 47 | 38  | 32  | 39  | 0            | 2                                            | 5   | 6   | 5   |    |     |     |     |
| NC 55 Byp  | NC 55/S Main St          | NC 55 Byp/E Williams St  | NB   | 4.4               | 52                        | 48  | 38  | 40  | 42 | 41  | 41  | 41  | 52                | 44  | 34  | 37  | 47 | 46  | 46  | 48  | 0            | -4                                           | -4  | -3  | 5   |    |     |     |     |
| NC 55      | US 401/N Main St         | MLK Pkwy                 | WB   | 27.6              | 42                        | 39  | 32  | 31  | 33 | 32  | 31  | 32  | 42                | 34  | 28  | 31  | 37 | 35  | 34  | 36  | 0            | -5                                           | -5  | 0   | 3   |    |     |     |     |
| NC 55      | MLK Pkwy                 | US 401/N Main St         | EB   | 27.7              | 41                        | 38  | 34  | 32  | 33 | 30  | 27  | 29  | 41                | 38  | 35  | 36  | 30 | 28  | 33  | 33  | 0            | 0                                            | 1   | 4   | 3   |    |     |     |     |
| NC 540     | I-40/Exit 1              | NC 55 Byp                | WB   | 15.1              | 71                        | 70  | 69  | 68  | 69 | 70  | 71  | 70  | 74                | 73  | 73  | 73  | 72 | 71  | 72  | 72  | 3            | 4                                            | 4   | 5   | 1   |    |     |     |     |
| NC 540     | NC 55 Byp                | I-40/Exit 1              | EB   | 16.5              | 72                        | 71  | 71  | 70  | 68 | 69  | 69  | 69  | 73                | 71  | 70  | 71  | 72 | 72  | 72  | 72  | 1            | 0                                            | -1  | 2   | 4   |    |     |     |     |
| NC 42      | US 70/S Lombard St       | US 401/N Main St         | WB   | 18.0              | 47                        | 42  | 38  | 38  | 40 | 37  | 35  | 36  | 44                | 39  | 38  | 39  | 39 | 36  | 34  | 38  | -3           | -3                                           | 0   | 1   |     |    |     |     |     |
| NC 42      | US 401/N Main St         | US 70/S Lombard St       | EB   | 18.1              | 46                        | 42  | 38  | 38  | 40 | 37  | 35  | 36  | 44                | 39  | 36  | 38  | 40 | 37  | 37  | 39  | -2           | -3                                           | -2  | 1   |     |    |     |     |     |
| NC 147     | TW Alexander Dr/Exit 7   | NC 540                   | SB   | 4.9               | 68                        | 68  | 64  | 60  | 66 | 56  | 60  | 65  | 66                | 65  | 64  | 64  | 64 | 62  | 61  | 64  | -2           | -3                                           | -1  | 4   |     |    |     |     |     |
| NC 147     | NC 540                   | TW Alexander Dr/Exit 7   | NB   | 5.2               | 69                        | 69  | 60  | 59  | 67 | 66  | 51  | 57  | 66                | 63  | 60  | 53  | 64 | 63  | 54  | 65  | -3           | -6                                           | 0   | -2  |     |    |     |     |     |
| I-540      | US 64/US 264             | I-40/Exit 1              | WB   | 26.0              | 70                        | 70  | 52  | 49  | 68 | 69  | 58  | 58  | 75                | 69  | 58  | 65  | 71 | 70  | 70  | 72  | 5            | -1                                           | 5   |     |     |    |     |     |     |
| I-540      | I-40/Exit 1              | US 64/US 264             | EB   | 24.9              | 69                        | 69  | 69  | 68  | 69 | 59  | 42  | 52  | 74                | 73  | 71  | 71  | 71 | 64  | 58  | 71  | 5            | 3                                            | 2   |     |     |    |     |     |     |
| I-440      | I-40/Exit 16             | US 64                    | WB   | 3.5               | 63                        | 62  | 54  | 54  | 62 | 62  | 60  | 62  | 61                | 58  | 56  | 58  | 59 | 57  | 57  | 60  | -2           | -4                                           | 2   |     |     |    |     |     |     |
| I-440      | US 64                    | I-40/Exit 16             | EB   | 4.0               | 62                        | 61  | 43  | 45  | 61 | 53  | 43  | 55  | 63                | 61  | 61  | 62  | 61 | 54  | 49  | 60  | 0            | 1                                            | 18  |     |     |    |     |     |     |
| I-40       | NC 210/Exit 319          | Fayetteville Rd/Exit 276 | WB   | 42.7              | 68                        | 60  | 45  | 46  | 65 | 64  | 53  | 58  | 68                | 54  | 51  | 55  | 60 | 55  | 56  | 62  | 0            | -6                                           | 7   |     |     |    |     |     |     |
| I-40       | Fayetteville Rd/Exit 276 | NC 210/Exit 319          | EB   | 36.2              | 67                        | 67  | 64  | 61  | 65 | 47  | 36  | 45  | 66                | 62  | 55  | 57  | 58 | 42  | 41  | 55  | -1           | -5                                           | -9  |     |     |    |     |     |     |
| Davis Dr   | E Cornwallis Rd          | US 64                    | SB   | 11.6              | 44                        | 42  | 37  | 35  | 37 | 35  | 30  | 32  | 44                | 42  | 39  | 39  | 40 | 34  | 32  | 37  | 0            | 1                                            | 1   |     |     |    |     |     |     |
| Davis Dr   | US 64                    | E Cornwallis Rd          | NB   | 11.6              | 44                        | 42  | 38  | 35  | 37 | 36  | 35  | 36  | 44                | 39  | 32  | 34  | 41 | 39  | 38  | 40  | 0            | 0                                            | -7  |     |     |    |     |     |     |



(1) Time periods correspond to the following hours:

AM1 = 0600-0700

AM2 = 0700-0800

AM3 = 0800-0900

MD = 0900-1600

PM1 = 1600-1700

PM2 = 1700-1800

PM3 = 1800-1900

**Table 5.5**  
**Through Trip Comparison - Model vs. Streetlight**

| <b>Direction</b> | <b>Origin Segment</b>   | <b>Destination Segment</b> | <b>Streetlight</b> | <b>Model</b> |
|------------------|-------------------------|----------------------------|--------------------|--------------|
| Northbound       | NC 55 Byp<br>to US 1    | North of US64              | 78%                | 60%          |
|                  |                         | North of NC55              | 52%                | 50%          |
|                  |                         | North of Toll NC 147       | 31%                | 19%          |
| <b>Location</b>  | <b>Origin Segment</b>   | <b>Destination Segment</b> | <b>Streetlight</b> | <b>Model</b> |
| Southbound       | NC 54 to<br>Toll NC 147 | North of NC 55             | 90%                | 80%          |
|                  |                         | North of US64              | 27%                | 39%          |
|                  |                         | North of NC 55 Byp         | 8%                 | 11%          |

## Chapter 6

# Scenario 1: Triangle Expressway Traffic and Revenue Forecast

As described in Chapter 1, this Traffic and Revenue Study develops two discrete forecast scenarios:

- **Scenario 1:** Triangle Expressway assuming Complete 540 is not constructed. This scenario will also be called the **Triangle Expressway Scenario** or forecast in this report. The Triangle Expressway is an existing toll road consisting of Toll NC 540 and Toll NC 147.
- **Scenario 2:** Triangle Expressway assuming the proposed Complete 540 Phase 1. Phase 1 would extend the Triangle Expressway from its southern terminus at the NC 55 Bypass to Interstate 40 (I-40) and U.S. 70 (the Clayton Bypass). This scenario will also be called the **Complete 540 Scenario** or forecast in this report. This study assumes that Complete 540 Phase 1 would open on July 1, 2023.

This chapter presents Scenario 1, the Triangle Expressway traffic and revenue forecast from Fiscal Year 2019 through 2058 and the toll sensitivity analysis. The forecast includes a new planned interchange with Morrisville Parkway, and planned toll-zone relocations at the Hopson Road and U.S. 64 interchanges, from the current ramp locations to mainline locations. No further additions or expansions to the Triangle Expressway are assumed in the forecast presented in this chapter. Important assumptions to the forecast are provided in this chapter.

Also included in this chapter is a description of the forecasting approach that was common to both Scenarios 1 and 2.

## 6.1 Forecasting Approach

For each of the two forecasting scenarios, traffic and revenue projections were developed for calendar years 2019 through 2058, and then converted to fiscal years (FY), which extend from July 1<sup>st</sup> through June 30<sup>th</sup>. In developing the long-range forecasts, the recently released Triangle Regional Model Version 6 (TRMv6) was used; this model has a long-range horizon year of 2045. In developing the estimates, travel demand model runs were made at 2020, 2025, 2035 and 2045. Projections for years 2018 and 2019 were based on historical traffic and toll revenue trends on the Triangle Expressway, available through June 2018. The forecast for 2020 was developed by using model impacts in combination with recent historical trend data. Forecasts between 2020 and 2045 were developed primarily through interpolation between model year control points. Estimates for years following 2045 were based on assumed nominal growth in traffic, and annual toll rate increases of approximately 2.0 percent.

The forecast period in this study extends beyond the year 2040. With progressive developments in vehicle technology, it is widely anticipated there will likely be modifications in urban mobility patterns in the long term. In particular, it is anticipated that there will be a gradual increasing shift toward “shared mobility” travel and ultimately, fully autonomous driverless vehicles. While it is

increasingly accepted that mobility change is coming, there remains considerable uncertainty regarding exactly what will occur and when the transition will happen.

As such, the modeling methodology and the overall forecasting process used in this study does not explicitly assume any specific change in how people and goods will travel in the future. Based on research now underway, it is likely that over the long term we may see a reduction in the number of vehicles on the road but an actual increase in vehicle miles of travel, depending on the level of shift to shared mobility services.

On balance, the impact on potential traffic and toll revenue may prove to be negligible. However, it is noted that the forecasts included in this report do not assume any specific change in travel patterns and characteristics, beyond modest assumed increases in telecommuting. If disruptive technology change does ultimately have a significant impact on urban mobility, it will likely occur after the year 2040; hence, relatively late in the forecast period covered by this study.

### 6.1.1 Planned Triangle Expressway Interchange and Tolling Configuration Changes

As discussed previously in Chapter 1, a new full-access interchange will be added to the Triangle Expressway at Morrisville Parkway, north of the existing interchange at Green Level West Road. This study assumes the interchange will open to tolled traffic on January 1, 2020. With the opening of the Morrisville Parkway Interchange, a new mainline toll zone will be located north of the interchange, as shown in Figure 1.3. This will, in turn, require an adjustment to the toll rate at the existing mainline toll zone north of Green Level West Road to maintain per-mile toll rates on the Triangle Expressway.

Two other toll-system changes are planned for the Triangle Expressway. Existing ramp toll zones, to-and-from the north at Hopson Road and U.S. 64 will be removed and replaced by new mainline toll zones to the north of each interchange (as shown in Figure 1.3). The net result will be the substitution of two new mainline toll points for two pairs of ramp toll locations. These toll system changes are assumed to be implemented on January 1, 2024. At that time, adjustments will be required at adjacent mainline toll points to maintain the overall per-mile rates for through trips.

The new Morrisville Parkway Interchange and changes in toll-zone locations will result in an increased number of toll transactions, and a slight decrease in overall average toll rates per transaction. These changes will be apparent beginning in the traffic and revenue forecasts for FY 2020 and FY 2024. These are the only changes to the current Triangle Expressway physical configuration assumed in the traffic and revenue forecast presented in this chapter. The same Triangle Expressway improvements are also assumed in Scenario 2.

## 6.2 Future Transportation Improvements

A critical element in any comprehensive traffic and revenue study is assumptions regarding competing and complementary transportation improvements which may be expected to occur during the forecast period. As part of this study, CDM Smith reviewed the planned and proposed roadway improvement programs in the study area from the following sources:

1. The adopted **2018-2027 NCDOT State Transportation Improvement Program** (STIP). These are projects that have an identified funding and construction schedule. Projects in the STIP were all scored and prioritized through the NCDOT's Strategic Prioritization Office (SPOT) program, which is the methodology used to evaluate and score all transportation projects.

2. The **2045 Metropolitan Transportation Plan (MTP)**. This is the long-range plan for transportation in the Triangle region. It includes roadway, transit, rail, bicycle, and pedestrian projects to be implemented through the year 2045. This plan is coordinated by the two Metropolitan Planning Organizations (MPOs) in the study area; the Capital Area MPO (CAMPO) and the Durham Chapel-Hill Carrboro MPO (DCHC MPO). Roadway improvements in the 2045 MTP include the current STIP projects. Future projects not included in the STIP do not have current schedules and are not financially committed but were developed recognizing overall future fiscal sources and constraints.

Roadway improvements in the STIP and the 2045 MTP were included in the newly developed and released TRMv6. The TRMv6 is developed and supported by the Institute for Transportation Research and Education (ITRE), a division of North Carolina State University. The TRMv6 model supports future years 2025, 2035 and 2045, so road improvements were incorporated into the appropriate completion year.

CDM Smith reviewed the STIP and MTP transportation projects and compared them to the projects in the TRMv6 for consistency. NCDOT personnel were contacted by CDM Smith to verify estimated project completion dates for modeling purposes.

A very large number of highway improvements were assumed in this study, many of which would be competitive to the Triangle Expressway or Complete 540 Phase 1. While many of these projects are not yet funded, it was considered appropriate and conservative to assume the completion of the projects for developing long-range forecasts for Triangle Expressway (and Complete 540 discussed in Chapter 7). The shorter-term projects identified in the NCDOT STIP were included in the 2025 travel demand model networks. The longer-range improvements covered in the MTP were included in either the 2035 or 2045 TRMv6 networks as received by CDM Smith.

The following subsections describe many of the roadway improvement projects assumed in the TRMv6 roadway networks in the study area (and included in the STIP and MTP). The improvements discussed are limited to planned additional capacity (increased number of through travel lanes) and new interchanges on limited access roadways. There are additional roadway improvements assumed in the TRMv6 that include work such as pavement repair and maintenance, signalization improvements, turning lane additions, and grade separations.

### 6.2.1 Assumed 2025 Roadway Improvements

**Figure 6.1** shows roadway improvements included in the TRMv6 2025 highway networks in the Triangle Expressway and Complete 540 corridors. These improvements were assumed in the modeling and in development of traffic and toll revenue forecasts. All the improvements shown are either road widenings, a new interchange, or, in a few cases, a new road segment. The improvements are generally competitive with the Triangle Expressway and Complete 540, as they improve traffic flow and connectivity through the area on toll-free routes. A notable exception would be the planned widening of NC 147 north of I-40 from four to eight lanes (STIP # U-5934) which does not compete with the Triangle Expressway or Complete 540.

**Table 6.1** provides more detail on each of the proposed improvements; the project ID number is shown for each improvement and can be related to the numbers shown in Figure 6.1. Of particular significance with respect to the planned Complete 540 Phase 1 is the assumed widening of I-40 from six to eight lanes on the north-south segment between U.S. 70 and I-440 and on the east-west segment between U.S. 401 and U.S. 1. Overall, a significant amount of increased capacity is assumed to





FIGURE 6.1



**Table 6.1**  
**2025 STIP Roadway Improvements**  
**Assumed in the TRMv6**

| Project<br>STIP/MTP ID | Roadway                              | Location                                  | Description                       |
|------------------------|--------------------------------------|-------------------------------------------|-----------------------------------|
| A164a2                 | Green Level Church Rd                | O'Kelly Chapel Rd to McCrimmon Parkway    | Widen from 2 to 4 lanes           |
| A164c1                 | Green Level Church Rd                | Folklore Way to O'Kelly Chapel Rd         | Widen from 2 to 4 lanes           |
| A218e                  | Jessie Dr (part NL)                  | NC 55 to Ten Ten Rd                       | Construct 2 lanes on new location |
| A220b                  | Morrisville Carpenter Rd             | Davis Dr to Louis Stephens Dr             | Widen from 2 to 4 lanes           |
| A220c                  | Morrisville Carpenter Rd             | Louis Stephens Dr to Good Hope Church Rd  | Widen from 2 to 4 lanes           |
| A28b                   | Davis Dr                             | Farm Pond Rd to US 64                     | Widen from 2 to 4 lanes           |
| A440a1                 | Carpenter Fire Station Rd            | Cameron Pond Dr to NC 55                  | Widen from 2 to 4 lanes           |
| A49a                   | Poole Rd                             | Maybrook Dr to Barwell Rd                 | Widen from 2 to 4 lanes           |
| A521                   | O'Kelley Chapel Rd                   | Louis Stephens Dr to NC 55                | Construct 4 lanes on new location |
| A648                   | US 1/Friendship Interchange          | OLs US 1 Highway to Friendship Rd         | Interchange                       |
| I-5111A                | I-40 (East)                          | I-440 to US 70 Buisness                   | Widen from 6 to 8 lanes           |
| I-5111BA & BB          | I-40 (East)                          | US 70 Business to NC 42                   | Widen from 4 to 8 lanes           |
| I-5506                 | Aviation Parkway Interchange (Impr)  | National Guard Dr to I-40                 | Interchange                       |
| I-5700                 | Airport Blvd Interchange (Impr)      | I-540 to Aviation Parkway                 | Construct auxillary lanes         |
| I-5701                 | I-40                                 | US 1/64 to Lake Wheeler Rd                | Widen from 6 to 8 lanes           |
| I-5703                 | I-40/US 1/US 64 Interchange          | I-40/US 1/US 64                           | Interchange                       |
| R-3410A                | NC 42 West                           | US 70 Business to US 70 Bypass            | Widen from 2 to 4 lanes           |
| R-3410B                | NC 42                                | NC 50 to I-40                             | Widen from 2 to 4 lanes           |
| R-3410B                | NC 42 West Widening                  | US 70 Bypass to I-40                      | Widen from 2 to 4 lanes           |
| R-3825                 | NC 42 East Widening                  | Glen Laurel Rd to Buffaloe Rd             | Widen from 2 to 4 lanes           |
| U-2719                 | I-440 Widening                       | US 1/64 to Wade Avenue                    | Widen from 4 to 6 lanes           |
| U-2823                 | US 70                                | Lumley/Westgate Rd to Duraleigh/Millbrook | Widen from 4 to 6 lanes           |
| U-2901B                | NC 55                                | Apex Peakway (South) to Salem St          | Widen from 2 to 4 lanes           |
| U-2901B                | NC 55                                | Salem St to Bryan Dr                      | Widen from 2 to 4 lanes           |
| U-5301A                | US 64/Laura Duncan Interchange (New) | US 64 to Laura Duncan Rd                  | Interchange                       |
| U-5301B                | US 64/Lake Pine Interchange (New)    |                                           | Interchange                       |
| U-5301C                | US 64/Lake Pine Interchange (New)    | US 1 to Lake Pine Dr                      | Interchange                       |
| U-5500                 | Green Level West Rd                  | NC 55 to I-540                            | Widen from 2 to 4 lanes           |
| U-5500                 | Green Lvl W Rd Widening              | NC 540 to Green Level Church Rd           | Widen from 2 to 4 lanes           |
| U-5502                 | Carpenter Fire Station Ext           | NC 55 to Morrisville Carpenter Rd         | Construct 4 lanes on new location |
| U-5618                 | Morrisville Carpenter Rd             | Page St to Davis Dr                       | Widen from 2 to 4 lanes           |
| U-5747A                | McCrimmon Parkway Ext                | NC 54 to Davis Dr                         | Widen from 2 to 4 lanes           |
| U-5747B                | McCrimmon Parkway                    | Airport Blvd to NC 54                     | Widen from 2 to 4 lanes           |
| U-5750                 | NC 54                                | Perimeter Park Dr to Northern Twn Limits  | Widen from 2 to 6 lanes           |
| U-5811                 | Aviation Parkway                     | Gateway Centre Blvd to Dominion Dr        | Widen from 2 to 4 lanes           |
| U-5811                 | Aviation Parkway                     | Evans Rd to NC 54                         | Widen from 2 to 4 lanes           |
| U-5811                 | Aviation Parkway                     | I-40 to Gateway Centre Blvd               | Widen from 4 to 6 lanes           |
| U-5825A                | Ten Ten Rd                           | US 1                                      | Interchange                       |
| U-5825B                | Ten Ten Rd                           | Kildare Farm Rd to US 1                   | Widen from 2 to 4 lanes           |
| U-5827                 | Louis Stephens Dr Ext (NL)           | Little Drive to Poplar Pike Lane          | Construct 4 lanes on new location |
| U-5828                 | McCrimmon Parkway                    | Airport Blvd to Aviation Parkway          | Widen from 2 to 4 lanes           |
| U-5928                 | Apex Peakway/Salem St Interchange    |                                           | Interchange                       |
| U-5934                 | NC 147                               | East End Connector to I-40                | Widen from 4 to 8 lanes           |
| U-5936                 | Wade Ave Widening                    | I-40 to I-440                             | Widen from 4 to 6 lanes           |

be provided by 2025; a relatively conservative assumption for purposes of projecting future traffic and revenue on the overall Toll NC 540 corridor.

### 6.2.2 Longer Range Roadway Improvements

**Figure 6.2** and **Table 6.2** present additional roadway improvements assumed to be completed by 2035. Many of the improvements are in the Triangle Expressway and Complete 540 corridors. The improvements are primarily road widenings, generally from two to four lanes.

There are many planned improvements on I-40, comprised primarily of roadway widening to address future anticipated traffic demand. Included in the planned improvements is a capacity increase on I-40 of an additional lane in each direction from the Durham County line, southward to NC 210 in Johnston County. This improvement may be implemented as either a managed lane, or possibly, an additional toll-free lane. The TRMv6 model assumes the additional capacity increase as a tolled, managed lane. This study also assumes the proposed capacity increase will be managed lanes, tolled at a level to preserve free-flow traffic conditions in the managed lanes. Managed lanes are also assumed to be implemented on I-540, north of Raleigh.

**Figure 6.3** and **Table 6.3** provide information on long-range improvements assumed to be in place by 2045. The projects shown are mostly roadway widenings, and most are located in the southern Triangle Expressway and Complete 540 corridors. Most notable would be the assumed widening of Ten Ten Road from two to four lanes. Again, improvements shown in Figure 6.3 and Table 6.3 are assumed to be in place by 2045, relatively late in the traffic and revenue projection period.

### 6.2.3 Excluded Improvement in the Base Case

One planned improvement was excluded from the Scenario 1: Triangle Expressway traffic and revenue analysis and forecast. Included in the STIP and MTP, and in the original TRMv6 2025, 2035 and 2045 networks are the planned improvement to build an approximately 1.6-mile toll-free extension of NC 147, from the southern end of Toll NC 147 to McCrimmon Parkway and Little Road. The improvement would include modifications to the existing interchange between Toll NC 540 and Toll NC 147 and associated toll zone and toll schedule modifications. This project is identified as TIP number U-5966.

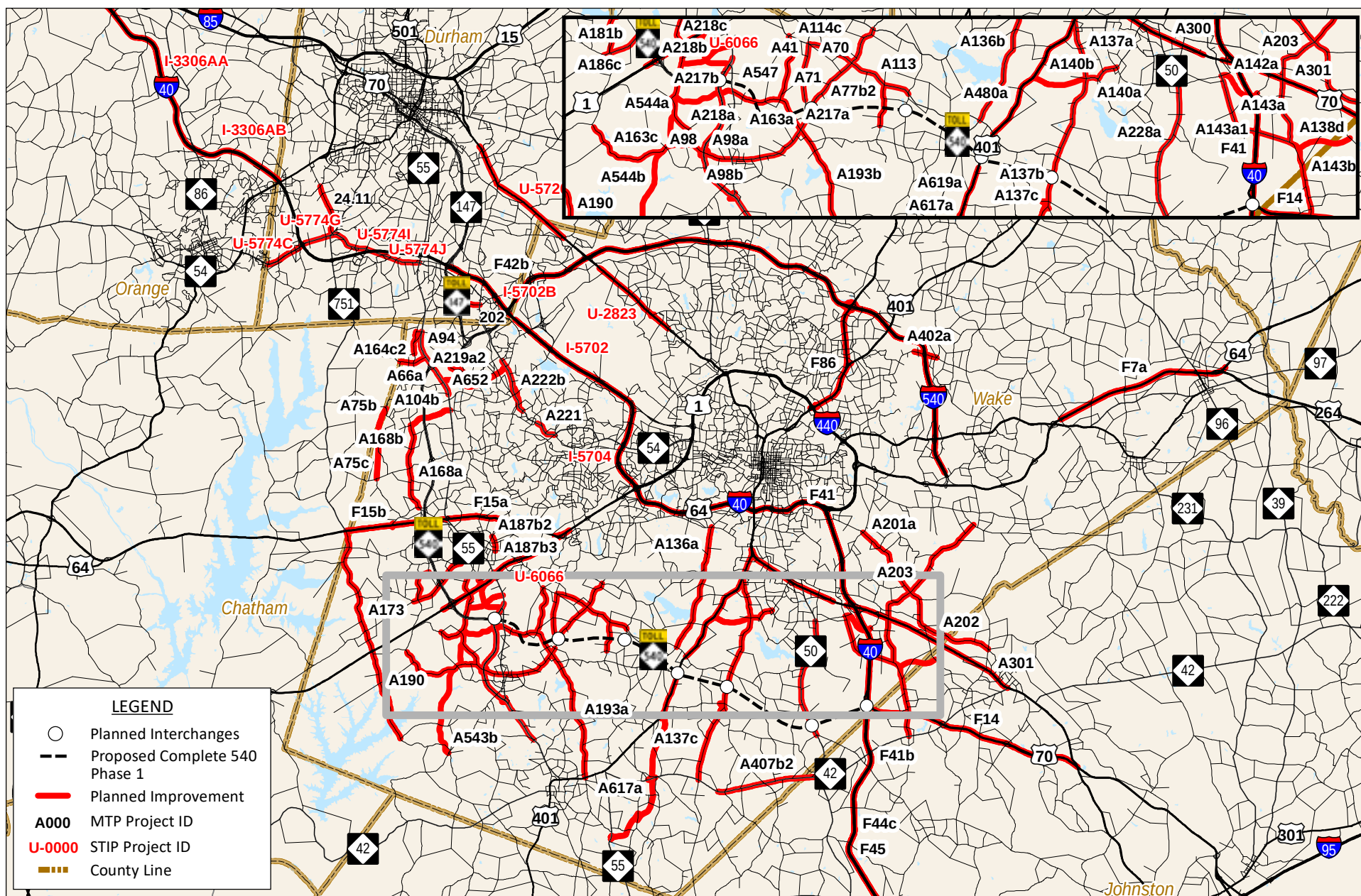
This improvement, while planned, does not have current committed funding, and the completion of the project does have estimated positive transaction and toll revenue impacts on the Triangle Expressway. For conservative purposes, the Scenario 1 and Scenario 2 forecasts assume that this project does not occur during the forecast period.

## 6.3 Basic Assumptions

Traffic and revenue estimates for the Triangle Expressway are predicated on the following basic assumptions, which are considered reasonable for purpose of the base case forecasts:

1. For purposes of Scenario 1, no portion of Complete 540 is assumed to be implemented during the projection period. Scenario 1 envisions only the continued operation of the existing Triangle Expressway with certain interchange and toll zone location modifications as enumerated herein.

# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



**Table 6.2 (Page 1 of 2)**  
**Year 2035 Roadway Improvements**  
**Assumed in the Complete 540 Forecast Model**

| Project<br>STIP/MTP ID | Roadway                               | Location                                        | Description                         |
|------------------------|---------------------------------------|-------------------------------------------------|-------------------------------------|
| 24.11                  | Garrett Rd                            | NC 751 to Old Durham Rd                         | Widen from 2 to 4 lanes             |
| 202                    | Hopson Rd                             | Davis Dr to S Miami Blvd (NC 54)                | Widen from 2 to 4 lanes             |
| A104b                  | Morrisville Parkway                   | Green Level Church Rd to NC 55                  | Widen from 2 to 4 lanes             |
| A113                   | Ten Ten Rd                            | Holly Springs Rd to Bells Lake Rd               | Widen from 2 to 4 lanes             |
| A114c                  | Ten Ten Rd                            | Holly Springs Rd and Kildare Farm Rd            | Widen from 2 to 4 lanes             |
| A136a                  | Lake Wheeler Rd                       | Tryon Rd to Penny Rd                            | Widen from 2 to 4 lanes             |
| A136b                  | Lake Wheeler Rd                       | Penny Rd to Ten Ten Rd                          | Widen from 2 to 4 lanes             |
| A136c                  | Lake Wheeler Rd                       | Ten Ten Rd to Hilltop-Needmore Rd               | Widen from 2 to 4 lanes             |
| A137a                  | Old Stage Rd                          | US 40 to Ten Ten Rd                             | Widen from 2 to 4 lanes             |
| A137b                  | Old Stage Rd                          | Ten Ten Rd to Rock Service Station              | Widen from 2 to 4 lanes             |
| A137c                  | Old Stage Rd                          | Rock Service Station to NC 42                   | Widen from 2 to 4 lanes             |
| A138d                  | White Oak-Guy Rd Connector            | White Oak Rd to Guy Rd                          | Construct 4 lanes on new location   |
| A140a                  | Vandora Springs Rd & Extension        | Timber Dr to Old Stage Rd                       | Widen from 2 to 4 lanes             |
| A140b                  | Vandora Springs Rd & Extension        | Old Stage Rd to US 401                          | Widen from 2 to 4 lanes             |
| A142a                  | Timber Dr East                        | Waterfiled Rd to White Oak Rd                   | Construct 4 lanes on new location   |
| A143a                  | White Oak Rd                          | US 70 to I-540                                  | Widen from 2 to 4 lanes             |
| A143a1                 | I-40/White Oak Interchange            |                                                 | Interchange                         |
| A143b                  | White Oak Rd                          | I-540 to NC 42 (Johnston Co)                    | Widen from 2 to 4 lanes             |
| A163a                  | Holly Springs Rd                      | Old Holly Springs Rd to N of NC 540 Interchange | Widen from 2 to 4 lanes             |
| A163c                  | Friendship Rd                         | Richardson Rd to Old Holly Springs Apex         | Widen from 2 to 4 lanes             |
| A164c2                 | Green Level Church Rd                 | Kit Creek Rd to Precept Way                     | Widen from 2 to 4 lanes             |
| A165a2                 | Airport Blvd Extension                | Garden Square Lane to NC 54                     | Construct 4 lanes on new location   |
| A165b                  | Airport Blvd Extension                | Davis Dr to Louis Stephens Rd                   | Construct 2 lanes on new location   |
| A168a                  | Green Level Church Rd                 | Green Level West to Jenks Rd                    | Widen from 2 to 4 lanes             |
| A168b                  | Green Level Church Rd                 | Green Level West to Morrisville Parkway         | Widen from 2 to 4 lanes             |
| A173                   | New Hill Olive Chapel Rd              | Old US 1 to Chatham Co.                         | Widen from 2 to 3 lanes             |
| A187b2                 | Apex Peakway (East)                   | Laura Duncan to Old Raleigh Rd                  | Widen from 2 to 4 lanes             |
| A187b3                 | Apex Peakway (East)                   | Old Raleigh Rd to Center Street                 | Widen from 2 to 4 lanes             |
| A190                   | New Hill Holleman Rd                  | Old US 1 to Avent Ferry Rd                      | Widen from 2 to 4 lanes             |
| A193a                  | Sunset Lake Rd                        | US 401 to Hilltop-Needmore Rd                   | Widen from 2 to 4 lanes             |
| A193b                  | Sunset Lake Rd                        | Hilltop-Needmore Rd to Optimist Farm Rd         | Widen from 2 to 4 lanes             |
| A201a                  | Rock Quarry Rd                        | New Hope Rd to Battle Bridge Rd                 | Widen from 2 to 4 lanes             |
| A202                   | East Garner Rd                        | Rock Quarry Rd to Shotwell Rd                   | Widen from 2 to 4 lanes             |
| A203                   | Auburn-Knightdale Rd                  | Grasshopper Rd to Raynor Rd                     | Widen from 2 to 4 lanes             |
| A217a                  | Sunset Lake Rd                        | Main St to Optimist Farm Rd                     | Widen from 2 to 4 lanes             |
| A217b                  | Sunset Lake Rd Extension              | Old Holly Springs Apex to Main St               | Construct 4 lanes on new location   |
| A218a                  | Old Holly Springs Apex Rd             | Holly Springs Rd to Jessie Dr                   | Widen from 2 to 4 lanes             |
| A218b                  | Jessie Dr (part NL)                   | Veridea Parkway to NC 55                        | Construct 4 lanes on new location   |
| A218c                  | Veridea Parkway                       | Tingen Rd to Jessie Dr                          | Widen from 2 to 3 lanes (turn lane) |
| A218d                  | Tingen Rd                             | Apex Peakway to Old Holly Springs Apex Rd       | Widen from 2 to 3 lanes (turn lane) |
| A219a2                 | McCrimmon Parkway Extension           | Davis Dr to Louis Stephens Rd                   | Widen from 2 to 4 lanes             |
| A219b                  | McCrimmon Parkway Extension           | Louis Stephens Rd to NC 55                      | Construct 4 lanes on new location   |
| A221                   | NC 54                                 | N.W. Maynard Rd to Wilson Rd                    | Widen from 2 to 6 lanes             |
| A222b                  | NC 54                                 | Weston Parkway to McCrimmon Pkwy                | Widen from 2 to 4 lanes             |
| A228a                  | NC 50                                 | Timber Dr to I-540                              | Widen from 2 to 4 lanes             |
| A27d                   | Louis Stephens Dr Ext (part existing) | Poplar Pike Lane to Airport Blvd                | Widen from 2 to 4 lanes             |



**Table 6.2 (Page 2 of 2)**  
**Year 2035 Roadway Improvements**  
**Assumed in the Complete 540 Forecast Model**

| Project<br>STIP/MTP ID | Roadway                             | Location                                   | Description                       |
|------------------------|-------------------------------------|--------------------------------------------|-----------------------------------|
| A300                   | US 70                               | US 401 to I-40                             | Widen from 4 to 6 lanes           |
| A301                   | US 70                               | I-40 to NC 42                              | Widen from 4 to 6 lanes           |
| A402a                  | Buffaloe Rd                         | Spring Forest Rd Ext to Forestville Rd     | Widen from 2 to 4 lanes           |
| A407b2                 | NC 42                               | John Adams Rd to NC 50                     | Widen from 2 to 4 lanes           |
| A41                    | Kildare Farm Rd                     | Ten Ten Rd to Kildare Farm Connector       | Widen from 2 to 4 lanes           |
| A449                   | Perry Rd Extension                  | Apex Peakway to NC 55 Bypass               | Construct 4 lanes on new location |
| A480a                  | US 401 (South)                      | US 70 to Ten Ten Rd                        | Widen from 4 to 6 lanes           |
| A543b                  | Rex Rd Realignment                  | Avent Ferry Connector to Cass Holt Rd      | Construct 4 lanes on new location |
| A544a                  | Avent Ferry Connector               | Old Holly Springs Apex to Holly Springs Rd | Construct 4 lanes on new location |
| A544b                  | Avent Ferry Connector               | Holly Springs Rd to Rex Rd                 | Construct 4 lanes on new location |
| A547                   | Stephenson Rd                       | Ten Ten Rd to Sunset Lake Rd               | Widen from 2 to 4 lanes           |
| A617a                  | US 401 Bypass                       | US 401 (East of Fuquay-Varina) to NC 55    | Construct 6 lanes on new location |
| A619a                  | US 401                              | NC 540 to US 401 Bypass                    | Widen from 4 to 6 lanes           |
| A619b                  | US 401                              | US 401 Bypass to NC 55/NC 42               | Widen from 4 to 6 lanes           |
| A652                   | NC 55                               | Morrisville Carpenter Rd to NC 540         | Widen from 4 to 6 lanes           |
| A66a                   | O'Kelley Chapel Rd                  | Alston Avenue to NC 55                     | Widen from 2 to 4 lanes           |
| A66b                   | O'Kelley Chapel Rd                  | Alston Avenue to NC 751                    | Widen from 2 to 4 lanes           |
| A70                    | Holly Springs Rd                    | Penny Rd to Ten Ten Rd                     | Widen from 2 to 4 lanes           |
| A71                    | Holly Springs Rd                    | Ten Ten Rd to Kildaire Farm Rd Connector   | Widen from 2 to 4 lanes           |
| A75b                   | Yates Store Rd                      | Yates Store Rd to Morrisville Parkway      | Construct 4 lanes on new location |
| A75c                   | Wimberley Rd                        | Morrisville Parkway to Green Level West Rd | Construct 4 lanes on new location |
| A77b2                  | West Lake Rd                        | Ten Ten Rd and Middle Creek Park Ave       | Widen from 2 to 4 lanes           |
| A94                    | NC 55                               | NC 540 to Kit Creek Rd                     | Widen from 4 to 6 lanes           |
| A98                    | NC 55 Bypass                        | North Main St to Honeycutt Connector       | Widen from 4 to 6 lanes           |
| F14                    | Clayton Bypass Widening             | I-40 to US 70                              | Widen from 4 to 6 lanes           |
| F15A                   | US 64 West conversion to expressway | Laura Duncan Rd to I-540                   | Widen from 4 to 6 lanes           |
| F15B                   | US 64 West conversion to expressway | NC 540/TriEx to NC 751                     | Widen from 4 to 6 lanes           |
| F41                    | I-40 Managed Lanes                  | Wade Avenue to Johnston County             | Construct 2 Managed Lanes         |
| F41b                   | I-40 Managed Lanes                  | Johnston County to Cornwallis Rd           | Construct 2 Managed Lanes         |
| F42b                   | I-540 Managed Lanes                 | I-40 to US 64 Bypass                       | Construct 2 Managed Lanes         |
| F44c                   | I-40 (East)                         | NC 42 to NC 210                            | Widen from 4 to 6 lanes           |
| F44d                   | I-40 (East)                         | NC 210 to CAMPO MAB                        | Widen from 4 to 6 lanes           |
| F45                    | I-40 Managed Lanes                  | Cornwallis Rd to NC 210                    | Construct 2 Managed Lanes         |
| F7a                    | US 64 East                          | US 64 Bypass to US 64/US 264 to            | Widen from 4 to 6 lanes           |
| F86                    | Capital Blvd                        | I-440 to I-540                             | Corridor Upgrades on new location |
| I-3306AA               | I-40                                | NC 86 to I-85                              | Widen from 4 to 6 lanes           |
| I-3306AB               | I-40                                | US 15-501 to NC 86                         | Widen from 4 to 6 lanes           |
| I-5702                 | I-40 Managed Lanes                  | Durham County Line to Wade Avenue          | Construct 2 Managed Lanes         |
| I-5702B                | I-40 Managed Lanes                  | Wake County Line to NC 147                 |                                   |
| I-5704                 | I-40                                | Wade Avenue to US 1/64                     | Widen from 6 to 8 lanes           |
| U-5774C                | US 70 (freeway conversion)          | S Miami Blvd to Northern Durham Parkway    | Widen from 4 to 6 lanes           |
| U-5774G                | NC 54                               | I-40 Interchange to NC 751                 | Widen from 2 to 4 lanes           |
| U-5774H                | NC 54                               | NC 751 to Highgate Dr                      | Widen from 2 to 4 lanes           |
| U-5774I                | NC 54                               | Fayetteville to Barbee                     | Widen from 2 to 4 lanes           |
| U-5774J                | NC 54                               | Barbee to NC 55                            | Widen from 2 to 4 lanes           |
| U-6066                 | US 1                                | US 64 to NC 540                            | Widen from 4 to 6 lanes           |



## ASSUMED LONG-RANGE HIGHWAY IMPROVEMENTS - 2045



**Table 6.3**  
**Year 2045 Roadway Improvements**  
**Assumed in the Complete 540 Forecast Model**

| Project<br>STIP/MTP | Roadway                     | Location                                   | Description                    |
|---------------------|-----------------------------|--------------------------------------------|--------------------------------|
| A149a               | Poole Rd                    | I-540 to Martin Pond Rd                    | Widen from 2 to 4 lanes        |
| A172                | Kelly Rd                    | Jenks Rd to Old US 1                       | Widen from 2 to 4 lanes        |
| A178a               | Olive Chapel Rd             | Kelly Rd to NC 55                          | Widen from 2 to 4 lanes        |
| A178b               | Olive Chapel Rd             | Richardson Rd to Kelly Rd                  | Widen from 2 to 3 lanes (turn  |
| A178c               | Olive Chapel Rd             | New Hill Olive Chapel Rd to Richardson     | Widen from 2 to 3 lanes (turn  |
| A179a               | Richardson Rd               | US 64 (West) to Olive Chapel Rd            | Construct 4 lanes on new       |
| A179b               | Richardson Rd               | Olive Chapel Rd to Humie Olive Rd          | Widen from 2 to 4 lanes        |
| A179c               | Richardson Rd               | Humie Olive Rd to Old US 1 Highway         | Construct 4 lanes on new       |
| A184                | Apex Barbecue Rd            | Old US 1 to Olive Chapel Rd                | Widen from 2 to 3 lanes (turn  |
| A186a               | Friendship Rd               | Friendship Rd to Winding Way               | Widen from 2 to 3 lanes (turn  |
| A186b               | Friendship Rd               | Winding Rd to Old US 1                     | Widen from 2 to 3 lanes (turn  |
| A187a               | Apex Peakway                | Olive Chapel Rd to Laura Duncan Rd         | Widen from 2 to 4 lanes        |
| A187c               | Apex Peakway                | Broadstone Way to Old US 1                 | Widen from 2 to 4 lanes        |
| A187d               | Apex Peakway                | Old US 1 to Olive Chapel Rd                | Widen from 2 to 4 lanes        |
| A192                | Graham Newton Rd            | Penny Rd to Optimist Farm Rd               | Widen from 2 to 4 lanes        |
| A197b               | Center Campus               | Main Campus Dr Connector to I-40           | Const. 4 lanes on new location |
| A214                | Garner Rd                   | Tryon Rd to Rock Quarry Rd                 | Widen from 2 to 3 lanes (turn  |
| A218f               | Jessie Dr                   | NC 55 to Ten Ten Rd                        | Widen from 2 to 4 lanes        |
| A228b               | NC 50                       | I-540 to NC 42                             | Widen from 2 to 4 lanes        |
| A237b               | Old Apex Rd                 | Cary Parkway to Laura Duncan Rd            | Widen from 2 to 4 lanes        |
| A27a                | Louis Stephens Dr Extension | Wake County Line to Kit Creek Rd           | Widen from 2 to 4 lanes        |
| A27b                | Louis Stephens Dr Extension | Kit Creek Rd to O'Kelly Chapel Rd          | Widen from 2 to 4 lanes        |
| A34                 | Cary Parkway                | Evans Rd to Harrison Ave                   | Widen from 2 to 4 lanes        |
| A36c                | Chatham St                  | N.E. Maynard Rd to I-40 Bridge             | Widen from 2 to 4 lanes        |
| A38                 | Tryon Rd                    | US 64 to Kildare Farm Rd                   | Widen from 2 to 6 lanes        |
| A400a               | Ten Ten Rd                  | Bells Lake Rd to Old Stage Rd              | Widen from 2 to 4 lanes        |
| A400b               | Ten Ten Rd                  | Old Stage Rd to NC 50                      | Widen from 2 to 4 lanes        |
| A403c               | Hodge Rd                    | Auburn-Knightdale Rd to Poole Rd           | Widen from 2 to 4 lanes        |
| A410                | Lake Pine Dr/Old Raleigh Rd | Cary Parkway to Apex Peakway               | Widen from 2 to 4 lanes        |
| A426                | NC 55 (Main St)             | Holly Springs Rd to Technology Dr          | Widen from 2 to 4 lanes        |
| A427c               | Avent Ferry Rd              | New Hill Holleman to Cass Holt             | Widen from 2 to 4 lanes        |
| A42a                | Penny Rd                    | Ten Ten Rd to Kildaire Farm Rd             | Widen from 2 to 4 lanes        |
| A42b                | Penny Rd                    | Kildaire Farm Rd to Holly Springs Rd       | Widen from 2 to 4 lanes        |
| A443a               | Jenks Rd                    | NC 55 to Wimberly Rd                       | Widen from 2 to 3 lanes (turn  |
| A443b               | Jenks Rd                    | Wimberly Rd to US 64                       | Widen from 2 to 4 lanes        |
| A510                | Cass Holt Rd                | Avent Ferry Rd to NC 42                    | Widen from 2 to 4 lanes        |
| A520a               | Pleasant Grove Church Rd    | Nelson Rd to Airport Blvd                  | Widen from 2 to 4 lanes        |
| A520b               | Pleasant Grove Church Rd    | Airport Blvd to Aviation Parkway           | Construct 2 lanes on new       |
| A538                | Bass Lake Rd                | Holly Springs Rd to Hilltop-Needmore Rd    | Widen from 2 to 4 lanes        |
| A539                | Banks Rd                    | US 401 to Fanny Brown Rd                   | Widen from 2 to 3 lanes (turn  |
| A540a               | Rock Service Station        | Old Stage Rd to NC 42                      | Widen from 2 to 3 lanes (turn  |
| A540b               | Rock Service Station        | NC 42 to Mt Pleasant Rd                    | Widen from 2 to 3 lanes (turn  |
| A549                | Wimberley Rd                | Jenks Rd to Green Level West Rd            | Widen from 2 to 3 lanes        |
| A568                | Kit Creek Rd                | Davis Dr to Green Level Church Rd          | Widen from 2 to 3 lanes (turn  |
| A571                | Slater Rd                   | Airport Blvd to West of NC 540             | Widen from 2 to 3 lanes (turn  |
| A578                | Auburn Church Rd            | Jones Sausage Rd to Garner Rd              | Widen from 2 to 3 lanes (turn  |
| A581                | Bethlehem Rd                | Old Faison Rd to Grasshopper Rd            | Widen from 2 to 3 lanes (turn  |
| A675a               | Morrisville East Connector  | Trans Air Dr/Airport Blvd to Int'l Dr/Nova | Construct 2 lanes on new       |
| A677                | Marcom Dr Extension         | Watkins Rd to Sorrell Grove Church Rd      | Construct 2 lanes on new       |
| A76                 | Optimist Farm Rd            | Lake Wheeler Rd to Sunset Lake Rd          | Widen from 2 to 4 lanes        |
| A77a                | West Lake Rd                | Larboard Rd to Bells Lake Rd               | Construct 2 lanes on new       |
| A98c                | Technology Drive            | Technology Drive and NC 55 Bypass          | Interchange                    |
| R-3618              | Guy Rd                      | US 70 Bus to NC 42                         | Widen from 2 to 4 lanes        |
| Jhns8               | Cornwallis Rd               | NC 42 to Old Drugstore Rd                  | Widen from 2 to 4 lanes        |
| Jhns9               | Old Drugstore Rd            | NC 42 to NC 50                             | Widen from 2 to 4 lanes        |
| Jhns10              | Cleveland Rd                | NC 50 to Barber Mill Rd                    | Widen from 2 to 4 lanes        |
| 45                  | I-40 Managed Lanes          | NC 54 to US 15-501                         | Widen from 6 to 8 lanes        |
| 45                  | I-40 Managed Lanes          | NC 147 to NC 54                            | Widen from 6 to 10 lanes       |
| 48                  | I-85                        | Sparger Rd to US 70                        | Widen from 4 to 6 lanes        |
| 48                  | I-85                        | US 70 to I-40                              | Widen from 4 to 6 lanes        |
| 77.2                | NC 751                      | NC 54 to Renaissance Pkwy                  | Widen from 2 to 4 lanes        |
| 77.3                | NC 751                      | Renaissance Pkwy to O'Kelly Chapel Rd      | Widen from 2 to 4 lanes        |
| 114                 | US 15-501 Bypass            | MLK Parkway to I-85                        | Widen from 4 to 6 lanes        |

2. A new interchange at Morrisville Parkway will be open to traffic on January 1, 2020. Associated with this new interchange will be a new mainline toll zone, north of the new Morrisville interchange, and associated adjustments in toll rates at the existing mainline toll zones, T17/T18, north of Green Level West Road. Triangle Expressway toll zones are shown in Figure 1.3 in Chapter 1.
3. Existing ramp toll zones at Hopson Road and U.S. 64 will be removed and replaced with two new mainline tolling zones immediately north of these respective interchanges. Associated toll rate adjustments also occurred to maintain consistent through-trip per-mile toll rates. The toll-collection system changes are assumed to begin on July 1, 2023.
4. Tolls on the Triangle Expressway will continue to be charged for three vehicle classes, using a cashless all-electronic toll collection methodology. Two payment types will continue to be offered; electronic toll collection with transponders (ETC) and Bill by Mail (BBM), utilizing video imaging of license plates for those vehicles not equipped with transponders. Toll rates for each year of the forecast period will be as shown in Table 6.5, which assumes continued annual increases in toll rates. Any changes in the assumed rates of annual increase, or discontinuation of annual rate increases, will impact traffic and revenue forecasts.
5. Highway and other transportation improvements as set forth in Tables 6.1, 6.2 and 6.3 will be implemented within the time frames assumed in those tables. No other transportation improvement projects, particularly new roads, additional road capacity or new interchanges will be constructed during the forecast period, other than those shown in Table 6.1, 6.2, and 6.3.
6. For purposes of the Scenario 1 forecast, no other planned or potential extensions or connections to Triangle Expressway are assumed during the projection period, other than the modifications described in numbers 2 and 3 above.
7. The annual rate of inflation and estimated method-of-payment market shares among ETC and BBM will be as shown in Table 6.7 for purposes of the forecast. Any change in inflation rates could affect traffic and revenue even if toll rates continue to be adjusted in accordance with assumptions shown in Table 6.5.
8. Economic growth in the project study area will generally occur as forecasted by the independent economist used in the study, whose work is summarized in Chapter 3.
9. Leakage and fee revenue adjustments are applied to the estimated gross toll revenue forecasts. The adjustments are based on 5 ½ years of actual experience on the Triangle Expressway, provided by NCTA. The forecast assumes that toll revenue collection, particularly as related to BBM transactions and processing fee revenue, will continue to be collected at similar rates over the forecast period.
10. The Triangle Expressway will continue to be well maintained, efficiently operated, effectively signed and promoted to encourage maximum usage.
11. Motor fuel will remain in adequate supply throughout the forecast period. Fuel price increases will not significantly exceed the overall rate of inflation. Fuel price forecasts provided by the U.S. Energy Information Administration through 2050 will generally be experienced.

12. No national, state or regional emergency will arise that would abnormally restrict the use of motor vehicles. Future transportation technology changes will not significantly negatively impact traffic and revenue on Triangle Expressway over the projection period.

Any significant departure from these basic assumptions could materially affect traffic and revenue potential on the Triangle Expressway.

## 6.4 Historical Trends and Short-Term Projections

**Table 6.4** shows recent trends in toll transactions, toll revenue and average tolls on the Triangle Expressway. Historical data is shown between calendar 2013, the first full year of operation for Triangle Expressway, and 2017. Near-term projections are shown for calendar 2018 and 2019.

The trend data shows a classic pattern of ramp-up on a new, urban toll facility. Transactions in 2014 exceeded opening year transactions by almost 33 percent, with transaction growth in the following years decreasing to 25.0, 18.1 and 9.3 percent, respectively. This very high level of early year transaction growth is consistent with ramp up patterns on other toll facilities. It is particularly strong,

**Table 6.4**  
**Triangle Expressway Annual Transactions and Gross Toll Revenue**  
**Historical Trends and Short-Term Projections**  
(transactions and revenue in thousands)

| Calendar<br>Year              | Toll Transactions and<br>Year-over-Year<br>Percent Growth |        | Average Weighted<br>Toll Rate and<br>Year-over-Year<br>Percent Growth (1) |        | Gross Toll Revenue<br>and Year-over-Year<br>Percent Growth (2) |        |
|-------------------------------|-----------------------------------------------------------|--------|---------------------------------------------------------------------------|--------|----------------------------------------------------------------|--------|
|                               | Transactions                                              | Growth | Toll Rate                                                                 | Growth | Revenue                                                        | Growth |
|                               |                                                           |        |                                                                           |        |                                                                |        |
| 2013                          | 23,059                                                    |        | \$0.617                                                                   |        | \$14,238                                                       |        |
| 2014                          | 30,650                                                    | 32.9 % | 0.687                                                                     | 11.2 % | 21,045                                                         | 47.8 % |
| 2015                          | 38,319                                                    | 25.0   | 0.751                                                                     | 9.4    | 28,779                                                         | 36.7   |
| 2016                          | 45,244                                                    | 18.1   | 0.782                                                                     | 4.2    | 35,393                                                         | 23.0   |
| 2017                          | 49,460                                                    | 9.3    | 0.825                                                                     | 5.4    | 40,792                                                         | 15.3   |
| 2018 (3)                      | 52,922                                                    | 7.0    | 0.855                                                                     | 3.6    | 45,231                                                         | 10.9   |
| 2019 (4)                      | 55,410                                                    | 4.7    | 0.886                                                                     | 3.7    | 49,100                                                         | 8.6    |
| Average Annual Percent Change |                                                           |        |                                                                           |        |                                                                |        |
| 2013-2017                     |                                                           | 21.0   |                                                                           | 7.5    |                                                                | 30.1   |
| 2013-2019                     |                                                           | 15.7   |                                                                           | 6.2    |                                                                | 22.9   |

(1) The average weighted toll rate is calculated by dividing total toll revenue for the year by total toll transactions for the year.

(2) This is toll revenue collected during the indicated year. It does not include fee revenue.

(3) Based on data through June 2018.

(4) Estimated based on trend data.

Source: NCTA

however, recognizing that toll rates were increased annually, resulting in revenue growth which averaged more than 30 percent per year over the first five years of operation. Specifically, the average

annual growth in transactions between 2013 and 2017 was 21.0 percent per year, together with the increase in average tolls, yielding a 30.1 percent per year average increase in revenue.

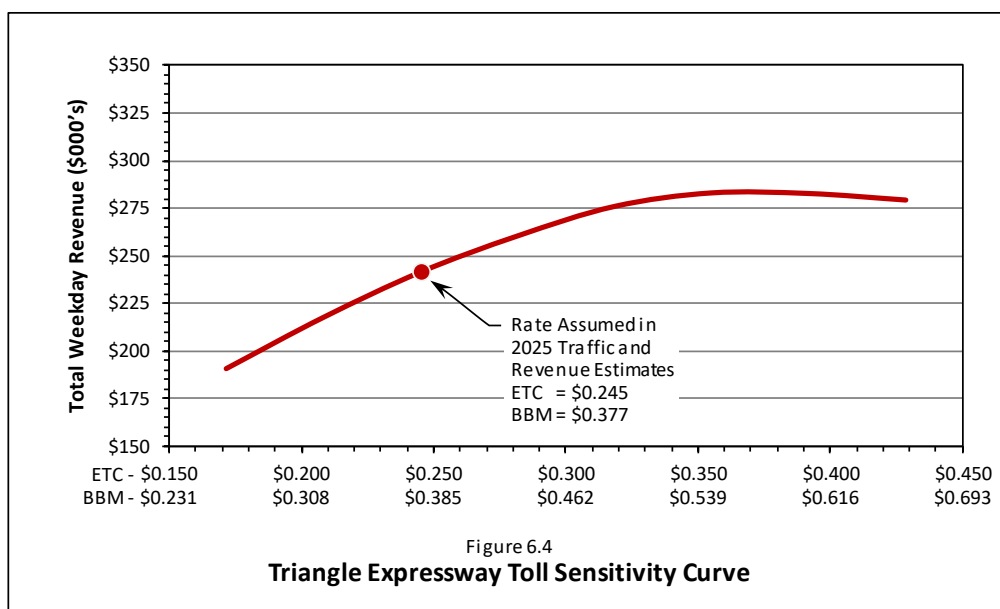
It is important to note that the rate of growth in the average toll per transaction is a function of both programmed rate increases (generally around 3 percent per year) as well as shifts in the distribution of transactions between local ramps and mainline tolling points, and changes in the mix of ETC versus BBM transactions.

Year-end estimates of annual transactions and revenue for calendar year 2018 were developed by extrapolating actual data from January through June of 2018. Transaction growth is expected to reach about 7.0 percent in 2018, with revenue increasing by about 10.9 percent. The projection for 2019 shows a 4.7 percent increase in annual transactions and an 8.6 percent increase in toll revenue growth compared to the prior calendar year. Toll transactions in calendar 2019 are expected to reach about 55 million while gross toll revenue, prior to adjustment for leakage and not including additional fee revenue, is expected to reach just over \$49 million.

## 6.5 Toll Sensitivity Assessment

As part of this traffic and revenue study, an updated toll sensitivity analysis was conducted at 2025 levels for the Triangle Expressway. Future toll rates and rate increases assumed in this study follow previously established patterns which have been adopted by the NCTA Board. The updated toll sensitivity analysis included herein is simply to provide an indication of where current and assumed future toll rates fall within the overall rate sensitivity curve; providing an indication of the ability to increase revenue, if ever needed, with future toll rate increases above those already assumed.

**Figure 6.4** shows the toll sensitivity curve at 2025 levels. The horizontal scale shows the per-mile toll rate levels which were tested in the analysis, for ETC and BBM payment methods. The prior relationship between ETC and BBM is assumed to remain constant, with ETC rates priced at 35 percent less than BBM rates. ETC rates tested ranged from \$0.170 per mile to \$0.430 per mile, at 2025 levels. As shown, maximum revenue potential would be generated at a per mile ETC toll rate of about \$0.35 per mile. The Scenario 1 forecast assumes the 2025 rates would be approximately \$0.245



per mile, well below the revenue maximizing rate. This indicates there is considerable ability to raise revenues by increasing toll rates above the assumed rates.

In the curve shown in Figure 6.4, revenue is expressed in average weekday terms, and includes both ETC and BBM revenue elements. On a weekday basis, in 2025, the current assumed toll rate of \$0.245 per mile would yield about \$242,000 revenue per weekday. At revenue maximizing rates, revenue would be increased to about \$283,000 per day, an increase of about 17 percent. However, given the relatively flat shape of the curve, this 17 percent revenue increase would be achieved through a 45 to 50 percent increase in toll rates.

**Figure 6.5** shows equivalent assumed 2025 toll rates by toll zones and vehicle class on the Triangle Expressway. As noted previously, by 2025 a new interchange will be added at Morrisville Parkway and three new mainline toll zones will be added north of the Hopson Road, Morrisville Parkway and U.S. 64 interchanges. Existing ramp toll zones will be removed at the Hopson Road and U.S. 64 interchanges.

Computed toll rates are shown separately for ETC and BBM rates, for each of the three vehicle classes. As is current practice, it is assumed that the Class 2 toll will be twice the Class 1 toll while the Class 3 toll, which represents vehicles with more than three axles, would be set at four times the Class 1 rate.

Figure 6.5 also shows the equivalent through-trip toll via Toll NC 540. Note these through-trip rates exclude the Toll NC 147 portion of the toll facility, and instead cover travel on Toll NC 540 between NC 54 on the north and NC 55 Bypass on the south. By 2025, the through-trip toll for passenger cars would be \$3.70 for the 15.1-mile trip. This is equivalent to \$0.245 per mile. Class 2 vehicles would be charged \$7.40 for the full trip while Class 3 vehicles would be charged \$14.80, a per-mile rate of almost \$1.00 per mile for the heaviest vehicles. It is important to recognize that the toll rates shown in Figure 6.5 reflect 2025 conditions, after seven years of annual rate increases from current day levels.

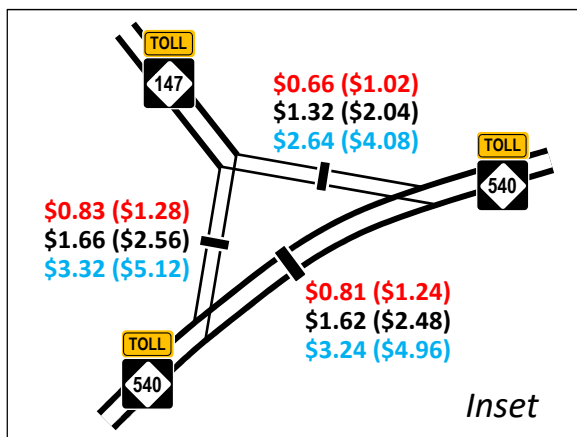
**Table 6.5** shows assumed Class 1 toll rates by year for the toll zones on Triangle Expressway. Rates are shown separately for ETC and BBM transactions at each location. Location T15/T16 is the new mainline toll point associated with the Morrisville Parkway interchange, that is assumed to open on January 1, 2020. Toll rate adjustments were made at the adjacent mainline toll zone (T17/T18) to maintain relatively consistent through-trip per-mile toll rates.

New mainline toll points are also introduced in 2024. The new mainlines toll zones replace ramp tolls at locations T01/T02 and T21/T22. These toll zone relocations necessitated adjustments to the toll schedule at adjacent mainline sections to maintain or improve consistent per-mile toll rates for both through-trips and shorter distance trips. Overall, the average through trip per mile toll rate for ETC Class 1 transactions will increase from \$0.191 in 2018 to \$0.245 in 2025 and to \$0.330 in 2035.

Table 6.5 also shows the assumed average annual percent increase in toll rates for each tolling point and payment category on Triangle Expressway. Using the through-trip rate as an overall measure, toll rates will increase by an average of 3.2 percent per year between 2018 and 2023, 3.0 percent per year between 2024 and 2035 and about 2.0 percent per year after 2035. Overall, between 2018 and 2058, toll rates will increase by an average annual amount of 2.6 percent. The values in Table 6.5 are assumed to be in place in each of the future years shown.

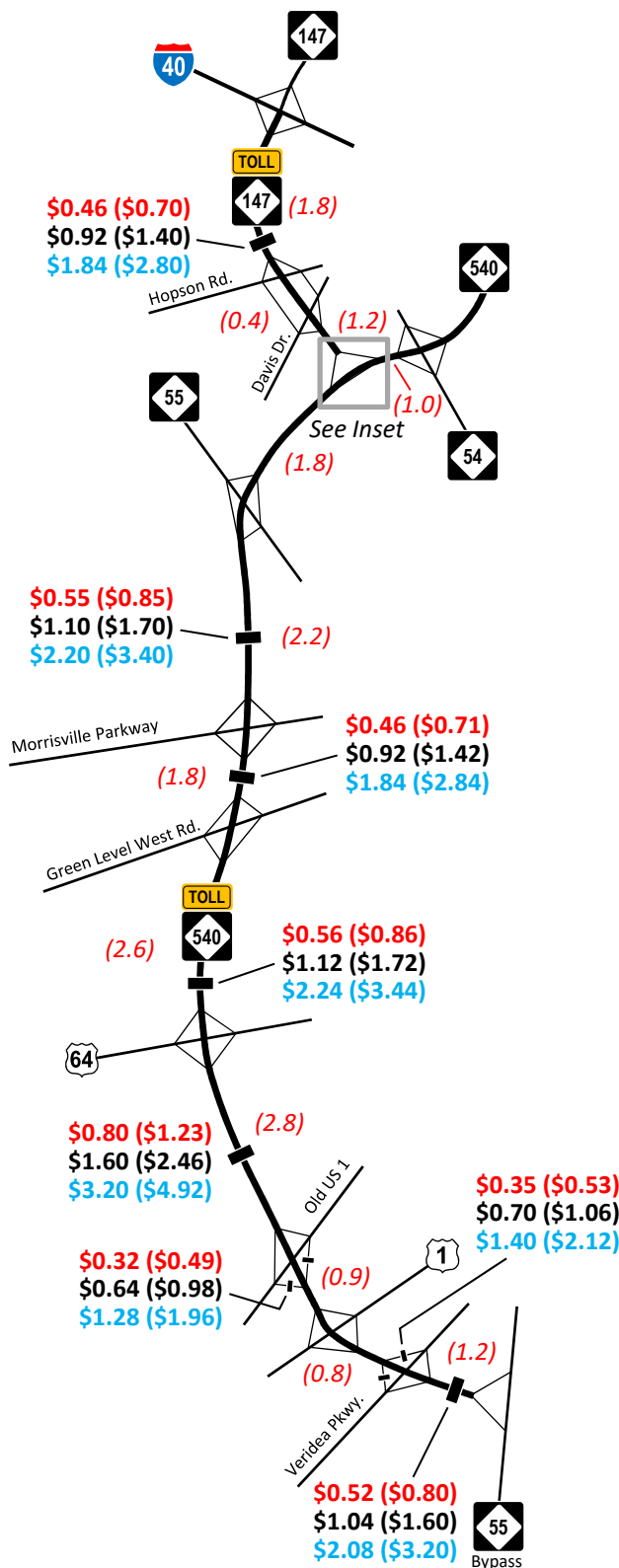
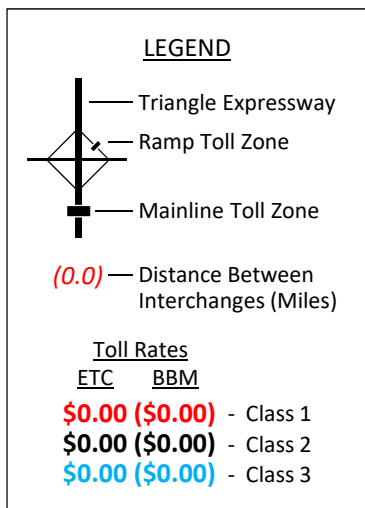


# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



## 2025 Through Trip ETC Toll Rates

| Via Toll NC 540 |         |               |
|-----------------|---------|---------------|
| Vehicle Class   | Toll    | Toll Per Mile |
| Class 1         | \$3.70  | \$0.245       |
| Class 2         | \$7.40  | \$0.490       |
| Class 3         | \$14.80 | \$0.980       |



## ASSUMED 2025 TOLL RATES BY TOLL ZONE AND VEHICLE CLASS - TRIANGLE EXPRESSWAY

Table 6.5  
Assumed Class 1 Toll Rates By Year  
Triangle Expressway Toll Zones

| Calendar<br>Year (1) | T01/T02 |        | T09/T10 |        | T05/T06 |        | T13/T14 |        | T15/T16 |      | T17/T18 |        | T24/T22 |        | T25/T26 |        | T29/T30 |        | T31/T32 |        | T33/T34 |        | ETC Through Trip via<br>Toll NC 540 |                      |
|----------------------|---------|--------|---------|--------|---------|--------|---------|--------|---------|------|---------|--------|---------|--------|---------|--------|---------|--------|---------|--------|---------|--------|-------------------------------------|----------------------|
|                      | ETC     | BBM    | ETC     | BBM    | ETC     | BBM    | ETC     | BBM    | ETC     | BBM  | ETC     | BBM    | ETC     | BBM    | ETC     | BBM    | ETC     | BBM    | ETC     | BBM    | ETC     | BBM    | Toll Rate (4)                       | Rate (4)<br>Per-mile |
| 2018                 | \$0.37  | \$0.56 | \$0.81  | \$1.24 | \$1.01  | \$1.55 | \$0.65  | \$1.00 | --      | --   | \$0.81  | \$1.24 | \$0.45  | \$0.69 | \$1.01  | \$1.54 | \$0.26  | \$0.39 | \$0.28  | \$0.43 | \$0.42  | \$0.64 | \$2.89                              | \$0.191              |
| 2019                 | 0.38    | 0.58   | 0.84    | 1.29   | 1.05    | 1.61   | 0.67    | 1.03   | --      | --   | 0.84    | 1.29   | 0.47    | 0.71   | 1.04    | 1.60   | 0.26    | 0.40   | 0.29    | 0.44   | 0.44    | 0.67   | 2.99                                | \$0.198              |
| 2020 (2)             | 0.39    | 0.60   | 0.87    | 1.33   | 1.08    | 1.66   | 0.70    | 1.07   | 0.48    | 0.73 | 0.39    | 0.60   | 0.48    | 0.73   | 1.08    | 1.65   | 0.28    | 0.42   | 0.30    | 0.46   | 0.45    | 0.69   | 3.10                                | \$0.205              |
| 2021                 | 0.41    | 0.62   | 0.90    | 1.38   | 1.12    | 1.72   | 0.72    | 1.10   | 0.49    | 0.76 | 0.41    | 0.63   | 0.50    | 0.76   | 1.11    | 1.70   | 0.28    | 0.43   | 0.31    | 0.47   | 0.47    | 0.71   | 3.20                                | \$0.212              |
| 2022                 | 0.42    | 0.64   | 0.93    | 1.42   | 1.16    | 1.77   | 0.74    | 1.13   | 0.51    | 0.78 | 0.42    | 0.65   | 0.51    | 0.78   | 1.14    | 1.75   | 0.30    | 0.45   | 0.32    | 0.49   | 0.48    | 0.73   | 3.29                                | \$0.218              |
| 2023 (3)             | 0.43    | 0.66   | 0.95    | 1.46   | 1.19    | 1.82   | 0.77    | 1.17   | 0.52    | 0.80 | 0.43    | 0.66   | 0.53    | 0.81   | 1.17    | 1.80   | 0.30    | 0.46   | 0.33    | 0.50   | 0.49    | 0.75   | 3.38                                | \$0.224              |
| 2024 (4)             | 0.43    | 0.66   | 0.95    | 1.46   | 1.19    | 1.82   | 0.77    | 1.17   | 0.52    | 0.80 | 0.43    | 0.66   | 0.53    | 0.81   | 1.17    | 1.80   | 0.30    | 0.46   | 0.33    | 0.50   | 0.49    | 0.75   | 3.38                                | \$0.224              |
| 2024 (5)             | 0.45    | 0.68   | 0.98    | 1.49   | 1.21    | 1.85   | 0.79    | 1.20   | 0.54    | 0.83 | 0.45    | 0.69   | 0.54    | 0.83   | 1.18    | 1.82   | 0.31    | 0.47   | 0.34    | 0.52   | 0.51    | 0.78   | 3.61                                | \$0.239              |
| 2025                 | 0.46    | 0.70   | 0.99    | 1.50   | 1.22    | 1.87   | 0.81    | 1.21   | 0.55    | 0.85 | 0.46    | 0.71   | 0.56    | 0.86   | 1.19    | 1.84   | 0.32    | 0.48   | 0.35    | 0.53   | 0.52    | 0.80   | 3.70                                | \$0.245              |
| 2026                 | 0.47    | 0.72   | 1.00    | 1.52   | 1.23    | 1.89   | 0.82    | 1.22   | 0.56    | 0.86 | 0.47    | 0.72   | 0.57    | 0.87   | 1.20    | 1.85   | 0.33    | 0.49   | 0.36    | 0.54   | 0.53    | 0.81   | 3.82                                | \$0.251              |
| 2027                 | 0.49    | 0.74   | 1.02    | 1.54   | 1.25    | 1.91   | 0.84    | 1.24   | 0.58    | 0.88 | 0.49    | 0.74   | 0.59    | 0.90   | 1.21    | 1.87   | 0.34    | 0.50   | 0.37    | 0.57   | 0.56    | 0.82   | 3.94                                | \$0.257              |
| 2028                 | 0.50    | 0.76   | 1.04    | 1.56   | 1.27    | 1.93   | 0.86    | 1.26   | 0.60    | 0.90 | 0.50    | 0.76   | 0.61    | 0.93   | 1.22    | 1.89   | 0.35    | 0.51   | 0.38    | 0.58   | 0.57    | 0.83   | 4.04                                | \$0.263              |
| 2029                 | 0.52    | 0.79   | 1.06    | 1.59   | 1.29    | 1.96   | 0.88    | 1.28   | 0.62    | 0.92 | 0.52    | 0.78   | 0.63    | 0.95   | 1.24    | 1.91   | 0.36    | 0.52   | 0.39    | 0.60   | 0.59    | 0.84   | 4.17                                | \$0.270              |
| 2030                 | 0.53    | 0.81   | 1.08    | 1.61   | 1.31    | 2.00   | 0.90    | 1.30   | 0.64    | 0.94 | 0.53    | 0.79   | 0.65    | 0.97   | 1.26    | 1.93   | 0.37    | 0.53   | 0.40    | 0.62   | 0.61    | 0.86   | 4.30                                | \$0.276              |
| 2031                 | 0.54    | 0.83   | 1.10    | 1.63   | 1.33    | 2.02   | 0.92    | 1.32   | 0.66    | 0.96 | 0.55    | 0.80   | 0.67    | 1.00   | 1.27    | 1.95   | 0.38    | 0.54   | 0.42    | 0.64   | 0.63    | 0.88   | 4.44                                | \$0.282              |
| 2032                 | 0.56    | 0.85   | 1.12    | 1.65   | 1.35    | 2.04   | 0.94    | 1.34   | 0.68    | 0.98 | 0.57    | 0.82   | 0.69    | 1.02   | 1.29    | 1.97   | 0.39    | 0.55   | 0.43    | 0.66   | 0.65    | 0.90   | 4.57                                | \$0.288              |
| 2033                 | 0.58    | 0.88   | 1.14    | 1.67   | 1.37    | 2.06   | 0.96    | 1.36   | 0.70    | 1.00 | 0.58    | 0.83   | 0.71    | 1.04   | 1.31    | 1.99   | 0.40    | 0.56   | 0.44    | 0.68   | 0.67    | 0.92   | 4.71                                | \$0.294              |
| 2034                 | 0.60    | 0.91   | 1.16    | 1.69   | 1.39    | 2.08   | 0.98    | 1.38   | 0.72    | 1.02 | 0.60    | 0.85   | 0.73    | 1.06   | 1.33    | 2.01   | 0.41    | 0.57   | 0.45    | 0.70   | 0.69    | 0.94   | 4.85                                | \$0.300              |
| 2035                 | 0.61    | 0.93   | 1.18    | 1.71   | 1.41    | 2.10   | 0.99    | 1.39   | 0.74    | 1.04 | 0.62    | 0.87   | 0.75    | 1.08   | 1.35    | 2.03   | 0.42    | 0.58   | 0.46    | 0.72   | 0.71    | 0.96   | 4.99                                | \$0.306              |
| 2036                 | 0.62    | 0.95   | 1.20    | 1.73   | 1.43    | 2.12   | 1.01    | 1.41   | 0.76    | 1.06 | 0.63    | 0.89   | 0.77    | 1.10   | 1.37    | 2.05   | 0.43    | 0.59   | 0.48    | 0.74   | 0.72    | 0.98   | 5.09                                | \$0.312              |
| 2037                 | 0.64    | 0.99   | 1.22    | 1.75   | 1.45    | 2.14   | 1.03    | 1.43   | 0.78    | 1.08 | 0.65    | 0.91   | 0.79    | 1.12   | 1.39    | 2.07   | 0.44    | 0.60   | 0.49    | 0.75   | 0.74    | 1.00   | 5.20                                | \$0.318              |
| 2038                 | 0.65    | 1.00   | 1.24    | 1.77   | 1.47    | 2.16   | 1.05    | 1.45   | 0.79    | 1.10 | 0.66    | 0.92   | 0.80    | 1.14   | 1.41    | 2.09   | 0.45    | 0.61   | 0.50    | 0.77   | 0.76    | 1.02   | 5.31                                | \$0.324              |
| 2039                 | 0.66    | 1.02   | 1.26    | 1.79   | 1.49    | 2.18   | 1.07    | 1.47   | 0.80    | 1.12 | 0.68    | 0.94   | 0.82    | 1.16   | 1.43    | 2.11   | 0.46    | 0.62   | 0.51    | 0.79   | 0.77    | 1.04   | 5.41                                | \$0.330              |
| 2040                 | 0.68    | 1.05   | 1.28    | 1.81   | 1.51    | 2.20   | 1.09    | 1.49   | 0.82    | 1.14 | 0.69    | 0.96   | 0.83    | 1.18   | 1.45    | 2.13   | 0.47    | 0.63   | 0.52    | 0.80   | 0.79    | 1.06   | 5.52                                | \$0.336              |
| 2041                 | 0.69    | 1.06   | 1.30    | 1.83   | 1.53    | 2.22   | 1.11    | 1.51   | 0.84    | 1.16 | 0.70    | 0.98   | 0.85    | 1.20   | 1.47    | 2.15   | 0.48    | 0.64   | 0.53    | 0.82   | 0.80    | 1.08   | 5.62                                | \$0.342              |
| 2042                 | 0.71    | 1.09   | 1.32    | 1.85   | 1.55    | 2.24   | 1.13    | 1.53   | 0.86    | 1.18 | 0.72    | 1.00   | 0.87    | 1.22   | 1.49    | 2.17   | 0.49    | 0.65   | 0.54    | 0.83   | 0.82    | 1.10   | 5.75                                | \$0.348              |
| 2043                 | 0.72    | 1.11   | 1.34    | 1.87   | 1.57    | 2.26   | 1.15    | 1.55   | 0.88    | 1.20 | 0.74    | 1.02   | 0.89    | 1.24   | 1.51    | 2.19   | 0.51    | 0.66   | 0.55    | 0.84   | 0.84    | 1.12   | 5.89                                | \$0.354              |
| 2044                 | 0.74    | 1.14   | 1.36    | 1.89   | 1.59    | 2.28   | 1.17    | 1.57   | 0.89    | 1.22 | 0.76    | 1.04   | 0.90    | 1.26   | 1.53    | 2.21   | 0.52    | 0.67   | 0.56    | 0.85   | 0.86    | 1.14   | 6.00                                | \$0.360              |
| 2045                 | 0.75    | 1.16   | 1.38    | 1.91   | 1.61    | 2.30   | 1.19    | 1.59   | 0.91    | 1.24 | 0.78    | 1.06   | 0.92    | 1.28   | 1.55    | 2.23   | 0.53    | 0.68   | 0.57    | 0.86   | 0.87    | 1.16   | 6.12                                | \$0.366              |
| 2046                 | 0.77    | 1.19   | 1.40    | 1.93   | 1.63    | 2.32   | 1.21    | 1.61   | 0.93    | 1.26 | 0.79    | 1.08   | 0.94    | 1.30   | 1.57    | 2.25   | 0.54    | 0.69   | 0.58    | 0.87   | 0.88    | 1.18   | 6.25                                | \$0.372              |
| 2047                 | 0.78    | 1.20   | 1.41    | 1.94   | 1.64    | 2.33   | 1.22    | 1.62   | 0.94    | 1.27 | 0.80    | 1.09   | 0.96    | 1.31   | 1.58    | 2.26   | 0.55    | 0.70   | 0.59    | 0.88   | 0.89    | 1.19   | 6.38                                | \$0.378              |
| 2048                 | 0.80    | 1.23   | 1.43    | 1.96   | 1.66    | 2.35   | 1.24    | 1.64   | 0.96    | 1.29 | 0.82    | 1.11   | 0.98    | 1.33   | 1.60    | 2.28   | 0.56    | 0.71   | 0.60    | 0.89   | 0.91    | 1.21   | 6.50                                | \$0.384              |
| 2049                 | 0.81    | 1.25   | 1.45    | 1.98   | 1.68    | 2.37   | 1.26    | 1.66   | 0.97    | 1.31 | 0.84    | 1.13   | 0.99    | 1.35   | 1.62    | 2.30   | 0.57    | 0.72   | 0.62    | 0.90   | 0.92    | 1.23   | 6.64                                | \$0.390              |
| 2050                 | 0.83    | 1.28   | 1.47    | 2.00   | 1.70    | 2.39   | 1.28    | 1.68   | 0.99    | 1.33 | 0.86    | 1.15   | 1.00    | 1.37   | 1.64    | 2.32   | 0.58    | 0.73   | 0.63    | 0.91   | 0.93    | 1.25   | 6.77                                | \$0.396              |
| 2051                 | 0.85    | 1.31   | 1.49    | 2.02   | 1.72    | 2.41   | 1.30    | 1.70   | 1.02    | 1.35 | 0.88    | 1.17   | 1.02    | 1.39   | 1.66    | 2.34   | 0.59    | 0.74   | 0.64    | 0.92   | 0.94    | 1.27   | 6.91                                | \$0.402              |
| 2052                 | 0.86    | 1.32   | 1.50    | 2.03   | 1.73    | 2.42   | 1.31    | 1.71   | 1.04    | 1.36 | 0.89    | 1.18   | 1.04    | 1.40   | 1.67    | 2.35   | 0.60    | 0.75   | 0.65    | 0.93   | 0.95    | 1.29   | 7.04                                | \$0.408              |
| 2053                 | 0.88    | 1.36   | 1.52    | 2.05   | 1.75    | 2.44   | 1.33    | 1.73   | 1.06    | 1.38 | 0.91    | 1.20   | 1.06    | 1.42   | 1.69    | 2.37   | 0.61    | 0.76   | 0.66    | 0.94   | 0.96    | 1.31   | 7.18                                | \$0.414              |
| 2054                 | 0.90    | 1.39   | 1.54    | 2.07   | 1.77    | 2.46   | 1.35    | 1.75   | 1.08    | 1.40 | 0.93    | 1.22   | 1.08    | 1.44   | 1.71    | 2.39   | 0.62    | 0.77   | 0.67    | 0.95   | 0.97    | 1.33   | 7.32                                | \$0.420              |
| 2055                 | 0.92    | 1.42   | 1.56    | 2.09   | 1.79    | 2.48   | 1.37    | 1.77   | 1.10    | 1.42 | 0.95    | 1.24   | 1.10    | 1.46   | 1.73    | 2.41   | 0.63    | 0.78   | 0.68    | 0.96   | 0.98    | 1.35   | 7.47                                | \$0.426              |
| 2056                 | 0.93    | 1.43   | 1.57    | 2.10   | 1.80    | 2.49   | 1.38    | 1.78   | 1.11    | 1.43 | 0.96    | 1.25   | 1.11    | 1.47   | 1.74    | 2.42   | 0.64    | 0.79   | 0.69    | 0.97   | 0.99    | 1.37   | 7.62                                | \$0.432              |
| 2057                 | 0.95    | 1.46   | 1.59    | 2.12   | 1.82    | 2.51   | 1.40    | 1.80   | 1.13    | 1.45 | 0.98    | 1.27   | 1.13    | 1.49   | 1.76    | 2.44   | 0.65    | 0.80   | 0.70    | 0.98   | 1.00    | 1.39   | 7.76                                | \$0.438              |
| 2058                 | 0.97    | 1.49   | 1.61    | 2.14   | 1.84    | 2.53   | 1.42    | 1.82   | 1.15    | 1.47 | 0.99    | 1.29   | 1.15    | 1.51   | 1.78    | 2.46   | 0.66    | 0.81   | 0.71    | 0.99   | 1.01    | 1.41   | 7.92                                | \$0.444              |
| 2018-2058            | 2.4     | 2.5    | 1.3     | 1.3    | 1.4     | 1.4    | 2.5     | 2.5    | 0.5     | 0.5  | 0.5     | 0.5    | 2.5     | 2.5    | 1.3     | 1.3    | 2.5     | 2.5    | 2.5     | 2.5    | 2.5     | 2.5    | 2.6                                 |                      |

## Average Annual Percent Change in Toll Rates

|           |     |     |     |     |     |     |     |     |       |       |     |     |     |     |     |     |     |     |     |     |     |     |     |  |
|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| 2018-2023 | 3.1 | 3.3 | 3.2 | 3.3 | 3.3 | 3.3 | 3.4 | 3.2 | -11.9 | -11.8 | 3.3 | 3.3 | 3.3 | 3.3 | 3.0 | 3.2 | 2.9 | 3.4 | 3.3 | 3.1 | 3.1 | 3.2 | 3.2 |  |
| 2024-2035 | 2.8 | 2.9 | 2.8 | 2.8 | 3.0 | 2.9 | 3.0 | 3.1 | 2.9   | 2.9   | 3.0 | 2.9 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.1 | 3.0 | 3.0 | 3.1 | 3.0 | 3.0 |  |
| 2036-2045 | 2.1 | 2.2 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1   | 2.1   | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.2 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 |  |
| 2046-2057 | 2.0 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 2.0 | 2.0   | 2.0   | 2.1 | 2.0 | 2.1 | 2.1 | 2.0 | 2.0 | 2.1 | 2.0 | 2.1 | 2.0 | 2.1 | 2.0 | 2.0 |  |
| 2018-2058 | 2.4 | 2.5 | 1.3 | 1.3 | 1.4 | 1.4 | 2.5 | 2.5 | 0.5   | 0.5   | 0.5 | 0.5 | 2.5 | 2.5 | 1.3 | 1.3 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.6 |  |

(1) Annual toll rate increases are assumed to be implemented on January 1st of each year.

(2) Assumes new Morrisville interchange and associated new mainline toll zones north of Morrisville Road open on January 1, 2020.

(3) Represents the toll rates from January 1 through June 30, 2023, prior to the conversion of ramp toll zones to mainline toll zones at Hopson Road and U.S. 64.

(4) Represents the toll rates from July 1 through December 31, 2023, that reflect the conversion of ramp toll zones to mainline toll zones at Hopson Road and U.S. 64, assumed to occur on July 1, 2023.

(5) Through-trip toll rates and distances, shown in this table, exclude the Toll NC 147 portion of Triangle Expressway.

Finally, **Table 6.6** provides a comparison of through-trip toll rates on Triangle Expressway, by vehicle class and payment method for each of the four primary modeling years. For example, in 2020, the through trip Class 1 toll for electronic toll collection would be \$3.10, or an average of about \$0.21 per mile. The through-trip toll for a vehicle without a transponder (BBM) would be \$4.74, or \$0.31 per mile. By 2025, the Class 1 ETC through trip toll would increase to \$3.70, and to \$4.99 by 2035. Through-trip tolls for Class 3 vehicles in 2035 would reach almost \$20.00, with a per-mile rate of \$1.32.

| Calendar Year | Toll Class | Through-Trip Toll |         | Per-Mile Toll Rate |         |
|---------------|------------|-------------------|---------|--------------------|---------|
|               |            | ETC               | BBM     | ETC                | BBM     |
| 2020          | Class 1    | \$ 3.10           | \$ 4.74 | \$ 0.21            | \$ 0.31 |
|               | Class 2    | 6.20              | 9.48    | 0.41               | 0.63    |
|               | Class 3    | 12.40             | 18.96   | 0.82               | 1.26    |
| 2025          | Class 1    | \$ 3.70           | \$ 5.69 | \$ 0.25            | \$ 0.38 |
|               | Class 2    | 7.40              | 11.38   | 0.49               | 0.75    |
|               | Class 3    | 14.80             | 22.76   | 0.98               | 1.51    |
| 2035          | Class 1    | \$ 4.99           | \$ 7.65 | \$ 0.33            | \$ 0.51 |
|               | Class 2    | 9.98              | 15.30   | 0.66               | 1.01    |
|               | Class 3    | 19.96             | 30.60   | 1.32               | 2.03    |
| 2045          | Class 1    | \$ 6.12           | \$ 9.42 | \$ 0.41            | \$ 0.62 |
|               | Class 2    | 12.24             | 18.84   | 0.81               | 1.25    |
|               | Class 3    | 24.48             | 37.68   | 1.62               | 2.50    |

## 6.6 Modeling Assumptions and Inputs

As noted above, travel demand model runs were made at 2020, 2025, 2035 and 2045. **Table 6.7** provides a concise summary of modeling assumptions and inputs used in each of the assignment years.

A critical parameter in any traffic and revenue analysis relates to value of time (VOT). This is a measure of motorist's willingness to pay for time savings, and the values in Table 6.7 are shown in terms of dollars per minute. VOT information was derived from stated preference (SP) surveys conducted in early 2017 by RSG and summarized in Chapter 4.

Values in Table 6.7 reflect regionwide average-weighted VOT, by primary categories of trip purpose, and further segregated by non-airport and airport-related trips.

The VOT was developed at 2016 levels and used in the model calibration. Values shown for subsequent years were adjusted in proportion to inflation assumptions, also shown in the table.

**Table 6.7**  
**Model Inputs (VOT, VOC and CPI)**

|                                         | <b>2016</b>           | <b>2020</b>           | <b>2025</b>           | <b>2035</b>           | <b>2045</b> |
|-----------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-------------|
| <b>Value Of Time (\$/minute)</b>        |                       |                       |                       |                       |             |
| Non-Airport                             |                       |                       |                       |                       |             |
| Commute                                 | \$0.289               | \$0.319               | \$0.357               | \$0.442               | \$0.550     |
| Work-Based Other                        | 0.373                 | 0.411                 | 0.460                 | 0.570                 | 0.708       |
| Other                                   | 0.267                 | 0.295                 | 0.330                 | 0.409                 | 0.510       |
| Airport                                 |                       |                       |                       |                       |             |
| Commute                                 | \$0.321               | \$0.355               | \$0.396               | \$0.491               | \$0.611     |
| Work-Based Other                        | 0.310                 | 0.341                 | 0.382                 | 0.473                 | 0.588       |
| Other                                   | 0.313                 | 0.346                 | 0.386                 | 0.479                 | 0.596       |
| <b>Vehicle Operating Cost (\$/mile)</b> |                       |                       |                       |                       |             |
| Toll Class 1                            | \$0.163               | \$0.211               | \$0.220               | \$0.257               | \$0.318     |
| Toll Class 2 & 3                        | 0.489                 | 0.633                 | 0.660                 | 0.771                 | 0.954       |
| <b>Annual Inflation (1)</b>             |                       |                       |                       |                       |             |
|                                         | <b>2016-<br/>2020</b> | <b>2020-<br/>2025</b> | <b>2025-<br/>2035</b> | <b>2035-<br/>2045</b> |             |
|                                         | 2.25%                 | 2.24%                 | 2.13%                 | 2.18%                 |             |

(1) Moody's Analytics Raleigh MSA Forecast

It is important to recognize that the VOT information in Table 6.7 reflects weighted regionwide averages. As part of the study, a relationship was established between VOT and estimated household income by Traffic Analysis Zone (TAZ). Hence, VOT in individual traffic zones also varied from the averages shown based on median household income in each traffic zone. The mean household income forecasts included a component for real income growth by TAZ.

Vehicle operating costs (VOC) are shown in dollars per mile. Estimates were derived for toll Class 1; (2-axle vehicles) and toll Classes 2 and 3 combined representing vehicles with three or more axles. As might be expected, vehicle operating costs are considerable higher for larger vehicles, primarily due to lower fuel efficiency. The operating costs were based on fuel costs for gasoline and diesel, fuel efficiency standards and inflation.

Finally, the bottom of Table 6.7 shows assumptions regarding annual inflation rates in the Raleigh Metropolitan Statistical Area (MSA). From 2016 to 2020, inflation is estimated at 2.25 percent per year, and slightly lower from 2020 to 2025. Forecast CPI averages 2.13 percent per year from 2025 to 2035, and 2.18 percent per from 2035 to 2045. The CPI forecasts were obtained from Moody's Analytics. VOT and VOC projections were increased to reflect changes in CPI. Toll rates on the Triangle Expressway are increased annually through 2035 by a previously adopted toll schedule. Annual rate increases beginning in 2036 are indexed to the forecast CPI. After 2045, toll rates increase by an assumed 2.0 percent per year.

## 6.7 Estimated 2020 Weekday Traffic and Revenue

Estimated weekday traffic on Triangle Expressway at 2020 levels is shown in **Figure 6.6**. The larger bold numbers reflect two-directional traffic on each mainline section. The smaller numbers at each interchange reflect balanced ramp volumes. All values are shown in thousands, and all reflect average weekday conditions. Average daily traffic would be lower than the volumes shown in Figure 6.6, given that weekend day traffic is considerably lower than weekday traffic on the Triangle Expressway.

As discussed previously, by January 1, 2020 the Morrisville Parkway interchange is assumed to be in operation. A new mainline tolling zone located just north of Morrisville Parkway will also be in place, but ramp tolls at U.S. 64 and Hopson Road would remain in operation. Weekday traffic is estimated to peak just north of the NC 55 interchange, estimated at 55,600. Of this, about 18,800 vehicles would use Toll NC 147 and the remaining 36,800 would continue on Toll NC 540 to NC 54 and beyond. Weekday mainline traffic on most of the Triangle Expressway would average between 35,000 and 55,000, as far south as U.S. 1. South of that point, volumes drop off considerably, with weekday traffic estimated at 21,200 at the southern end of the project near the NC 55 Bypass.

Gross weekday toll revenue in 2020 is calculated in **Table 6.8**, based on the weekday traffic volumes shown in Figure 6.6, by toll zone, method-of-payment and toll class. The calculated toll revenue is prior to any adjustment for leakage or fee revenue. Traffic volumes in Table 6.8 may not exactly match traffic volumes in Figure 6.6 due to rounding.

The right portion of the Table 6.8 summarizes average weekday transactions and revenue by ETC and BBM. The average weighted toll is provided by toll location. It is influenced by the mix of vehicle classes and the distribution of payment modes.

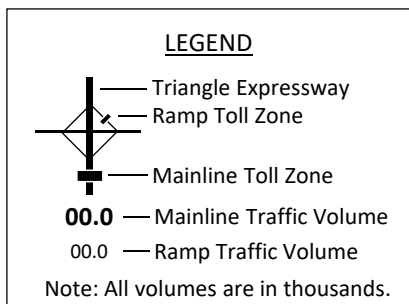
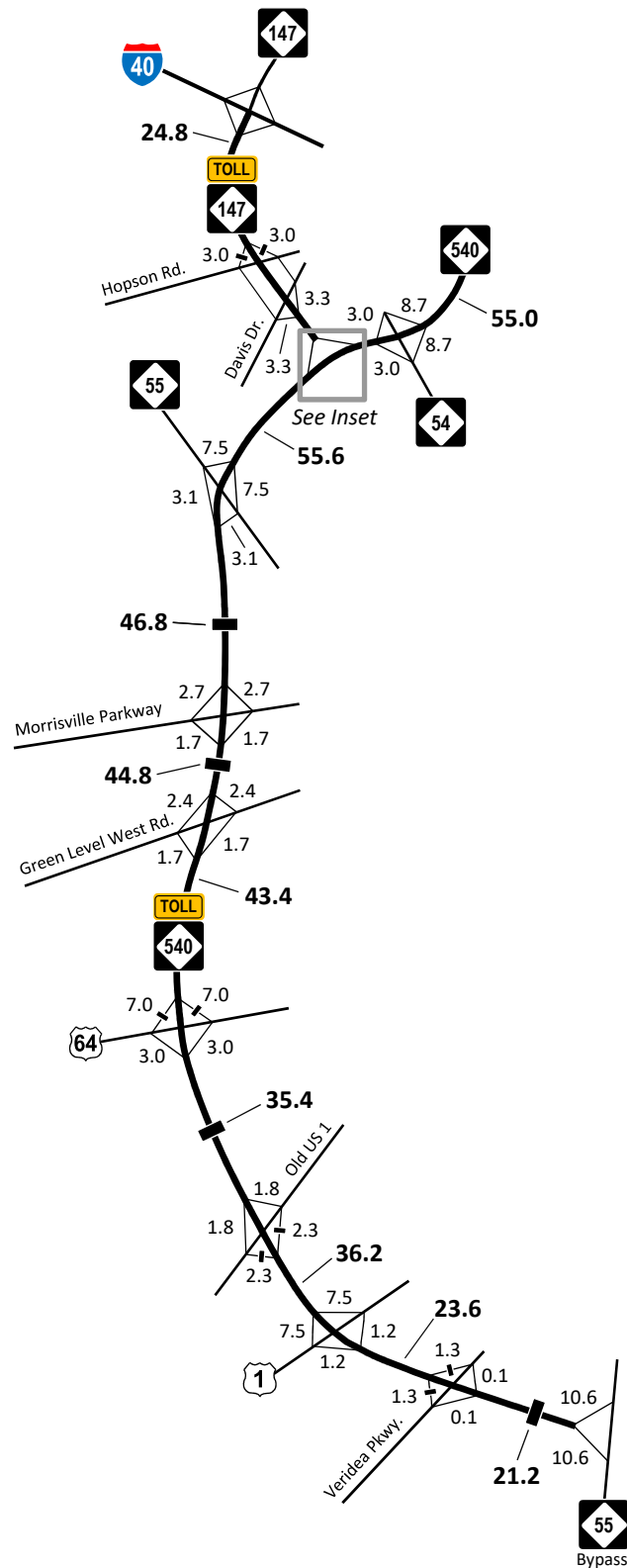
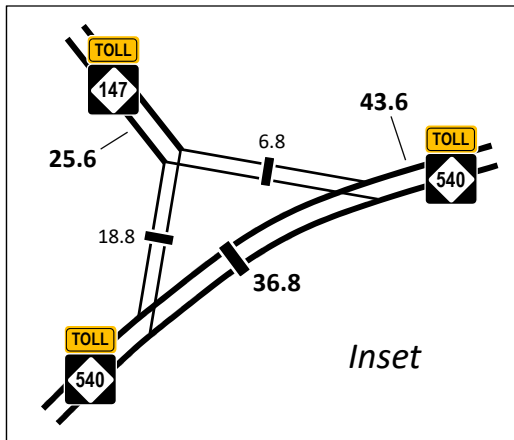
In total, it is estimated that there will be a total of 237,565 transactions on Triangle Expressway on an average weekday in 2020, producing an average weekday revenue estimated at \$196,065. This revenue reflects gross or “expected” revenue and has not yet been adjusted to reflect leakage or other uncollectable revenue, particularly from BBM customers.

The bottom row of Table 6.8 converts the estimated weekday values at 2020 levels to estimated annual transaction and revenues. In this case, the figures shown are rounded to thousands. Hence, total annual transactions are estimated at 72.5 million. Of these, an estimated 48.1 million would be ETC and 24.3 million would be BBM. Annual gross revenue is estimated at \$59.8 million. In moving from average weekday to average day an effective annualization factor of 305 days has been used. This annualization factor reflects the relationship between weekday and weekend day transactions and revenue. Since weekend day transactions and revenue are considerably lower than weekdays, the annualization factor, as applied to average weekday conditions, is less than the 365 days per year.



# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study

NC 222909 Complete 540 2017 IG Study\Graphics\Powerpoint\Portrait Complete 540\10-24-18



## ESTIMATED WEEKDAY TRAFFIC TRIANGLE EXPRESSWAY - 2020



FIGURE 6.6

**Table 6.8**  
**Estimated 2020 Weekday Transactions and Revenue by Toll Zone**  
**Scenario 1 - Triangle Expressway**

| Toll Zone                                                                                 | Class 1 Vehicles |        |                 |               |        |                 | Class 2 and 3 Vehicles |        |                 |              |        |                 | Total Weekday Transactions |               |                |                  | Total Weekday Revenue |                  |         |  | Average Weekday Toll per Transaction<br>(all vehicles and payment types) |
|-------------------------------------------------------------------------------------------|------------------|--------|-----------------|---------------|--------|-----------------|------------------------|--------|-----------------|--------------|--------|-----------------|----------------------------|---------------|----------------|------------------|-----------------------|------------------|---------|--|--------------------------------------------------------------------------|
|                                                                                           | ETC              |        |                 | BBM           |        |                 | ETC                    |        |                 | BBM          |        |                 | ETC                        |               | BBM            |                  | ETC                   |                  | BBM     |  |                                                                          |
|                                                                                           | Trans.           | Toll   | Revenue         | Trans.        | Toll   | Revenue         | Trans.                 | Toll   | Revenue         | Trans.       | Toll   | Revenue         | ETC                        | BBM           | Total          | ETC              | BBM                   | Total            |         |  |                                                                          |
| 01/02 Ramps North at Hopson Rd.                                                           | 3,870            | \$0.39 | \$1,509         | 1,982         | \$0.60 | \$1,189         | 54                     | \$1.33 | \$72            | 47           | \$1.96 | \$92            | 3,924                      | 2,029         | 5,953          | \$1,581          | \$1,281               | \$2,862          | \$0.481 |  |                                                                          |
| 05/06 SR 147/SR 540 Jct. NW Connection                                                    | 12,239           | \$1.08 | \$13,218        | 5,669         | \$1.66 | \$9,411         | 441                    | \$3.59 | \$1,582         | 368          | \$5.78 | \$2,126         | 12,680                     | 6,037         | 18,717         | \$14,800         | \$11,537              | \$26,337         | \$1.407 |  |                                                                          |
| 09/10 SR 147/SR 540 Jct. NE Connection                                                    | 3,989            | \$0.87 | \$3,470         | 2,602         | \$1.33 | \$3,461         | 95                     | \$3.05 | \$290           | 93           | \$4.27 | \$395           | 4,084                      | 2,695         | 6,779          | \$3,760          | \$3,856               | \$7,616          | \$1.124 |  |                                                                          |
| 13/14 SR 147/SR 540 Jct. 540 Thru Mvt.                                                    | 23,318           | \$0.70 | \$16,322        | 12,054        | \$1.07 | \$12,898        | 743                    | \$2.28 | \$1,694         | 615          | \$3.52 | \$2,166         | 24,061                     | 12,669        | 36,730         | \$18,017         | \$15,064              | \$33,081         | \$0.901 |  |                                                                          |
| 15/16 Mainline N of Morrisville Pky                                                       | 30,715           | \$0.48 | \$14,743        | 14,082        | \$0.73 | \$10,280        | 1,155                  | \$1.62 | \$1,872         | 790          | \$2.42 | \$1,911         | 31,871                     | 14,872        | 46,742         | \$16,615         | \$12,191              | \$28,806         | \$0.616 |  |                                                                          |
| 17/18 Mainline N. of Green Level Rd                                                       | 28,333           | \$0.39 | \$11,050        | 14,428        | \$0.60 | \$8,657         | 1,132                  | \$1.31 | \$1,482         | 895          | \$1.99 | \$1,781         | 29,465                     | 15,323        | 44,788         | \$12,532         | \$10,438              | \$22,970         | \$0.513 |  |                                                                          |
| 21/22 Ramps North at U.S. 64                                                              | 9,147            | \$0.48 | \$4,391         | 4,327         | \$0.73 | \$3,159         | 289                    | \$1.68 | \$486           | 281          | \$2.41 | \$678           | 9,436                      | 4,608         | 14,045         | \$4,876          | \$3,837               | \$8,713          | \$0.620 |  |                                                                          |
| 25/26 Mainline S of US 64                                                                 | 21,872           | \$1.08 | \$23,622        | 11,692        | \$1.65 | \$19,292        | 982                    | \$3.66 | \$3,595         | 777          | \$5.65 | \$4,392         | 22,854                     | 12,469        | 35,324         | \$27,216         | \$23,684              | \$50,900         | \$1.441 |  |                                                                          |
| 29/30 Ramps South at S. Salem St.                                                         | 3,205            | \$0.28 | \$897           | 1,295         | \$0.42 | \$544           | 69                     | \$0.96 | \$66            | 29           | \$1.37 | \$40            | 3,273                      | 1,324         | 4,597          | \$963            | \$584                 | \$1,547          | \$0.336 |  |                                                                          |
| 31/32 Ramps North at Veridea Pky                                                          | 1,762            | \$0.30 | \$529           | 867           | \$0.46 | \$399           | 37                     | \$1.03 | \$38            | 26           | \$1.50 | \$39            | 1,799                      | 893           | 2,692          | \$567            | \$438                 | \$1,005          | \$0.373 |  |                                                                          |
| 33/34 Mainline N of SR 55 Bypass                                                          | 13,908           | \$0.45 | \$6,259         | 6,449         | \$0.69 | \$4,450         | 503                    | \$1.49 | \$750           | 339          | \$2.27 | \$770           | 14,411                     | 6,788         | 21,200         | \$7,008          | \$5,220               | \$12,228         | \$0.577 |  |                                                                          |
| <u>Weekday Total Triangle Expressway</u>                                                  | <u>152,358</u>   |        | <u>\$96,010</u> | <u>75,447</u> |        | <u>\$73,738</u> | <u>5,499</u>           |        | <u>\$11,926</u> | <u>4,261</u> |        | <u>\$14,391</u> | <u>157,858</u>             | <u>79,707</u> | <u>237,565</u> | <u>\$107,936</u> | <u>\$88,129</u>       | <u>\$196,065</u> |         |  |                                                                          |
| <u>Annual Total Triangle Expressway (000)</u><br>Assumes Annualization Factor of 305 Days | <u>46,469</u>    |        | <u>\$29,283</u> | <u>23,011</u> |        | <u>\$22,490</u> | <u>1,677</u>           |        | <u>\$3,637</u>  | <u>1,300</u> |        | <u>\$4,389</u>  | <u>48,147</u>              | <u>24,311</u> | <u>72,457</u>  | <u>\$32,921</u>  | <u>\$26,879</u>       | <u>\$59,800</u>  |         |  |                                                                          |

Assumes Annualization Factor of 305 Days

Note: Transactions by toll zone in this table may not match transactions shown in Figure 6.6 due to rounding by direction in the figure.

## 6.8 Estimated 2025 Weekday Traffic and Revenue

**Figure 6.7** shows estimated weekday traffic on the Triangle Expressway at 2025 levels. These estimated traffic volumes include the impacts associated with the planned relocation of the ramp toll zones at the Hopson Road and U.S. 64 interchanges to the mainline sections north of each interchange. The traffic volumes also reflect the toll schedule adjustments required to maintain the Triangle Expressway's per-mile rate structure. Weekday traffic at the south end of the project is estimated at 23,600, increasing to a peak of 58,800 north of NC 55. Weekday traffic volumes on the U.S. 64 interchange ramps to and from the south are projected to decrease between 2020 and 2025. A similar decrease is projected for the U.S. 1 interchange ramps to and from the north over the same 5-year period. These changes are the result of minor changes in travel patterns on the southern portion of the Triangle Expressway due primarily to roadway widening on nearby NC 55, U.S. 64 and Ten Ten Road, among others.

**Table 6.9** shows the calculation of estimated 2025 weekday transactions and gross toll revenue by toll zone. Again, both transactions and revenue are broken out by payment category and overall vehicle class. Weekday revenue is estimated at \$243,760, resulting in estimated annual gross toll revenue of \$74.3 million. Of this, about \$43.3 million would be attributed to ETC transactions, while the remaining \$31.1 million would come from BBM collections. Systemwide, the overall average toll per transaction would be about \$0.78, reflecting the overall mix of toll rates by location, payment type and vehicle class.

## 6.9 Estimated 2035 Weekday Traffic and Revenue

**Figure 6.8** shows estimated weekday traffic on the Triangle Expressway in 2035. Traffic is expected to reach a peak of 66,600 vehicles just north of NC 55. Of this, about 25,000 vehicles would use Toll NC 147, while about 41,600 vehicles per weekday would continue on Toll NC 540 to NC 54 and beyond.

Toll revenue calculations for 2035 are shown in **Table 6.10**. In 2035, average weekday gross revenue from ETC is estimated at \$255,369 per day. This compares with \$130,860 per day from BBM, resulting in total revenue of about \$386,229 per weekday. The weekday traffic and revenue was annualized, using the 305-day annualization factor to produce estimated annual revenue of almost \$118 million. Of this, about \$78 million would come from electronic toll collection while about \$40 million would come from BBM.

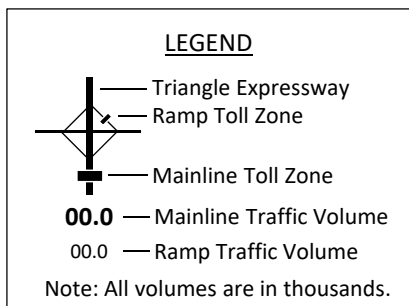
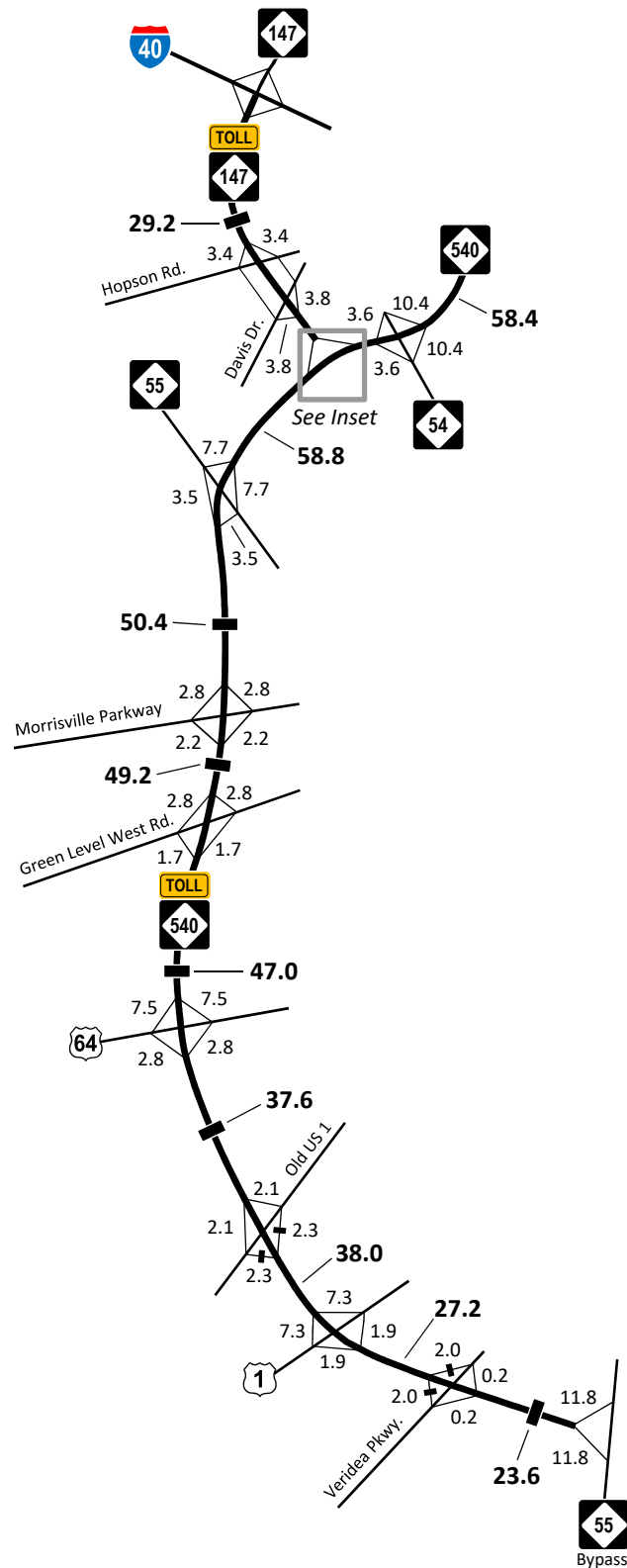
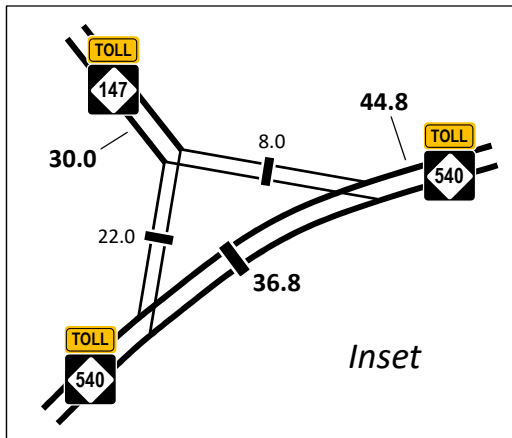
## 6.10 Estimated 2045 Weekday Traffic and Revenue

Finally, **Figure 6.9** presents estimated weekday traffic for Triangle Expressway at in year 2045. Estimated weekday traffic would increase from 36,000 at the south end of the project to 70,400 per weekday north of US 64, to 80,400 north of NC 55.

**Table 6.11** provides estimated 2045 weekday transactions and gross toll revenue by toll zone. It is estimated that an average of almost 475,000 transactions will be recorded systemwide, each weekday, yielding more than \$567,000. This results in an overall average toll per transaction, systemwide, of \$1.20.

On an annual basis, almost 145 million annual transactions can be expected by 2045, of which 116 million would be ETC and about 28 million would be BBM. Total annual expected revenue, before leakage adjustment, is estimated at more than \$173 million for Triangle Expressway.

# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



## ESTIMATED WEEKDAY TRAFFIC TRIANGLE EXPRESSWAY - 2025



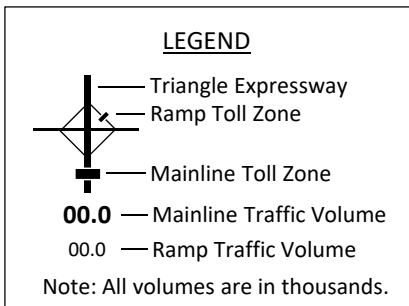
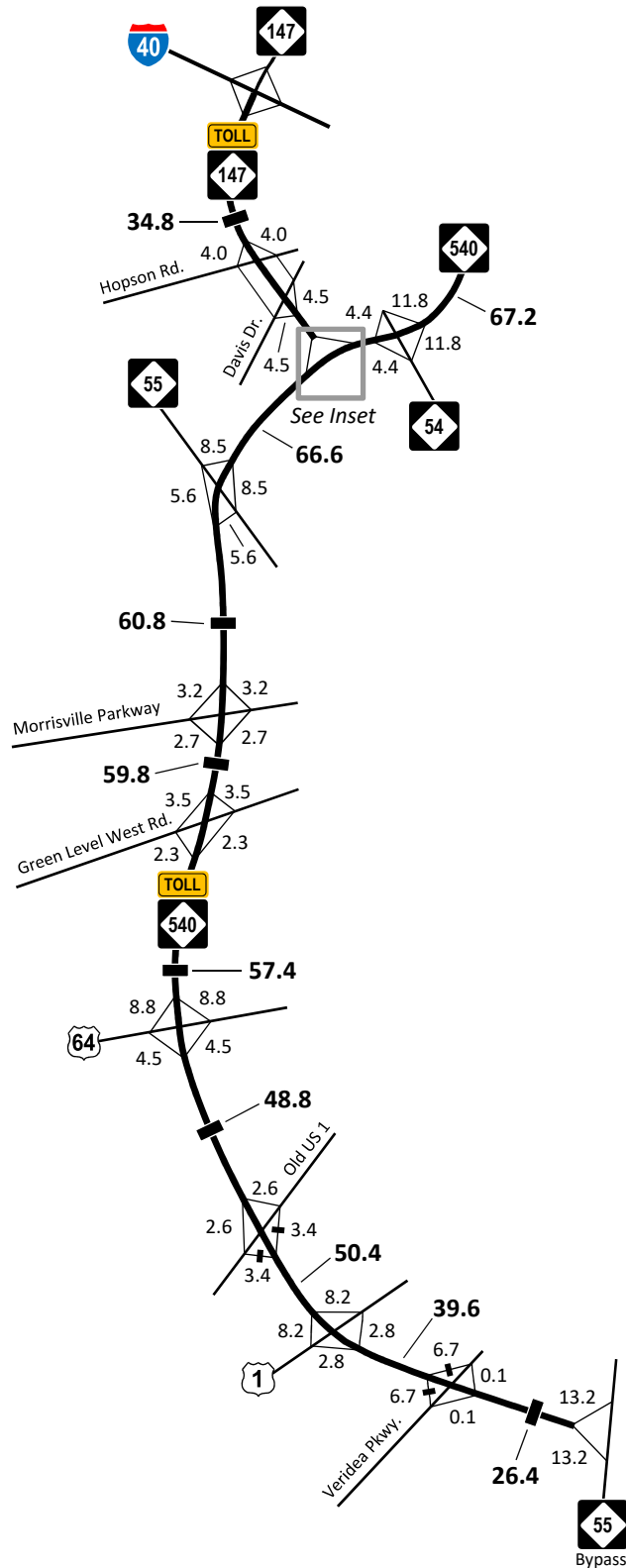
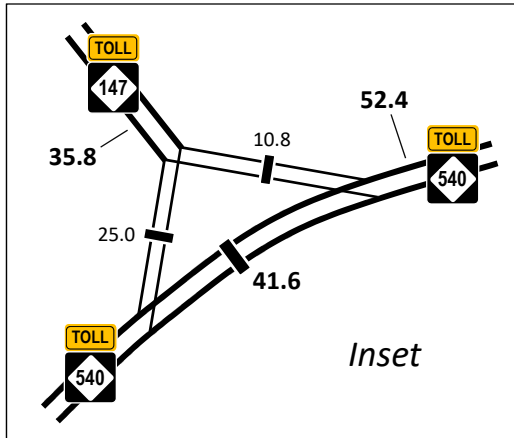
**Table 6.9**  
**Estimated 2025 Weekday Transactions and Revenue by Toll Zone**  
**Scenario 1 - Triangle Expressway**

|                                           | Toll Zone                        |          | Class 1 Vehicles |        |           |        | Class 2 and 3 Vehicles |          |         |        | Total Weekday Transactions |         |        |          | Total Weekday Revenue |         | Average Weekday Toll per Transaction<br>(all vehicles and payment types) |           |           |           |         |
|-------------------------------------------|----------------------------------|----------|------------------|--------|-----------|--------|------------------------|----------|---------|--------|----------------------------|---------|--------|----------|-----------------------|---------|--------------------------------------------------------------------------|-----------|-----------|-----------|---------|
|                                           | Number                           | Location | ETC              | Toll   | Revenue   | BBM    | Trans.                 | Toll     | Revenue | ETC    | Toll                       | Revenue | BBM    | Trans.   | Toll                  | Revenue |                                                                          | ETC       | BBM       | Total     |         |
| 01/02                                     | Ramps North at Hopson Rd.        |          | 19,856           | \$0.46 | \$9,134   | 8,224  | \$0.70                 | \$5,757  | 699     | \$1.57 | \$1,098                    | 482     | \$2.29 | \$1,103  | 20,556                | 8,706   | 29,262                                                                   | \$10,232  | \$6,860   | \$17,092  | \$0.584 |
| 05/06                                     | SR 147/SR 540 Jct. NW Connection |          | 15,152           | \$0.83 | \$12,577  | 5,950  | \$1.28                 | \$7,616  | 544     | \$2.76 | \$1,502                    | 431     | \$4.46 | \$1,920  | 15,697                | 6,381   | 22,077                                                                   | \$14,079  | \$9,536   | \$23,615  | \$1.070 |
| 09/10                                     | SR 147/SR 540 Jct. NE Connection |          | 4,980            | \$0.66 | \$3,287   | 2,757  | \$1.02                 | \$2,813  | 188     | \$2.31 | \$434                      | 160     | \$3.27 | \$524    | 5,168                 | 2,918   | 8,086                                                                    | \$3,721   | \$3,336   | \$7,057   | \$0.873 |
| 13/14                                     | SR 147/SR 540 Jct. 540 Thru Mvt. |          | 24,057           | \$0.81 | \$19,486  | 11,275 | \$1.24                 | \$13,981 | 780     | \$2.63 | \$2,051                    | 635     | \$4.08 | \$2,590  | 24,836                | 11,910  | 36,746                                                                   | \$21,536  | \$16,571  | \$38,107  | \$1.037 |
| 15/16                                     | Mainline N of Morrisville Pky    |          | 34,312           | \$0.55 | \$18,872  | 13,886 | \$0.85                 | \$11,803 | 1,289   | \$1.85 | \$2,385                    | 869     | \$2.82 | \$2,449  | 35,601                | 14,754  | 50,355                                                                   | \$21,256  | \$14,252  | \$35,509  | \$0.705 |
| 17/18                                     | Mainline N. of Green Level Rd    |          | 32,585           | \$0.46 | \$14,989  | 14,383 | \$0.71                 | \$10,212 | 1,270   | \$1.55 | \$1,969                    | 974     | \$2.36 | \$2,298  | 33,856                | 15,357  | 49,213                                                                   | \$16,958  | \$12,510  | \$29,469  | \$0.599 |
| 21/22                                     | Ramps North at U.S. 64           |          | 31,926           | \$0.56 | \$17,878  | 12,975 | \$0.86                 | \$11,158 | 1,278   | \$1.96 | \$2,505                    | 904     | \$2.84 | \$2,568  | 33,204                | 13,879  | 47,083                                                                   | \$20,384  | \$13,726  | \$34,110  | \$0.724 |
| 25/26                                     | Mainline S of US 64              |          | 24,307           | \$0.80 | \$19,446  | 11,379 | \$1.23                 | \$13,996 | 1,055   | \$2.71 | \$2,859                    | 818     | \$4.21 | \$3,445  | 25,362                | 12,197  | 37,559                                                                   | \$22,305  | \$17,441  | \$39,746  | \$1.058 |
| 29/30                                     | Ramps South at S. Salem St.      |          | 3,263            | \$0.32 | \$1,044   | 1,184  | \$0.49                 | \$580    | 86      | \$1.10 | \$95                       | 39      | \$1.59 | \$63     | 3,349                 | 1,223   | 4,572                                                                    | \$1,139   | \$643     | \$1,782   | \$0.390 |
| 31/32                                     | Ramps North at Veridea Pky       |          | 2,629            | \$0.35 | \$920     | 1,174  | \$0.53                 | \$622    | 68      | \$1.20 | \$82                       | 48      | \$1.72 | \$83     | 2,697                 | 1,222   | 3,919                                                                    | \$1,002   | \$705     | \$1,708   | \$0.436 |
| 33/34                                     | Mainline N of SR 55 Bypass       |          | 16,028           | \$0.52 | \$8,334   | 6,594  | \$0.80                 | \$5,275  | 554     | \$1.72 | \$953                      | 380     | \$2.64 | \$1,004  | 16,581                | 6,974   | 23,556                                                                   | \$9,287   | \$6,280   | \$15,567  | \$0.661 |
| Weekday Total Triangle Expressway         |                                  |          | 209,094          |        | \$125,966 | 89,780 |                        | \$83,813 | 7,813   |        | \$15,933                   | 5,740   |        | \$18,048 | 216,907               | 95,521  | 312,428                                                                  | \$141,899 | \$101,860 | \$243,760 | \$0.780 |
| Annual Total Triangle Expressway (000)    |                                  |          | 63,774           |        | \$38,420  | 27,383 |                        | \$25,563 | 2,383   |        | \$4,860                    | 1,751   |        | \$5,504  | 66,157                | 29,134  | 95,290                                                                   | \$43,279  | \$31,067  | \$74,347  |         |
| Assumes Annualization Factor of .305 Days |                                  |          |                  |        |           |        |                        |          |         |        |                            |         |        |          |                       |         |                                                                          |           |           |           |         |

Assumes Annualization Factor of 305 Days

Note: Transactions by toll zone in this table may not match transactions shown in Figure 6.7 due to rounding by direction in the figure.

# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



## ESTIMATED WEEKDAY TRAFFIC TRIANGLE EXPRESSWAY - 2035

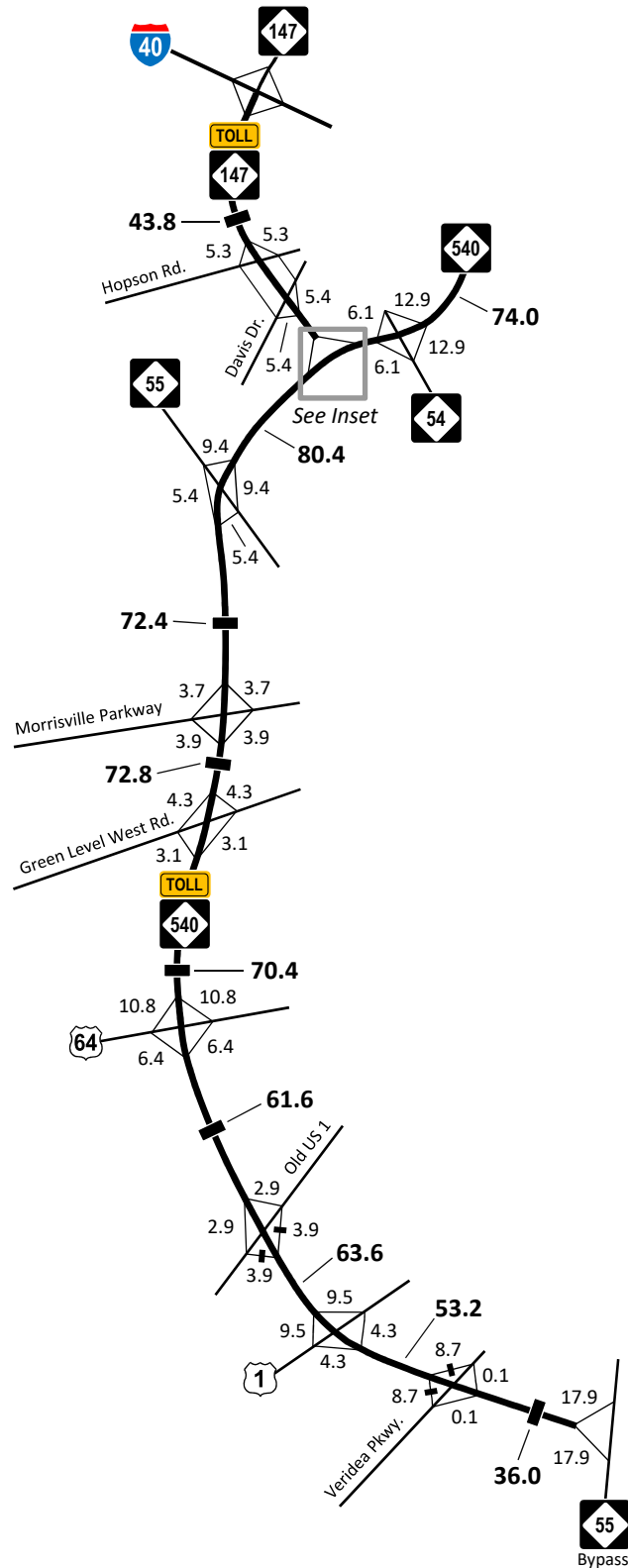
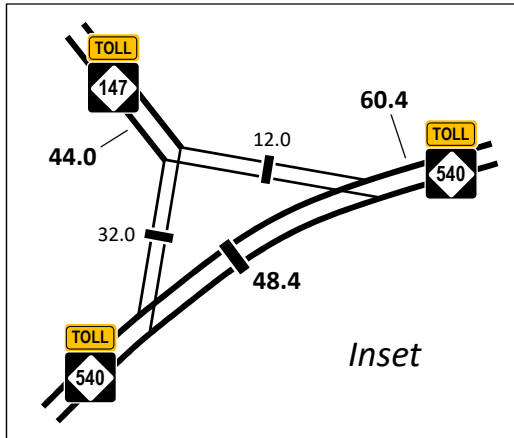


**Table 6.10**  
**Estimated 2035 Weekday Transactions and Revenue by Toll Zone**  
**Scenario 1 - Triangle Expressway**

| Toll Zone                                |                                  | Class 1 Vehicles |        |           |        |         |           | Class 2 and 3 Vehicles |        |          |        |         |          | Total Weekday Transactions |        |         |           | Total Weekday Revenue |           | Average Weekday Toll per Transaction<br>(all vehicles and payment types) |
|------------------------------------------|----------------------------------|------------------|--------|-----------|--------|---------|-----------|------------------------|--------|----------|--------|---------|----------|----------------------------|--------|---------|-----------|-----------------------|-----------|--------------------------------------------------------------------------|
|                                          |                                  | ETC              |        | BBM       |        | Revenue |           | Trans.                 |        | BBM      |        | Revenue |          | ETC                        |        | BBM     |           | ETC                   |           |                                                                          |
| Number                                   | Location                         | Trans.           | Toll   | Revenue   | Trans. | Toll    | Revenue   | Trans.                 | Toll   | Revenue  | Trans. | Toll    | Revenue  | ETC                        | BBM    | Total   | ETC       | BBM                   | Total     |                                                                          |
| 01/02                                    | Ramps North at Hopson Rd.        | 25,493           | \$0.61 | \$15,551  | 7,801  | \$0.93  | \$7,255   | 1,025                  | \$2.08 | \$2,132  | 429    | \$3.04  | \$1,304  | 26,518                     | 8,230  | 34,748  | \$17,683  | \$8,559               | \$26,242  | \$0.755                                                                  |
| 05/06                                    | SR 147/SR 540 Jct. NW Connection | 18,915           | \$1.12 | \$21,185  | 5,017  | \$1.72  | \$8,629   | 709                    | \$3.72 | \$2,636  | 355    | \$5.99  | \$2,129  | 19,624                     | 5,372  | 24,996  | \$23,821  | \$10,758              | \$34,580  | \$1.383                                                                  |
| 09/10                                    | SR 147/SR 540 Jct. NE Connection | 7,651            | \$0.87 | \$6,657   | 2,786  | \$1.34  | \$3,733   | 322                    | \$3.05 | \$982    | 127    | \$4.30  | \$547    | 7,973                      | 2,913  | 10,886  | \$7,638   | \$4,279               | \$11,918  | \$1.095                                                                  |
| 13/14                                    | SR 147/SR 540 Jct. 540 Thru Mvt. | 29,405           | \$1.09 | \$32,051  | 10,493 | \$1.67  | \$17,524  | 1,057                  | \$3.54 | \$3,741  | 598    | \$5.49  | \$3,283  | 30,462                     | 11,091 | 41,553  | \$35,792  | \$20,807              | \$56,599  | \$1.362                                                                  |
| 15/16                                    | Mainline N of Morrisville Pky    | 44,839           | \$0.74 | \$33,181  | 13,342 | \$1.14  | \$15,209  | 1,756                  | \$2.49 | \$4,374  | 801    | \$3.79  | \$3,036  | 46,595                     | 14,143 | 60,738  | \$37,554  | \$18,246              | \$55,800  | \$0.919                                                                  |
| 17/18                                    | Mainline N. of Green Level Rd    | 43,444           | \$0.62 | \$26,935  | 13,789 | \$0.95  | \$13,100  | 1,753                  | \$2.09 | \$3,663  | 880    | \$3.15  | \$2,771  | 45,197                     | 14,669 | 59,866  | \$30,599  | \$15,871              | \$46,470  | \$0.776                                                                  |
| 21/22                                    | Ramps North at U.S. 64           | 42,311           | \$0.75 | \$31,733  | 12,532 | \$1.15  | \$14,412  | 1,743                  | \$2.63 | \$4,584  | 817    | \$3.80  | \$3,105  | 44,054                     | 13,350 | 57,404  | \$36,318  | \$17,518              | \$53,835  | \$0.938                                                                  |
| 25/26                                    | Mainline S of US 64              | 34,910           | \$1.08 | \$37,702  | 11,655 | \$1.66  | \$19,346  | 1,445                  | \$3.66 | \$5,289  | 779    | \$5.68  | \$4,423  | 36,355                     | 12,433 | 48,788  | \$42,992  | \$23,769              | \$66,761  | \$1.368                                                                  |
| 29/30                                    | Ramps South at S. Salem St.      | 5,121            | \$0.43 | \$2,202   | 1,489  | \$0.66  | \$983     | 140                    | \$1.47 | \$205    | 34     | \$2.15  | \$73     | 5,261                      | 1,523  | 6,784   | \$2,407   | \$1,056               | \$3,463   | \$0.510                                                                  |
| 31/32                                    | Ramps North at Veridea Pky       | 9,802            | \$0.47 | \$4,607   | 3,266  | \$0.72  | \$2,351   | 217                    | \$1.61 | \$350    | 104    | \$2.34  | \$243    | 10,019                     | 3,370  | 13,389  | \$4,957   | \$2,595               | \$7,551   | \$0.564                                                                  |
| 33/34                                    | Mainline N of SR 55 Bypass       | 19,746           | \$0.71 | \$14,020  | 5,727  | \$1.08  | \$6,185   | 676                    | \$2.35 | \$1,589  | 342    | \$3.56  | \$1,218  | 20,422                     | 6,069  | 26,492  | \$15,608  | \$7,404               | \$23,012  | \$0.869                                                                  |
| Weekday Total Triangle Expressway        |                                  | 281,637          |        | \$225,824 | 87,896 |         | \$108,727 | 10,843                 |        | \$29,545 | 5,266  |         | \$22,133 | 292,479                    | 93,162 | 385,642 | \$255,369 | \$130,860             | \$386,229 | \$1.002                                                                  |
| Annual Total Triangle Expressway (000)   |                                  | 85,899           |        | \$68,876  | 26,808 |         | \$33,162  | 3,307                  |        | \$9,011  | 1,606  |         | \$6,751  | 89,206                     | 28,415 | 117,621 | \$77,888  | \$39,912              | \$117,800 |                                                                          |
| Assumes Annualization Factor of 305 Days |                                  |                  |        |           |        |         |           |                        |        |          |        |         |          |                            |        |         |           |                       |           |                                                                          |

Note: Transactions by toll zone in this table may not match transactions shown in Figure 6.8 due to rounding by direction in the figure.

# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



## ESTIMATED WEEKDAY TRAFFIC TRIANGLE EXPRESSWAY - 2045

Table 6.11  
Estimated 2045 Weekday Transactions and Revenue by Toll Zone  
Scenario 1 - Triangle Expressway

| Number                                   | Toll Zone<br>Location            | Class 1 Vehicles |        |           |        | Class 2 and 3 Vehicles |           |         |        | Total Weekday Transactions |       |        |          | Total Weekday Revenue |        |         |           | Average<br>Weekday<br>Toll per<br>Transaction<br><br>(all vehicles and<br>payment types) |           |         |
|------------------------------------------|----------------------------------|------------------|--------|-----------|--------|------------------------|-----------|---------|--------|----------------------------|-------|--------|----------|-----------------------|--------|---------|-----------|------------------------------------------------------------------------------------------|-----------|---------|
|                                          |                                  | Trans.           | ETC    | Revenue   | BBM    | Trans.                 | ETC       | Revenue | BBM    | ETC                        | BBM   | Total  | ETC      | BBM                   | Total  |         |           |                                                                                          |           |         |
| 01/02                                    | Ramps North at Hopson Rd.        | 33,904           | \$0.75 | \$25,428  | 8,061  | \$1.16                 | \$9,350   | 1,452   | \$2.55 | \$3,703                    | 373   | \$3.80 | \$1,418  | 35,356                | 8,434  | 43,790  | \$29,131  | \$10,768                                                                                 | \$39,899  | \$0.911 |
| 05/06                                    | SR 147/SR 540 Jct. NW Connection | 25,551           | \$1.38 | \$35,260  | 5,035  | \$2.13                 | \$10,724  | 1,023   | \$4.59 | \$4,696                    | 328   | \$7.41 | \$2,434  | 26,574                | 5,363  | 31,937  | \$39,956  | \$13,158                                                                                 | \$53,114  | \$1.663 |
| 09/10                                    | SR 147/SR 540 Jct. NE Connection | 9,037            | \$1.07 | \$9,670   | 2,480  | \$1.65                 | \$4,092   | 400     | \$3.75 | \$1,502                    | 70    | \$5.30 | \$371    | 9,438                 | 2,550  | 11,988  | \$11,172  | \$4,463                                                                                  | \$15,635  | \$1.304 |
| 13/14                                    | SR 147/SR 540 Jct. 540 Thru Mvt. | 36,230           | \$1.34 | \$48,549  | 10,420 | \$2.06                 | \$21,466  | 1,318   | \$4.36 | \$5,749                    | 525   | \$6.77 | \$3,551  | 37,549                | 10,945 | 48,494  | \$54,297  | \$25,017                                                                                 | \$79,314  | \$1.636 |
| 15/16                                    | Mainline N of Morrisville Pky    | 56,448           | \$0.91 | \$51,367  | 13,072 | \$1.40                 | \$18,301  | 2,248   | \$3.06 | \$6,880                    | 686   | \$4.65 | \$3,188  | 58,696                | 13,758 | 72,454  | \$58,247  | \$21,489                                                                                 | \$79,737  | \$1.101 |
| 17/18                                    | Mainline N. of Green Level Rd    | 56,024           | \$0.76 | \$42,578  | 13,691 | \$1.17                 | \$16,018  | 2,264   | \$2.56 | \$5,795                    | 752   | \$3.89 | \$2,925  | 58,287                | 14,443 | 72,730  | \$48,373  | \$18,943                                                                                 | \$67,316  | \$0.926 |
| 21/22                                    | Ramps North at U.S. 64           | 54,854           | \$0.92 | \$50,466  | 12,661 | \$1.42                 | \$17,979  | 2,232   | \$3.22 | \$7,188                    | 691   | \$4.69 | \$3,243  | 57,086                | 13,353 | 70,439  | \$57,654  | \$21,222                                                                                 | \$78,876  | \$1.120 |
| 25/26                                    | Mainline S of US 64              | 46,955           | \$1.32 | \$61,981  | 12,095 | \$2.03                 | \$24,552  | 1,863   | \$4.48 | \$8,345                    | 696   | \$6.95 | \$4,839  | 48,818                | 12,791 | 61,609  | \$70,326  | \$29,391                                                                                 | \$99,717  | \$1.619 |
| 29/30                                    | Ramps South at S. Salem St.      | 6,186            | \$0.53 | \$3,278   | 1,396  | \$0.82                 | \$1,145   | 173     | \$1.81 | \$313                      | 13    | \$2.67 | \$36     | 6,359                 | 1,410  | 7,768   | \$3,591   | \$1,180                                                                                  | \$4,772   | \$0.614 |
| 31/32                                    | Ramps North at Veridea Pky       | 13,462           | \$0.58 | \$7,808   | 3,513  | \$0.89                 | \$3,126   | 295     | \$1.99 | \$587                      | 92    | \$2.89 | \$267    | 13,756                | 3,605  | 17,361  | \$8,394   | \$3,393                                                                                  | \$11,787  | \$0.679 |
| 33/34                                    | Mainline N of SR 55 Bypass       | 28,339           | \$0.87 | \$24,655  | 6,426  | \$1.34                 | \$8,611   | 851     | \$2.88 | \$2,450                    | 308   | \$4.42 | \$1,363  | 29,190                | 6,735  | 35,924  | \$27,105  | \$9,975                                                                                  | \$37,079  | \$1.032 |
| Weekday Total Triangle Expressway        |                                  | 366,989          |        | \$361,040 | 88,850 |                        | \$135,365 | 14,120  |        | \$47,207                   | 4,536 |        | \$23,635 | 381,109               | 93,386 | 474,495 | \$408,247 | \$159,000                                                                                | \$567,247 | \$1.195 |
| Annual Total Triangle Expressway (000)   |                                  | 111,932          |        | \$110,117 | 27,099 |                        | \$41,286  | 4,306   |        | \$14,398                   | 1,383 |        | \$7,209  | 116,238               | 28,483 | 144,721 | \$124,515 | \$48,495                                                                                 | \$173,010 |         |
| Assumes Annualization Factor of 305 Days |                                  |                  |        |           |        |                        |           |         |        |                            |       |        |          |                       |        |         |           |                                                                                          |           |         |

Assumes Annualization Factor of 305 Days

Note: Transactions by toll zone in this table may not match transactions shown in Figure 6.9 due to rounding by direction in the figure.

## 6.11 Estimated Annual Transactions and Revenue

The weekday transaction and revenue estimates calculated at 2020, 2025, 2035 and 2045 levels, based on travel demand model assignments, were used to develop annual transaction and revenue forecasts over a 40-year projection period. As noted previously, estimates for 2018 and 2019 were based on a review of recent historical trends through mid-2018. Forecasts for 2020 were developed using model output and recent historical trends. Intermediate years were developed by interpolating between model years 2020 and 2025, 2025 and 2035, and 2035 and 2045. After the last model year of 2045, traffic growth was assumed to occur at a nominal 0.6 percent per year.

Estimated annual transactions and revenue for the Triangle Expressway are shown in **Table 6.12** from FY 2019 through FY 2058. The toll revenue in Table 6.12 represents expected toll revenue based on forecast traffic volumes and does not include adjustments for leakage associated with BBM or anticipated fee revenue.

Annual transactions are expected to increase from 54.2 million in FY 2019 to 94.2 million in FY 2025, an average annual increase of 9.7 percent per year. However, a significant part of this transaction growth results from the new Morrisville Parkway interchange and its associated mainline toll zones that open on January 1, 2020 and the relocation of the ramp toll zones at the Hopson Road and U.S. 64 interchanges to mainline toll zones on July 1, 2023. Toll revenue from FY 2019 to 2025 is projected to increase by 5.5 percent per year, increasing from \$52.8 million in FY 2019 to \$72.8 million in FY 2025. During this period, programmed annual toll rate increases will occur, but the average toll per transaction will decrease. This is due to the increase in transactions associated with toll zone relocations and the corresponding revisions to toll rates on mainline sections.

After 2025, transaction and toll revenue growth are not impacted by any additional interchanges or toll zone relocations on the Triangle Expressway. Annual transactions are expected to increase from 94.2 million in FY 2025 to 116.3 million in FY 2035, an average annual increase of 2.1 percent per year. Revenue in that same period is expected to increase by 4.7 percent per year, resulting from increased transactions and annual toll rate increases. The average toll per transaction will have increased by 2.5 percent per year. ETC average toll rates will increase by 2.9 percent per year, however, the share of BBM versus ETC transactions will decrease between 2025 and 2035. Specifically, ETC transactions will increase by 3.0 percent per year over those 10 years, while BBM transactions will decrease by an average of 0.2 percent per year.

Over the 30-year interval between FY 2025 and FY 2055, in which no toll system changes or new interchanges are assumed to be added, overall annual transactions are forecast to increase by 1.6 percent per year while expected toll revenue will increase by 3.7 percent per year. Annual revenue is expected to reach \$218.7 million in FY 2055.

**Figure 6.10** provides a graphic depiction of forecasted annual transactions on the Triangle Expressway, including the distribution of transactions between ETC and BBM. The number of BBM transactions remain fairly constant over time, but they comprise a smaller and smaller proportion of total transactions.

**Table 6.12**  
**Estimated Annual Transactions and Revenue**  
**Scenario 1 - Triangle Expressway**

| Fiscal Year | Estimated Annual Transactions (000) |        |         |       | Estimated Annual Revenue (000) |          |          |       | Average Toll Per Transaction |         |         |
|-------------|-------------------------------------|--------|---------|-------|--------------------------------|----------|----------|-------|------------------------------|---------|---------|
|             | ETC                                 | BBM    | Total   | % ETC | ETC                            | BBM      | Total    | % ETC | ETC                          | BBM     | Overall |
| 2019        | 35,142                              | 19,024 | 54,166  | 64.9  | \$28,238                       | \$24,580 | \$52,818 | 53.5  | \$0.804                      | \$1.292 | \$0.975 |
| 2020 (1,2)  | 41,835                              | 21,564 | 63,399  | 66.0  | 31,243                         | 26,056   | 57,299   | 54.5  | 0.747                        | 1.208   | 0.904   |
| 2021 (2)    | 48,219                              | 24,018 | 72,237  | 66.8  | 33,832                         | 27,286   | 61,118   | 55.4  | 0.702                        | 1.136   | 0.846   |
| 2022 (2)    | 49,742                              | 24,114 | 73,856  | 67.4  | 35,783                         | 28,129   | 63,912   | 56.0  | 0.719                        | 1.167   | 0.865   |
| 2023 (2)    | 51,170                              | 24,135 | 75,304  | 68.0  | 37,726                         | 28,882   | 66,608   | 56.6  | 0.737                        | 1.197   | 0.885   |
| 2024 (2,3)  | 63,268                              | 29,057 | 92,326  | 68.5  | 39,994                         | 29,770   | 69,763   | 57.3  | 0.632                        | 1.025   | 0.756   |
| 2025 (2)    | 65,125                              | 29,085 | 94,210  | 69.1  | 42,203                         | 30,642   | 72,844   | 57.9  | 0.648                        | 1.054   | 0.773   |
| 2026 (2)    | 67,056                              | 29,082 | 96,138  | 69.7  | 44,567                         | 31,419   | 75,987   | 58.7  | 0.665                        | 1.080   | 0.790   |
| 2027        | 69,308                              | 29,152 | 98,460  | 70.4  | 47,481                         | 32,316   | 79,797   | 59.5  | 0.685                        | 1.109   | 0.810   |
| 2028        | 71,195                              | 29,030 | 100,224 | 71.0  | 50,182                         | 33,091   | 83,273   | 60.3  | 0.705                        | 1.140   | 0.831   |
| 2029        | 73,327                              | 28,974 | 102,301 | 71.7  | 53,165                         | 34,035   | 87,200   | 61.0  | 0.725                        | 1.175   | 0.852   |
| 2030        | 75,533                              | 28,910 | 104,443 | 72.3  | 56,418                         | 34,995   | 91,412   | 61.7  | 0.747                        | 1.210   | 0.875   |
| 2031        | 77,817                              | 28,838 | 106,655 | 73.0  | 59,860                         | 35,890   | 95,750   | 62.5  | 0.769                        | 1.245   | 0.898   |
| 2032        | 80,186                              | 28,758 | 108,944 | 73.6  | 63,525                         | 36,801   | 100,326  | 63.3  | 0.792                        | 1.280   | 0.921   |
| 2033        | 82,644                              | 28,669 | 111,313 | 74.2  | 67,368                         | 37,659   | 105,026  | 64.1  | 0.815                        | 1.314   | 0.944   |
| 2034        | 85,196                              | 28,573 | 113,769 | 74.9  | 71,432                         | 38,543   | 109,975  | 65.0  | 0.838                        | 1.349   | 0.967   |
| 2035        | 87,852                              | 28,469 | 116,320 | 75.5  | 75,704                         | 39,473   | 115,177  | 65.7  | 0.862                        | 1.387   | 0.990   |
| 2036        | 90,406                              | 28,442 | 118,848 | 76.1  | 79,749                         | 40,412   | 120,161  | 66.4  | 0.882                        | 1.421   | 1.011   |
| 2037        | 92,836                              | 28,493 | 121,329 | 76.5  | 83,595                         | 41,360   | 124,955  | 66.9  | 0.900                        | 1.452   | 1.030   |
| 2038        | 95,330                              | 28,533 | 123,864 | 77.0  | 87,620                         | 42,249   | 129,868  | 67.5  | 0.919                        | 1.481   | 1.048   |
| 2039        | 97,890                              | 28,564 | 126,454 | 77.4  | 91,739                         | 43,072   | 134,811  | 68.1  | 0.937                        | 1.508   | 1.066   |
| 2040        | 100,517                             | 28,584 | 129,101 | 77.9  | 96,080                         | 43,854   | 139,934  | 68.7  | 0.956                        | 1.534   | 1.084   |
| 2041        | 103,213                             | 28,593 | 131,806 | 78.3  | 100,625                        | 44,631   | 145,256  | 69.3  | 0.975                        | 1.561   | 1.102   |
| 2042        | 105,980                             | 28,590 | 134,570 | 78.8  | 105,504                        | 45,463   | 150,967  | 69.9  | 0.996                        | 1.590   | 1.122   |
| 2043        | 108,819                             | 28,575 | 137,394 | 79.2  | 110,852                        | 46,437   | 157,288  | 70.5  | 1.019                        | 1.625   | 1.145   |
| 2044        | 111,734                             | 28,547 | 140,281 | 79.6  | 116,256                        | 47,366   | 163,622  | 71.1  | 1.040                        | 1.659   | 1.166   |
| 2045        | 114,724                             | 28,506 | 143,230 | 80.1  | 121,711                        | 48,135   | 169,846  | 71.7  | 1.061                        | 1.689   | 1.186   |
| 2046        | 116,543                             | 28,539 | 145,083 | 80.3  | 126,186                        | 49,100   | 175,286  | 72.0  | 1.083                        | 1.720   | 1.208   |
| 2047        | 117,155                             | 28,653 | 145,808 | 80.3  | 129,525                        | 50,280   | 179,806  | 72.0  | 1.106                        | 1.755   | 1.233   |
| 2048        | 117,770                             | 28,767 | 146,537 | 80.4  | 132,868                        | 51,416   | 184,284  | 72.1  | 1.128                        | 1.787   | 1.258   |
| 2049        | 118,389                             | 28,881 | 147,270 | 80.4  | 136,305                        | 52,594   | 188,899  | 72.2  | 1.151                        | 1.821   | 1.283   |
| 2050        | 119,010                             | 28,996 | 148,006 | 80.4  | 139,823                        | 53,826   | 193,649  | 72.2  | 1.175                        | 1.856   | 1.308   |
| 2051        | 119,635                             | 29,111 | 148,746 | 80.4  | 143,434                        | 55,080   | 198,514  | 72.3  | 1.199                        | 1.892   | 1.335   |
| 2052        | 120,263                             | 29,227 | 149,490 | 80.4  | 147,026                        | 56,320   | 203,346  | 72.3  | 1.223                        | 1.927   | 1.360   |
| 2053        | 120,894                             | 29,343 | 150,237 | 80.5  | 150,670                        | 57,568   | 208,238  | 72.4  | 1.246                        | 1.962   | 1.386   |
| 2054        | 121,529                             | 29,459 | 150,989 | 80.5  | 154,479                        | 58,870   | 213,349  | 72.4  | 1.271                        | 1.998   | 1.413   |
| 2055        | 122,167                             | 29,576 | 151,743 | 80.5  | 158,454                        | 60,225   | 218,680  | 72.5  | 1.297                        | 2.036   | 1.441   |
| 2056        | 122,808                             | 29,694 | 152,502 | 80.5  | 162,495                        | 61,622   | 224,117  | 72.5  | 1.323                        | 2.075   | 1.470   |
| 2057        | 123,453                             | 29,812 | 153,265 | 80.5  | 166,489                        | 63,006   | 229,495  | 72.5  | 1.349                        | 2.113   | 1.497   |
| 2058        | 124,101                             | 29,930 | 154,031 | 80.6  | 170,725                        | 64,421   | 235,147  | 72.6  | 1.376                        | 2.152   | 1.527   |

**Average Annual Percent Change**

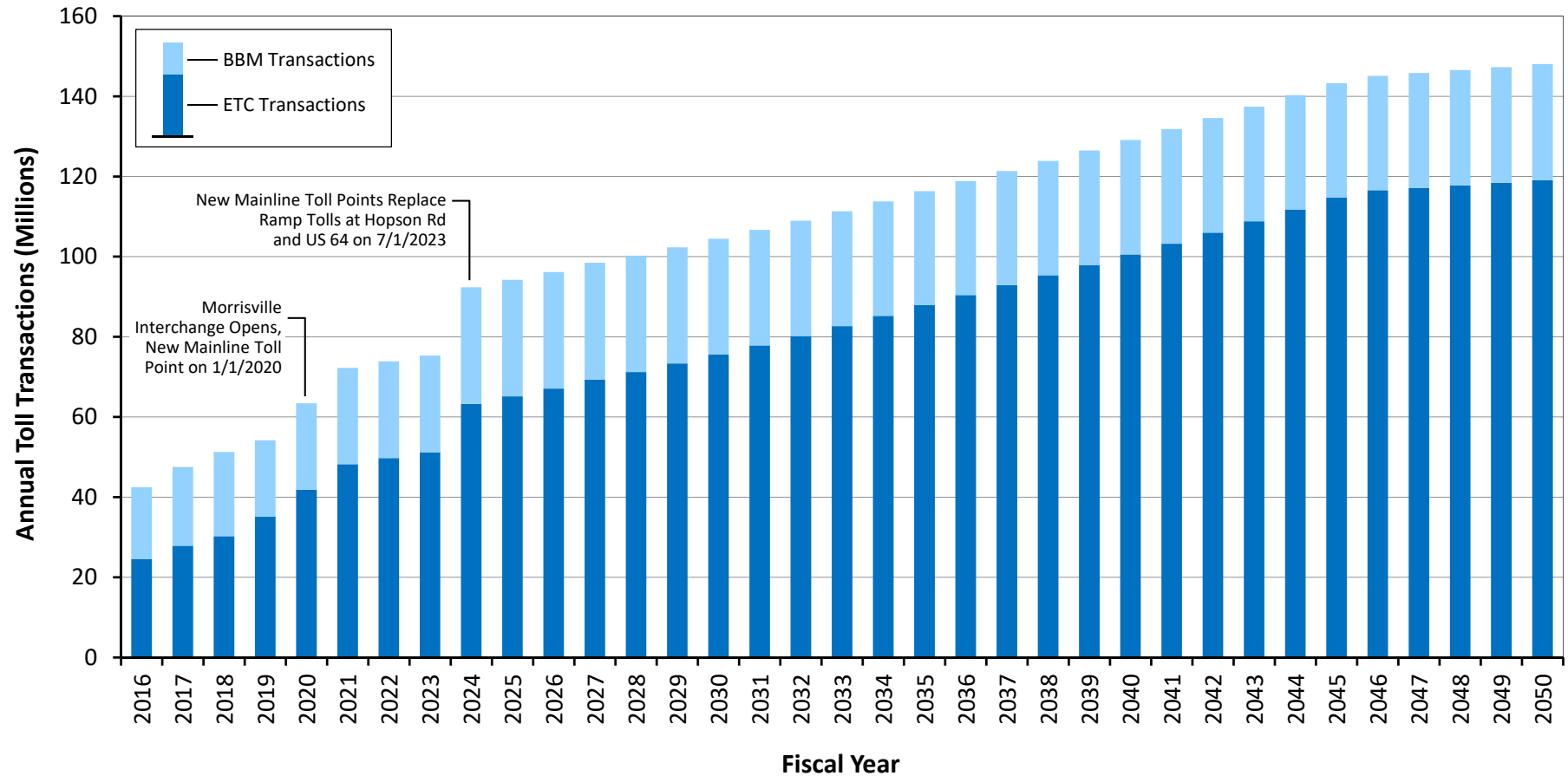
|         |       |       |      |      |      |      |       |       |       |
|---------|-------|-------|------|------|------|------|-------|-------|-------|
| 2019-25 | 10.8% | 7.3%  | 9.7% | 6.9% | 3.7% | 5.5% | -3.5% | -3.3% | -3.8% |
| 2025-35 | 3.0%  | -0.2% | 2.1% | 6.0% | 2.6% | 4.7% | 2.9%  | 2.8%  | 2.5%  |
| 2035-45 | 2.7%  | 0.0%  | 2.1% | 4.9% | 2.0% | 4.0% | 2.1%  | 2.0%  | 1.8%  |
| 2045-55 | 0.6%  | 0.4%  | 0.6% | 2.7% | 2.3% | 2.6% | 2.0%  | 1.9%  | 2.0%  |
| 2025-55 | 2.1%  | 0.1%  | 1.6% | 4.5% | 2.3% | 3.7% | 2.3%  | 2.2%  | 2.1%  |

(1) Assumes new Morrisville Parkway Interchange is opened January 1, 2020. Also, a new mainline toll zone north of the Morrisville Parkway Interchange is put into operation January 1, 2020.

(2) Ramp up is applied to the first 36-month period of transaction and revenue impacts associated with new toll zones.

(3) Assumes ramp tolls at U.S. 64 and Hopson Road on the Triangle Expressway are removed and replaced by new mainline toll zones north of each interchange, on July 1, 2023.

Note: Annual revenue comprises gross or expected toll revenue, not accounting for leakage associated with BBM, or fee revenue.



**ESTIMATED ANNUAL TRANSACTIONS BY PAYMENT METHOD  
TRIANGLE EXPRESSWAY**



The transactions in Figure 6.10 are actual for FY 2016 through FY 2018. The increase in transactions seen in FY 2020 and FY 2021 is associated with the opening of the Morrisville Parkway interchange and its mainline toll zone on January 1, 2020 in addition to normal growth. The normal growth pattern is also impacted in FY 2024 when two new mainline toll zones replace existing ramp tolls at the Hopson Road and U.S. 64 interchanges.

After FY 2025, traffic and toll revenue growth is not impacted by any new interchanges or toll zone relocations. As seen in Figure 6.10, transaction growth levels off after FY 2045. This is because 2045 was the last supported model year, and transactions were assumed to increase at a nominal 0.6 percent per year.

**Figure 6.11** provides a visual depiction of forecasted expected toll revenue, by ETC and BBM, for FY 2016 through FY 2050. The forecast toll revenue shown in this figure has not been adjusted for leakage or fee revenue. FY 2016 through FY 2018 reflect actual collected toll revenues. In the case of toll revenue, one doesn't see the same large increases evidenced in transactions in FYs 2020 and 2021, and FY 2024. This is because the new toll revenue associated with the Morrisville Parkway interchange is relatively small compared to the total toll revenue, and the increase in toll transactions due to toll zone relocations was intended to be toll revenue neutral, which was accomplished by modifying toll rates on mainline sections to maintain a uniform per-mile rate on the Triangle Expressway. Hence, the addition of new mainline toll zones adds to transactions but does not have an equivalent impact on revenue. Figure 6.11 also demonstrates the increasing share of total revenue expected to come from electronic toll collection. Annual toll revenue estimates shown in Figure 6.11 and Table 6.12 do not yet reflect any adjustment for leakage, nor do they include estimates of fee revenue associated with the BBM collection process.

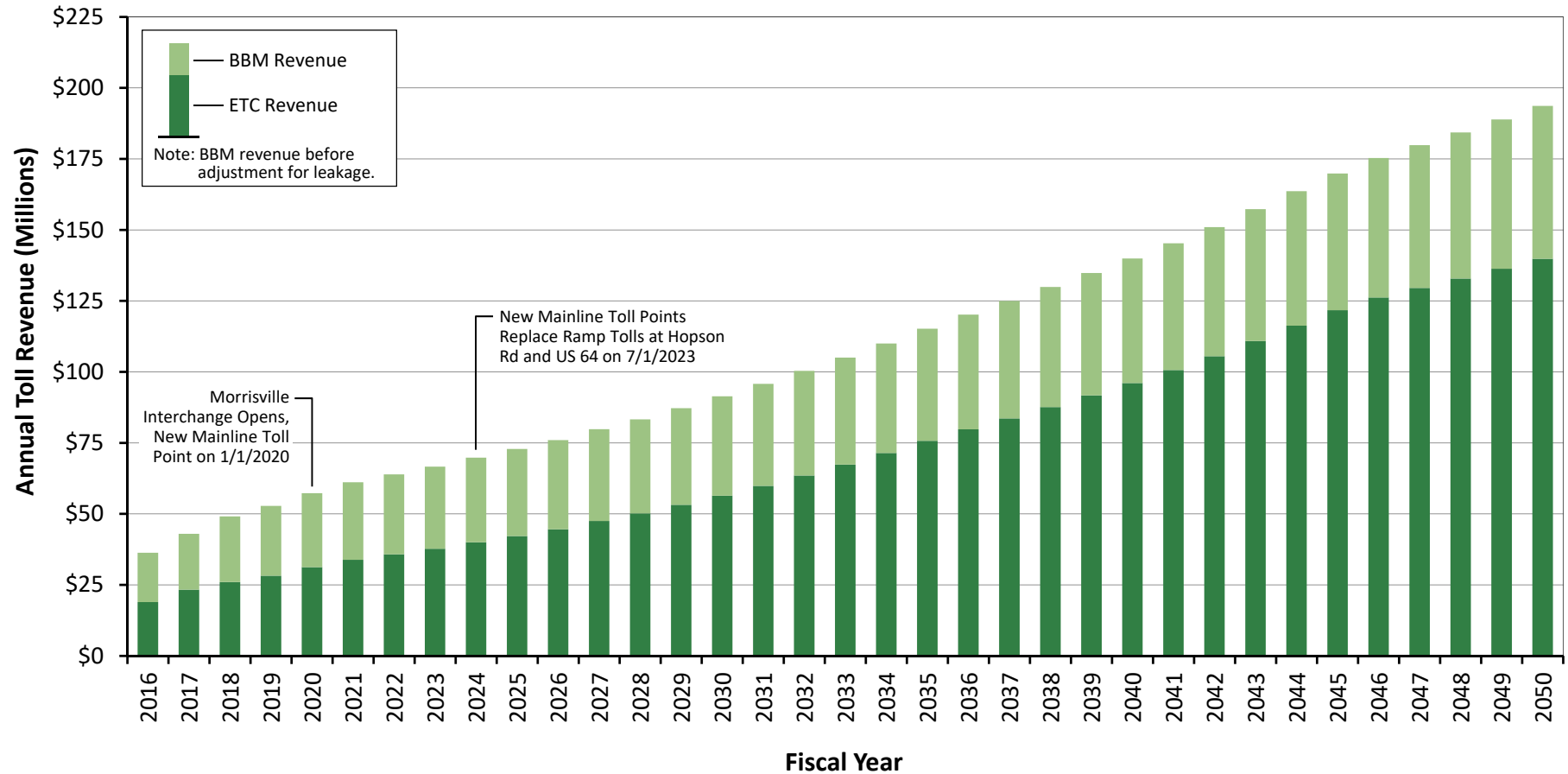
### 6.11.1 Estimated Adjusted Annual Revenue

The final step in the forecast process was to adjust gross toll revenue estimates for leakage and potential additional processing fee revenue associated with the BBM collections process. Annual forecasts of adjusted total revenue are provided in **Table 6.13**. Estimated gross revenue for FY 2019 is shown at \$52.8 million. Of this, \$24.6 million is estimated to come from BBM transactions.

As with other all-electronic toll collection facilities in the United States, there is always some portion of BBM revenue which may not be collected. This is generally referred to as "leakage" and is a result of a variety of factors, including:

- Unreadable or obscured license plates at the time of the transaction;
- Incomplete, unavailable or inaccurate information about vehicle owner name and address; and,
- Non-payment of billed BBM transactions.

Based on actual Triangle Expressway experience, estimates of BBM leakage were applied for each year in Table 6.13. This was applied only to the BBM share of gross revenue. In 2019, for example, losses due to BBM leakage were estimated at \$5.7 million, resulting in adjusted annual revenue of \$47.2 million. Leakage adjustments are expected to increase over time in proportion with the increase in computed BBM revenue. Even though the number of BBM transactions were estimated to grow only slightly over the forecast period, the amount of revenue, and hence the BBM leakage estimate, was assumed to increase over time because of assumptions regarding annual increases in toll rates per



## ESTIMATED ANNUAL REVENUE BY PAYMENT METHOD TRIANGLE EXPRESSWAY

**Table 6.13**  
**Estimated Adjusted Annual Revenue**  
**Scenario 1 - Triangle Expressway**

| Fiscal Year | Computed Gross Revenue |           |           | BBM Leakage | Adjusted Toll Revenue | Processing Fees | Total Collected Revenue |
|-------------|------------------------|-----------|-----------|-------------|-----------------------|-----------------|-------------------------|
|             | ETC                    | BBM       | Total     |             |                       |                 |                         |
| 2019        | \$ 28,238              | \$ 24,580 | \$ 52,818 | \$ (5,652)  | \$ 47,166             | \$ 5,657        | \$ 52,823               |
| 2020 (1,2)  | 31,243                 | 26,056    | 57,299    | (5,991)     | 51,308                | 5,778           | 57,086                  |
| 2021 (2)    | 33,832                 | 27,286    | 61,118    | (6,274)     | 54,844                | 5,870           | 60,714                  |
| 2022 (2)    | 35,783                 | 28,129    | 63,912    | (6,468)     | 57,444                | 5,893           | 63,337                  |
| 2023 (2)    | 37,726                 | 28,882    | 66,608    | (6,641)     | 59,966                | 5,898           | 65,865                  |
| 2024 (2,3)  | 39,994                 | 29,770    | 69,763    | (6,845)     | 62,918                | 5,934           | 68,852                  |
| 2025 (2)    | 42,203                 | 30,642    | 72,844    | (7,046)     | 65,798                | 5,940           | 71,738                  |
| 2026 (2)    | 44,567                 | 31,419    | 75,987    | (7,225)     | 68,762                | 5,939           | 74,701                  |
| 2027        | 47,481                 | 32,316    | 79,797    | (7,431)     | 72,366                | 5,953           | 78,320                  |
| 2028        | 50,182                 | 33,091    | 83,273    | (7,609)     | 75,664                | 5,928           | 81,592                  |
| 2029        | 53,165                 | 34,035    | 87,200    | (7,826)     | 79,374                | 5,917           | 85,291                  |
| 2030        | 56,418                 | 34,995    | 91,412    | (8,047)     | 83,365                | 5,904           | 89,269                  |
| 2031        | 59,860                 | 35,890    | 95,750    | (8,253)     | 87,497                | 5,889           | 93,386                  |
| 2032        | 63,525                 | 36,801    | 100,326   | (8,462)     | 91,864                | 5,873           | 97,737                  |
| 2033        | 67,368                 | 37,659    | 105,026   | (8,659)     | 96,367                | 5,855           | 102,222                 |
| 2034        | 71,432                 | 38,543    | 109,975   | (8,863)     | 101,112               | 5,835           | 106,948                 |
| 2035        | 75,704                 | 39,473    | 115,177   | (9,077)     | 106,100               | 5,814           | 111,914                 |
| 2036        | 79,749                 | 40,412    | 120,161   | (9,293)     | 110,868               | 5,808           | 116,677                 |
| 2037        | 83,595                 | 41,360    | 124,955   | (9,511)     | 115,445               | 5,819           | 121,263                 |
| 2038        | 87,620                 | 42,249    | 129,868   | (9,715)     | 120,153               | 5,827           | 125,981                 |
| 2039        | 91,739                 | 43,072    | 134,811   | (9,904)     | 124,907               | 5,833           | 130,740                 |
| 2040        | 96,080                 | 43,854    | 139,934   | (10,084)    | 129,850               | 5,837           | 135,687                 |
| 2041        | 100,625                | 44,631    | 145,256   | (10,263)    | 134,994               | 5,839           | 140,833                 |
| 2042        | 105,504                | 45,463    | 150,967   | (10,454)    | 140,513               | 5,839           | 146,352                 |
| 2043        | 110,852                | 46,437    | 157,288   | (10,678)    | 146,611               | 5,836           | 152,446                 |
| 2044        | 116,256                | 47,366    | 163,622   | (10,892)    | 152,730               | 5,830           | 158,560                 |
| 2045        | 121,711                | 48,135    | 169,846   | (11,069)    | 158,777               | 5,822           | 164,599                 |
| 2046        | 126,186                | 49,100    | 175,286   | (11,290)    | 163,996               | 5,828           | 169,824                 |
| 2047        | 129,525                | 50,280    | 179,806   | (11,562)    | 168,244               | 5,851           | 174,095                 |
| 2048        | 132,868                | 51,416    | 184,284   | (11,823)    | 172,461               | 5,875           | 178,336                 |
| 2049        | 136,305                | 52,594    | 188,899   | (12,094)    | 176,805               | 5,898           | 182,703                 |
| 2050        | 139,823                | 53,826    | 193,649   | (12,377)    | 181,272               | 5,922           | 187,193                 |
| 2051        | 143,434                | 55,080    | 198,514   | (12,666)    | 185,848               | 5,945           | 191,794                 |
| 2052        | 147,026                | 56,320    | 203,346   | (12,951)    | 190,396               | 5,969           | 196,364                 |
| 2053        | 150,670                | 57,568    | 208,238   | (13,238)    | 195,001               | 5,992           | 200,993                 |
| 2054        | 154,479                | 58,870    | 213,349   | (13,537)    | 199,812               | 6,016           | 205,828                 |
| 2055        | 158,454                | 60,225    | 218,680   | (13,849)    | 204,831               | 6,040           | 210,871                 |
| 2056        | 162,495                | 61,622    | 224,117   | (14,170)    | 209,947               | 6,064           | 216,011                 |
| 2057        | 166,489                | 63,006    | 229,495   | (14,488)    | 215,007               | 6,088           | 221,095                 |
| 2058        | 170,725                | 64,421    | 235,147   | (14,813)    | 220,333               | 6,112           | 226,446                 |

(1) Assumes new Morrisville Parkway Interchange is opened January 1, 2020. Also, a new mainline toll zone north of the Morrisville Parkway Interchange is put into operation January 1, 2020.

(2) Ramp up is applied to the first 36-month period of transaction and revenue impacts associated with new toll zones.

(3) Assumes ramp tolls at US 64 and Hopson Road on the Triangle Expressway are removed, and replaced by new mainline toll zones north of each interchange, on July 1, 2023.

transaction. After adjusting for leakage, adjusted annual revenue would be expected to increase from \$47.2 million in 2019 to \$65.8 million in 2025 and \$106.1 million in FY 2035.

Also shown in Table 6.13 are estimates of processing fee revenue. This relates to processing fees which are added to BBM invoices which are not paid within the first payment interval. These fees, \$6.00 per unpaid invoice, are estimated to generate about \$5.7 million in 2019, increasing to about \$5.9 million in 2025 and remain around that level in subsequent years. Relatively little growth is shown in processing fee revenue, because BBM transactions are forecast to remain fairly stable and no annual increase in the \$6.00 processing fee is assumed in this forecast.

The rightmost column of Table 6.13 shows estimated total collected revenue, which includes the adjusted revenue plus processing fee revenue. Total collected revenue from the Triangle Expressway is expected to grow from \$52.8 million in FY 2019 to \$164.6 million in FY 2045.

## 6.12 Disclaimer

Current accepted professional practices and procedures were used in the development of these updated traffic and revenue forecasts. However, as with any forecast of the future, there may be differences between forecasted and actual results caused by events and circumstances beyond the control of CDM Smith. In formulating its forecasts, CDM Smith has reasonably relied upon the accuracy and completeness of information provided (both written and oral) by the NCDOT/NCTA and other local and state agencies. CDM Smith also has relied upon the reasonable assurances of some independent parties and is not aware of any facts that would make such information misleading.

CDM Smith has made qualitative judgments related to several key variables in the development and analysis of the traffic and revenue forecasts that must be considered as a whole; therefore, selecting portions of any individual result without consideration of the intent of the whole may create a misleading or incomplete view of the results and the underlying methodologies used to obtain the results. CDM Smith gives no opinion as to the value or merit to partial information extracted from this report. All forecasts and projections reported herein are based on CDM Smith's experience and judgment and on a review of information obtained from multiple state and local agencies, including NCDOT/NCTA. These estimates and projections may not be indicative of actual or future values and are therefore subject to substantial uncertainty. Future developments, economic conditions, and changes in travel behavior resulting from advances in automotive technology cannot be predicted with certainty and may affect the forecasts or projections expressed in this report, such that CDM Smith does not specifically guarantee or warrant any estimate or projection contained within this report.

While CDM Smith believes that some of the projections or other forward-looking statements contained within the report are based on reasonable assumptions as of the date in the report, such forward looking statements involve risks and uncertainties that may cause actual results to differ materially from the results predicted. Therefore, following the date of this report, CDM Smith will take no responsibility or assume any obligation to advise of changes that may affect its assumptions contained within the report, as they pertain to: socioeconomic and demographic forecasts, proposed residential or commercial land use development projects and/or potential improvements to the regional transportation network.

CDM Smith is not, and has not been, a municipal advisor as defined in Federal law (the Dodd Frank Bill) to NCDOT/NCTA and does not owe a fiduciary duty pursuant to Section 15B of the Exchange Act

to NCDOT/NCTA with respect to the information and material contained in this report. CDM Smith is not recommending and has not recommended any action to NCDOT/NCTA. NCDOT/NCTA should discuss the information and material contained in this report with any and all internal and external advisors that it deems appropriate before acting on this information.

## Chapter 7

# Scenario 2: Complete 540 Phase 1 Traffic and Revenue Forecast

Chapter 6 provided a detailed description of traffic and revenue forecasts for Scenario 1, the existing Triangle Expressway without Complete 540 Phase 1. This chapter provides the forecast for Scenario 2, Complete 540 Phase 1, which assumes the Triangle Expressway and its planned improvements in addition to Complete 540 Phase 1. Phase 2, a possible future completion of Complete 540 from I-40/U.S. 70 to U.S. 64/U.S. 264/Knightdale Bypass, is contained in the ***State Transportation Improvement Program*** (STIP); but impacts from that portion of the project are *not* assumed in Scenario 2.

As shown previously in Figure 1.2 (Chapter 1), Complete 540 Phase 1 will extend the Triangle Expressway from its southern terminus at the NC 55 Bypass to I-40 and U.S. 70 (the Clayton Bypass). This study assumes that Complete 540 Phase 1 would open on July 1, 2023. In combination with the existing Triangle Expressway, Complete 540 Phase 1 would provide an alternative to congested areas on I-40 south of Raleigh. Scenario 2 will also be called the Complete 540 Scenario or Complete 540 forecast.

It is anticipated that through trips will be a small component of total travel on the combined Triangle Expressway and Complete 540 Phase 1. Rather, Complete 540 will provide access into the Holly Springs, Apex and western Cary areas from the lower portion of the I-40 corridor.

There will be seven interchanges on Complete 540 Phase 1, including the end points at I-40 and NC 55 Bypass at the southern terminus of the existing Triangle Expressway. Toll zones will be located on each of the six new mainline sections. Toll collection will be all electronic, using ETC and BBM, the same methods employed on the Triangle Expressway. For purposes of this study, it is assumed that the per-mile toll rates assessed on Complete 540 will be equal to the through-trip per-mile rate charged on the Toll NC 540 portion of the Triangle Expressway in any given year. The Complete 540 toll rates at each mainline section will be calculated by multiplying the per-mile toll rate by the distance between the adjacent interchanges. As with the Triangle Expressway, ETC toll rates will be 35 percent lower than the BBM toll.

Complete 540 Phase 1 is assumed to be open to traffic by July 1, 2023. Beyond traffic and revenue generated on the Complete 540 project itself, its completion is expected to add incremental traffic to the existing Triangle Expressway. Transaction and revenue estimates, including the incremental amount on the existing Triangle Expressway were forecast and will be presented in this Chapter.

Note that the wide range of highway improvements, described previously in Chapter 6, are still assumed to be in place in the years 2025, 2035 and 2045 for Scenario 2. As noted previously, several of these projects are likely competitive to the proposed Complete 540 project, particularly the planned widening on I-40 through much of the study area, and the widening of Ten Ten Road, which closely parallels Complete 540 Phase 1.



## 7.1 Analytical Approach

Traffic and revenue forecasts for Scenario 2 followed the same methodology described in Chapter 6. Specifically, assignments with Complete 540 Phase 1 were conducted at 2025, 2035 and 2045 levels. Transaction and revenue estimates for intermediate years were developed through interpolation. Transaction and revenue forecasts for the combined project were developed over a total 40-year period, ending in FY 2058. Estimates for years subsequent to 2045 were based on nominal and conservative annual traffic growth forecasts, assuming continuing annual increases in toll rates after 2045. Additionally, analysis was conducted to identify the transaction and revenue impacts on the existing Triangle Expressway attributable to the opening of Complete 540 Phase 1.

## 7.2 Basic Assumptions

The traffic and revenue estimates for Scenario 2, including both Triangle Expressway and Complete 540 Phase 1, are predicated on the basic assumptions which have been defined previously in Chapter 6. Additional assumptions with respect to the Complete 540 analysis are set forth below; these are considered reasonable for purposes of the Scenario 2 forecast:

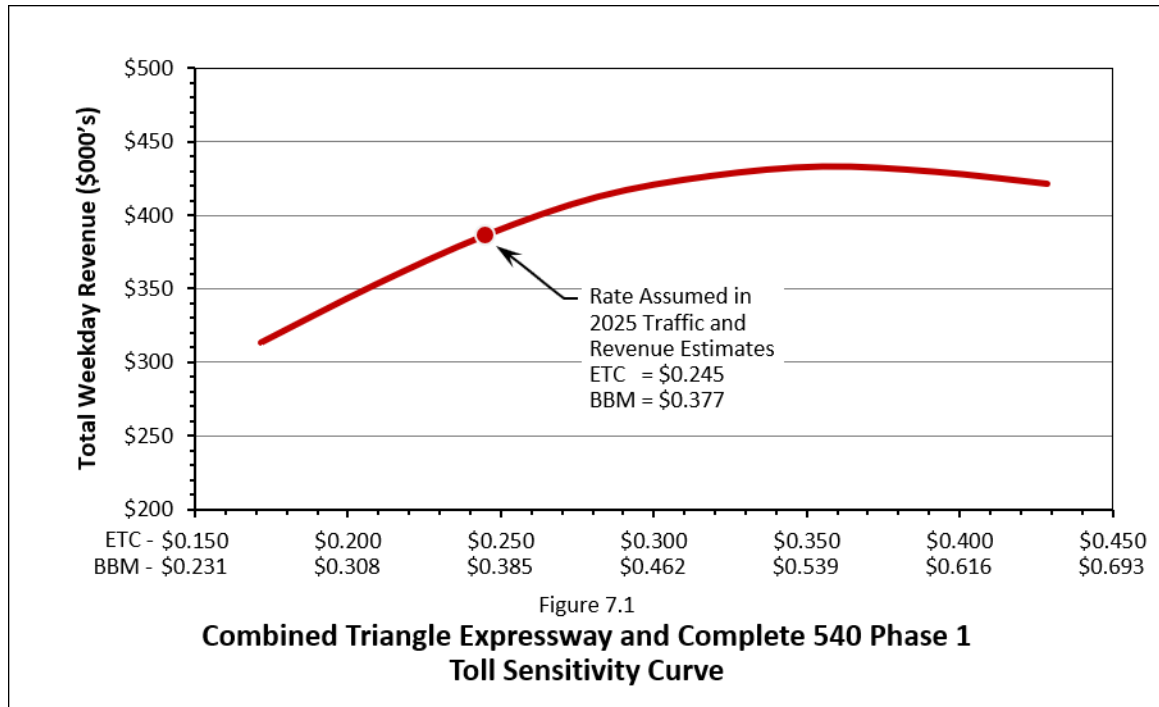
1. The proposed Complete 540 Phase 1 will be open to traffic on July 1, 2023.
2. The configuration, number of lanes and number and location of interchanges on Complete 540 Phase 1 will be as defined in this report and will not change during the forecast period.
3. Tolls on Complete 540 will be collected in a manner identical to Triangle Expressway, with three vehicle classes and two payment options, as defined in Chapter 6. Toll rates for each of the six new mainline toll zones will be based on the same per-mile through-trip rates planned for the Toll NC 540 portion of the existing Triangle Expressway in any given year.
4. Complete 540 Phase 3 is not included at any point during the forecast period of Scenario 2.

All other basic assumptions defined previously in Chapter 6 also apply to the Scenario 2 forecast. Any significant departure from these basic assumptions could materially affect traffic and revenue potential on the Triangle Expressway and Complete 540 Phase 1.

## 7.3 Toll Sensitivity Assessment

A toll sensitivity analysis was conducted for Scenario 2, assuming both Triangle Expressway and Complete 540 Phase 1 were in place. As discussed in Chapter 6, the expanded toll sensitivity analysis was conducted at 2025 levels. The results of the analysis are depicted in **Figure 7.1**.

The horizontal axis shows Class 1, per-mile toll rates for ETC and BBM payment modes. ETC rates are 35 percent lower than BBM rates at each of the discrete levels tested. The red dot shows the per-mile toll rate assumed for 2025 traffic and revenue estimates included in this report. In that year, the nominal per-mile rate for ETC transactions on both Complete 540 Phase 1 and the Triangle Expressway is assumed at \$0.245 per mile. The equivalent per-mile rate for BBM travel (Class 1) would be \$0.377 per mile. These rates are assumed for Complete 540, as they match the existing, planned per-mile rates for a through trip on the Toll NC 540 portion of the Triangle Expressway.



Under the full project configuration, including both the Triangle Expressway and Complete 540 Phase 1, maximum revenue would be achieved at per-mile rates between \$0.35 and \$0.40 per mile. The assumed 2025 rate, \$0.245 per mile, is considerably below the maximum rate. If revenue maximizing tolls were used, revenue would be increased by about 13 percent versus the assumed rate. This indicates that the selected per-mile rates would provide an opportunity to increase revenue in future years by rate increase levels above those assumed in the study, if ever needed.

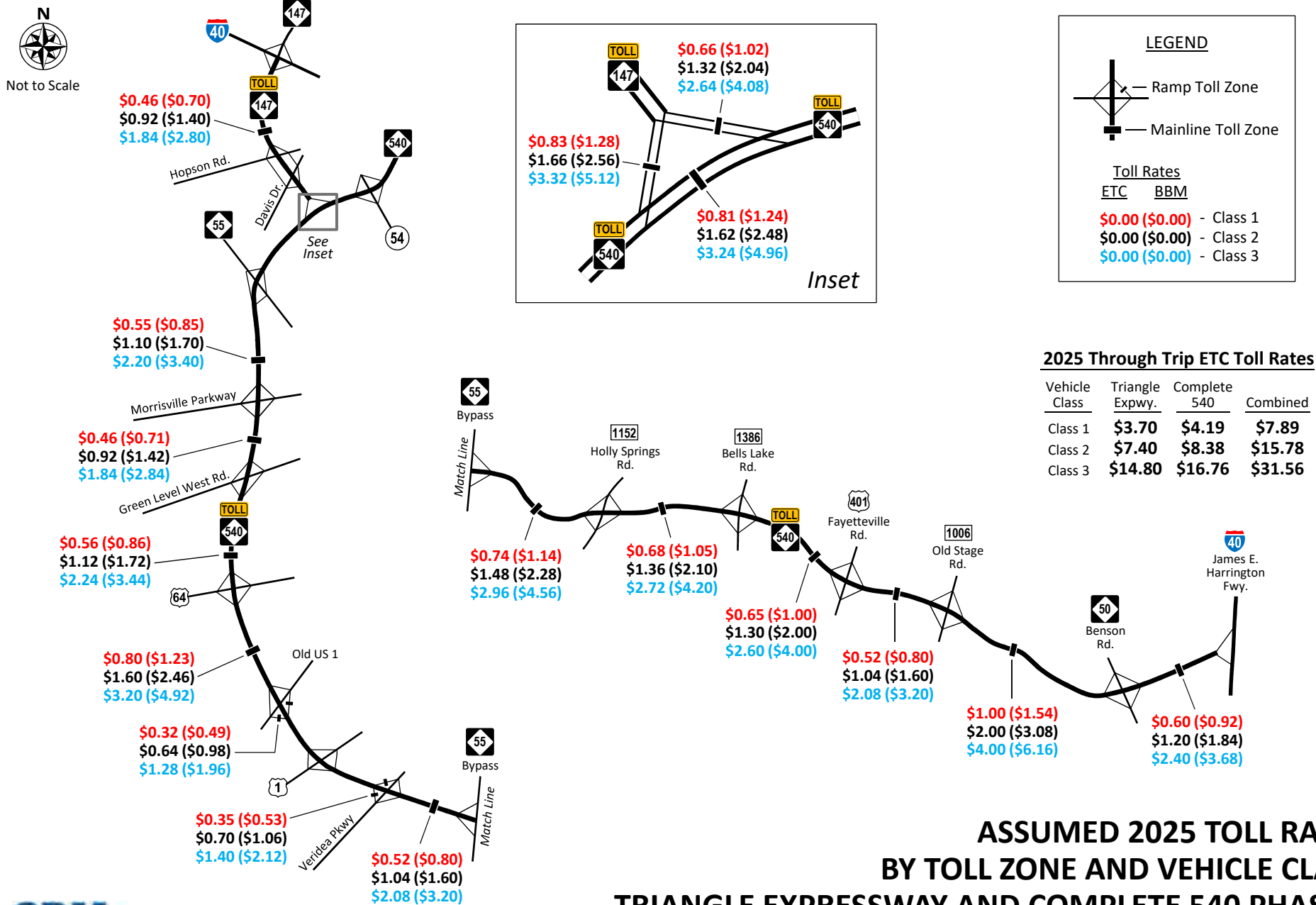
### 7.3.1 Assumed 2025 Toll Rates

**Figure 7.2** shows assumed toll rates by vehicle class and payment category at each tolling point in the year 2025. The left side of the graphic shows the 2025 toll configuration of the Triangle Expressway. The remaining portion shows the toll configuration and toll rates on the proposed Complete 540 Phase 1.

For example, at the eastern-most mainline toll point located just west of I-40, the ETC toll rate for Class 1 vehicles would be \$0.60, shown in red. At the same location, a Class 1 vehicle without an ETC transponder would be charged \$0.92. Higher toll rates are shown at the mainline toll point immediately to the west; this is because of a longer distance between interchanges at Old Stage Road and NC 50 as compared with the eastern-most section of the project. As described previously in Chapter 6, it is assumed that the Class 2 toll will be twice the Class 1 toll while the Class 3 toll, which represents vehicles with more than three axles, would be set at four times the Class 1 rate.

Figure 7.2 also shows through-trip rates for ETC vehicles on both the Triangle Expressway and Complete 540 Phase 1 at 2025 levels. For a Class 1 vehicle, using ETC, a through trip on the Triangle Expressway portion of the project would be charged \$3.70. The through-trip toll for the Complete 540 Phase 1 portion of the project, which is about one mile longer than the Triangle Expressway trip, would be \$4.19. A through trip on the entire Triangle Expressway and Complete 540 Phase 1, a distance of more than 32 miles, would cost a Class 1 ETC vehicle \$7.89 in tolls in 2025.

# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



### 7.3.2 Future Toll Increases

As described in Chapter 6, the NCTA has an adopted toll schedule for the Triangle Expressway that assumes an annual increase in toll rates through 2035. These toll rate increases are not indexed to current CPI. After 2035, annual toll rate increases are assumed on both the Triangle Expressway and Complete 540 that are indexed to CPI inflation forecasts. **Table 7.1** shows assumed Class 1 toll rates for ETC and BBM at each of the six new mainline toll zones on Complete 540. Toll rates are shown for the entire forecast period from the assumed opening year of the project in 2023 through 2058.

The through-trip toll for Phase 1 of Complete 540, for a Class 1 ETC vehicle, is shown on the right side of Table 7.1. Through-trip rates would increase from \$4.19 in 2025 to \$5.65 in 2035, an average annual increase of 3.0 percent per year. A through-trip Class 1 ETC toll would total \$6.93 by 2045, an increase of about 2.1 percent per year between 2035 and 2045.

**Table 7.2** provides a summary of through-trip toll rates by toll class on both the Triangle Expressway and Complete 540. Values are shown at each of the modeling years, including 2020, 2025, 2035 and 2045, for each of the three toll classes. The 2020 values include only the Triangle Expressway since Complete 540 Phase 1 is not assumed to open until July 1, 2023. The first model year in Table 7.2 with the entire project in place would be 2025 which shows a full length through-trip ETC toll of \$7.89 for Class 1, \$15.78 for Class 2 and \$31.56 for Class 3. Through-trip toll rates for BBM transactions are also shown in Table 7.2.

## 7.4 Estimated 2025 Weekday Transactions and Revenue

Estimated weekday traffic volumes on the Triangle Expressway and Complete 540 Phase 1 are shown in **Figure 7.3**. Mainline traffic is the sum of both directions, and the ramp traffic is posted by entry and exit ramps, balanced by reciprocal movements. The traffic volumes on the Triangle Expressway include the impact of additional trips associated with Complete 540.

As shown in Figure 7.3, average weekday traffic in calendar 2025 at the far eastern end of Complete 540 is estimated at 19,800. This would increase to about 29,000 just east of U.S. 401. Traffic at the south end of the existing Triangle Expressway would total 43,400. Weekday traffic on the Triangle Expressway peaks at 65,600 on the mainline north of NC 55.

**Figure 7.4** illustrates the net impacts of Complete 540 on Triangle Expressway in 2025. The traffic volumes and net impacts are prior to the application of ramp-up factors. They represent traffic demand prior to ramp-up. The black numbers in Figure 7.4 represent estimated weekday traffic on the Triangle Expressway in 2025 with Complete 540 Phase 1 in place. The red numbers are the estimated traffic impacts on the Triangle Expressway due solely to Complete 540 Phase 1.

Complete 540 draws more traffic onto the Triangle Expressway, with the largest positive impacts occurring on the southern sections. As might be expected, the biggest impact would occur at the southernmost mainline of the Triangle Expressway, where traffic just west of the NC 55 Bypass would increase by almost 20,000 vehicles per day.

**Table 7.1**  
**Assumed Class 1 Toll Rates By Year**  
**Complete 540 Phase 1**

| Calendar<br>Year (1)                               | NC 55 Bypass<br>Holly Springs |            | Holly Springs -<br>Bells Lake Rd. |            | Bells Lake Rd. -<br>U.S. 401 |            | U.S. 401 -<br>Old Stage Rd. |            | Old Stage Rd. -<br>NC 50 |            | NC 50<br>I-40 |            | Through Trip<br>ETC Toll |            | Through Trip<br>Rate Per<br>Mile |            |
|----------------------------------------------------|-------------------------------|------------|-----------------------------------|------------|------------------------------|------------|-----------------------------|------------|--------------------------|------------|---------------|------------|--------------------------|------------|----------------------------------|------------|
|                                                    | ETC                           | BBM        | ETC                               | BBM        | ETC                          | BBM        | ETC                         | BBM        | ETC                      | BBM        | ETC           | BBM        | ETC                      | BBM        | ETC                              | BBM        |
| 2023 (2)                                           | \$0.70                        | \$1.08     | \$0.64                            | \$0.99     | \$0.61                       | \$0.94     | \$0.49                      | \$0.75     | \$0.94                   | \$1.45     | \$0.57        | \$0.88     | \$3.95                   | \$0.88     | \$0.231                          |            |
| 2024                                               | 0.72                          | 1.11       | 0.66                              | 1.02       | 0.63                         | 0.97       | 0.51                        | 0.79       | 0.97                     | 1.49       | 0.58          | 0.89       | 4.07                     | 0.89       | 0.238                            |            |
| 2025                                               | 0.74                          | 1.14       | 0.68                              | 1.05       | 0.65                         | 1.00       | 0.52                        | 0.80       | 1.00                     | 1.54       | 0.60          | 0.92       | 4.19                     | 0.92       | 0.245                            |            |
| 2026                                               | 0.77                          | 1.19       | 0.70                              | 1.08       | 0.67                         | 1.03       | 0.54                        | 0.83       | 1.03                     | 1.59       | 0.62          | 0.95       | 4.33                     | 0.95       | 0.253                            |            |
| 2027                                               | 0.79                          | 1.22       | 0.73                              | 1.12       | 0.69                         | 1.06       | 0.55                        | 0.85       | 1.06                     | 1.63       | 0.64          | 0.99       | 4.46                     | 0.99       | 0.261                            |            |
| 2028                                               | 0.81                          | 1.25       | 0.74                              | 1.14       | 0.71                         | 1.09       | 0.57                        | 0.88       | 1.09                     | 1.68       | 0.65          | 1.00       | 4.57                     | 1.00       | 0.267                            |            |
| 2029                                               | 0.84                          | 1.29       | 0.77                              | 1.19       | 0.73                         | 1.12       | 0.59                        | 0.91       | 1.12                     | 1.72       | 0.67          | 1.03       | 4.72                     | 1.03       | 0.276                            |            |
| 2030                                               | 0.86                          | 1.32       | 0.79                              | 1.22       | 0.75                         | 1.16       | 0.60                        | 0.92       | 1.16                     | 1.79       | 0.69          | 1.06       | 4.85                     | 1.06       | 0.284                            |            |
| 2031                                               | 0.89                          | 1.37       | 0.82                              | 1.26       | 0.78                         | 1.20       | 0.62                        | 0.95       | 1.20                     | 1.85       | 0.72          | 1.11       | 5.03                     | 1.11       | 0.294                            |            |
| 2032                                               | 0.92                          | 1.42       | 0.84                              | 1.29       | 0.80                         | 1.23       | 0.64                        | 0.99       | 1.23                     | 1.89       | 0.74          | 1.14       | 5.17                     | 1.14       | 0.302                            |            |
| 2033                                               | 0.95                          | 1.46       | 0.87                              | 1.34       | 0.83                         | 1.28       | 0.66                        | 1.02       | 1.27                     | 1.96       | 0.76          | 1.17       | 5.34                     | 1.17       | 0.312                            |            |
| 2034                                               | 0.97                          | 1.49       | 0.89                              | 1.37       | 0.85                         | 1.31       | 0.68                        | 1.05       | 1.31                     | 2.02       | 0.78          | 1.20       | 5.48                     | 1.20       | 0.320                            |            |
| 2035                                               | 1.00                          | 1.54       | 0.92                              | 1.42       | 0.88                         | 1.36       | 0.70                        | 1.08       | 1.34                     | 2.06       | 0.81          | 1.25       | 5.65                     | 1.25       | 0.330                            |            |
| 2036                                               | 1.02                          | 1.57       | 0.94                              | 1.45       | 0.89                         | 1.37       | 0.71                        | 1.09       | 1.37                     | 2.11       | 0.82          | 1.26       | 5.75                     | 1.26       | 0.336                            |            |
| 2037                                               | 1.04                          | 1.60       | 0.96                              | 1.48       | 0.91                         | 1.40       | 0.73                        | 1.12       | 1.40                     | 2.16       | 0.84          | 1.29       | 5.88                     | 1.29       | 0.344                            |            |
| 2038                                               | 1.07                          | 1.65       | 0.98                              | 1.51       | 0.93                         | 1.43       | 0.75                        | 1.16       | 1.43                     | 2.20       | 0.86          | 1.32       | 6.02                     | 1.32       | 0.352                            |            |
| 2039                                               | 1.09                          | 1.68       | 1.00                              | 1.54       | 0.95                         | 1.46       | 0.76                        | 1.17       | 1.46                     | 2.25       | 0.87          | 1.34       | 6.13                     | 1.34       | 0.358                            |            |
| 2040                                               | 1.11                          | 1.71       | 1.02                              | 1.57       | 0.97                         | 1.49       | 0.77                        | 1.19       | 1.49                     | 2.29       | 0.89          | 1.37       | 6.25                     | 1.37       | 0.365                            |            |
| 2041                                               | 1.13                          | 1.74       | 1.03                              | 1.59       | 0.99                         | 1.52       | 0.79                        | 1.22       | 1.51                     | 2.33       | 0.91          | 1.40       | 6.36                     | 1.40       | 0.372                            |            |
| 2042                                               | 1.15                          | 1.77       | 1.06                              | 1.63       | 1.01                         | 1.56       | 0.81                        | 1.25       | 1.55                     | 2.39       | 0.93          | 1.43       | 6.51                     | 1.43       | 0.381                            |            |
| 2043                                               | 1.18                          | 1.82       | 1.08                              | 1.66       | 1.03                         | 1.59       | 0.83                        | 1.28       | 1.59                     | 2.45       | 0.95          | 1.46       | 6.66                     | 1.46       | 0.389                            |            |
| 2044                                               | 1.20                          | 1.85       | 1.10                              | 1.69       | 1.05                         | 1.62       | 0.84                        | 1.29       | 1.62                     | 2.49       | 0.97          | 1.49       | 6.78                     | 1.49       | 0.396                            |            |
| 2045                                               | 1.23                          | 1.89       | 1.13                              | 1.74       | 1.07                         | 1.65       | 0.86                        | 1.32       | 1.65                     | 2.54       | 0.99          | 1.52       | 6.93                     | 1.52       | 0.405                            |            |
| 2046                                               | 1.25                          | 1.93       | 1.15                              | 1.77       | 1.10                         | 1.69       | 0.88                        | 1.36       | 1.68                     | 2.59       | 1.01          | 1.56       | 7.07                     | 1.56       | 0.413                            |            |
| 2047                                               | 1.28                          | 1.97       | 1.17                              | 1.80       | 1.12                         | 1.72       | 0.90                        | 1.39       | 1.72                     | 2.65       | 1.03          | 1.59       | 7.22                     | 1.59       | 0.422                            |            |
| 2048                                               | 1.30                          | 2.00       | 1.20                              | 1.85       | 1.14                         | 1.76       | 0.91                        | 1.40       | 1.75                     | 2.70       | 1.05          | 1.62       | 7.35                     | 1.62       | 0.430                            |            |
| 2049                                               | 1.33                          | 2.05       | 1.22                              | 1.88       | 1.17                         | 1.80       | 0.93                        | 1.43       | 1.79                     | 2.76       | 1.07          | 1.65       | 7.51                     | 1.65       | 0.439                            |            |
| 2050                                               | 1.36                          | 2.09       | 1.25                              | 1.93       | 1.19                         | 1.83       | 0.95                        | 1.46       | 1.82                     | 2.80       | 1.09          | 1.68       | 7.66                     | 1.68       | 0.448                            |            |
| 2051                                               | 1.39                          | 2.14       | 1.27                              | 1.96       | 1.21                         | 1.86       | 0.97                        | 1.49       | 1.86                     | 2.86       | 1.12          | 1.72       | 7.82                     | 1.72       | 0.457                            |            |
| 2052                                               | 1.41                          | 2.17       | 1.30                              | 2.00       | 1.24                         | 1.91       | 0.99                        | 1.52       | 1.90                     | 2.93       | 1.14          | 1.76       | 7.98                     | 1.76       | 0.467                            |            |
| 2053                                               | 1.44                          | 2.22       | 1.32                              | 2.03       | 1.26                         | 1.94       | 1.01                        | 1.56       | 1.94                     | 2.99       | 1.16          | 1.79       | 8.13                     | 1.79       | 0.475                            |            |
| 2054                                               | 1.47                          | 2.26       | 1.35                              | 2.08       | 1.28                         | 1.97       | 1.03                        | 1.59       | 1.97                     | 3.03       | 1.18          | 1.82       | 8.28                     | 1.82       | 0.484                            |            |
| 2055                                               | 1.50                          | 2.31       | 1.38                              | 2.13       | 1.31                         | 2.02       | 1.05                        | 1.62       | 2.01                     | 3.10       | 1.21          | 1.86       | 8.46                     | 1.86       | 0.495                            |            |
| 2056                                               | 1.53                          | 2.36       | 1.40                              | 2.16       | 1.34                         | 2.06       | 1.07                        | 1.65       | 2.05                     | 3.16       | 1.23          | 1.89       | 8.62                     | 1.89       | 0.504                            |            |
| 2057                                               | 1.56                          | 2.40       | 1.43                              | 2.20       | 1.36                         | 2.09       | 1.09                        | 1.68       | 2.09                     | 3.22       | 1.25          | 1.93       | 8.78                     | 1.93       | 0.513                            |            |
| 2058                                               | 1.59                          | 2.45       | 1.46                              | 2.25       | 1.39                         | 2.14       | 1.11                        | 1.71       | 2.13                     | 3.28       | 1.28          | 1.97       | 8.96                     | 1.97       | 0.524                            |            |
| <b>Average Annual Percent Change in Toll Rates</b> |                               |            |                                   |            |                              |            |                             |            |                          |            |               |            |                          |            |                                  |            |
| 2023-2035                                          | 3.0                           | 3.0        | 3.1                               | 3.1        | 3.1                          | 3.1        | 3.0                         | 3.1        | 3.0                      | 3.0        | 3.0           | 3.0        | 3.0                      | 3.0        | 3.0                              | 3.0        |
| 2035-2045                                          | 2.1                           | 2.1        | 2.1                               | 2.1        | 2.0                          | 2.0        | 2.1                         | 2.0        | 2.1                      | 2.1        | 2.0           | 2.0        | 2.1                      | 2.0        | 2.1                              | 2.1        |
| 2045-2058                                          | 2.0                           | 2.0        | 2.0                               | 2.0        | 2.0                          | 2.0        | 2.0                         | 2.0        | 2.0                      | 2.0        | 2.0           | 2.0        | 2.0                      | 2.0        | 2.0                              | 2.0        |
| <b>2024-2045</b>                                   | <b>2.6</b>                    | <b>2.6</b> | <b>2.6</b>                        | <b>2.6</b> | <b>2.6</b>                   | <b>2.6</b> | <b>2.5</b>                  | <b>2.5</b> | <b>2.6</b>               | <b>2.6</b> | <b>2.6</b>    | <b>2.6</b> | <b>2.6</b>               | <b>2.6</b> | <b>2.6</b>                       | <b>2.6</b> |

(1) Annual toll rate increases are assumed to be implemented on January 1st of each year.

(2) Complete 540 Phase 1 is assumed to open on July 1, 2023.

**Table 7.2**  
**Through-Trip Toll Rates By Toll Class (1)**  
**Triangle Expressway (Toll 540) and Complete 540 Phase 1**

| Calendar Year | Toll Class | Triangle Expressway |         | Complete 540 Phase 1 |          | Total    |          |
|---------------|------------|---------------------|---------|----------------------|----------|----------|----------|
|               |            | ETC                 | BBM     | ETC                  | BBM      | ETC      | BBM      |
| 2020          | Class 1    | \$ 3.10             | \$ 4.74 | \$ -                 | \$ -     | \$ 3.10  | \$ 4.74  |
|               | Class 2    | 6.20                | 9.48    | -                    | -        | 6.20     | 9.48     |
|               | Class 3    | 12.40               | 18.96   | -                    | -        | 12.40    | 18.96    |
| 2025          | Class 1    | \$ 3.70             | \$ 5.69 | \$ 4.19              | \$ 6.45  | \$ 7.89  | \$ 12.14 |
|               | Class 2    | 7.40                | 11.38   | 8.38                 | 12.90    | 15.78    | 24.28    |
|               | Class 3    | 14.80               | 22.76   | 16.76                | 25.80    | 31.56    | 48.56    |
| 2035          | Class 1    | \$ 4.99             | \$ 7.65 | \$ 5.65              | \$ 8.71  | \$ 10.64 | \$ 16.36 |
|               | Class 2    | 9.98                | 15.30   | 11.30                | 17.42    | 21.28    | 32.72    |
|               | Class 3    | 19.96               | 30.60   | 22.60                | 34.84    | 42.56    | 65.44    |
| 2045          | Class 1    | \$ 6.12             | \$ 9.42 | \$ 6.93              | \$ 10.66 | \$ 13.05 | \$ 20.08 |
|               | Class 2    | 12.24               | 18.84   | 13.86                | 21.32    | 26.10    | 40.16    |
|               | Class 3    | 24.48               | 37.68   | 27.72                | 42.64    | 52.20    | 80.32    |

(1) The Triangle Expressway through trip is comprised of a through movement on Toll 540 and does not include any travel on Toll 147.

There would be some increases in ramp traffic, primarily to and from the south, especially south of U.S. 64. There would also be some decreases in traffic on ramps to and from the north, as motorists access the Triangle Expressway via Complete 540 as opposed to other local roadways. Estimated traffic impacts drop to about 8,400 vehicles per day north of U.S. 64 and to 6,800 vehicles per day just north of NC 55. At that point, most of the net increase would continue onto Toll NC 147.

Much of the net impact on the northern-most sections of the Triangle Expressway would reflect through-trip diversions; shifts from the I-40 corridor to use the full length of the combined Triangle Expressway and Complete 540 Phase 1. Based on this analysis, through trips are estimated to total about 5,500 vehicles per weekday at 2025 levels. While not insignificant, it is important to recognize that these 5,500 through trips would represent a very small portion of traffic on most portions of I-40, generally in the range of 2 to 4 percent of I-40 traffic.

**Table 7.3** presents estimated weekday transactions and revenue by toll zone and payment method. Total weekday transactions on the entire system are estimated at more than 531,000, before adjustment for ramp-up, of which over 154,000, or 29.0 percent, would occur at the 6 new mainline toll zones of Complete 540 Phase 1. The remaining 71.0 percent of transactions would take place at toll zones located on the Triangle Expressway.

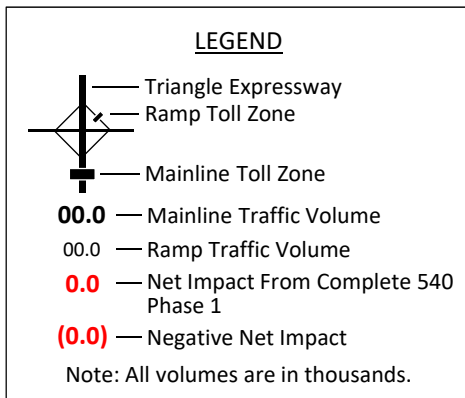
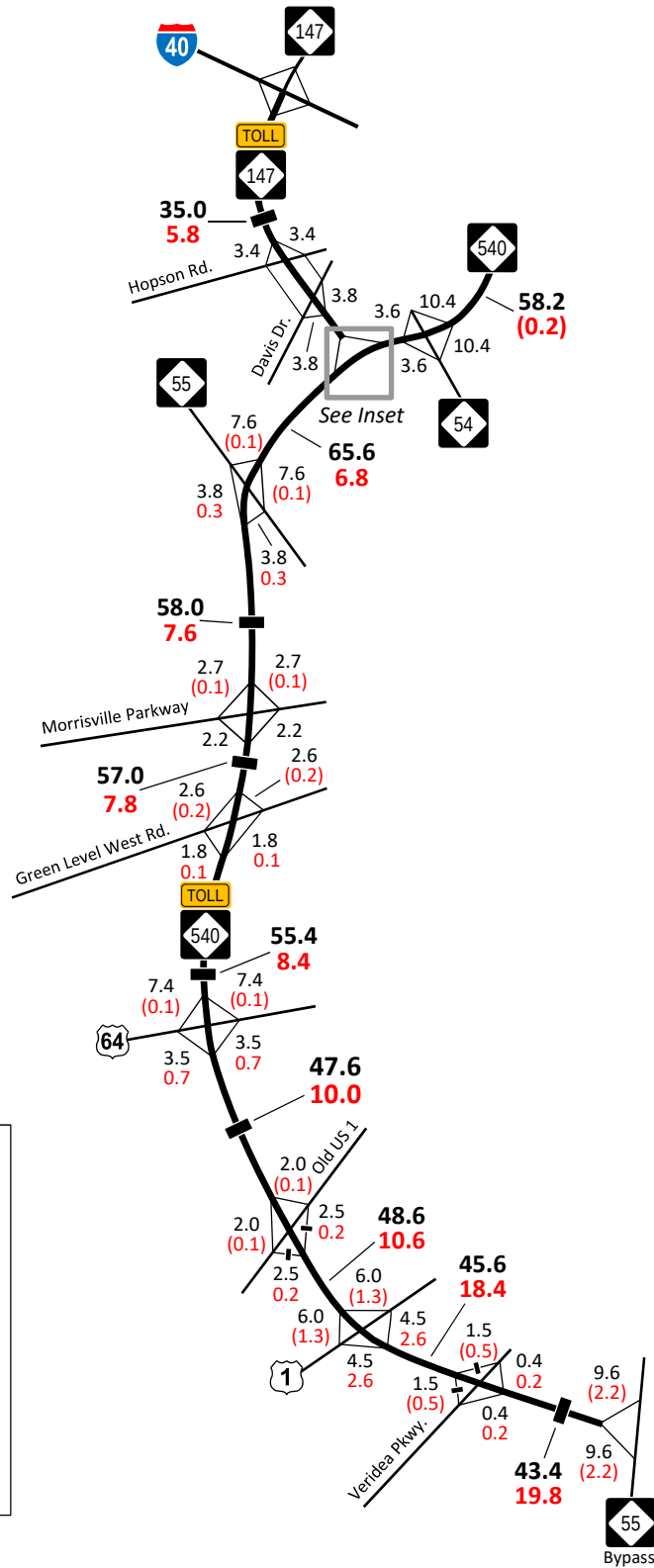
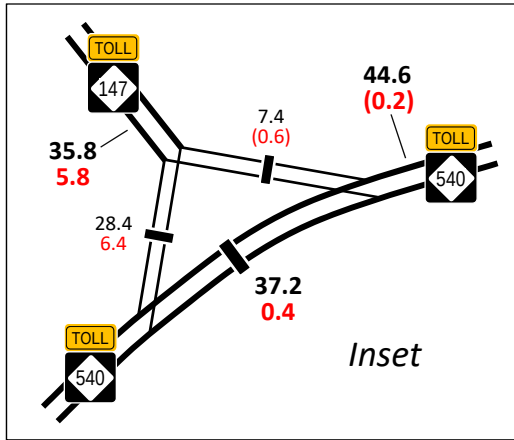




**ESTIMATED WEEKDAY TRAFFIC**  
**TRIANGLE EXPRESSWAY AND COMPLETE 540 PHASE 1 - 2025**

FIGURE 7.3

# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



**ESTIMATED TRIANGLE EXPRESSWAY  
NET WEEKDAY TRAFFIC IMPACTS FROM  
COMPLETE 540 PHASE 1 - 2025**

**Table 7.3**  
**Estimated 2025 Weekday Transactions and Revenue by Toll Zone**  
**Scenario 2 - Triangle Expressway and Complete 540 Phase 1**

| Toll Zone                                                                                      | Class 1 Vehicles |           |          |           | Class 2 and 3 Vehicles |          |         |          | Total Weekday Transactions |         |         |           | Total Weekday Revenue |           |         |          | Average Weekday Toll per Transaction<br>(all vehicles and payment types) |          |         |
|------------------------------------------------------------------------------------------------|------------------|-----------|----------|-----------|------------------------|----------|---------|----------|----------------------------|---------|---------|-----------|-----------------------|-----------|---------|----------|--------------------------------------------------------------------------|----------|---------|
|                                                                                                | Trans.           | ETC       | Revenue  | BBM       | Trans.                 | ETC      | Revenue | BBM      | ETC                        | BBM     | Total   | ETC       | BBM                   | Total     |         |          |                                                                          |          |         |
| Triangle Expressway                                                                            |                  |           |          |           |                        |          |         |          |                            |         |         |           |                       |           |         |          |                                                                          |          |         |
| 01/02 SR 147/Mainline N of Hopson Rd.                                                          | 22,801           | \$0.46    | \$10,488 | 9,798     | \$0.70                 | \$6,858  | 1,370   | \$1.57   | \$2,150                    | 989     | \$2.29  | \$2,264   | 24,170                | 10,787    | 34,957  | \$12,639 | \$9,123                                                                  | \$21,761 | \$0.623 |
| 05/06 SR 147/SR 540 Jct. NW Connection                                                         | 18,521           | \$0.83    | \$15,373 | 7,494     | \$1.28                 | \$9,592  | 1,341   | \$2.76   | \$3,701                    | 1,010   | \$4.46  | \$4,506   | 19,862                | 8,504     | 28,366  | \$19,073 | \$14,097                                                                 | \$33,171 | \$1.169 |
| 09/10 SR 147/SR 540 Jct. NE Connection                                                         | 4,449            | \$0.66    | \$2,936  | 2,700     | \$1.02                 | \$2,754  | 124     | \$2.31   | \$286                      | 123     | \$3.27  | \$401     | 4,573                 | 2,822     | 7,395   | \$3,222  | \$3,154                                                                  | \$6,376  | \$0.862 |
| 13/14 SR 147/SR 540 Jct. 540 Thru Mvt.                                                         | 24,043           | \$0.81    | \$19,475 | 11,917    | \$1.24                 | \$14,777 | 648     | \$2.63   | \$1,704                    | 595     | \$4.08  | \$2,426   | 24,691                | 12,512    | 37,202  | \$21,179 | \$17,203                                                                 | \$38,382 | \$1.032 |
| 15/16 Mainline N of Morrisville Pky                                                            | 38,292           | \$0.55    | \$21,061 | 16,136    | \$0.85                 | \$13,715 | 2,029   | \$1.85   | \$3,753                    | 1,468   | \$2.82  | \$4,141   | 40,321                | 17,604    | 57,925  | \$24,814 | \$17,856                                                                 | \$42,670 | \$0.737 |
| 17/18 Mainline N. of Green Level Rd                                                            | 36,759           | \$0.46    | \$16,909 | 16,583    | \$0.71                 | \$11,774 | 2,053   | \$1.55   | \$3,182                    | 1,587   | \$2.36  | \$3,745   | 38,812                | 18,170    | 56,982  | \$20,091 | \$15,519                                                                 | \$35,610 | \$0.625 |
| 21/22 Mainline N. of US 64                                                                     | 36,550           | \$0.56    | \$20,468 | 15,293    | \$0.86                 | \$13,152 | 2,052   | \$1.96   | \$4,022                    | 1,520   | \$2.84  | \$4,318   | 38,602                | 16,813    | 55,415  | \$24,489 | \$17,470                                                                 | \$41,959 | \$0.757 |
| 25/26 Mainline S of US 64                                                                      | 30,416           | \$0.80    | \$24,333 | 13,925    | \$1.23                 | \$17,128 | 1,901   | \$2.71   | \$5,150                    | 1,456   | \$4.21  | \$6,128   | 32,317                | 15,381    | 47,698  | \$29,484 | \$23,256                                                                 | \$52,740 | \$1.106 |
| 29/30 Ramps South at S. Salem St.                                                              | 3,564            | \$0.32    | \$1,141  | 1,353     | \$0.49                 | \$663    | 68      | \$1.10   | \$75                       | 32      | \$1.59  | \$51      | 3,633                 | 1,385     | 5,018   | \$1,216  | \$714                                                                    | \$1,930  | \$0.385 |
| 31/32 Ramps North at Veridea Pky                                                               | 1,924            | \$0.35    | \$673    | 942       | \$0.53                 | \$499    | 39      | \$1.20   | \$47                       | 31      | \$1.72  | \$53      | 1,963                 | 973       | 2,936   | \$720    | \$553                                                                    | \$1,273  | \$0.433 |
| 33/34 Mainline N of SR 55 Bypass                                                               | 29,040           | \$0.52    | \$15,101 | 11,716    | \$0.80                 | \$9,373  | 1,531   | \$1.72   | \$2,634                    | 1,088   | \$2.64  | \$2,871   | 30,571                | 12,804    | 43,375  | \$17,735 | \$12,244                                                                 | \$29,979 | \$0.691 |
| Subtotal Triangle Expressway                                                                   | 246,359          | \$147,957 | 107,856  | \$100,285 | \$26,704               | 13,155   | 9,898   | \$30,904 | 259,514                    | 117,754 | 377,268 | \$174,661 | \$131,190             | \$305,851 | \$0.811 |          |                                                                          |          |         |
| Complete 540 Phase 1 (C540 Phase 1)                                                            |                  |           |          |           |                        |          |         |          |                            |         |         |           |                       |           |         |          |                                                                          |          |         |
| 35/36 Mainline East of SR 55 Bypass                                                            | 17,965           | \$0.74    | \$13,294 | 6,811     | \$1.14                 | \$7,765  | 1,201   | \$2.46   | \$2,954                    | 831     | \$3.80  | \$3,158   | 19,166                | 7,642     | 26,808  | \$16,248 | \$10,922                                                                 | \$27,171 | \$1.014 |
| 37/38 Mainline East of Holy Springs Rd.                                                        | 19,132           | \$0.68    | \$13,010 | 7,603     | \$1.05                 | \$7,983  | 1,225   | \$2.26   | \$2,768                    | 852     | \$3.50  | \$2,982   | 20,357                | 8,455     | 28,812  | \$15,778 | \$10,965                                                                 | \$26,743 | \$0.928 |
| 39/40 Mainline East of Bells Lake Rd.                                                          | 18,955           | \$0.65    | \$12,321 | 7,771     | \$1.00                 | \$7,771  | 1,233   | \$2.16   | \$2,663                    | 859     | \$3.34  | \$2,869   | 20,188                | 8,630     | 28,818  | \$14,984 | \$10,640                                                                 | \$25,624 | \$0.889 |
| 41/42 Mainline East U.S. 401                                                                   | 18,916           | \$0.52    | \$9,836  | 8,055     | \$0.80                 | \$6,444  | 1,235   | \$1.73   | \$2,137                    | 873     | \$2.67  | \$2,331   | 20,151                | 8,928     | 29,079  | \$11,973 | \$8,775                                                                  | \$20,747 | \$0.713 |
| 43/44 Mainline East of Old Stage Rd.                                                           | 13,250           | \$1.00    | \$13,250 | 5,483     | \$1.54                 | \$8,444  | 1,220   | \$3.32   | \$4,050                    | 862     | \$5.14  | \$4,431   | 14,470                | 6,345     | 20,815  | \$17,300 | \$12,875                                                                 | \$30,175 | \$1.450 |
| 45/46 Mainline East of SR 50                                                                   | 12,499           | \$0.60    | \$7,499  | 5,486     | \$0.92                 | \$5,047  | 1,092   | \$1.99   | \$2,173                    | 778     | \$3.07  | \$2,388   | 13,591                | 6,264     | 19,855  | \$9,672  | \$7,436                                                                  | \$17,108 | \$0.862 |
| Subtotal Complete 540 Phase 1                                                                  | 100,717          | \$69,210  | 41,209   | \$43,453  | \$16,746               | 7,206    | 5,055   | \$18,159 | 107,923                    | 46,264  | 154,186 | \$85,956  | \$61,612              | \$147,569 | \$0.957 |          |                                                                          |          |         |
| Weekday Total Triangle Exp. Plus C540 Phase 1                                                  | 347,076          | \$217,167 | 149,065  | \$143,739 | \$43,450               | 20,361   | 14,953  | \$49,063 | 367,436                    | 164,018 | 531,454 | \$260,617 | \$192,802             | \$463,419 | \$0.853 |          |                                                                          |          |         |
| Annual Total Triangle Exp. Plus C540 Phase 1 (000)<br>Assumes Annualization Factor of 305 Days | 105,858          | \$66,236  | 45,465   | \$43,840  | \$13,252               | 6,210    | 4,561   | \$14,964 | 112,068                    | 50,025  | 162,094 | \$79,488  | \$58,805              | \$138,293 |         |          |                                                                          |          |         |

Note: Transactions by toll zone in this table may not match transactions shown in Figure 7.4 due to rounding by direction in the figure.

Estimated weekday revenue in 2025 is computed at more than \$453,000, with the average toll per transaction estimated at about \$0.853 over the entire system. The average toll per transaction would be slightly higher at toll points on Complete 540, estimated at \$0.957. This would produce almost \$148,000 in average weekday revenue on Complete 540 itself, representing about 32.5 percent of systemwide revenue.

After applying the annualization factor of 305 “typical weekdays”, annual transactions in 2025 on the combined Triangle Expressway and Complete 540 are estimated to total 162.1 million, of which 112.1 million would be ETC transactions and about 50.0 million would be BBM transactions. This represents an overall ETC transaction share of just over 69 percent. Annual revenue in 2025, before adjustment for ramp-up and before adjusting for leakage, is estimated at \$138.3 million, for Scenario 2, Triangle Expressway and Complete 540 Phase 1.

#### 7.4.1 Time Distance Relationships

**Figure 7.5** provides a comparison of time and distance relationships for selected movements along Triangle Expressway and Complete 540 Phase 1 as compared with the best alternative non-tolled routing. Information shown in Figure 7.5 was derived from travel demand modeling performed at 2025 levels, under a network configuration which assumed both Triangle Expressway and Complete 540 Phase 1.

Four control points were identified for purposes of this analysis:

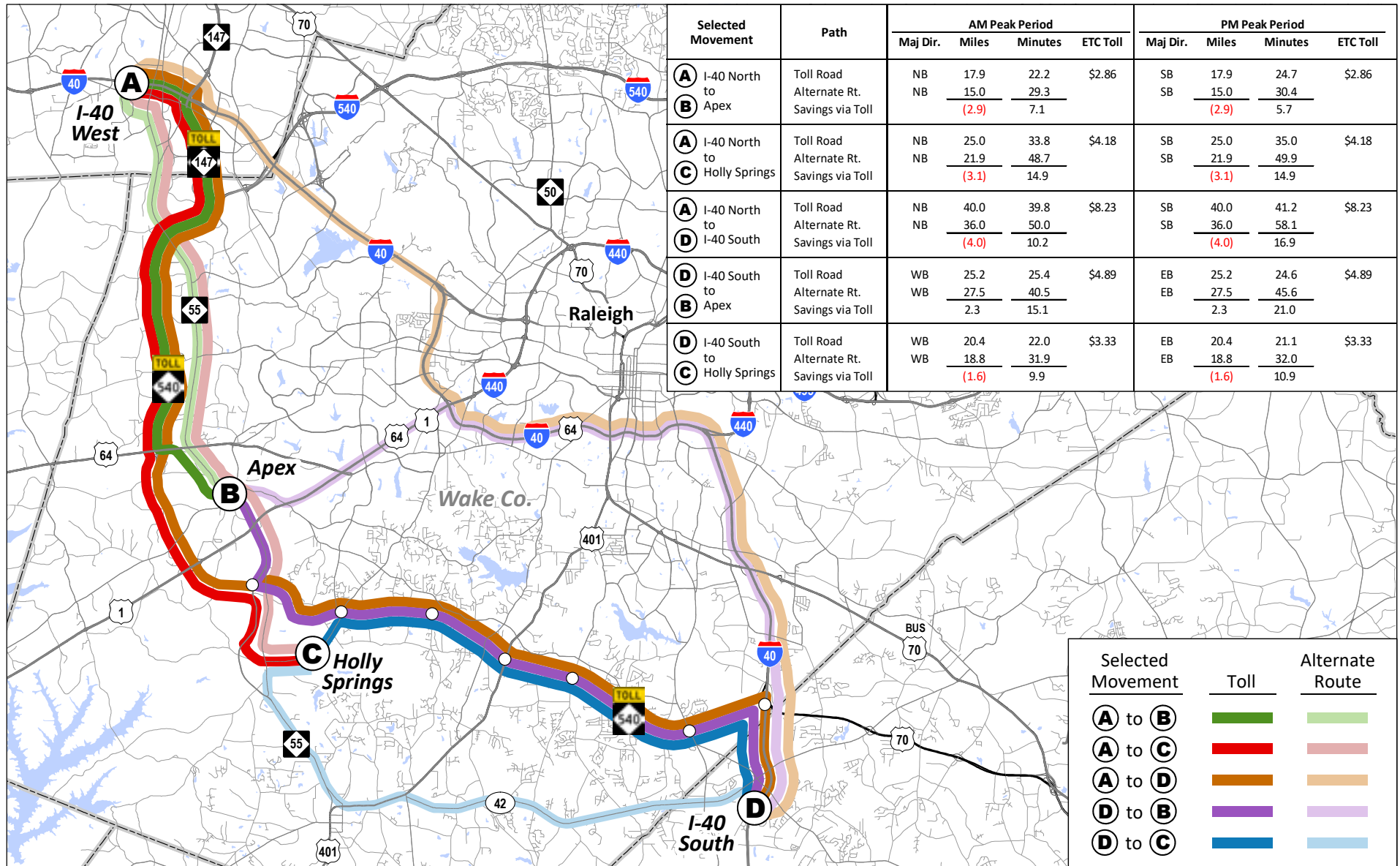
- A: A location on I-40 west of NC 55 south of Durham;
- B: A location within the city of Apex;
- C: A location within the city of Holly Springs; and,
- D: A location on I-40 just south of the NC 42 interchange.

A total of five movements were selected for comparison, as shown in the lower right-hand corner of Figure 7.5. These included two movements (A-B and A-C) which primarily use the existing Triangle Expressway for toll road travel. Two other movements (D-B and D-C) would primarily use only Complete 540. The fifth movement, from A to D, would be a through movement and would use both Triangle Expressway and Complete 540.

The toll paths used for each of these movements are depicted in darker colors, with a unique color for each of the five movements. The best alternative non-tolled route for the respective movements is illustrated using a lighter shade of the same color. The table in the upper right-hand corner of Figure 7.5 provides a comparison of distance and travel times, for both AM peak and PM peak period conditions. It also shows the Class 1, ETC toll rate for each movement.

In all cases, using the tolled path would save time, with the specific amount varying in some cases between morning and afternoon peak periods. For example, a trip from Location A, I-40 North, to Location C, Holly Springs, via the Triangle Expressway would save about 15 minutes, although it would require about 3.1 miles of additional driving. A trip from Location D, I-40 South, to Location B, Apex, would save 15 to 21 minutes (depending on time-period) by using the new Complete 540, in addition to distance savings. This is because the fastest alternative route was more circuitous, using I-40 and U.S. 64. For the through movement from Location A to Location D, a passenger-car using the toll facility would save up to 16.9 minutes during the PM peak period in 2025 for a toll of \$8.23.

# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



**TYPICAL TIME-DISTANCE RELATIONSHIPS  
SELECTED MOVEMENTS AT 2025 LEVELS**

## 7.5 Estimated 2035 Weekday Transactions and Revenue

**Figure 7.6** shows estimated weekday traffic on both the Triangle Expressway and Complete 540 Phase 1 at 2035 levels. Mainline weekday traffic volumes on Complete 540 would range from 25,200 to 36,600. The peak load point would be just west of the U.S. 401 interchange. With the positive impact of Complete 540, estimated traffic on Triangle Expressway peaks at 73,600 vehicles on a typical weekday in 2035, at a point just north of NC 55. This is still within the existing roadway capacity available at that location. Traffic on the northern end of Toll NC 147 is estimated at 40,400 per weekday.

**Table 7.4** shows estimated weekday transactions and revenue computed by toll location, vehicle class and payment method at 2035 levels. Subtotals are provided for the existing Triangle Expressway and Complete 540 Phase 1. Total weekday transactions on Triangle Expressway are estimated at nearly 457,000, about 75 percent of which would use the ETC payment mode. The remaining 25 percent of transactions would use BBM.

On Complete 540 Phase 1, total weekday transactions were estimated at just under 190,000 in 2035; about 76 percent of which are estimated to use ETC.

Weekday revenue, from all classes and all payment types, is estimated at \$713,367 per weekday. After annualization, this is equivalent to more than \$217.6 million in annual revenue. The overall average toll per transaction on the full project, for all vehicle classes and all payment modes, is estimated at \$1.103 in 2035.

It is important to recognize that all figures in Table 7.4, and other similar weekday traffic and revenue tables in this report are expressed on a “calendar year” basis. The figures in Table 7.4 represent, therefore, estimates for calendar year 2035. In subsequent annual transaction and revenue tables, the calendar year estimates are converted to fiscal year, so there are slight differences when compared with annual traffic and revenue estimates in the weekday tables.

## 7.6 Estimated 2045 Weekday Transactions and Revenue

**Figure 7.7** shows estimated average weekday transactions for calendar 2045. This is the most distant future year which was modeled in developing the long-range forecasts. It represents the horizon year of the most recent regional travel demand model for the greater Raleigh-Durham area (TRMv6). Traffic on Complete 540 Phase 1 is expected to peak at about 48,800 vehicles per day west of Bells Lake Road. Weekday traffic is expected to reach a maximum of 90,000 on the Triangle Expressway section just north of NC 55.

**Table 7.5** summarizes the calculations to develop the weekday expected or gross toll revenue in 2045 for Scenario 2. Again, these figures are shown on a calendar year basis. Overall, total average weekday revenue in the year 2045 is estimated at \$1,096,169. This would represent an average toll per transaction of \$1.332, which reflects continued annual increases in toll rates at each toll collection location. After annualization, annual revenue for calendar 2045 is estimated at more than \$334.3 million. As noted previously, all revenue estimates shown in Table 7.5 are not yet adjusted to reflect anticipated leakage of the BBM category, or the inclusion of anticipated revenue from BBM invoice processing fees.





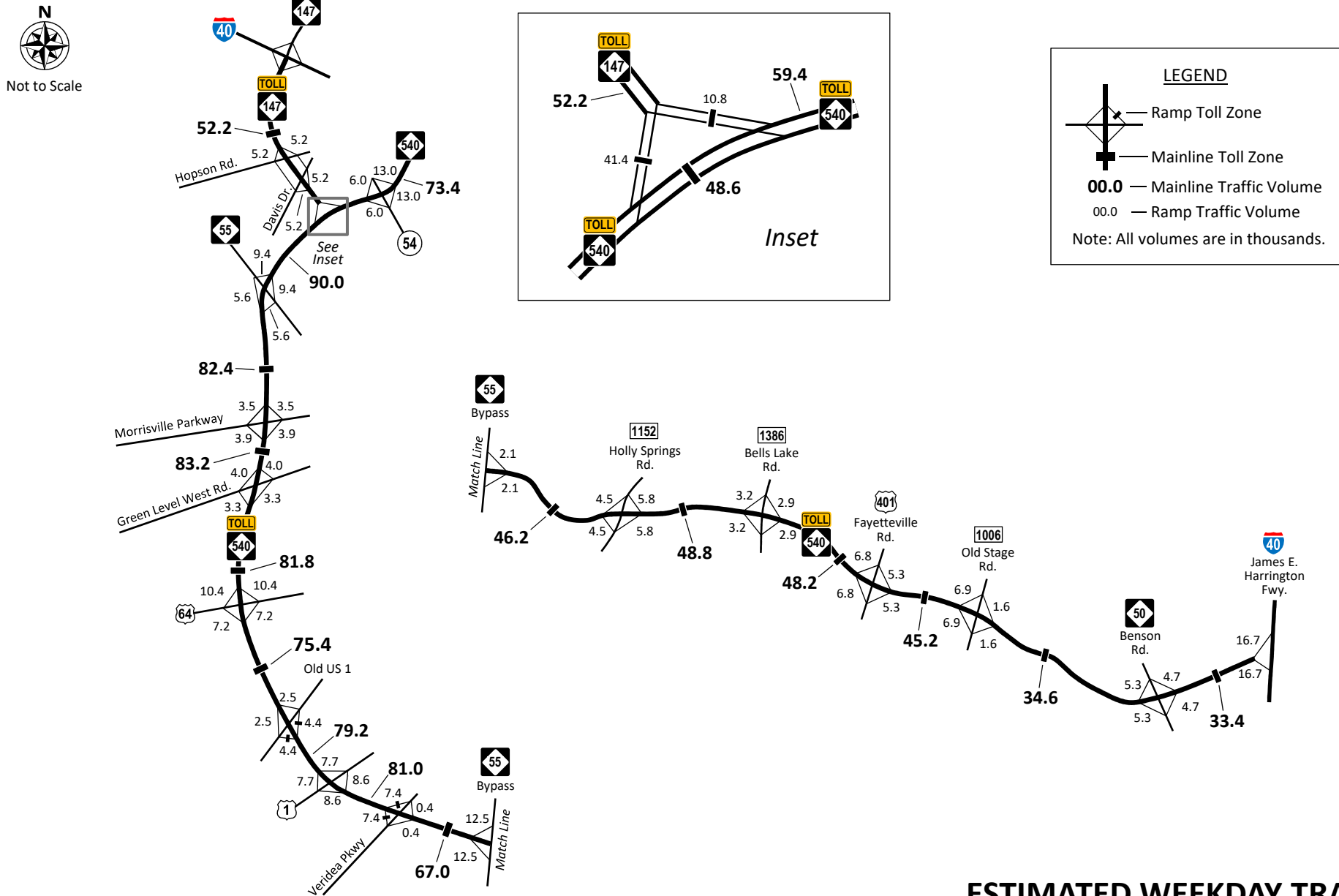
FIGURE 7.6

**Table 7.4**  
**Estimated 2035 Weekday Transactions and Revenue by Toll Zone**  
**Scenario 2 – Triangle Expressway and Complete 540 Phase 1**

| Toll Zone                                          |                                   | Class 1 Vehicles |        |           |         |        |           | Class 2 and 3 Vehicles |        |          |        |        |          | Total Weekday Transactions |         |         | Total Weekday Revenue |           |           | Average<br>Weekday<br>Toll per<br>Transaction<br>(all vehicles and<br>payment types) |
|----------------------------------------------------|-----------------------------------|------------------|--------|-----------|---------|--------|-----------|------------------------|--------|----------|--------|--------|----------|----------------------------|---------|---------|-----------------------|-----------|-----------|--------------------------------------------------------------------------------------|
|                                                    |                                   | ETC              |        | BBM       |         | Trans. |           | ETC                    |        | BBM      |        | Trans. |          | ETC                        | BBM     | Total   | ETC                   | BBM       | Total     |                                                                                      |
| Number                                             | Location                          | Trans.           | Toll   | Revenue   | Trans.  | Toll   | Revenue   | Trans.                 | Toll   | Revenue  | Trans. | Toll   | Revenue  | Trans.                     | Toll    | Revenue | ETC                   | BBM       | Total     | Total                                                                                |
| Triangle Expressway                                |                                   |                  |        |           |         |        |           |                        |        |          |        |        |          |                            |         |         |                       |           |           |                                                                                      |
| 01/02                                              | SR 147 Mainline N of Hopson Rd.   | 28,726           | \$0.61 | \$17,523  | 9,078   | \$0.93 | \$8,442   | 1,793                  | \$2.08 | \$3,729  | 813    | \$3.04 | \$2,470  | 30,518                     | 9,890   | 40,408  | \$21,251              | \$10,912  | \$32,163  | \$0.796                                                                              |
| 05/06                                              | SR 147/SR 540 Jct. NW Connection  | 22,834           | \$1.12 | \$25,574  | 6,376   | \$1.72 | \$10,967  | 1,652                  | \$3.72 | \$6,145  | 813    | \$5.99 | \$4,867  | 24,486                     | 7,189   | 31,675  | \$31,720              | \$15,834  | \$47,554  | \$1.501                                                                              |
| 09/10                                              | SR 147/SR 540 Jct. NE Connection  | 6,735            | \$0.87 | \$5,859   | 2,623   | \$1.34 | \$3,515   | 211                    | \$3.05 | \$642    | 80     | \$4.30 | \$345    | 6,945                      | 2,703   | 9,649   | \$6,501               | \$3,860   | \$10,362  | \$1.074                                                                              |
| 13/14                                              | SR 147/SR 540 Jct. 540 Thru Mt.   | 29,425           | \$1.09 | \$32,074  | 10,890  | \$1.67 | \$18,186  | 905                    | \$3.54 | \$3,204  | 561    | \$5.49 | \$3,080  | 30,331                     | 11,451  | 41,782  | \$35,278              | \$21,267  | \$56,545  | \$1.353                                                                              |
| 15/16                                              | Mainline N of Morrisville Pky     | 49,765           | \$0.74 | \$36,826  | 15,280  | \$1.14 | \$17,419  | 2,784                  | \$2.49 | \$6,933  | 1,343  | \$3.79 | \$5,089  | 52,549                     | 16,623  | 69,172  | \$43,759              | \$22,508  | \$66,267  | \$0.958                                                                              |
| 17/18                                              | Mainline N. of Green Level Rd     | 48,632           | \$0.62 | \$30,152  | 15,728  | \$0.95 | \$14,942  | 2,824                  | \$2.09 | \$5,903  | 1,431  | \$3.15 | \$4,507  | 51,456                     | 17,159  | 68,615  | \$36,054              | \$19,449  | \$55,503  | \$0.809                                                                              |
| 21/22                                              | Mainline N. of US 64              | 48,097           | \$0.75 | \$36,073  | 14,581  | \$1.15 | \$16,769  | 2,811                  | \$2.63 | \$7,393  | 1,374  | \$3.80 | \$5,220  | 50,908                     | 15,955  | 66,863  | \$43,465              | \$21,988  | \$65,454  | \$0.979                                                                              |
| 25/26                                              | Mainline S of US 64               | 42,462           | \$1.08 | \$45,859  | 13,967  | \$1.66 | \$23,186  | 2,607                  | \$3.66 | \$9,543  | 1,356  | \$5.68 | \$7,702  | 45,070                     | 15,323  | 60,393  | \$55,403              | \$30,888  | \$86,290  | \$1.429                                                                              |
| 29/30                                              | Ramps South at S. Salem St.       | 5,577            | \$0.43 | \$2,398   | 1,640   | \$0.66 | \$1,082   | 116                    | \$1.47 | \$170    | 26     | \$2.15 | \$55     | 5,693                      | 1,665   | 7,358   | \$2,568               | \$1,137   | \$3,705   | \$0.504                                                                              |
| 31/32                                              | Ramps North at Veridea Pky        | 8,359            | \$0.47 | \$3,929   | 2,985   | \$0.72 | \$2,149   | 144                    | \$1.61 | \$232    | 76     | \$2.34 | \$179    | 8,503                      | 3,061   | 11,564  | \$4,161               | \$2,328   | \$6,489   | \$0.561                                                                              |
| 33/34                                              | Mainline N of SR 55 Bypass        | 36,057           | \$0.71 | \$25,601  | 10,323  | \$1.08 | \$11,148  | 2,049                  | \$2.35 | \$4,816  | 997    | \$3.56 | \$3,549  | 38,107                     | 11,320  | 49,426  | \$30,417              | \$14,698  | \$45,114  | \$0.913                                                                              |
| Subtotal Triangle Expressway                       |                                   | 326,668          |        | \$261,867 | 103,471 |        | \$127,805 | 17,896                 |        | \$48,710 | 8,869  |        | \$37,064 | 344,565                    | 112,339 | 456,904 | \$310,577             | \$164,869 | \$475,446 | \$1.041                                                                              |
| Complete 540 Phase 1 (C540 Phase 1)                |                                   |                  |        |           |         |        |           |                        |        |          |        |        |          |                            |         |         |                       |           |           |                                                                                      |
| 35/36                                              | Mainline East of SR 55 Bypass     | 24,020           | \$1.00 | \$24,020  | 6,730   | \$1.54 | \$10,364  | 1,682                  | \$3.32 | \$5,584  | 777    | \$5.14 | \$3,994  | 25,702                     | 7,507   | 33,209  | \$29,604              | \$14,358  | \$43,962  | \$1.324                                                                              |
| 37/38                                              | Mainline East of Holy Springs Rd. | 25,604           | \$0.92 | \$23,556  | 7,500   | \$1.42 | \$10,650  | 1,728                  | \$3.05 | \$5,270  | 801    | \$4.74 | \$3,797  | 27,332                     | 8,301   | 35,633  | \$28,826              | \$14,447  | \$43,273  | \$1.214                                                                              |
| 39/40                                              | Mainline East of Bells Lake Rd.   | 26,189           | \$0.88 | \$23,047  | 7,949   | \$1.36 | \$10,811  | 1,739                  | \$2.92 | \$5,078  | 807    | \$4.54 | \$3,664  | 27,928                     | 8,756   | 36,685  | \$28,125              | \$14,475  | \$42,599  | \$1.161                                                                              |
| 41/42                                              | Mainline East U.S. 441            | 23,702           | \$0.70 | \$16,591  | 7,360   | \$1.08 | \$7,949   | 1,752                  | \$2.32 | \$4,065  | 826    | \$3.60 | \$2,974  | 25,454                     | 8,186   | 33,639  | \$20,656              | \$10,922  | \$31,578  | \$0.939                                                                              |
| 43/44                                              | Old Stage Rd.                     | 17,582           | \$1.34 | \$23,560  | 5,384   | \$2.06 | \$11,091  | 1,747                  | \$4.45 | \$7,774  | 826    | \$6.87 | \$5,675  | 19,329                     | 6,210   | 25,539  | \$31,334              | \$16,766  | \$48,100  | \$1.883                                                                              |
| 45/46                                              | Mainline East of SR 50            | 17,163           | \$0.81 | \$13,902  | 5,566   | \$1.25 | \$6,958   | 1,608                  | \$2.69 | \$4,326  | 773    | \$4.17 | \$3,223  | 18,771                     | 6,339   | 25,110  | \$18,228              | \$10,181  | \$28,409  | \$1.131                                                                              |
| Subtotal Complete 540 Phase 1                      |                                   | 134,260          |        | \$124,676 | 40,489  |        | \$57,822  | 10,256                 |        | \$32,097 | 4,810  |        | \$23,326 | 144,516                    | 45,299  | 189,815 | \$156,772             | \$81,148  | \$237,921 | \$1.253                                                                              |
| Weekday Total Triangle Exp. Plus C540 Phase 1      |                                   | 460,929          |        | \$386,542 | 143,960 |        | \$185,628 | 28,153                 |        | \$80,807 | 13,679 |        | \$60,390 | 489,081                    | 157,638 | 646,720 | \$467,349             | \$246,018 | \$713,367 | \$1.103                                                                              |
| Annual Total Triangle Exp. Plus C540 Phase 1 (000) |                                   | 140,583          |        | \$117,895 | 43,908  |        | \$56,616  | 8,587                  |        | \$24,646 | 4,172  |        | \$18,419 | 149,170                    | 48,080  | 197,249 | \$142,542             | \$75,035  | \$217,577 |                                                                                      |
| Assumes Annualization Factor of 305 Days           |                                   |                  |        |           |         |        |           |                        |        |          |        |        |          |                            |         |         |                       |           |           |                                                                                      |

Note: Transactions by toll zone in this table may not match transactions shown in Figure 7.6 due to rounding by direction in the figure.

# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study



**Table 7.5**  
**Estimated 2045 Weekday Transactions and Revenue by Toll Zone**  
**Scenario 2 - Triangle Expressway and Complete 540 Phase 1**

| Number                                             | Toll Zone<br>Location             | Class 1 Vehicles |        |           |         |        |           | Class 2 and 3 Vehicles |        |           |        |        |          | Total Weekday Transactions |         |         | Total Weekday Revenue |           |             | Average<br>Weekday<br>Toll per<br>Transaction<br><br>(all vehicles and<br>payment types) |  |
|----------------------------------------------------|-----------------------------------|------------------|--------|-----------|---------|--------|-----------|------------------------|--------|-----------|--------|--------|----------|----------------------------|---------|---------|-----------------------|-----------|-------------|------------------------------------------------------------------------------------------|--|
|                                                    |                                   | ETC              |        |           | BBM     |        |           | ETC                    |        |           | BBM    |        |          | ETC                        | BBM     | Total   | ETC                   | BBM       | Total       |                                                                                          |  |
|                                                    |                                   | Trans.           | Toll   | Revenue   | Trans.  | Toll   | Revenue   | Trans.                 | Toll   | Revenue   | Trans. | Toll   | Revenue  |                            |         |         |                       |           |             |                                                                                          |  |
| Triangle Expressway                                |                                   |                  |        |           |         |        |           |                        |        |           |        |        |          |                            |         |         |                       |           |             |                                                                                          |  |
| 01/02                                              | SR 147 Mainline N of Hopson Rd.   | 38,741           | \$0.75 | \$29,056  | 9,515   | \$1.16 | \$11,037  | 3,005                  | \$2.55 | \$7,663   | 886    | \$3.80 | \$3,368  | 41,746                     | 10,401  | 52,147  | \$36,719              | \$14,405  | \$51,123    | \$0.980                                                                                  |  |
| 05/06                                              | SR 147/SR 540 Jct. NW Connection  | 31,065           | \$1.38 | \$42,870  | 6,566   | \$2.13 | \$13,985  | 2,788                  | \$4.59 | \$12,797  | 904    | \$7.41 | \$6,698  | 33,853                     | 7,469   | 41,323  | \$55,667              | \$20,683  | \$76,350    | \$1.848                                                                                  |  |
| 09/10                                              | SR 147/SR 540 Jct. NE Connection  | 8,144            | \$1.07 | \$8,714   | 2,356   | \$1.65 | \$3,888   | 298                    | \$3.75 | \$1,119   | 40     | \$5.30 | \$214    | 8,442                      | 2,397   | 10,839  | \$9,833               | \$4,102   | \$13,935    | \$1.286                                                                                  |  |
| 13/14                                              | SR 147/SR 540 Jct. 540 Thru Mvt.  | 36,296           | \$1.34 | \$48,636  | 10,733  | \$2.06 | \$22,110  | 1,156                  | \$4.36 | \$5,041   | 487    | \$6.77 | \$3,295  | 37,452                     | 11,220  | 48,672  | \$53,677              | \$25,405  | \$79,082    | \$1.625                                                                                  |  |
| 15/16                                              | Mainline N of Morrisville Pky     | 62,348           | \$0.91 | \$56,737  | 14,881  | \$1.40 | \$20,833  | 3,916                  | \$3.06 | \$11,982  | 1,252  | \$4.65 | \$5,821  | 66,264                     | 16,132  | 82,396  | \$68,719              | \$26,654  | \$95,373    | \$1.157                                                                                  |  |
| 17/18                                              | Mainline N. of Green Level Rd     | 62,354           | \$0.76 | \$47,389  | 15,544  | \$1.17 | \$18,186  | 3,981                  | \$2.56 | \$10,191  | 1,327  | \$3.89 | \$5,160  | 66,335                     | 16,870  | 83,205  | \$57,580              | \$23,347  | \$80,927    | \$0.973                                                                                  |  |
| 21/22                                              | Mainline N. of US 64              | 61,911           | \$0.92 | \$56,958  | 14,606  | \$1.42 | \$20,741  | 3,950                  | \$3.22 | \$12,720  | 1,270  | \$4.69 | \$5,958  | 65,861                     | 15,877  | 81,738  | \$69,678              | \$26,699  | \$96,377    | \$1.179                                                                                  |  |
| 25/26                                              | Mainline S of US 64               | 56,186           | \$1.32 | \$74,166  | 14,296  | \$2.03 | \$29,022  | 3,686                  | \$4.48 | \$16,511  | 1,288  | \$6.95 | \$8,949  | 59,872                     | 15,584  | 75,456  | \$90,677              | \$37,971  | \$128,648   | \$1.705                                                                                  |  |
| 29/30                                              | Ramps South at S. Salem St.       | 6,987            | \$0.53 | \$3,703   | 1,586   | \$0.82 | \$1,301   | 145                    | \$1.81 | \$262     | 7      | \$2.67 | \$19     | 7,132                      | 1,594   | 8,725   | \$3,965               | \$1,320   | \$5,285     | \$0.606                                                                                  |  |
| 31/32                                              | Ramps North at Veridea Pky        | 11,363           | \$0.58 | \$6,591   | 3,168   | \$0.89 | \$2,820   | 208                    | \$1.99 | \$415     | 71     | \$2.89 | \$205    | 11,572                     | 3,239   | 14,811  | \$7,006               | \$3,025   | \$10,030    | \$0.677                                                                                  |  |
| 33/34                                              | Mainline N of SR 55 Bypass        | 51,515           | \$0.87 | \$44,818  | 11,592  | \$1.34 | \$15,534  | 2,999                  | \$2.88 | \$8,637   | 986    | \$4.42 | \$4,357  | 54,514                     | 12,578  | 67,093  | \$53,456              | \$19,891  | \$73,347    | \$1.093                                                                                  |  |
| Subtotal Triangle Expressway                       |                                   | 426,911          |        | \$419,638 | 104,844 |        | \$159,455 | 26,132                 |        | \$87,338  | 8,518  |        | \$44,045 | 453,043                    | 113,361 | 566,405 | \$506,976             | \$203,500 | \$710,477   | \$1.254                                                                                  |  |
| Complete 540 Phase 1 (C540 Phase 1)                |                                   |                  |        |           |         |        |           |                        |        |           |        |        |          |                            |         |         |                       |           |             |                                                                                          |  |
| 35/36                                              | Mainline East of SR 55 Bypass     | 35,155           | \$1.23 | \$43,241  | 7,758   | \$1.89 | \$14,663  | 2,583                  | \$4.08 | \$10,539  | 799    | \$6.30 | \$5,034  | 37,738                     | 8,557   | 46,295  | \$53,779              | \$19,696  | \$73,476    | \$1.587                                                                                  |  |
| 37/38                                              | Mainline East of Holy Springs Rd. | 36,885           | \$1.13 | \$41,680  | 8,406   | \$1.74 | \$14,626  | 2,656                  | \$3.75 | \$9,960   | 825    | \$5.80 | \$4,785  | 39,541                     | 9,231   | 48,772  | \$51,640              | \$19,411  | \$71,051    | \$1.457                                                                                  |  |
| 39/40                                              | Mainline East of Belis Lake Rd.   | 36,194           | \$1.07 | \$38,727  | 8,517   | \$1.65 | \$14,053  | 2,672                  | \$3.55 | \$9,486   | 831    | \$5.50 | \$4,570  | 38,866                     | 9,348   | 48,214  | \$46,213              | \$18,623  | \$66,836    | \$1.386                                                                                  |  |
| 41/42                                              | Mainline East U.S. 441            | 33,523           | \$0.86 | \$28,829  | 8,068   | \$1.32 | \$10,650  | 2,710                  | \$2.85 | \$7,724   | 853    | \$4.40 | \$3,753  | 36,233                     | 8,921   | 45,154  | \$36,553              | \$14,403  | \$50,956    | \$1.129                                                                                  |  |
| 43/44                                              | Old Stage Rd.                     | 24,980           | \$1.65 | \$41,218  | 5,974   | \$2.54 | \$15,174  | 2,706                  | \$5.47 | \$14,801  | 861    | \$8.47 | \$7,293  | 27,686                     | 6,835   | 34,521  | \$56,019              | \$22,466  | \$78,485    | \$2.274                                                                                  |  |
| 45/46                                              | Mainline East of SR 50            | 24,136           | \$0.99 | \$23,895  | 6,113   | \$1.52 | \$9,292   | 2,388                  | \$3.28 | \$7,833   | 763    | \$5.07 | \$3,868  | 26,524                     | 6,876   | 33,400  | \$31,727              | \$13,160  | \$44,887    | \$1.344                                                                                  |  |
| Subtotal Complete 540 Phase 1                      |                                   | 190,873          |        | \$217,590 | 44,836  |        | \$78,457  | 15,715                 |        | \$60,342  | 4,932  |        | \$29,303 | 206,588                    | 49,768  | 256,355 | \$277,931             | \$107,761 | \$385,692   | \$1.505                                                                                  |  |
| Weekday Total Triangle Exp. Plus C540 Phase 1      |                                   | 617,783          |        | \$637,228 | 149,679 |        | \$237,913 | 41,847                 |        | \$147,680 | 13,450 |        | \$73,348 | 659,631                    | 163,129 | 822,760 | \$784,908             | \$311,261 | \$1,096,169 | \$1.332                                                                                  |  |
| Annual Total Triangle Exp. Plus C540 Phase 1 (000) |                                   | 188,424          |        | \$194,354 | 45,652  |        | \$72,563  | 12,763                 |        | \$45,042  | 4,102  |        | \$22,371 | 201,187                    | 49,754  | 250,942 | \$239,397             | \$94,935  | \$334,332   |                                                                                          |  |
| Assumes Annualization Factor of 365 Days           |                                   |                  |        |           |         |        |           |                        |        |           |        |        |          |                            |         |         |                       |           |             |                                                                                          |  |

Assumes Annualization Factor of 305 Days

Note: Transactions by toll zone in this table may not match transactions shown in Figure 7.7 due to rounding by direction in the figure.

## 7.7 Complete 540 Phase 1 Corridor Share Comparison

Examining the Complete 540's share of total corridor traffic is useful in reviewing the reasonableness of the traffic forecasts. **Figure 7.8** shows two corridor share "screenlines". Screenline A is between U.S. 401 and I-40 and Screen Line B is between the existing Triangle Expressway and U.S. 401. Each of the screenlines covers a "travel shed" from which Complete 540 would draw traffic. The screenlines include all significant routes between NC 42 on the south and I-40 on the north.

**Table 7.6** provides a corridor-share comparison for model years 2025, 2035 and 2045. In 2025, total traffic crossing Screenline A is estimated at 269,172 on a typical weekday. Of this, almost 60 percent would be on I-40. On Complete 540, traffic is estimated at 20,800, or about 7.7 percent of the total screenline. At Screenline B, located west of U.S. 401, traffic on Complete 540 is estimated at about 28,800 on a typical weekday in 2025. This represents about 9.1 percent of the total model forecasted traffic. On this screenline, I-40 carries almost half of the total traffic. Estimated Complete 540 weekday traffic volumes in Table 7.6 do not reflect ramp-up adjustments.

Similar corridor share patterns are shown at 2035 and 2045 levels. On Screenline A, the Complete 540 screenline share remains at 7.7 percent in 2035 and increases by 1.1 percentage point, to total 8.8 percent 2045. This consistent screenline share is partly due to the assumed widening of I-40, which would provide additional capacity and congestion relief on that competing route.

Complete 540 screenline shares in 2045 increase slightly, to about 8.8 percent on Screenline A and 11.5 percent on Screenline B. The increased corridor share after 2035 is, in part, due to anticipated economic growth in the immediate project corridor itself. Overall, traffic along the two screenlines would grow by an average of 1.5 to 2.0 percent per year depending on location. Projected traffic along Complete 540 is estimated to grow around 2.5 percent per year between 2025 and 2045.

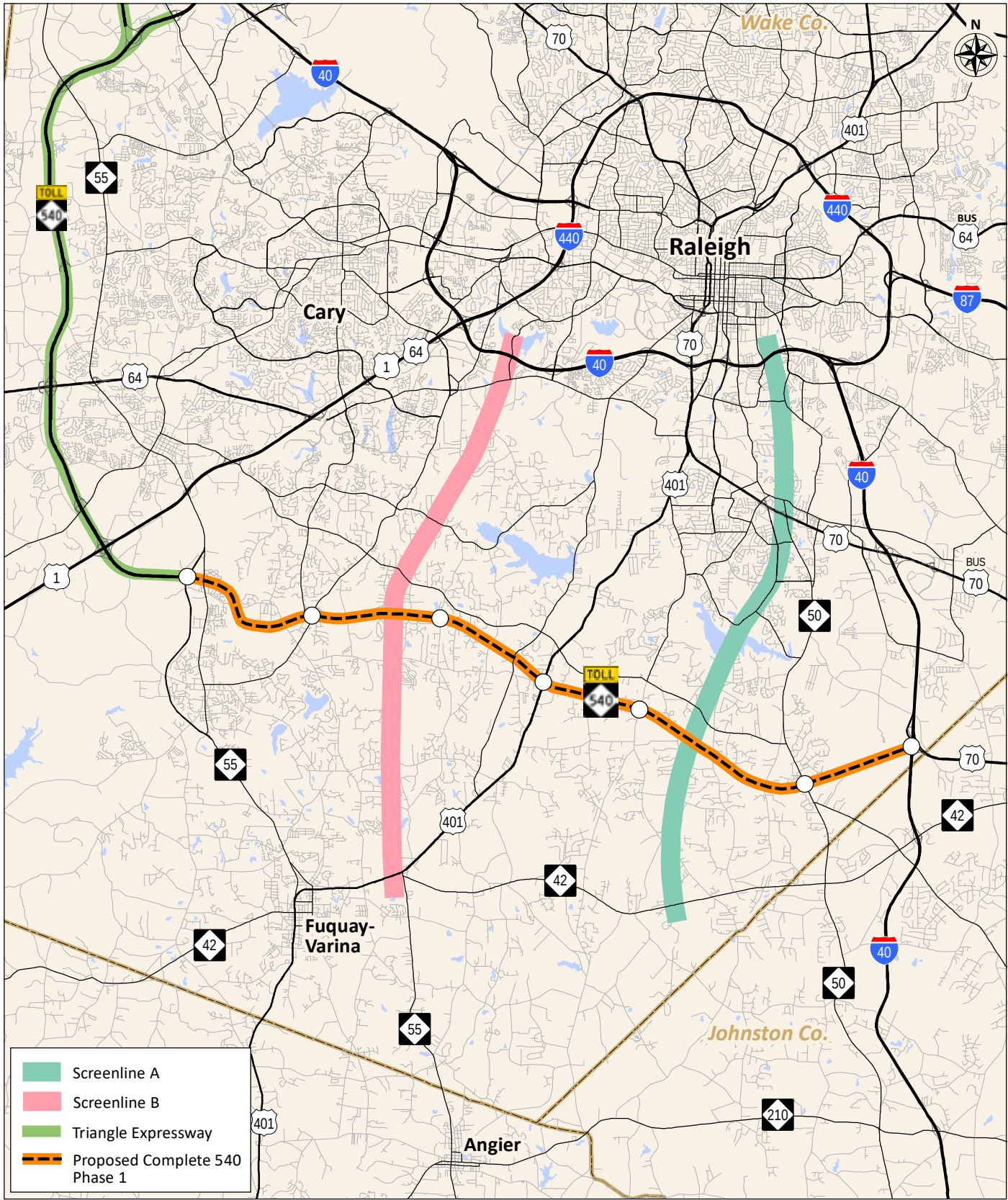
## 7.8 Estimated Annual Transactions and Revenue – Forecast Scenario 2

Estimated annual transactions and revenue for Scenario 2 are presented in **Table 7.7**. This Scenario assumes full construction of Complete 540 Phase 1 and includes transactions and revenue from all tolling points on both Triangle Expressway and the new Complete 540. All transaction and revenue figures shown in Table 7.7 reflect annual totals, rounded to thousands. Information is shown on a fiscal year basis, with each fiscal year representing the 12 months ending June 30. Forecasts are provided for FY 2019 through 2058. Complete 540 Phase 1 is assumed to come online July 1, 2023, so it would be open through the entire FY 2024.

As noted at the bottom of the table, estimates of transactions and revenue on Complete 540, as well as the net incremental transactions and revenue on the Triangle Expressway, have been adjusted downward to reflect "ramp-up", since this portion of the facility would be newly opened to traffic. Ramp-up adjustments are applied as net reduction factors to the modeled forecasts; generally intended to reflect the transition period where it takes time for motorists to become aware of new toll facilities; to initially try and eventually modify travel habits.



Triangle Expressway and  
Complete 540 Phase 1 Traffic and Revenue Study



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**CORRIDOR SHARE SCREENLINES  
COMPLETE 540 PHASE 1**



**Table 7.6**  
**Complete 540 Weekday Corridor-Share Comparison**

| Road Name               | 2025 (1)        |                         | 2035            |                         | 2045            |                         |
|-------------------------|-----------------|-------------------------|-----------------|-------------------------|-----------------|-------------------------|
|                         | Weekday Traffic | Screenline Market Share | Weekday Traffic | Screenline Market Share | Weekday Traffic | Screenline Market Share |
| <b>Screenline A</b>     |                 |                         |                 |                         |                 |                         |
| I-40                    | 157,758         | 58.6%                   | 197,738         | 59.6%                   | 225,585         | 57.2%                   |
| Garner Rd               | 9,323           | 3.5%                    | 9,926           | 3.0%                    | 12,724          | 3.2%                    |
| US 70                   | 27,094          | 10.1%                   | 32,291          | 9.7%                    | 38,981          | 9.9%                    |
| Lakeside Dr             | 2,137           | 0.8%                    | 2,197           | 0.7%                    | 2,805           | 0.7%                    |
| Timber Dr.              | 21,427          | 8.0%                    | 27,594          | 8.3%                    | 30,701          | 7.8%                    |
| Buffalo Rd.             | 1,437           | 0.5%                    | 2,075           | 0.6%                    | 2,555           | 0.6%                    |
| Ten Ten Rd.             | 9,684           | 3.6%                    | 10,732          | 3.2%                    | 15,812          | 4.0%                    |
| <b>Toll NC 540</b>      | <b>20,815</b>   | <b>7.7%</b>             | <b>25,539</b>   | <b>7.7%</b>             | <b>34,521</b>   | <b>8.8%</b>             |
| Pagan Rd                | 4,142           | 1.5%                    | 3,917           | 1.2%                    | 6,854           | 1.7%                    |
| Rock Service Station Rd | 3,677           | 1.4%                    | 4,752           | 1.4%                    | 5,426           | 1.4%                    |
| NC 42                   | 11,679          | 4.3%                    | 14,754          | 4.5%                    | 18,499          | 4.7%                    |
| <b>Total</b>            | <b>269,172</b>  | <b>100.0%</b>           | <b>331,513</b>  | <b>100.0%</b>           | <b>394,464</b>  | <b>100.0%</b>           |
| <b>Screenline B</b>     |                 |                         |                 |                         |                 |                         |
| I-40                    | 152,658         | 48.2%                   | 187,148         | 51.0%                   | 206,866         | 48.6%                   |
| Tryon Rd                | 33,231          | 10.5%                   | 36,611          | 10.0%                   | 39,838          | 9.4%                    |
| Yates Mill Pond Rd      | 13,936          | 4.4%                    | 13,972          | 3.8%                    | 15,774          | 3.7%                    |
| Penny Rd                | 9,687           | 3.1%                    | 8,367           | 2.3%                    | 10,553          | 2.5%                    |
| Ten Ten Rd              | 24,783          | 7.8%                    | 36,299          | 9.9%                    | 43,553          | 10.2%                   |
| <b>Toll NC 540</b>      | <b>28,812</b>   | <b>9.1%</b>             | <b>35,633</b>   | <b>9.7%</b>             | <b>48,772</b>   | <b>11.5%</b>            |
| Optimist Farm Rd        | 8,717           | 2.8%                    | 9,306           | 2.5%                    | 11,717          | 2.8%                    |
| Hilltop Needmore Rd     | 9,518           | 3.0%                    | 10,697          | 2.9%                    | 16,735          | 3.9%                    |
| US 401                  | 35,227          | 11.1%                   | 28,821          | 7.9%                    | 32,001          | 7.5%                    |
| <b>Total</b>            | <b>316,569</b>  | <b>100.0%</b>           | <b>366,854</b>  | <b>100.0%</b>           | <b>425,808</b>  | <b>100.0%</b>           |

(1) 2025 traffic estimates are prior to ramp-up adjustments on Complete 540.

Ramp-up reflects the patterns typically experienced on new toll facilities, in which transaction and revenue growth over the first several years considerably exceeds long-term averages. Significant ramp-up was observed on the Triangle Expressway over its first 3 to 4 years of operation. The weekday estimates provided in Tables 7.3, 7.4 and 7.5 do not include any adjustments for ramp-up. However, the ramp-up adjustments were applied in the annual forecasts shown in Table 7.7, using the following downward adjustment factors over the first 36-months of Complete 540 Phase 1 operation:

- Months 1-12: 0.618
- Months 13-24: 0.814
- Months 25-36: 0.945

Ramp-up adjustments were also made to forecasted transactions and revenue on the existing Triangle Expressway for that incremental portion of demand which would be attributable directly to the implementation of Complete 540 Phase 1.

Annual toll revenue is estimated to increase from about \$52.8 million in FY 2019 to \$66.6 million by FY 2023, the fiscal year immediately prior to opening of Complete 540. Annual revenue is estimated to increase to \$123 million in FY 2025, reflecting the impacts of Complete 540, even after adjustment for ramp-up. By FY 2027, the effect of ramp-up adjustments has been completed and annual revenue is estimated at \$147.9 million. This is projected to increase to almost \$213 million by 2035 and \$327 million by 2045.

**Table 7.7**  
**Estimated Annual Transactions and Revenue**  
**Scenario 2 - Triangle Expressway Combined with Complete 540 Phase 1**

| Fiscal Year  | Estimated Annual Transactions (000) |        |         |       | Estimated Annual Revenue (000) |          |          |       | Average Toll Per Transaction |          |          |
|--------------|-------------------------------------|--------|---------|-------|--------------------------------|----------|----------|-------|------------------------------|----------|----------|
|              | ETC                                 | BBM    | Total   | % ETC | ETC                            | BBM      | Total    | % ETC | ETC                          | BBM      | Overall  |
| 2019         | 35,142                              | 19,024 | 54,166  | 64.9  | \$28,238                       | \$24,580 | \$52,818 | 53.5  | \$ 0.804                     | \$ 1.292 | \$ 0.975 |
| 2020 (1,2)   | 41,835                              | 21,564 | 63,399  | 66.0  | 31,243                         | 26,056   | 57,299   | 54.5  | 0.747                        | 1.208    | 0.904    |
| 2021 (2)     | 48,219                              | 24,018 | 72,237  | 66.8  | 33,832                         | 27,286   | 61,118   | 55.4  | 0.702                        | 1.136    | 0.846    |
| 2022 (2)     | 49,742                              | 24,114 | 73,856  | 67.4  | 35,783                         | 28,129   | 63,912   | 56.0  | 0.719                        | 1.167    | 0.865    |
| 2023 (2)     | 51,170                              | 24,135 | 75,304  | 68.0  | 37,726                         | 28,882   | 66,608   | 56.6  | 0.737                        | 1.197    | 0.885    |
| 2024 (2,3,4) | 89,100                              | 41,286 | 130,386 | 68.3  | 59,547                         | 45,263   | 104,810  | 56.8  | 0.668                        | 1.096    | 0.804    |
| 2025 (2)     | 101,516                             | 45,837 | 147,353 | 68.9  | 70,518                         | 52,536   | 123,054  | 57.3  | 0.695                        | 1.146    | 0.835    |
| 2026 (2)     | 110,951                             | 48,732 | 159,683 | 69.5  | 79,769                         | 57,897   | 137,666  | 57.9  | 0.719                        | 1.188    | 0.862    |
| 2027         | 116,870                             | 49,804 | 166,675 | 70.1  | 86,903                         | 61,011   | 147,914  | 58.8  | 0.744                        | 1.225    | 0.887    |
| 2028         | 120,312                             | 49,703 | 170,015 | 70.8  | 92,104                         | 62,634   | 154,739  | 59.5  | 0.766                        | 1.260    | 0.910    |
| 2029         | 123,779                             | 49,545 | 173,324 | 71.4  | 97,547                         | 64,301   | 161,848  | 60.3  | 0.788                        | 1.298    | 0.934    |
| 2030         | 127,353                             | 49,369 | 176,722 | 72.1  | 103,452                        | 66,016   | 169,468  | 61.0  | 0.812                        | 1.337    | 0.959    |
| 2031         | 131,038                             | 49,175 | 180,213 | 72.7  | 109,773                        | 67,691   | 177,464  | 61.9  | 0.838                        | 1.377    | 0.985    |
| 2032         | 134,842                             | 48,963 | 183,805 | 73.4  | 116,506                        | 69,391   | 185,897  | 62.7  | 0.864                        | 1.417    | 1.011    |
| 2033         | 138,771                             | 48,733 | 187,504 | 74.0  | 123,510                        | 71,003   | 194,513  | 63.5  | 0.890                        | 1.457    | 1.037    |
| 2034         | 142,832                             | 48,485 | 191,317 | 74.7  | 130,858                        | 72,603   | 203,461  | 64.3  | 0.916                        | 1.497    | 1.063    |
| 2035         | 147,033                             | 48,218 | 195,251 | 75.3  | 138,552                        | 74,223   | 212,775  | 65.1  | 0.942                        | 1.539    | 1.090    |
| 2036         | 151,436                             | 48,202 | 199,638 | 75.9  | 146,238                        | 76,027   | 222,265  | 65.8  | 0.966                        | 1.577    | 1.113    |
| 2037         | 156,037                             | 48,439 | 204,476 | 76.3  | 154,009                        | 78,036   | 232,044  | 66.4  | 0.987                        | 1.611    | 1.135    |
| 2038         | 160,777                             | 48,661 | 209,438 | 76.8  | 162,374                        | 80,098   | 242,472  | 67.0  | 1.010                        | 1.646    | 1.158    |
| 2039         | 165,660                             | 48,868 | 214,528 | 77.2  | 170,934                        | 82,039   | 252,973  | 67.6  | 1.032                        | 1.679    | 1.179    |
| 2040         | 170,691                             | 49,057 | 219,748 | 77.7  | 179,842                        | 83,874   | 263,716  | 68.2  | 1.054                        | 1.710    | 1.200    |
| 2041         | 175,874                             | 49,229 | 225,103 | 78.1  | 189,189                        | 85,716   | 274,906  | 68.8  | 1.076                        | 1.741    | 1.221    |
| 2042         | 181,214                             | 49,381 | 230,595 | 78.6  | 199,323                        | 87,703   | 287,026  | 69.4  | 1.100                        | 1.776    | 1.245    |
| 2043         | 186,715                             | 49,514 | 236,229 | 79.0  | 210,468                        | 89,949   | 300,417  | 70.1  | 1.127                        | 1.817    | 1.272    |
| 2044         | 192,383                             | 49,626 | 242,008 | 79.5  | 221,760                        | 92,057   | 313,817  | 70.7  | 1.153                        | 1.855    | 1.297    |
| 2045         | 198,223                             | 49,715 | 247,938 | 79.9  | 233,365                        | 93,969   | 327,334  | 71.3  | 1.177                        | 1.890    | 1.320    |
| 2046         | 201,716                             | 49,854 | 251,569 | 80.2  | 242,587                        | 96,137   | 338,724  | 71.6  | 1.203                        | 1.928    | 1.346    |
| 2047         | 202,775                             | 50,052 | 252,827 | 80.2  | 249,030                        | 98,485   | 347,515  | 71.7  | 1.228                        | 1.968    | 1.375    |
| 2048         | 203,839                             | 50,252 | 254,091 | 80.2  | 255,373                        | 100,721  | 356,094  | 71.7  | 1.253                        | 2.004    | 1.401    |
| 2049         | 204,910                             | 50,452 | 255,362 | 80.2  | 261,908                        | 103,045  | 364,953  | 71.8  | 1.278                        | 2.042    | 1.429    |
| 2050         | 205,986                             | 50,653 | 256,638 | 80.3  | 268,761                        | 105,471  | 374,232  | 71.8  | 1.305                        | 2.082    | 1.458    |
| 2051         | 207,067                             | 50,854 | 257,922 | 80.3  | 275,723                        | 107,925  | 383,649  | 71.9  | 1.332                        | 2.122    | 1.487    |
| 2052         | 208,154                             | 51,057 | 259,211 | 80.3  | 282,724                        | 110,425  | 393,148  | 71.9  | 1.358                        | 2.163    | 1.517    |
| 2053         | 209,247                             | 51,260 | 260,507 | 80.3  | 289,778                        | 112,941  | 402,719  | 72.0  | 1.385                        | 2.203    | 1.546    |
| 2054         | 210,346                             | 51,464 | 261,810 | 80.3  | 297,016                        | 115,479  | 412,495  | 72.0  | 1.412                        | 2.244    | 1.576    |
| 2055         | 211,450                             | 51,669 | 263,119 | 80.4  | 304,644                        | 118,171  | 422,816  | 72.1  | 1.441                        | 2.287    | 1.607    |
| 2056         | 212,560                             | 51,875 | 264,435 | 80.4  | 312,407                        | 120,927  | 433,333  | 72.1  | 1.470                        | 2.331    | 1.639    |
| 2057         | 213,676                             | 52,081 | 265,758 | 80.4  | 320,025                        | 123,591  | 443,616  | 72.1  | 1.498                        | 2.373    | 1.669    |
| 2058         | 214,798                             | 52,289 | 267,087 | 80.4  | 328,108                        | 126,383  | 454,491  | 72.2  | 1.528                        | 2.417    | 1.702    |

**Average Annual Percent Change**

|         |       |       |       |       |       |       |       |       |       |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 2019-25 | 19.3% | 15.8% | 18.2% | 16.5% | 13.5% | 15.1% | -2.4% | -2.0% | -2.6% |
| 2025-35 | 3.8%  | 0.5%  | 2.9%  | 7.0%  | 3.5%  | 5.6%  | 3.1%  | 3.0%  | 2.7%  |
| 2035-45 | 3.0%  | 0.3%  | 2.4%  | 5.4%  | 2.4%  | 4.4%  | 2.3%  | 2.1%  | 1.9%  |
| 2045-55 | 0.6%  | 0.4%  | 0.6%  | 2.7%  | 2.3%  | 2.6%  | 2.0%  | 1.9%  | 2.0%  |
| 2025-55 | 2.5%  | 0.4%  | 2.0%  | 5.0%  | 2.7%  | 4.2%  | 2.5%  | 2.3%  | 2.2%  |

(1) Assumes new Morrisville Parkway Interchange is opened January 1, 2020. Also, a new mainline toll zone north of the Morrisville Parkway Interchange is put into operation January 1, 2020.

(2) Ramp up is applied to the first 36-month period of transaction and revenue impacts associated with new toll zones.

(3) Assumes ramp tolls at US 64 and Hopson Road on Triangle Expressway are removed, and replaced by new mainline toll zones north of each interchange, on July 1, 2023.

(4) Assumes Complete 540 Phase 1 opens on July 1, 2023.

Table 7.7 provides estimates of transactions and revenue by payment type, and also shows average annual percent change for major increments during the forecast period along the bottom.

Growth in BBM transactions is estimated to be quite low, increasing 0.4 percent per year over the 30-year period extending from FY 2025 to FY 2055. This compares with an annual average increase of ETC transactions of 2.5 percent per year.

Annual revenue is expected to grow by 15.1 percent per year between FY 2019 and FY 2025. Much of this exceptionally high growth relates to the net impact of the assumed opening of Complete 540 Phase 1 in FY 2024. Between FY 2025 and FY 2035, annual revenue increases would average about 5.6 percent per year, slowing to a 4.4 percent average annual rate of increase between 2035 and 2045.

It should be kept in mind that revenue increases are influenced both by traffic growth and the assumption of continued annual increases in toll rates. The right three columns of Table 7.7 show estimated average toll per transaction, by payment category and overall. The overall average toll per transaction increases at 2.2 percent per year between 2025 and 2055.

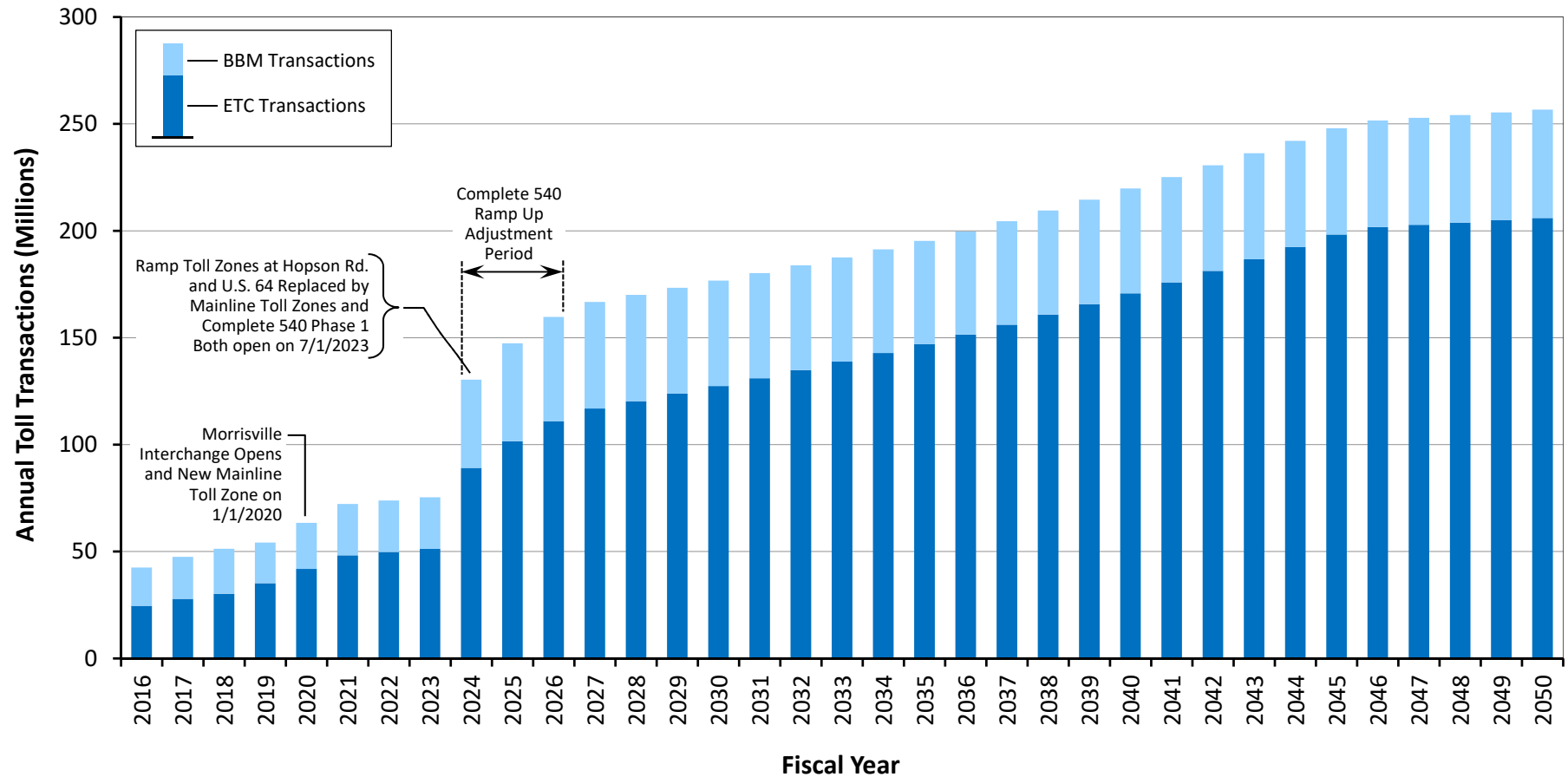
Estimated annual transactions by payment method are presented graphically in **Figure 7.9**. Fiscal years 2016 through 2018 represent actual Triangle Expressway transactions; subsequent years represent forecasts. The darker shade of each column represents estimated ETC transactions while the lighter shade represents BBM transactions. The significant impacts of the Complete 540 Phase 1, together with assumed changes in toll zone locations on Triangle Expressway, result in a significant increase in traffic between fiscal years 2023 and 2025. The graphic also shows the years in which ramp-up adjustments have been applied.

The number of estimated BBM annual transactions remains relatively constant over the long-term forecast. Most of the growth occurs in the darker shaded ETC transaction category. By 2050, ETC transactions represent about 80 percent of total systemwide toll transactions.

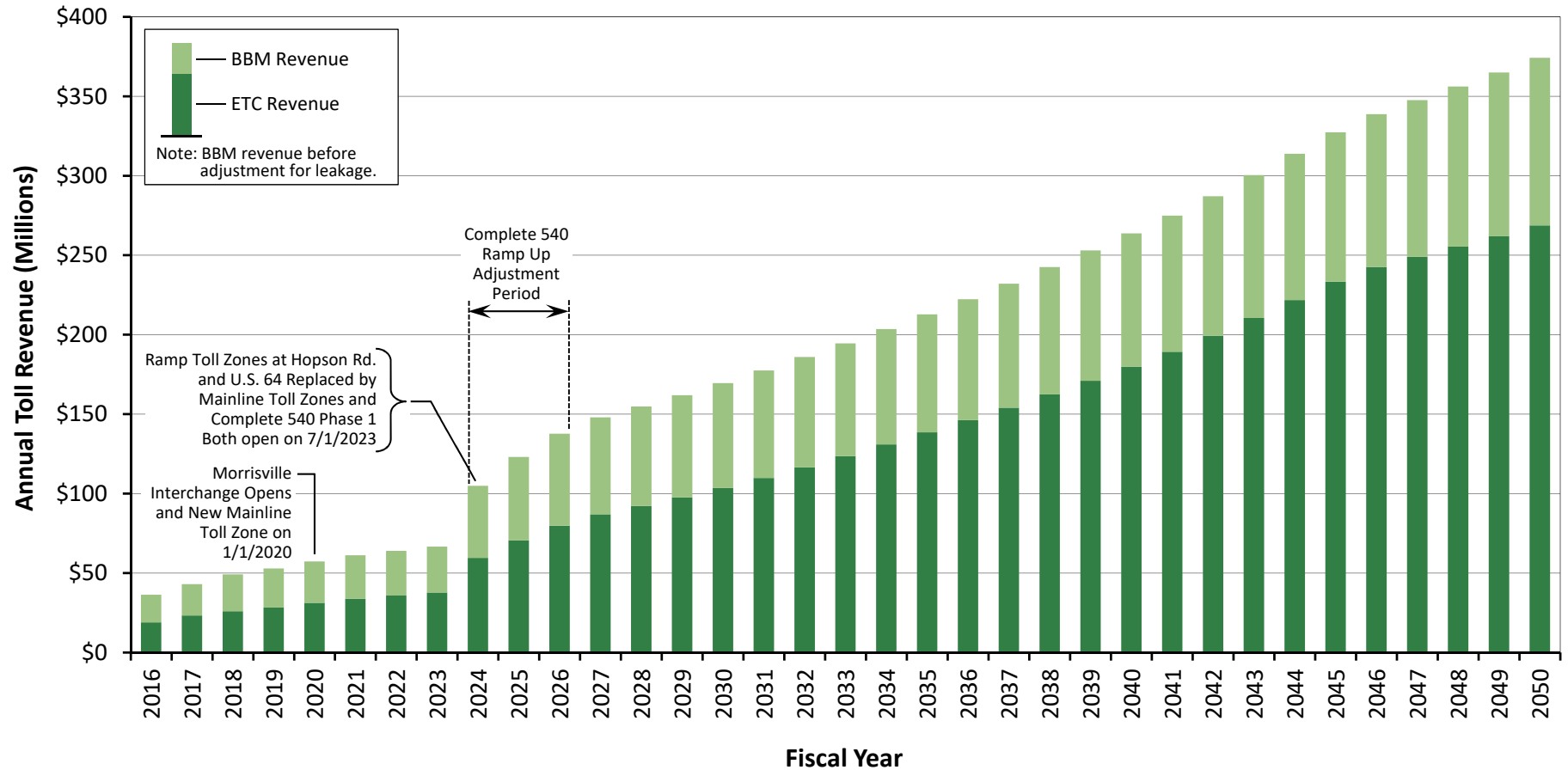
**Figure 7.10** graphically displays the annual revenue forecasts. Again, we see a significant increase in annual revenue over the fiscal year period between 2023 and 2026. This is attributable to the assumed opening of Complete 540 Phase 1. The magnitude of change in annual revenue estimates is not as large as annual transactions. This difference relates to the fact that a portion of the steep increase in transactions is associated with changes from ramp to mainline toll locations on Triangle Expressway, which actually result in a net reduction in average toll per transaction. This does not, however, significantly impact anticipated revenue. The revenue estimates shown in Figure 7.10 are estimates of expected revenue prior to any adjustment for leakage. They also do not include estimates of BBM invoice processing fee revenue.

**Figure 7.11** also shows estimates of annual revenue by primary source. Three components of revenue are depicted in the illustration:

- The blue portion of the bars reflect estimated revenue on the Triangle Expressway which would be expected without the implementation of Complete 540;
- The green portion of the bars reflects estimated incremental revenue from Triangle Expressway toll zones attributable to the opening of Complete 540; and,
- The yellow portion of each bar represents estimated revenue from toll zones on Complete 540 itself.

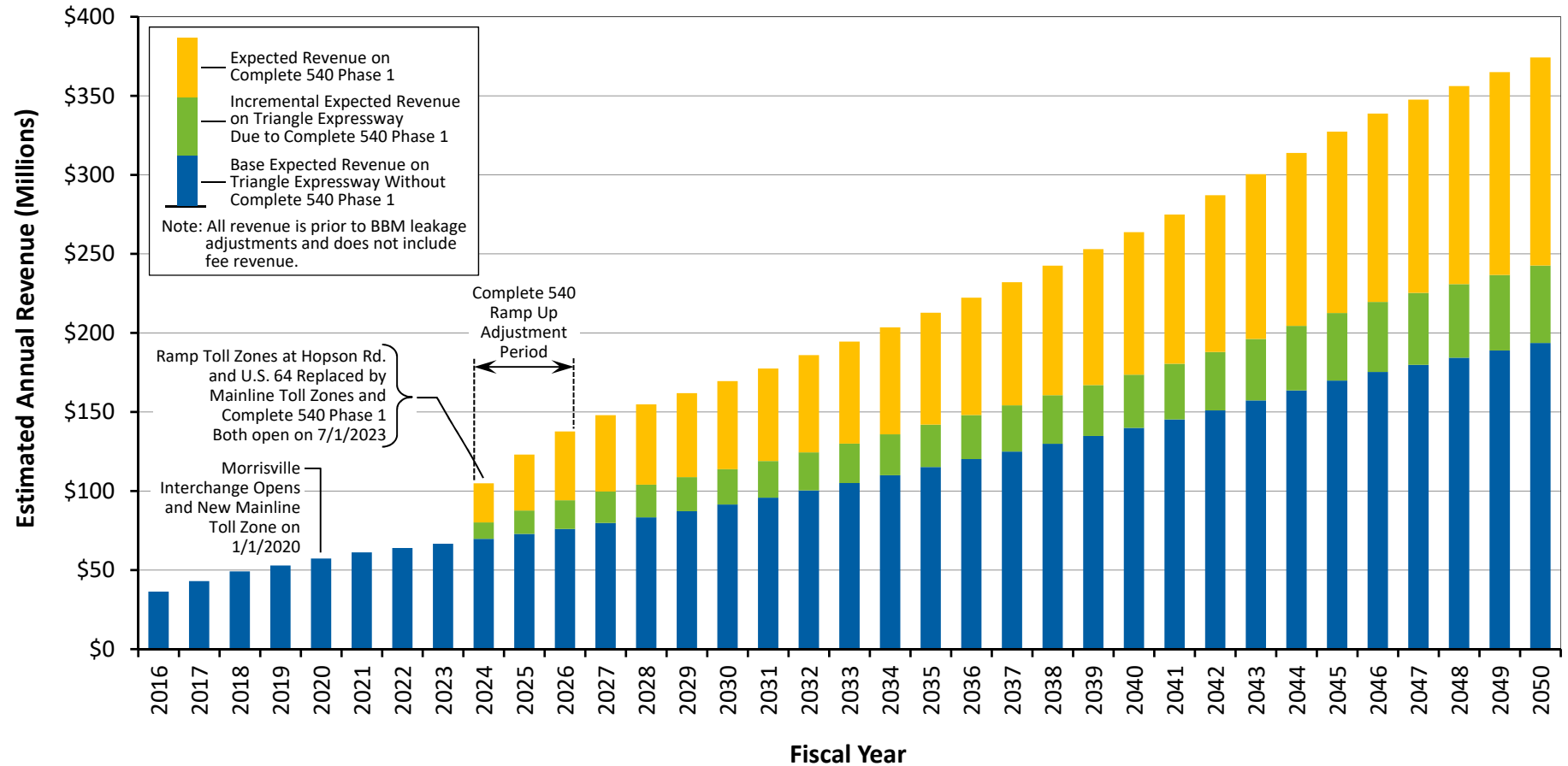


**ESTIMATED ANNUAL TRANSACTIONS BY PAYMENT METHOD  
TRIANGLE EXPRESSWAY PLUS COMPLETE 540 PHASE 1**



**ESTIMATED ANNUAL REVENUE BY PAYMENT METHOD  
TRIANGLE EXPRESSWAY PLUS COMPLETE 540 PHASE 1**

# Triangle Expressway and Complete 540 Phase 1 Traffic and Revenue Study





The ramp-up adjustment process was applied to both the green and yellow portions of revenue shown on each bar in Figure 7.11. Overall, the combined forecasts of annual revenue projects total expected revenue would reach around \$374 million by FY 2050. More than half of this is represented by the forecast of revenue on Triangle Expressway without Complete 540. Almost 13 percent of the total projected revenue is represented by incremental revenue on the existing Triangle Expressway. Revenue from Complete 540 toll zones represent the remaining 35.7 percent of the total.

### 7.8.1 Estimated Annual Adjusted Revenue

Finally, **Table 7.8** presents estimated adjusted annual revenue for Triangle Expressway and Complete 540 Phase 1. Computed gross revenue estimates are summarized by ETC and BBM components. In developing adjusted toll revenue estimates, anticipated losses due to uncollectable BBM revenue, referred to as “leakage” are subtracted from the total. After leakage, adjusted annual toll revenue is expected to increase from \$47.2 million in FY 2019 to \$111.0 million in FY 2025 and \$195.7 million in FY 2035. In addition, NCTA receives a relatively significant amount annually from processing fees; these are fees associated with the BBM billing process. Processing fee revenue is estimated to increase from almost \$5.7 million in FY 2019 to \$8.7 million in FY 2035. The growth in processing fee revenue is related to the growth in BBM transactions. No change in the current processing fee rate of \$6.00 per unpaid invoice is assumed over the forecast period. Hence, the increase in processing fees does not keep pace with the increase in leakage amounts, which increase over time by virtue of assumed annual increases in BBM toll rates.

The right-most column shows estimated total collected revenue in thousands. This is expected to increase from \$52.8 million in FY 2019 to \$119.2 million in FY 2025, and \$204.4 million in FY 2035.

Scenario 2 estimated gross toll revenue and adjusted toll revenue is shown in **Table 7.9** by fiscal year. The gross toll revenue is split into the revenue generated by Triangle Expressway toll zones, and Complete 540 Phase 1 toll zones. In FY 2025, gross toll revenue generated on the Triangle Expressway is about 75 percent of the total system toll revenue (Triangle Expressway and Complete 540). The Triangle Expressway’s share of gross toll revenue decreases to about 67 percent in 2035 and 65 percent in 2045 as toll revenue on Complete 540 increases. Also shown is the assumed leakage, adjusted toll revenue and fee revenue for each forecast fiscal year.

## 7.9 Disclaimer

The disclaimer setting forth the conditions and limitations of the traffic and revenue forecast presented at the end of Chapter 6 also apply to traffic and revenue forecasts included in Chapter 7 and other areas of this report.

**Table 7.8**  
**Estimated Adjusted Annual Revenue**  
**Scenario 2 - Triangle Expressway with Complete 540 Phase 1**

| Fiscal Year  | Computed Gross Revenue |           |           | BBM Leakage | Adjusted Toll Revenue | Processing Fees | Total Collected Revenue |
|--------------|------------------------|-----------|-----------|-------------|-----------------------|-----------------|-------------------------|
|              | ETC                    | BBM       | Total     |             |                       |                 |                         |
| 2019         | \$ 28,238              | \$ 24,580 | \$ 52,818 | \$ (5,652)  | \$ 47,166             | \$ 5,657        | \$ 52,823               |
| 2020 (1,2)   | 31,243                 | 26,056    | 57,299    | (5,991)     | 51,308                | 5,778           | 57,086                  |
| 2021 (2)     | 33,832                 | 27,286    | 61,118    | (6,274)     | 54,844                | 5,870           | 60,714                  |
| 2022 (2)     | 35,783                 | 28,129    | 63,912    | (6,468)     | 57,444                | 5,893           | 63,337                  |
| 2023 (2)     | 37,726                 | 28,882    | 66,608    | (6,641)     | 59,966                | 5,898           | 65,865                  |
| 2024 (2,3,4) | 59,547                 | 45,263    | 104,810   | (10,408)    | 94,402                | 7,442           | 101,844                 |
| 2025 (2)     | 70,518                 | 52,536    | 123,054   | (12,080)    | 110,974               | 8,262           | 119,236                 |
| 2026 (2)     | 79,769                 | 57,897    | 137,666   | (13,313)    | 124,352               | 8,784           | 133,137                 |
| 2027         | 86,903                 | 61,011    | 147,914   | (14,029)    | 133,885               | 8,978           | 142,862                 |
| 2028         | 92,104                 | 62,634    | 154,739   | (14,403)    | 140,336               | 8,959           | 149,295                 |
| 2029         | 97,547                 | 64,301    | 161,848   | (14,786)    | 147,062               | 8,931           | 155,993                 |
| 2030         | 103,452                | 66,016    | 169,468   | (15,180)    | 154,288               | 8,899           | 163,187                 |
| 2031         | 109,773                | 67,691    | 177,464   | (15,565)    | 161,899               | 8,864           | 170,763                 |
| 2032         | 116,506                | 69,391    | 185,897   | (15,956)    | 169,941               | 8,826           | 178,767                 |
| 2033         | 123,510                | 71,003    | 194,513   | (16,327)    | 178,186               | 8,784           | 186,971                 |
| 2034         | 130,858                | 72,603    | 203,461   | (16,695)    | 186,766               | 8,740           | 195,506                 |
| 2035         | 138,552                | 74,223    | 212,775   | (17,067)    | 195,708               | 8,692           | 204,399                 |
| 2036         | 146,238                | 76,027    | 222,265   | (17,482)    | 204,783               | 8,689           | 213,472                 |
| 2037         | 154,009                | 78,036    | 232,044   | (17,944)    | 214,100               | 8,731           | 222,832                 |
| 2038         | 162,374                | 80,098    | 242,472   | (18,418)    | 224,054               | 8,771           | 232,825                 |
| 2039         | 170,934                | 82,039    | 252,973   | (18,864)    | 234,108               | 8,809           | 242,917                 |
| 2040         | 179,842                | 83,874    | 263,716   | (19,287)    | 244,429               | 8,843           | 253,272                 |
| 2041         | 189,189                | 85,716    | 274,906   | (19,710)    | 255,196               | 8,874           | 264,070                 |
| 2042         | 199,323                | 87,703    | 287,026   | (20,167)    | 266,859               | 8,901           | 275,760                 |
| 2043         | 210,468                | 89,949    | 300,417   | (20,684)    | 279,734               | 8,925           | 288,659                 |
| 2044         | 221,760                | 92,057    | 313,817   | (21,168)    | 292,649               | 8,945           | 301,594                 |
| 2045         | 233,365                | 93,969    | 327,334   | (21,608)    | 305,726               | 8,961           | 314,687                 |
| 2046         | 242,587                | 96,137    | 338,724   | (22,106)    | 316,618               | 8,986           | 325,604                 |
| 2047         | 249,030                | 98,485    | 347,515   | (22,646)    | 324,869               | 9,022           | 333,891                 |
| 2048         | 255,373                | 100,721   | 356,094   | (23,160)    | 332,934               | 9,058           | 341,992                 |
| 2049         | 261,908                | 103,045   | 364,953   | (23,695)    | 341,258               | 9,094           | 350,353                 |
| 2050         | 268,761                | 105,471   | 374,232   | (24,253)    | 349,979               | 9,130           | 359,110                 |
| 2051         | 275,723                | 107,925   | 383,649   | (24,817)    | 358,832               | 9,167           | 367,998                 |
| 2052         | 282,724                | 110,425   | 393,148   | (25,392)    | 367,757               | 9,203           | 376,960                 |
| 2053         | 289,778                | 112,941   | 402,719   | (25,970)    | 376,749               | 9,240           | 385,989                 |
| 2054         | 297,016                | 115,479   | 412,495   | (26,554)    | 385,941               | 9,277           | 395,218                 |
| 2055         | 304,644                | 118,171   | 422,816   | (27,173)    | 395,642               | 9,314           | 404,956                 |
| 2056         | 312,407                | 120,927   | 433,333   | (27,807)    | 405,527               | 9,351           | 414,877                 |
| 2057         | 320,025                | 123,591   | 443,616   | (28,419)    | 415,197               | 9,388           | 424,585                 |
| 2058         | 328,108                | 126,383   | 454,491   | (29,061)    | 425,430               | 9,425           | 434,855                 |

(1) Assumes new Morrisville Parkway Interchange is opened January 1, 2020. Also, a new mainline toll zone north of the Morrisville Parkway Interchange is put into operation January 1, 2020.

(2) Ramp up is applied to the first 36-month period of transaction and revenue impacts associated with new toll zones.

(3) Assumes ramp tolls at U.S. 64 and Hopson Road on Triangle Expressway are removed and replaced by new mainline toll zones north of each interchange on July 1, 2023.

(4) Assumes Complete 540 Phase 1 is opened on July 1, 2023.

**Table 7.9**  
**Estimated Adjusted Annual Revenue**  
**Scenario 2 - Triangle Expressway With Complete 540 Phase 1**

| Fiscal<br>Year | Computed Gross Revenue         |           |           |                         |        |         |            |           |           | BBM<br>Leakage | Adjusted<br>Revenue | Processing<br>Fees | Total<br>Collected |
|----------------|--------------------------------|-----------|-----------|-------------------------|--------|---------|------------|-----------|-----------|----------------|---------------------|--------------------|--------------------|
|                | Triangle Expressway Toll Zones |           |           | Complete 540 Toll Zones |        |         | Systemwide |           |           |                |                     |                    |                    |
|                | ETC                            | BBM       | Total     | ETC                     | BBM    | Total   | ETC        | BBM       | Total     |                |                     |                    |                    |
| 2019           | \$ 28,238                      | \$ 24,580 | \$ 52,818 | \$ -                    | \$ -   | \$ -    | \$ 28,238  | \$ 24,580 | \$ 52,818 | \$ (5,652)     | \$ 47,166           | \$ 5,657           | \$ 52,823          |
| 2020 (1,2)     | 31,243                         | 26,056    | 57,299    | -                       | -      | -       | 31,243     | 26,056    | 57,299    | (5,991)        | 51,308              | 5,778              | 57,086             |
| 2021 (2)       | 33,832                         | 27,286    | 61,118    | -                       | -      | -       | 33,832     | 27,286    | 61,118    | (6,274)        | 54,844              | 5,870              | 60,714             |
| 2022 (2)       | 35,783                         | 28,129    | 63,912    | -                       | -      | -       | 35,783     | 28,129    | 63,912    | (6,468)        | 57,444              | 5,893              | 63,337             |
| 2023 (2)       | 37,726                         | 28,882    | 66,608    | -                       | -      | -       | 37,726     | 28,882    | 66,608    | (6,641)        | 59,966              | 5,898              | 65,865             |
| 2024 (2,3,4)   | 45,342                         | 34,750    | 80,092    | 14,204                  | 10,513 | 24,718  | 59,547     | 45,263    | 104,810   | (10,408)       | 94,402              | 7,442              | 101,844            |
| 2025 (2)       | 49,960                         | 37,646    | 87,606    | 20,558                  | 14,890 | 35,448  | 70,518     | 52,536    | 123,054   | (12,080)       | 110,974             | 8,262              | 119,236            |
| 2026 (2)       | 54,260                         | 39,896    | 94,156    | 25,509                  | 18,001 | 43,510  | 79,769     | 57,897    | 137,666   | (13,313)       | 124,352             | 8,784              | 133,137            |
| 2027           | 58,266                         | 41,406    | 99,673    | 28,637                  | 19,604 | 48,241  | 86,903     | 61,011    | 147,914   | (14,029)       | 133,885             | 8,978              | 142,862            |
| 2028           | 61,607                         | 42,400    | 104,007   | 30,498                  | 20,234 | 50,732  | 92,104     | 62,634    | 154,739   | (14,403)       | 140,336             | 8,959              | 149,295            |
| 2029           | 65,193                         | 43,522    | 108,715   | 32,354                  | 20,779 | 53,133  | 97,547     | 64,301    | 161,848   | (14,786)       | 147,062             | 8,931              | 155,993            |
| 2030           | 69,108                         | 44,655    | 113,763   | 34,344                  | 21,361 | 55,705  | 103,452    | 66,016    | 169,468   | (15,180)       | 154,288             | 8,899              | 163,187            |
| 2031           | 73,239                         | 45,699    | 118,938   | 36,534                  | 21,991 | 58,526  | 109,773    | 67,691    | 177,464   | (15,565)       | 161,899             | 8,864              | 170,763            |
| 2032           | 77,638                         | 46,761    | 124,399   | 38,868                  | 22,631 | 61,498  | 116,506    | 69,391    | 185,897   | (15,956)       | 169,941             | 8,826              | 178,767            |
| 2033           | 82,233                         | 47,742    | 129,975   | 41,278                  | 23,260 | 64,538  | 123,510    | 71,003    | 194,513   | (16,327)       | 178,186             | 8,784              | 186,971            |
| 2034           | 87,071                         | 48,751    | 135,822   | 43,787                  | 23,852 | 67,639  | 130,858    | 72,603    | 203,461   | (16,695)       | 186,766             | 8,740              | 195,506            |
| 2035           | 92,142                         | 49,799    | 141,941   | 46,410                  | 24,423 | 70,833  | 138,552    | 74,223    | 212,775   | (17,067)       | 195,708             | 8,692              | 204,399            |
| 2036           | 97,083                         | 50,952    | 148,035   | 49,155                  | 25,075 | 74,230  | 146,238    | 76,027    | 222,265   | (17,482)       | 204,783             | 8,689              | 213,472            |
| 2037           | 101,972                        | 52,220    | 154,192   | 52,037                  | 25,815 | 77,852  | 154,009    | 78,036    | 232,044   | (17,944)       | 214,100             | 8,731              | 222,832            |
| 2038           | 107,123                        | 53,421    | 160,544   | 55,251                  | 26,677 | 81,929  | 162,374    | 80,098    | 242,472   | (18,418)       | 224,054             | 8,771              | 232,825            |
| 2039           | 112,394                        | 54,542    | 166,937   | 58,540                  | 27,497 | 86,036  | 170,934    | 82,039    | 252,973   | (18,864)       | 234,108             | 8,809              | 242,917            |
| 2040           | 117,954                        | 55,618    | 173,572   | 61,887                  | 28,256 | 90,143  | 179,842    | 83,874    | 263,716   | (19,287)       | 244,429             | 8,843              | 253,272            |
| 2041           | 123,793                        | 56,689    | 180,482   | 65,397                  | 29,027 | 94,424  | 189,189    | 85,716    | 274,906   | (19,710)       | 255,196             | 8,874              | 264,070            |
| 2042           | 130,065                        | 57,831    | 187,897   | 69,258                  | 29,872 | 99,130  | 199,323    | 87,703    | 287,026   | (20,167)       | 266,859             | 8,901              | 275,760            |
| 2043           | 136,948                        | 59,162    | 196,110   | 73,520                  | 30,788 | 104,307 | 210,468    | 89,949    | 300,417   | (20,684)       | 279,734             | 8,925              | 288,659            |
| 2044           | 143,947                        | 60,452    | 204,399   | 77,814                  | 31,605 | 109,418 | 221,760    | 92,057    | 313,817   | (21,168)       | 292,649             | 8,945              | 301,594            |
| 2045           | 151,017                        | 61,552    | 212,569   | 82,349                  | 32,416 | 114,765 | 233,365    | 93,969    | 327,334   | (21,608)       | 305,726             | 8,961              | 314,687            |
| 2046           | 156,714                        | 62,844    | 219,558   | 85,873                  | 33,293 | 119,166 | 242,587    | 96,137    | 338,724   | (22,106)       | 316,618             | 8,986              | 325,604            |
| 2047           | 160,890                        | 64,373    | 225,263   | 88,140                  | 34,112 | 122,252 | 249,030    | 98,485    | 347,515   | (22,646)       | 324,869             | 9,022              | 333,891            |
| 2048           | 165,023                        | 65,835    | 230,858   | 90,350                  | 34,887 | 125,237 | 255,373    | 100,721   | 356,094   | (23,160)       | 332,934             | 9,058              | 341,992            |
| 2049           | 169,257                        | 67,344    | 236,602   | 92,651                  | 35,700 | 128,351 | 261,908    | 103,045   | 364,953   | (23,695)       | 341,258             | 9,094              | 350,353            |
| 2050           | 173,644                        | 68,934    | 242,578   | 95,118                  | 36,537 | 131,654 | 268,761    | 105,471   | 374,232   | (24,253)       | 349,979             | 9,130              | 359,110            |
| 2051           | 178,143                        | 70,550    | 248,694   | 97,580                  | 37,375 | 134,955 | 275,723    | 107,925   | 383,649   | (24,817)       | 358,832             | 9,167              | 367,998            |
| 2052           | 182,607                        | 72,151    | 254,757   | 100,117                 | 38,274 | 138,391 | 282,724    | 110,425   | 393,148   | (25,392)       | 367,757             | 9,203              | 376,960            |
| 2053           | 187,136                        | 73,760    | 260,897   | 102,641                 | 39,181 | 141,822 | 289,778    | 112,941   | 402,719   | (25,970)       | 376,749             | 9,240              | 385,989            |
| 2054           | 191,873                        | 75,441    | 267,313   | 105,144                 | 40,038 | 145,182 | 297,016    | 115,479   | 412,495   | (26,554)       | 385,941             | 9,277              | 395,218            |
| 2055           | 196,793                        | 77,190    | 273,983   | 107,852                 | 40,981 | 148,833 | 304,644    | 118,171   | 422,816   | (27,173)       | 395,642             | 9,314              | 404,956            |
| 2056           | 201,774                        | 78,972    | 280,746   | 110,633                 | 41,954 | 152,587 | 312,407    | 120,927   | 433,333   | (27,807)       | 405,527             | 9,351              | 414,877            |
| 2057           | 206,702                        | 80,741    | 287,443   | 113,323                 | 42,850 | 156,174 | 320,025    | 123,591   | 443,616   | (28,419)       | 415,197             | 9,388              | 424,585            |
| 2058           | 211,940                        | 82,564    | 294,503   | 116,169                 | 43,819 | 159,988 | 328,108    | 126,383   | 454,491   | (29,061)       | 425,430             | 9,425              | 434,855            |

(1) Assumes new Morrisville Parkway Interchange is opened January 1, 2020. Also new mainline toll zone north of the Morrisville Pkwy is put into operation January 1, 2020.

(2) Ramp up is applied to the first 36-month period of transaction and revenue impacts associated with new toll zones.

(3) Assumes ramp tolls at U.S. 64 and Hopson Road on Triangle Expressway are removed and replaced by new mainline toll zones north of each interchange on July 1, 2023.

(4) Assumes Complete 540 Phase 1 is opened on July 1, 2023.

## Chapter 8

### Sensitivity Tests

Five hypothetical tests were conducted to determine the sensitivity of the Scenario 2 annual transaction and toll revenue forecasts detailed in Chapter 7 to changes in key study assumptions. The sensitivity tests were conducted for calendar modeled years 2025 and 2045. The results were converted to fiscal year (FY) and are reported for FY 2025 and FY 2045. The following describes the five sensitivity tests:

1. **Reduced Economic Growth** – trip table growth was reduced by 30 percent.
2. **Reduced Value of Time** - passenger car (Class 1) and truck (Classes 2 and 3) values of time were reduced by 25 percent.
3. **Increased Motor Fuel Prices** – motor fuel prices were increased by 50 percent.
4. **Reduced Truck Market Share** – 25 percent of the forecasted truck transactions were converted to be passenger cars. Total toll transactions remained unchanged.
5. **Increase ramp-up to 5 years** – ramp-up on Complete 540 Segments Phase 1 increased from 3 years to 5 years.

**Table 8.1** presents the estimated impacts on Scenario 2 transactions and revenue associated with the five sensitivity tests described above. Scenario 2 forecasts of toll transactions, gross toll revenue, and total collected revenue for fiscal years 2025 and 2045 are shown across the top of the table. The results of tests 1 through 4 are also shown for FY 2025 and FY 2045, including the difference and percent impact between the sensitivity test forecast and the Scenario 2 forecast. The percent impact on total collected revenue for each of these sensitivity tests compared to Scenario 2 is shown graphically in **Figure 8.1**. Since sensitivity test number 5 relates to ramp-up assumptions of Phase 1, the results for that test are shown at the bottom of Table 8.1 as a cumulative impact between FY 2024 and FY 2028 (the first 5 years of operation of Complete 540 Phase 1).

#### 8.1 Reduced Economic Growth

The rate of trip table growth was reduced by 30 percent between our base year calibration year 2016 and future year 2045 to simulate slower economic growth than assumed in the trip tables used for Scenario 2. Because of the slower assumed regional growth, toll transactions would be lower by 10.3 percent in FY 2025 and 21.4 percent in FY 2045. Similarly, total collected revenue decreased by 10.4 percent in FY 2025 and 21.9 percent in FY 2045. The percent impacts in 2045 are larger compared to those estimated for 2025 because of the compounding nature of the reduced annual growth rates.

#### 8.2 Reduced Value of Time

Motorist value of time (VOT) is an important factor in the modeling process, as it influences a driver's willingness to pay a toll to achieve a time savings by using the toll road. The VOT is based in part on the median household income in each traffic analysis zone in the TRMv6 model. Base Condition VOTs were reduced by 25 percent in calendar years 2025 and 2045, resulting in an estimated 12.6 percent

and 11.1 percent decrease in transactions in FY 2025 and FY 2045, respectively. Annual total collected revenue estimates were reduced by 11.9 and 10.5 percent in FY 2025 and FY 2045, respectively.

**Table 8.1**  
**Summary of Sensitivity Test Results on Fiscal Year Transaction and Toll Revenue Estimates**  
**On Scenario 2: Triangle Expressway and Complete 540 Phase 1**  
**(in thousands)**

| Scenario 2 and Sensitivity Scenarios         | Annual<br>Toll Transactions |          | Annual Gross<br>Toll Revenue (7) |           | Annual Total<br>Collected Revenue (8) |           |
|----------------------------------------------|-----------------------------|----------|----------------------------------|-----------|---------------------------------------|-----------|
|                                              | 2025 (6)                    | 2045     | 2025 (6)                         | 2045      | 2025 (6)                              | 2045      |
| Scenario 2                                   | 147,353                     | 247,938  | \$123,054                        | \$327,334 | \$119,236                             | \$314,687 |
| <b>Sensitivity Scenarios</b>                 |                             |          |                                  |           |                                       |           |
| 1 Overall Economic Growth Reduced by 30% (1) | 132,135                     | 194,770  | \$110,229                        | \$255,465 | \$106,814                             | \$245,692 |
| Difference                                   | (15,218)                    | (53,168) | (12,825)                         | (71,869)  | (12,422)                              | (68,996)  |
| Percent Difference                           | -10.3%                      | -21.4%   | -10.4%                           | -22.0%    | -10.4%                                | -21.9%    |
| 2 Value of Time Reduced by 25% (2)           | 128,809                     | 220,434  | \$108,457                        | \$292,714 | \$105,022                             | \$281,761 |
| Difference                                   | (18,544)                    | (27,504) | (14,597)                         | (34,620)  | (14,214)                              | (32,926)  |
| Percent Difference                           | -12.6%                      | -11.1%   | -11.9%                           | -10.6%    | -11.9%                                | -10.5%    |
| 3 Fuel Price Increased by 50% (3)            | 135,440                     | 229,593  | \$114,216                        | \$305,359 | \$110,555                             | \$293,349 |
| Difference                                   | (11,913)                    | (18,345) | (8,838)                          | (21,975)  | (8,681)                               | (21,339)  |
| Percent Difference                           | -8.1%                       | -7.4%    | -7.2%                            | -6.7%     | -7.3%                                 | -6.8%     |
| 4 Truck Market Share Reduced by 25% (4)      | 147,353                     | 247,938  | \$118,819                        | \$315,710 | \$115,519                             | \$303,965 |
| Difference                                   | 0                           | 0        | (4,235)                          | (11,623)  | (3,717)                               | (10,723)  |
| Percent Difference                           | 0.0%                        | 0.0%     | -3.4%                            | -3.6%     | -3.1%                                 | -3.4%     |
| <b>5-year Total</b>                          |                             |          |                                  |           |                                       |           |
| <b>Toll Transactions</b>                     |                             |          |                                  |           |                                       |           |
| <b>2024-2028</b>                             |                             |          |                                  |           |                                       |           |
| Scenario 2                                   | 774,111                     |          | \$668,182                        |           | \$646,374                             |           |
| 5 Extended Ramp-up Period (5)                | 747,840                     |          | \$642,380                        |           | \$621,647                             |           |
| Difference                                   | (26,271)                    |          | (25,802)                         |           | (24,728)                              |           |
| Percent Difference                           | -3.4%                       |          | -3.9%                            |           | -3.8%                                 |           |

(1) 30 percent global reduction in TRM trip table growth from base year 2016 through 2045.

(2) Value of time is reduced by 25 percent for cars and trucks.

(3) Fuel price is increased by 50 percent.

(4) Truck transactions forecast for Triangle Expressway and Complete 540 Phase 1 are reduced by 25 percent.

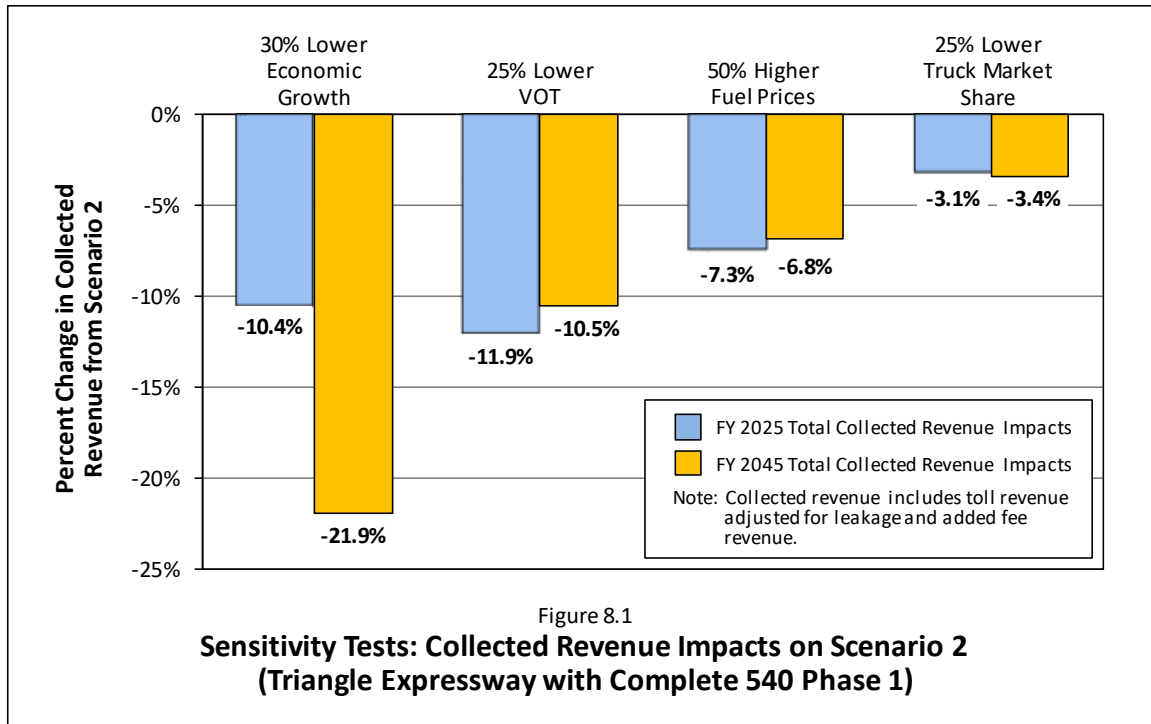
Those same transactions are assumed to be car transactions. Total transactions remain unchanged.

(5) 5-year ramp-up period applied to traffic and revenue impacts due to Complete 540 Phase 1.

(6) Includes a dampening factor (ramp-up) on traffic and revenue.

(7) Total expected toll revenue for all toll transactions, prior to accounting for leakage or fee revenue.

(8) Total collected toll revenue and processing fee revenue.



### 8.3 Increased Motor Fuel Prices

Motor fuel prices can be volatile over a long-term forecast, and this test assumes that Scenario 2 motor fuel prices increase by 50 percent. This change would result in higher operating costs for the motorist and likely result in reduced travel demand. To reflect the reduced travel demand, the trip tables were reduced by five percent representing an elasticity of -0.10. The motor vehicle operating cost used in the tolling assignment was also increased to reflect the increase in motor fuel prices. Under this test, annual toll transactions decreased by 8.1 percent in FY 2025 and by 7.4 percent in FY 2045. Total collected revenue decreased by 7.3 percent and by 6.8 percent for FY 2025 and FY 2045, respectively.

### 8.4 Reduced Truck Market Share

Truck toll rates are significantly higher than passenger car toll rates. Class 2 vehicles (those with 3 axles) pay twice the Class 1 (2-axle vehicles) toll rates, and Class 3 vehicles (those with 4 or more axles) pay four times the Class 1 toll rates. For this sensitivity test, 25 percent of the Class 2 and 3 vehicles forecast to use the facility were converted into Class 1 vehicles. The total number of transactions remain unchanged from the Scenario 2. Annual total collected revenue decreased by 3.1 percent and by 3.4 percent for 2025 and 2045, respectively.

### 8.5 Increased Ramp-Up

Scenario 2 assumes that Complete 540 Phase 1 will experience ramp-up over a three-year period. This test assumes the ramp-up period to extend over a five-year period before reaching a normal growth rate. By the sixth year and beyond, annual transactions and revenue would match those estimated for Scenario 2. Under this test, cumulative toll transactions between FY 2024 and FY 2028 are lower by 3.4 percent. Cumulative total collected revenue between 2024 and 2028 is lower by 3.8 percent.



## Appendix A

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# Volume Calibration Results by Time Period and Direction on Screenlines

## Appendix A

## Volume Calibration Results by Time Period and Direction on Screenlines

| Screenline | Roadname                            | Dir.      | AM             |                |                    | PM             |                |                    | MD             |                |                    | NT             |                |                    |
|------------|-------------------------------------|-----------|----------------|----------------|--------------------|----------------|----------------|--------------------|----------------|----------------|--------------------|----------------|----------------|--------------------|
|            |                                     |           | Observed Count | Modeled Volume | Percent Difference | Observed Count | Modeled Volume | Percent Difference | Observed Count | Modeled Volume | Percent Difference | Observed Count | Modeled Volume | Percent Difference |
| 1          | S. New Hope Rd                      | NB        | 2,710          | 2,261          | -17%               | 2,305          | 2,035          | -12%               | 2,146          | 2,380          | 11%                | 1,448          | 1,355          | -6%                |
| 1          | S. New Hope Rd                      | SB        | 1,920          | 1,981          | 3%                 | 3,174          | 2,680          | -16%               | 2,195          | 2,507          | 14%                | 1,530          | 1,589          | 4%                 |
| 1          | Barwell Rd                          | NB        | 718            | 503            | -30%               | 948            | 1,006          | 6%                 | 679            | 750            | 10%                | 540            | 399            | -26%               |
| 1          | Barwell Rd                          | SB        | 803            | 960            | 20%                | 1,034          | 768            | -26%               | 723            | 807            | 12%                | 523            | 435            | -17%               |
| 1          | Auburn Knightdale Rd                | NB        | 373            | 627            | 68%                | 479            | 729            | 52%                | 412            | 563            | 37%                | 194            | 252            | 30%                |
| 1          | Auburn Knightdale Rd                | SB        | 405            | 547            | 35%                | 514            | 815            | 58%                | 394            | 590            | 50%                | 157            | 234            | 49%                |
| 1          | Mial Plantation Rd                  | NB        | 800            | 988            | 24%                | 669            | 970            | 45%                | 532            | 845            | 59%                | 271            | 325            | 20%                |
| 1          | Mial Plantation Rd                  | SB        | 581            | 828            | 42%                | 933            | 1,112          | 19%                | 567            | 811            | 43%                | 270            | 379            | 40%                |
| 2          | White Oak Rd (NC 2547)              | NB        | 3,098          | 2,716          | -12%               | 1,513          | 1,530          | 1%                 | 2,057          | 2,282          | 11%                | 671            | 705            | 5%                 |
| 2          | White Oak Rd (NC 2547)              | SB        | 983            | 1,044          | 6%                 | 2,910          | 2,901          | 0%                 | 2,088          | 2,240          | 7%                 | 1,088          | 1,091          | 0%                 |
| 2          | I-40                                | NB        | 7,456          | 7,842          | 5%                 | 14,797         | 15,109         | 2%                 | 13,401         | 13,932         | 4%                 | 9,306          | 9,255          | -1%                |
| 2          | I-40                                | SB        | 12,878         | 13,886         | 8%                 | 10,694         | 10,046         | -6%                | 14,269         | 14,402         | 1%                 | 7,314          | 7,291          | 0%                 |
| 2          | Raynor Rd (NC 2555)                 | NB        | 1,442          | 1,536          | 7%                 | 383            | 899            | 135%               | 549            | 975            | 78%                | 302            | 448            | 48%                |
| 2          | Raynor Rd (NC 2555)                 | SB        | 256            | 669            | 161%               | 1,045          | 1,367          | 31%                | 597            | 882            | 48%                | 348            | 511            | 47%                |
| 2          | Guy Rd (NC 2558)                    | NB        | 1,930          | 1,652          | -14%               | 657            | 825            | 26%                | 791            | 1,022          | 29%                | 412            | 373            | -10%               |
| 2          | Guy Rd (NC 2558)                    | SB        | 345            | 412            | 20%                | 1,986          | 1,770          | -11%               | 835            | 953            | 14%                | 685            | 622            | -9%                |
| 2          | I-40                                | NB        | 8,963          | 9,478          | 6%                 | 7,799          | 7,767          | 0%                 | 10,391         | 10,706         | 3%                 | 5,516          | 5,407          | -2%                |
| 2          | I-40                                | SB        | 5,410          | 5,534          | 2%                 | 11,595         | 10,712         | -8%                | 10,170         | 9,998          | -2%                | 7,111          | 6,707          | -6%                |
| 3          | Timber Dr.                          | EB        | 1,202          | 1,532          | 27%                | 4,250          | 3,614          | -15%               | 2,709          | 2,825          | 4%                 | 1,241          | 1,250          | 1%                 |
| 3          | Timber Dr.                          | WB        | 3,415          | 3,499          | 2%                 | 1,990          | 2,803          | 41%                | 2,664          | 3,605          | 35%                | 969            | 1,077          | 11%                |
| 3          | Buffalo Rd.                         | EB        | 289            | 140            | -51%               | 558            | 302            | -46%               | 488            | 150            | -69%               | 231            | 96             | -58%               |
| 3          | Buffalo Rd.                         | WB        | 329            | 264            | -20%               | 449            | 212            | -53%               | 429            | 192            | -55%               | 147            | 100            | -32%               |
| 3          | Ten Ten Rd.                         | EB        | 1,076          | 1,006          | -7%                | 2,446          | 2,082          | -15%               | 2,025          | 1,904          | -6%                | 961            | 1,041          | 8%                 |
| 3          | Ten Ten Rd.                         | WB        | 1,991          | 1,948          | -2%                | 1,592          | 1,441          | -9%                | 1,910          | 1,701          | -11%               | 817            | 825            | 1%                 |
| 3          | Pagan Rd                            | EB        | 233            | 149            | -36%               | 297            | 434            | 46%                | 213            | 280            | 31%                | 101            | 110            | 9%                 |
| 3          | Pagan Rd                            | WB        | 293            | 330            | 13%                | 234            | 195            | -17%               | 247            | 203            | -18%               | 102            | 98             | -4%                |
| 3          | Rock Service Station Rd             | NB        | 1,000          | 581            | -42%               | 372            | 389            | 5%                 | 434            | 485            | 12%                | 189            | 196            | 4%                 |
| 3          | Rock Service Station Rd             | SB        | 316            | 225            | -29%               | 943            | 591            | -37%               | 516            | 469            | -9%                | 282            | 278            | -1%                |
| 3          | NC 42                               | EB        | 1,127          | 1,127          | 0%                 | 1,738          | 1,612          | -7%                | 1,567          | 1,413          | -10%               | 737            | 778            | 5%                 |
| 3          | NC 42                               | WB        | 1,452          | 1,375          | -5%                | 1,471          | 1,333          | -9%                | 1,526          | 1,390          | -9%                | 801            | 861            | 7%                 |
| 4          | US 401                              | NB        | 6,348          | 7,441          | 17%                | 4,091          | 4,268          | 4%                 | 5,616          | 5,725          | 2%                 | 2,184          | 2,279          | 4%                 |
| 4          | US 401                              | SB        | 3,576          | 3,171          | -11%               | 6,797          | 6,847          | 1%                 | 5,304          | 4,817          | -9%                | 2,553          | 2,559          | 0%                 |
| 4          | Ten Ten Rd                          | EB        | 1,161          | 1,185          | 2%                 | 3,630          | 3,404          | -6%                | 2,933          | 2,683          | -9%                | 1,536          | 1,611          | 5%                 |
| 4          | Ten Ten Rd                          | WB        | 3,181          | 3,466          | 9%                 | 1,953          | 1,997          | 2%                 | 2,589          | 2,631          | 2%                 | 944            | 977            | 3%                 |
| 4          | Banks Rd                            | EB        | 455            | 402            | -12%               | 1,367          | 881            | -36%               | 752            | 644            | -14%               | 423            | 243            | -43%               |
| 4          | Banks Rd                            | WB        | 1,682          | 882            | -48%               | 774            | 486            | -37%               | 783            | 405            | -48%               | 335            | 192            | -43%               |
| 5          | Penny Rd                            | EB        | 609            | 498            | -18%               | 2,535          | 1,973          | -22%               | 1,252          | 1,019          | -19%               | 675            | 631            | -7%                |
| 5          | Penny Rd                            | WB        | 2,013          | 1,630          | -19%               | 1,033          | 922            | -11%               | 1,345          | 1,083          | -20%               | 356            | 352            | -1%                |
| 5          | Ten Ten Rd                          | EB        | 1,967          | 2,204          | 12%                | 3,325          | 4,026          | 21%                | 3,061          | 3,661          | 20%                | 1,371          | 1,666          | 22%                |
| 5          | Ten Ten Rd                          | WB        | 2,890          | 3,693          | 28%                | 2,437          | 2,967          | 22%                | 3,260          | 3,821          | 17%                | 1,091          | 1,223          | 12%                |
| 5          | Optimist Farm Rd                    | EB        | 1,174          | 1,987          | 69%                | 1,839          | 1,331          | -28%               | 1,137          | 1,391          | 22%                | 489            | 576            | 18%                |
| 5          | Optimist Farm Rd                    | WB        | 1,705          | 1,166          | -32%               | 1,406          | 1,674          | 19%                | 1,376          | 1,429          | 4%                 | 476            | 562            | 18%                |
| 5          | Hilltop Needmore Rd                 | EB        | 1,400          | 1,350          | -4%                | 1,493          | 1,359          | -9%                | 1,322          | 1,199          | -9%                | 523            | 530            | 1%                 |
| 5          | Hilltop Needmore Rd                 | WB        | 1,066          | 1,095          | 3%                 | 1,539          | 1,299          | -16%               | 1,303          | 1,131          | -13%               | 619            | 546            | -12%               |
| 6          | New Hill Holleman Rd                | NB        | 1,898          | 2,511          | 32%                | 434            | 557            | 28%                | 526            | 695            | 32%                | 227            | 170            | -25%               |
| 6          | New Hill Holleman Rd                | SB        | 311            | 280            | -10%               | 1,738          | 2,248          | 29%                | 583            | 704            | 21%                | 209            | 255            | 22%                |
| 6          | Holly Springs Rd                    | NB        | 425            | 696            | 64%                | 394            | 363            | -8%                | 273            | 415            | 52%                | 117            | 71             | -39%               |
| 6          | Holly Springs Rd                    | SB        | 294            | 180            | -39%               | 451            | 657            | 46%                | 306            | 297            | -3%                | 113            | 252            | 123%               |
| 6          | Old Holly Springs Apex Rd           | NB        | 1,187          | 1,558          | 31%                | 444            | 642            | 45%                | 444            | 720            | 62%                | 131            | 185            | 41%                |
| 6          | Old Holly Springs Apex Rd           | SB        | 245            | 316            | 29%                | 1,305          | 1,347          | 3%                 | 448            | 638            | 42%                | 185            | 260            | 41%                |
| 6          | <b>NC 540 / Triangle Expressway</b> | <b>NB</b> | <b>4,748</b>   | <b>5,343</b>   | <b>13%</b>         | <b>1,682</b>   | <b>1,751</b>   | <b>4%</b>          | <b>1,829</b>   | <b>2,350</b>   | <b>28%</b>         | <b>767</b>     | <b>906</b>     | <b>18%</b>         |
| 6          | <b>NC 540 / Triangle Expressway</b> | <b>SB</b> | <b>1,332</b>   | <b>1,237</b>   | <b>-7%</b>         | <b>4,035</b>   | <b>4,879</b>   | <b>21%</b>         | <b>2,098</b>   | <b>2,223</b>   | <b>6%</b>          | <b>1,337</b>   | <b>1,042</b>   | <b>-22%</b>        |
| 6          | NC 55                               | NB        | 7,859          | 6,702          | -15%               | 5,266          | 5,767          | 10%                | 7,185          | 7,731          | 8%                 | 3,438          | 3,613          | 5%                 |
| 6          | NC 55                               | SB        | 3,829          | 3,318          | -13%               | 8,581          | 6,055          | -29%               | 7,290          | 6,617          | -9%                | 4,082          | 4,324          | 6%                 |
| 6          | Ten Ten Rd                          | NB        | 4,172          | 3,297          | -21%               | 3,416          | 2,442          | -29%               | 4,371          | 3,339          | -24%               | 1,576          | 1,434          | -9%                |
| 6          | Ten Ten Rd                          | SB        | 2,327          | 1,339          | -42%               | 4,555          | 3,272          | -28%               | 3,744          | 2,740          | -27%               | 1,846          | 1,527          | -17%               |
| 7          | Davis Dr.                           | NB        | 5,232          | 4,460          | -15%               | 4,059          | 3,913          | -4%                | 4,242          | 4,488          | 6%                 | 2,048          | 2,073          | 1%                 |
| 7          | Davis Dr.                           | SB        | 2,748          | 2,987          | 9%                 | 6,252          | 4,677          | -25%               | 4,312          | 4,600          | 7%                 | 1,670          | 2,104          | 26%                |
| 7          | Louis Stephenson Dr.                | NB        | 423            | 487            | 15%                | 619            | 161            | -74%               | 509            | 183            | -64%               | 164            | 44             | -73%               |
| 7          | Louis Stephenson Dr.                | SB        | 305            | 190            | -38%               | 685            | 493            | -28%               | 467            | 242            | -48%               | 195            | 58             | -70%               |
| 7          | NC 55                               | NB        | 5,375          | 4,813          | -10%               | 4,256          | 4,319          | 1%                 | 4,526          | 4,968          | 10%                | 2,112          | 2,148          | 2%                 |
| 7          | NC 55                               | SB        | 3,195          | 3,519          | 10%                | 5,800          | 5,154          | -11%               | 4,397          | 5,063          | 15%                | 1,705          | 2,303          | 35%                |
| 7          | <b>NC 540 / Triangle Expressway</b> | <b>NB</b> | <b>8,205</b>   | <b>8,267</b>   | <b>1%</b>          | <b>3,198</b>   | <b>3,626</b>   | <b>13%</b>         | <b>3,512</b>   | <b>4,282</b>   | <b>22%</b>         | <b>1,371</b>   | <b>1,532</b>   | <b>12%</b>         |
| 7          | <b>NC 540 / Triangle Expressway</b> | <b>SB</b> | <b>2,307</b>   | <b>2,650</b>   | <b>15%</b>         | <b>8,736</b>   | <b>8,396</b>   | <b>-4%</b>         | <b>3,575</b>   | <b>4,307</b>   | <b>20%</b>         | <b>2,390</b>   | <b>2,161</b>   | <b>-10%</b>        |
| 7          | Green Level Church Rd               | NB        | 981            | 1,113          | 13%                | 1,586          | 1,056          | -33%               | 1,138          | 1,010          | -11%               | 581            | 487            | -16%               |
| 7          | Green Level Church Rd               | SB        | 1,202          | 946            | -21%               | 1,718          | 1,338          | -22%               | 1,238          | 1,056          | -15%               | 429            | 497            | 16%                |
| 7          | White Oak Church Rd                 | NB        | 103            | 119            | 16%                | 152            | 168            | 10%                | 90             | 150            | 66%                | 30             | 69             | 130%               |
| 7          | White Oak Church Rd                 | SB        | 135            | 172            | 28%                | 114            | 162            | 42%                | 101            | 154            | 52%                | 18             | 74             | 310%               |
| 7          | Green Level Rd                      | EB        | 151            | 291            | 92%                | 213            | 402            | 89%                | 138            | 297            | 116%               | 55             | 89             | 61%                |
| 7          | Green Level Rd                      | WB        | 175            | 296            | 69%                | 239            | 450            | 88%                | 141            | 315            | 123%               | 43             | 70             | 63%                |
| 7          | NC 751                              | NB        | 1,495          | 1,650          | 10%                | 931            | 1,166          | 25%                | 906            | 1,151          | 27%                | 303            | 285            | -6%                |
| 7          | NC 751                              | SB        | 785            | 796            | 1%                 | 1,772          | 1,673          | -6%                | 1,050          | 1,196          | 14%                | 376            | 502            | 34%                |
| 8          | NC 55 (Apex Highway)                | NB        | 5,400          | 4,129          | -24%               | 2,775          | 2,969          | 7%                 | 3,124          | 3,098          | -1%                | 1,350          | 1,191          | -12%               |
| 8          | NC 55 (Apex Highway)                | SB        | 1,985          | 1,594          | -20%               | 4,890          | 4,069          | -17%               | 2,989          | 2,676          | -10%               | 1,555          | 1,381          | -11%               |
| 8          | Louis Stephens Dr.                  | NB        | 565            | 462            | -18%               | 1,324          | 129            | -90%               | 715            | 70             | -90%               | 173            | 33             | -81%               |
| 8          | Louis Stephens Dr.                  | SB        | 1,215          | 101            | -92%               | 562            | 279            | -50%               | 710            | 65             | -91%               | 125            | 41             | -67%               |
| 8          | Davis Dr.                           | NB        | 5,007          | 5,023          | 0%                 | 3,130          | 4,261          | 36%                | 3,055          | 3,587          | 17%                | 946            | 1,352          | 43%                |
| 8          | Davis Dr.                           | SB        | 2,773          | 3,393          | 22%                | 4,736          | 4,762          | 1%                 | 2,860          | 3,685          | 29%                | 1,026          | 1,878          | 83%                |
| 8          | <b>NC 147/Triangle Expressway</b>   | <b>NB</b> | <b>4,504</b>   | <b>6,380</b>   | <b>42%</b>         | <b>2,132</b>   | <b>2,501</b>   | <b>17%</b>         | <b>1,767</b>   | <b>2,503</b>   | <b>42%</b>         | <b>616</b>     | <b>1,038</b>   | <b>68%</b>         |
| 8          | <b>NC 147/Triangle Expressway</b>   | <b>SB</b> | <b>1,131</b>   | <b>1,904</b>   | <b>68%</b>         | <b>5,354</b>   | <b>6,593</b>   | <b>23%</b>         | <b>1,835</b>   | <b>2,499</b>   | <b>36%</b>         | <b>1,123</b>   | <b>1,336</b>   | <b>19%</b>         |
| 8          | NC 54                               | NB        | 3,938          | 2,292          | -42%               | 2,979          | 2,112          | -29%               | 3,900          | 2,540          | -35%               | 1,471          | 1,065          | -28%               |
| 8          | NC 54                               | SB        | 1,752          | 2,087          | 19%                | 4,393          | 2,830          | -36%               | 3,482          | 2,531          | -27%               | 1,121          | 1,002          | -11%               |
| 8          | Airport Blvd                        | NB        | 1,812          | 2,634          | 45%                | 3,508          | 4,034          | 15%                | 3,670          | 4,213          | 15%                | 1,535          | 1,635          | 7%                 |
| 8          | Airport Blvd                        | SB        | 5,456          | 4,942          | -9%                | 2,591          | 3,454          | 33%                | 4,068          | 4,683          | 15%                | 1,583          | 1,921          | 21%                |

## Appendix A (continued)

## Volume Calibration Results by Time Period and Direction on Screenlines

| Screenline | Roadname             | Dir. | AM             |                |                    | PM             |                |                    | MD             |                |                    | NT             |                |                    |
|------------|----------------------|------|----------------|----------------|--------------------|----------------|----------------|--------------------|----------------|----------------|--------------------|----------------|----------------|--------------------|
|            |                      |      | Observed Count | Modeled Volume | Percent Difference | Observed Count | Modeled Volume | Percent Difference | Observed Count | Modeled Volume | Percent Difference | Observed Count | Modeled Volume | Percent Difference |
| 9A         | I-40                 | EB   | 21,828         | 19,663         | -10%               | 27,273         | 25,529         | -6%                | 29,452         | 27,849         | -5%                | 14,881         | 15,863         | 7%                 |
| 9A         | I-40                 | WB   | 26,475         | 24,564         | -7%                | 22,909         | 22,222         | -3%                | 28,524         | 28,826         | 1%                 | 14,269         | 13,987         | -2%                |
| 9A         | NC 54                | EB   | 1,071          | 835            | -22%               | 2,110          | 744            | -65%               | 1,801          | 1,087          | -40%               | 583            | 264            | -55%               |
| 9A         | NC 54                | WB   | 1,579          | 646            | -59%               | 2,499          | 1,036          | -59%               | 1,971          | 972            | -51%               | 522            | 269            | -48%               |
| 9A         | Davis Dr.            | NB   | 4,719          | 3,294          | -30%               | 2,622          | 2,175          | -17%               | 2,594          | 1,922          | -26%               | 677            | 700            | 3%                 |
| 9A         | Davis Dr.            | SB   | 2,236          | 1,684          | -25%               | 4,316          | 2,917          | -32%               | 2,331          | 1,839          | -21%               | 997            | 1,307          | 31%                |
| 9A         | Hopson Rd            | EB   | 2,074          | 1,687          | -19%               | 1,273          | 969            | -24%               | 1,338          | 1,393          | 4%                 | 419            | 409            | -2%                |
| 9A         | Hopson Rd            | WB   | 1,159          | 594            | -49%               | 2,374          | 1,710          | -28%               | 1,388          | 1,146          | -17%               | 573            | 530            | -7%                |
| 9A         | NC 55                | NB   | 7,367          | 5,769          | -22%               | 4,093          | 3,449          | -16%               | 4,697          | 4,200          | -11%               | 1,864          | 1,817          | -3%                |
| 9A         | NC 55                | SB   | 3,004          | 1,909          | -36%               | 6,906          | 4,987          | -28%               | 4,259          | 2,831          | -34%               | 2,266          | 1,981          | -13%               |
| 9A         | Green Hope School Rd | EB   | 733            | 695            | -5%                | 1,041          | 674            | -35%               | 745            | 730            | -2%                | 312            | 262            | -16%               |
| 9A         | Green Hope School Rd | WB   | 640            | 535            | -16%               | 1,170          | 702            | -40%               | 739            | 696            | -6%                | 357            | 243            | -32%               |
| 9A         | Green Level West Rd  | EB   | 1,367          | 1,262          | -8%                | 2,150          | 1,797          | -16%               | 1,299          | 1,146          | -12%               | 397            | 321            | -19%               |
| 9A         | Green Level West Rd  | WB   | 1,429          | 1,617          | 13%                | 1,518          | 1,534          | 1%                 | 1,298          | 1,208          | -7%                | 480            | 380            | -21%               |
| 9A         | US 64                | EB   | 6,837          | 6,177          | -10%               | 7,282          | 5,881          | -19%               | 7,096          | 7,012          | -1%                | 2,184          | 2,283          | 5%                 |
| 9A         | US 64                | WB   | 5,315          | 4,502          | -15%               | 7,826          | 6,046          | -23%               | 7,164          | 6,417          | -10%               | 2,843          | 2,955          | 4%                 |
| 9A         | Old US Highway 1     | NB   | 992            | 803            | -19%               | 1,292          | 715            | -45%               | 1,150          | 654            | -43%               | 297            | 406            | 37%                |
| 9A         | Old US Highway 1     | SB   | 1,075          | 747            | -31%               | 1,138          | 1,007          | -11%               | 1,134          | 798            | -30%               | 367            | 582            | 59%                |
| 9A         | NC 55                | NB   | 4,950          | 4,336          | -12%               | 4,202          | 4,586          | 9%                 | 4,722          | 4,965          | 5%                 | 2,267          | 2,551          | 13%                |
| 9A         | NC 55                | SB   | 3,052          | 2,696          | -12%               | 4,891          | 4,032          | -18%               | 4,310          | 4,375          | 2%                 | 2,616          | 2,771          | 6%                 |
| 9B         | Green Level West Rd  | EB   | 976            | 813            | -17%               | 1,161          | 791            | -32%               | 962            | 756            | -21%               | 258            | 177            | -31%               |
| 9B         | Green Level West Rd  | WB   | 611            | 533            | -13%               | 1,211          | 992            | -18%               | 919            | 768            | -16%               | 386            | 392            | 1%                 |
| 9B         | US 64                | EB   | 3,947          | 3,344          | -15%               | 4,083          | 3,533          | -13%               | 3,825          | 3,338          | -13%               | 1,237          | 1,142          | -8%                |
| 9B         | US 64                | WB   | 3,584          | 2,961          | -17%               | 4,685          | 3,704          | -21%               | 4,157          | 3,316          | -20%               | 1,547          | 1,456          | -6%                |
| 9B         | Olive Chapel Rd      | EB   | 688            | 845            | 23%                | 821            | 767            | -7%                | 736            | 831            | 13%                | 208            | 381            | 83%                |
| 9B         | Olive Chapel Rd      | WB   | 598            | 470            | -21%               | 846            | 971            | 15%                | 763            | 874            | 15%                | 318            | 549            | 73%                |
| 9C         | Holly Springs Rd     | NB   | 4,096          | 3,258          | -20%               | 2,328          | 2,549          | 9%                 | 2,993          | 3,370          | 13%                | 964            | 992            | 3%                 |
| 9C         | Holly Springs Rd     | SB   | 1,539          | 1,721          | 12%                | 4,030          | 3,184          | -21%               | 3,352          | 3,479          | 4%                 | 1,475          | 1,881          | 28%                |
| 9C         | Bells Lake Rd        | NB   | 1,174          | 1,654          | 41%                | 575            | 936            | 63%                | 767            | 1,171          | 53%                | 257            | 344            | 34%                |
| 9C         | Bells Lake Rd        | SB   | 339            | 511            | 51%                | 1,418          | 1,770          | 25%                | 811            | 1,194          | 47%                | 468            | 642            | 37%                |
| 9C         | Johnson Pond Rd      | NB   | 188            | 982            | 423%               | 1,100          | 430            | -61%               | 439            | 537            | 22%                | 283            | 134            | -53%               |
| 9C         | Johnson Pond Rd      | SB   | 1,015          | 214            | -79%               | 335            | 1,099          | 228%               | 469            | 429            | -9%                | 175            | 191            | 9%                 |
| 9C         | Lake Wheeler Rd      | NB   | 1,592          | 1,839          | 16%                | 672            | 428            | -36%               | 890            | 575            | -35%               | 402            | 270            | -33%               |
| 9C         | Lake Wheeler Rd      | SB   | 601            | 270            | -55%               | 1,990          | 1,550          | -22%               | 1,012          | 658            | -35%               | 543            | 402            | -26%               |
| 9C         | US 401               | NB   | 5,560          | 6,000          | 8%                 | 4,019          | 4,239          | 5%                 | 6,104          | 5,915          | -3%                | 2,150          | 2,282          | 6%                 |
| 9C         | US 401               | SB   | 2,075          | 2,957          | 43%                | 2,731          | 5,633          | 106%               | 2,624          | 4,278          | 63%                | 768            | 1,483          | 93%                |
| 9C         | Fanny Brown Rd       | NB   | 926            | 1,724          | 86%                | 450            | 940            | 109%               | 611            | 1,137          | 86%                | 259            | 384            | 48%                |
| 9C         | Fanny Brown Rd       | SB   | 215            | 483            | 124%               | 1,036          | 1,577          | 52%                | 728            | 1,165          | 60%                | 518            | 662            | 28%                |
| 9C         | Old Stage Rd         | NB   | 727            | 1,172          | 61%                | 2,136          | 1,263          | -41%               | 1,283          | 1,214          | -5%                | 797            | 657            | -18%               |
| 9C         | Old Stage Rd         | SB   | 1,946          | 1,115          | -43%               | 1,068          | 1,425          | 33%                | 1,298          | 1,012          | -22%               | 554            | 596            | 8%                 |
| 9C         | Sauls Rd             | NB   | 997            | 441            | -56%               | 492            | 408            | -17%               | 579            | 482            | -17%               | 214            | 170            | -20%               |
| 9C         | Sauls Rd             | SB   | 305            | 286            | -6%                | 890            | 488            | -45%               | 608            | 455            | -25%               | 377            | 229            | -39%               |
| 9C         | Jordan Rd            | NB   | 453            | 491            | 8%                 | 211            | 356            | 68%                | 246            | 423            | 72%                | 102            | 141            | 38%                |
| 9C         | Jordan Rd            | SB   | 125            | 187            | 50%                | 449            | 590            | 31%                | 275            | 396            | 44%                | 182            | 205            | 13%                |
| 9C         | NC 50                | NB   | 2,792          | 2,410          | -14%               | 1,956          | 2,095          | 7%                 | 2,211          | 2,448          | 11%                | 971            | 904            | -7%                |
| 9C         | NC 50                | SB   | 1,154          | 1,309          | 13%                | 3,326          | 2,518          | -24%               | 2,479          | 2,289          | -8%                | 1,286          | 1,213          | -6%                |
| 9D         | White Oak Rd         | NB   | 3,267          | 2,288          | -30%               | 966            | 1,160          | 20%                | 1,206          | 1,434          | 19%                | 527            | 411            | -22%               |
| 9D         | White Oak Rd         | SB   | 444            | 585            | 32%                | 2,478          | 2,352          | -5%                | 1,380          | 1,164          | -16%               | 798            | 664            | -17%               |
| 9D         | Rock Quarry Road     | EB   | 377            | 743            | 97%                | 1,217          | 1,732          | 42%                | 650            | 1,205          | 85%                | 368            | 582            | 58%                |
| 9D         | Rock Quarry Road     | WB   | 1,050          | 1,525          | 45%                | 594            | 1,094          | 84%                | 623            | 1,199          | 92%                | 306            | 388            | 27%                |
| 9D         | Pooler Rd (NC 2555)  | EB   | 692            | 574            | -17%               | 2,272          | 2,389          | 5%                 | 1,199          | 1,178          | -2%                | 779            | 750            | -4%                |
| 9D         | Pooler Rd (NC 2555)  | WB   | 2,383          | 2,415          | 1%                 | 950            | 1,103          | 16%                | 1,113          | 1,247          | 12%                | 551            | 513            | -7%                |
| 9E         | I-40                 | EB   | 12,366         | 13,777         | 11%                | 16,295         | 18,220         | 12%                | 16,900         | 17,997         | 6%                 | 9,374          | 9,476          | 1%                 |
| 9E         | I-40                 | WB   | 15,548         | 18,022         | 16%                | 12,699         | 14,365         | 13%                | 15,875         | 16,986         | 7%                 | 8,079          | 8,444          | 5%                 |
| 9F         | NC 55                | NB   | 8,832          | 8,724          | -1%                | 4,508          | 4,922          | 9%                 | 6,355          | 6,615          | 4%                 | 2,740          | 3,093          | 13%                |
| 9F         | NC 55                | SB   | 3,588          | 2,979          | -17%               | 8,622          | 7,496          | -13%               | 6,792          | 5,897          | -13%               | 3,522          | 3,450          | -2%                |
| 9F         | Main St              | NB   | 2,412          | 2,269          | -6%                | 1,981          | 1,928          | -3%                | 2,086          | 2,458          | 18%                | 1,022          | 960            | -6%                |
| 9F         | Main St              | SB   | 1,194          | 1,291          | 8%                 | 3,241          | 2,177          | -33%               | 1,999          | 2,085          | 4%                 | 1,152          | 1,174          | 2%                 |
| 9F         | US 1                 | NB   | 12,954         | 13,138         | 1%                 | 10,547         | 10,656         | 1%                 | 11,815         | 12,316         | 4%                 | 4,754          | 4,922          | 4%                 |
| 9F         | US 1                 | SB   | 7,631          | 7,259          | -5%                | 12,719         | 12,217         | -4%                | 11,314         | 11,033         | -2%                | 7,446          | 7,220          | -3%                |
| 9F         | US 64                | NB   | 6,844          | 5,632          | -18%               | 7,849          | 7,138          | -9%                | 9,217          | 8,615          | -7%                | 3,478          | 3,748          | 8%                 |
| 9F         | US 64                | SB   | 6,957          | 7,008          | 1%                 | 7,593          | 6,579          | -13%               | 9,264          | 8,811          | -5%                | 3,081          | 3,245          | 5%                 |
| 9F         | NC 55                | NB   | 4,693          | 3,747          | -20%               | 4,640          | 3,857          | -17%               | 5,224          | 4,772          | -9%                | 2,261          | 2,319          | 3%                 |
| 9F         | NC 55                | SB   | 3,289          | 3,374          | 3%                 | 5,109          | 4,238          | -17%               | 5,212          | 4,713          | -10%               | 1,928          | 1,884          | -2%                |
| 9F         | Davis Dr.            | NB   | 2,184          | 2,420          | 11%                | 2,041          | 2,380          | 17%                | 1,964          | 3,009          | 53%                | 892            | 1,333          | 49%                |
| 9F         | Davis Dr.            | SB   | 1,567          | 2,034          | 30%                | 2,856          | 2,641          | -8%                | 2,250          | 3,025          | 34%                | 875            | 1,440          | 65%                |
| 9F         | Davis Dr.            | NB   | 5,943          | 4,729          | -20%               | 2,306          | 2,454          | 6%                 | 3,270          | 3,096          | -5%                | 1,268          | 1,277          | 1%                 |
| 9F         | Davis Dr.            | SB   | 1,710          | 2,084          | 22%                | 6,330          | 4,462          | -30%               | 3,600          | 3,454          | -4%                | 1,296          | 1,671          | 29%                |
| 9F         | Church St            | NB   | 805            | 672            | -17%               | 1,372          | 1,167          | -15%               | 1,012          | 1,023          | 1%                 | 748            | 640            | -14%               |
| 9F         | Church St            | SB   | 1,170          | 1,113          | -5%                | 1,942          | 929            | -52%               | 1,104          | 997            | -10%               | 451            | 488            | 8%                 |
| 9F         | NC 54                | NB   | 2,654          | 2,811          | 6%                 | 2,342          | 2,763          | 18%                | 3,242          | 3,558          | 10%                | 1,306          | 1,825          | 40%                |
| 9F         | NC 54                | SB   | 1,685          | 2,233          | 33%                | 2,239          | 2,740          | 22%                | 2,824          | 3,486          | 23%                | 1,381          | 1,969          | 43%                |
| 1          | Total                |      | 8,310          | 8,696          | 5%                 | 10,056         | 10,115         | 1%                 | 7,648          | 9,254          | 21%                | 4,933          | 4,967          | 1%                 |
| 2          | Total                |      | 42,761         | 44,769         | 5%                 | 53,379         | 52,925         | -1%                | 55,148         | 57,392         | 4%                 | 32,753         | 32,409         | -1%                |
| 3          | Total                |      | 12,723         | 12,176         | -4%                | 16,340         | 15,008         | -8%                | 14,728         | 14,616         | -1%                | 6,578          | 6,712          | 2%                 |
| 4          | Total                |      | 16,403         | 16,547         | 1%                 | 18,612         | 17,882         | -4%                | 17,977         | 16,905         | -6%                | 7,975          | 7,862          | -1%                |
| 5          | Total                |      | 12,824         | 13,623         | 6%                 | 15,607         | 15,551         | 0%                 | 14,056         | 14,732         | 5%                 | 5,600          | 6,086          | 9%                 |
| 6          | Total                |      | 28,627         | 26,775         | -6%                | 32,301         | 29,977         | -7%                | 29,097         | 28,468         | -2%                | 14,028         | 14,039         | 0%                 |
| 7          | Total                |      | 32,817         | 32,755         | 0%                 | 40,330         | 37,153         | -8%                | 30,342         | 33,461         | 10%                | 13,490         | 14,495         | 7%                 |
| 8          | Total                |      | 35,538         | 34,940         | -2%                | 38,374         | 37,993         | -1%                | 32,175         | 32,150         | 0%                 | 12,624         | 13,874         | 10%                |
| 9          | Total                |      | 248,364        | 235,448        | -5%                | 278,612        | 260,104        | -7%                | 276,643        | 273,945        | -1%                | 126,253        | 131,643        | 4%                 |

Source: Counts conducted by CDM Smith in 2016 and 2017 and travel demand model output.