


TRIANGLE REGIONAL FREIGHT PLAN

Final Report

Prepared for:

Durham-Chapel Hill-Carrboro MPO
Capital Area MPO
North Carolina Department of Transportation

CAMPO NC Capital Area Metropolitan Planning Organization

DCHC Metropolitan Planning Organization Planning Tomorrow Today

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Acknowledgements

The freight plan recommendations reported herein is the culmination of freight modeling, technical analysis, and stakeholder engagement that were carried out under the Triangle Regional Freight Plan study. The study was a collaborative effort to develop the region's first freight plan, and it was jointly funded by the Durham-Chapel Hill-Carrboro (DCHC) Metropolitan Planning Organization (MPO), the Capital Area MPO (CAMPO), and the North Carolina Department of Transportation (NCDOT). The study was performed by WSP, Baseline Mobility Group, Cambridge Systematics, Dr. George List, Westat, and Tompkins International. Joe Bryan of WSP Freight & Logistics Advisory Services U.S., served as the Project Manager, and Mushtaq Rahman of Baseline Mobility Group, served as the Deputy Project Manager for the consultant team. On the client side, the project was guided by Felix Nwoko and Andy Henry from the DCHC MPO, Chris Lukasina, Kenneth Withrow, and Paul Black from CAMPO, and Julie Bollinger from the NCDOT.

The study team wishes to acknowledge the many contributions and valuable inputs received throughout long study process from each of the consultant team members, Steering Committee members, the Regional Freight Stakeholders Advisory Council (RFSAC), and the DCHC MPO Executive Board. This was truly a collaborative effort of many individuals and stakeholders that enabled us to understand what moves freight, what effects it has on our region, and what strategies will change the freight future.

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List of Acronyms and Abbreviations

3PL - Third Party Logistics
AADTT - Average Annual Daily Truck Traffic
ACP - Atlantic Coast Pipeline
ACWR - Aberdeen Carolina and Western Railway
AHTD - Annual Hours of Truck Delay
ATRI - American Transportation Research Institute
ATW - Atlantic and Western Railway
BTI - Buffer Time Index
BTS - Bureau of Transportation Statistics
CAFE - Corporate Average Fuel Economy
CAMPO - Capital Area MPO
CAV - Connected and Automated/Autonomous Vehicles
CBD - Central Business District
CLNA - Carolina Coastal Railway
CNG - Compressed Natural Gas
COG - Council of Governments
CPI - Consumer Price Index
CSA - Combined Statistical Area
CSCMP - Council of Supply Chain Management Professionals
DC - Distribution Center
DCHC - Durham-Chapel Hill-Carrboro
EDPNC - Economic Development Partnership of North Carolina
EIS - Environmental Impact Statement
EISA - Energy Independence and Security Act
EJ - Environmental Justice
ELB - Electronic Log Book
ELD - Electronic Logging Device
FAA - Federal Aviation Administration
FAF - Freight Analysis Framework
FAST Act - Fixing America's Surface Transportation Act
FASTLANE - Fostering Advancements in Shipping and Transportation for the Long-term Achievement of National Efficiencies
FERC - Federal Energy Regulatory Commission
FHWA - Federal Highway Administration
FOD - Freight-Oriented Development
FRA - Federal Railroad Administration
FTZ - Foreign Trade Zone
GDP - Gross Domestic Product
GHG - Greenhouse Gas
GIS - Geographic Information Systems
HD - Heavy-Duty
HVL - Highly Volatile Liquid
ILC - Intermodal Logistics Center
IRI - International Roughness Index
ITS - Intelligent Transportation Systems
LNG - Liquefied Natural Gas
LOGTECH - Logistics and Technology Center
LPG - Liquefied Petroleum Gas
LTL - Less than Load

MAP-21 - Moving Ahead for Progress in the 21st Century Act
MD - Medium-Duty
MPO - Metropolitan Planning Organization
MSA - Metropolitan Statistical Area
MTP - Metropolitan Transportation Plan
MY - Model Year
NAICS - North American Industry Classification System
NCCU - North Carolina Central University
NCDOT - North Carolina Department of Transportation
NCRR - North Carolina Railroad Company
NCSTM - NCDOT Statewide Transportation Model
NHS - National Highway System
NHTSA - National Highway Traffic and Safety Administration
NOX - Nitrogen Oxides
NPMRDS - National Performance Management Research Data Set
NS - Norfolk Southern
NSFHP - Nationally Significant Freight and Highway Projects
NTAD - National Transportation Atlas Database
PCI - Pavement Condition Index
PM - Fine Particulate Matter
PSNC - Public Service Company of North Carolina (known as PSNC Energy)
R&D - Research and Development
RDU - Raleigh-Durham International Airport
RFSAC - Regional Freight Stakeholders Advisory Council
RTK - Revenue Ton-Kilometers
RTP - Research Triangle Park
SCTG - Standard Classification of Transported Goods
SF - Square Feet
SFC - Strategic Freight Corridors
SR - State Route
STB - Surface Transportation Board
STI - Strategic Transportation Investments
STIP - Statewide Transportation Improvement Program
TAZ - Traffic Analysis Zone
TCV - Triangle CommunityViz Model
TEU - Twenty-foot Equivalent Unit
TFFM - Truck Flow Forecasting Model
TIP - Transportation Improvement Program
TJCOG - Triangle J Council of Governments
TSA - Transportation Security Administration
TTI - Travel Time Index
UA - Urbanized Area
UC - Urbanized Cluster
ULI - Urban Land Institute
UNC - University of North Carolina
V/C - Volume-to-Capacity
VHT - Vehicle Hours Traveled
VMT - Vehicle Miles Traveled
VSRR - Virginia Southern Railroad

1 INTRODUCTION

This is the first comprehensive multimodal freight plan prepared for the Triangle Region of North Carolina. The region covers an eight-county area centered on the cities of Raleigh and Durham. It boasts renowned universities, cutting edge technology companies located particularly in the Research Triangle Park (RTP), and the region's population growth rates have been among the fastest in the country. Projections contained in these pages show that growth will continue, and the associated pressures will need to be managed. This Triangle Regional Freight Plan is a joint effort of the Capital Area and the Durham-Chapel Hill-Carrboro Metropolitan Planning Organizations (CAMPO and DCHC MPO), in association with the North Carolina Department of Transportation (NCDOT). Its purpose is to contend with these pressures, support the benefits the freight sector brings to the economy and families of the region, and preserve the character of the region that is so much of its appeal as a place to live and work.

Those benefits are substantial. Industries dependent on freight transportation make a $21 billion contribution to the region's economy, accounting for one-third of its Gross Regional Product. This includes businesses engaged in the construction trade, agricultural producers, high technology companies, and the retailers supplying the household goods that put shirts on resident's backs, smartphones in their hands, and food on their tables. The Triangle Region handled 82 million tons of freight worth $109 billion in 2012. The next three decades are forecasted to see freight tonnage increase by one-third, yet the value of that freight will more than double. This difference points to the importance of valuable goods manufactured in the region's technology sector, and to the growth in consumer products coming to the region from the world. Both sets of goods are time sensitive, with fast, reliable delivery a fundamental requirement and service standards climbing. The availability of same-day delivery for some products ordered on-line is an obvious example of the trend, yet the reliability of service is subject to overcoming the delays and higher costs associated with traffic congestion, and to the ability to locate logistics facilities where they are needed.

The objective of the Triangle Regional Freight Plan is to guide policy and investment to address the needs of industry and people, within overarching regional goals for safety, equity, livability, sustainability, and economic productivity. After a review of the outreach efforts that supported plan development, this document begins with an inventory and assessment of freight activities and traffic, including roadway performance and discussion of the rail, marine and air modes. It continues with freight goals, objectives and performance measures, and then follows with an extensive treatment of trends, conditions, forecasts and capacity issues. Corridors and development zones come next, with presentation of the Strategic Freight Corridor (SFC) roadway network, modal expansion plans, and land use opportunities. The document concludes with recommendations and implementation, setting forth a $7.2 billion plan of investment over the next two decades, freight policies and programs, and strategy and packages that combine these elements into plans of action.

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2 STAKEHOLDER OUTREACH

The Triangle Regional Freight Plan was developed over a two-year period using a multi-prong stakeholder engagement approach. This multi-prong outreach approach is summarized in this Chapter. One key aspect of this approach was launching a Regional Freight Stakeholder Advisory Council (RFSAC) that consisted of private sector executives from a broad range of industries that are active in the local, regional and national freight economy. In addition, the study process organized a series of technical and brainstorming workshops with public sector officials, economic development officials, and the project's multi-agency steering committee. The study also conducted an online survey, several phone and on-site interviews of freight industry representatives, a couple of site visits at local freight distribution terminals, discussion with vehicle fleet supervisors on truck route recurrent bottlenecks, a supply chain industry outlook survey, and a presentation at the joint MPO Board meeting. These outreach activities are further documented in the following sections.

Regional Freight Stakeholder Advisory Council (RFSAC)

The study compiled a broad-based list of potential RFSAC members and sent out a formal invitation letter signed by the two MPO Executive Directors (Felix Nwoko and Chris Lukasina). The letter requested formal acceptance of the appointment as a charter member of the RFSAC. The purpose of the RFSAC was defined as follows in the invitation letter:

> To bring into our planning the specialized judgment of industry professionals like yourself, both now as we develop findings and recommendations, and later as we take action on policies and investments. We are seeking a cross-section of enterprises in the region and will ask you to wear two hats: first as a member of your industry, and second as a resident of the community with family and households needs, because we'll want both perspectives to shape a future in

The roles and responsibilities of the RFSAC were defined to include the following:

- Advise on freight-related priorities, issues, projects, and funding needs
- Act as forum for discussion of transportation decisions affecting freight mobility
- Communicate and coordinate regional priorities with other organizations
- Promote sharing of information between sectors
- Participate in freight plan development

The RFSAC membership evolved during the course of the study as some members dropped out and some new members were added. Overall, the membership consisted of representatives from technology, pharmaceutical and manufacturing companies, railroads, state economic development partnership, third party logistics providers (3PLs), local real estate developers, utility companies, supply chain managers, trucking companies, and package delivery operators. This industry representation of the RFSAC includes the following:

Advance Auto Parts	Duke Energy	Norfolk Southern
Avison Young	Econ Dev Partnership of NC	Old Dominion
Bayer Crop Science	Epes Carriers	Pepsi
Capitol Broadcasting	FedEx	Professional Builders Supply
Carolina Coastal Railway	GlaxoSmithKline	Puryear Tank Lines
CBRE	Kane Realty	Red Hat
CEVA Logistics	Kuehne & Nagel	Siemens
Cisco	Lenovo	The Body Shop
Cree, Inc.	Martin Marietta Materials	US Foods
CSX	NC Farm Bureau	Variety Wholesalers
DTZ	NCSU	XPO Logistics

Two technical workshops were organized with the RFSAC at critical milestones of the study to discuss freight plan goals, objectives, performance measures, and priority freight projects and policies. The first RFSAC workshop was held June 9, 2016 and the second workshop was held on September 22, 2016, both at the TJCOG office in the RTP. The first RFSAC workshop was a joint meeting with the project steering committee and the second workshop was a separate meeting with the RFSAC members to allow more in-depth discussion about issues and opportunities to improve freight mobility and safety in the region. The meeting agendas with the RFSAC are summarized below.

June 9, 2016 RFSAC Agenda	Sep 22, 2016 RFSAC Agenda
• **Introductions** • **The Plan and the RFSAC** • **Vision, Goals & Objectives** • **Logistics Trends** • **Forecasts for Industrial Growth** • **New Funding: FAST Act** • **Performance Challenges** • **Discussion & Next Steps**	• Introductions • Plan Development Status • Freight Future Conditions Assessment • Draft Strategic Freight Corridors • Discussion: Triangle Corridors • Potential Development Zones • Discussion: Mobility & Development Strategies • Next Steps

Steering Committee Meetings

The freight planning study was guided by a multi-agency steering committee throughout the study. This steering committee was formed at the beginning of the study with a project kick-off meeting on July 27, 2015 at the RDU Center. The steering committee was responsible for providing critical data for the study, reviewing technical analysis results, and making decisions regarding project priorities. The agency and industry representation of the project steering committee is listed below.

CAMPO	NCDOT-Traffic / ITS

DCHC MPO	NCDOT-Transportation Planning
Federal Highway Administration (FHWA)	NCDOT-Strategic Planning
Longistics	North Carolina Railroad (NCRR)
NCDOT-Division 4	North Carolina Trucking Association (NCTA)
NCDOT-Division 5	Raleigh-Durham Airport Authority (RDUAA)
NCDOT-Division 7	Regional Transportation Alliance (RTA)
NCDOT-Rail Division	Triangle J COG (TJCOG)

In addition to members from these agencies, the steering committee meetings had other participants from City of Durham's Public Works and Transportation departments, GoTriangle, Kerr-Tar COG, NCDOT-Division 8, NCDOT's SPOT office, Orange County, and Town of Carrboro.

Overall, the study was managed by a core planning staff from the project steering committee who were responsible for decision making, stakeholder coordination, workshop agenda items, and communication with their respective MPO Boards. This core project steering committee members were Kenneth Withrow, Paul Black and Chris Lukasina from CAMPO; Felix Nwoko and Andy Henry from DCHC MPO; John Hodges-Copple of TJCOG, and Julie Bollinger of NCDOT.

The freight planning study team conducted four meetings with the project steering committee after the project kick-off meeting at key milestones during the study. These steering committee meetings were held on December 17, 2015 at the RDU Center, and on April 14, 2016, June 9, 2016, and September 22, 2016 at the TJCOG office in the RTP. The meeting agendas for these meetings included technical presentation on a variety of topics as well as group discussion on plan goals and objectives, performance measures, Strategic Freight Corridors (SFC), and potential development opportunity zones. These meeting agendas are summarized below.

Dec 17, 2015 SC Agenda	**April 14, 2016 SC Agenda**
• **Introductions** • **FAST Act Highlights** • **Freight Profiles & FAF4 Data Analysis** • **Existing Conditions & Performance Measures** • **Private & Public Sector Outreach** • **Vision, Goals & Objectives** • **Group Discussion** • **Next Steps**	• Introductions • Updates: RFSAC, Outreach, Rail, FAST Act • FAF4.1 Forecasts of Industrial Growth • Truck Flow Forecasting Model • Freight Clusters & Performance • Vision, Goals & Objectives • Group Discussion • Next Steps
June 9, 2016 SC Agenda	**Sep 22, 2016 SC Agenda**
• **Introductions** • **The Plan and the RFSAC** • **Vision, Goals & Objectives** • **Logistics Trends** • **Forecasts for Industrial Growth** • **New Funding: FAST Act** • **Performance Challenges** • **Discussion & Next Steps**	• Introductions • Plan Development Status • Freight Future Conditions Assessment • Draft Strategic Freight Corridors • Discussion: Triangle Corridors & FAST Act Urban Corridors • Potential Development Zones • Discussion: Mobility & Development Strategies • Next Steps

Public Sector/Economic Development Officials Workshop

The freight planning study involved conducting a workshop on October 9, 2015 with public sector executive officials who are responsible for community planning and economic development in their respective organizations. The following agencies were invited for this special workshop to increase awareness about the freight plan and also to solicit specific inputs for development of the freight plan elements.

Title	Agency
Planning Director	City of Durham
Planning Director	City of Raleigh
Regional Manager	Federal Rail Administration
Project Manager	Federal Rail Administration
Executive Director	NC Center for Global Logistics
Assistant Director, Foreign Direct Investment	NC Department of Agriculture
Assistant Commissioner, Agricultural Services	NC Department of Agriculture
Executive Director, Office of Science, Technology & Innovation	NC Department of Commerce
Chief Economic Development Liaison	NC Department of Commerce
GTP Executive Director/Director of Logistics	NC Department of Transportation
GTP Airport Director	NC Department of Transportation - Aviation Division
Director	NC Department of Transportation - Rail Division
Director of Global Commerce	NC Economic Development Partnership
Legislative Liaison	NC General Assembly
Director, Port Planning & Development	NC Ports
Director, Community Economic Development	NC Ports
VP Engineering	North Carolina Railroad Company
VP Economic Development	North Carolina Railroad Company
Executive Vice President	Research Triangle Regional Partnership
Executive Director, Cleantech Cluster	Research Triangle Regional Partnership
CEO	RTP Foundation
Executive VP	RTP Foundation
Planning Director	Town of Carrboro
Planning & Sustainability Executive Director	Town of Chapel Hill
Executive Director, Kenan Institute	UNC Chapel Hill
Executive Director, Logistics and Technology Center (LOGTECH)	UNC Chapel Hill

The meeting agenda utilized for this workshop is summarized below.

Oct 9, 2015 Public Sector Officials Workshop Agenda

- **Introductions**
- **Regional Plan Overview**
- **Significance & Requirements**
- **Performance & Technology**
- **Questions for Discussion**
    - **Organizational & Operational**
        1. **What are the freight-related projects or initiatives that your organization is currently responsible for?**
        2. **Do you coordinate with others for any of these projects or initiatives? Please describe your freight partner agencies or groups and your means and frequency of coordination and communication with them.**
        3. **How do you establish needs for freight transportation in your organization? Is there interaction with private stakeholders, and how is that done?**
        4. **What changes are needed in your organization and more broadly in the public and private sectors to improve freight mobility, productivity or safety in the Triangle region?**
    - **Data & Forecasts**
        1. **Do you collect or analyze freight activity related data? Please describe the type of data, geographic coverage area, and data sources.**
        2. **Do you develop projections for your freight related demand activities?**
    - **Funding & Priority**
        1. **How do you define implementation or funding priorities for freight transportation projects or programs in your organization? Do they tend to move forward, or lag behind?**
        2. **What are the key freight related issues you foresee in the near-term (1-5 years) and in the long-term (5-10 years) either from your organization's perspective or industry perspective?**
    - **Opportunities**
        1. **Are you aware of either any brownfield or greenfield sites for potential future industrial uses or logistics and freight hub operations? Are there serious obstacles to this kind of development taking place? Are any of these sites suited for Public-Private partnership ventures?**
        2. **In your opinion, are there any highway corridors in the Triangle region that can benefit from separated and managed truck lanes? Looking ahead, which corridors or arteries might be best suited for development of connected vehicle freight operations? (This refers to interaction of the truck with the infrastructure, and not to driverless vehicles or truck platoons)**
        3. **In your opinion, what steps should be taken to improve freight mobility, productivity and safety and enhance economic competitiveness of the Research Triangle region?**
        4. **[For economic development organizations:] In your opinion, what type of**

industries can and should be located in the region generally, and specifically in the Research Triangle region?

5. **[For economic development organizations:] In your experience, what are the critical advantages that make the Triangle Region competitive for attracting and keeping industry? Are any of these advantages seriously threatened, or should any of them be enhanced? Are we missing anything that we could realistically seek to add?**

Online Survey

A Shipper/Receiver survey was launched in 2016 through website to solicit inputs on operational footprint of manufacturing, warehouse, utility and retail operators in the Triangle region. The survey included a total of 32 questions probing information on freight flows, types of ground transportation services, accessibility to highways, rail usage, marine freight, air freight, and general transportation system issues such as bottlenecks, backhaul issues, and performance measures.

Stakeholder Interviews, CSCMP Forum and Site Visit

The freight study outreach activities included several interviews with stakeholders throughout the study. These interviews were targeted for those who were unable to join other events in the study due to schedule or other conflicts. Some of the interviews involved follow up conversation based on email and other meeting inputs. In addition, the study team participated in the Raleigh Roundtable forum on March 30, 2016 that was organized by the Council of Supply Chain Management Professionals (CSCMP). A presentation was made at the meeting to share findings from the freight study including Logistics Trends, Forecasts for Industrial Growth, New Funding: FAST Act, and Performance Challenges.

The study team also made visits to Triangle area freight-intensive facilities at Cree's manufacturing facility in Durham and Old Dominion Freight Line's truck terminal in Morrisville.

Joint MPO Executive Board Presentation

The freight planning study team made a technical and policy overview presentation at the joint MPO Executive Board meeting on November 30, 2017 at the Friday Center in Chapel Hill. The presentation provided a high-level brief overview of the freight planning process, purpose, and priorities and provided a general update on the project's next steps for the elected officials attending the meeting.

Strategic Freight Corridors (SFC) Prioritization Workshops

The freight study team conducted two separate workshops on July 21, 2017, one at the CAMPO office in downtown Raleigh and one at the DCHC MPO office in downtown Durham, to discuss roadway project recommendations and prioritization process for the SFC network, and draft policy recommendations related to ITS, Signage, Truck Parking, Development Programs, Rail freight program, Marine freight program, and Air freight program. These two meetings utilized several large size maps to review the underlying mobility, reliability, safety, and freight industry data and forecasts, and for markups on project ideas, prioritization of corridor segments, and determining emphasis areas. These workshops were participated by smaller work groups from the project steering committee who have familiarity with the NCDOT's Statewide Transportation Improvement Program (STIP) and the MPO's MTP projects.

Tompkins Supply Chain Consortium and 2017 Business Outlook Survey

Tompkins International is a global supply chain consulting company based in Raleigh. The company manages a Supply Chain Consortium of 400 major manufacturers and retailers. Consortium members share information among themselves for benchmarking purposes, covering a wide range of key logistics performance indicators. Extracts from benchmarking data were made available to this study for the evaluation of logistics trends.

In addition, Tompkins conducted a national on-line business outlook survey of logistics managers, probing current industry developments to aid the study team in the formulation of strategy. Tompkins approached its Consortium firms and several thousand other pre-qualified companies in February, 2017. Completed surveys were obtained from 54 respondents; 50 percent were from retail companies, 45 percent from manufacturers and 5 percent from wholesalers. Approximately 85 percent of respondents were involved in e-commerce in some way. Survey results are cited in Chapter 9 of this plan.

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3

DATA COLLECTION, INVENTORY, ASSESSMENT

The purpose of this chapter is to examine the freight data available to the Triangle Region to inform a regional goods movement plan. Of particular interest are data that describe the flow of commodities throughout the region, identify clusters of freight-intensive economic activities, and characterize truck performance on the Triangle Region's highways. A thorough examination of these types of information will yield a clearer picture of existing conditions in the region. Having established a strong baseline, it will then be possible to develop informed freight transportation goals and objectives for the Triangle Region along with the performance measures necessary for measuring progress.

To this end, the analysis utilizes data from a number of sources including the NCDOT, the Freight Analysis Framework (FAF – Versions 3, 4, 4.1, and 4.2), the National Performance Management Research Data Set (NPMRDS), and information from the Capital Area and DCHC MPOs. In respect to freight traffic, this chapter presents an initial overview of volume, commodities, modes and geographic patterns that is enlarged upon in Chapter 5. Included in the following pages are the following analyses: Section 1 describes the freight flows for the Triangle Region, with statistics on commodity flow, mode split, truck volumes, and trading partners. Section 2 identifies key freight clusters in the region, evaluating the size and location of different types of freight clusters. The section also presents information about employment in freight-intensive sectors to further develop a complete list of the areas of freight-intensive economic activity in the region. Next, Section 3 evaluates the highway freight performance throughout the Triangle Region, and Section 4 focuses on non-highway freight modes. The last section features a set of conclusions about the existing conditions of freight flow and economic development in the region. Appendix A contains a bibliography of MPO freight planning practices from around the nation as background for this study, and a review of freight data resources utilized in these plans and drawn upon for the Triangle Region.

Freight Flows for the Triangle Region

The FAF4 data from the Bureau of Transportation Statistics (BTS) and Federal Highway Administration (FHWA), provides insight into the freight movements throughout the Triangle Region. For this analysis, the 10 Triangle Region counties are included in the region's summary, including Chatham, Durham, Franklin, Granville, Harnett, Johnston, Nash, Orange, Person, and Wake. Table 1 and Figure 1 present the commodity flow by direction for each freight transportation mode. Trucks are the dominant transportation mode by tonnage, carrying over 67.1 million tons in 2012, 81 percent of all freight. Rail is the second-highest mode for transporting freight, and comprised 16 percent of overall tonnage in 2012. Water and air transport each comprise less than 1 percent of total freight flow. Additionally, the majority of freight flow was internal, meaning that the origin and destination is within the Triangle Region. Thirty-seven percent of all freight flows (excluding through) were internal in 2012. There is an imbalance between inbound and outbound flows for the remaining tonnage – 36 percent arrived inbound and 27 percent traveled outbound – suggesting that the Triangle Region is a net importer of goods.

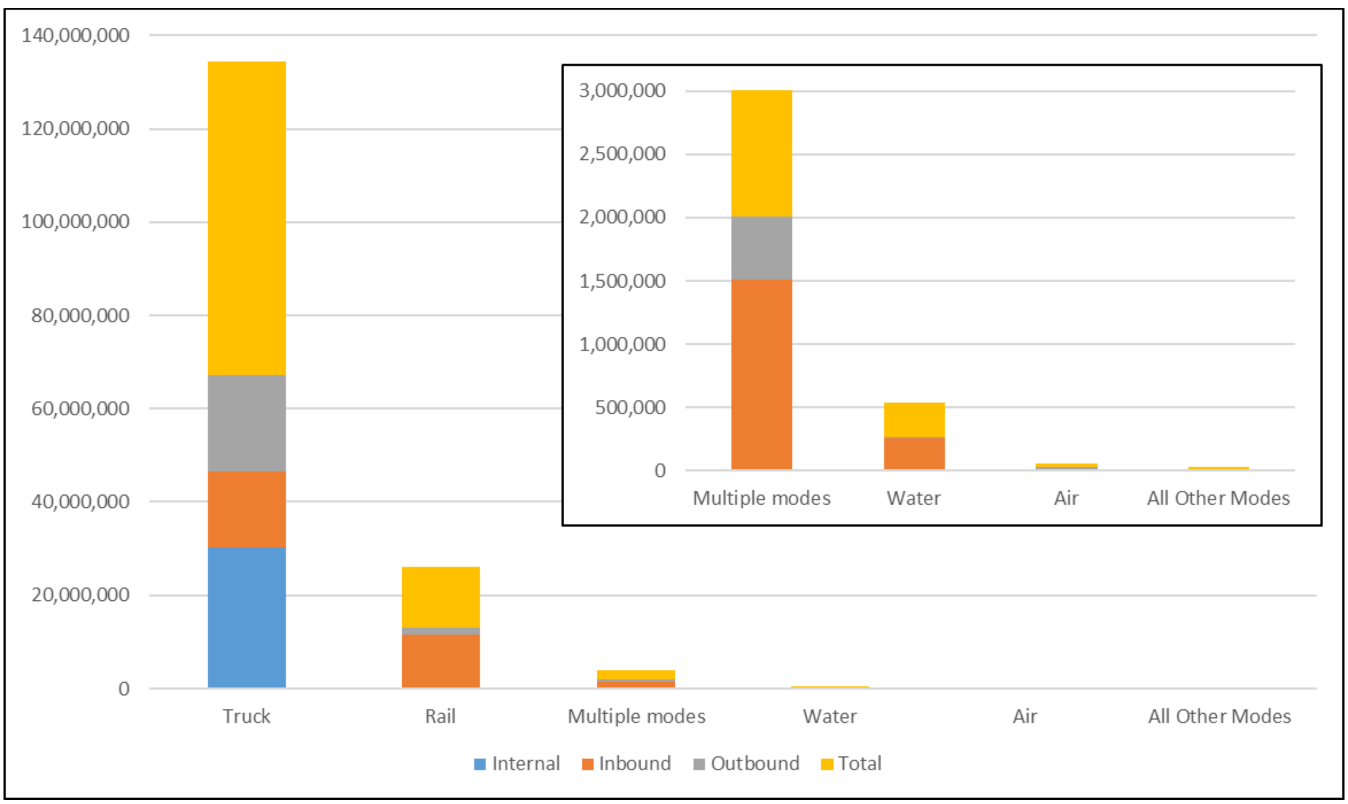
Several key commodities comprise the majority of tonnage in the Triangle Region, as shown in Table 2 and Figure 2. Gravel is the top commodity in the region, comprising 21 percent of total tonnage, followed by non-metallic mineral products (13 percent) and coal (12 percent). Together, these three commodities account for nearly 50 percent of all tonnage shipped to, from, and within the Triangle Region. Gravel and non-metallic mineral products are shipped primarily by truck, while the vast majority of coal is shipped by rail. The top 10 commodities comprise 74 percent of total tonnage.

Table 1: 2012 Commodity Flow Tonnage by Direction

Direction	Truck	Rail	Multiple modes	Water	Air	All Other Modes	Total	Percent of Total
Internal	30,309,000	27,000	12,000				30,348,000	37%
Inbound	16,283,000	11,639,000	1,497,000	257,000	13,000		29,689,000	36%
Outbound	20,589,000	1,320,000	499,000	11,000	13,000	13,000	22,444,000	27%
Total	**67,181,000**	**12,985,000**	**2,008,000**	**268,000**	**26,000**	**13,000**	**82,481,000**	**100%**
Percent of Total	81%	16%	2%	<1%	<1%	<1%	100%	

Source: FAF4
Note: Multiple modes includes freight rail intermodal movements.

Figure 1: Commodity Flow Tonnage by Direction



Source: FAF4
Note: Multiple modes includes freight rail intermodal movements.

Table 2: Top 10 Commodities by Total Tonnage

Commodity	Truck	Rail	Multiple modes	Water	Air	All Other Modes	Total	Percent of Total
Gravel	15,887,000	918,000	256,000	24,000			17,085,000	21%
Nonmetal min. prods.	10,010,000	540,000	30,000	81,000	<500		10,661,000	13%
Coal	79,000	8,554,000	949,000				9,582,000	12%
Wood prods.	4,532,000	188,000	6,000		2,000		4,729,000	6%
Mixed freight	3,679,000		39,000		<500	1,000	3,718,000	5%
Gasoline	3,311,000	135,000		1,000			3,447,000	4%
Natural sands	2,950,000	204,000		6,000			3,160,000	4%
Basic chemicals	2,649,000	442,000	10,000	2,000	<500		3,102,000	4%
Other foodstuffs	2,770,000	79,000	2,000	5,000			2,857,000	3%
Waste/scrap	2,270,000	111,000	78,000	1,000			2,460,000	3%
Subtotal	**48,135,000**	**11,171,000**	**1,370,000**	**120,000**	**3,000**	**1,000**	**60,801,000**	**74%**
All Other Commodities	19,046,000	1,814,000	637,000	148,000	23,000	13,000	21,680,000	26%
Total	**67,181,000**	**12,985,000**	**2,008,000**	**268,000**	**26,000**	**13,000**	**82,481,000**	**100%**
Subtotal Percent	**58%**	**14%**	**2%**	**<1%**	**<1%**	**<1%**	**74%**	
Percent of Total	**81%**	**16%**	**2%**	**<1%**	**<1%**	**<1%**	**100%**	

Source: FAF4
Note: Multiple modes includes freight rail intermodal movements.

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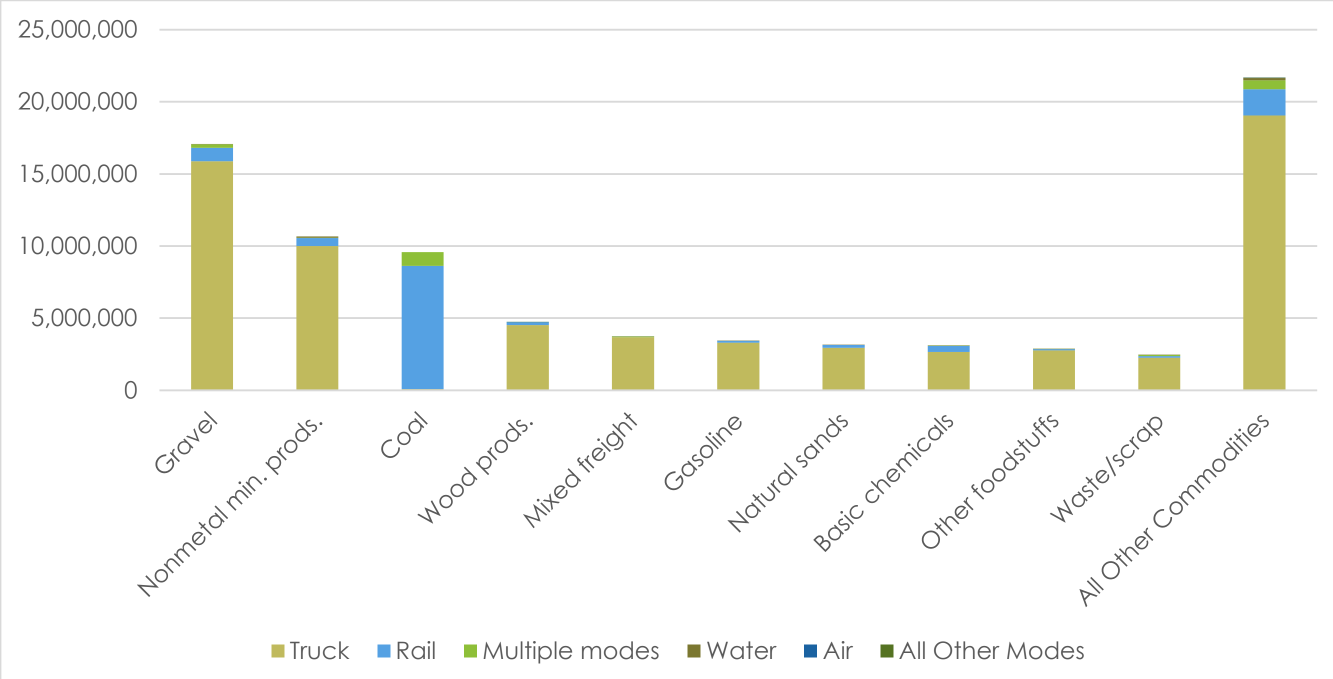
Figure 2: Top 10 Commodities by Total Tonnage



Source: FAF4

Note: Multiple modes includes freight rail intermodal movements.

Truck Trips from Disaggregated FAF4

There are several key commodities transported by truck in and out of the region, as measured by the average truck trips per day. Information about the top outbound commodities is presented in Table 3. An average of 6,624 daily truck trips were made outbound from the Triangle Region. Gravel and crushed stone was the most frequently transported outbound commodity, with an average of 1,292 truck trips per day from the Triangle Region, comprising nearly 20 percent of the total outbound daily truck trips. Non-metallic mineral products was the second-most transported commodity, nearly 10 percent of the total. In addition, mixed freight and wood products were two other important products, each comprising 8 percent of the total outbound daily truck trips.

Table 3: Top 10 Outbound Commodities by Average Daily Truck Trips in Triangle Region

SCTG Code	Commodity Description	Avg. Truck Trips per Day	% of Total
12	Gravel and Crushed Stone	1,292	20%
31	Non-Metallic Mineral Products	651	10%
43	Mixed Freight	552	8%
26	Wood Products	519	8%
17	Gasoline and Aviation Turbine Fuel	457	7%
20	Basic Chemicals	312	5%
41	Waste and Scrap	302	5%
11	Natural Sands	250	4%
25	Logs and Other Wood in the	243	4%

SCTG Code	Commodity Description	Avg. Truck Trips per Day	% of Total
	Rough		
6	Milled Grain Products	237	4%

Source: Disaggregated FAF4 Analysis.

The pattern of inbound commodities is similar to that of outbound commodities, as presented in Table 4. An average of 7,030 daily truck trips were made inbound to the Triangle Region. The top four inbound goods were the same as the top four outbound goods. Again, gravel and crushed stone was the top inbound commodity with 1,109 average daily truck trips to the region, comprising nearly 16 percent of total inbound truck trips. Non-metallic mineral products were also the second-most common inbound commodity with 791 average daily truck trips (11 percent of total). Mixed freight and wood products were two other important products, comprising 8 and 6 percent, respectively, of the total inbound daily truck trips. Compared to the pattern of outbound goods, other prepared foodstuffs and milled grain products were transported more frequently to the region. Additionally, basic chemicals was transported more frequently outbound rather than inbound.

Table 4: Top 10 Inbound Commodities by Average Truck Trips per Day in Triangle Region

SCTG Code	Commodity Description	Avg. Truck Trips per Day	% of Total
12	Gravel and Crushed Stone	1,109	16%
31	Non-Metallic Mineral Products	791	11%
43	Mixed Freight	529	8%
26	Wood Products	443	6%
7	Other Prepared Foodstuffs	398	6%
6	Milled Grain Products	362	5%
17	Gasoline and Aviation Turbine Fuel	316	4%
41	Waste and Scrap	297	4%
11	Natural Sands	293	4%
25	Logs and Other Wood in the Rough	265	4%

Source: Disaggregated FAF4 Analysis.

It is also beneficial to analyze the trucking activity that occurred locally within the Triangle Region. An average of 3,352 daily truck trips were made within the 10-county region. The top intra-region commodities are presented in Table 5. The top two commodities were the same as in the inbound/outbound analysis, gravel and crushed stone (27 percent of total) and non-metallic mineral products (13 percent of total). However, several other commodities were transported more frequently within the Triangle Region, including gasoline and aviation turbine fuel (7 percent) and waste and scrap (7 percent).

Table 5: Top 10 Intra-Region Commodities by Average Daily Truck Trips in Triangle Region

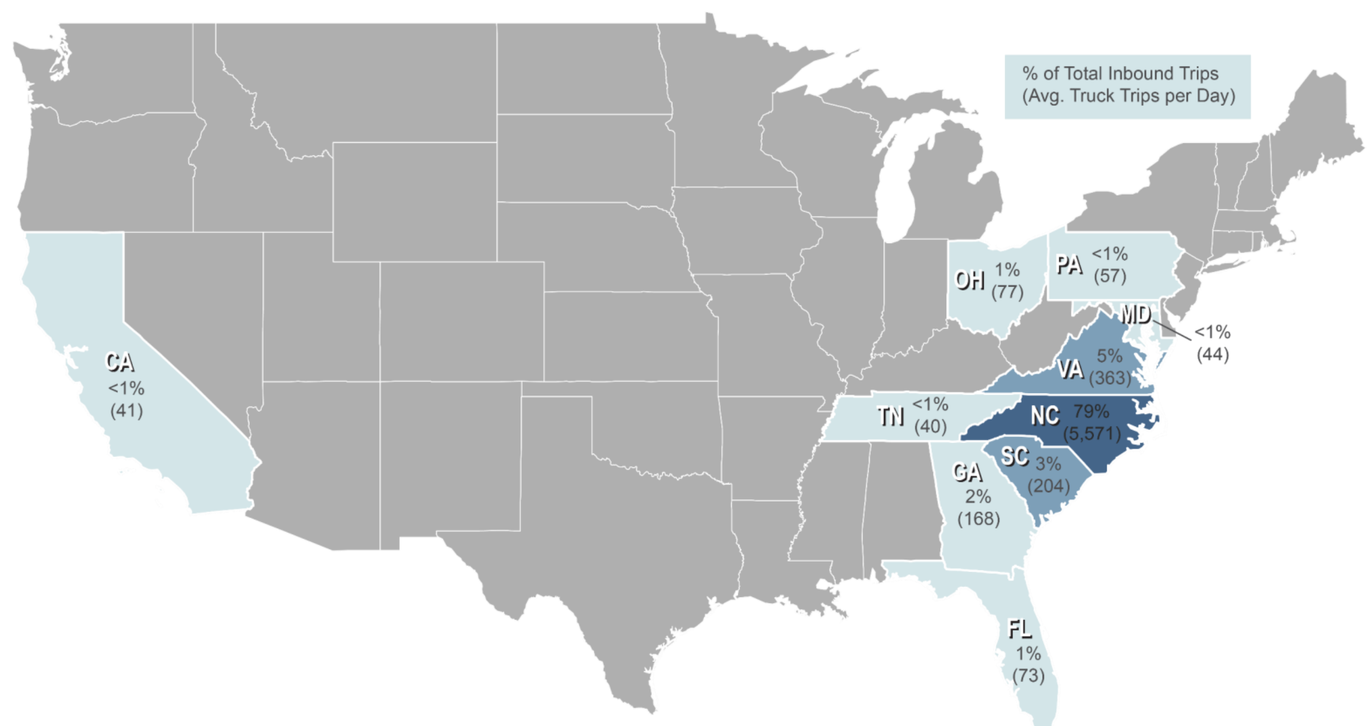
SCTG Code	Commodity Description	Avg. Truck Trips per Day	% of Total
12	Gravel and Crushed Stone	890	27%
31	Non-Metallic Mineral Products	429	13%
17	Gasoline and Aviation Turbine Fuel	240	7%
41	Waste and Scrap	225	7%
43	Mixed Freight	195	6%

25	Logs and Other Wood in the Rough	192	6%
11	Natural Sands	184	5%
6	Milled Grain Products	181	5%
26	Wood Products	172	5%
20	Basic Chemicals	90	3%

Source: Disaggregated FAF4 Analysis.

In general, the majority of trucks entering and leaving the Triangle Region originated within the State of North Carolina. The top inbound trade partners by average daily truck trips are presented in Figure 3. Trucks traveling inbound from within North Carolina averaged 5,571 truck trips per day, comprising 79 percent of the total daily truck trips. Trucks originating from Virginia were the second trade partner by volume, averaging 363 truck trips per day (5 percent of total). Neighboring states South Carolina (3 percent) and Georgia (2 percent) were also important trade partners, with the remaining partners from all areas of the country.

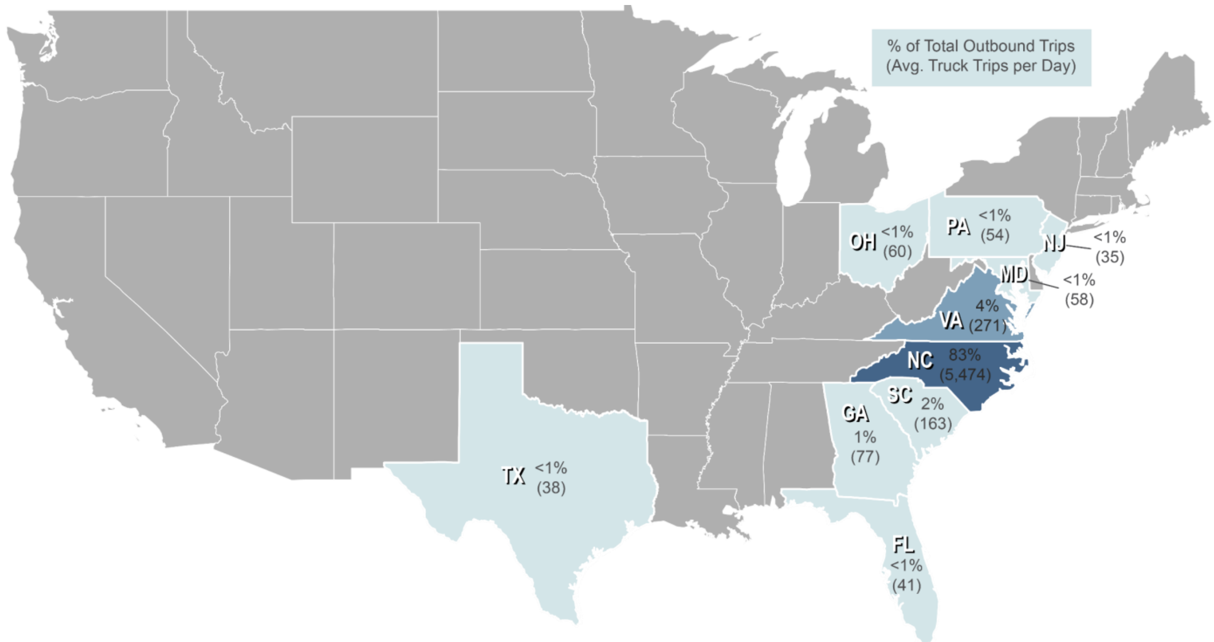
Figure 3: Top 10 Inbound Trade Partners by Average Truck Trips per Day



Source: Disaggregated FAF4 Analysis.

The top outbound trade partners by average daily truck trips are presented in Figure 4. Trucks traveling outbound for within North Carolina averaged 5,474 truck trips per day, comprising 83 percent of the total daily truck trips. Trucks leaving for Virginia were the second trade partner by volume, averaging 271 truck trips per day (4 percent of total). Again, South Carolina and Georgia were notable trade partners, comprising 2 percent and 1 percent, respectively, of the total outbound daily truck trips.

Figure 4: Top 10 Outbound Trade Partners by Average Truck Trips per Day



Source: Disaggregated FAF4 Analysis.

In addition to the inbound and outbound trade partners, there is a significant amount of trucking activity between Triangle Region counties. Table 6 presents a matrix of average daily truck trips between each of the 10 counties, totaling 3,352 truck trips on a daily basis. The most truck trips occurred within Wake County (Raleigh county seat) at nearly 800 daily truck trips on average. Wake County received 1,835 daily truck trips and originated 1,469 daily truck trips. In addition, Wake County was a key destination for many of the counties in the Triangle Region, particularly Durham, Granville, and Johnston. Durham County was also an important destination county, with the majority of truck traffic arriving from Wake County (337 average daily truck trips) followed by within Durham (111 daily truck trips).

Table 6: Average Truck Trips per Weekday within Triangle Region Counties

Origin County	Destination County										
	Wake	**Durham**	**Orange**	**Johnston**	**Harnett**	**Chatham**	**Nash**	**Granville**	**Person**	**Franklin**	**Total**
Wake	796	337	90	86	37	40	25	23	18	17	**1,469**
Durham	251	111	28	31	12	6	6	15	9	6	**475**
Granville	220	59	28	19	9	4	5	6	1	7	**358**
Johnston	157	74	13	14	8	7	4	1	5	2	**285**
Chatham	147	68	14	13	4	8	2	6	3	3	**268**
Harnett	122	51	15	12	7	4	1	4	7	4	**227**
Franklin	73	20	4	12	4	3	2	1	3	2	**124**
Orange	35	20	3	2	3	2	1	-	1	-	**67**
Nash	24	13	-	1	-	2	-	-	-	-	**40**
Person	10	6	2	1	-	1	17	-		2	**39**
Total	**1,835**	**759**	**197**	**191**	**84**	**77**	**63**	**56**	**47**	**43**	**3,352**

Source: Disaggregated FAF4 Analysis.

Freight Activity Clusters

In this analysis, the Triangle Region's freight clusters are identified by individually and jointly examining the following:

- the location and square footage of the region's freight-intensive industries;
- the location of areas with substantial freight-related employment; and
- the location of areas that attract and/or generate relatively large numbers of truck trips.

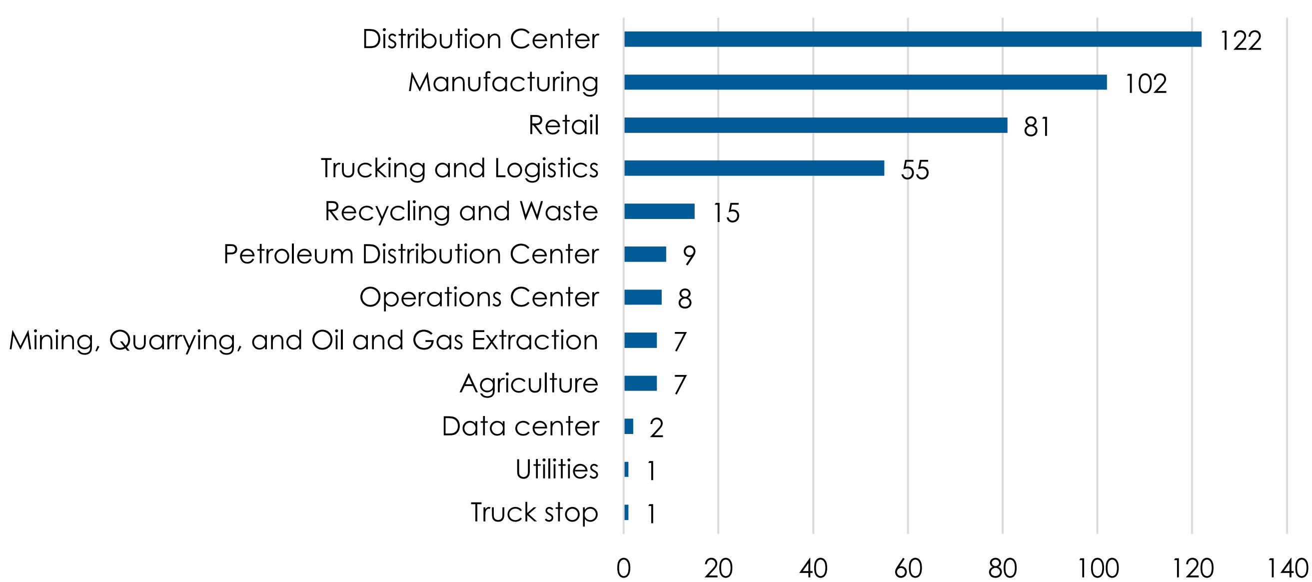
Though a statistical clustering algorithm was not used to determine the freight clusters, the methodology used accounts for the major factors that indicate the aggregation of freight-related activities at the regional level.

Freight-Intensive Industries

The locations of freight-intensive industries in the Triangle Region point to areas of high truck traffic and freight activity. To help evaluate them, the project team created a data set of freight-significant facilities. This was based on a freight node database established for development of the NCDOT's Statewide Transportation Model (NCSTM), which itself drew from multiple state and local data sources including lists maintained by chambers of commerce. Additional data points were collected for the Triangle region and more attribute details included based on Geographic Information Systems (GIS) data, aerial imagery, and Google Street View examination.

The resulting data set identifies 410 freight facilities in the region, the majority of which were classified as distribution centers (DCs), as shown in Figure 5. Manufacturing was the second-most common type of freight facility, with 102 in the region. Together, these categories comprised over half of all types of freight facilities, 224 total. Facilities designated for retail and trucking/logistics uses were also important types of facilities, comprising nearly 10 percent and over 13 percent, respectively.

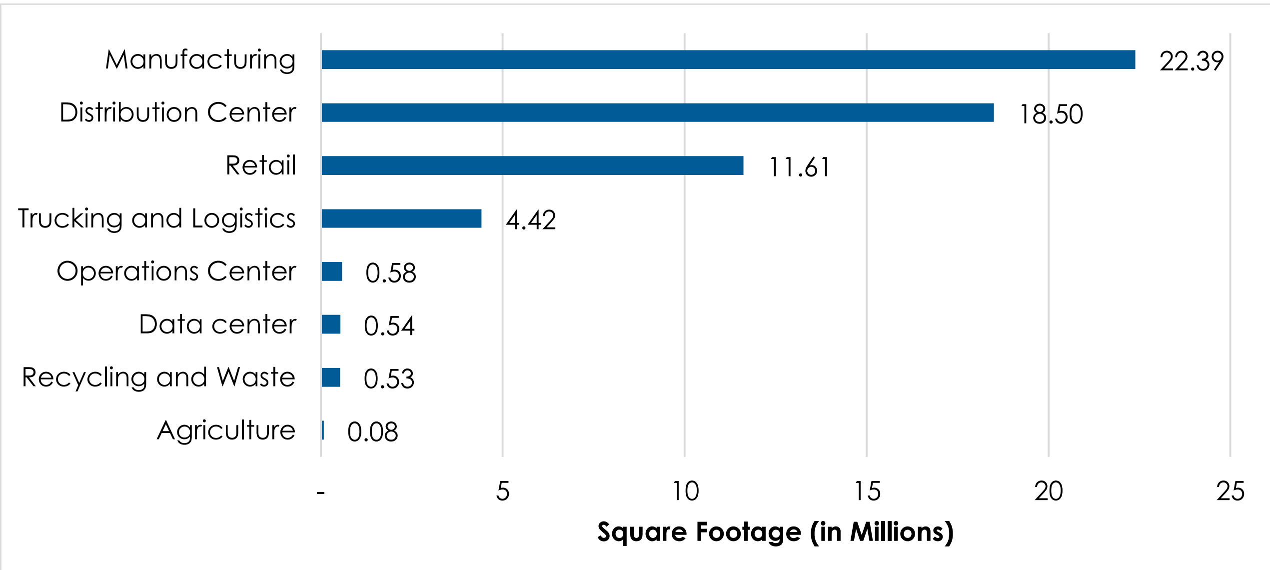
Figure 5: Number of Freight-Intensive Business Locations by Industry



Source: Westat (2015)

Information on the facilities belonging to firms involved in freight-intensive industries is summarized in Figure 6 and Figure 7. Although DCs were greatest in number, manufacturing facilities was the largest category by square footage, as shown in Figure 6. Manufacturing facilities took over nearly 22.4 million square feet (SF) throughout the region, over 38 percent of the total freight facilities square footage. Distribution centers took over nearly 18.5 million SF, 31.5 percent of the total. Retail facilities were the third-most significant type of facility by square footage, with over 11.6 million SF. Together, these three types of freight facilities comprise nearly 90 percent of all square footage for freight facilities in the Triangle Region. There was no square footage reported for utilities, truck stop, petroleum DC, and mining freight facilities. In total, there were 410 facilities belonging to businesses in freight-intensive industries as shown in Figure 7. These facilities span over 58.6 million SF in the Triangle Region.

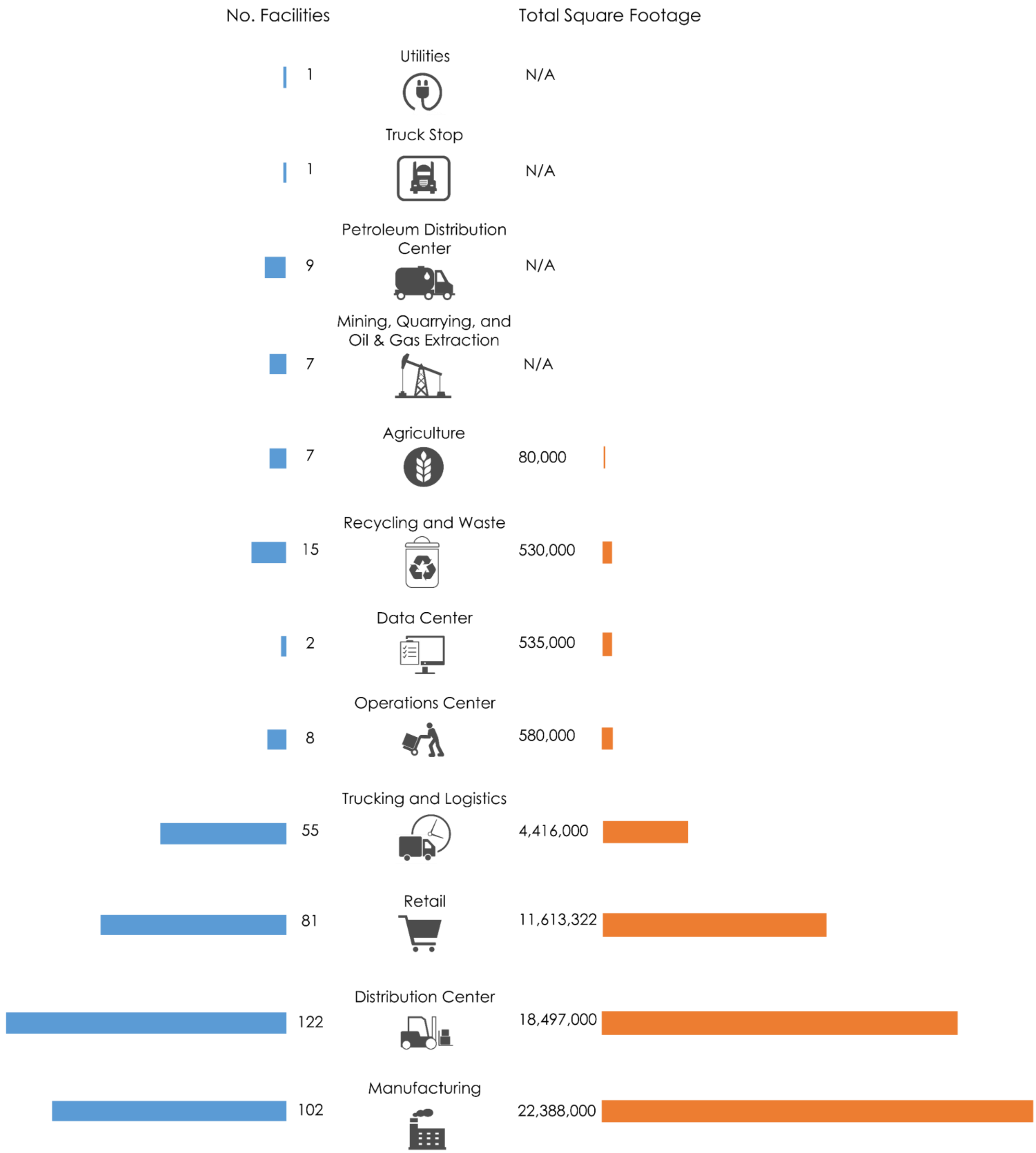
Figure 6: Total Square Footage of Freight-Intensive Business Facilities by Industry



Source: Westat (2015)
Note: Square footage for Mining, Petroleum Distribution Centers, Truck Stops, and Utilities facilities was not available.

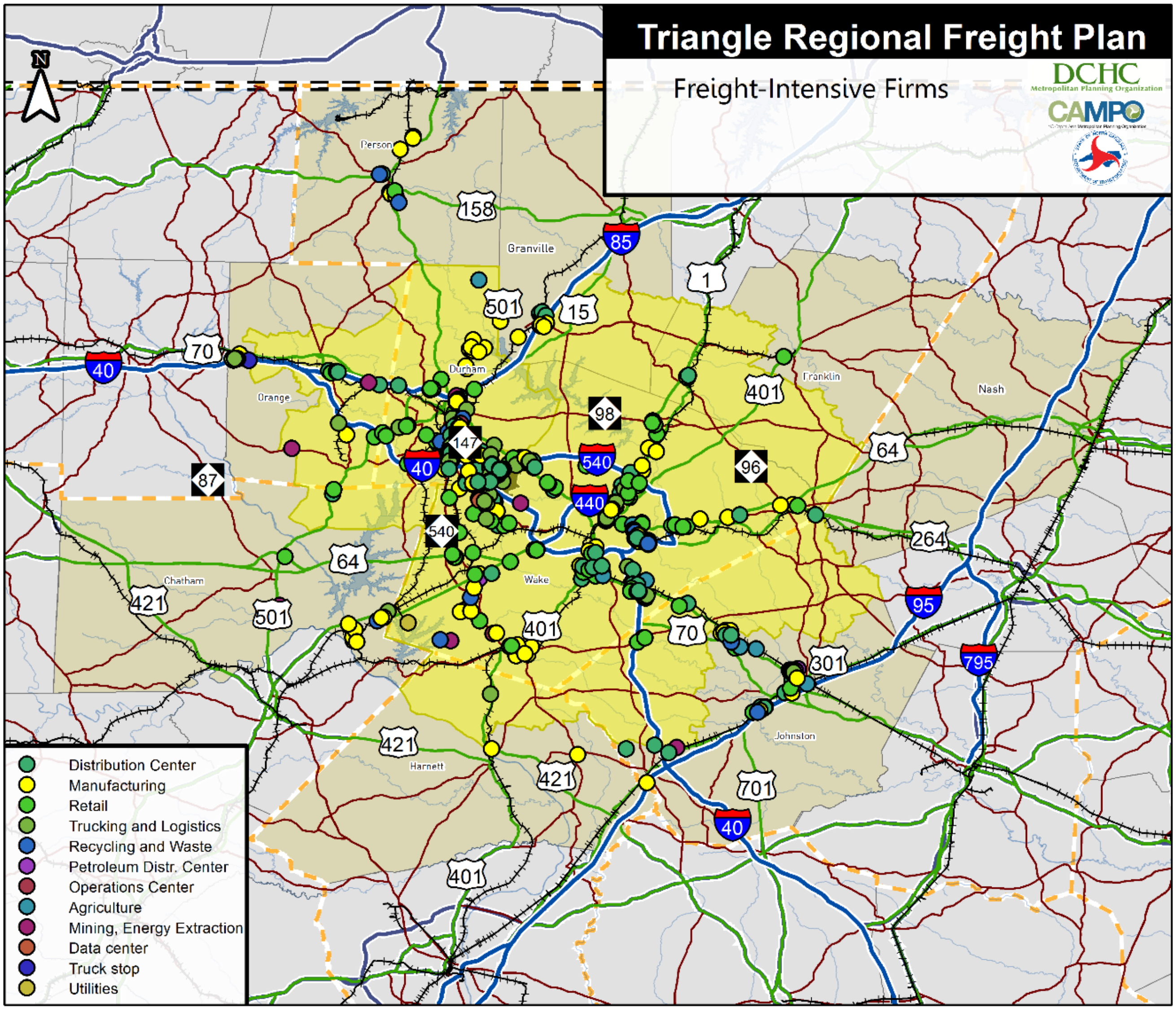
Figure 8 presents a map of the locations of freight-intensive industries in the Triangle Region. Largely, these facilities are clustered in the center of the region between the Cities of Raleigh and Durham. Particularly, facilities associated with the transportation (i.e. distribution centers and trucking/logistics firms) and manufacturing industries are clustered in this area – two sectors that typically produce substantial truck volumes. This location was likely chosen due to companies seeking close access to the Triangle Region's dual population centers and critical roadway corridors, namely I-40, I-540, and SR 147. Other freight-intensive industries were situated along primary highway corridors in the Raleigh and Durham areas, specifically I-85, U.S. 1, U.S. 70, and U.S. 264.

Figure 7: Freight-Intensive Industries in Triangle Region



Source: Westat (2015)

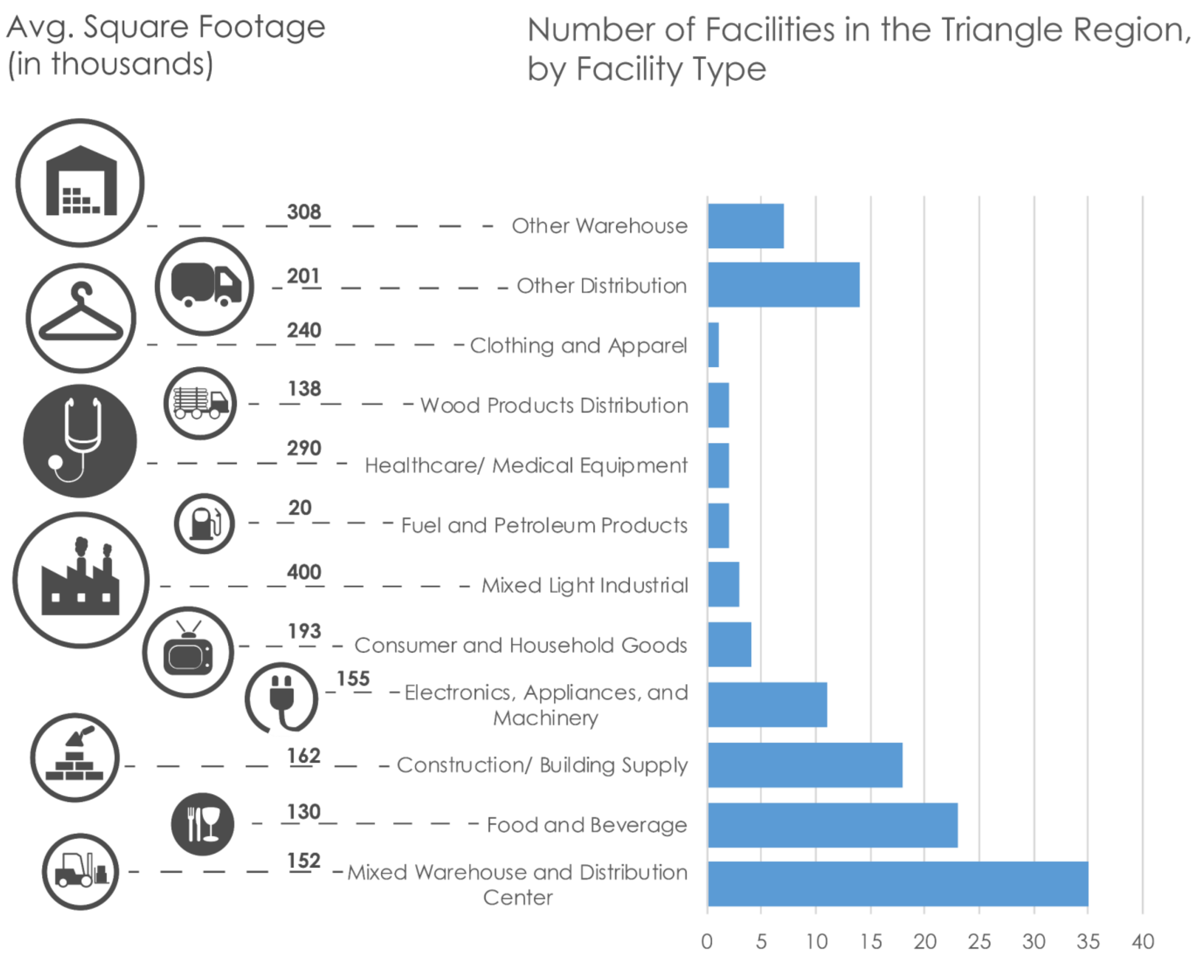
Figure 8: Freight-Intensive Industries in the Triangle Region by Sector



Source: Westat (2015)

In Figure 9, warehouse/distribution centers throughout the Triangle Region are classified according to the primary industries they serve based on the owner and the description of the facility. The most prevalent types of facilities are Mixed Warehouse and Distribution Centers, facilities dedicated to the Food and Beverage industry, and those serving the Construction/ Building Supply industry. Mixed Warehouse and Distribution Centers are flexible spaces that can be used for a wide variety of logistics purposes. These facilities represent about 29 percent of the warehouse/distribution centers in the Triangle Region. On average they consist of about 152,000 SF and have 23 truck bays. Facilities serving the Food and Beverage and Construction/ Building Supply industries represent 19 and 15 percent of the warehouses/distribution centers in the Triangle Region, respectively. Among the largest spaces in the region are those dedicated to mixed light industrial and warehousing activities. On average, these facilities consist of about 308,000 and 400,000 SF and have 23 and 53 truck bays, respectively. The average square footage and number of truck bays are indicators of the amount of truck traffic produced by these facilities. Larger facilities with more truck bays are likely to produce more trucks trips than smaller facilities with fewer truck bays.

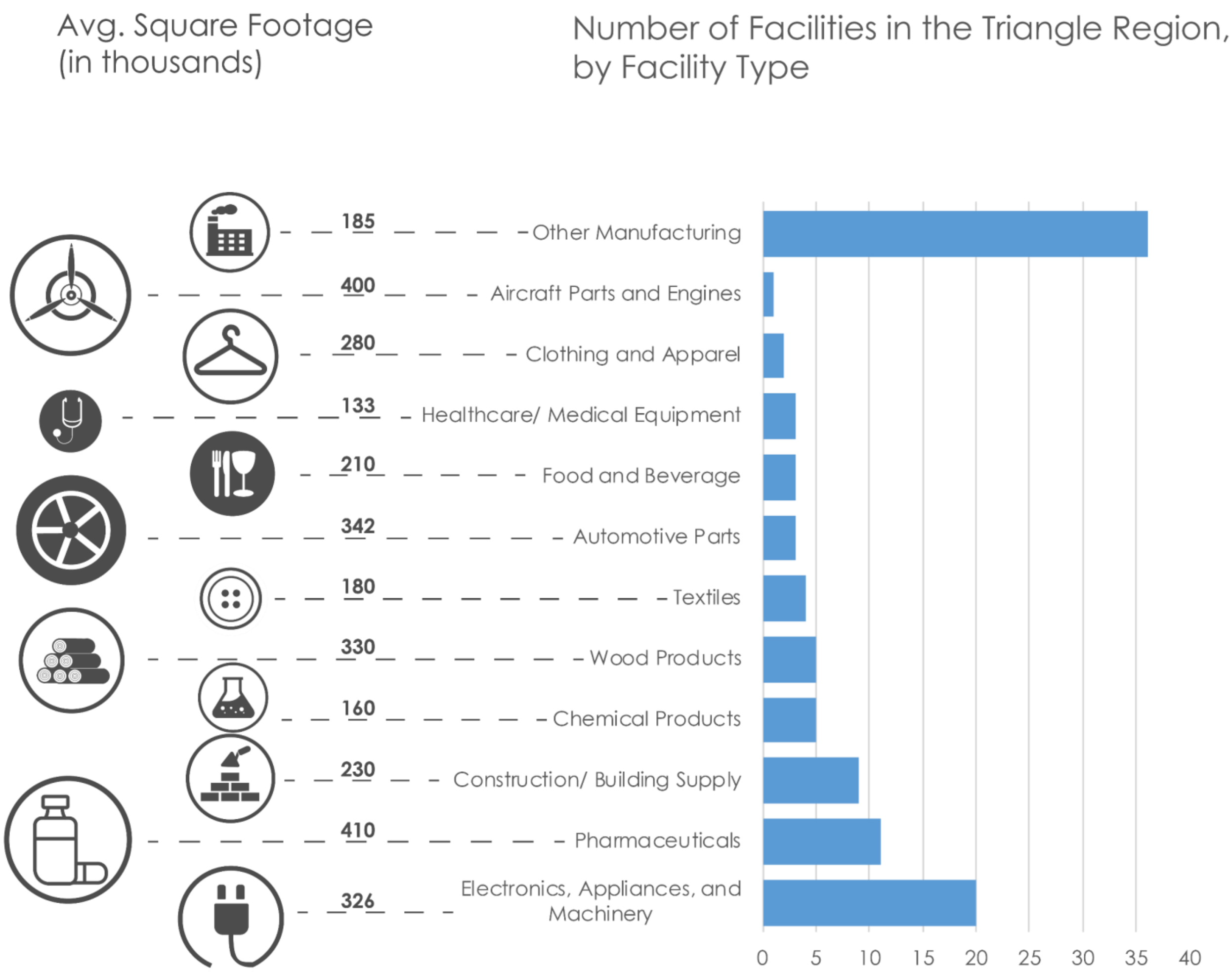
Figure 9: Warehouse/ Distribution Center Facility Types in the Triangle Region



Source: Westat (2015)

A similar analysis was done for manufacturing facilities and is presented in Figure 10. The most prevalent types of facilities are those serving the Electronics, Pharmaceuticals, and Construction/ Building Supply industries. About 20 percent of manufacturing facilities in the Triangle Region produce electronics, appliances, and machinery. Also, these facilities are relatively large (about 326,000 SF on average) with a higher number of truck bays on average. This indicates that they generate a substantial number of truck trips. Facilities dedicated to the Pharmaceuticals and Construction/ Building Supply industries represent 11 and 9 percent of the region's manufacturing base, respectively. While Pharmaceutical plants are relatively larger on average (410,000 SF), Construction/ Building Supply facilities are smaller at 230,000 SF. Both manufacturing facility types have 17 truck bays on average, which is higher than the mean across all manufacturing plants within the region. Intuitively, manufacturing facilities generally have fewer truck bays than warehouses/distribution centers. Though manufacturing plants produce substantial numbers of truck trips, it is not likely as high as the region's warehouses/distribution centers.

Figure 10: Manufacturing Facility Types in the Triangle Region



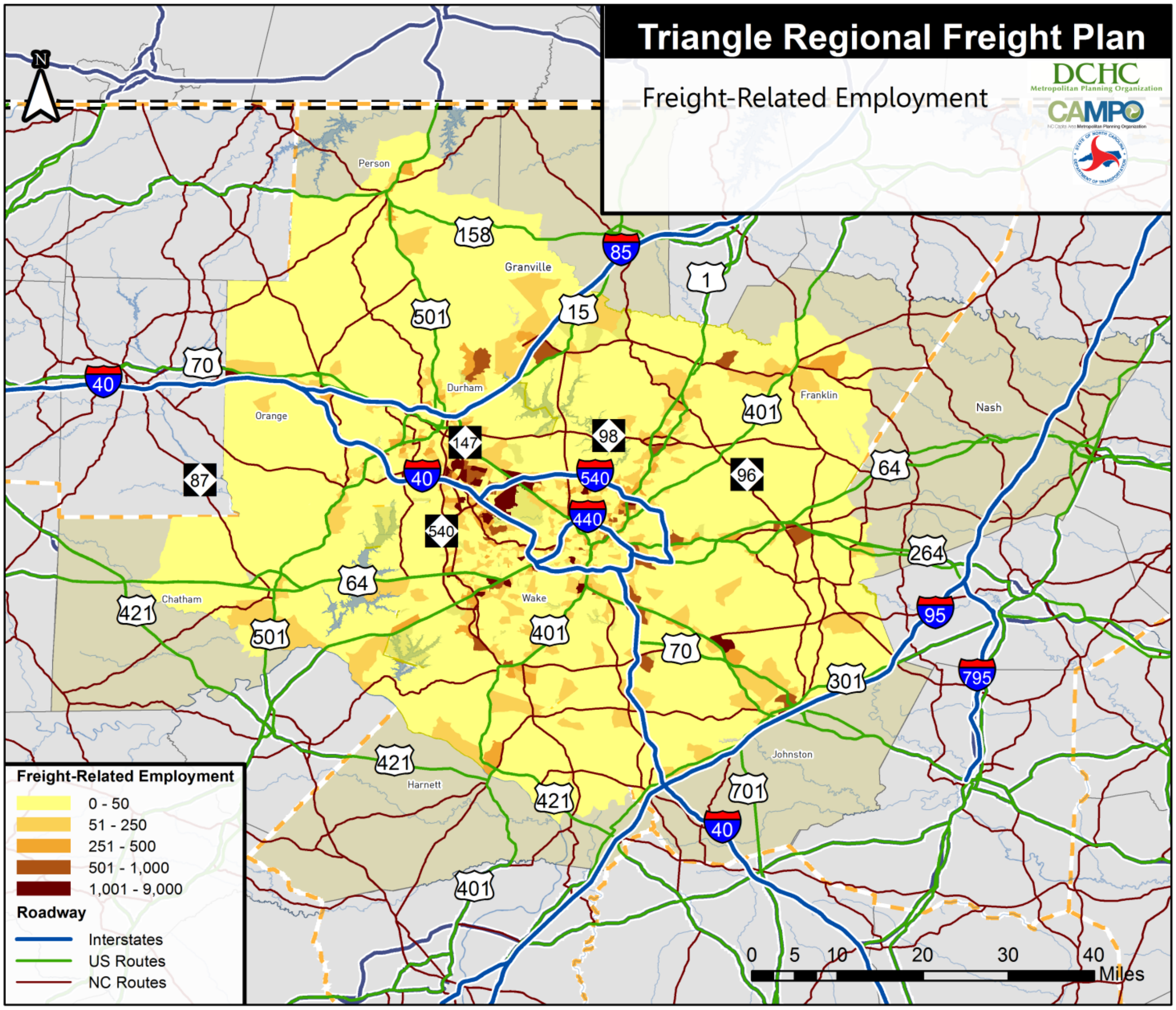
Source: Westat (2015)

Freight-Related Employment

In addition to the location of freight-intensive industries, in identifying the Triangle Region's freight clusters it is also important to understand where freight-related employment is located throughout the region. For purposes of this analysis, freight-related employment is defined as North American Industry Classification System (NAICS) codes corresponding to Retail Trade, Manufacturing, Construction, Wholesale Trade, Transportation and Warehousing, Utilities, Agriculture, and Mining. Figure 11 presents a map of freight-related employment by traffic analysis zone (TAZ). Though freight-related employment is generally distributed throughout the Triangle Region, there is a large concentration in the center of the region between the Cities of Raleigh and Durham (including the RTP). Other areas with clusters of freight-related employment include Raleigh-Durham International Airport (RDU), the I-85 corridor north of Durham, the U.S. 1 corridor north of Raleigh, and U.S. 401 north near Louisburg, among others.

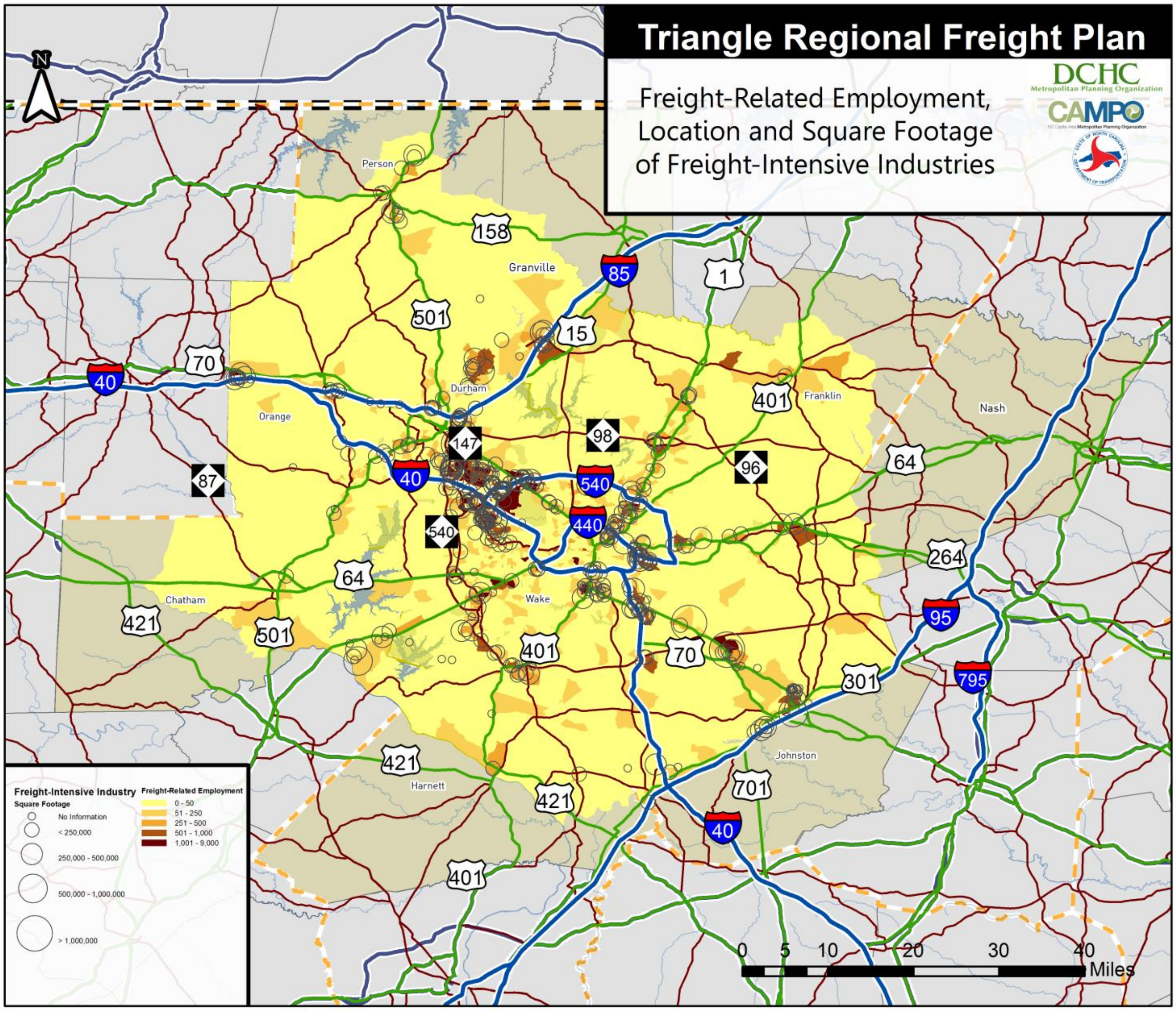
When viewed in conjunction with the freight-intensive industry location data (Figure 12), the expected overlap can be observed between the locations of significant facilities and the concentrations of freight-related employment overall. This alignment will be put to use in the definition of the region's key freight clusters in a later section of this chapter.

Figure 11: Triangle Region Freight-Related Employment



Source: InfoUSA (2013)

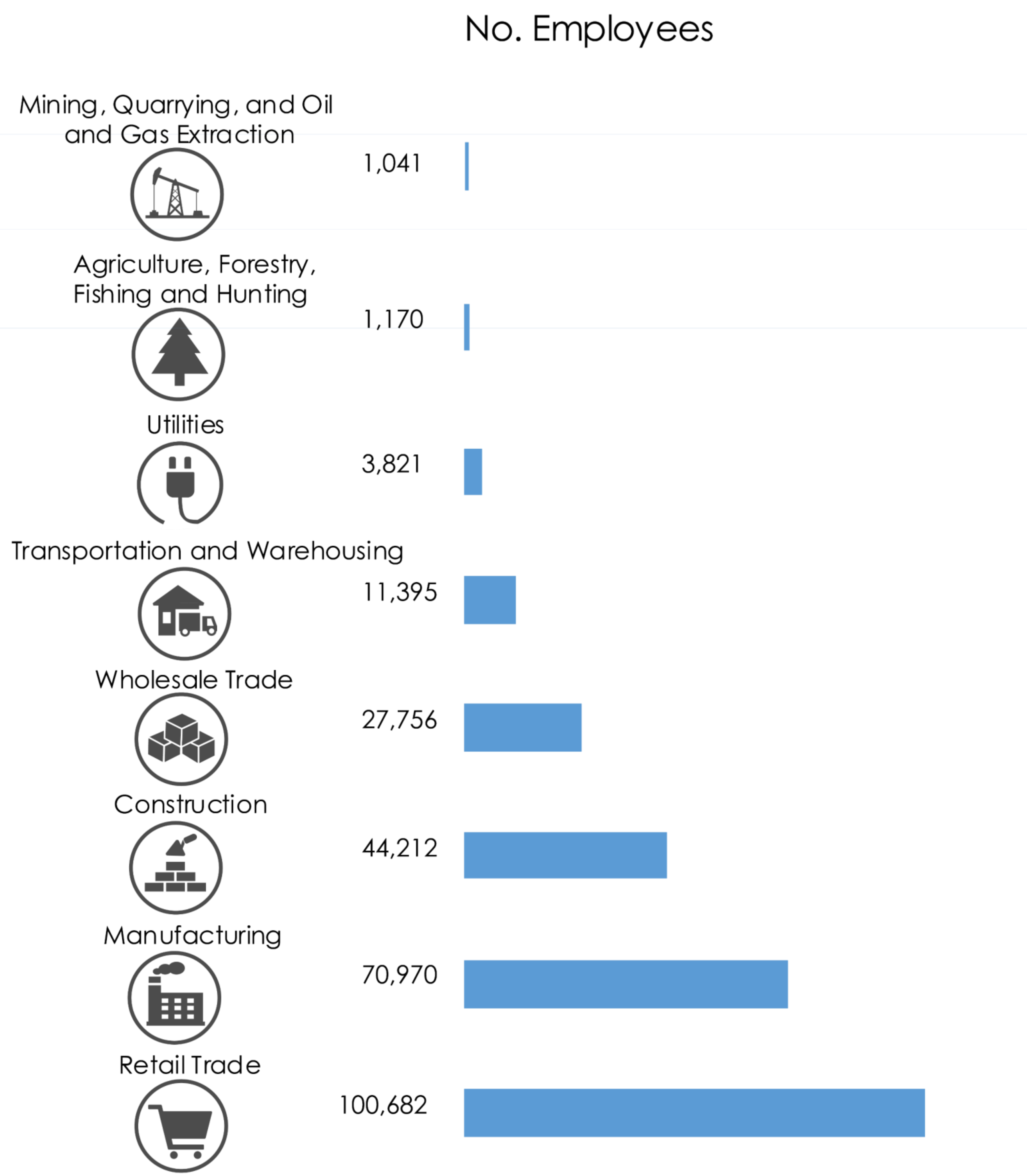
Figure 12: Proximity of Freight-Intensive Industries to Freight-Related Employment



Source: InfoUSA (2013); Westat (2015).

Figure 13 displays the number of employees in each freight-intensive industry by NAICS code, a total of nearly 258,000 employees. Out of these industries, the retail trade sector employed the highest number of workers (39 percent) followed by manufacturing (28 percent). These figures align with the information on freight facilities in the Triangle Region, as the highest number of freight facilities were classified as manufacturing and DCs.

Figure 13: Triangle Region Employment by Freight-Intensive Industry, 2013



Source: InfoUSA (2013)

Retail trade and manufacturing were the highest employing freight-intensive sectors in the Triangle Region. Table 7 presents the number of employees for each subsector of the retail trade sector, which employed over 100,000 people. Food and beverage stores was the top subsector (18.6

percent of total retail trade employment), followed by general merchandise stores (16.6 percent) and motor vehicle and parts dealers (11.3 percent).

Table 8 presents the number of employees for each subsector of the manufacturing sector, which employed nearly 71,000 people. Computer and electronic product manufacturing was the top subsector (26.2 percent of total manufacturing employment), followed by chemical manufacturing (22.3 percent) and miscellaneous manufacturing (10.2 percent).

Table 7: Retail Trade Employment in Triangle Region, 2013

NAICS Code	NAICS 2-Digit Description	No. Employees	%
445	Food and Beverage Stores	18,748	19%
452	General Merchandise Stores	16,670	17%
441	Motor Vehicle and Parts Dealers	11,400	11%
444	Building Material and Garden Equipment and Supplies Dealers	10,550	10%
448	Clothing and Clothing Accessories Stores	8,656	9%
443	Electronics and Appliance Stores	8,609	9%
446	Health and Personal Care Stores	7,104	7%
453	Miscellaneous Store Retailers	6,763	7%
451	Sporting Goods, Hobby, Musical Instrument, and Book Stores	5,252	5%
442	Furniture and Home Furnishings Stores	3,712	4%
447	Gasoline Stations	2,101	2%
454	Nonstore Retailers	1,117	1%
	Total	**100,682**	**100%**

Source: InfoUSA (2013)

Table 8: Manufacturing Employment in Triangle Region, 2013

NAICS Code	NAICS 2-Digit Description	No. Employees	%
334	Computer and Electronic Product Manufacturing	18,580	26%
325	Chemical Manufacturing	15,805	22%
339	Miscellaneous Manufacturing	7,257	10%
333	Machinery Manufacturing	5,866	8%
332	Fabricated Metal Product Manufacturing	3,632	5%
327	Nonmetallic Mineral Product Manufacturing	2,999	4%
311	Food Manufacturing	2,473	3%
323	Printing and Related Support Activities	2,014	3%
312	Beverage and Tobacco Product Manufacturing	1,947	3%
336	Transportation Equipment Manufacturing	1,688	2%
335	Electrical Equipment, Appliance, and Component Manufacturing	1,669	2%
322	Paper Manufacturing	1,667	2%

NAICS Code	NAICS 2-Digit Description	No. Employees	%
321	Wood Product Manufacturing	1,538	2%
326	Plastics and Rubber Products Manufacturing	1,096	2%
337	Furniture and Related Product Manufacturing	925	1%
313	Textile Mills	667	1%
315	Apparel Manufacturing	603	1%
314	Textile Product Mills	220	<1%
331	Primary Metal Manufacturing	218	<1%
324	Petroleum and Coal Products Manufacturing	71	<1%
316	Leather and Allied Product Manufacturing	35	<1%
	Total	**70,970**	**100%**

Source: InfoUSA (2013)

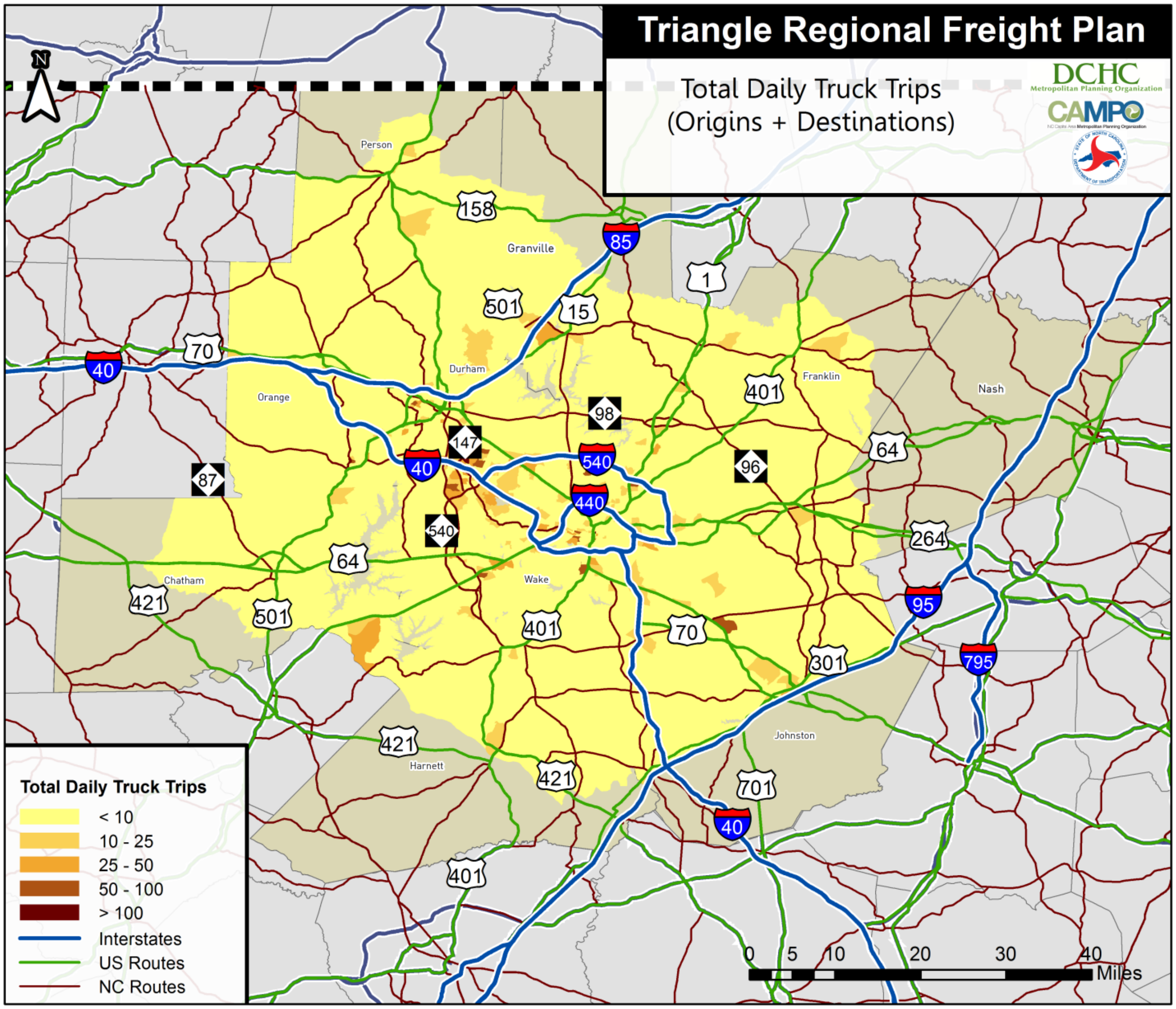
Truck Trips in the Triangle Region

The results of the FAF4 disaggregation are also used to identify which areas within the Triangle Region generate and attract substantial numbers of truck trips. As shown in Figure 14, the estimated truck trips from the disaggregated FAF4 analysis suggests that much of the Triangle Region's freight-related activity occurs in the center of the region between the Cities of Raleigh and Durham. This area contains the Research Triangle and RDU, both of which likely generate significant numbers of truck trips. Many zones in this area are estimated to produce more than 50 truck trips per weekday, both inbound and outbound. This translates into nearly 18,000 truck trips per year in and out of these zones.

Outside the center of the region, areas that generate substantial numbers of truck trips include: southeastern Chatham County near the Cape Fear River and U.S. 1, southern Raleigh and south suburban Raleigh (including the City of Garner), the I-85 corridor north of Durham (including the Cities of Butner and Creedmoor), and north Raleigh near the CSX Transportation (CSX) and Norfolk Southern (NS) rail yards along Capitol Avenue and Atlantic Blvd. Though these areas are not estimated to produce as many truck trips as zones in the core of the region, their numbers are still significant (about 25 to 50 truck trips per weekday). Further, based on the Westat data they all have major freight-intensive industries located within their boundaries as shown in Figure 15.

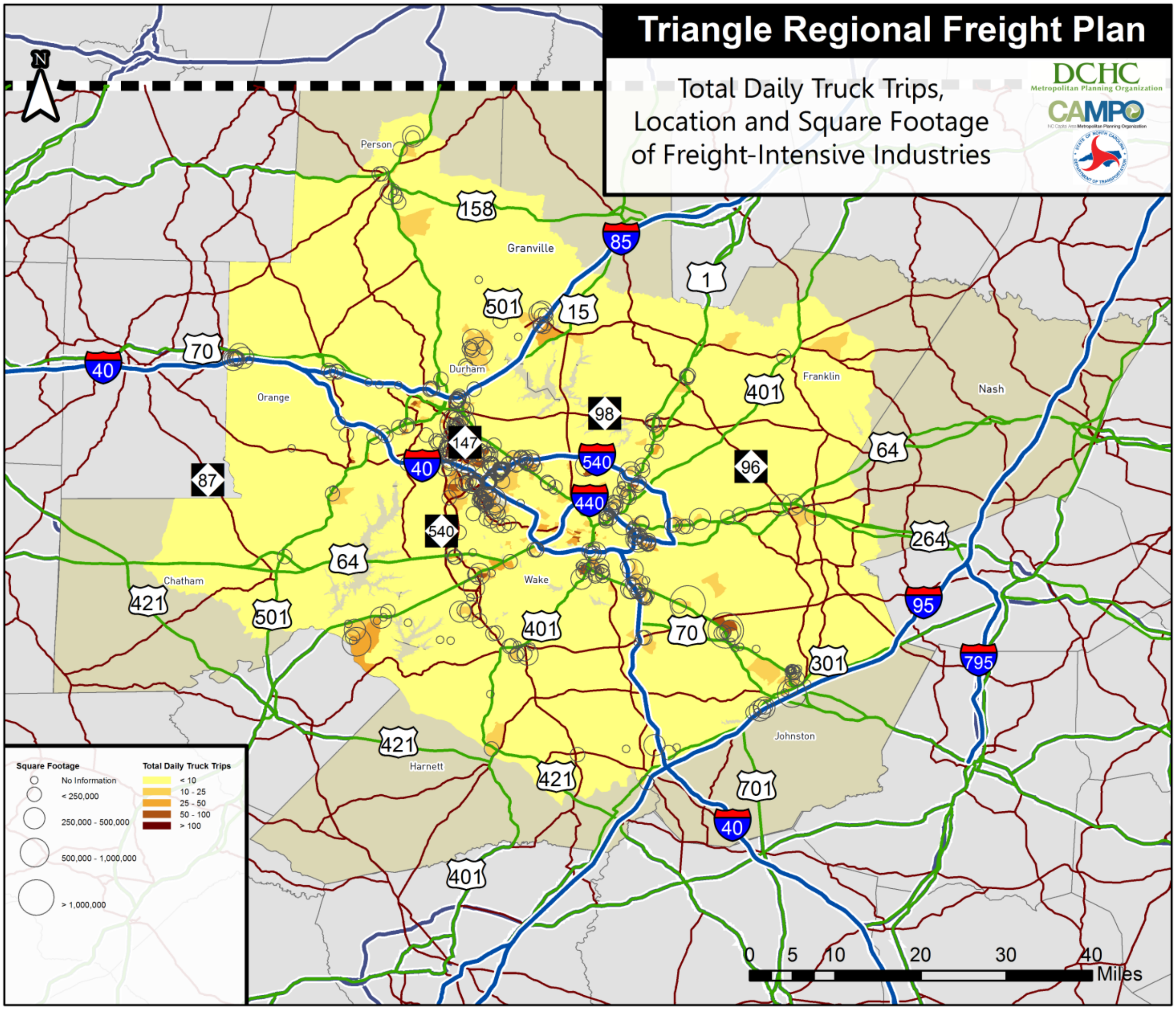
Figure 15 also shows that the location of freight-intensive industries largely overlaps the zones which generate the most truck trips. While larger facilities, as indicated by the square footage, appear to more strongly correlate with increased truck trips outside the core of the region, within the core major truck trip generating zones contain numerous facilities of moderate size. This is intuitive given that the central part of the Triangle Region is more densely developed. Thus, there is not as much room to build large facilities.

Figure 14: Total Daily Truck Trips in the Triangle Region



Source: Disaggregated FAF4 Analysis.

Figure 15: Proximity of Freight-Intensive Industries to Zones with Substantial Truck Trips



Source: Disaggregated FAF4 Analysis; Westat (2015).

Freight Clusters

By jointly examining the locations of freight-intensive industries, areas with high levels of freight-related employment, and zones that generate and attract substantial numbers of truck trips, we can begin to identify the Triangle Region's primary freight clusters. Largely, the business location data showed that freight-intensive industries are clustered in the center of the region between the Cities of Raleigh and Durham. In particular, transportation (i.e. DCs and trucking/logistics firms) and manufacturing industries (two sectors that typically produce substantial truck volumes) are located here. This area provides the most access to the Triangle Region's population centers, critical roadway corridors (i.e. I-40, I-540, and SR 147), and the region's major research universities. The data also showed that other freight-intensive industries were situated along primary highway corridors, specifically I-85, U.S. 1, U.S. 70, and U.S. 264.

The freight-related employment location data was largely consistent with the business location data. It also indicated that there is a large concentration in the center of the Triangle Region, near and including the RTP. These data also suggested that other areas with clusters of freight-related employment include communities near the RDU and locations along primary highway corridors. Specifically, the I-85 corridor north of Durham, the U.S. 1 corridor north of Raleigh, and U.S. 401 north near Louisburg all show concentrations of freight-related employment.

Lastly, the truck trip data was examined to determine which portions of the Triangle Region generate and attract relatively large numbers of truck trips. Overall, it was consistent with the business location and freight-related employment data in that it indicated that many of the Triangle Region's estimated truck trips begin and/ or end in the center of the region. Many of the TAZ in this area are estimated to produce more than 50 truck trips per weekday, which translates into nearly 18,000 truck trips per year based out of these zones. Other areas with significant freight activity as suggested by the truck trip data include: southeastern Chatham County near the Cape Fear River and U.S. 1, southern Raleigh and south suburban Raleigh (including the City of Garner), the I-85 corridor north of Durham (including the Cities of Butner and Creedmoor), and north Raleigh near the CSX and NS rail yards along Capitol Avenue and Atlantic Blvd.

Altogether, these data reveal a pattern that indicates which areas within the Triangle Region are clusters of freight activity across the various measures examined in this analysis: business locations, freight-related employment, and truck trips. In general, the Triangle Region's freight activity centers are located in the core of the region and along primary highway corridors. The Triangle Region's six primary freight clusters are:

- South Raleigh/Garner - Generally the area bounded by I-540 to the north, U.S. 401 to the west, U.S. 70 to the south, and I-40 to the east.
- Capitol Avenue-Atlantic Blvd. Corridor – The area in Raleigh bounded by U.S. 41/Capitol Blvd. to the east, Atlantic Avenue to the west, and I-440 to the north.
- Raleigh-Durham International Airport – The areas surrounding RDU including Davis Drive to the west, Leesville Road to the east, and I-540 to the north.
- Bethesda – The area south of U.S 70, east of SR 147, north of I-40, and west of I-540.
- Research Triangle – The area enclosed by I-40, SR 55, and I-40.
- North Durham – Generally the area south of the I-85/SR 56 interchange and enclosed by I-85 and U.S. 501.

A map of these clusters depicted alongside freight-related employment appears in Figure 16. Further, in examining manufacturing and DCs specifically, we can determine the primary roles of these clusters. Figure 17 and Figure 18 display these employment types and show that while concentration of distribution firms is generally closer to the center of the region and the urban cores of Raleigh and Durham, manufacturing activity is more broadly spread throughout the region. Thus, clusters such as South Raleigh/Garner and Capitol Avenue-Atlanta Blvd. Corridor appear to be more distribution-oriented. On the other hand, clusters such as North Durham appear to be more manufacturing-oriented. However, given the significant amount of overlap between manufacturing and distribution activity (as indicated by business locations and freight-related employment) all of the freight clusters likely perform in dual roles for the Triangle Region as both manufacturing and DCs to some degree. This is partly a reflection of land use policies, and partly because of combined functions: factories can serve as distribution points, and DCs may perform final-stage manufacturing.

Figure 16: Freight Clusters and Employment

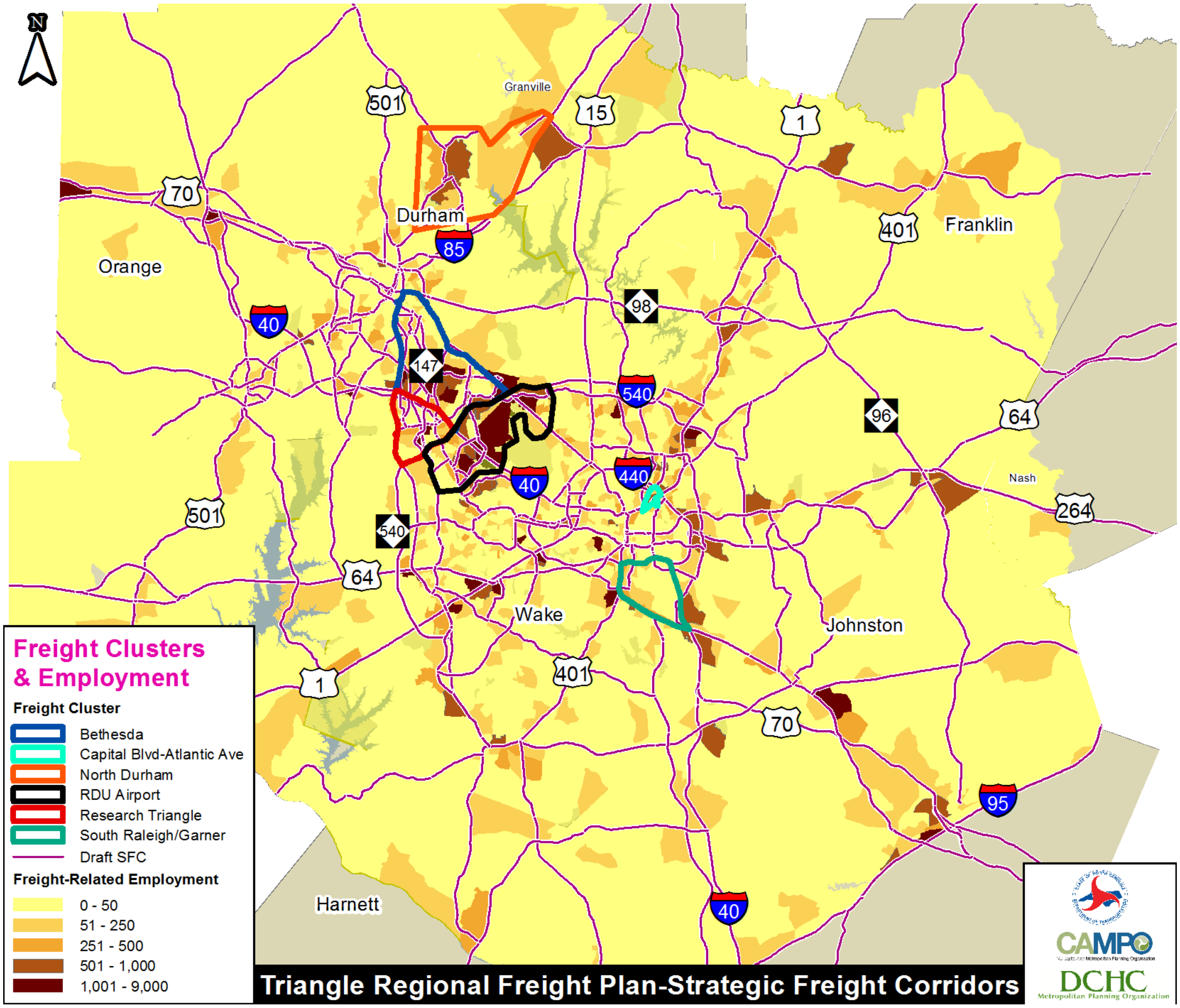
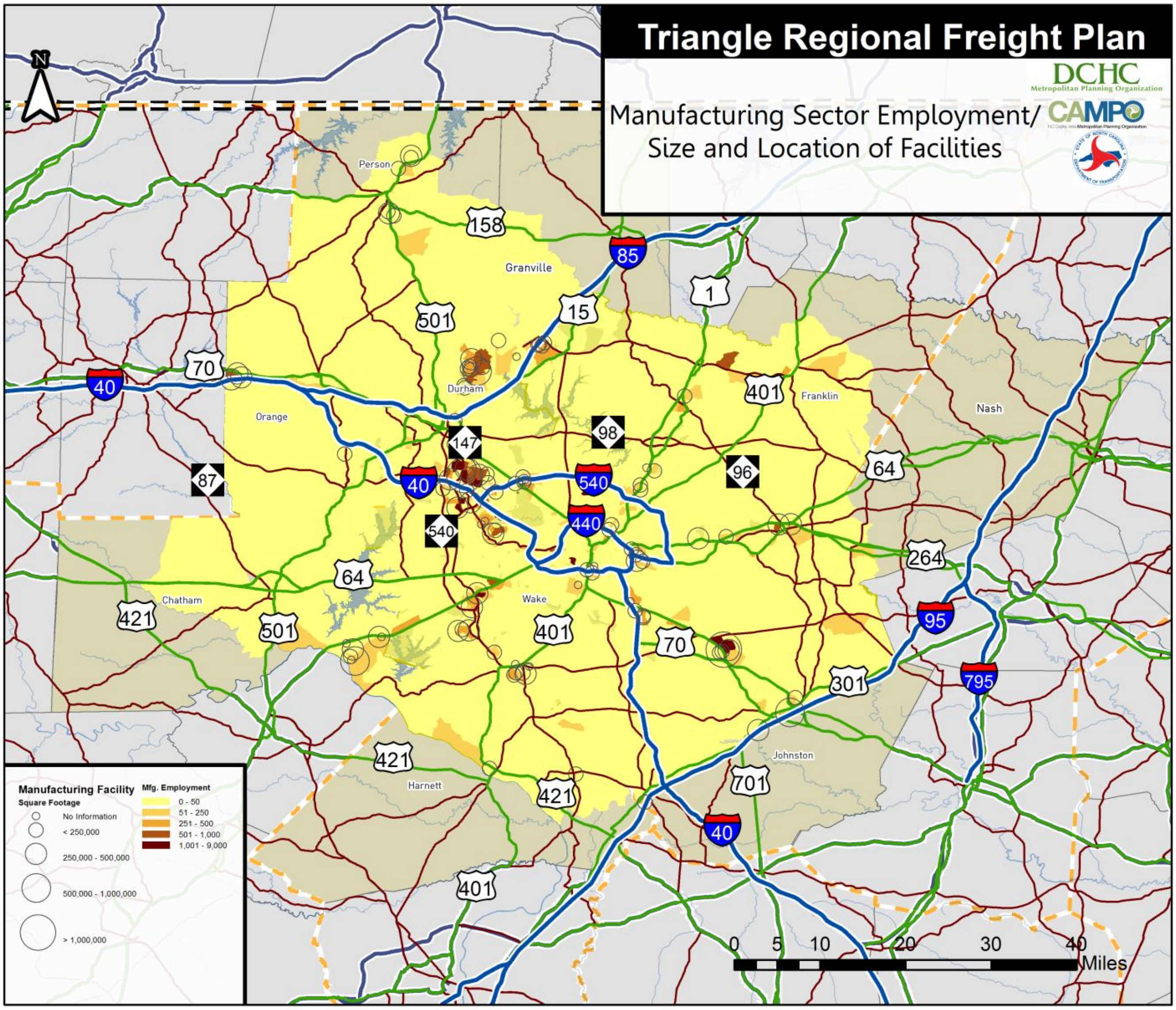
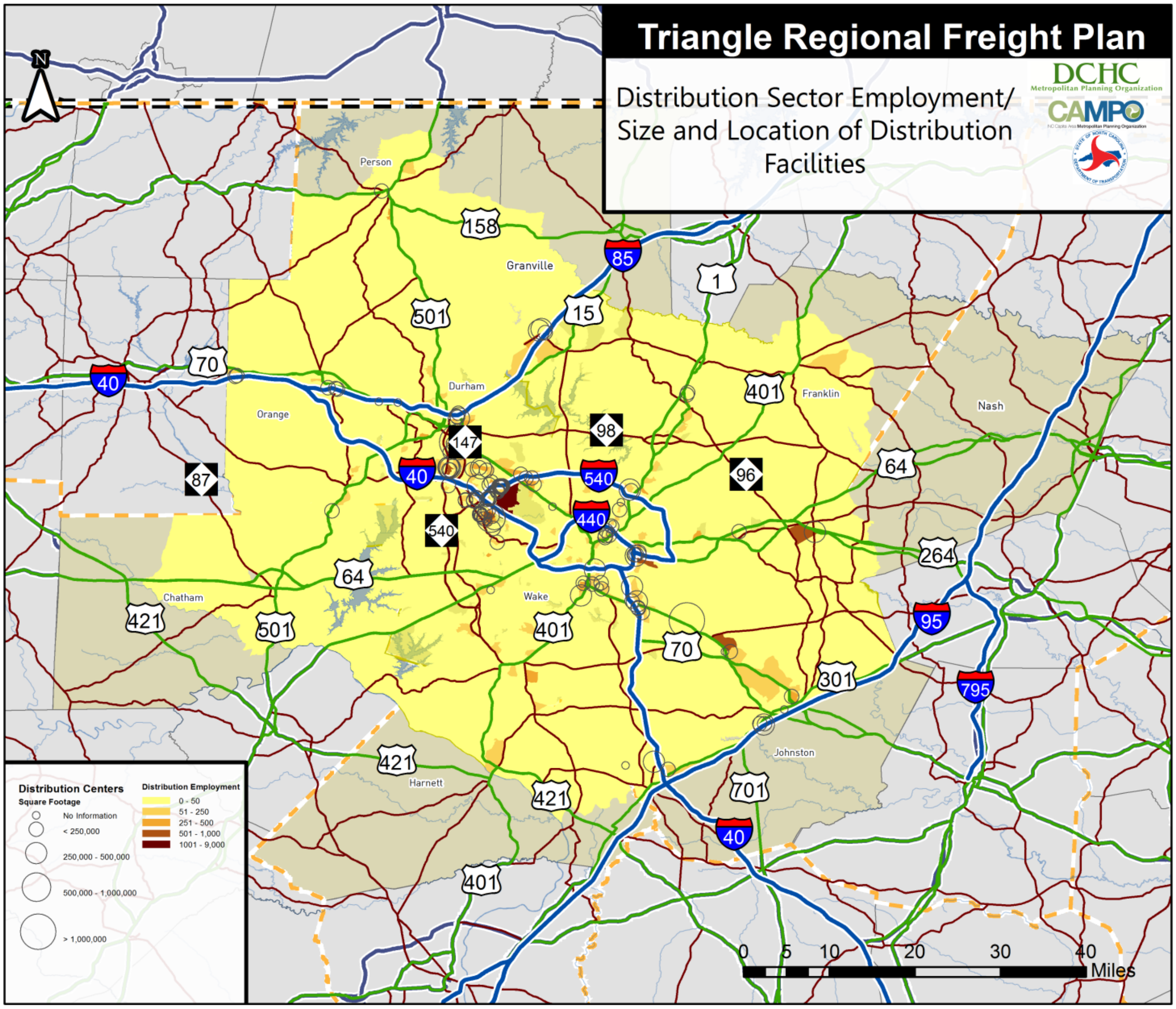


Figure 17: Manufacturing Sector Employment/ Size and Location of Facilities



Source: InfoUSA (2013); Westat (2015).

Figure 18: Distribution Sector Employment/ Size and Location of Facilities



Source: InfoUSA (2013); Westat (2015).

Highway Freight Performance

This section of the report examines truck performance on the Triangle Region's highway network as indicated by truck volume data from the North Carolina DOT (NCDOT), truck-involved collision data also from NCDOT, and truck travel time data from the NPMRDS. Combined, these various data sources help to identify the Triangle Region's critical freight corridors, bottlenecks, and areas that present safety concerns for motor carriers.

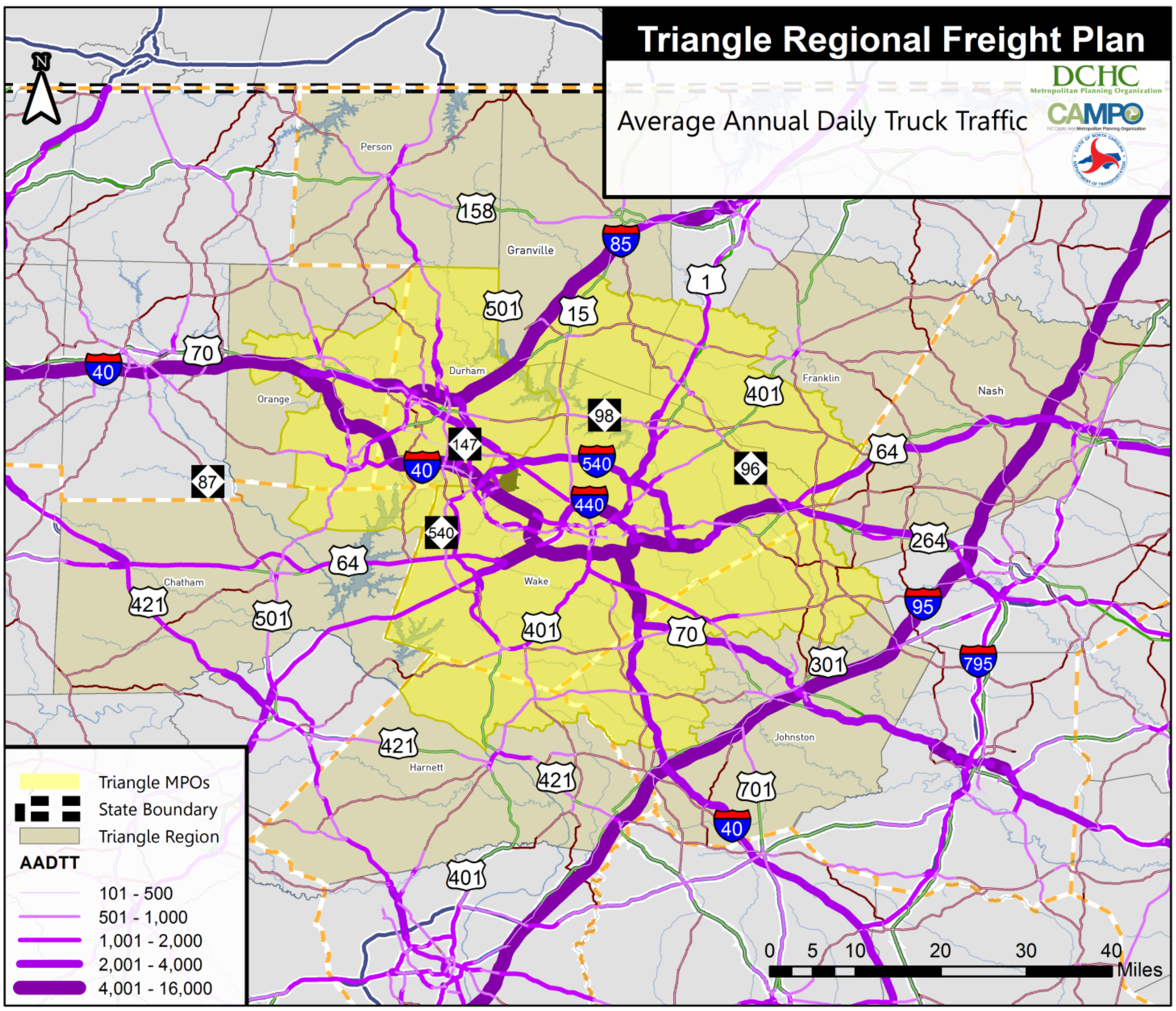
Key Truck Corridors in the Triangle Region

Key truck corridors in the Triangle Region can be identified through the analysis of truck count data. Figure 19 shows a map of the region's average annual daily truck traffic (AADTT) for the year 2014. Darker, thicker lines indicate roadways with higher truck volumes. Intuitively, the Triangle Region's interstate highways carry the bulk of the metropolitan area's truck traffic. Within the core of the

Triangle Region, the largest truck volumes are experienced on I-40 and I-85. Both of these highways carry more than 4,000 trucks daily. Outside the core of the region, I-95 carries close to 8,000 trucks per day at some locations.

Besides the Triangle Region's interstate highways, several state routes and U.S. highways carry significant truck volumes. U.S. Highways 1, 64, 70, and 264 all achieve daily truck volumes between 2,000 and 4,000 along some portion of their routes. SR 55 southwest of downtown Raleigh also reaches this level of daily truck traffic. The relatively high truck volumes on these roadways suggest that they are important corridors for facilitating truck movements within the Triangle Region. In many cases, these routes provide access to areas without nearby interstate highways (the northern portion of the Triangle Region between I-95 and I-85 for example).

Figure 19: Average Annual Daily Truck Traffic (AADTT), 2014



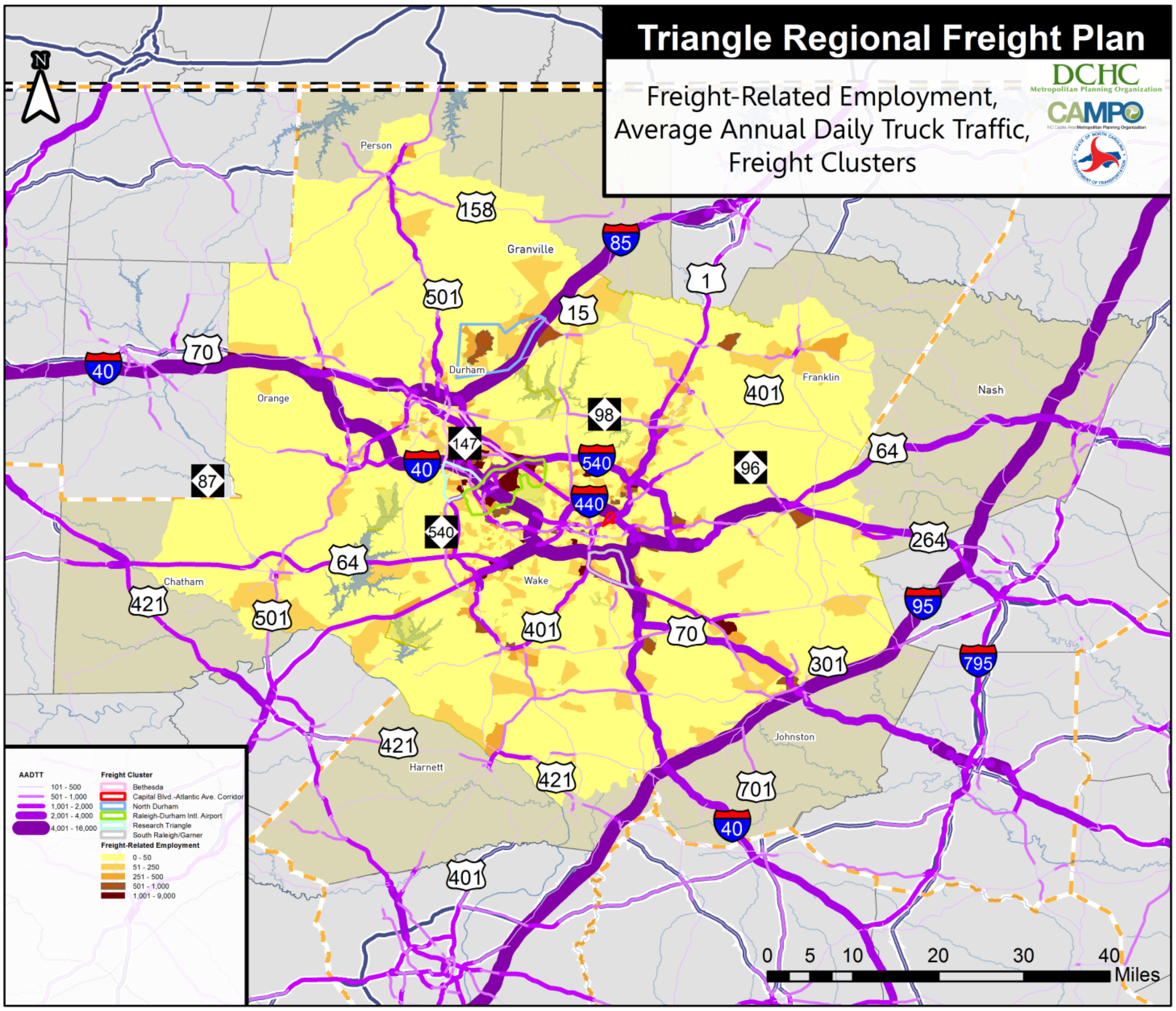
Source: NCDOT.

Truck Volumes near Freight Activity Clusters

Several of the highest concentrations of freight-related employment in the Triangle region are proximate to the most heavily utilized truck routes, as shown in Figure 20, which overlays the clusters of freight-related activity with the AADTT. Several of the freight employment clusters are located southwest of downtown Raleigh along I-40 which experiences some of the highest truck volumes in the region.

Truck volumes are also relatively high along some non-interstate highway corridors, specifically U.S. 1 north of I-540 and U.S. 501 in Person County. Both of the corridors exhibit high levels of freight-related employment with numbers of employees ranging from 250 to over 500.

Figure 20: Freight Sector Employment with Truck Volume Overlay



Source: NCDOT.

Truck Congestion

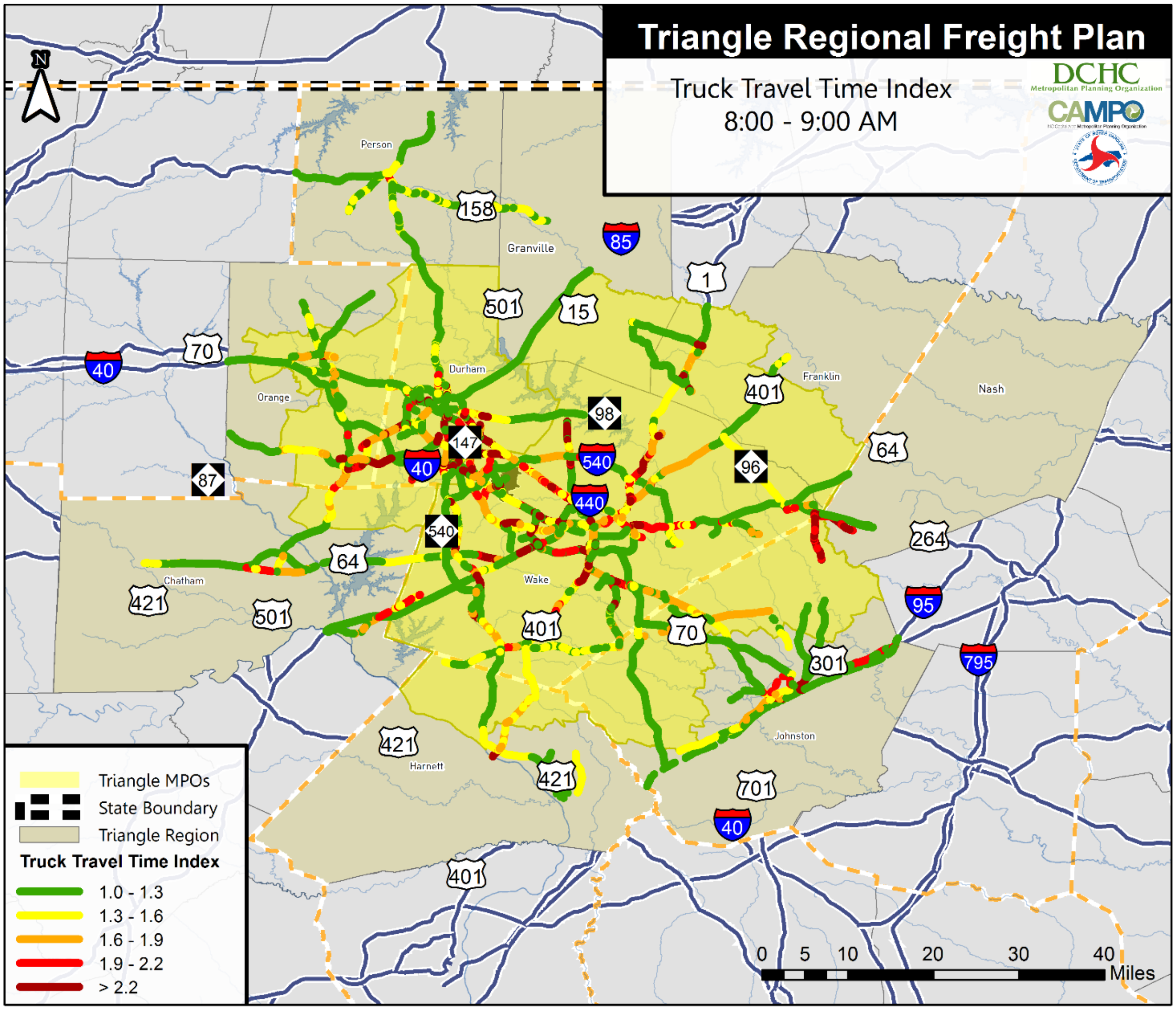
Two measures were used to gauge the level of truck congestion throughout the Triangle Region: average truck speeds and truck travel time index (TTI). TTI is a commonly used measure of congestion intensity on a roadway network. It is expressed as the ratio of travel time during peak conditions to travel time during free flow conditions: Peak Period Travel Time / 15^{th} Percentile Travel Time. Thus, TTI reflects the degree to which speeds decline during peak periods. A low truck TTI indicates that that the peak and off-peak travel periods have generally the same level of intensity, and that variability between these time periods is minimal. Conversely, a high TTI indicates that peak period performance is much worse relative to its off-peak performance. For instance, a TTI equal to 1.6 indicates that travel times during peak periods are 60 percent longer than during free flow conditions.

In this analysis, the morning, midday, and evening peak periods were taken as 8:00 – 9:00 AM, 1:00 – 2:00 PM, and 5:00 – 6:00 PM, respectively. Figure 21 through Figure 23 present maps of the truck TTI in the Triangle Region during April 2015 for the three time periods. Much of the most intense truck congestion in concentrated in Wake County, specifically along the I-40 and I-440 corridors in Raleigh. In addition to the interstate highways, arterials providing cross-town connectivity (specifically U.S. 70, U.S. 1, and U.S. 401) also suffer from relatively intense truck congestion. These corridors, both interstate and arterial, provide access to several freight clusters as indicated by freight-related employment data (see Figure 20) located west and southwest of downtown Raleigh.

Following Wake County the most intense truck congestion in the Triangle Region is experienced in Durham County. However, unlike Wake County where much of the truck congestion is centered in the urban core of Raleigh, much of Durham County's truck congestion is nearest its border with Wake County. This portion of Durham County has three major interchanges relatively proximate to one another: I-540/ U.S. 70, I-540/ I-40, and I-540/ SR 147. Closer to downtown Durham, much of the truck congestion is concentrated along the SR 147, I-85, and U.S. 501 corridors. Similar to Wake County, these corridors provide access to several freight clusters as indicated by the freight-related employment data in Figure 20. Specifically, the I-540 interchanges are proximate to the freight clusters on the border of Durham and Wake Counties.

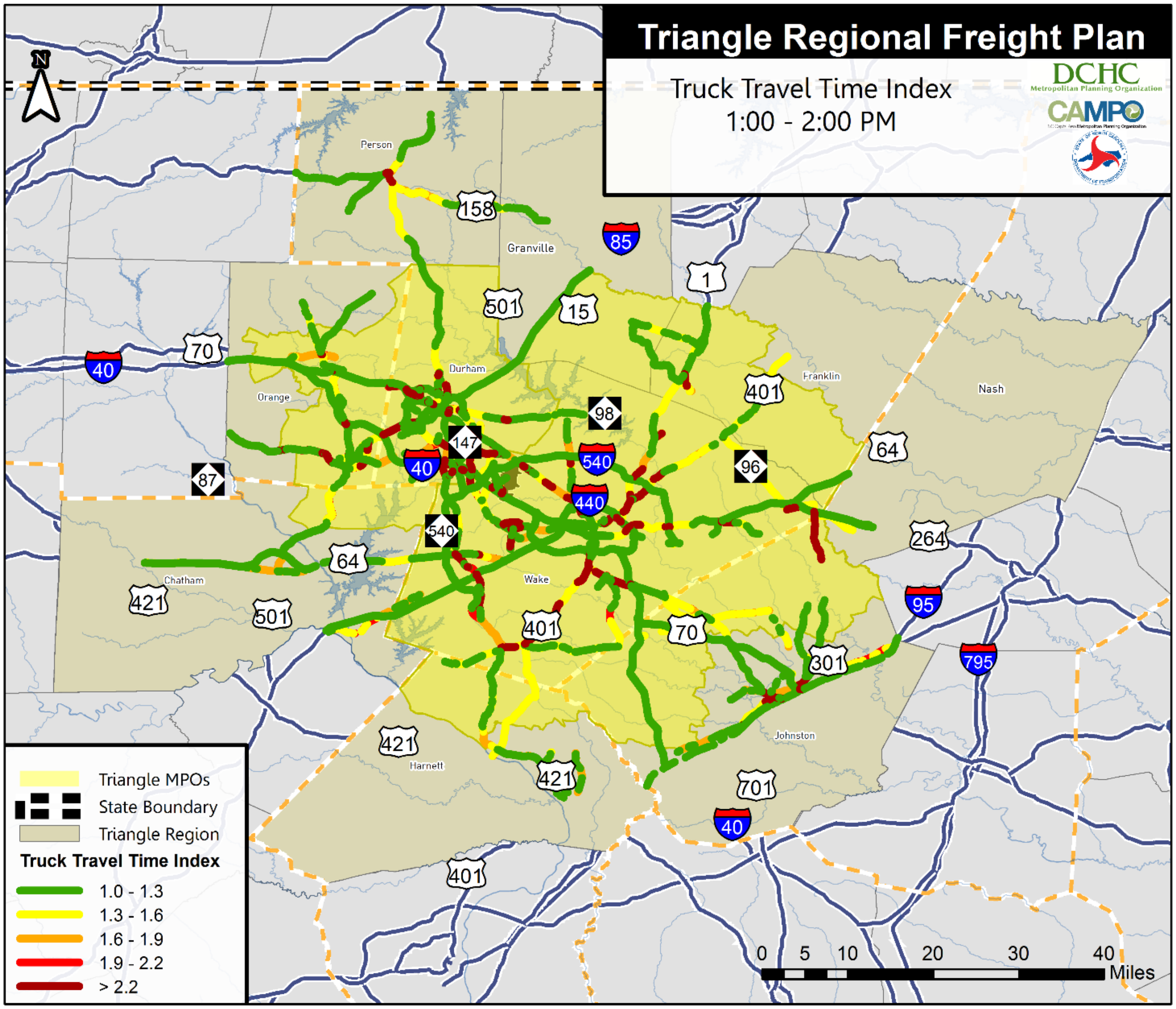
Intuitively, the intensity of truck congestion significantly decreases in the less densely populated portions of the Triangle Region. This includes portions of Harnett, Johnston, Nash, Chatham, Person, Orange, Franklin, and Granville Counties. Though portions of the highway network in these areas do exhibit some severe truck congestion, generally the extent and magnitude of this congestion is not as severe as in Wake and Durham Counties.

Figure 21: Truck Travel Time Index, April 2015 (8:00 – 9:00 AM)



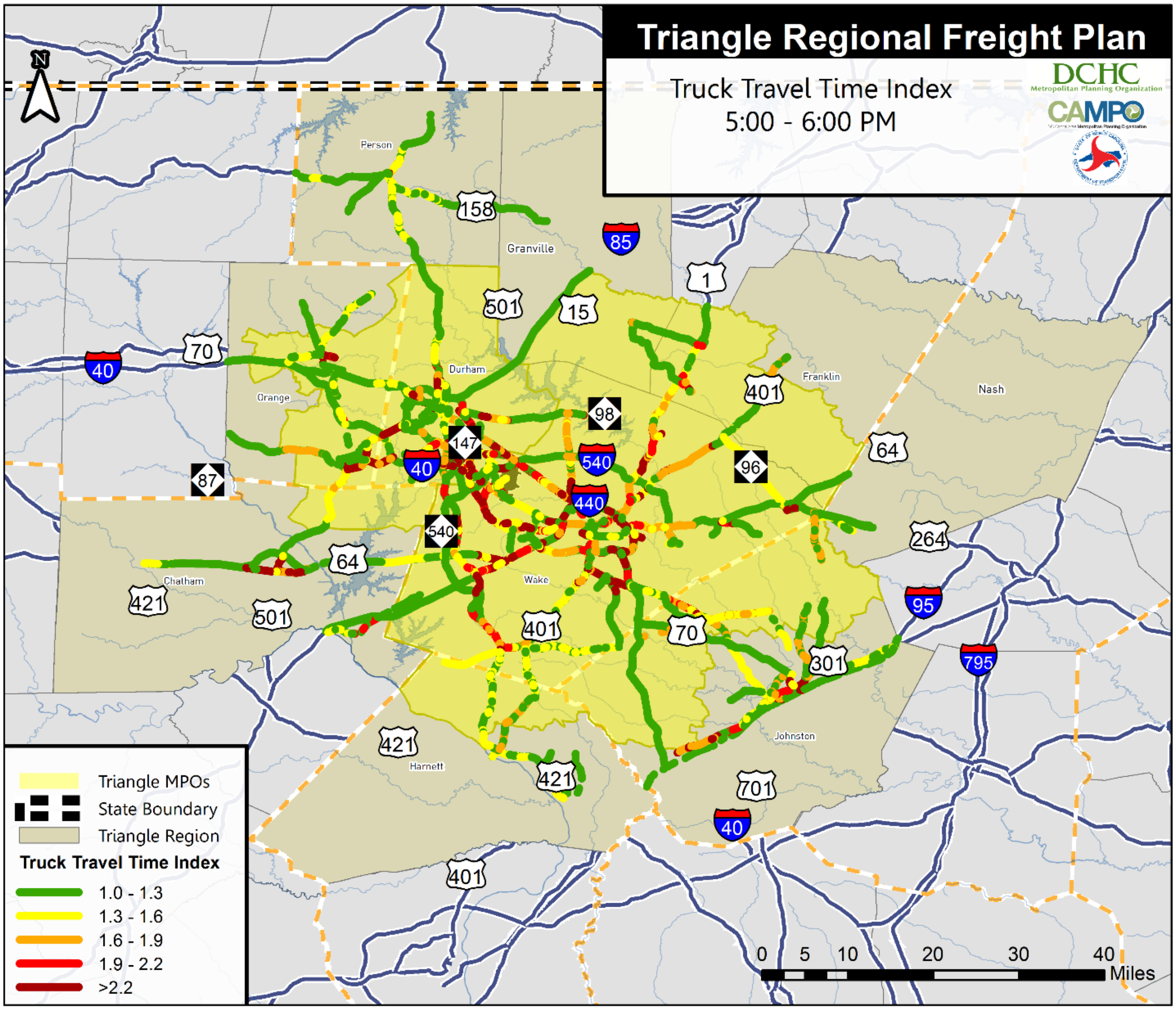
Source: NPMRDS; Consultant analysis.

Figure 22: Truck Travel Time Index, April 2015 (1:00 – 2:00 PM)



Source: NPMRDS; Consultant analysis.

Figure 23: Truck Travel Time Index, April 2015 (5:00 – 6:00 PM)



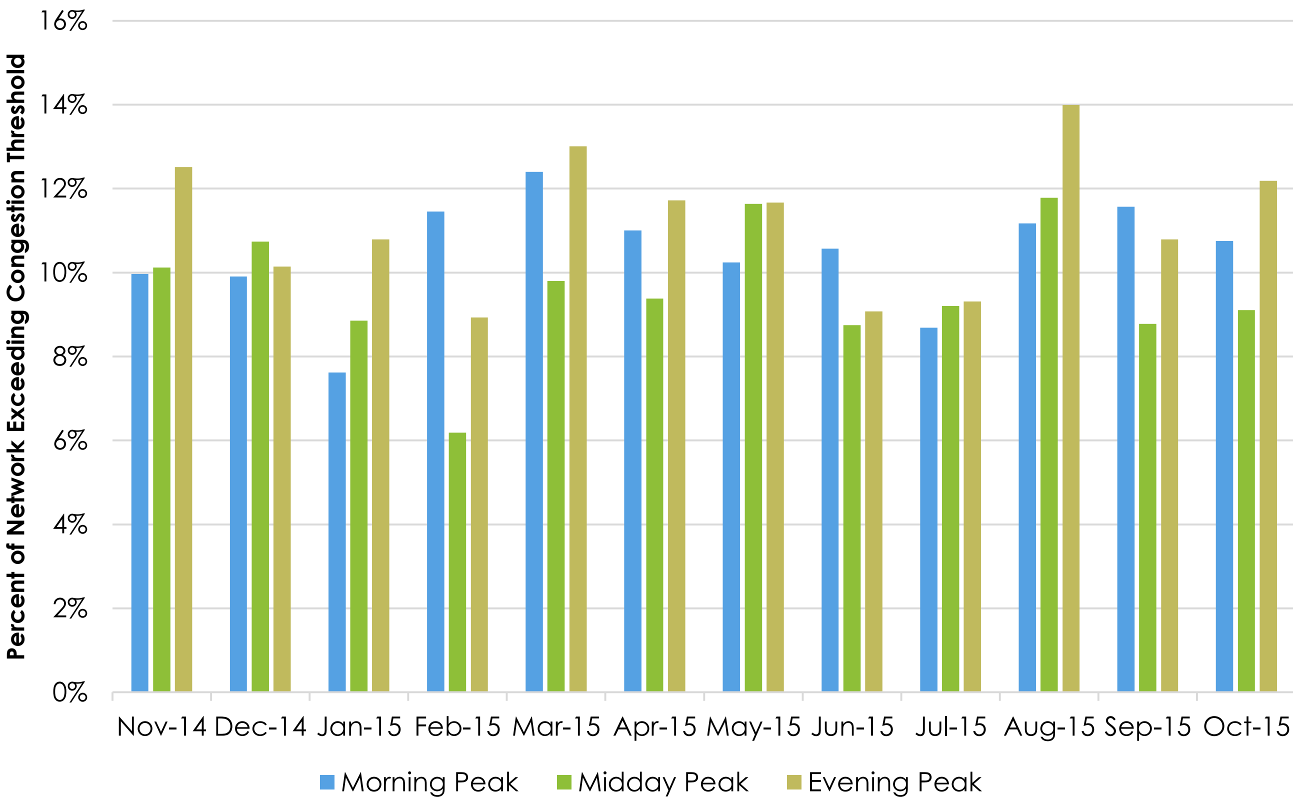
Source: NPMRDS; Consultant analysis.

The truck TTI can also be used to gauge the extent of truck congestion on the Triangle Region's highway network and patterns in seasonality. In this analysis, every link on the highway network that meets or exceeds a TTI value of 1.9 is flagged. For each month of data, the length of the total number of links that meet this threshold is summed and then divided by the sum total length of all links for which there is data during the observation period. That result is then multiplied by 100. This is done for the morning, midday, and evening peak periods. The resulting values indicate the physical extent to which truck congestion is pervasive on the Triangle Region's highway network. High percentages indicate that congestion is widely distributed over the Triangle Region's network while lower values indicate congestion that is less distributed over the network. Differences in the magnitudes of these values across months indicate the extent to seasonal patterns exist in truck performance.

As shown in Figure 24, the extent of truck congestion as indicated by the evening peak period is consistently higher than what is indicated by the morning and midday peaks. Except for February and September 2015, the extent of evening peak congestion met or exceeded the morning peak. Only in December 2014 did the midday peak exceed the extent of evening peak congestion. The reason for this may be that the evening peak is characterized by a number of different trip purposes (e.g. returning home, shopping errands, childcare, etc.) while the morning peak is primarily travel to work and school. This could have the effect of dispersing travel, and consequently congestion, across the highway system.

Also, Figure 24 shows that the extent of congestion tends to peak during March, August, October, and November. In these months, more than 12 percent of the region's network was regularly congested, as indicated by truck traffic conditions, during the morning and/or evening peaks. The reasons for this could be travel associated with holidays or school breaks, in the cases of March and November. Otherwise, the observed differences may be due to year-to-year fluctuations in the data.

Figure 24: Amount of Network Exceeding Truck Travel Time Index Threshold, 11/14 – 10/15



Source: NPMRDS. Consultant analysis.

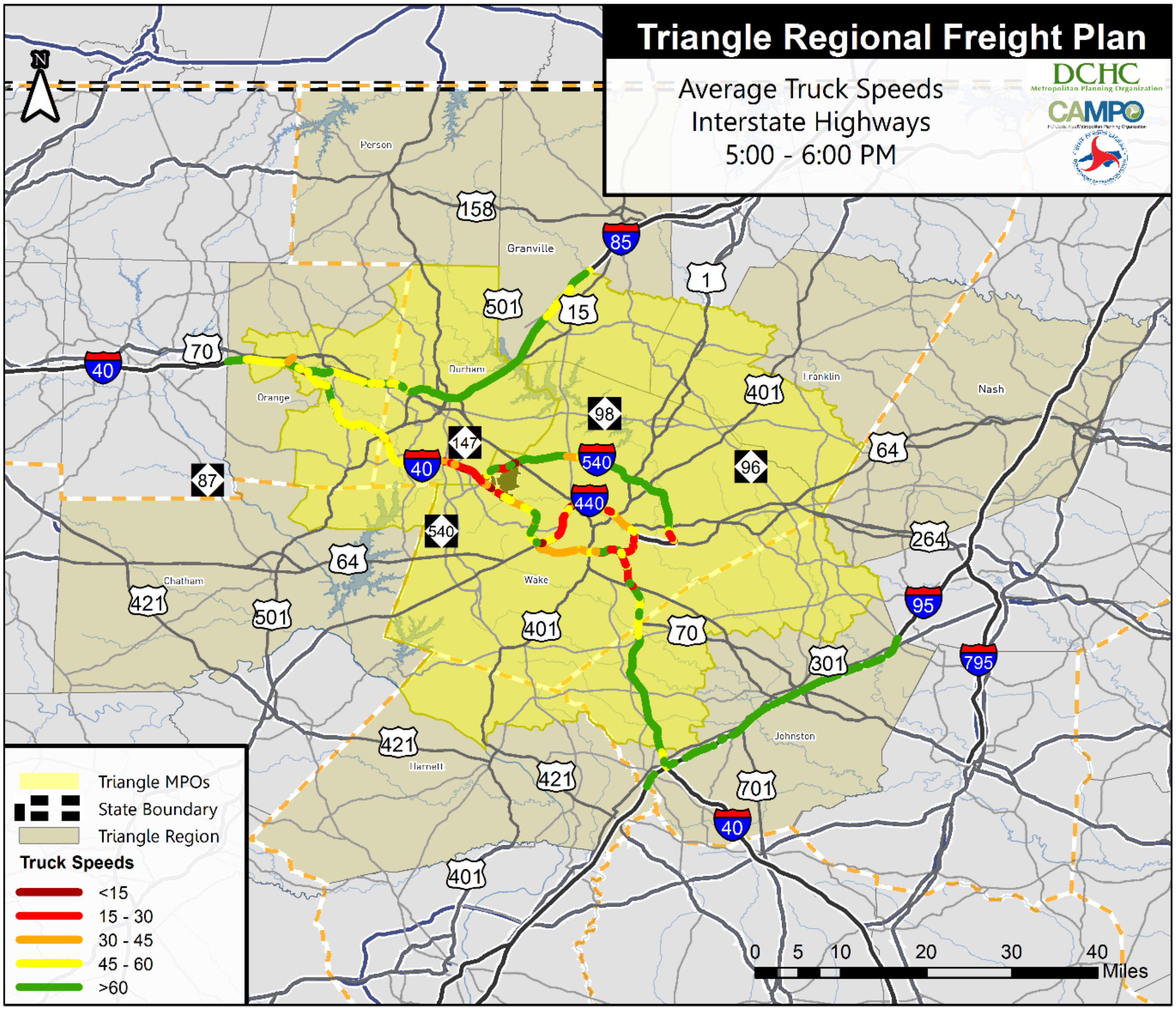
Note: The morning, midday, and evening peak periods are from 8:00 – 9:00 AM, 1:00 – 2:00 PM, and 5:00 – 6:00 PM, respectively.

Average Truck Speeds

When examining truck congestion through the lens of average truck speeds, similar conclusions are drawn. Figure 25 presents the average truck speeds for interstate highways. During the evening peak, truck congestion is concentrated in many of the same areas as identified by examining TTI – primarily the perimeter formed by I-440 and I-40 around Raleigh, and I-40 between I-540 and U.S. 501. Though there is congestion, there are not many portions of the interstate highway system with average speeds that would suggest recurring gridlock. Those portions of the interstate system with recurring average truck speeds below 15 miles per hour primarily occur in the following locations:

near the I-40/I-440 interchange southeast of Raleigh, the I-40/I-440 interchange southwest of Raleigh, the I-540/U.S. 70 interchange, the I-40/I-540 interchange near RDU, and the I-40/Davis Drive interchange. Though only the evening peak is shown, the morning and midday peak periods have similar results.

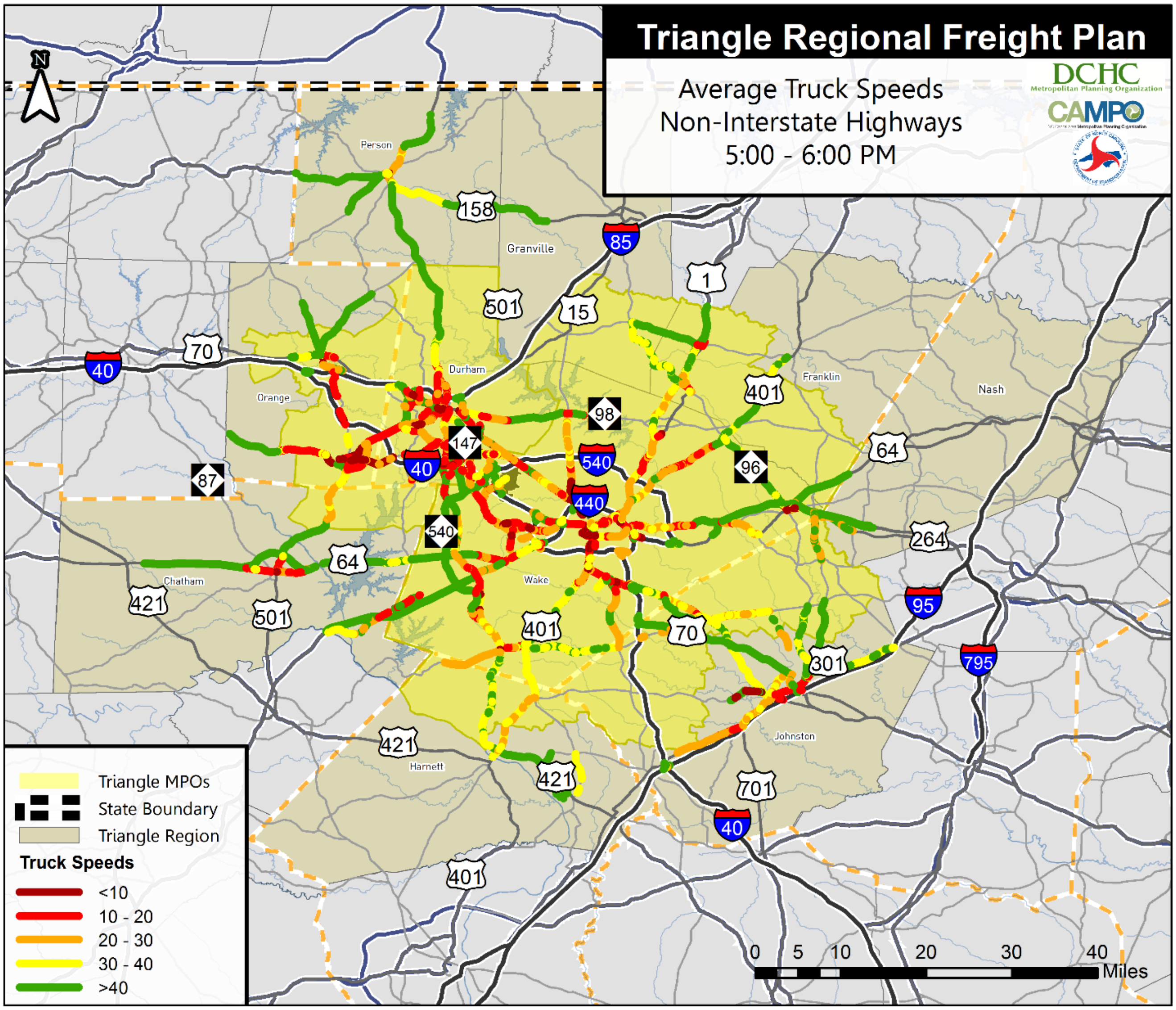
Figure 25: Average Truck Speeds on Interstate Highways, April 2015 (5:00 – 6:00 PM)



Source: NPMRDS; Consultant analysis.

Average truck speeds are much lower on the Triangle Region's non-interstate highways as shown in Figure 26. Many of these roadways have average truck speeds between 10 and 20 miles per hour. However, given that these roadways are in a large metropolitan area, those speeds may be necessary for safe operations. Intuitively, those roadways with the slowest average speeds (i.e. 10 miles per hour and below) are mostly clustered in or near the cities of Raleigh and Durham. For instance, in Durham portions of SR 54 near I-40, TW Alexander Drive and SR 55 near I-40, and U.S. 70/Hillsborough Blvd. near I-85, among others, all exhibit among the lowest average truck speeds during the evening peak. In Raleigh, the confluence of U.S. 70 and SR 50 at I-440, Hillsborough Street and McDowell Street near downtown Raleigh, and the intersection of Fayetteville Road and U.S. 70 south of I-40, among others, all exhibit among the slowest average truck speeds.

Figure 26: Average Truck Speeds on Non-Interstate Highways, April 2015 (5:00 – 6:00 PM)



Source: NPMRDS; Consultant analysis.

Truck Travel Time Reliability

A similar analysis was done to gauge truck travel time reliability in the Triangle Region. In general, measures of reliability gauge the variability of travel times between peak and non-peak periods. Roadway segments with highly variable travel times are deemed less reliable than those with more consistent travel times. Reliability is a particularly useful freight performance measure because it is directly related to a motor carrier's operating cost. Truck travel on less reliable routes compels carriers to build into their schedules extra time because they are unsure of the actual travel time any given trip on that route will require. This results in lower productivity and higher effective costs, in the form of less output per hour of labor and forgone opportunities to use a truck to carry an additional shipment.

This analysis measures reliability via the buffer time index (BTI). The BTI is the ratio of the difference between the 95th percentile truck travel time and average travel time to the average travel time: (95th Percentile Travel Time – Average Travel Time) / Average Travel Time. Thus, the BTI represents the extra time (i.e. buffer) that must be factored into scheduling to ensure an on-time arrival for 95 percent of truck trips. The freight industry uses 95 percent on-time arrival as a minimum standard of reliability, so the BTI represents the standard threshold for dependable schedule times. A lower BTI indicates that expected travel delays are negligible and additional time may not be required to travel through that corridor. A higher BTI indicates the opposite, that extra travel time is needed to traverse a corridor. For example, a BTI equal to 1.0 indicates that a trip that on average takes 1 hour would need an extra hour (for a total scheduled travel time of 2 hours) to reach its destination on time. This is illustrated in Figure 27. The buffer is unproductive time added to every schedule. It causes carriers to add more equipment and more drivers to handle shipments, and shipments are therefore more expensive.

Figure 27: Example of Buffer Time Index

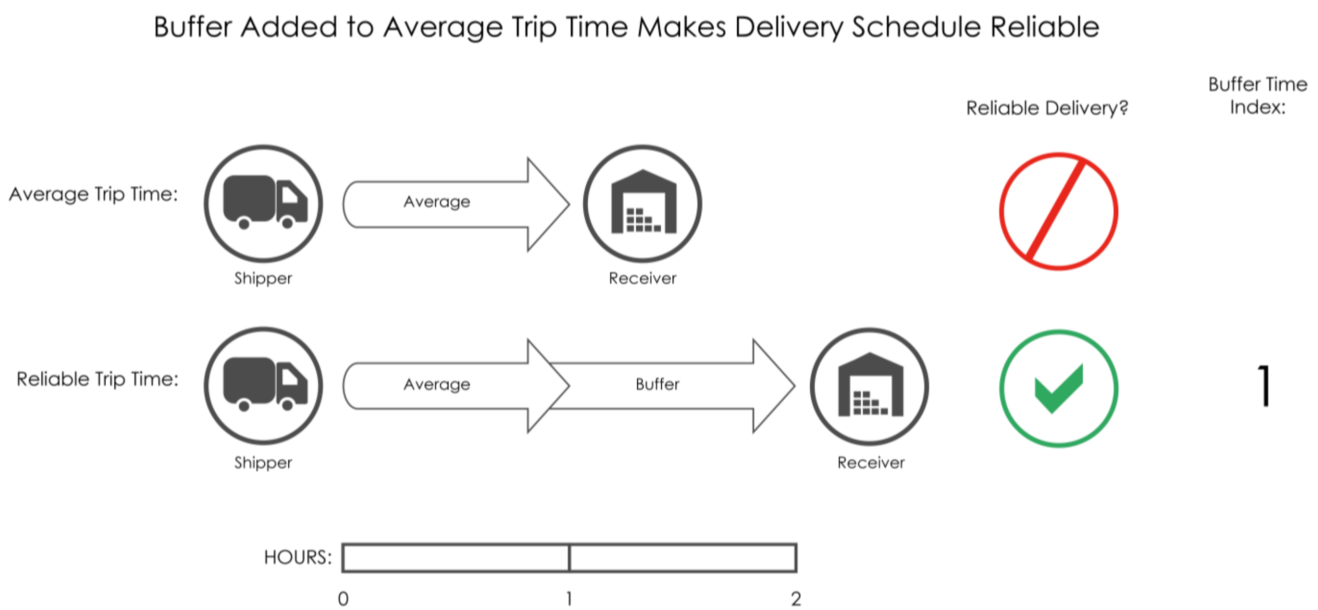
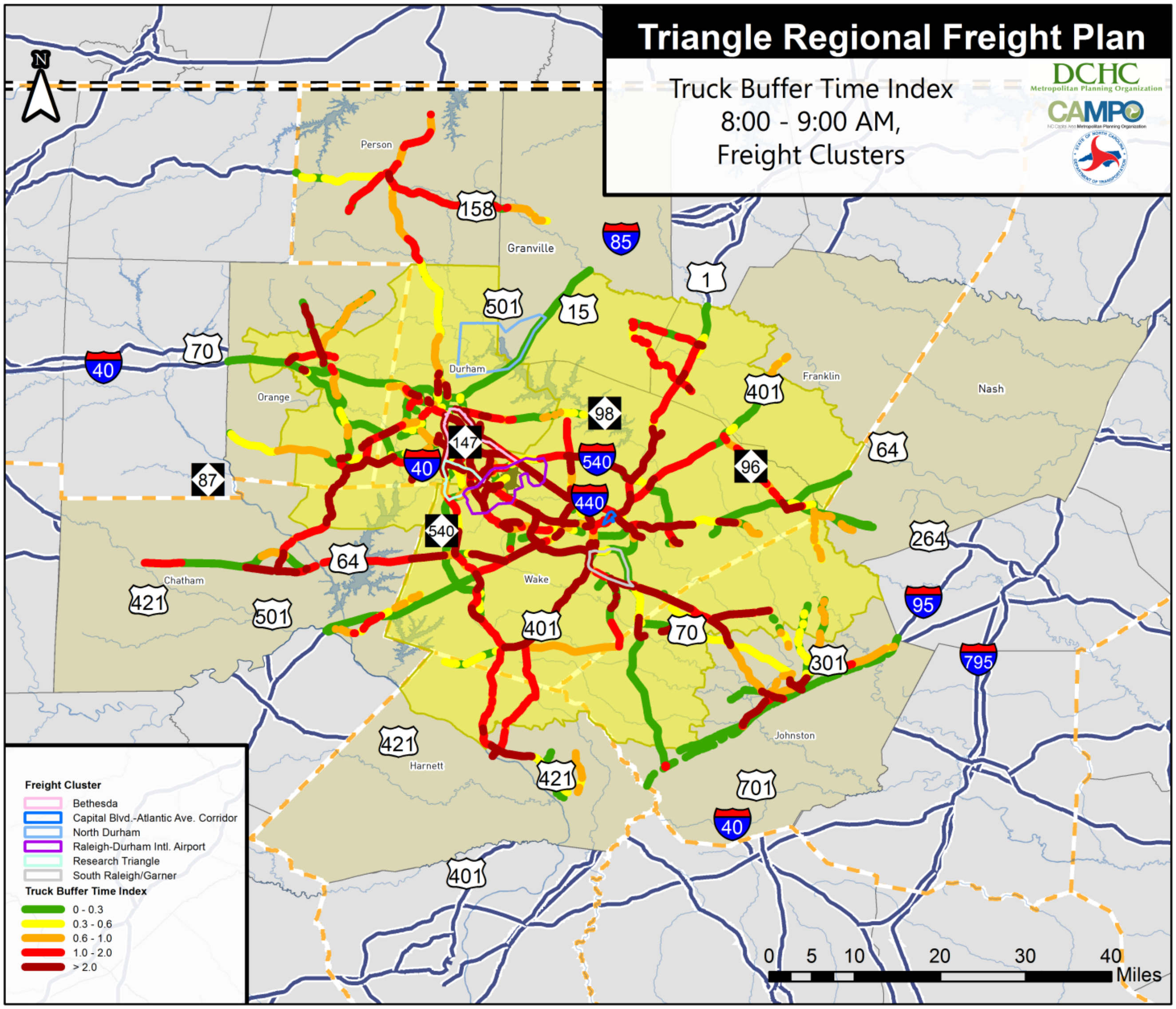


Figure 28 through Figure 30 present maps of BTI in the Triangle Region for peak and mid-day periods during the month of April 2015. Similar to the results for truck congestion, the most unreliable roadway segments are concentrated in Wake County, specifically along the I-40, I-440, and I-540 (west of U.S. 1) corridors in Raleigh. In addition to those corridors, several important arterials (namely U.S. 70, U.S. 1, and U.S. 401) exhibit poor reliability as well. While morning peak appears the most challenging and conditions can be better at later hours (notably along I-540), many facilities remain under stress throughout the day.

As in the analysis of truck congestion, following Wake County the most unreliable portions of the Triangle Region's network are in Durham County. Specifically, the roadway network east of U.S. 15 near its border with Wake County experiences heavy unreliability during the evening peak. Closer to downtown Durham, the most unreliable roadway segments are along the SR 147, I-85, and U.S. 501 corridors.

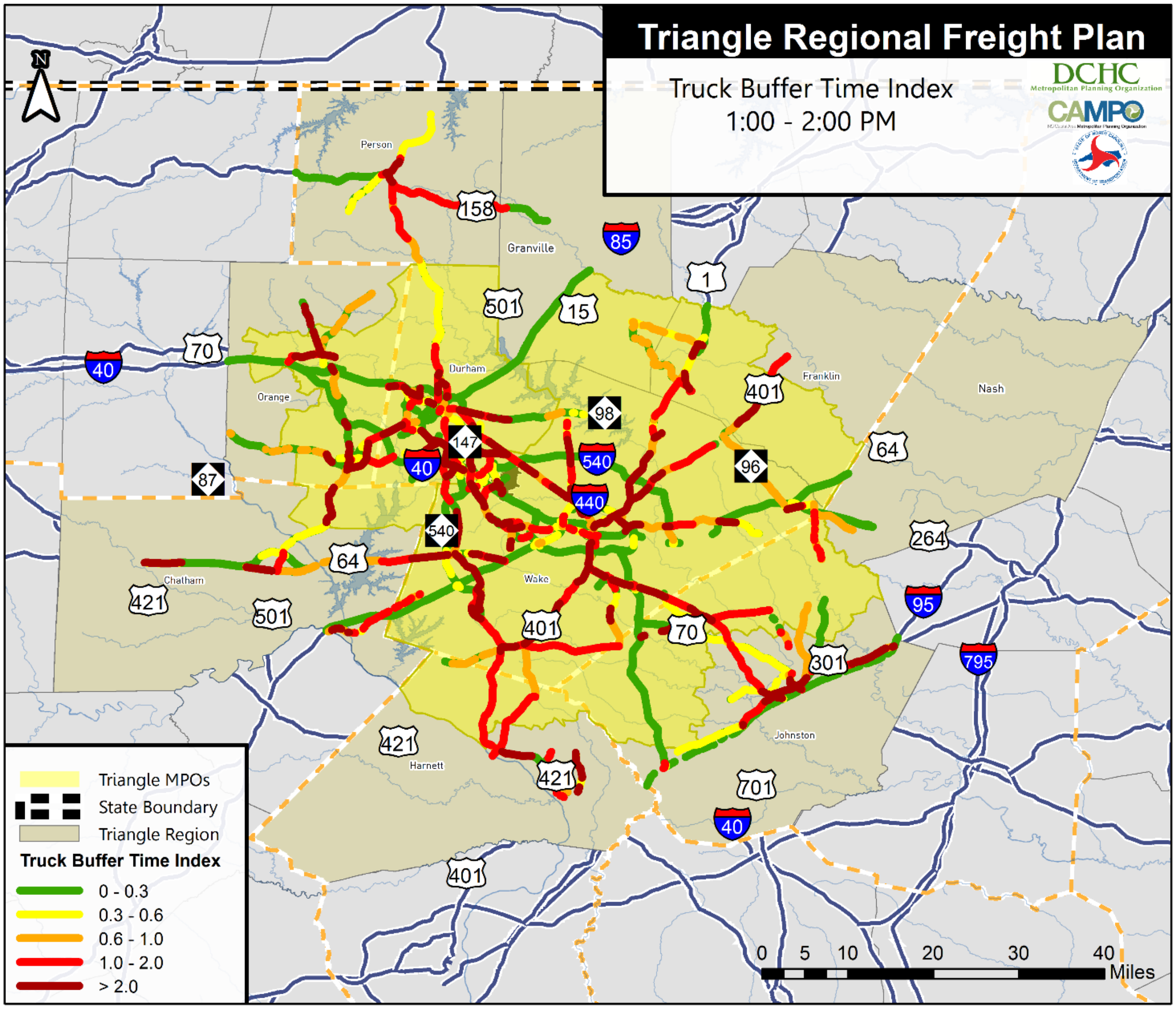
Similar to the observations on truck congestion, reliability improves as trucks travel away from the urban core of the Triangle Region. This is intuitive since those areas are much less densely populated and thus experience lower traffic volumes. However, the most unreliable portions of the network are located nearest the region's freight clusters, as indicated for the morning peak in the map below. Apart from North Durham cluster - itself the most distant from the core – the region's freight concentrations face clear challenges on their access. This directly impacts the ability of those firms to build and maintain reliable supply chains.

Figure 28: Truck Buffer Time Index, April 2015 (8:00 – 9:00 AM)



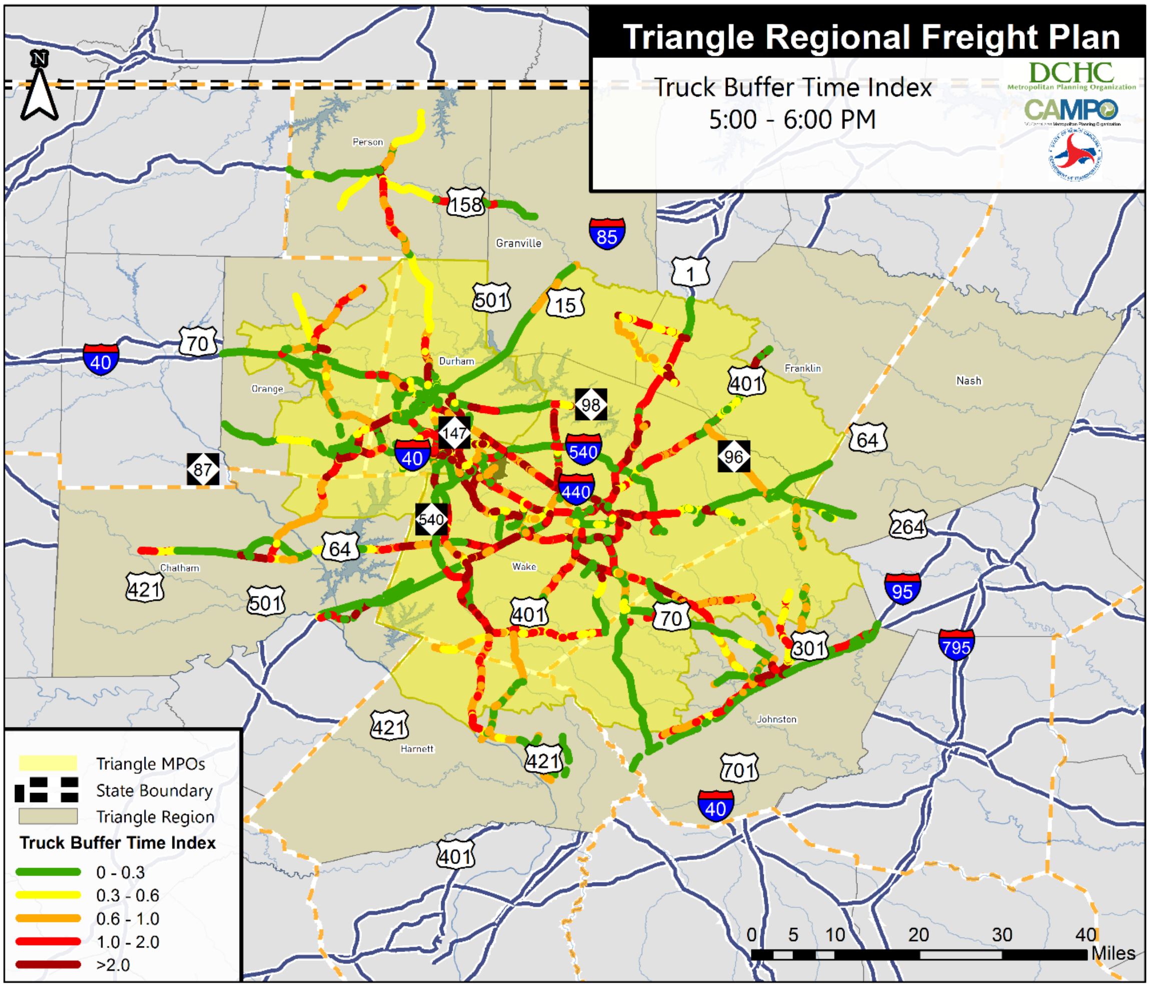
Source: NPMRDS; Consultant analysis.

Figure 29: Truck Buffer Time Index, April 2015 (1:00 – 2:00 PM)



Source: NPMRDS; Consultant analysis.

Figure 30: Truck Buffer Time Index, April 2015 (5:00 – 6:00 PM)



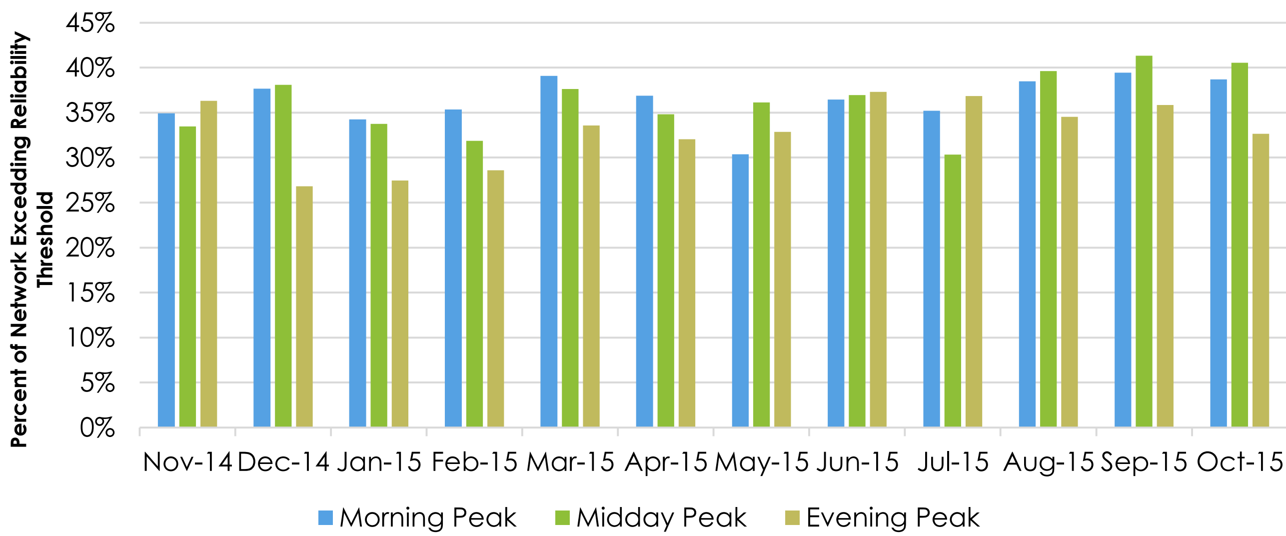
Source: NPMRDS; Consultant analysis.

Similar to truck TTI, the BTI can also be used to gauge the extent of poor truck travel time reliability on the Triangle Region's highway network and patterns in seasonality. In this analysis, every link on the highway network that meets or exceeds a BTI value of 1.0 is flagged. For each month over the 12-month observation period, the length of the total number of links that meet this threshold is summed and then divided by the sum total length of all links for which there is data during the peak period. That result is then multiplied by 100. The resulting values indicate the physical extent to which truck congestion is pervasive on the Triangle Region's highway network for the morning (8:00 – 9:00 AM), midday (1:00 – 2:00 PM), and evening peaks (5:00 – 6:00 PM). Differences in the magnitudes of these values indicate the extent to seasonal patterns exist in truck reliability performance.

As shown in Figure 31, reliability does not exhibit seasonality to the extent that congestion does (see Figure 24). Also, unlike what was observed with truck congestion, in general the poor reliability is more extensive across the Triangle Region's highway network during the morning and midday peak periods. Evening peak period unreliability is more extensive during the summer months – May to July 2015.

Figure 31 also shows that in general poor reliability is more pervasive throughout the Triangle Region network than is congestion. Up to one-third of the network regularly exceeded the BTI threshold over the 12-month period. Likely reasons for this include recurring congestion due to heavy traffic volumes that lead to the breakdown of traffic flows on the network. Another likely contributing factor is non-recurring congestion (due to weather, vehicle malfunctions, construction, and incidents, among others).

Figure 31: Amount of Network Exceeding Buffer Time Index Threshold, Nov. 2014 – Oct. 2015



Source: NPMRDS. Consultant analysis.

Note: The morning, midday, and evening peak periods are from 8:00 – 9:00 AM, 1:00 – 2:00 PM, and 5:00 – 6:00 PM, respectively.

Truck-Involved Collisions

At the regional level, Table 9 shows the breakdown of truck-involved collisions by county. The data was collected by NCDOT over the five year period between January 2010 and December 2014. In the context of this analysis, truck-involved collisions are defined as those involving at least one of the following vehicle types: truck/trailer, truck/tractor, tractor/semi-trailer, tractor/doubles, or unknown heavy truck. Wake County experienced the highest proportion of truck collisions, with 2,365 crashes (43 percent) reported during this period. This is a far higher percentage than the next two highest counties, Durham and Johnston, which each had 15 and 12 percent of all truck-involved crashes, respectively.

Table 9: Truck-Involved Crashes by County, Jan 2010 – Dec 2014

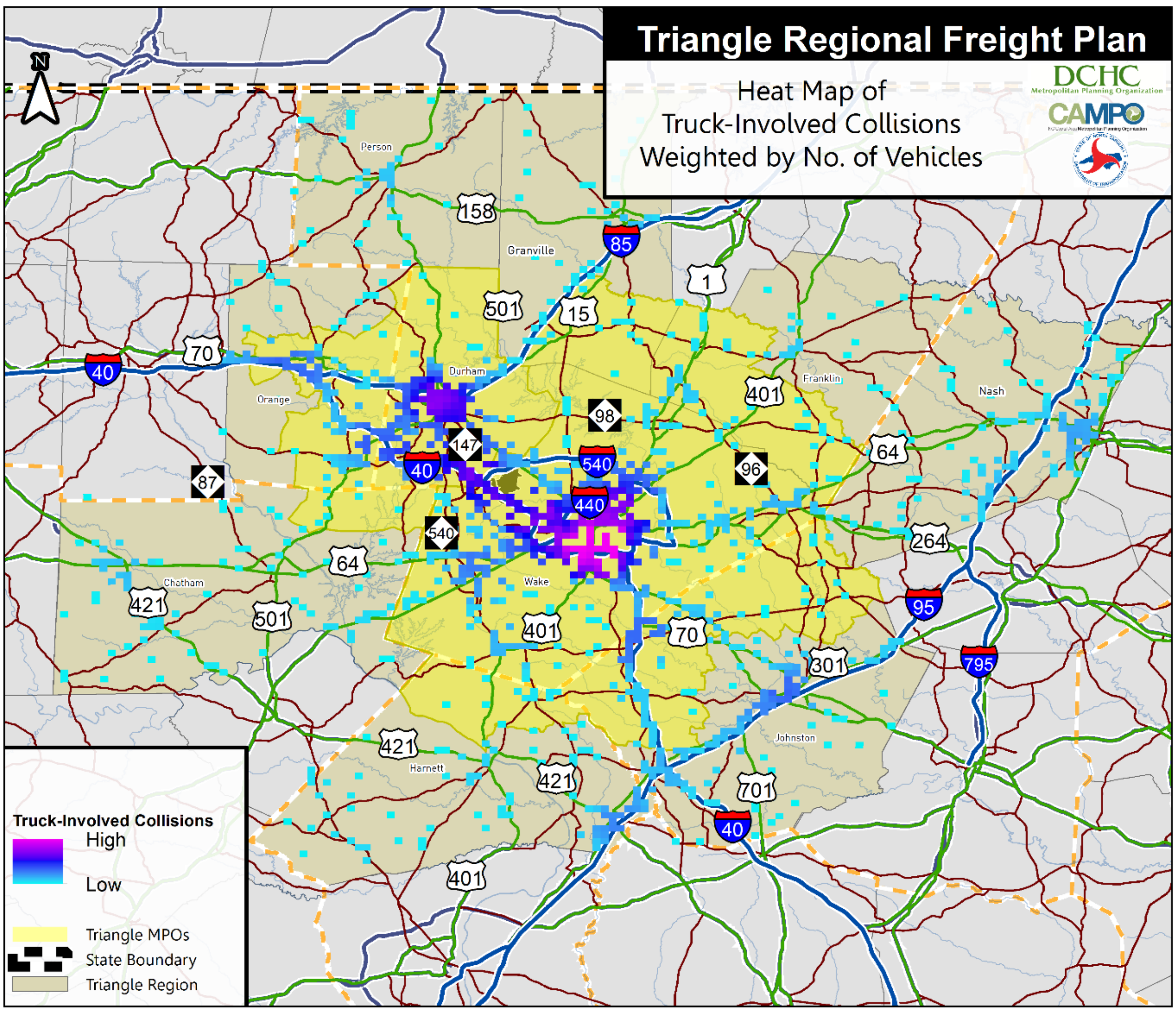
County	Total Crashes	Percentage of Total Crashes
Wake	2,365	43%
Durham	844	15%
Johnston	675	12%
Nash	394	7%
Orange	392	7%
Harnett	295	5%
Granville	189	3%
Chatham	175	3%
Franklin	118	2%

County	Total Crashes	Percentage of Total Crashes
Person	72	1%
Total	**5,519**	**100%**

Source: NCDOT.

Figure 32 presents a heat map showing the distribution of truck-involved crashes throughout the region. The color ramp conveys the concentration of truck-involved collisions on a scale from low to high and are weighted by the number vehicles involved in the incident. Intuitively, the majority of truck-involved crashes occurred along the Interstate Highway System and state routes. These routes carry the majority of the region's truck traffic. Further, the highest clusters of truck-involved collisions were apparent in the cities of Durham and Raleigh. This is also intuitive as these cities contain much of the region's highway infrastructure. However, Raleigh has a noticeably higher concentration of truck-involved collisions than Durham. Many of these occur on the perimeter formed by I-440 and I-40. Additionally, many truck-involved collisions occur on U.S. 70 and U.S. 1 the primary north-south routes through Raleigh.

Figure 32: Heat Map of Truck-Involved Collisions in the Triangle Region



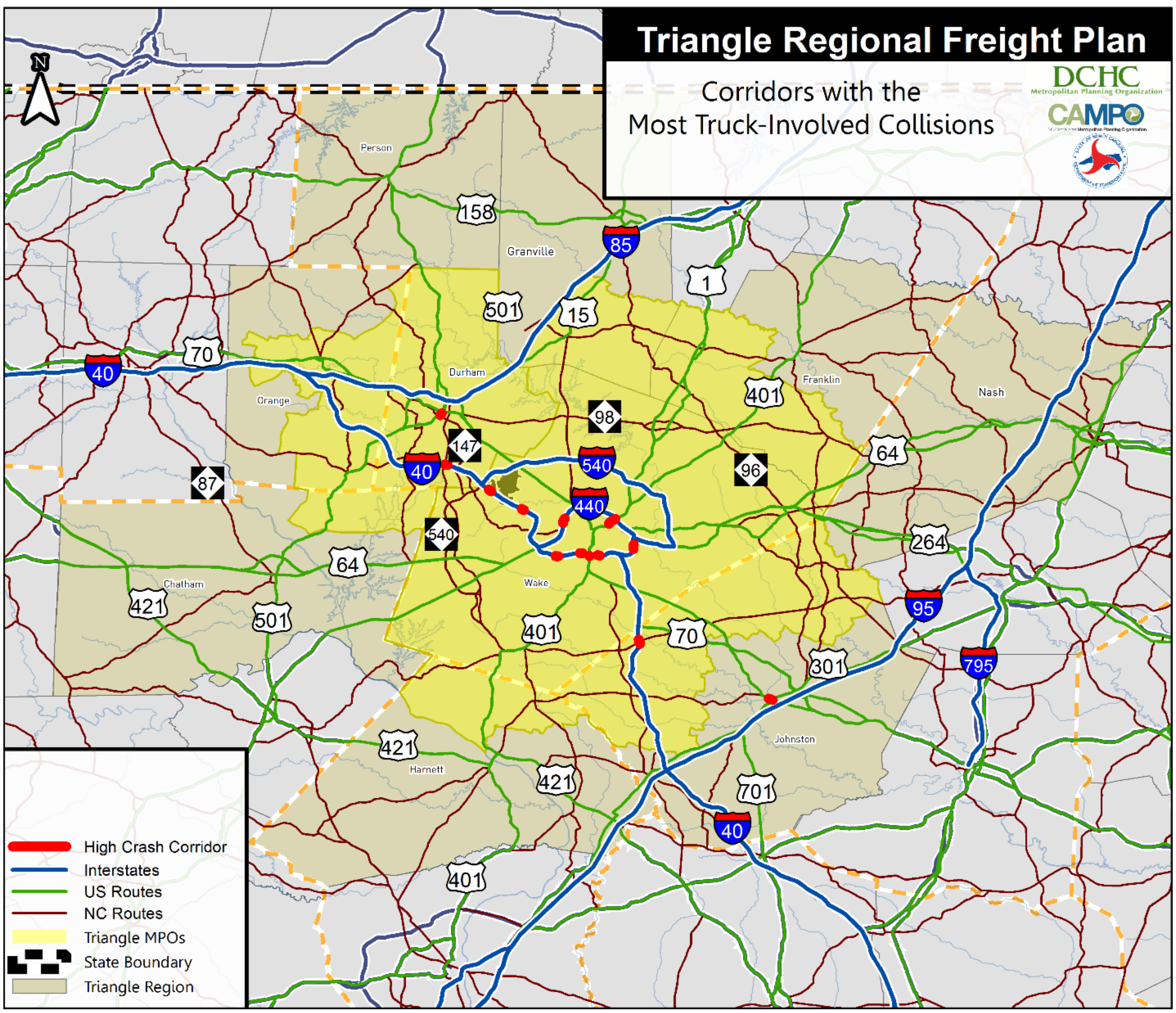
Source: NCDOT.

The highway corridors with the highest occurrences of truck-involved collisions are shown in Figure 33. These corridors were identified by joining the geocoded collisions to the NCDOT highway network. Then the truck crash rate for each segment was calculated as follows: $R = \frac{C*1{,}000{,}000}{V*365*N*L}$. In the equation, the variables are defined as follows:

- R = the crash rate expressed as crashes per 1 million truck-miles traveled;
- C = the total number of crashes on a roadway segment;
- V = AADTT;
- N = number of years of data;
- L = length of the roadway segment.

The corridors highlighted in Figure 33 are only those which had 10 or more truck-involved crashes occur over the five year period from 2010 to 2014. In addition, they all have truck crash rates in excess of 3 crashes per 1 million truck-miles of travel.

Figure 33: Concentration of Truck-Involved Collisions on Key Corridors in the Triangle Region



Source: NCDOT; Consultant analysis.

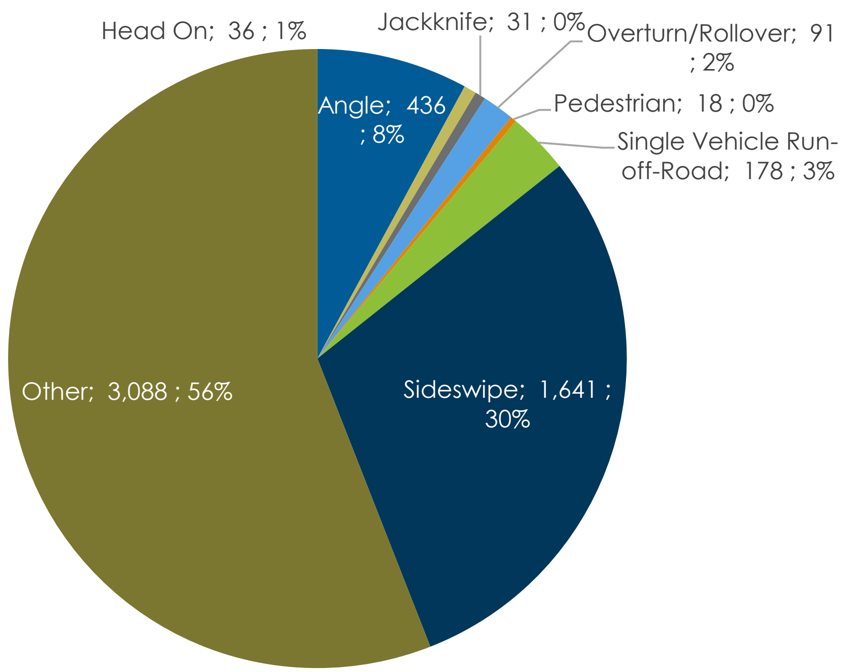
Figure 33 shows that at the roadway segment level, the Triangle Region's truck-involved crashes are concentrated along the I-40 corridor. In particular, I-40 between its two interchanges with I-440 and from Wade Avenue to SR 147 have high rates of truck crashes relative to other parts of the region. The I-40 corridor also exhibits high crash rates near its interchange with U.S. 70/Clayton Bypass and east of Durham where it merges with I-85. Portions of I-440 and I-95 also have relatively high rates of truck collisions. Despite crash rates that are high relative to other parts of the region, the overall number of truck-involved collisions on these roadways does not suggest a significant safety problem. Instead, Figure 33 implies which portions of the region's infrastructure do not perform as well as other portions in terms of truck safety. Generally, the Triangle Region's highway system performs well in the area of truck safety.

Figure 34 presents the breakdown of truck-involved crashes by crash type in the Triangle Region. Collision types are classified into seven different categories:

1) Head On collisions are those in which the front ends of two vehicles traveling in opposite directions collide;
2) Angle collisions are those in which the front end of one vehicle strikes the side of the other vehicle;
3) Jackknife incidents are those where the truck's trailer pushes into the cab forcing the entire vehicle into a folded position;
4) Overturn/Roller incidents are those where a vehicle tips over onto its side;
5) Single Vehicle Run-off-Road incidents are those where a vehicle departs the roadway;
6) Sideswipe collisions are those where the sides of two vehicles strike each other;
7) Pedestrian collisions are those where a vehicle strikes a pedestrian;

The largest single crash type category is sideswipe, which accounted for over 1,600 crashes and comprised 30 percent of total truck crashes in the region. Angle crashes were another common crash type, comprising 8 percent of total truck crashes. This type of crash can happen in several ways, including same direction, opposite direction, and right angle (also known as T-Bone crashes). The "other" category includes crashes involving animals, backing up, movable objects, and rear ends, among others.

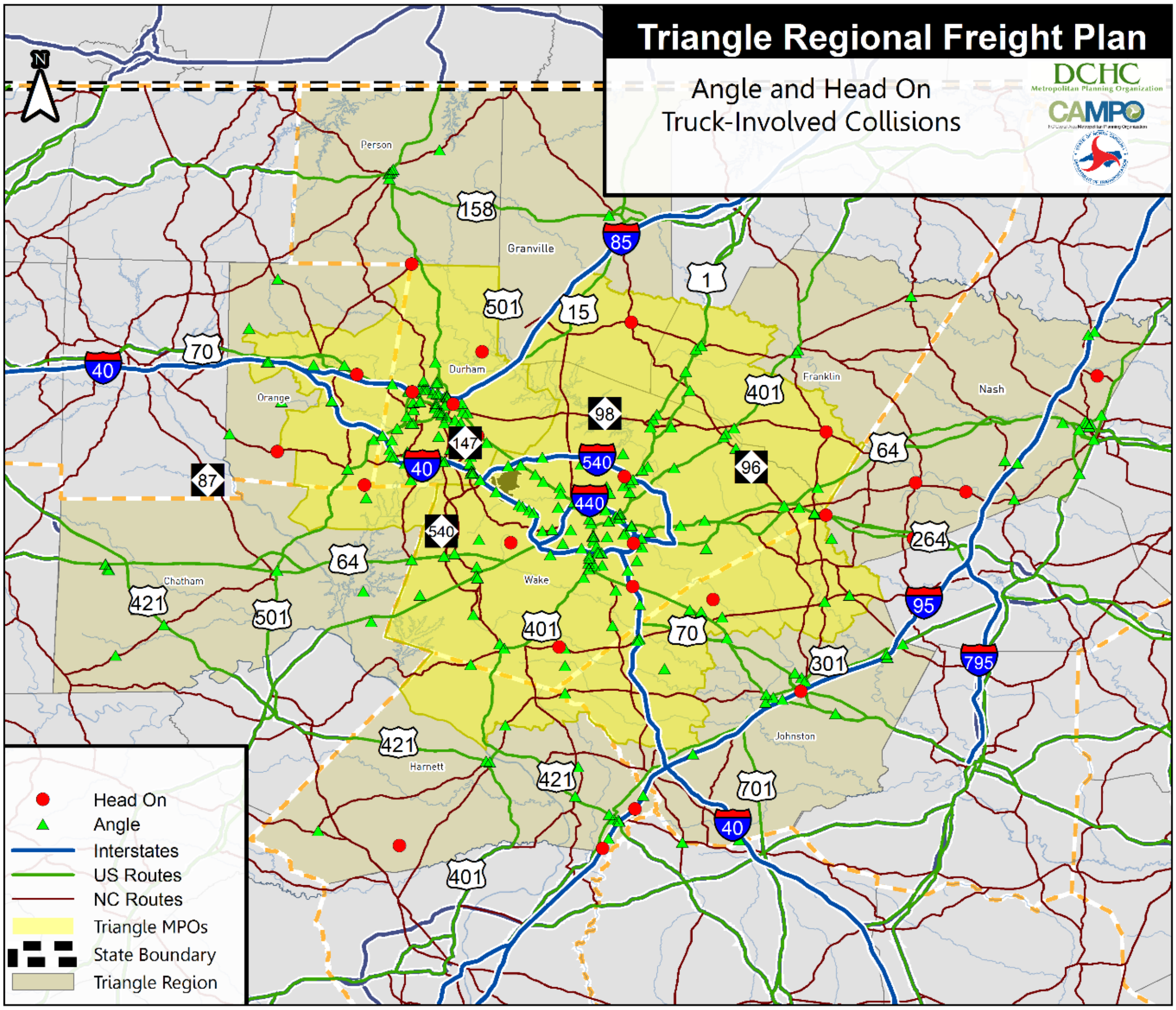
Figure 34: Truck-Involved Collisions by Crash Type



Source: NCDOT.

Given that truck-involved angle and head on collisions are particularly dangerous, the locations at which these crashes occurred are shown in Figure 35. Many of these collisions occur on state as opposed to National Highway System (NHS) roadways. Often, these roadways are not median separated which helps to prevent head on collisions. Head on collisions are distributed throughout the Triangle Region. Like all other crash types, angle collisions are mostly clustered within the urban cores of Raleigh and Durham where there are more opportunities for conflicting movements and interactions with passenger vehicles.

Figure 35: Truck-Involved Angle and Head-On Collisions

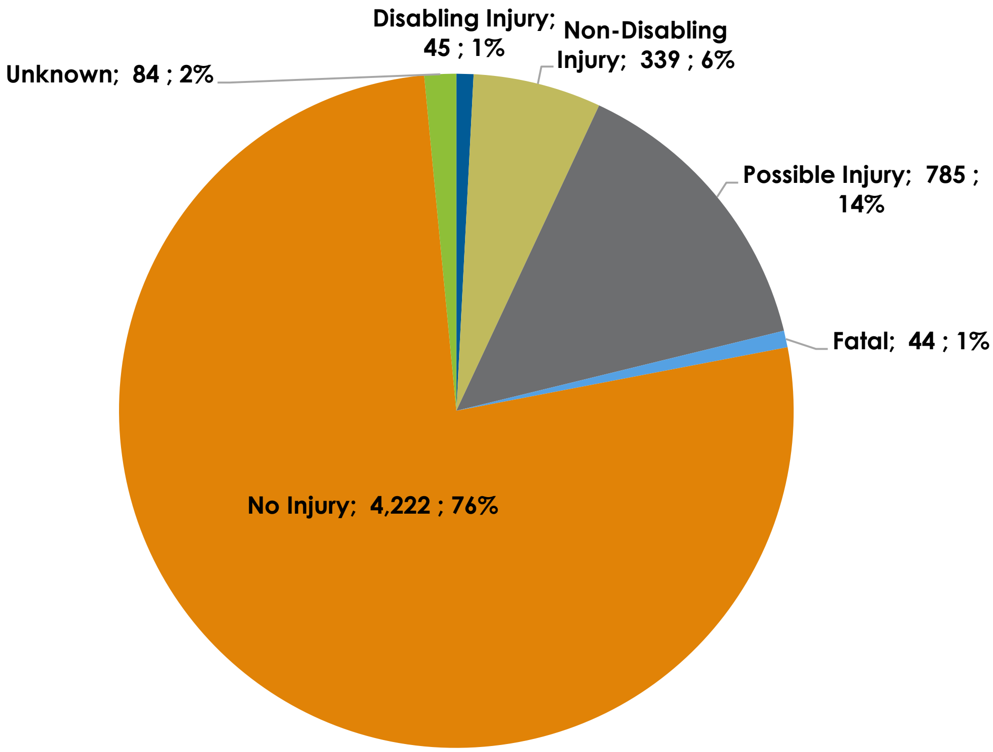


Source: NCDOT

Figure 36 7 presents the breakdown of truck-involved crashes in the Triangle Region by crash severity. Over three-quarters of all truck-involved crashes resulted in no injuries, a total of 4,222 crashes or 76 percent of the total. Fatal or disabling injuries comprised approximately 2 percent of all truck-involved crashes, a total of 89 crashes over the five year period. Crashes resulting in a possible injury were the second-most common crash type, comprising 14 percent. Overall, although injuries and fatalities resulting from truck-involved crashes occurred in the region, the vast majority do not result in injuries to the driver or victims.

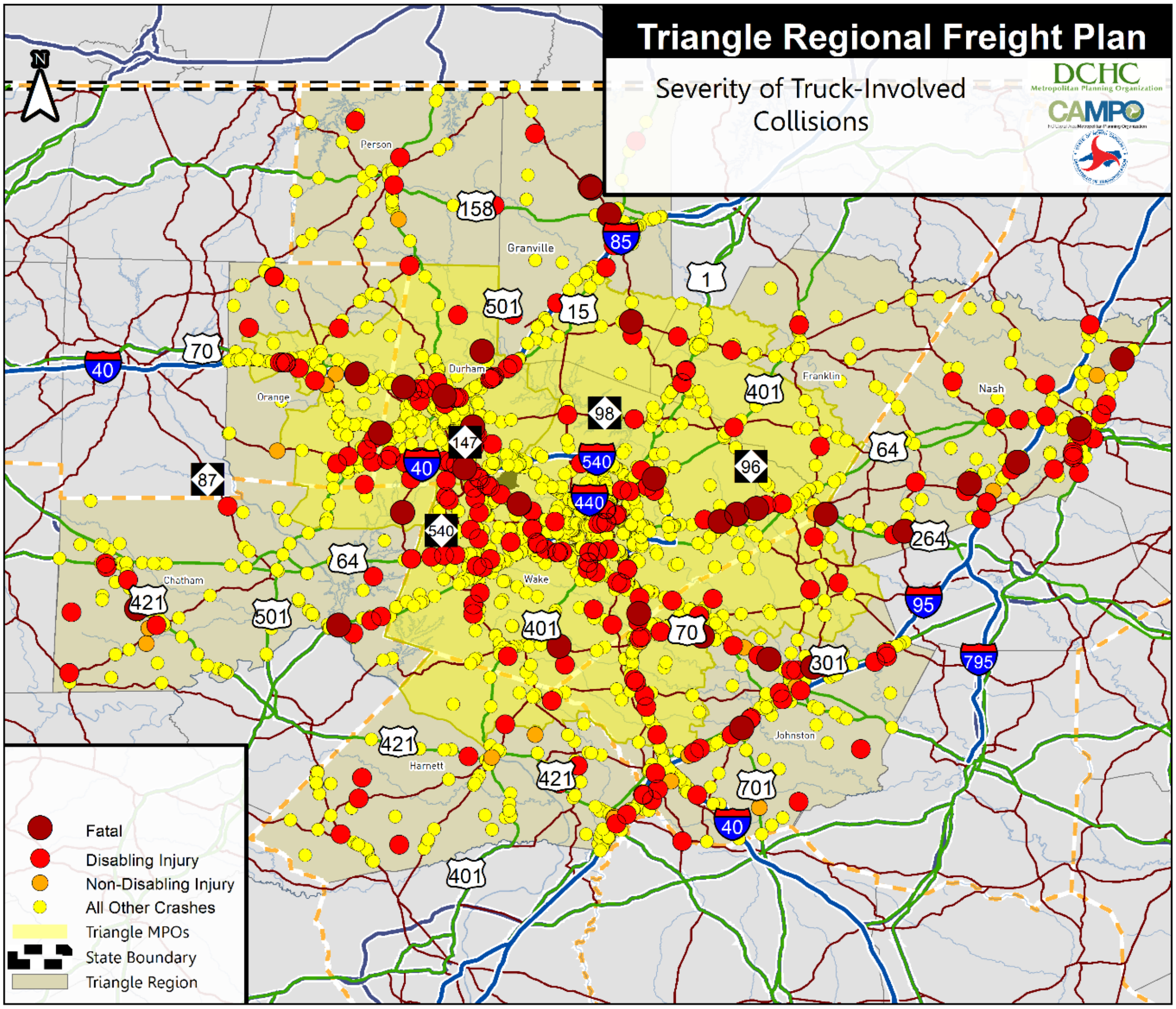
Figure 37 presents a map of truck crashes by severity of crash throughout the Triangle Region. Although the majority of crashes resulted in no injuries at all, the cluster around Durham shows concentrations of possible injuries and some non-disabling injuries. The cluster around Raleigh also shows high concentrations of both possible injuries and non-disabling injuries. Fatal and disabling injuries occurred primarily along I-40, U.S. 264, and I-85, although they also occasionally occurred on less trafficked State roads and local roads.

Figure 36: Truck-Involved Crashes by Crash Severity



Source: NCDOT

Figure 37: Truck-Involved Collisions by Severity in the Triangle Region



Source: NCDOT

Non-Highway Freight Modes

The discussion of non-highway freight modes focuses on characterizing the extent and traffic volumes of the Triangle Region's rail and air cargo systems. There are several miles of freight rail infrastructure in the region. As indicated by the commodity flow analysis, this infrastructure primarily facilitates the transport of the region bulk commodities (e.g. coal, basic chemicals, and aggregates such as gravel and sand). Despite the large extent of rail coverage throughout the region, there are no intermodal terminals in the metropolitan area, although a CSX hub facility is being explored nearby.

The Triangle Region's air cargo facilities are solely located at RDU. Air cargo is an important element of a region's freight network as it primarily transports time-sensitive, high value goods. Air cargo operations in the Triangle Region are further explored in this section, primarily using data from the Raleigh-Durham Airport Authority.

Rail

The Triangle Region is served by two of the seven Class I railroads –NS and CSX. Class I rail carriers are those railroads that have annual operating revenues of $250 million or more.[1] Using data from the BTS National Transportation Atlas Database (NTAD), there are approximately 500 track miles of rail throughout the region. By track mileage, CSX is the largest rail carrier in the Triangle Region. It owns approximately 25 percent (127 miles) of the region's rail infrastructure. NS owns about 21 percent (103 miles) of the Triangle Region's rail. Altogether, Class I rail carriers own nearly half, about 230 miles (46 percent), of the Triangle Region's freight rail infrastructure. About 38 percent (189 miles) are either state owned, abandoned, or otherwise not in use (Figure 38 and Figure 39).

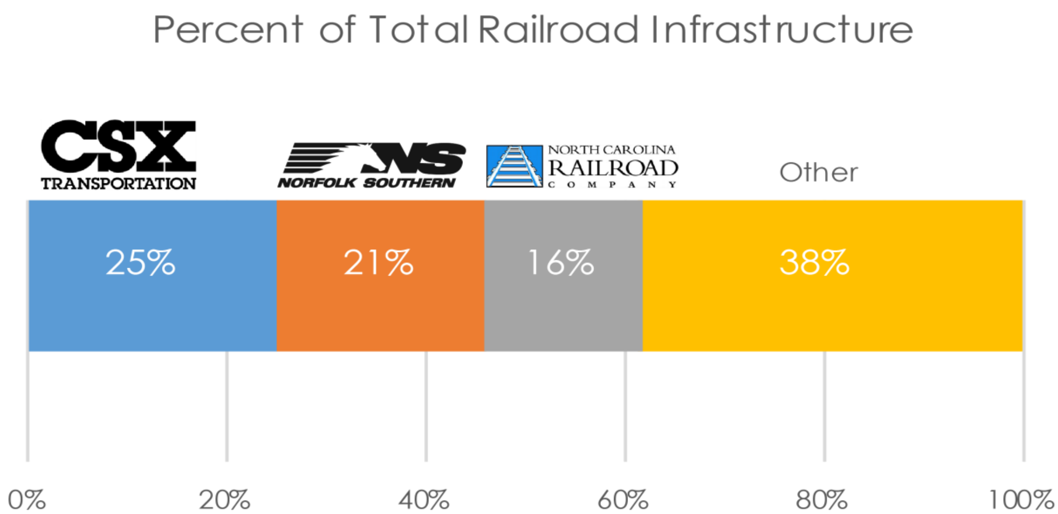
While Class I rail carriers focus on moving cargo across long distances, Class II and Class III railroads (also referred to as shortline carriers) provide first- and last-mile service to local customers linking them to the larger railroads. Though no privately held Class II or Class III railroads (also referred to as shortline carriers) own any infrastructure within the study area, the state-owned North Carolina Railroad (NCRR) does possess a significant share of the Triangle Region's rail infrastructure – about 81 miles (16 percent). The NCRR's rail line provides a critical east-west link across the state that connects the Triangle Region with Charlotte. Though NCRR owns this rail line it is operated by NS through a trackage rights agreement.[2]

The Carolina Coastal Railway (CLNA), a shortline carrier, also operates in the Triangle Region via a trackage rights agreement. CLNA has access to about 34 miles (7 percent) of the region's rail infrastructure allowing the company to connect its customers to both the NS and CSX mainlines. Typical commodities transported by CLNA include grains, fertilizers, lumber, cement, and coal, among others. Though not within the study area, other shortline carriers operating in Triangle Region counties include the Virginia Southern Railroad (VSRR), Aberdeen Carolina and Western Railway (ACWR), and Atlantic and Western Railway (ATW).

There are no intermodal terminals in the Triangle Region. The closest intermodal terminals are in Greensboro and Charlotte. However, both NS and CSX operate classification yards in the Triangle Region. Both the Glenwood Yard (NS) and Raleigh Yard (CSX) are located in Raleigh. NS also operates the Selma Yard located in Selma.[3]

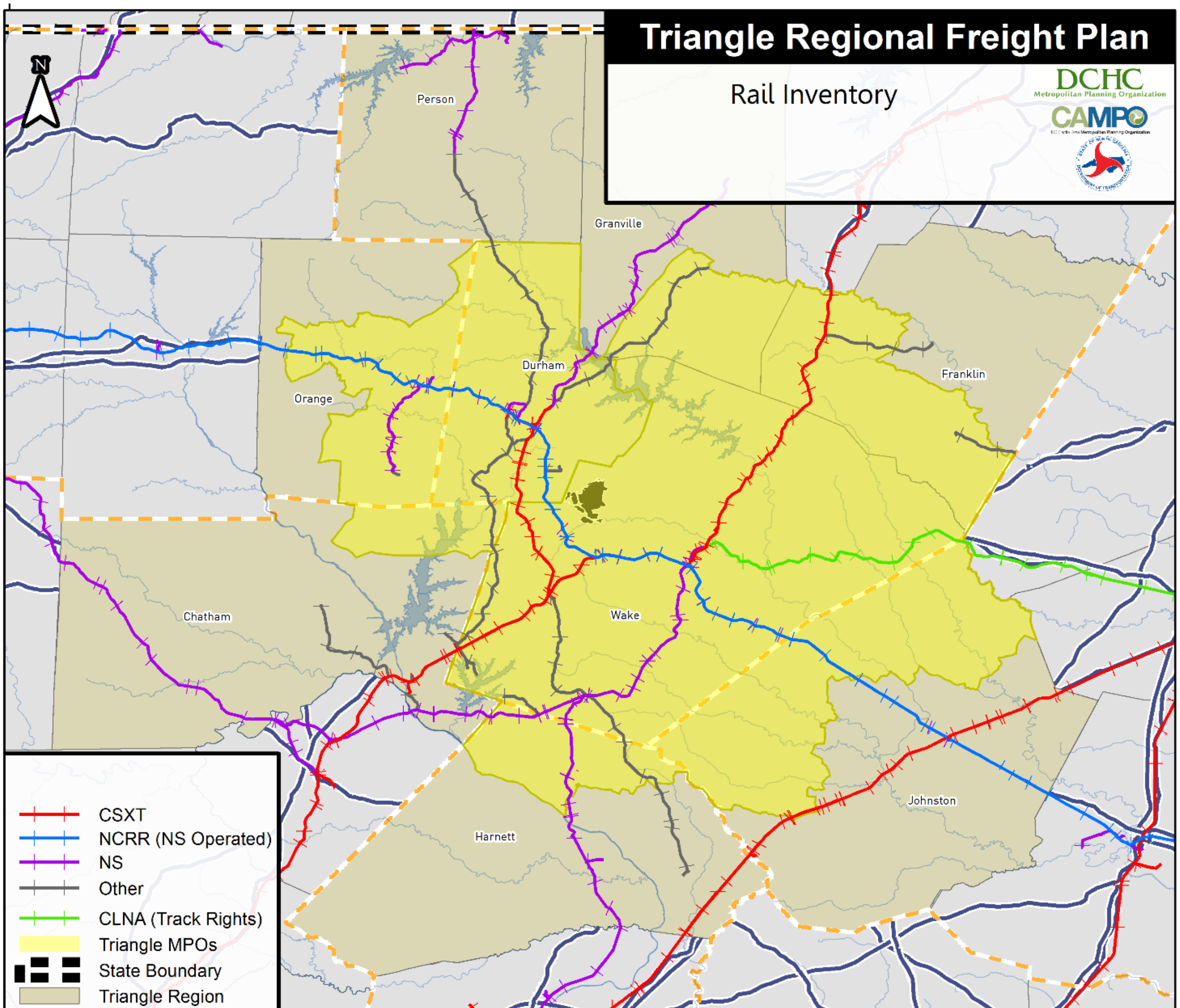
[1] Surface Transportation Board. https://www.stb.dot.gov/stb/faqs.html.
[2] Trackage rights agreements allow rail carriers to operate over sections of rail infrastructure that they do not own.
[3] NCDOT. 2015 Comprehensive State Rail Plan.

Figure 38: Railroad Infrastructure in the Triangle Region Study Area



Source: BTS NTAD

Figure 39: Triangle Region Rail Inventory



Source: BTS NTAD; Consultant analysis.

Though Wake County has the largest share of the Triangle Region's rail by mileage, the infrastructure is greatly distributed through the metropolitan area with many counties having near equal shares, as shown in Table 10. Wake County has about 27 percent (136 miles) of the region's rail infrastructure. Durham, Johnston, and Chatham Counties each have approximately 90, 66, and 60 miles of rail (18, 13, and 12 percent), respectively. Harnett County has 44 miles of rail, about 9 percent. The remaining counties (Franklin, Orange, Person, Granville, and Nash) all have between 1 and 6 percent of the region's rail infrastructure.

Table 10: Railroad Infrastructure in the Triangle Region Study Area by County

County	Miles	Percent of Total
Wake	136	27%
Durham	90	18%

County	Miles	Percent of Total
Johnston	66	13%
Chatham	60	12%
Harnett	44	9%
Franklin	31	6%
Orange	30	6%
Person	20	4%
Granville	18	4%
Nash	4	1%
Total	**500**	**100%**

Source: BTS NTAD; Consultant analysis.

There are ten at-grade crossings in the Triangle Region with 25 or more trains per day according to Federal Railroad Administration (FRA) data (including switching movements), as shown in Table 11 and mapped in Figure 40. Of the ten at-grade crossings, all but two are located in Johnston County along the CSX corridor. The Johnston County grade-level crossings are located in the cities of Selma and Kenly along relatively low volume roadways as indicated by the FRA and NCDOT data. Among these crossings, the busiest roadway is Anderson Street in Selma which carries over 4,000 vehicles per day.

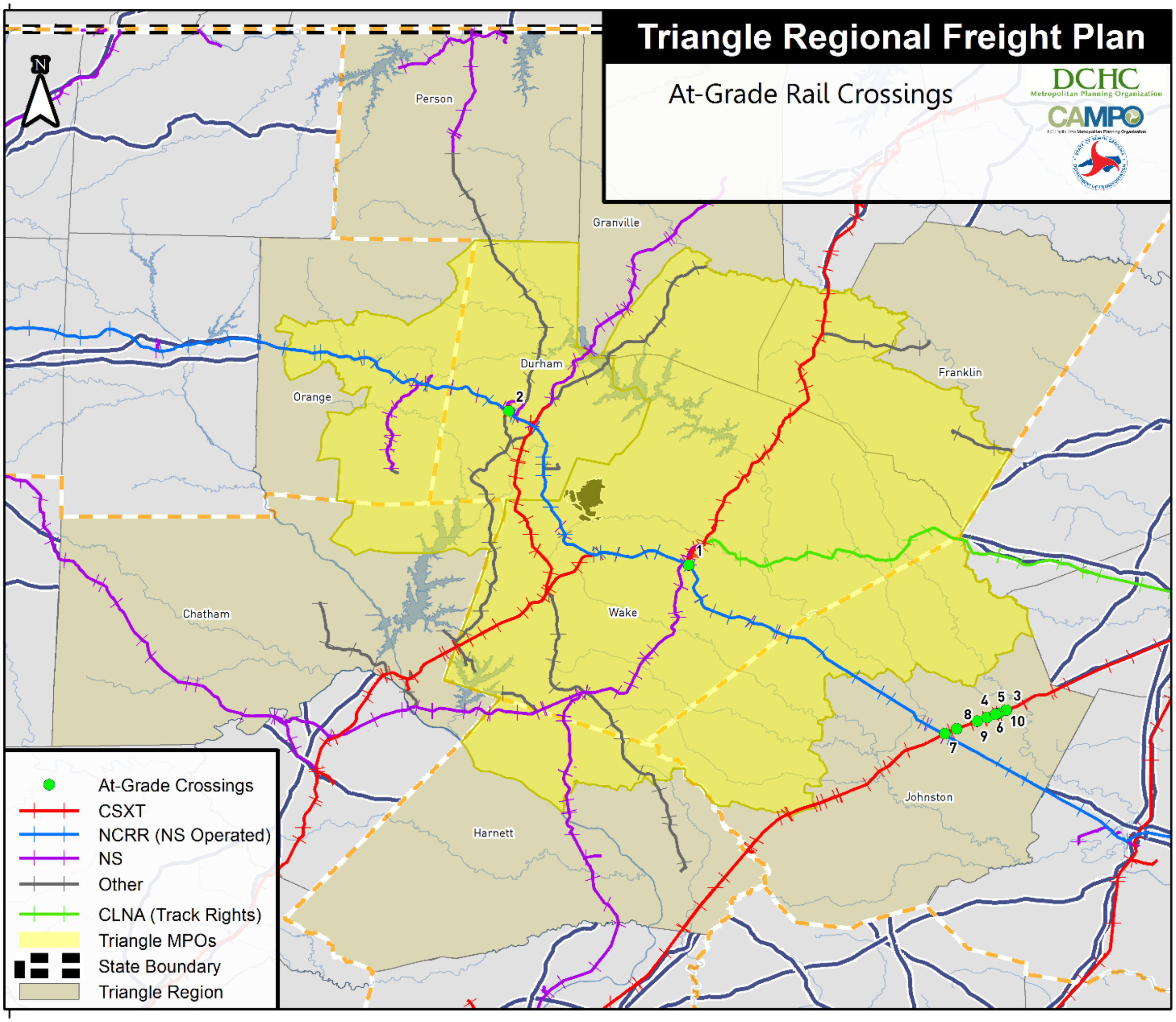
Two of the top ten at-grade crossings by daily train volumes are located in the cities of Raleigh and Durham. Both of these crossings are located on the NS corridor on Cabarrus and Blackwell Streets. Similar to the other crossings region-wide, these roadways have relatively modest volumes. Based on FRA data, the busiest of these roadways is Blackwell Street with nearly 4,900 vehicles daily. Cabarrus Street carries nearly 2,200 vehicles per day. However, because of the proximity of Blackwell Street to Mangum Street (another busy at-grade crossing with 22 trains per day) and its location in downtown Durham, the effect of this grade-level crossing on local traffic circulation could be significant.

Table 11: Top At-Grade Crossings by Total Daily Trains

Rank	Railroad	Roadway	City	AADT	Total Daily Trains
1	NS	Cabarrus Street	Raleigh	2,192	31
2	NS	Blackwell Street	Durham	4,888	26
3	CSX	SR 2141/ Bizzell Grove Church Road	Micro	1,100	25
4	CSX	SR 2137/ Pittman Road	Micro	1,100	25
5	CSX	Wilson Street	Micro	104	25
6	CSX	Main Street	Micro	2,310	25
7	CSX	Anderson Street	Selma	4,123	25
8	CSX	SR 1001/ Lizzie Mill Road	Selma	3,600	25
9	CSX	Brown Wall Road	Micro	127	25
10	CSX	Field Street	Micro	291	25

Source: FRA Rail Crossing Inventory; NCDOT.
Note: Traffic volumes on state routes are as reported by NCDOT.

Figure 40: Top At-Grade Crossings by Total Daily Trains



Source: FRA Rail Crossing Inventory; BTS NTAD; Consultant analysis.

Air Cargo

The Raleigh-Durham International Airport (RDU) is the primary airport for Triangle Region. In addition to its two passenger terminals, RDU has over 672,000 SF of cargo space. RDU's cargo facilities are located in the North Cargo and South Cargo areas of the airport's campus as shown in Figure 41.[4] The North Cargo area is located along International Drive near Cemetery Road. The North Cargo facilities house RDU's two all-cargo carriers, FedEx and UPS. The South Cargo facilities are located near Aviation Pkwy. The South Cargo facilities are reserved for cargo shipped via commercial airlines.

[4] Raleigh Durham International Airport. http://www.rdu.com/general-aviation-and-cargo/. Accessed March 24, 2016.

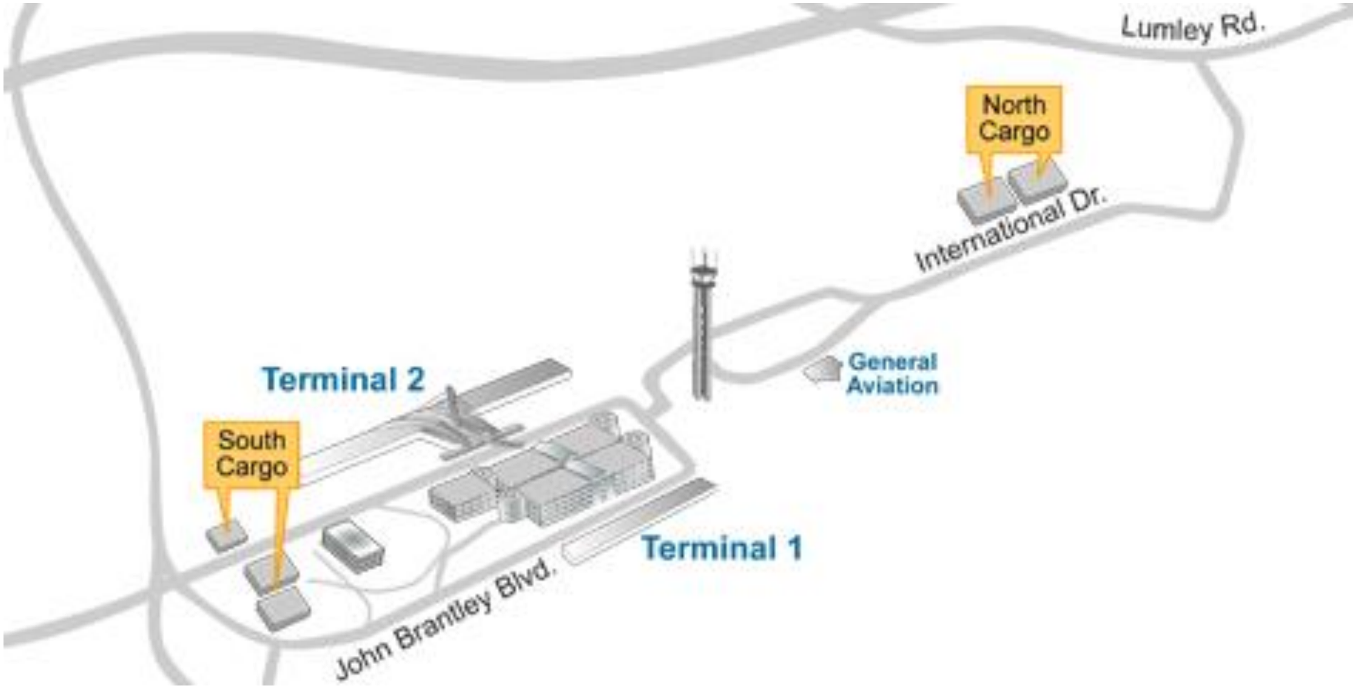


Figure 41: Raleigh-Durham International Airport Cargo Facilities

Source: Raleigh-Durham International Airport.

Figure 42 presents total air cargo activity at RDU in 2015, with growth rates between 2010-2015 and 2005-2015. Total air cargo, which includes both enplaned and deplaned cargo, totaled 176.3 million pounds in 2015. In general, air cargo activity at RDU has followed the national trend of decreasing volumes. At RDU, air cargo volumes decreased by 29 percent over the 2005 to 2015 period (see Table 12). While air cargo volumes were steady from 2004 to 2007, when it peaked at 249.6 million pounds, they dropped in 2009 (following the 2008 recession) to 197.4 million pounds. Air cargo activity continued to decline through 2012, and rose slightly to 169.54 million by 2015. Though air cargo has been in decline at RDU, it still outperforms larger airports located in other parts of the U.S. Southeast (notably Charlotte and Nashville).[5]

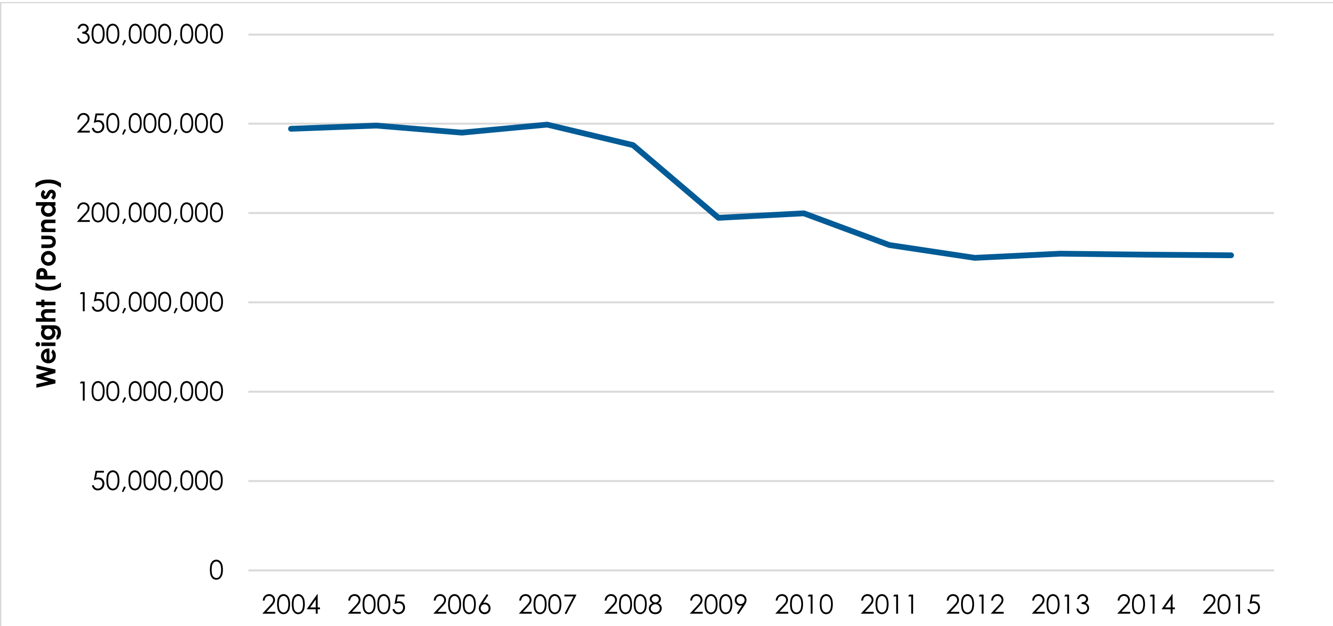
Table 12: Air Cargo at Raleigh-Durham International Airport, 2015

Air Cargo (LBS), Enplaned and Deplaned	CY 2015	% Change 2010-2015	% Change 2005-2015
Air Freight - Air Shipped	164,602,614	-10.4%	-29.6%
Air Mail	4,942,573	-50.2%	22.3%
Domestic Total	**169,545,187**	**-12.5%**	**-28.8%**
International	6,782,659	11.0%	-38.6%
Total	**176,327,846**	**-11.8%**	**-29.2%**

Source: Raleigh-Durham Airport Authority Finance Dept.

[5] Federal Aviation Administration. All-Cargo Data Reported for Calendar Year 2014. http://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/media/cy14-cargo-airports.pdf. Accessed March 24, 2016.

Figure 42: Annual Air Cargo Activity at Raleigh-Durham International Airport, 2004-2015



Source: Raleigh-Durham Airport Authority Finance Dept.

Note: Includes enplaned, deplaned, and international air cargo volumes.

In 2014, the Raleigh-Durham Airport Authority along with the Urban Land Institute (ULI) reviewed the airport's physical assets and developed a set of recommendations that would benefit the greater region. As a result, the report identified several opportunities for cargo expansion on-site.[6] One such recommendation was to set aside 50 acres for development of cargo operations, including refrigerated space. The report also suggested that RDU increase efforts to expand international cargo operations, specifically expanded shipping operations for forestry-based products such as furniture, and pork products, both of which are major products from North Carolina. Finally, it recommended that significant portions of undeveloped land owned by RDU be dedicated to freight-related economic development opportunities such as bonded warehouse facilities, a just-in-time manufacturing park, a freight-forwarders corridor, research & development (R&D) parks, and flex industrial/warehouse parks.

Conclusions

Some key insights can be drawn from the various analyses in this chapter regarding the clustering of freight activity within the Triangle Region, the primary truck routes through the region, performance on those highway routes, and freight activity on non-highway modes. Freight activity in the Triangle Region is largely clustered within its center, between Raleigh and Durham, as indicated by business locations, freight-related employment, and truck trip data. This portion of the region provides the greatest access to the Triangle Region's population and commercial centers as well as the major research universities. Further, while manufacturing activity is more broadly spread across the region distribution activity appears to remain closer to the center and the urban cores of Raleigh and Durham.

[6] An Urban Land Institute (ULI) Advisory Services Panel Report. http://connect.rdu.com/wp-content/uploads/2015/01/ULIfinal.pdf

I-40 and I-85 form the backbone of the Triangle Region's highway freight system as these roadways carry larger truck volumes than any other routes. Besides the region's interstate highways, several state routes and U.S. highways carry significant truck volumes including U.S. Highways 1, 64, 70, and 264 as well as SR 55. These roadways provide first- and last-mile connectivity for some of the Triangle Region's most prominent freight clusters. In many cases, these routes provide access to areas without nearby interstate highways.

Overall, the Triangle Region's highway freight system faces deficient performance in the same locations where freight activity is clustered. Much of the region's highway freight performance challenges are concentrated on the I-40 and I-440 corridors. Congestion, as indicated by relatively low average truck speeds and high TTI, are most prevalent on these corridors. In addition, some segments of the I-40 and I-440 corridors exhibit relatively high truck crash rates. Performance challenges related to truck travel time reliability and truck safety on the interstate highway system are similarly acute on the I-40 and I-440 corridors. These corridors and related facilities serve the population centers and the freight centers of the region, and will be under increasing stress as the region continues to grow.

While motor freight is the predominant freight mode, the Triangle Region also has non-highway resources, namely rail freight and air cargo. Though there are no intermodal terminals in the Triangle Region, it does have two classification yards each operated by its two Class I rail carriers – NS and CSX. In addition, though no shortline carriers own any infrastructure within the study area, the CLNA has trackage rights to a small portion of the region's rail infrastructure.

RDU is the only major airport serving the Triangle Region. Both of the major air cargo carriers, FedEx and UPS, provide service out of RDU. Since 2010, the decline in air cargo experienced in the mid-2000s at RDU has largely leveled. Should RDU wish to expand cargo operations beyond its North and South Cargo facilities, there is ample room for new freight-related development as identified by the land use study commissioned by RDU in 2014.

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FREIGHT GOALS, OBJECTIVES, PERFORMANCE MEASURES

The purpose of this chapter is to outline the vision, goals, objectives, and performance measures and targets for the Triangle Region's freight plan. This work builds off of the existing Metropolitan Transportation Plan (MTP) visions, goals, objectives, and performance measures that have already been established, and anticipates those that will be used at the State and Federal level, particularly in light of the recent Fixing America's Surface Transportation (FAST) Act, which was signed into law in December 2015. This chapter will also outline the best practices for developing freight performance measures to support public sector freight planning activity, as well as practical metrics which are both useful for decision makers and readily available to collect in the Triangle Region. The intent of employing a performance-based evaluation process is to provide an objective means of evaluating projects, programs and policies (i.e. strategies) relative to the Triangle Region Freight Plan vision and goals. The performance measures should inform strategy development, advance key needs and issues, and provide a basis for establishing performance targets. This chapter does not go on to specify targets because the measures themselves first need to be agreed upon, relevant data collected (portions of which appear in Chapters 3 and 5), and consensus reached on the practical degrees of improvement or maintenance that can be achieved and financed.

Freight Plan Vision, Goals and Objectives

The Triangle Region has a common vision of what it wants its freight transportation system to be:

> The Triangle Region's goods movement system will be safe and efficient, provide multimodal interconnectivity, enhance economic competitiveness, create jobs, and promote innovation, while reducing environmental impacts and improving local communities' quality of

The Triangle Region Freight Plan Project commits the region to freight transportation services and infrastructure that contribute to a distinctive place where people and businesses can both coexist and thrive. The Triangle Region has adopted goals and objectives shown in Table 13 that are designed to achieve the region's overall vision for its freight transportation system. These seven goals align with the MTP's goals with a stronger emphasis on goods movement throughout the region.

Table 13: Freight Plan Goals and Objectives

Freight Plan Goals	Freight Plan Objectives
Manage Congestion and System Reliability Allow goods to move with minimal congestion and time delay, and greater predictability.	Relieve congestion on heavily-traveled truck routes, including through the encouragement of expanded rail transportation. Reduce economic losses due to transportation crashes and incidents. Establish and designate truck routes consistent with federal, state and local regulations, and incorporate flexibility in routes to reduce the risk from disruption.
Improve Infrastructure Condition Increase proportion of highways and highway assets in "good" condition.	Ensure maximum regional mobility through improvements to and maintenance of the road and highway network. Provide safe, reliable, efficient and well-maintained goods movement facilities.
Promote Multimodal and Affordable Choices Increase utilization of non-truck travel modes	Relieve congestion on heavily-traveled truck routes, including through the encouragement of expanded rail transportation. Improve mobility and access to intermodal operations and facilities.
Promote Safety and Health Increase safety and security of transportation users.	Reduce fatality, injury, and crash/incident rates on all modes. Improve the ability to identify high accident locations, and evaluate their impacts in TIP project prioritization. Partner with Law Enforcement and Emergency Response agencies to provide support and reduce delay during traffic incident management events. Reduce economic losses due to transportation crashes and incidents.
Protect Environment and Minimize Climate Change Reduce mobile source emissions, GHG, and energy consumption.	Promote the adoption of efficient freight vehicles and technologies offering safer, environmentally cleaner performance. Plan and design our community centers for the timely and fuel efficient supply of goods necessary for living and working.
Stimulate Economic Vitality Increase economic growth and prosperity that supports communities and businesses.	Ensure a productive operating environment for freight transportation in the region. Plan and preserve industrial land uses for job creation and efficient service to markets and population.

Freight Plan Goals	Freight Plan Objectives
Ensure Equity Link land use and transportation planning and ensure that transportation investments do not create a disproportionate burden for any community.	Ensure the alignment of land use planning and the siting of freight producing and staging facilities for compatibility and safe, productive function. Reduce environmental and community impacts from goods movement operations to create healthy communities and a clean environment, and improve quality of life for those communities most impacted by goods movement.

Performance Measures & Targets

The development and application of performance measures enable agencies to gauge system condition and use, evaluate transportation programs and projects and help decision-makers allocate limited resources more effectively than would otherwise be possible. In addition, development and application of freight performance measures was emphasized in the Moving Ahead for Progress in the 21st Century Act (MAP-21), the Fixing America's Surface Transportation Act (FAST Act), and in FHWA's guidance on state freight plans and freight advisory committees. The regional MPOs should consider applying performance measures to the freight system for the following general purposes:

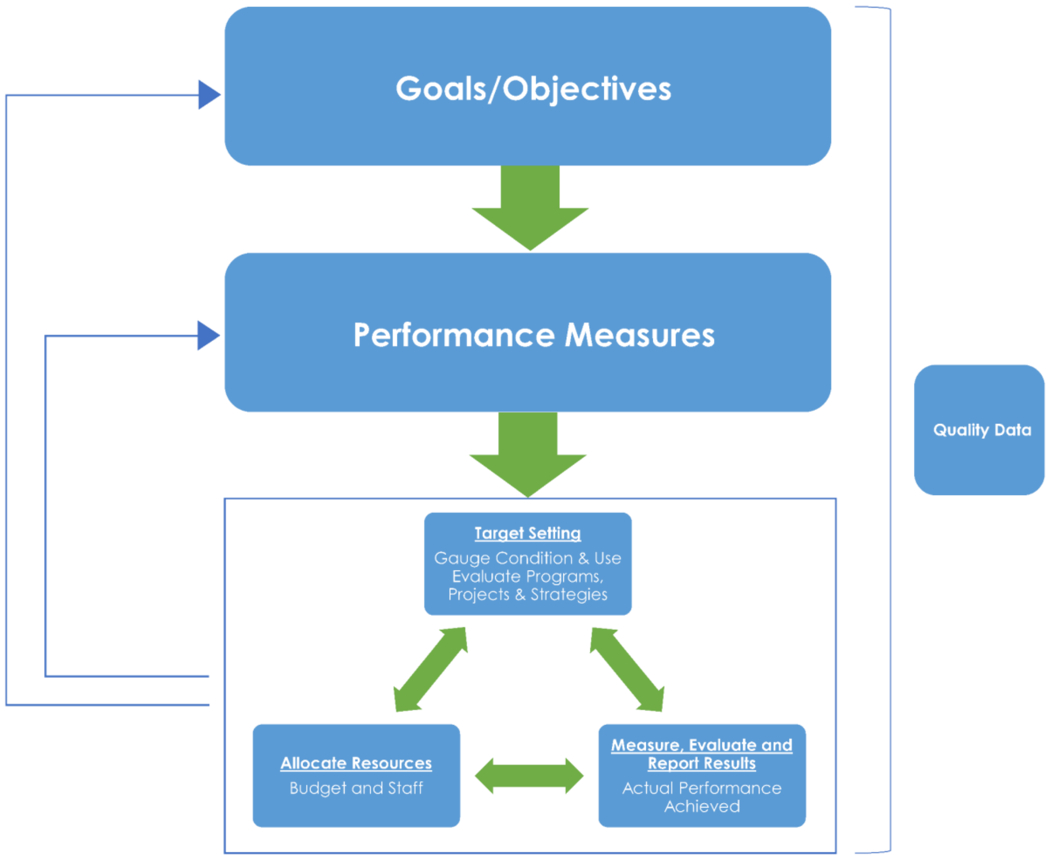
Linking Actions to Goals. Performance measures can help link plans and actions to CAMPO and DCHC MPO's goals and objectives;

Prioritizing Projects. Performance measures can provide information needed to invest in projects and programs that provide the greatest benefits;

Managing Performance. Applying performance measures can improve the management and delivery of programs, projects, and services. The right performance measures can highlight the technical, administrative, and financial issues critical to governing the fundamentals of any program or project;

Communicating Results. Performance measures can help communicate the value of public investments in transportation. They can provide a concrete way for stakeholders to see CAMPO and DCHC MPO's commitment to improving the transportation system and help build support for transportation investments; and

Figure 43: Performance-Based Planning and Programming Framework



Source: Cambridge Systematics.

Strengthening Accountability. Performance measures can promote accountability with respect to the use of taxpayer resources. They reveal whether transportation investments are providing the expected performance or demonstrate need for improvement.

In order to best accomplish one or more of these general purposes, a comprehensive performance management process, illustrated in Figure 43, should be implemented.

Choosing Performance Measures

Performance measures should be carefully selected to align with transportation agency goals and the existing (or potential) data and resources available. When considering performance measures, questions related to how they will be applied and the availability of data should be considered. The most appropriate performance measures will also depend on regional and local characteristics and unique features. Performance measures should encapsulate the multimodal nature of the goods movement system and types of goods movement activities.

The criteria for selecting performance measures used to monitor progress toward achieving the Plan's Goals and Objectives include: Feasibility; Policy Sensitivity; Ease of Understanding; and Usefulness in Decision-Making.

While performance measures provide many benefits, a few pitfalls should be avoided when implementing performance measurement systems, including:

- **Selecting performance measures based only on available data, and not adequately fulfilling agency Vision and Goals**. High-quality data may not immediately be available to measure performance against overarching Vision and Goals. Although it is prudent to begin with measures for which data are available, it is also important to ensure that each of the measures implemented does in fact link to the Vision and Goals of the agency, and are not selected purely on the basis of data availability.
- **Avoiding performance measures based on availability of quantitative data and robust forecasting and analysis tools.** Similar to the previous point, while high-quality data are important to performance evaluation (and desired), qualitative information can also be applied and provide insight into system conditions and use. In addition, in some cases, there may be an inability of quantitative measures to adequately address all political and community value considerations and/or project types. Likewise, while robust tools such as travel demand and economic models can provide detailed evaluation of discrete projects, other lower-tech tools such as spreadsheets and sketch analyses can also be applied and provide useful results.
- **Too many, or too few, performance measures can undermine the agency's ability to utilize them effectively.** Too many performance measures may cause a lack of focus and foster wide-ranging data collection efforts that consume valuable resources. As states and regions progress in their efforts to incorporate performance measures they tend to reduce their number of measures to a "critical few." However, utilizing too few performance measures can leave agencies with gaps in critical areas, undermining the effectiveness of their performance measurement program. One solution to the "too many" or "too few" measures conundrum is the development of performance indices. The philosophy behind using performance indices is simple - consolidate a great deal of information into one number. When it is necessary to present information from several related areas simultaneously (e.g., demand and capacity), a performance index can be used as a management tool that allows these sets of information to be compiled into an overall measure.

Over the long term, an MPO may set a target for a measure after the system performance for that measure, and the mechanisms for improving performance for that measure, are better understood. Actually using performance to drive resource allocation, such as budgeting or project prioritization, is the lynchpin of performance management. Finally, the data for each performance measure should be collected and analyzed to indicate how close the organization is to achieving its targets and identify the actions necessary to improve results (e.g., a change in the types of projects or policies being prioritized).

Performance Measures Recommendations

In developing and selecting the performance measures, the key points raised earlier in this chapter were fully considered. Performance measures have been selected to reflect the Vision and Goals, as well as issues, needs and opportunities identified to date. Table 14 contains the complete list of recommended performance measures under each goal area.

Table 14: Proposed Performance Measures by Goal

Freight Plan Goals	Objectives	Proposed Performance Measures
Manage Congestion and System Reliability 	Relieve congestion on heavily-traveled truck routes, including through the encouragement of expanded rail transportation. Establish and designate truck routes consistent with federal, state and local regulations, and incorporate flexibility in routes to reduce the risk from disruption. Reduce economic losses due to transportation crashes and incidents.	Travel time reliability. BTI can be calculated on key freight routes for each project. BTI expresses the percentage of extra travel time for a typical trip needed to ensure an on-time arrival. TTI – ratio of the average peak period travel time to the free-flow travel time for a selected highway or network. Measure freight system vulnerability to major service disruptions due to major natural or other events, such as severe weather events. Average clearance time for crashes on principal roadways. Annual percentage of the roadway system (NHS and non-NHS) with reliable travel times Annual percentage of the roadway system (NHS and non-NHS) where peak hour travel time meets expectations. Annual percentage of the NHS with reliable truck travel times. Annual Hours of Truck Delay (AHTD) Delays on rail lines and various freight nodes (terminals, airports, railways). Measured as the sum of all of the extra time trucks experience due to speeds below the selected delay threshold.
Improve Infrastructure Condition 	Ensure maximum regional mobility through improvements to and maintenance of the road and highway network. Provide safe, reliable, efficient and well-maintained goods movement facilities.	Pavement conditions on key highway and arterial freight routes, e.g., International Roughness Index (IRI) Bridge conditions ratings Lane miles of streets with unacceptable pavement condition ratings by NCDOT Percentage of structurally deficient and functionally obsolete bridges and tunnels Transportation Improvement Program (TIP) expenditures in MPO for roadway maintenance.

Freight Plan Goals	Objectives	Proposed Performance Measures
Promote Multimodal and Affordable Travel Choices 	Relieve congestion on heavily-traveled truck routes, including through the encouragement of expanded rail transportation. Improve mobility and access to intermodal operations and facilities.	Multimodal connectivity and redundancy. Projects can be evaluated for providing access on freight routes from/to locations with significant freight activities (e.g., businesses, warehouses, etc., and clusters of these) both in terms of highway access as well as access to rail lines, terminals, ports and airports. Location of major generators near Interstate highways, four-lane highways, or intermodal terminal.
Promote Safety and Health 	Reduce fatality, injury, and crash/incident rates on all modes. Improve the ability to identify high accident locations, and evaluate their impacts in TIP project prioritization. Partner with law enforcement and emergency response agencies to provide support and reduce delay during traffic incident management events. Reduce economic losses due to transportation crashes and incidents.	Number of truck-involved crashes, serious injury, and fatalities per million vehicle miles traveled (VMT). Rate of truck-involved crashes, serious injury, and fatalities per million VMT. Location of truck-involved crashes, serious injury, and fatalities per million VMT Rate and number of crash incidents at rail grade crossings. Average emergency response time for truck-involved traffic incidents in minutes. Use of ITS and innovative technologies to improve safety.
Protect Environment and Minimize Climate Change 	Promote the adoption of efficient freight vehicles and technologies offering safer, environmentally cleaner performance. Plan and design our community centers for the timely and fuel efficient supply of goods necessary for living and working.	Measure reduction of air quality/health impacts by tracking Greenhouse Gas (GHG), Fine Particulate Matter (PM), and Nitrogen Oxides (NOx) emissions per capita. Use of ITS and innovative technologies to reduce emissions.
Stimulate Economic Vitality 	Ensure a productive operating environment for freight transportation in the region. Plan and preserve industrial land uses for job creation and efficient service to markets and population.	Jobs and output generated by freight transportation projects to measure whether a project supports economic growth and prosperity.

Freight Plan Goals	Objectives	Proposed Performance Measures
Ensure Equity	Ensure the alignment of land use planning and the siting of freight producing and staging facilities for compatibility and safe, productive function. Reduce environmental and community impacts from goods movement operations to create healthy communities and a clean environment, and improve quality of life for those communities most impacted by goods movement	Evaluate the impact on specific communities that are disproportionately affected by freight. Measure light pollution, noise pollution, air pollution and emissions related to goods movement vehicles, job creation, and encroachment due to close proximity to freight sources.

For each of the performance measures recommended, a discussion of what they are, why they are included, and how these metrics can be evaluated are included below under each goal area.

Manage Congestion and System Reliability

Travel time reliability is one of the most commonly used performance measures and directly addresses the goal to provide a reliable and efficient goods movement facility. For freight, BTI and TTI can be calculated on key freight routes for each project. BTI expresses the percentage of extra travel time for a typical trip needed to ensure an on-time arrival. TTI measures the intensity of congestion; it is the ratio of the average peak period travel time to the free-flow travel time for a selected highway or network.

Travel time delay due to recurrent and non-recurrent congestion on the freight network significantly impedes mobility on the system. By quantifying the travel time delay on the freight links and nodes, projects can be evaluated based on how well they support and improve mobility. Two specific metrics can be developed for this measure that calculates the delay on key freight (truck) routes and delay on rail lines and various freight nodes (terminals, ports, airports). Travel delay on key freight routes is measured as the sum of all of the extra time trucks experience due to speeds below the selected delay threshold. Changes in truck travel time delay can be calculated through changes in Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT) using the regional travel demand model for project evaluation. The delay on rail lines and terminals, and airports metric can be used for needs assessment. The delay data can be calculated using quantitative data obtained from individual sources such as railroads. However, it should be kept in mind that some of the delay in this metric will be hard to capture, and in such cases, qualitative evaluations may be used based on input from stakeholders or drawing from best practice examples in other locations.

An important factor that increases delay and impedes mobility are crashes on the principal truck routes, and measuring and tracking the average clearance time for these crashes will be a good metric to evaluate how much delay is being added or being avoided due to these crashes and incidents. Additionally, measuring freight system resiliency addresses freight system vulnerability to major service disruptions due to major natural or other events, such as severe weather events.

Improve Infrastructure Condition

Bridge and pavement conditions on key highway and arterial freight routes are two important metrics in understanding the region's maintenance goals. For example, performance can be measured using estimates of Pavement Condition Index (PCI) or International Roughness Index (IRI), and bridge sufficiency rating.

Promote Multimodal and Affordable Travel Choices

To provide better access, projects should improve/support multimodal connectivity and redundancy. Redundancy of the system can also support system resiliency and emergency response goals by providing alternative routes of transport. By using GIS spatial tools, projects can be evaluated for providing access on freight routes from/to locations with significant freight activities (e.g. freight clusters) both in terms of highway access as well as access to rail line, terminals, and ports.

Promote Safety and Health

Understanding the safety benefits of projects is another essential performance measure for freight projects; the change in both the number and rate of truck-related crashes should be looked at. These truck-involved crashes will include crashes with pedestrians and bicycles, as well as passenger vehicles. Baseline crash data is readily available for the region. VMT data can be obtained from NCDOT to normalize the absolute number of crashes into a crash rate.

In addition, the number of crashes at at-grade crossings is of particular importance from a freight perspective, as crashes at at-grade crossings demonstrate a key preventable source of crashes for which countermeasures can be deployed from both the rail and the roadside. The FHWA Office of Safety offers existing at-grade crossing crash data for which project-specific impacts can be estimated from.

Use of new technologies (also measured under environmental protection, below) is becoming an especially important means of achieving safety improvement as the family of technologies grouped under Connected and Automated/Autonomous Vehicles (CAV) arrives on the market. Safety risks are a principal citizen concern with freight activity, and safety enhancements for trucks, passenger vehicles, and for assistance of drivers are a major benefit of CAV. Use could be tracked through the number or mileage of projects deploying vehicle-to-infrastructure systems on freight routes, or new vehicles purchased with features such as back-up cameras.

Protect Environment and Minimize Climate Change

Measuring air quality/health impacts can be focused on GHG ($CO2$) as well as Fine Particulate Matter ($PM2.5$) and NOx reduction. Tracking GHG emissions will help us understand if projects help meet goals to reduce GHG emissions. The regional travel demand model can be used to estimate changes in vehicle emissions of the aforementioned pollutants.

Technological advances including vehicle technologies to reduce emissions and Intelligent Transportation System (ITS) technologies to improve efficiency should be included as part of the project evaluation process. A simple qualitative method can be used to determine whether projects employ innovative technologies.

Stimulate Economic Vitality

Jobs and output generated by projects is the most direct way to measure whether a project supports economic growth and prosperity. Co-benefits of public health strategies can also be qualitatively evaluated. Changes in employment and output can be modeled through IMPLAN and other economic modeling tool, or through quantitative calculations. The project can also be qualitatively evaluated for providing opportunities for workforce development.

Ensure Equity

It is also critical to evaluate the impact on specific communities that are disproportionally affected by freight, including communities adjacent to freight facilities, communities that are socioeconomically disadvantaged, or both. Freight impacts on such communities can be determined with the aid of visual tools including GIS maps. These impacts can include light, noise pollution, air pollution and emissions related to goods movement vehicles, job creation, and encroachment due to close proximity to freight sources. Projects that help reduce such impacts on communities most burdened by goods movement can support quality of life goals.

Freight projects should be coordinated with land use decisions to ensure that land use plans do not introduce non-compatible land uses when expanding residential/commercial developments abut existing freight facilities, or materially increase curb cuts on major freight routes, or freight facilities are expanded in proximity to neighborhoods. To evaluate projects, GIS spatial tools can be used to determine the proximity of the freight infrastructure (both specific locations as well as corridors) to non-compatible land uses with and without the project. In cases where there are non-compatible land uses in proximity to freight uses, strategies will be developed that either move towards more effective buffers or that offset the impacts of higher exposure of communities to adverse impacts of proximity to freight uses.

5 EXISTING TRENDS AND CONDITIONS

Freight Flows

A region's demand for freight transportation is fundamentally driven by the structure and strength of its economy. In the Triangle Region, the local economy is boosted by a substantial base of high-tech industries that leverage high quality human capital and technology from the nearby universities, research centers, existing businesses. This co-location of high-tech industries has several implications for freight transportation in the region. Foremost, the total value of shipments has increased over the past decade as high-tech industries gain prominence, which is expected to continue as these industries play a greater role in the local economy. Outbound shipments in particular are expected to increase the fastest as the products of these industries see higher demand in domestic and international markets.

Reliance on high-tech industries has made freight flows in the Triangle Region more resilient to recent cyclical economic downturns. The economic recession of 2008 decreased freight flows significantly across the U.S. However, contrary to this trend, the Triangle Region saw growth from 2007 to 2012 for outbound shipments, particularly for higher-value commodities.

Like in other urban centers, inbound shipments of consumer goods also represent a large driver of freight flows. From 2007 to 2012 these flows decreased because of the economic recession of 2008—consumer spending was one of the areas hardest hit by the economic downturn. However these flows are expected to rebound strongly into the future as the area continues to see growth in incomes and population. This will place greater demands on a wide range of distribution systems, from retail supply-chains to home deliveries.

Approach

This section analyzes various datasets to examine key freight trends and patterns for the Triangle Region. It relies primarily on the FAF, which is a data set developed and maintained by the BTS in partnership with the Federal Highway Administration. FAF builds on the Commodity Flow Survey by including additional data from a variety of sources to develop the most comprehensive description of freight flows in the U.S. that is publicly available.

FAF reports the tonnages, value, and ton-miles shipped by truck, rail, water, a, air, multiple modes & mail, and other and unknown modes. It provides commodity detail at the 2-digit SCTG level, which contains 43 commodity groups. FAF considers both domestic and international shipments. Domestic origins or destinations are reported at the city-level (by either Census defined Consolidated Statistical Regions or Metropolitan Statistical Areas) and remainder of State.

The FAF zone that most closely approximates the Triangle Region is the "Greater Raleigh-Durham Combined Statistical Area (CSA)", which includes the counties of: Person, Orange, Durham, Chatham, Harnett, Franklin, Johnston, and Wake. This FAF zone is called hereafter the "Raleigh-

Durham" region to distinguish it from the slightly different Triangle Region. However, it is safe to assume that the FAF trends and patterns observed for Raleigh-Durham are representative of the freight movements of the Triangle Region because of their extensive overlap.

Two versions of FAF were used in the analysis. Version 4.0, which was published in 2015, contains the first estimates developed for freight flows in 2012. An analysis was performed on this version of the data to disaggregate the 2012 flows to the county-level for the Triangle Region. In 2016, version 4.1 of FAF was published, which included a forecast of freight flows out to 2045 and made slight revisions to the 2012 estimates. Both of these versions are reported in this section. The 4.0 version is first used to establish a baseline for 2012, make historical comparisons to 2007, and disaggregate flows to the county level. Then, version 4.1 is used to show forecasts out to 2045.

In addition to using FAF, other modal data sources were used to provide additional detail where needed. The T-100 data set developed by the BTS was used to describe air cargo operation at RDU. For rail, the Public and Confidential Waybill Samples developed by the Surface Transportation Board (STB) were used to describe rail shipments in more detail.

Overview of Commodity Flows

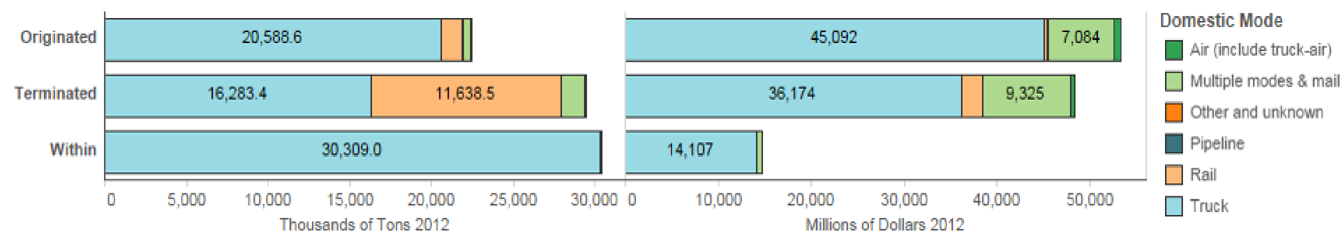
In 2012, Raleigh-Durham originated or received 82 million tons of freight valued at 116 billion dollars.[7] This represented roughly 19 percent of all value moved in North Carolina, highlighting the importance of Raleigh-Durham to the State's economy. As can be seen in Figure 44, the co-location of high tech firms in the Triangle Region has caused the region to be a net originator of freight by value (and by tonnage if coal is excluded), which is uncommon for comparable U.S. cities where consumption goods often represent the main driver of economic activity and freight flows. For these outbound shipments the most important modes were truck, multiple modes, and air. Most of this freight was moved by truck, which accounts for 81.7 percent of tons and 81.8 percent of value. Rail played a specific function in bringing freight to the region, accounting for 11.6 million tons in 2012. As will be seen below, most of these tonnages were coal shipments for electricity generation. Rail as a whole was responsible for 15.8 percent of all tonnages and 2.25 percent of value. Even though the air mode did not carry a large quantity of tons, it was used extensively in the movement of high value commodities that are particularly important to the region.[8] Multiple modes and mail accounted for 16.3 billion dollars, representing 14.6 percent of all value. However, this modal category in FAF includes rail intermodal shipments and small package shipments (such as UPS and USPS) without distinguishing between them.

The co-location of high tech firms in the Triangle Region has caused the region to be a net originator of freight by value (and by tonnage if coal is excluded), which is uncommon for comparable U.S. cities where consumption goods often represent the main driver of economic activity and freight flows. For these outbound shipments the most important modes were truck, multiple modes, and air.

[7] All values are shown in 2012 U.S. dollars, unless otherwise indicated.

[8] For domestic shipments the air mode considers movements of cargo by air with truck drayage, however for international shipments it considers the air moves separately from truck drays. Truck drays in these shipments are included in the truck mode.

Figure 44: Freight Flow Overview, 2012

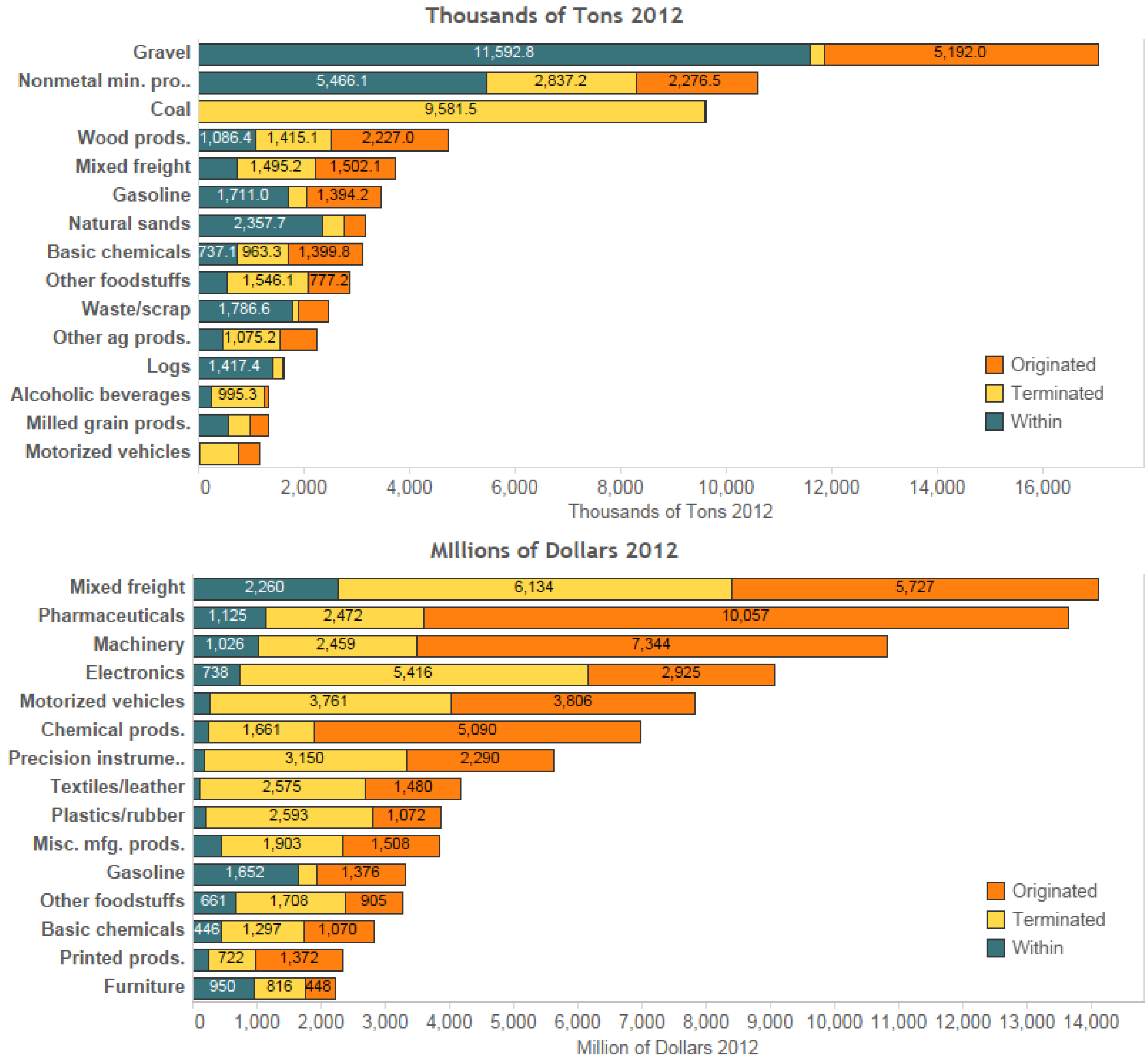


Source: BTS and FHWA, FAF4, 2016.

A breakdown of the major commodity flows is presented in Figure 45. The top 15 commodities represented 83 percent of tons and 80 percent of value moved. Flows of tonnages are dominated by shipments to the Triangle Region and within. The main commodity flows were 11.6 million tons of gravel moving within Raleigh-Durham, 9.6 million tons of coal moving by rail to Raleigh-Durham, 5.5 million tons of nonmetal mineral products moving within Raleigh-Durham, 5.2 million tons of gravel originating from Raleigh-Durham to outside destinations, and 2.4 million tons of natural sands moving within Raleigh-Durham. Commodities such as natural sands, waste/scrap, and logs primarily have origins and destinations within the region. Coal, mixed freight, other foodstuffs, alcoholic beverages, and motorized vehicles were shipped to Raleigh-Durham, while wood products, gravel, basic chemicals, gasoline, and mixed freight were mostly produced in Raleigh-Durham and shipped elsewhere.

The picture is reversed in terms of value with outbound shipments accounting for a larger share of commodity flows. As can be seen in Figure 45, Raleigh-Durham produces several high-value commodities. Pharmaceuticals, machinery, chemical products are just some of the commodities that Raleigh-Durham originated more in value than it received. Electronics, precision instruments, textiles, plastics and mixed freight are some of the commodities that are predominantly delivered to area. The high-tech structure of the local economy supports both a large proportion of high-value outbound shipments and a robust consumer economy that demands inbound shipments of retail goods.

Figure 45: Top 15 Commodities by Flow Type, 2012

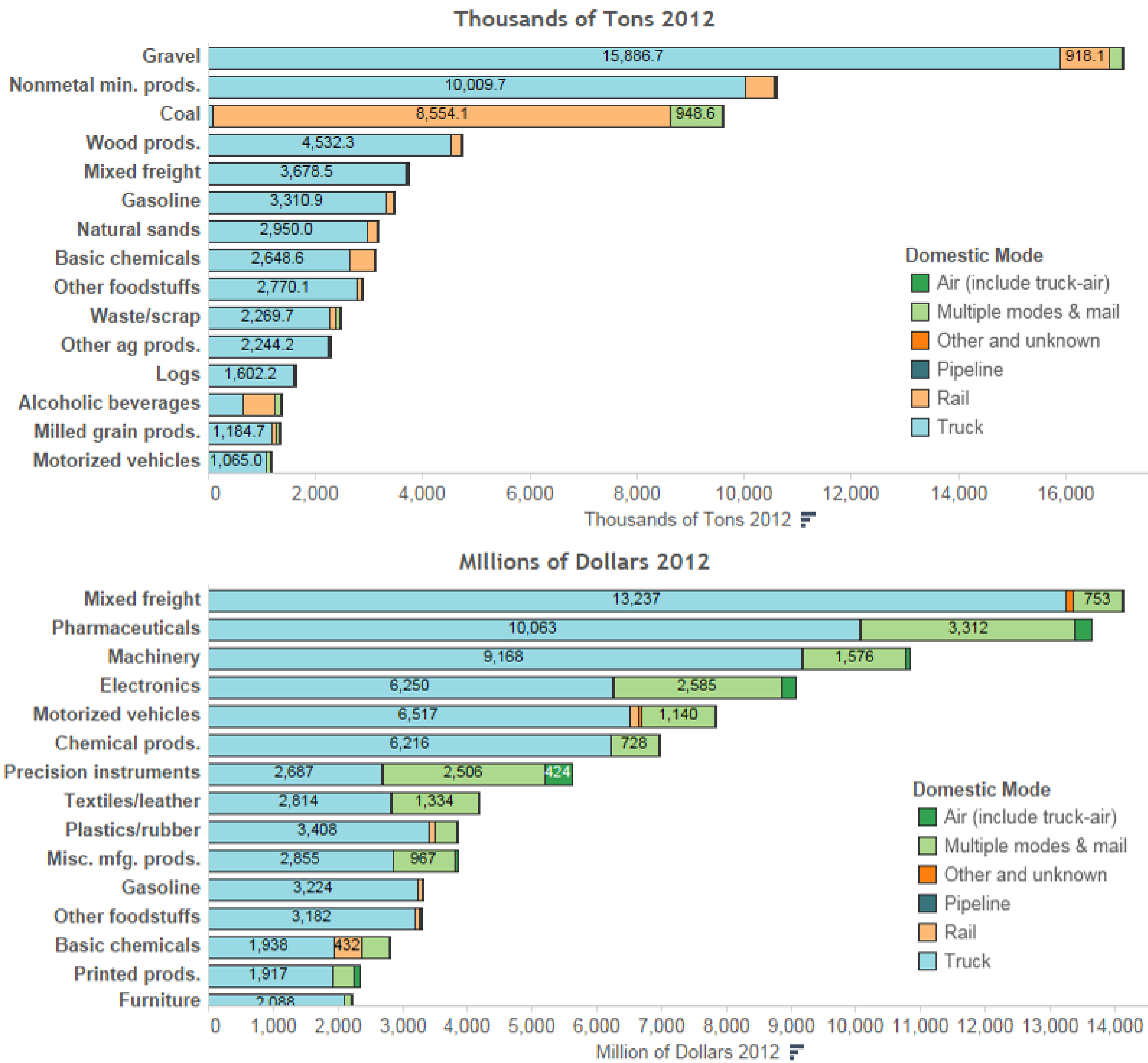


Source: BTS and FHWA, FAF4, 2016.

For these 15 top commodities, Figure 46 shows the breakdown of flows by mode. In terms of tonnage, trucking is by far the dominant mode, except for coal, and alcoholic beverages (which includes non-beverage alcohols). In terms of value other modes play a greater role. Multiple modes were used extensively in the transportation of pharmaceuticals, electronics, precision instruments, textiles/leather, and motorized vehicles. Even though the air mode does not show up prominently in this figure, some of the shipments in the 'multiple modes' category might have air movements, especially those by USPS, FedEx, and UPS.[9]

[9] While ground shipping of parcels is categorized as Multiple Modes and air shipping of parcels (including drayage) is categorized as Air, the day-to-day operating choices by carriers can muddy the picture.

Figure 46: Top 15 Commodities by Mode, 2012



Source: BTS and FHWA, FAF4, 2016.

The economic recession of 2008 had a different impact on different supply chains. As can be seen in Table 15, shipments within the Raleigh-Durham decreased significantly, especially for the truck mode. Inbound shipments also decreased considerably as consumer spending contracted from the deleveraging of household debt. However, at the same time, outbound shipments increased over this period, as the high-tech economy demonstrated resilience in the face of the broader economic downturn.

Even though FAF made several methodological improvements in the definitions of the modes and commodity groups from 2007 to 2012 that could reduce the accuracy of comparisons across these two years, the changes affect a minority of the records and are unlikely to alter significantly the observed trends.

Table 15: Thousands of Tons 2007 to 2012

	Originated		Terminated		Within		Grand Total	
	Tons 2007	Tons 2012	Tons 2007	Tons 2012	Tons 2007	Tons 2012	Tons 2007	Tons 2012
Air (include truck-air)	19	11	11	12			30	23
Multiple modes & mail	1,031	499	1,449	1,497	274	12	2,754	2,008
Other and unknown	251	13	298	0	165		714	13
Pipeline			1,134	0			1,134	0
Rail	171	1,320	10,150	11,639	884	27	11,205	12,985
Truck	15,743	20,589	22,970	16,283	44,392	30,309	83,105	67,181
Grand Total	17,215	22,431	36,011	29,431	45,715	30,348	98,941	82,210
Air (include truck-air)	0.1%	0.1%	0.0%	0.0%			0.0%	0.0%
Multiple modes & mail	6.0%	2.2%	4.0%	5.1%	0.6%	0.0%	2.8%	2.4%
Other and unknown	1.5%	0.1%	0.8%	0.0%	0.4%		0.7%	0.0%
Pipeline			3.1%	0.0%			1.1%	0.0%
Rail	1.0%	5.9%	28.2%	39.5%	1.9%	0.1%	11.3%	15.8%
Truck	91.4%	91.8%	63.8%	55.3%	97.1%	99.9%	84.0%	81.7%
Grand Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: BTS and FHWA, FAF3.5, FAF4, 2016.

Table 16 shows the changes in value from 2007 to 2012 in nominal dollars. During this time period, inflation eroded the value of the dollar by 11 percent according to the Bureau of Labor Statistics Consumer Price Index (CPI) calculator. Total value shipped kept up with inflation, despite the tonnages shipped decreasing by 17 percent over this time period. This indicates that Raleigh-Durham saw an increase in higher value commodities. At the same time, value shipped within the region decreased substantially, signaling an increase in commerce with nearby regions as opposed to within Raleigh-Durham. Only outbound shipments saw growth over this time period, while local and inbound shipments decreased.

Table 16: Millions of Dollars (nominal) 2007 to 2012

	Originated		Terminated		Within		Grand Total	
	Value 2007	Value 2012	Value 2007	Value 2012	Value 2007	Value 2012	Value 2007	Value 2012
Air (include truck-air)	697	753	618	507			1,315	1,260
Multiple modes & mail	5,685	7,084	10,180	9,325	256	649	16,120	17,058
Other and unknown	463	162	415	1	460		1,338	163
Pipeline			409	0			409	0
Rail	91	273	1,184	2,346	45	0	1,320	2,620
Truck	32,705	45,092	29,770	36,174	22,869	14,107	85,344	95,373
Grand Total	39,641	53,363	42,576	48,354	23,629	14,757	105,846	116,473
Air (include truck-air)	1.8%	1.4%	1.5%	1.0%			1.2%	1.1%
Multiple modes & mail	14.3%	13.3%	23.9%	19.3%	1.1%	4.4%	15.2%	14.6%
Other and unknown	1.2%	0.3%	1.0%	0.0%	1.9%		1.3%	0.1%
Pipeline			1.0%	0.0%			0.4%	0.0%
Rail	0.2%	0.5%	2.8%	4.9%	0.2%	0.0%	1.2%	2.2%
Truck	82.5%	84.5%	69.9%	74.8%	96.8%	95.6%	80.6%	81.9%
Grand Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: BTS and FHWA, FAF3.5, FAF4, 2016.

Comparing mode shares in terms of value across years eliminates the effect of inflation. For shipments that terminated in Raleigh-Durham, trucks increasingly carried a higher proportion of value, while multiple modes and mail carried less value. Rail mode share doubled during this time period in terms of value.

Changes in mode shares are fundamentally driven by changes in the economic activity of the industries. Table 17 shows the top 5 commodities for each mode by tonnage. For truck, shipments of gravel decreased rapidly at a rate of 8.3 percent per year from 2007 to 2012. Increases in mixed freight and wood products were not enough to offset these reductions, leading trucking as a whole to decrease at a rate of 4.2 percent per year.

Rail increased its mode share at 3 percent per year, primarily through consistent growth in coal over this time period. Alcoholic beverage shipments by rail (including non-biofuel ethanol) grew at over 300 percent per year, leading this commodity to become the third most important for rail in 2012. Multiple modes and other decreased at 6.1 percent per year, even though several of its top commodities increased quickly, such as alcoholic beverages, textiles/leather, and waste/scrap. Air cargo decreased at 4.9 percent per year over this time period, mostly driven by a sharp drop in shipments of electronics and printer products. On the other hand, air shipments of precision instruments, wood products and pharmaceuticals all increased at a double-digit pace. Note that for these higher value commodities it might be misleading to focus on tonnages.

Table 17: Top Commodities by Mode by Tons in 2012 & Volume Trends 2007 to 2012

Truck Thousand Tons

Rank Tons	Commodity Name	Tons 2012	Growth Rate 2007 to 2012
1	Gravel	15,886.7	-8.29%
2	Nonmetal min. prods.	10,009.7	-0.62%
3	Wood prods.	4,532.3	3.75%
4	Mixed freight	3,678.5	10.42%
5	Gasoline	3,310.9	-7.48%
	Grand Total	67,181.1	-4.16%

Rail Thousand Tons

Rank Tons	Commodity Name	Tons 2012	Growth Rate 2007 to 2012
1	Coal	8,554.1	1.68%
2	Gravel	918.1	47.92%
3	Alcoholic beverages	603.5	330.28%
4	Nonmetal min. prods.	540.0	-14.45%
5	Basic chemicals	441.5	13.27%
	Grand Total	12,985.2	2.99%

Multiple and Mail Thousand Tons

Rank Tons	Commodity Name	Tons 2012	Growth Rate 2007 to 2012
1	Coal	948.6	5.61%
2	Gravel	256.5	-8.50%
3	Alcoholic beverages	92.0	35.51%
4	Textiles/leather	86.5	19.48%
5	Waste/scrap	78.5	187.40%
	Grand Total	2,007.6	-6.13%

Air Thousand Tons

Rank Tons	Commodity Name	Tons 2012	Growth Rate 2007 to 2012
1	Electronics	4.1	-22.66%
2	Precision instruments	3.2	16.18%
3	Printed prods.	2.6	-8.88%
4	Wood prods.	2.4	52.71%
5	Pharmaceuticals	1.9	21.90%
	Grand Total	23.4	-4.92%

Source: BTS and FHWA, FAF3.5, FAF4, 2016.

Table 18 shows the changes in the top five commodities for each mode in terms of value. Note that from 2007 to 2012 inflation averaged 2.1 percent per year, therefore a growth rate higher than 2.1 percent implies that values saw real growth. Total rail value grew significantly higher than inflation, at a double-digit pace, spurred by shipments of alcoholic beverages and motorized vehicles. On the other hand, truck value grew slightly above inflation, spurred by growth in mixed freight. Air value declined rapidly in real terms over this time period.

Table 18: Top Commodities by Mode by Value in 2012 & Volume Trends 2007 to 2012

Truck Million Dollars

Rank Value	Commodity Name	Value 2012	Growth Rate Value 2007 to 2012
1	Mixed freight	13,237	14.40%
2	Pharmaceuticals	10,063	-11.20%
3	Machinery	9,168	0.91%
4	Motorized vehicles	6,517	1.76%
5	Electronics	6,250	-4.10%
	Grand Total	95,373	2.25%

Rail Million Dollars

Rank Value	Commodity Name	Value 2012	Growth Rate Value 2007 to 2012
1	Coal	603	11.60%
2	Alcoholic beverages	442	238.11%
3	Basic chemicals	432	24.25%
4	Fertilizers	138	9.61%
5	Motorized vehicles	138	185.93%
	Grand Total	2,620	14.69%

Multiple and Mail Million Dollars

Rank Value	Commodity Name	Value 2012	Growth Rate Value 2007 to 20..
1	Pharmaceuticals	3,312	1.39%
2	Electronics	2,585	-13.40%
3	Precision instrumen..	2,506	13.36%
4	Machinery	1,576	18.43%
5	Textiles/leather	1,334	12.82%
	Grand Total	17,058	1.14%

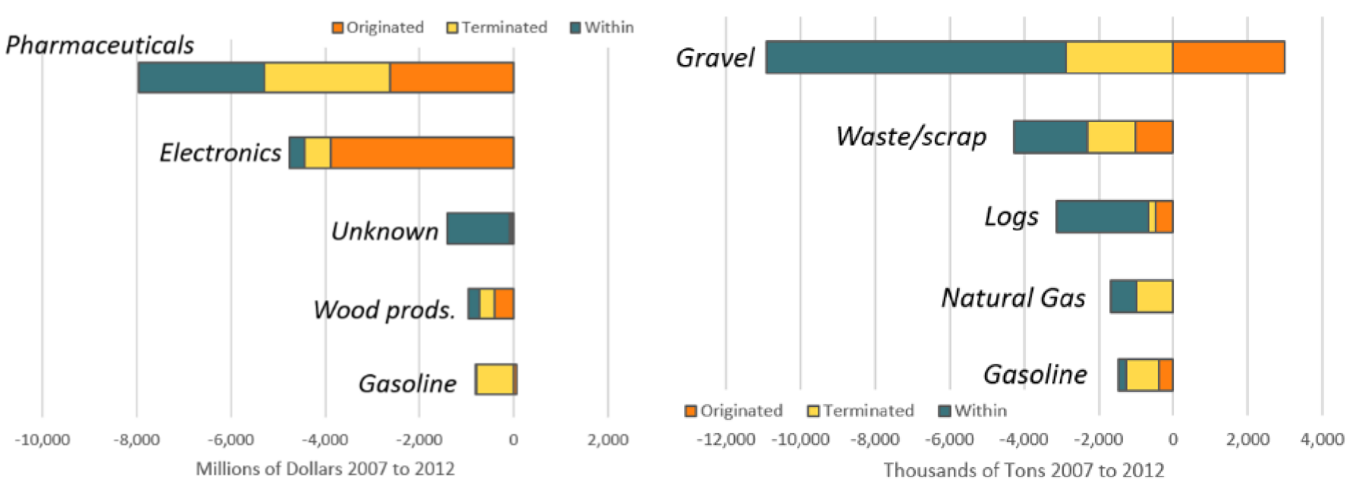
Air Million Dollars

Rank Value	Commodity Name	Value 2012	Growth Rate Value 2007 to 2012
1	Precision instru..	424	27.88%
2	Pharmaceuticals	275	-0.57%
3	Electronics	223	-16.83%
4	Printed prods.	91	18.82%
5	Machinery	63	-9.91%
	Grand Total	1,260	-0.85%

Source: BTS and FHWA, FAF3.5, FAF4, 2016.

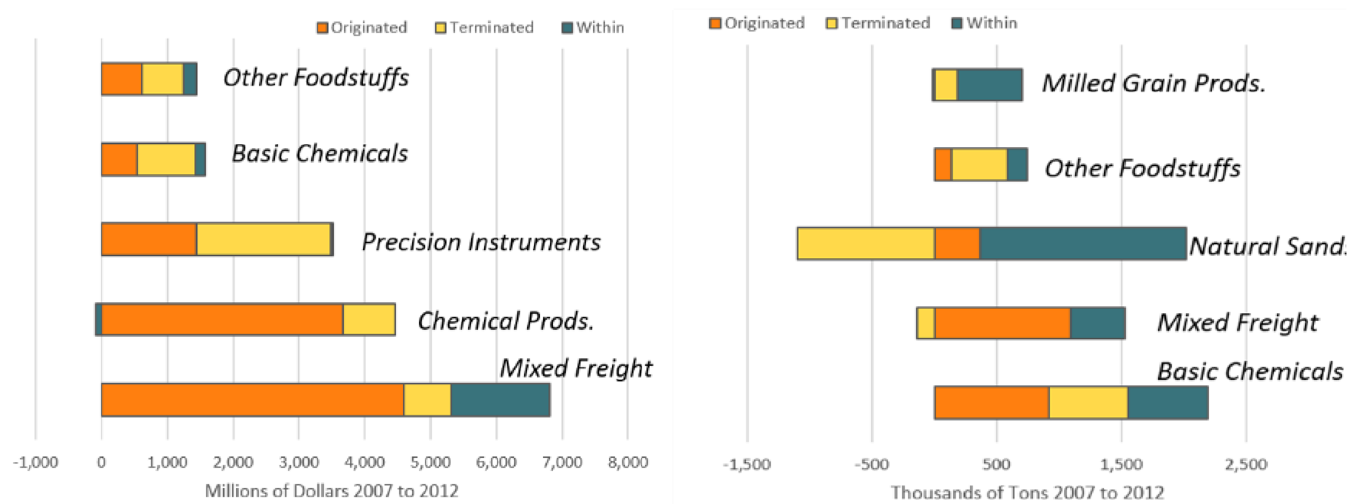
Figure 47 highlights the commodities that declined the fastest for all modes from 2007 to 2012 and Figure 48 shows the commodities that increased the fastest. Because of the economic recession of 2008, pharmaceuticals and electronics decreased substantially in value. In terms of tonnage, most of the declines came from gravel, waste/scrap, and logs. The commodities that grew the quickest in terms of value were mixed freight, chemical products, and precision instruments, and in terms of tonnage they were basic chemicals, mixed freight, and natural sands. From these figures it can be seen that while overall gravel tons declined rapidly, shipments that originated in the Raleigh-Durham region increased substantially. A similar pattern occurred with natural sands, where the commodity saw significant growth, despite shipments terminating in Raleigh-Durham decreasing.

Figure 47: Top Declining Commodities by Tons and Value, 2007 to 2012



Source: BTS and FHWA, FAF3.5, FAF4, 2016.

Figure 48: Top Growing Commodities by Tons and Value, 2007 to 2012



Source: BTS and FHWA, FAF3.5, FAF4, 2016.

For shipments heading to Raleigh-Durham, Table 19 shows the top origins around the country. In terms of tons, West Virginia, North Carolina, and Kentucky 'remainder of state' account for almost half of all tons. In terms of value, the principal origins include large metropolitan areas with important ports, such as Norfolk, New York, Los Angeles and Jacksonville. Around 12 percent of all value originates in the 'remainder of state' North Carolina zone.

Table 19: Top 10 Origins of Shipments to Raleigh-Durham by Tons and Value, 2012

	Origin MSA	Org State	Tons (000')	% of Total
1	Remainder of State	West Virginia	6,524	22%
2	Remainder of State	North Carolina	4,640	16%
3	Remainder of State	Kentucky	2,446	8%
4	Greensboro	North Carolina	2,037	7%
5	Remainder of State	Virginia	1,343	5%
6	Charlotte	North Carolina	895	3%
7	Norfolk	Virginia	813	3%
8	Remainder of State	Pennsylvania	771	3%
9	Remainder of State	Iowa	758	3%
10	Atlanta	Georgia	708	2%
	Other		8478	29%

	Origin MSA	Org State	M USD	% of Total
1	Rem. of North Caroli	North Carolina	5,389	12%
2	Greensboro	North Carolina	2,921	7%
3	Atlanta	Georgia	2,586	6%
4	New York	New York	2,535	6%
5	Norfolk	Virginia	2,485	6%
6	Charlotte	North Carolina	1,703	4%
7	Los Angeles	California	1,152	3%
8	Austin	Texas	1,110	3%
9	Jacksonville	Florida	1,089	3%
10	Rem. of Virginia	Virginia	975	2%
	Other		**21,586**	**50%**

Source: BTS and FHWA, FAF4, 2016.

Table 20 shows the top 10 destinations of shipments originating in Raleigh-Durham. In terms of tonnage, the 'remainder of state' regions in North Carolina, South Carolina, and Virginia are the largest recipients. As expected, the closest major cities are large attractors of shipments, including Greensboro, Charlotte, Atlanta and Richmond. In terms of value, it is noteworthy that Ohio was the second largest destination of shipments, accounting for 9 percent of the total.

Table 20: Top 10 Destinations of Shipments from Raleigh-Durham by Tons and Value, 2012

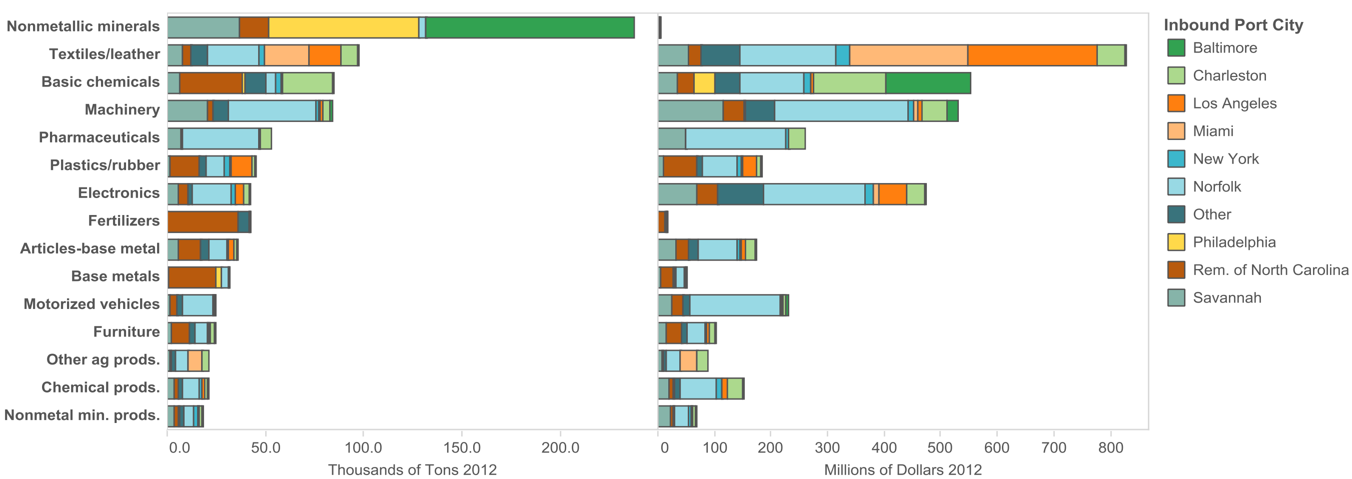
	Destination MSA	Destination State	Tons (000')	% of Total
1	Remainder of State	North Carolina	10,827	49%
2	Remainder of State	South Carolina	1,479	7%
3	Greensboro	North Carolina	1,478	7%
4	Charlotte	North Carolina	806	4%
5	Remainder of State	Virginia	761	3%
6	Atlanta	Georgia	481	2%
7	Richmond	Virginia	467	2%
8	Norfolk	Virginia	401	2%
9	Remainder of State	West Virginia	248	1%
10	Greenville	South Carolina	228	1%
	Other		**5,037**	**23%**

	Destination MSA	Destination State	M USD	% of Total
1	Remainder of State	North Carolina	10,004	22%
2	Remainder of State	Ohio	4,261	9%
3	Remainder of State	South Carolina	2,956	6%
4	Greensboro	North Carolina	2,642	6%
5	Charlotte	North Carolina	2,357	5%
6	Philadelphia	Pennsylvania	1,245	3%
7	Rem. of Virginia	Virginia	1,219	3%
8	New York	New York	1,190	3%
9	Atlanta	Georgia	1,141	2%
10	Chicago	Illinois	843	2%
	Other		18,456	40%

Source: BTS and FHWA, FAF4, 2016.

Many of the products consumed in the Raleigh-Durham region are imported from around the world, often traveling to the U.S. by ship. Figure 49 shows the gateway ports for the top import commodities. The top import commodities in terms of tons are nonmetallic minerals (24.4% of total), textiles/leather (10%), basic chemicals (8.7%), machinery (8.6%), and pharmaceuticals (5.4%). On the other hand, the top import commodities in terms of value are textiles/leather (19.8% of total), basic chemicals (13.3%), machinery (12.6%), electronics (11.4%), and pharmaceuticals (5.4%). Overall, 23.9 percent of tons enter through Norfolk, 11.6 percent enter through Savannah, and 11.2 percent enter though Baltimore. In terms of value, 35.3 percent enters through Norfolk, 12.1 percent enters through Savannah, and 10.3 percent through Charleston. Baltimore and Philadelphia are used exclusively for imports of nonmetallic minerals.

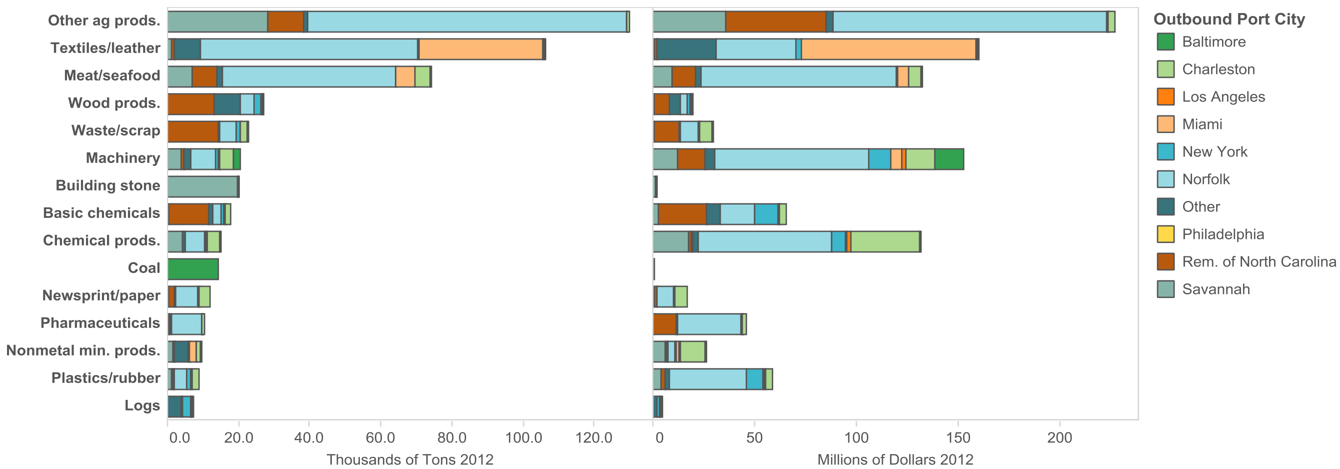
Figure 49: Port Cities used for International Inbound Waterborne Shipments to Raleigh-Durham



Source: BTS and FHWA, FAF4.1, 2016.

Marine exports from the region appear in Figure 50. Agricultural products, meats and seafood, textiles and leather are leading commodities by tonnage and value, but machinery and chemical products stand out by value and reflect the high technology side of the Triangle economy. North Carolina ports are used for many commodities, but Norfolk stands out as the region's largest gateway, exceeding volumes Charleston and Savannah. Textiles and leather exports make significant use of Miami, presumably for trade to Latin American markets.

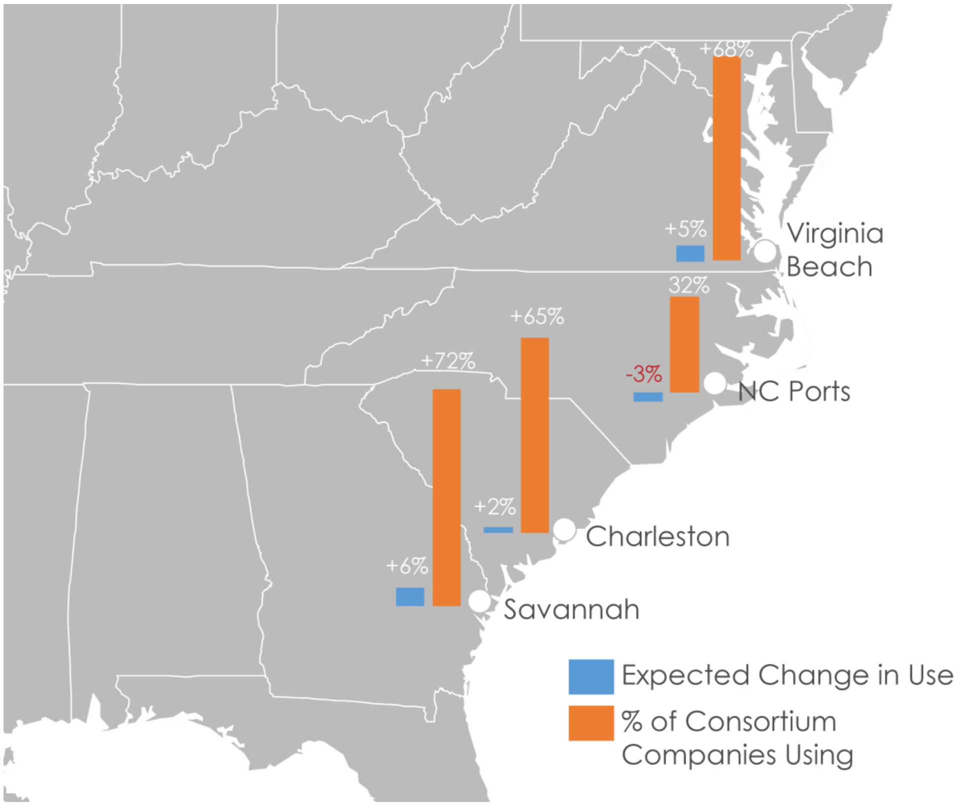
Figure 50: Port Cities used for International Outbound Waterborne Shipments from Raleigh-Durham



Source: BTS and FHWA, FAF4.1, 2016.

Tompkins conducted a survey of shippers to assess the general outlook of ports that serve North Carolina. The results of this survey are summarized in Figure 51. For ports in North Carolina, the outlook reported was moderately negative, with survey takers indicating that in aggregate they will decrease usage by 3 percent. On the other hand, the outlook for larger ports outside North Carolina, such as Charleston, Savannah, and Virginia Beach, was considerably more positive. The general expectation is that ports in the Atlantic will be used more intensively, reflecting a positive outlook on trade. Because the Triangle Region currently does not have a nearby rail intermodal terminal, the majority of shipments from these ports will be delivered by truck. This could change if intermodal access was more readily available. The Tompkins survey also found that a majority of shippers (60 percent) expect exports to grow as a percent of their outbound shipment. If this shift materializes it would signal increased demand for ports that serve the Region.

Figure 51: Outlook for Regional Ports



Source: Tompkins International: Supply-Chain Consortium

Patterns of maritime shipments are evolving as the expansion of the Panama Canal is completed this year, doubling the Canal's capacity and allowing the transit of much larger ships that will lower transportation costs. These much larger ships will require deeper port channels and berths, larger cranes, and more short term storage and handling, among other requirements. Since fewer ships will be needed to carry the same cargo, use of these larger ships will also mean fewer port calls from larger ships, potentially changing carriers' calling patterns, especially on the United States East Coast. Allowing larger ships will also reduce per-unit shipping costs due to economies of scale, especially on longer-distance and high-volume trade lanes where economies of scale are largest.

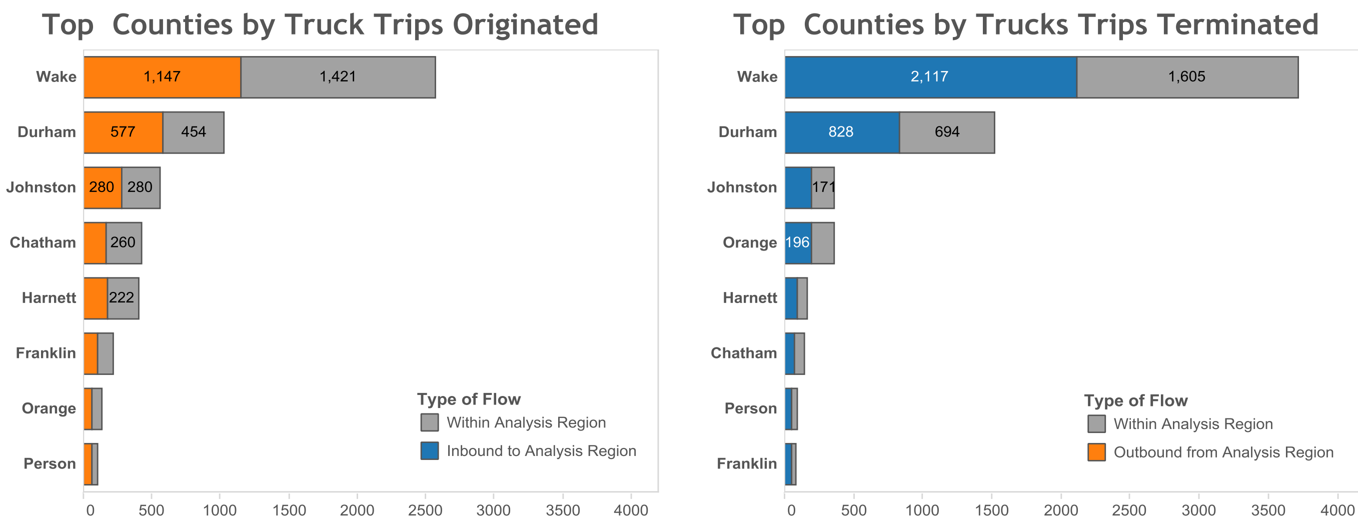
Much uncertainty exists over the implications of these changes on international supply-chains. However, it is likely that the impact on volumes will be larger for the main ports in the Atlantic, including ports outside North Carolina (shown in Figure 51). These ports stand to provide even better service to the Triangle Region and increase maritime shipping options. It is also likely that the major shifts in container volumes have occurred already, with these larger ports seeing most of the gains. The long-run implications of this expansion project are still largely uncertain, particularly for North Carolina.

Truck Trips

In order to investigate the implications of truck shipments inside the Triangle Region, the FAF truck data was disaggregated to the county level. Providing additional detail about the geography of truck shipments is important because it is by far the most important freight mode in the region and uses a significant amount of capacity on local highways and roads. Moreover, local modeling efforts stand to benefit from having information about the origination and termination of truck trips by county and economic sector. Later in this report, additional detail is provided about rail shipments and air shipments.

FAF truck volumes were disaggregated based on a commonly used methodology recommended by the FHWA.[10] Figure 52 shows the origination and termination of truck trips in an average weekday by county. As expected, Wake County shows up as the largest attractor and generator of trips. Roughly half of the trips start and end within Wake County itself and the rest have origins or destinations outside of the Triangle Region. Durham County is second in terms of trip generation or attraction.

Figure 52: Truck Trips Originated and Terminated in Average Weekday, 2012

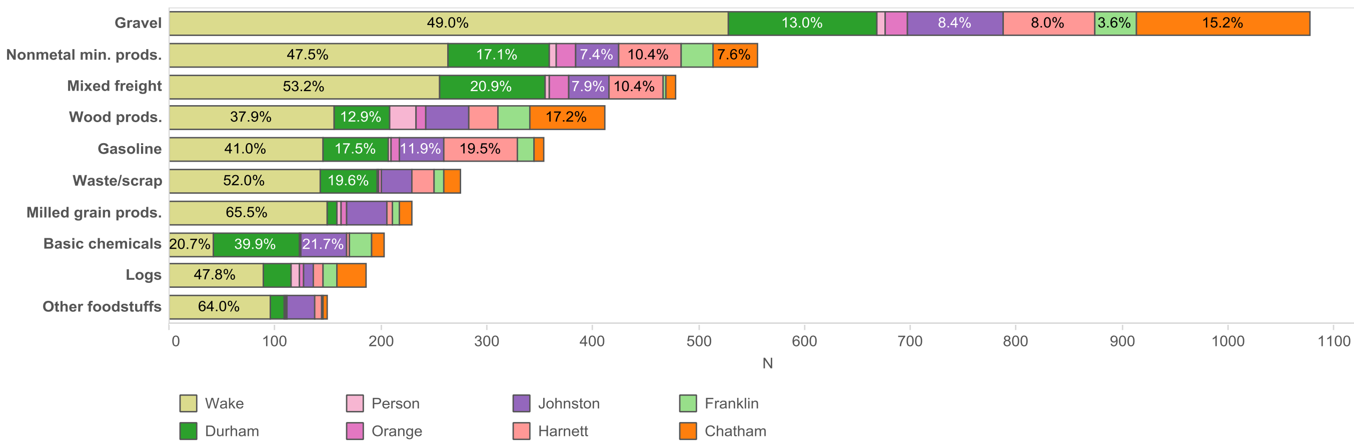


Source: Disaggregated FAF v4.0 by WSP

The FAF disaggregation included detail on the types of commodities carried by the trucks. This information is summarized for the Triangle Region in Figure 53 and Figure 54. As mentioned before, the largest commodity originated is gravel. This represents a significant number of truck trips in the Region, representing more than 1,000 trips on an average weekday, with roughly half of these trips originating in Wake County. Mineral products, mixed freight and wood products round out the top four commodities in terms of truck trip generation. Truck trip generation is driven primarily by the bulkier commodities.

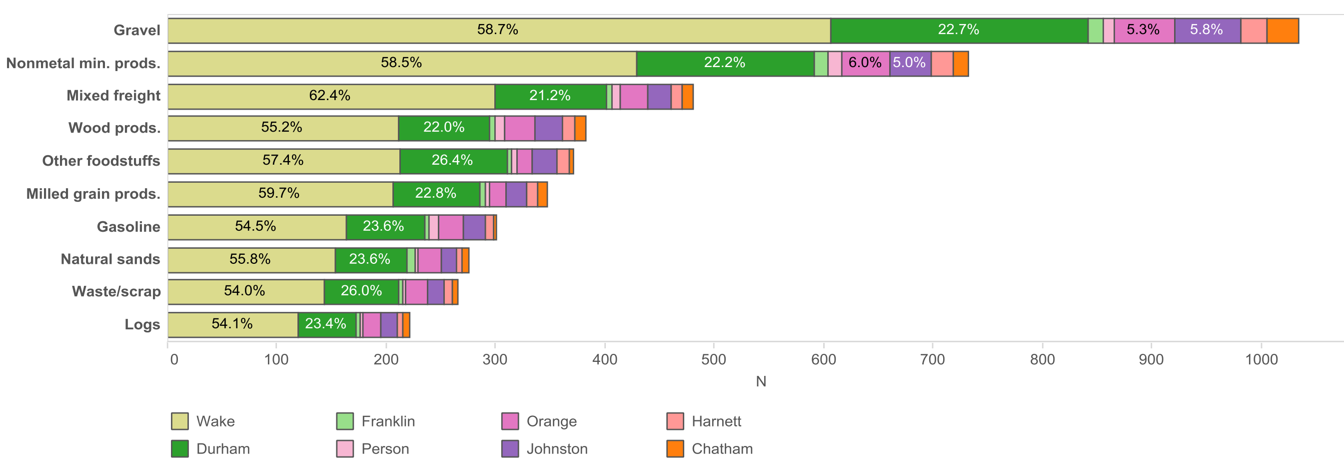
[10] In brief, the methodology consisted of using a variety of economic indicators to apportion truck freight movements to the county-level, and then use the traffic analysis methodology developed by the FHWA for FAF to convert flows of commodities to truck trips.

Figure 53: Top 10 Commodities Originated in Triangle Region Counties by Number of Truck Trips in Average Weekday



Source: Disaggregated FAF v4.0 by WSP

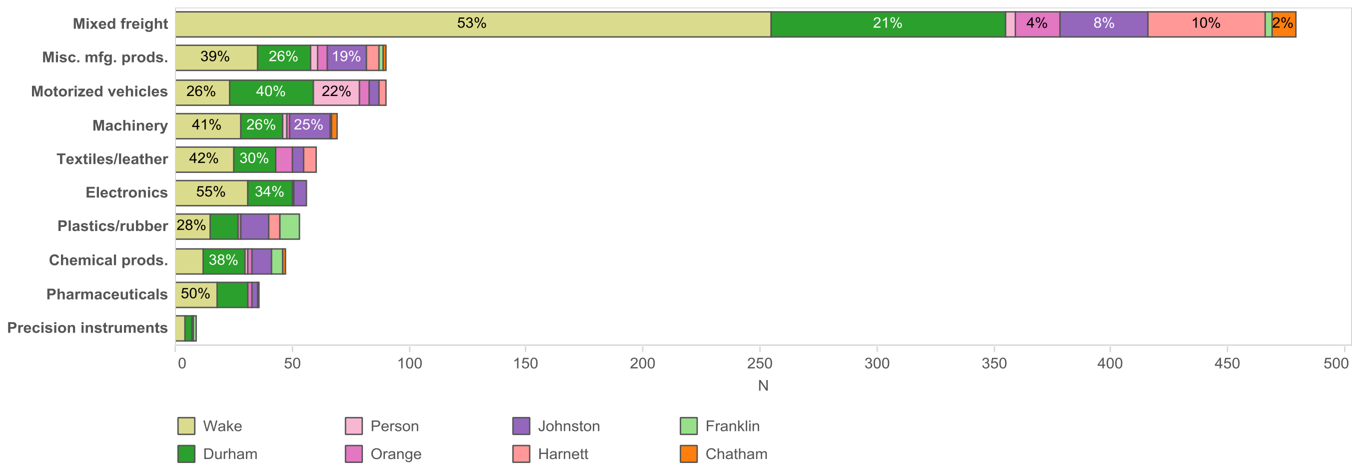
Figure 54: Top 10 Commodities Terminated in Triangle Region Counties by Number of Truck Trips in Average Weekday



Source: Disaggregated FAF v4.0 by WSP

Even though shipments of high-value commodities are not a major generator of truck trips, they are arguably more important for the local economy than shipments of bulkier commodities. Figure 55 shows the counties originating the 10 highest value commodities identified in Figure 45. As expected, Wake County is responsible for the largest share of these shipments, particularly for mixed freight shipments, although for the rest of the commodities Durham County generates a larger share.

Figure 55: Top 10 High-Value Commodities Originated in Triangle Region Counties by Number of Truck Trips in Average Weekday



Source: Disaggregated FAF v4.0 by WSP

Forecasts and Proposed Developments

This section provides a preliminary assessment of freight infrastructure needs over the coming decades. First, it describes freight trends for different modes and markets as patterns of consumption and production continue to evolve. Even though forecasting the future is fraught with challenges, clear trends emerge that have substantial impacts on the Region's infrastructure needs.

This section then builds on Chapter 3 (description of physical extent of freight infrastructure) by describing projects that are currently proposed or in the pipeline to improve freight movement. This includes both projects led by the public or private sector. Focus is placed on how different modes serve distinct markets and how service is anticipated to change in response to shipper needs. Note, however, that this section does not represent a precise assessment of investment needs and project prioritization. Instead, it is a description of how freight demand is forecasted to change in the future and an accounting of the various infrastructure projects in the pipeline to meet this demand.

Forecasted Demand

Long-term forecasts are obtained from FAF, which reports expected freight flows in tons and value out to 2045. These forecasts were generated by the FHWA based on long-term economic projections for industries that produce and consume commodities. The forecasts assume that freight modes maintain the same mode share for each origin-destination-commodity group. Mode shifts observed in the aggregate are therefore a consequence of the different rates of growth for particular commodities and geographic regions, and are not due to changes in modal competitiveness.

Overall, tonnages to, from, and within the Raleigh-Durham region are expected to increase over the following decades at an average rate of 0.82 percent per year. The forecast also includes optimistic and pessimistic scenarios of economic activity. Under the optimistic scenario growth is forecasted at 1.12 percent per year and under the pessimistic scenario it is forecasted at 0.42 percent per year.

As can be seen in Table 21, the truck mode is expected to see the fastest growth in tonnages originated and terminated. This effect is stronger for terminated tonnages, where truck mode share will increase from 54 percent in 2012 to 66 percent in 2045. In contrast, rail is anticipated to see slower growth over this time period, which will translate into a decreasing modal share. For tons terminated, rail mode share is expected to decrease by over 10 percentage points. Declines in rail are primarily caused by declines in coal shipments. Shipments within the Triangle Region are expected to see the slowest growth out to 2045, continuing the trend observed from 2007 to 2012.

Table 21: Thousands of Tons 2012 to 2045

	Originated		Terminated		Within		Grand Total	
	Tons 2012	Tons 2045	Tons 2012	Tons 2045	Tons 2012	Tons 2045	Tons 2012	Tons 2045
Air (include truck-air)	32	127	34	131			67	258
Multiple modes & mail	533	942	1,494	1,614	12	20	2,039	2,575
Other and unknown	5	13	26	148	0	9	31	170
Pipeline			0	0			0	0
Rail	1,231	1,473	11,626	11,356	27	17	12,884	12,846
Truck	20,810	30,900	15,557	25,670	30,317	34,540	66,683	91,110
Grand Total	22,611	33,455	28,738	38,919	30,356	34,587	81,704	106,960
Air (include truck-air)	0.1%	0.4%	0.1%	0.3%			0.1%	0.2%
Multiple modes & mail	2.4%	2.8%	5.2%	4.1%	0.0%	0.1%	2.5%	2.4%
Other and unknown	0.0%	0.0%	0.1%	0.4%	0.0%	0.0%	0.0%	0.2%
Pipeline			0.0%	0.0%			0.0%	0.0%
Rail	5.4%	4.4%	40.5%	29.2%	0.1%	0.1%	15.8%	12.0%
Truck	92.0%	92.4%	54.1%	66.0%	99.9%	99.9%	81.6%	85.2%
Grand Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: BTS and FHWA, FAF4.1, 2016.

As can be seen in Table 22, truck mode share is expected to decrease 5.4 percentage points for originated value and 6.4 percentage points for terminated value. This decrease appears to come from trucking not increasing as fast as the other modes in terms of value, especially air. Air value is expected to increase by around five-fold over this time period, much faster than the other modes. This is driven predominantly by a rapid increase in high-value commodities in the Triangle Region. Overall, freight value is expected to increase at 2.4 percent per year on average out to 2045. In the optimistic scenario of economic activity the growth rate could reach 2.85 percent per year, while in the pessimistic scenario the growth rate could be as low as 0.98 percent.

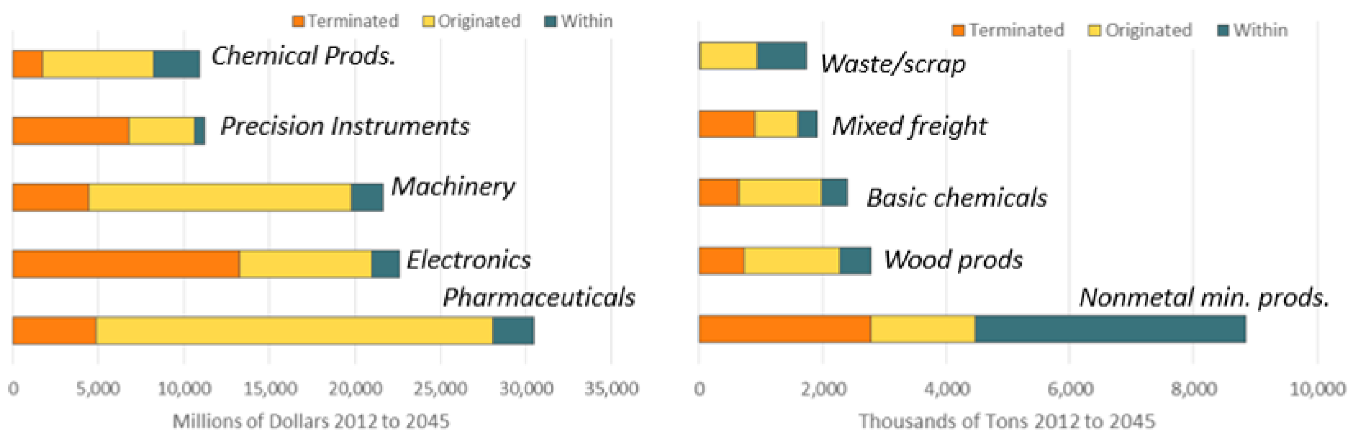
Table 22: Millions of Dollars 2012 to 2045 (real 2012 dollars)

	Originated		Terminated		Within		Grand Total	
	Value 2012	Value 2045	Value 2012	Value 2045	Value 2012	Value 2045	Value 2012	Value 2045
Air (include truck-air)	2,515	13,192	2,196	11,394			4,711	24,586
Multiple modes & mail	7,149	15,666	9,360	20,805	649	1,301	17,158	37,773
Other and unknown	52	1,970	148	728	1	235	201	2,933
Pipeline			0	0			0	0
Rail	277	667	2,392	4,089	0	0	2,670	4,756
Truck	45,803	98,046	34,733	67,875	16,906	32,234	97,443	198,154
Grand Total	55,796	129,542	48,830	104,890	17,557	33,770	122,183	268,202
Air (include truck-air)	4.5%	10.2%	4.5%	10.9%			3.9%	9.2%
Multiple modes & mail	12.8%	12.1%	19.2%	19.8%	3.7%	3.9%	14.0%	14.1%
Other and unknown	0.1%	1.5%	0.3%	0.7%	0.0%	0.7%	0.2%	1.1%
Pipeline			0.0%	0.0%			0.0%	0.0%
Rail	0.5%	0.5%	4.9%	3.9%	0.0%	0.0%	2.2%	1.8%
Truck	82.1%	75.7%	71.1%	64.7%	96.3%	95.4%	79.8%	73.9%
Grand Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: BTS and FHWA, FAF4.1, 2016.

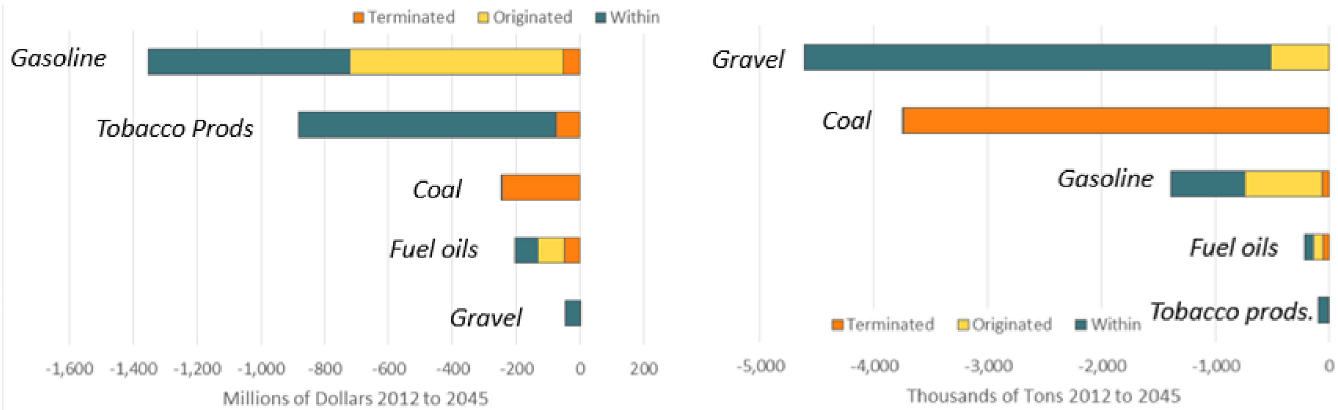
Figure 56 and Figure 57 show the top growing and declining commodities out to 2045. There are significant declines expected in shipments of bulk commodities and energy products, and rapid increases in higher value commodities. Reductions are also expected in tobacco---a historically important sector that has been on a long term decline.

Figure 56: Top Growing Commodities by Value and Tons, 2012 to 2045 (real 2012 dollars)



Source: BTS and FHWA, FAF4.1, 2016.

Figure 57: Top Declining Commodities by Value and Tons, 2012 to 2045 (real 2012 dollars)



Source: BTS and FHWA, FAF4.1, 2016.

The increase in truck mode share in terms of tonnage reflects strength growth in commodities such as nonmetallic minerals, wood, and basic chemicals, to just name a few, as can be seen in Table 23. These growing commodities will more than off-set trucking declines in gravel and gasoline. For rail, modest growth is expected in fertilizers, nonmetallic mineral products, and basic chemicals, however these are off-set by substantial declines in coal, leading rail on the whole to lose tonnages over this time period. Multiple modes and mail will also see modest growth in a wide variety of commodities and substantial declines in coal. Coal production and shipments are projected to see large decreases over the coming decades as tighter environmental regulations make coal less competitive relative to other sources of energy. The air mode will see some growth in tonnage, however as demonstrated below this represents a large increase in value because of the types of commodities carried.

Table 23: Top Commodity Gains and Declines from 2012 to 2045 by Mode, Thousands of Tons

Top Growing Commodities

Truck Tons (000')

Commodity Name	
Nonmetal min. prods.	8,385
Wood prods.	2,430
Basic chemicals	1,973
Mixed freight	1,712
Waste/scrap	1,551
Grand Total	24,618

Rail Tons (000')

Commodity Name	
Fertilizers	778
Nonmetal min. prods.	398
Basic chemicals	374
Alcoholic beverages	354
Wood prods.	338
Grand Total	-39

Multiple & Mail Tons (000')

Commodity Name	
Pharmaceuticals	182
Electronics	180
Textiles/leather	143
Waste/scrap	92
Chemical prods.	74
Grand Total	537

Air Tons (000')

Commodity Name	
Electronics	50.4
Machinery	30.5
Pharmaceuticals	16.2
Precision instruments	15.3
Textiles/leather	13.3
Grand Total	191.4

Top Declining Commodities

Truck Tons (000')

Commodity Name	
Gravel	-4,442
Gasoline	-1,373
Fuel oils	-224
Tobacco prods.	-93
Building stone	-35
Grand Total	24,618

Rail Tons (000')

Commodity Name	
Coal	-2,987
Gravel	-208
Gasoline	-19
Coal-n.e.c.	-16
Building stone	0
Grand Total	-39

Multiple & Mail Tons (000')

Commodity Name	
Coal	-729
Tobacco prods.	-1
Fuel oils	0
Metallic ores	0
Logs	0
Grand Total	537

Air Tons (000')

Commodity Name	
Tobacco prods.	0.0
Metallic ores	0.0
Gravel	0.0
Logs	0.0
Nonmetallic minerals	0.0
Grand Total	191.4

Source: BTS and FHWA, FAF4.1, 2016.

Table 24: Top Commodity Gains and Declines from 2012 to 2045 by Mode, $Millions (real $2012)

Top Growing Commodities

Truck Value (M US$)

Commodity Name	
Pharmaceuticals	24,784
Machinery	19,064
Electronics	16,232
Chemical prods.	10,056
Precision instruments	7,371
Grand Total	120,587

Rail Value (M US$)

Commodity Name	
Basic chemicals	639
Fertilizers	395
Alcoholic beverages	265
Plastics/rubber	189
Wood prods.	135
Grand Total	2,086

Multiple & Mail Value (M US$)

Commodity Name	
Pharmaceuticals	5,440
Electronics	4,175
Precision instruments	3,154
Machinery	2,142
Misc. mfg. prods.	915
Grand Total	20,615

Air Value (M US$)

Commodity Name	
Electronics	6,092
Pharmaceuticals	4,056
Machinery	3,136
Precision instruments	1,815
Textiles/leather	378
Grand Total	19,875

Top Declining Commodities

Truck Value (M US$)

Commodity Name	
Gasoline	-1,339
Tobacco prods.	-876
Fuel oils	-206
Gravel	-48
Metallic ores	-8
Grand Total	120,587

Rail Value (M US$)

Commodity Name	
Coal	-207
Coal-n.e.c.	-20
Gasoline	-12
Gravel	-3
Building stone	0
Grand Total	2,086

Multiple & Mail Value (M US$)

Commodity Name	
Coal	-35
Tobacco prods.	-2
Nonmetallic minerals	-1
Metallic ores	0
Fuel oils	0
Grand Total	20,615

Air Value (M US$)

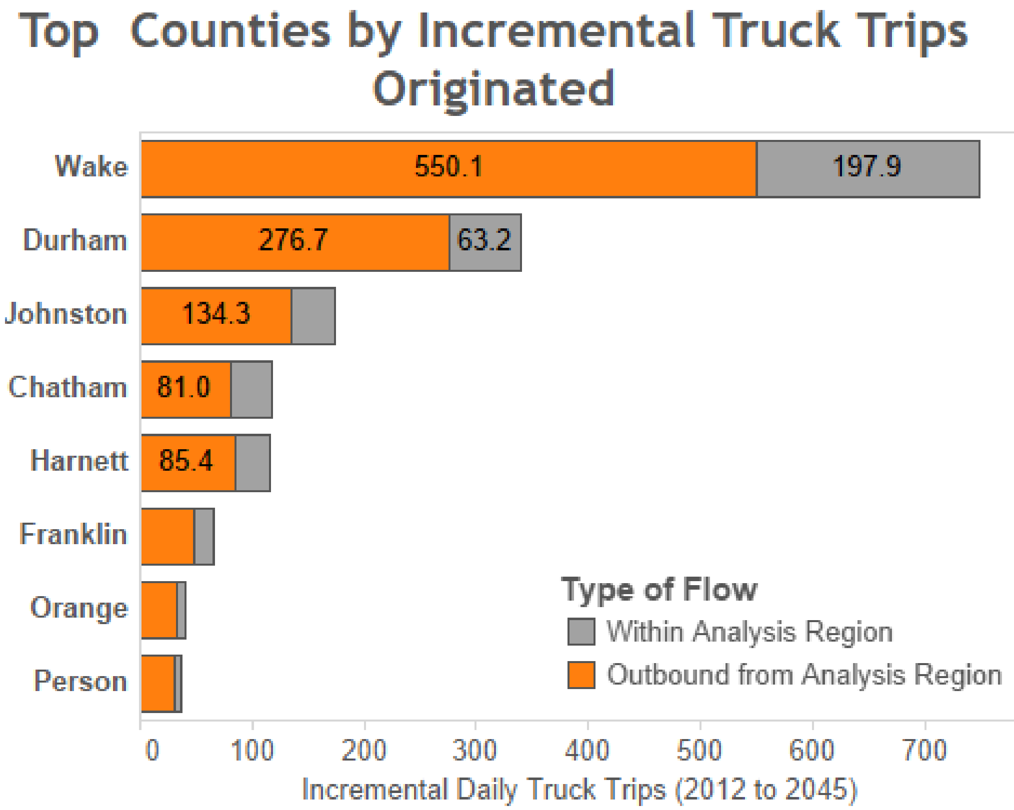
Commodity Name	
Metallic ores	-1
Logs	0
Gasoline	0
Gravel	0
Building stone	0
Grand Total	19,875

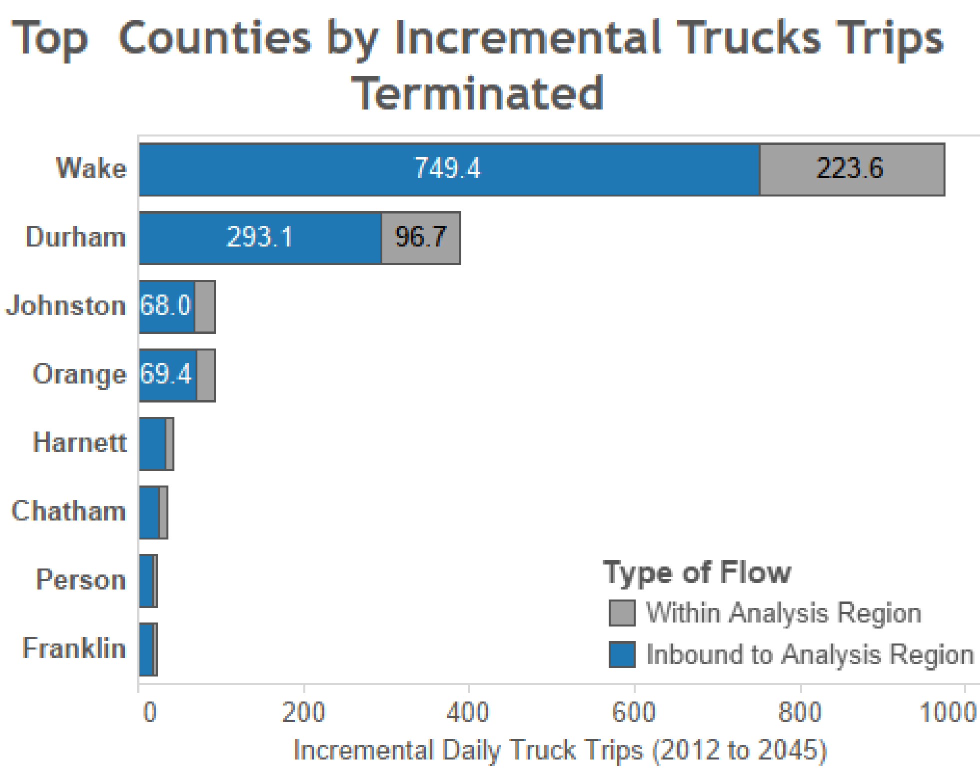
Source: BTS and FHWA, FAF4.1, 2016.

Table 24 displays the same information as Table 23 but for value instead of tonnage. Strong growth in pharmaceuticals, electronics, machinery, and precision instruments will drive growth in truck, multiple modes and air. These four commodities will be responsible for most air cargo growth. The top declining commodities for truck are tobacco products, gasoline, and fuel oils. For rail, coal is expected to see significant declines out to 2045.

The FAF forecasts were also used to project the truck trip generation out to 2045. Figure 58 shows the increase in daily truck trips that is expected for each Triangle Region county. As expected, Wake and Durham will see the largest increases in truck activity, with most of the gains occurring on trips with origins or destinations outside the Triangle Region. This resonates with the previous finding that trips within the Region decreased the fastest from 2007 to 2012 and are expected to see the weakest growth in the future.

Figure 58: Incremental Truck Trips per day 2012 to 2045





Source: WSP Disaggregation of FAF, 2016

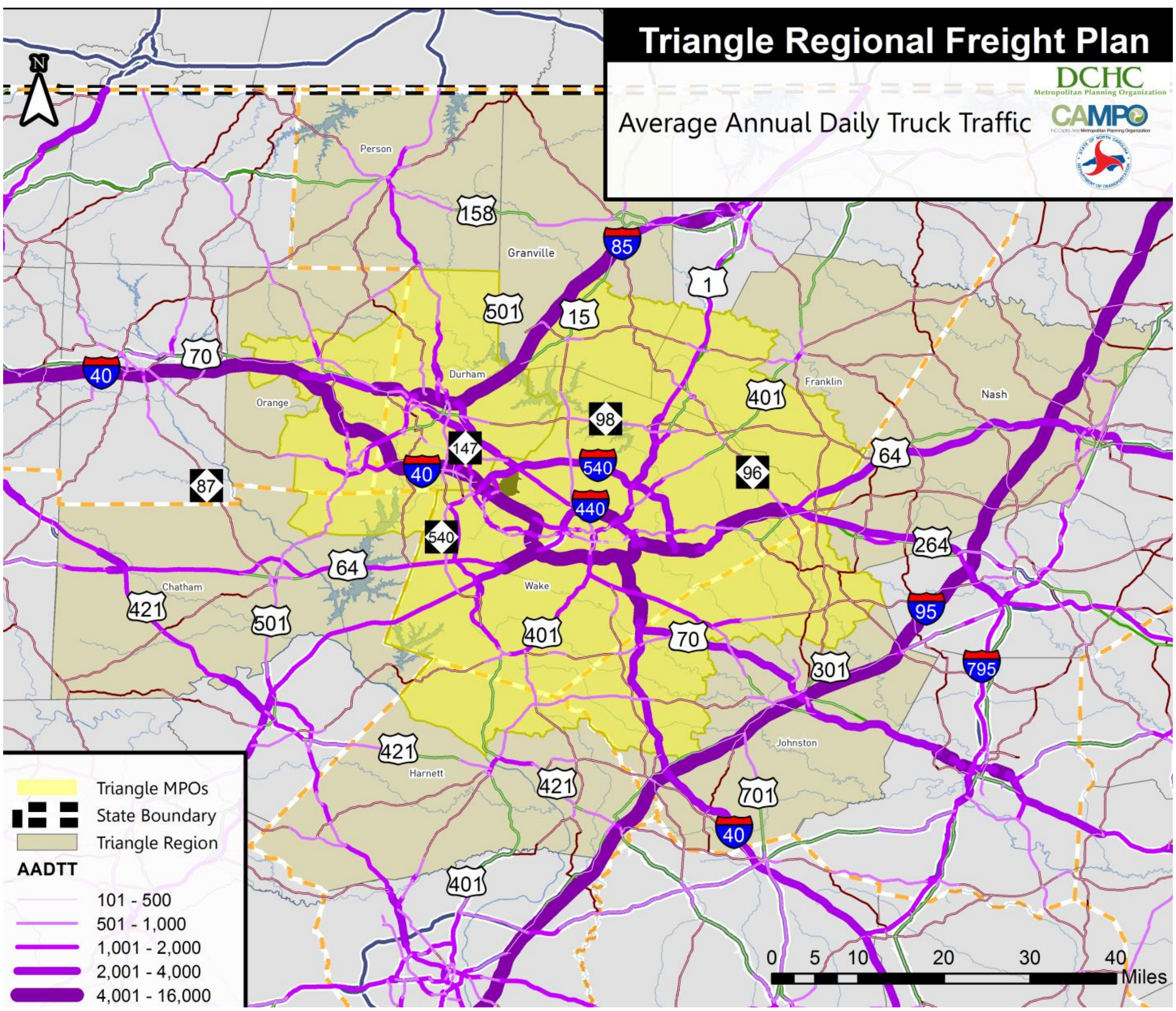
Highways

Existing Service

The Triangle Region is well connected to other cities in North Carolina and the rest of the U.S. through the following Interstate highways:

- I-95 is the main artery moving traffic along the East Coast, passing just east of the Triangle Region. Outside the core Region, I-95 carries close to 8,000 trucks per day at some locations (see Figure 59).
- I-85 is the main highway connecting Atlanta, GA to Norfolk, VA, passing through the Triangle Region, as well as other important urban centers. In segments in or around the Triangle Region this road carries over 8,000 trucks per day (see Figure 59).
- I-40 is the main highway connecting Greensboro and western portions of the state, also passes through the Triangle Region. Towards the east I-40 heads to Wilmington, which is home to North Carolina's largest port, serving several key regional markets. This Interstate sees truck volumes higher than 4,000 per day at some locations near the Region.

Figure 59: Average Annual Daily Truck Traffic, 2014



Source: NCDOT

Other important regional highways include U.S. Routes 64 (the main road towards the Port of Norfolk), 264, 1, 70 and 401. Each of these reaches volumes over 2,000 trucks per day in segments near the Triangle Region. The relatively high truck volumes on these U.S. routes and interstates suggest that they are important corridors for facilitating freight movement. In many cases, these routes provide access to areas without nearby interstate highways (the northern portion of the Triangle Region between I-95 and I-85 for example).

Meeting Future Demand

As shown in Table 21, truck tonnages are expected to increase considerably out to 2045, especially for shipments to and from the Triangle Region. For these shipments, tonnages are forecasted to increase by 53.1 percent out to 2045. If truck volumes on major Interstates increase by a similar proportion (assuming roughly constant load factors) it would represent thousands of additional trucks on highways that are already congested during many periods of the day. However, transportation within the Triangle Region is likely to see a smaller negative impact from this truck traffic than other urban areas as I-95 and I-85 do not cross core areas, and therefore are not used for local trips. Other cities that have a greater dependence on important interstates for local trips would be more heavily impacted, especially as through traffic continues to increase.

Local traffic operations will also benefit from truck shipments within the Region not increasing considerably over the coming decades. This will mitigate emissions, congestion, and other negative externalities of trucking relative to other urban centers in the U.S. that will see faster increases. This will increase the competitiveness of the region from a livability point of view, and also ease access for inbound and outbound shipments.

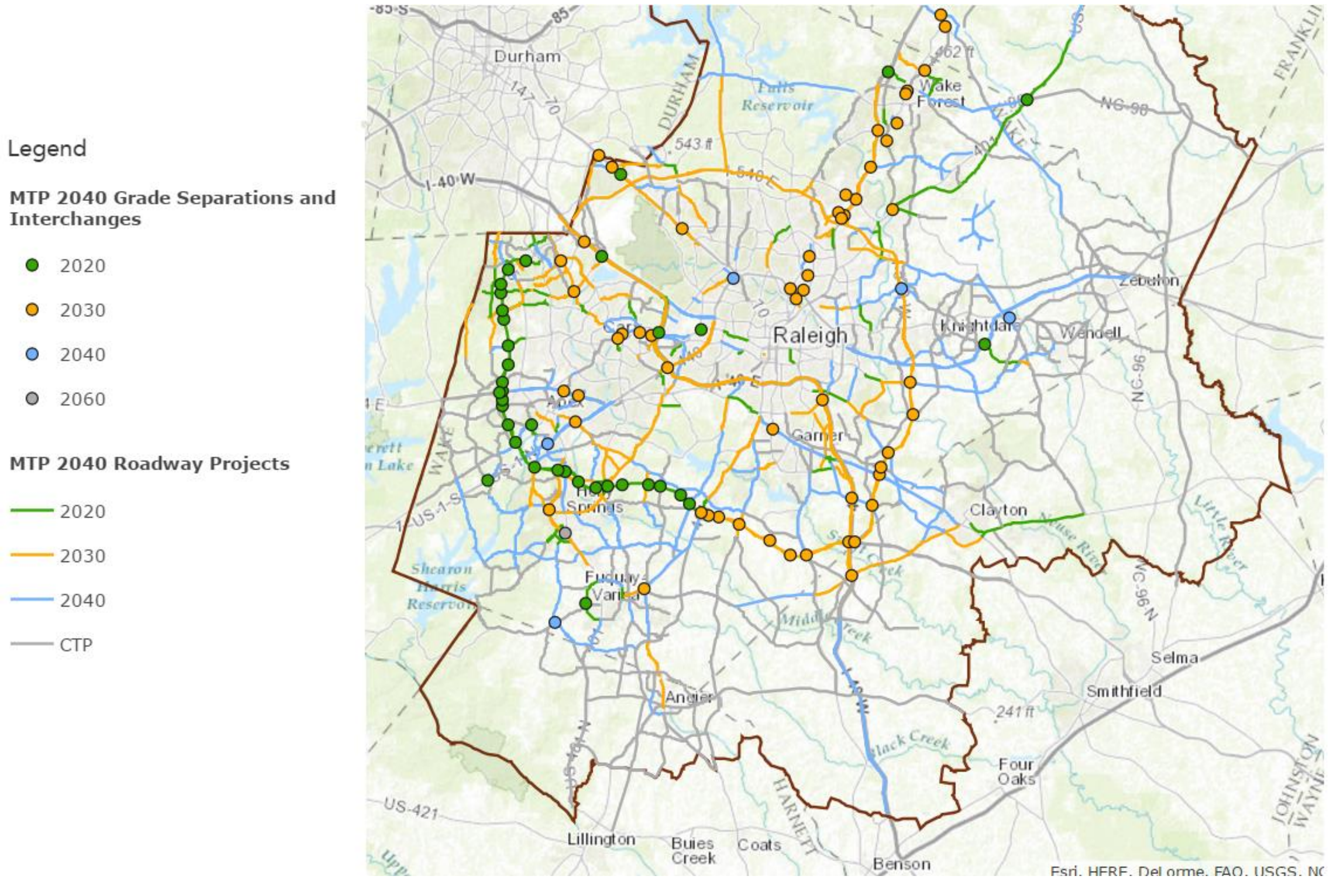
An analysis outlined in Chapter 3 on truck travel time reliability found that operations on nearby Interstates were relatively fluid during peak hours of the day, with congestion developing along several regional highways such as U.S.-401, U.S.-1, I-440, and SR-147, among others. These levels of congestions are not atypical of an urban area of this size. Performance was measured using the TTI, which is a metric often used to assess the variability of roadway operations from day to day, and throughout the day. This measure has been closely related to congestion—roadways that have a wide range of operating travel times are likely facing recurring or non-recurring congestion.

The Triangle Region is better positioned to meet future increases in truck traffic than other regions. This will facilitate increases in shipments of nonmetal mineral products, wood products, basic chemicals, pharmaceuticals, machinery and electronics (see Table 23 and Table 24). Nonetheless, projects are needed to ensure that the roadway network keeps up with the rapid increase expected of inbound and outbound shipments. This will likely entail improving the routes that are already congested that provide regional connection to Interstates and the rest of the State (flagged in the travel time reliability analysis), and generally removing bottlenecks on the local network.

Proposed Projects

A large number of projects are proposed that would improve the mobility and safety of highway travel in the region. The Capital Area and DCHC-MPO each maintains an extensive list of proposed highway projects resulting from planning efforts. Figure 60 provides an overview of the projects proposed by CAMPO out to 2040. A list of these projects is also shown on CAMPO's website.[11] A variety of roadway improvement and grade separation projects are being considered. Figure 61 summarizes the proposed projects out to 2040 for DCHC-MPO. For a list of short-term and long-term projects being considered, including detailed information about the characteristics of each project, see the DCHC-MPO website.[12]

Figure 60: CAMPO Metropolitan Transportation Plan 2040 Proposed Projects

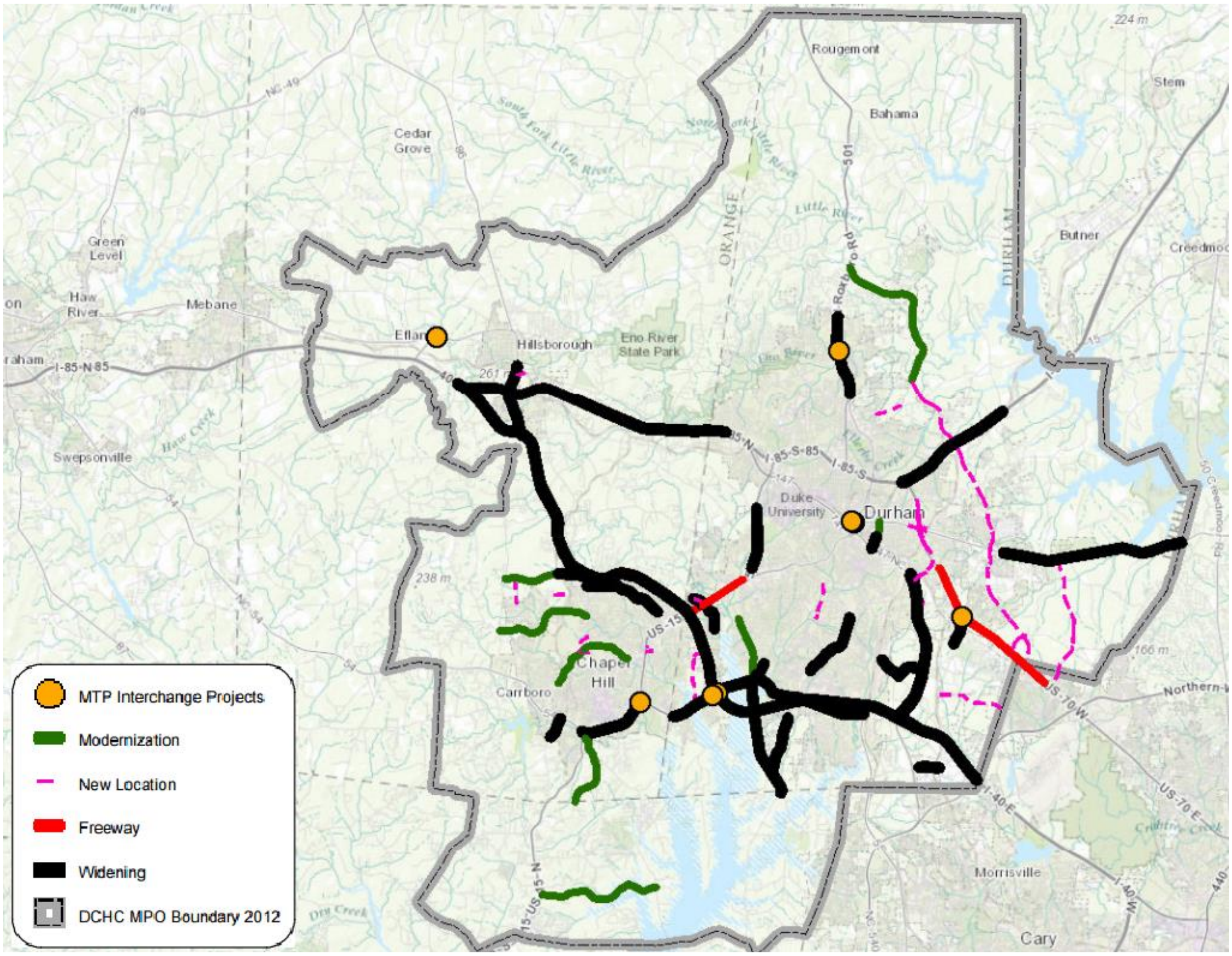


Source: CAMPO

[11] http://files.www.campo-nc.us/Plans/MTP/2040/Projects_List/2040_Metropolitan_Transportation_Plan_-_Roadway_Projects.pdf

[12] http://www.dchcmpo.org/publications/documents/current/pgms/tip.asp

Figure 61: DCHC MPO Final 2040 Long Range Transportation Plan Highway Project Maps



Source: DCHC MPO

Rail

Existing Service

As can be seen in Figure 62, CSX and NS are the two Class-1 railroads[13] that serve the Triangle Region. Chapter 3 contains a detailed description of the extent and orientation of the track owned and operated by these and other railroads. In summary, CSX owns 25 percent of the rail miles in the Triangle Region and NS owns 21 percent. The state-owned NCRR owns 18 percent of the miles, providing connectivity to Charlotte. NS operates along this corridor through trackage rights agreements. No privately owned shortline railroad own track in the Region, although they provide service through trackage rights. See Figure 62 for an overview of North Carolina's rail network.

[13] Class-1 rail carriers are those railroads that have annual operating revenues of $250 million or more.

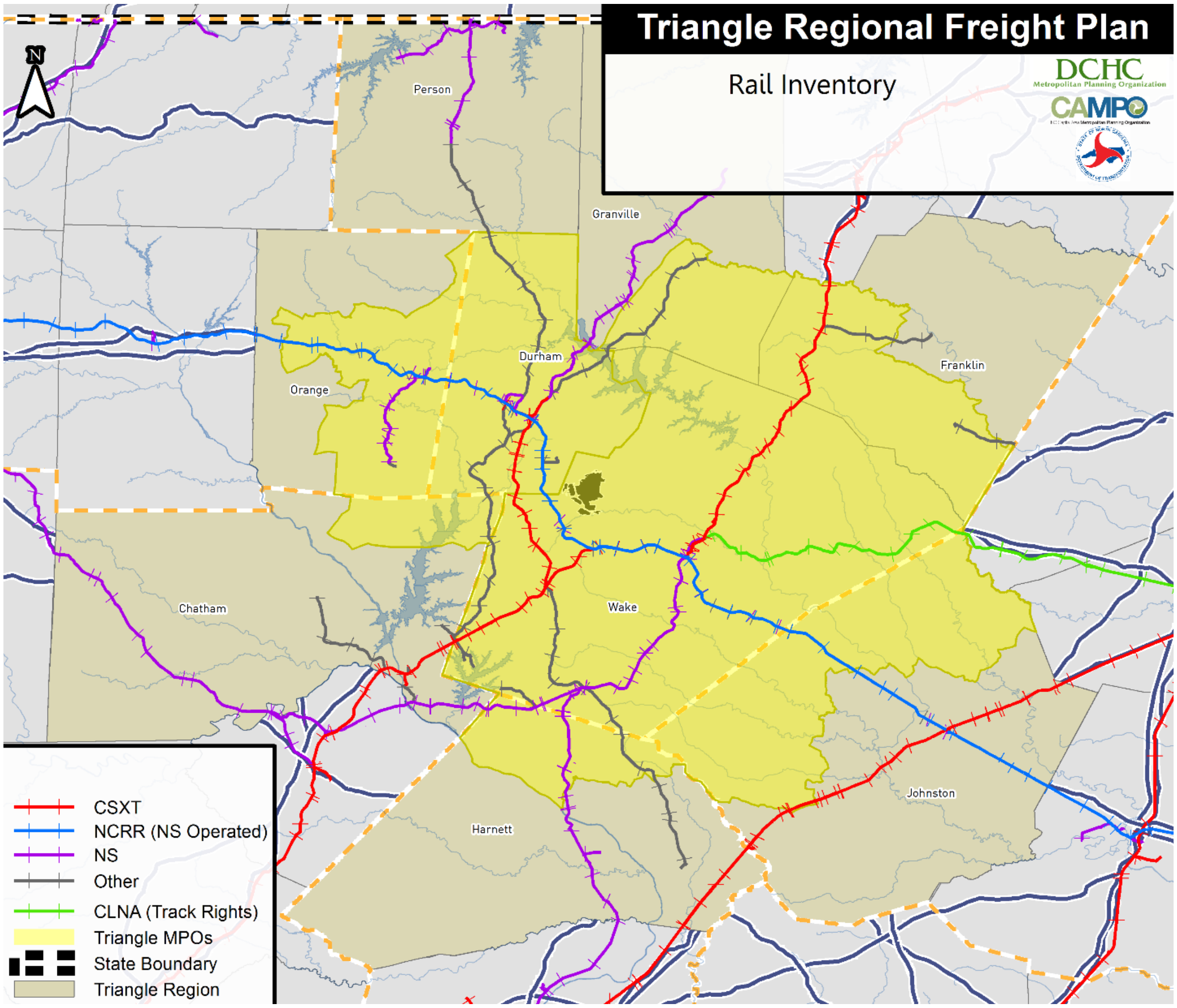
Figure 62: Major Freight Rail Infrastructure in North Carolina

Source: NCDOT North Carolina Comprehensive State Rail Plan, 2015

These railroads serve the businesses and consumers in the Triangle Region through a host of facilities and access points inside and outside the boundary of the Region. As can be seen in Figure 63, several transload facilities are located within the Region. Even though no intermodal terminal is present within the Region, the closest intermodal terminal is just 70 miles away in Greensboro. This terminal is operated by NS. Also, both NS and CSX operate intermodal facilities in Charlotte, 170 miles away. Having nearby access to rail intermodal service represents a boon to local producers and manufactures as it typically provides a cheaper shipping option, particularly to large cities with important markets. Intermodal service is also used often for delivering merchandize to ports for import and export.

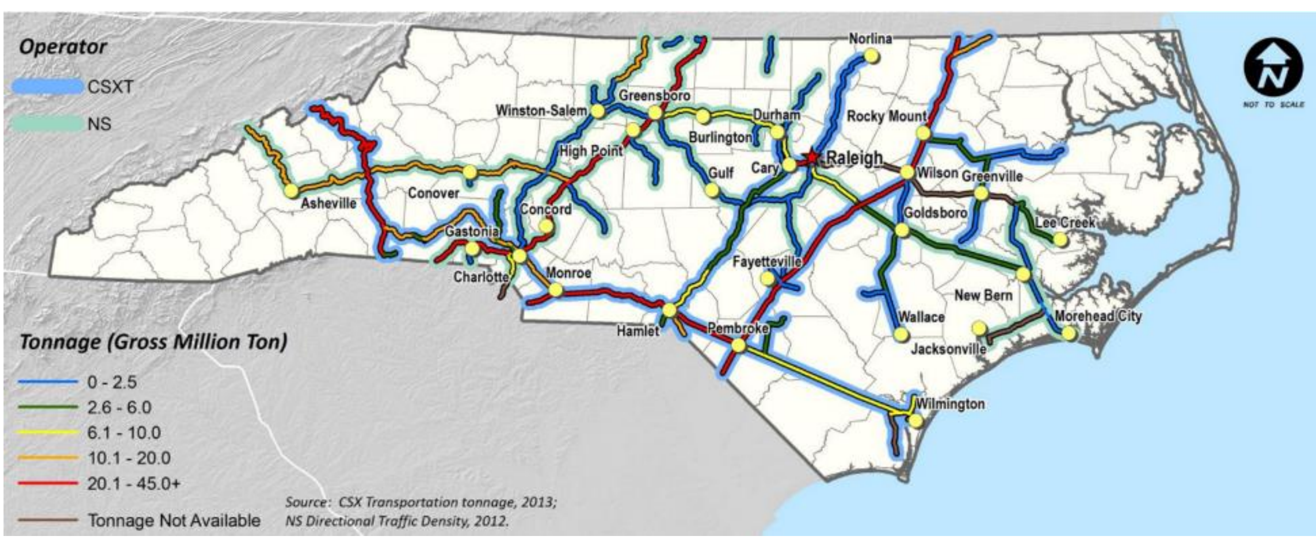
CSX's main north-south track along the East Coast passes just east of the Triangle Region. On this track CSX operates several transload facilities that are within reasonable distance. As can be seen in Figure 64 this section of track carries some of the highest freight volumes in North Carolina.

Figure 63: Triangle Region Rail Inventory



Source: BTSNTAD; Consultant analysis.

Figure 64: Annual Tonnage on North Carolina's Class 1 Freight Network



Source: NCDOT North Carolina Comprehensive State Rail Plan, 2015

Freight rail is an important mode for the Triangle Region, particularly for inbound shipments. The STB Public Waybill Sample was analyzed to describe in greater detail the rail services used. This data set consists of a sample of shipment waybills that used rail as a mode, covering intermodal, carload, and unit train services. For each shipment information is provided about its origin, destination, car type, commodity, etc. To protect the confidentiality of the railroads, origin and destination information is suppressed when less than three freight rail terminals serve the area. Fortunately, the Raleigh-Durham-Chapel Hill area has more than three terminals, and therefore inbound and outbound shipments are not suppressed in the Waybill Sample. In the data set, the Raleigh-Durham region is defined as a Business Economic Area (BEA) comprised of the following counties: Chatham, Durham, Edgecombe, Franklin, Granville, Halifax, Harnett, Johnston, Lee, Nash, Northampton, Orange, Person, Sampson, Vance, Wake, Warren, Wilson.

The Public Waybill Sample, summarized in Table 25, agrees with FAF in showing that rail is used primarily for inbound shipments. Around 13.3 percent of these inbound tons use manifest service and 86.7 percent use unit train service. Unit train service is used by shippers that are transporting enough quantities of freight to charter a complete train at a time, typically for bulk commodities. The average shipment length of manifest service is 738 miles while the average length of unit train service is 508 miles. Overall, 4.5 billion ton-miles of freight rail shipments are originated or terminated in the Raleigh-Durham-Chapel Hill area.

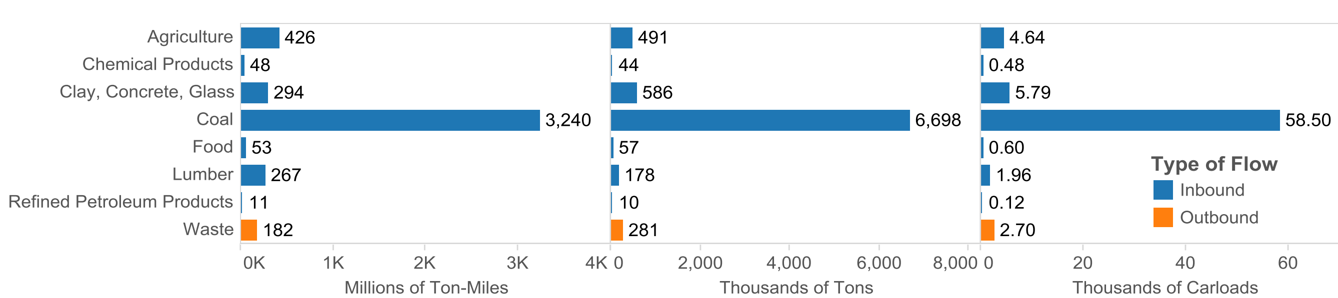
Table 25: Railroad Service Inbound and Outbound to Raleigh-Durham-Chapel Hill BEA, 2014

Type of Flow	Type of Service Augmented	Carloads (000')	Tons (000')	Ton-miles (M)	Avg. Miles per Shipment
Inbound	Manifest Service	10.9	1,069.3	789	738
	Unit Train Service	61.2	6,994.0	3,550	508
Outbound	Manifest Service	2.7	281.0	182	649
Grand Total		74.8	8,344.3	4,521	542

Source: STB Public Waybill Sample, 2014

Figure 65 shows the major commodities shipped by rail. In 2014, 6.7 million tons of coal were shipped to the region, representing 58,500 carloads. The second largest commodity flow was inbound shipments of agricultural products, accounting for 491,000 tons in 4,600 carloads. The only outbound commodity that showed up in the waybill sample was 281,000 tons of waste shipments in 2,700 carloads.

Figure 65: Commodities Moving to/from Raleigh-Durham-Chapel Hill BEA, 2014



Source: STB Public Waybill Sample, 2014

The types of rail cars used are shown in Table 26. The most common car type is 'open top hoppers', which are used primarily to transport coal.

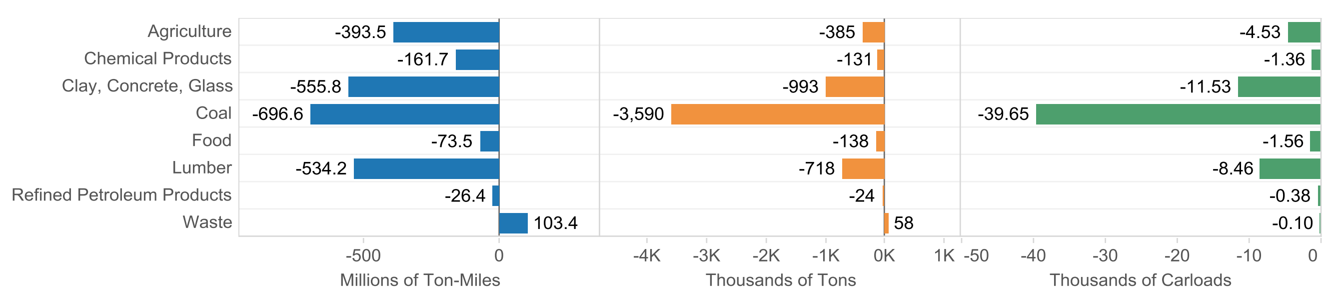
Table 26: Rail Freight Activity by Car Type and Service Type, 2014

Type of Service Augmented	Car Type Name	Millions of Tons-Miles	Thousands of Tons	Thousands of Carloads
Manifest Service	Covered Hopper Cars	380.2	628.1	6.20
	Equipped Box Cars	30.3	42.8	0.44
	Equipped Gondola Cars	20.5	55.3	0.60
	Flat Cars–Other	267.3	177.6	1.96
	Open Top Hopper Cars–General Service	66.2	160.2	1.64
	Open Top Hopper Cars–Special Service	12.1	27.6	0.27
	Plain Gondola Cars	162.0	225.6	2.10
	Tank Cars–Under 22,000 Gallons	14.5	15.1	0.16
	Tanks Cars–22,000 Gallons And Over	18.5	18.0	0.20
	Total	971.5	1,350.3	13.57
Unit Train Service	Covered Hopper Cars	350.7	397.2	3.71
	Open Top Hopper Cars–General Service	66.1	123.3	1.19
	Open Top Hopper Cars–Special Service	3,133.1	6,473.6	56.32
	Total	3,549.8	6,994.0	61.22
Grand Total		4,521.4	8,344.3	74.79

Source: STB Public Waybill Sample, 2014

The STB Public Waybill contains records going back to at least 2000. Figure 66 shows the change in ton-miles, tons, and carloads involving Raleigh-Durham-Chapel Hill. There appear to have been significant decreases in shipments of coal, lumber, and agricultural products over this time period. Shipments of waste have increased slightly.

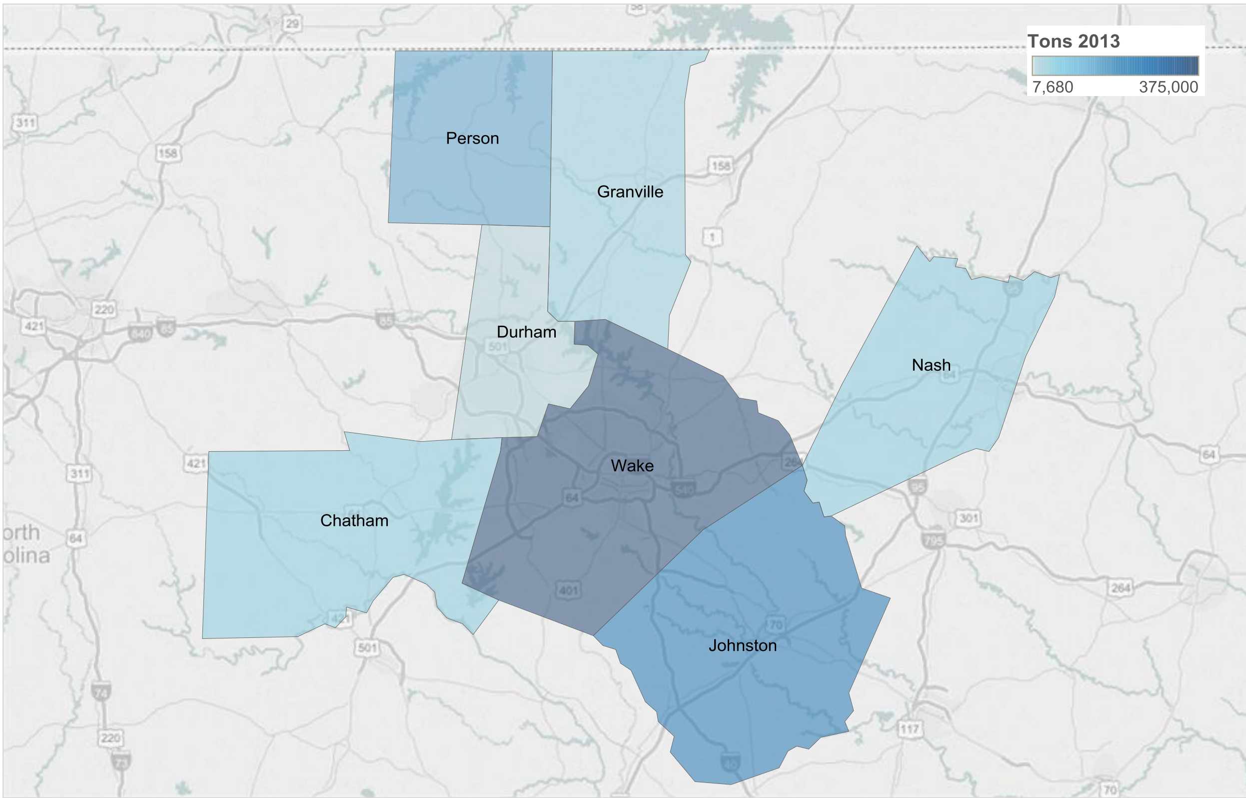
Figure 66: Change in Freight Rail Commodity Flows from 2000 to 2014



Source: STB Public Waybill Sample, 2014

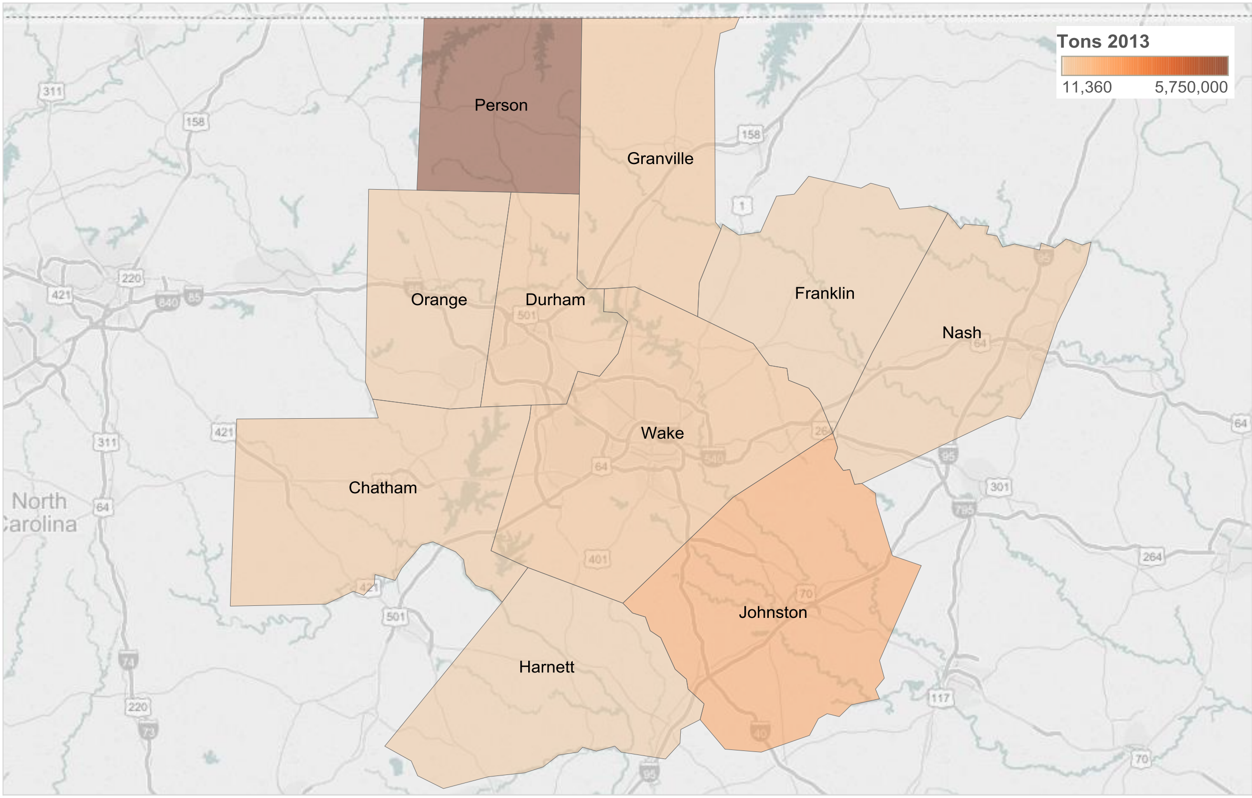
Figure 67 and Figure 68 show the county origins and destinations of rail waybills. This information comes from the confidential version of the Waybill Sample, and it is therefore displayed at an appropriate level of detail. In tons originated, the two top commodities for Wake County are food and waste and for Johnston County they are agriculture and waste. The top county receiving tons by rail is Person County, with most of these shipments containing coal. This county is home to some of the largest coal power plants in the Region, including the Roxboro Steam Plant, the Primary Energy Roxboro Power Plant, and the Mayo Generating Plant. There are currently two smaller coal powered plants adjacent to Raleigh, one in Moncure in Chatham County and another one at the University of North Carolina in Chapel Hill (using innovative 'congregation' technology).

Figure 67: Rail Tons Originated by Triangle County, 2013



Source: STB Confidential Waybill Sample, 2013

Figure 68: Rail Tons Delivered by Triangle County, 2013



Source: STB Confidential Waybill Sample, 2013

Meeting Future Demand

The ways that the economy relies on rail transportation are expected to change considerably in the coming decades. Even though total tonnages moved by rail are forecasted to remain constant out to 2045 (see Table 21), the composition of commodities moved will be almost entirely different, having important implications on the rail assets and operations. As can be seen from Table 23, coal shipments to the Region are expected to decrease by 3 million tons, representing over a third of total tonnages shipped in 2012. This decline in coal could potentially accelerate if regulations on coal power plants are tightened further and alternative sources of energy become more competitive.

The sharp drop in coal tonnages is expected to be off-set by increases in shipments of other commodities, as can be seen in Table 21. Commodities such as fertilizers, nonmetallic mineral products, basic chemicals, alcoholic beverages, and wood products are expected to see significant growth in tonnages. In terms of value the storyline is the same.

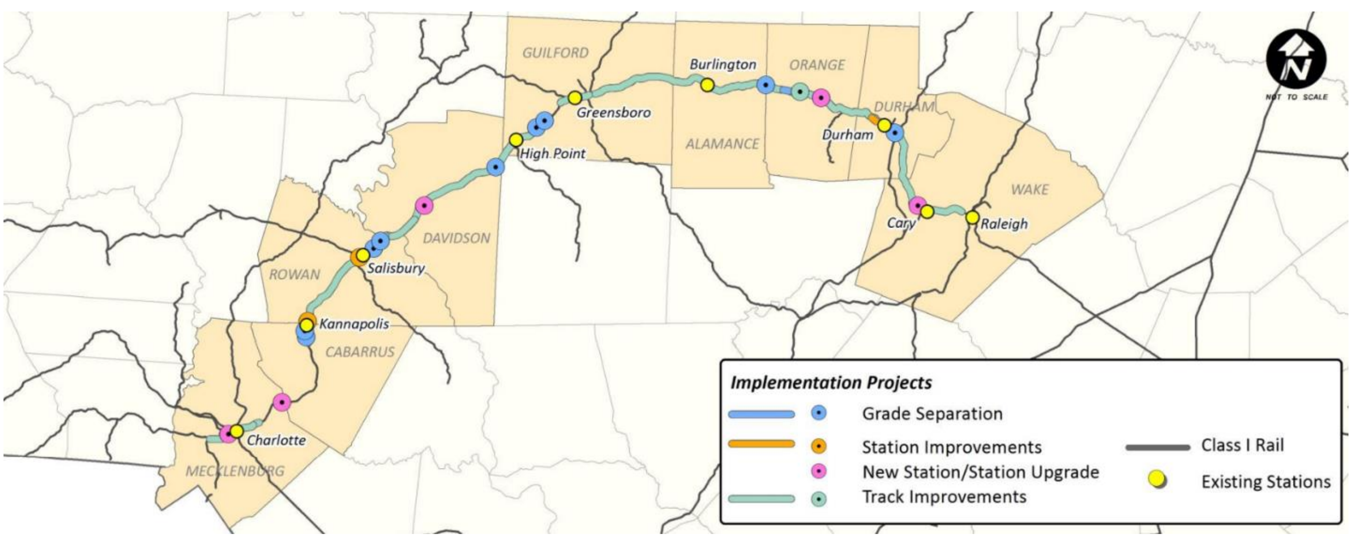
This shift in demand for freight rail will require a proportional shift in services offered. Traditional unit trains will become less frequent, giving way to greater use of mixed manifest trains and intermodal trains (to nearby terminals). This shift will be accompanied by a greater importance being placed on rail travel times and travel time reliability as the supply chains that will increasingly use more rail are higher in value and priority than coal. The capacity of the network might not be constrained in the traditional sense of not having enough track or terminal space, but instead each train could be less flexible than before and require faster and more fluid operations to compete with other modes. Network capacity will be increasingly defined by performance rather than physical extent. This has important implications for the types of investments that will have the highest returns over the coming years.

Proposed Projects

There are several freight rail initiatives that are currently being proposed that would benefit the Triangle Region. CSX currently has plans to develop an intermodal terminal somewhere near the Triangle Region. CSX's plans for this intermodal terminal to be used as a hub for consolidating and rerouting containers from all over the country. In effect, this would allow CSX to increase the lane density of shipments on large parts of its network, theoretically permitting more frequent and more competitive service to a broader range of markets around the U.S. (just like hub airports have led to efficiencies in air travel). This proposed intermodal hub could benefit the Triangle Region in that intermodal service would now be provided to many more markets all over the U.S. than a traditional intermodal terminal would support, because of hubbing efficiencies. Intermodal service has usually only been provided between large markets that can support a regular service of several trains per week. With a hub, medium-size markets can be served as all outbound cargo can be combined into a single train that is heading to the intermodal terminal.

A detailed discussion of CSX plans appears in Chapter 7, along with a review of other freight rail projects in the region. In addition to freight-specific activity, several projects are being proposed to improve the operations of passenger rail service on freight rail track. One of the corridors seeing much attention is the stretch of track connecting Raleigh to Greensboro to Charlotte (corridor 9 in Figure 100). The Comprehensive State Rail Plan points out that several projects are needed for the Raleigh-Greensboro segment to support more than 5 passenger trains per day. This includes the projects shown in Figure 69. These projects generate benefits to both the movement of passengers and freight. The grade separations in particular will reduce safety risks and reduce the externalities of moving freight.

Figure 69: Improvement Projects for Southeast Corridor 9



Source: [NCDOT North Carolina Comprehensive State Rail Plan, 2015]

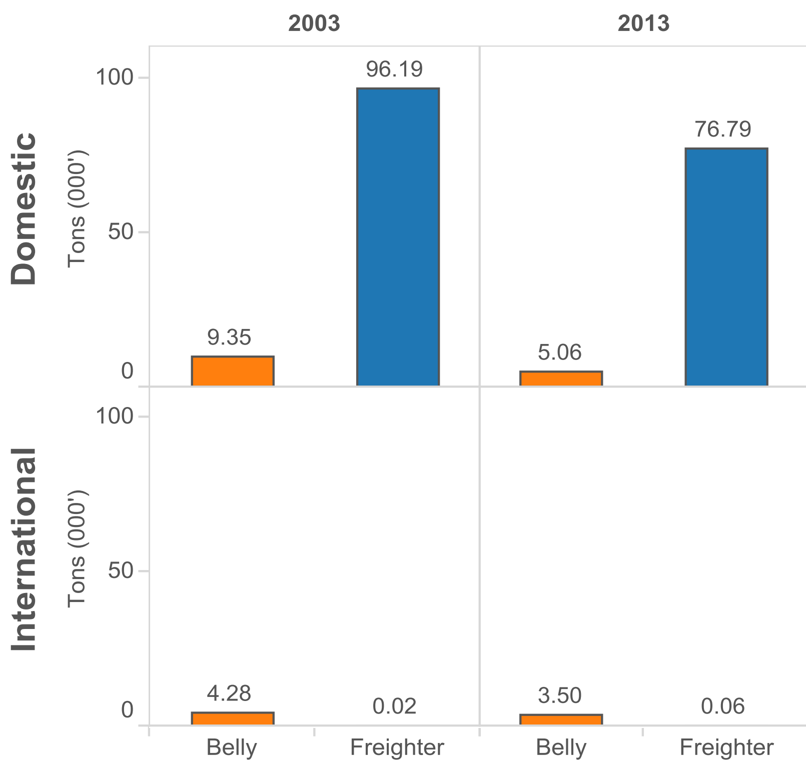
The presence of roadway congestion in the Triangle Region along highways that follow existing train tracks has led to proposals for increased commuter rail service in the Region. However, Go Triangle has prioritized the development of light rail projects instead of commuter rail lines, leading these proposed projects to be hypothetical in nature. These include corridors such as: CSX S line parallel to U.S.-1 and NS VF Line parallel to U.S.-401. Other commuter rail lines have been studied nearby, such as Mebane to Selma, Greensboro to Goldsboro, and Greensboro to Winston Salem. However, these studies have generally shown deficiencies in potential ridership. Given this and the current focus on light rail in the Triangle Region, it is unlikely that commuter rail projects will be implemented in the medium-term that affects freight operations.

Air

Existing Service

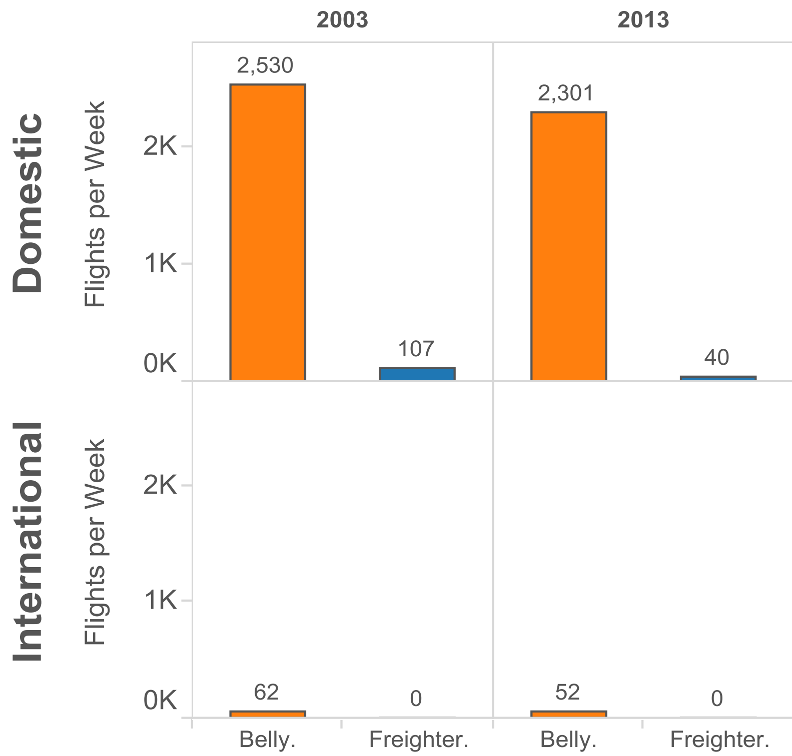
The main airport in the Triangle Region is RDU. This airport is located halfway between Raleigh and Durham, and has access to I-40 and I-540. As can be seen in Figure 70, RDU handled 87.4 thousand tons in 2013, down 22 percent since 2003. Currently, the majority of cargo handled by RDU comes from domestic freighter airlines, which includes integrated carriers such as FedEx and UPS. As shown in Figure 71, the airport has on average 40 freighter flights per week. The great majority of RDU's air cargo is domestic—only 4.1 percent of cargo has an international origin or destination, which chiefly moves in the belly of passenger flights.

Figure 70: Air Cargo Tonnages at RDU Airport



Source: BTS T-100 Segment Data, 2003 – 2013

Figure 71: Flight Frequency at RDU Airport



Source: BTS T-100 Segment Data, 2003 - 2013

The position of FedEx and UPS as the largest airlines with cargo operations at RDU is displayed further in Table 27. Combined, they account for 87.6 percent of cargo coming in and out of RDU. In terms of belly freight (cargo in the belly of passenger planes), American Airlines, Southwest, and Delta are the largest.

Table 27: Main Cargo Airlines Serving RDU Airport, 2013

Rank	Carrier	Belly Tons	Freighter Tons	Grand Total Tons
1	Federal Express Corporation		54,405	54,405
2	United Parcel Service		22,167	22,167
3	American Airlines Inc.	3,701		3,701
4	Southwest Airlines Co.	2,266		2,266
5	Delta Air Lines Inc.	1,774		1,774
6	US Airways Inc.	610		610
7	Kalitta Air LLC		490	490
8	United Air Lines Inc.	176		176
9	AirTran Airways Corporation	109		109
10	Envoy Air	105		105
11	PSA Airlines Inc.	45		45
12	Air Wisconsin Airlines Corp	10		10
13	Mesa Airlines Inc.	8		8
14	Gulf And Caribbean Cargo		5	5
15	Nolinor Aviation		4	4
	Other	4	2	6

Source: BTS T-100 Segment Data, 2003 - 2013

Meeting Future Demand

Recent draft forecasts for RDU airport are shown in Table 28. This forecast shows cargo volumes growing moderately out to 2040. Growth in tonnages is expected to average 0.8 percent per year from 2015 to 2024, and 0.9 percent from 2025 to 2040. The number of air cargo operations is expected to grow at a comparable rate. By 2040 RDU airport is expected to handle 25 percent more cargo than today. Even though tonnages at RDU have declined over the past decade, according to Table 24 it can be seen that the value shipped through this airport has declined at a much smaller rate, with some commodity groups such as precision instruments and printed products seeing increases over this time period.

Table 28: RDU Cargo Volumes and All-Cargo Operations

Year		Total Cargo Volumes (tons)	All Cargo Operations
Historical	2005	119,002	6,630
Historical	2010	96,867	5,000
Historical	2014	84,013	4,326
Forecast	2020	88,157	4,534
Forecast	2030	95,906	4,870
Forecast	2040	104,976	5,236

Source: Draft - Raleigh-Durham Airport Authority Master Plan, 2015.

Proposed Projects

Future conditions for air cargo are detailed in Chapter 7, including an additional look at forecasts and a review of the results of the 2016 RDU Master Plan.

Economic Activities Linked to Freight Movement

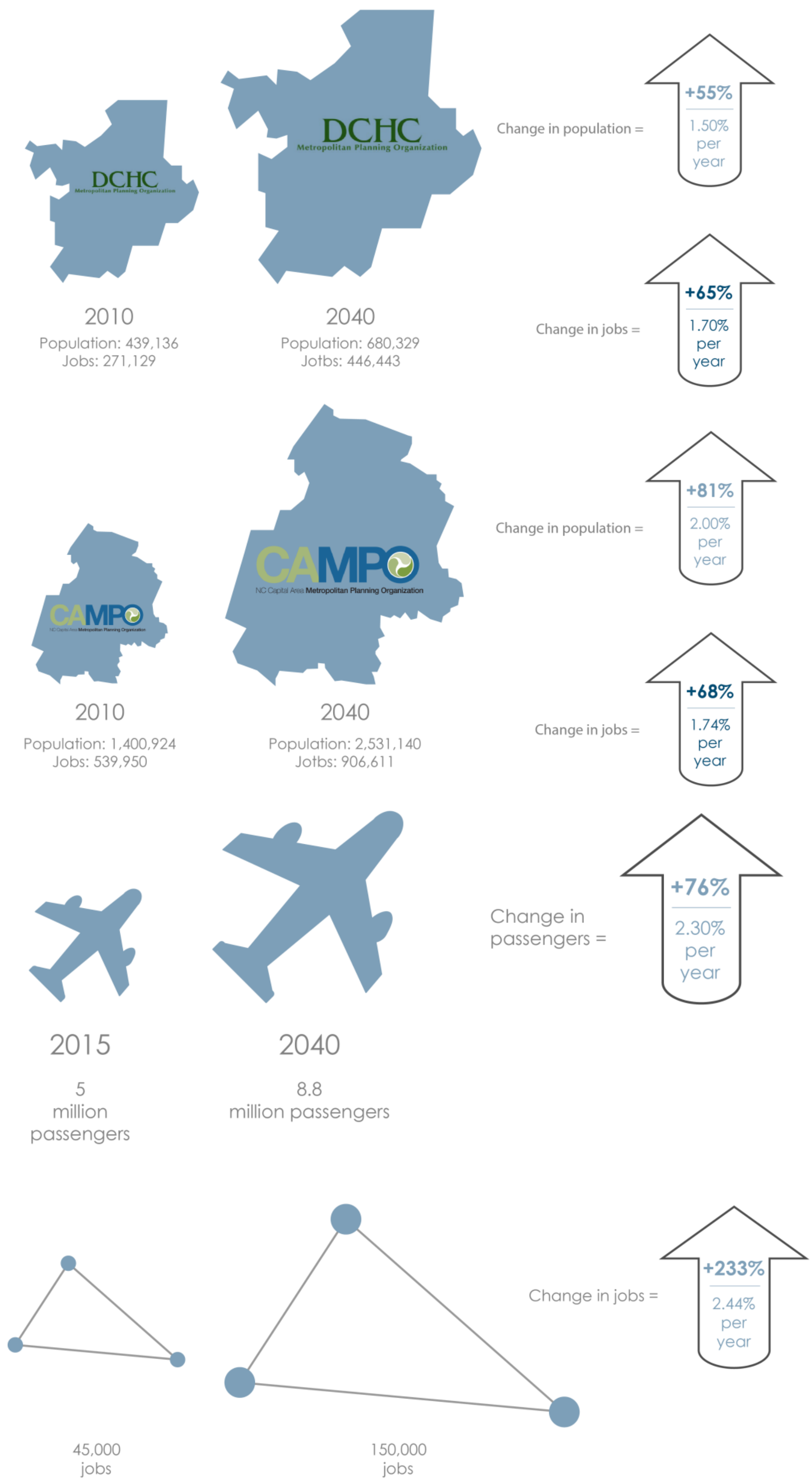
The Research Triangle region's employment base is growing steadily at a rate well above the national rate. Education, healthcare and technology sectors of the economy that provide high-wage jobs are key pillars of the region's buoyant economy. Anchored by the 7,000-acre RTP campus, the region is home to some of the largest technology, research, and development companies in the country such as IBM, Cisco, Biogen, BASF, SAS, GlaxoSmithKline, and Red Hat. The RTP campus currently has 200+ companies employing over 39,000 high-tech jobs. In Durham and Raleigh, high-tech employment accounts for 14 percent and 9 percent of employment, respectively.

The region's continued growth in jobs and personal income combined with cheaper gasoline prices are generating robust demand in the retail, leisure and hospitality sectors of the economy. Home prices in the region have been rising moderately in recent years. Single-family home sales have also been accelerating in recent years due to the high rate of job growth, moderate income growth, pent-up demand, and historically low mortgage rates. Strong population growth in the region is also generating demand for multifamily housing. The region's real estate market economists are anticipating a brighter outlook for the region's housing market, which is expected to drive strong construction activity in the near term.

The long term population and job forecasts, as outlined in the region's long range transportation plans, also show robust growth rates. These demographic growth forecasts for the region are illustrated in Figure 72.

These growth projections for the Triangle region will drive future demand for goods and services, and to serve those needs in the "next day" or "same day" delivery economy, it is critical to have efficient movement of raw materials and finished goods through a reliable urban freight transportation system. The critical urban freight network to be designated later in this study not only can serve the existing freight-oriented facilities but can also preserve future freight mobility for the anticipated population growth and industrial and commercial developments in the region.

Figure 72: Demographic Forecasts for DCHC MPO, CAMPO, RDU, and RTP



Existing Freight Facilities

A freight facilities database for the Triangle region was developed for this study to geocode the locations of important freight-oriented facilities, and to estimate generalized capacity and operational characteristics of these facilities using a combination of stakeholder interviews, research, and local knowledge. The database included a wide range of freight-oriented facilities such as DCs, manufacturing sites, and industrial parks. The database currently has 410 data records with detailed facility related attribute features. A significant number of these freight facilities are in Wake County, centered around the RTP and the RDU. A significant number of these freight facilities are also located along major transportation corridors such I-40, I-85, I-540, I-440, U.S. 1, and U.S. 70 (see Figure 73).

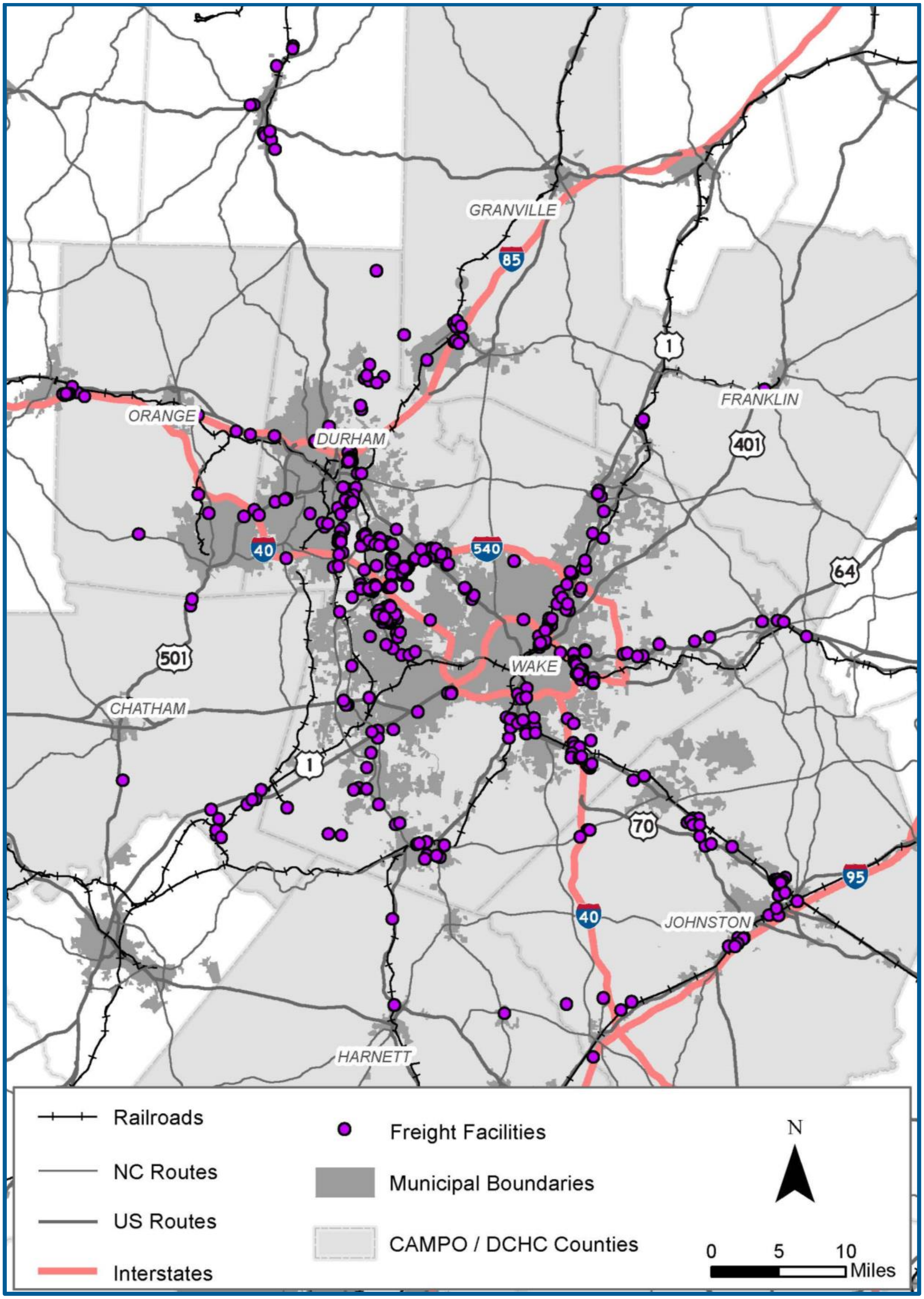
To further examine the relationship between freight facilities and transportation infrastructure, the freight facilities were spatially correlated with the underlying interstate freeway network and the rail network. This highway and rail accessibility analysis results are depicted in Figure 74 and it shows that approximately 300 facilities (or 73%) are located within 3 miles of an interstate, 50 facilities (or 12%) are served by rail, and 60 facilities (15%) are located along U.S. and NC routes or local arterials. It should be noted that the rail-served facilities were identified based on aerial imagery and they ranged from lumber, building supply and petroleum DCs to chemical manufacturing plants to nuclear power plant. The level of rail traffic activities at these rail-served facilities is currently unknown, as no site-specific interviews were conducted as part of the study. The rail-served sites should be targeted for special land use designations as they represent unique freight assets and can serve as future freight hubs.

Figure 75 shows the freight DCs and the manufacturing plants that are larger than 500,000 gross square foot in building size. This subset shows the locations of 13 largest freight facilities in the region. They are not ranked in the map legend, although larger symbols indicate larger facilities. These larger facilities included the Carolina Distribution Center, Grifols pharmaceutical manufacturing site, Lincoln Park North Industrial Park, Southport Business Park, Regional Commerce Center, and Skyware Global.

In addition to reviewing the size of the freight facilities, a cross-classification review of the freight facilities was prepared to identify those freight facilities that are producing potentially high-value goods. These high-value freight facilities are depicted in Figure 76 and include 32 facilities in Pharmaceutical/Healthcare, Machinery/Automobiles/Engines, or Computer/Electronics industries. A majority of the high-value pharmaceutical/healthcare facilities are located in Wake and Durham counties in the urban center of the region, which is reflective of the type of educated workforce that they employ. The region will continue to attract these and other bio-tech industries that are driving the region's economy and its future growth. These industry clusters will continue to grow and expand in the heart of region to attract workforce talents from the region's three major research universities. Consequently, several interstate corridors (e.g. I-40, I-440, I-540) and the RDU airport will continue to remain as critical urban freight corridors and freight gateway for the region.

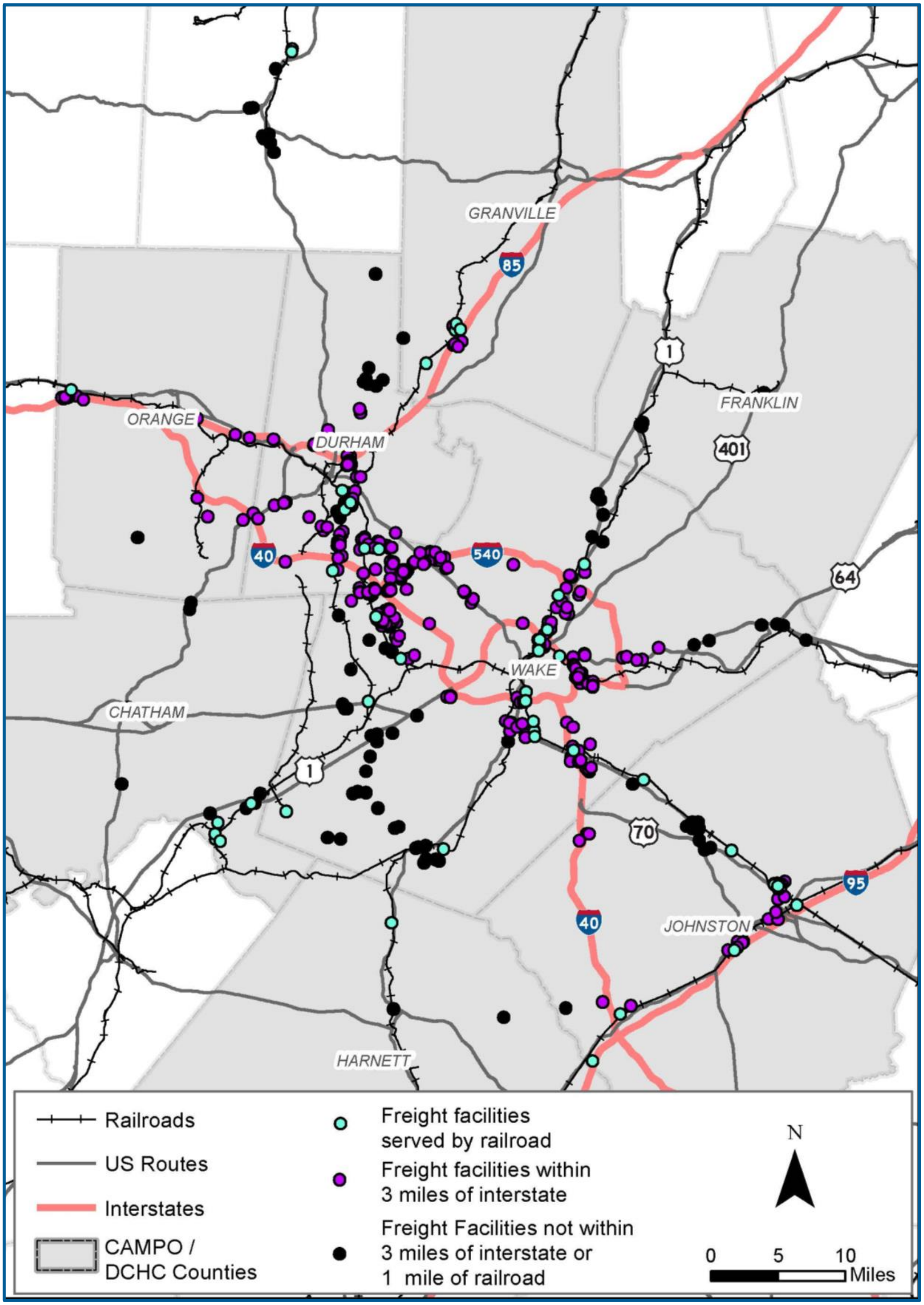
In addition to understanding the spatial characteristics of the region's freight facilities, a land use analysis was prepared to explore how these freight facilities are operating as good neighbors within the urban fabric. This land use analysis relied on available land use zoning data only for two counties – Wake and Durham, and converting different land use categories into two simplified land use categories – industrial uses and commercial uses. The purpose of this analysis was to understand the land use context of the critical freight facilities that are producing high-value goods or are operating with large building footprints in Wake and Durham counties.

Figure 73: Existing Freight-Oriented and Freight Facilities



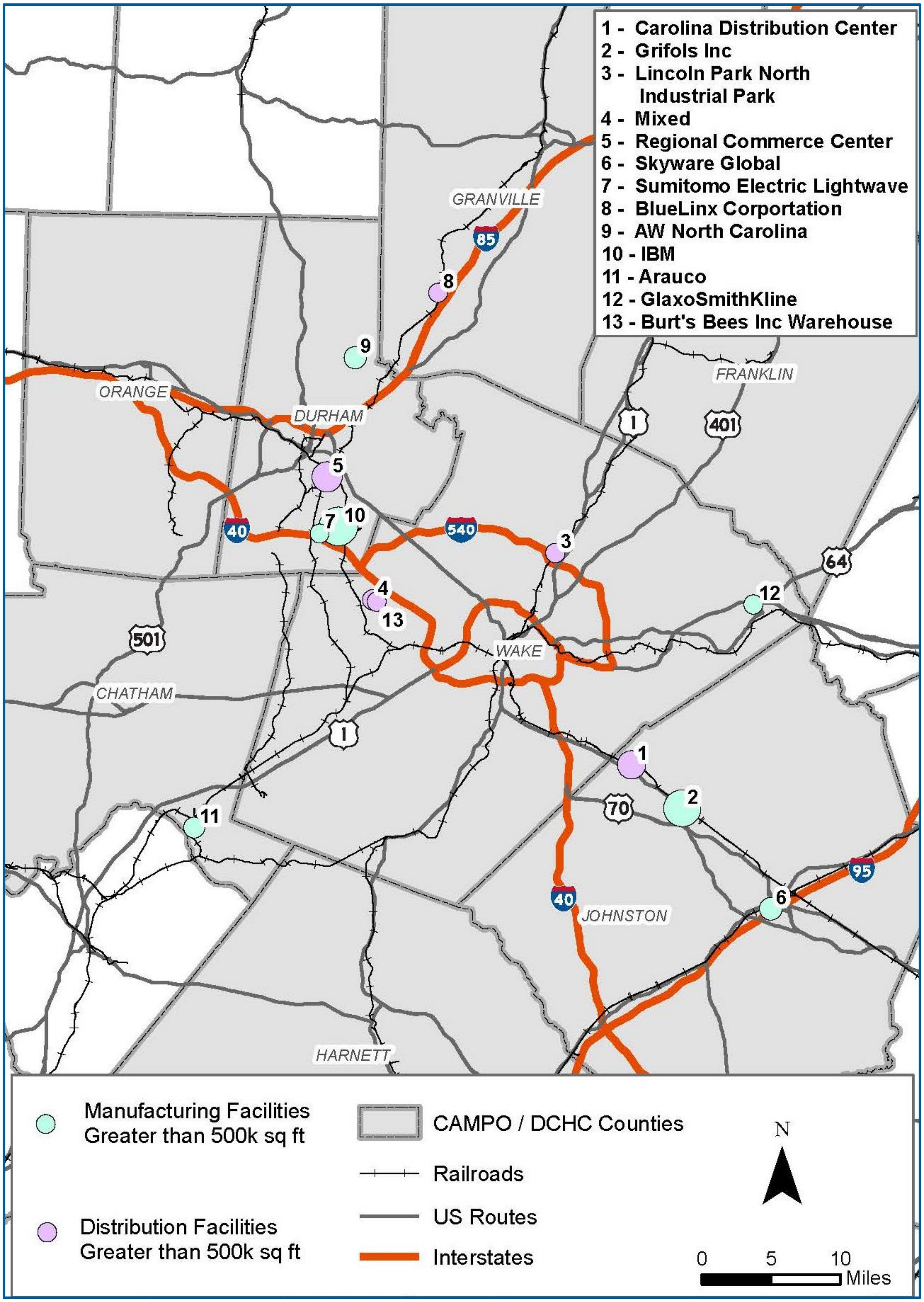
Source: Development & Analysis by WSP from publicly available data sources

Figure 74: Highway and Rail Accessibility of Freight Facilities



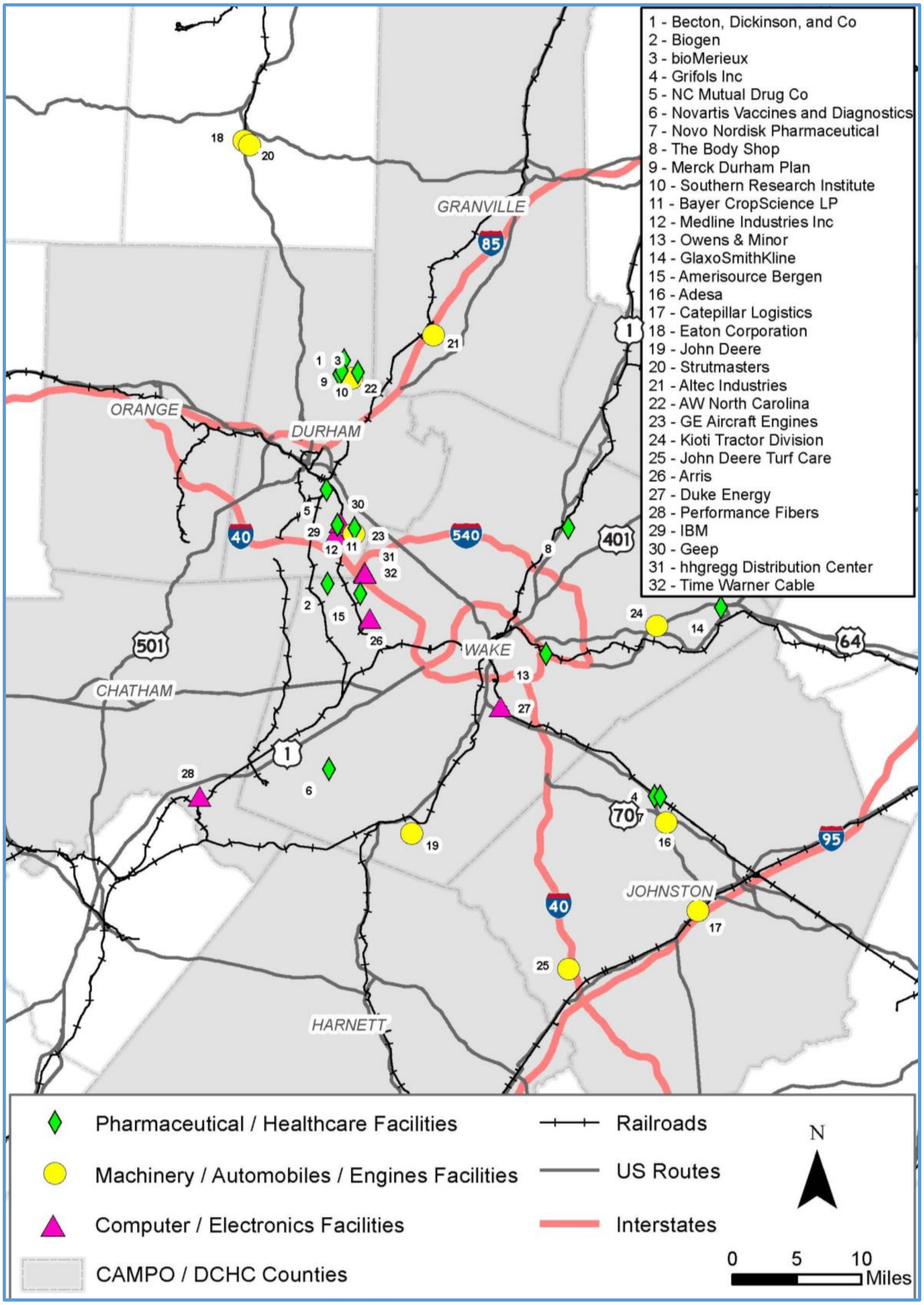
Source: Development & Analysis by WSP from publicly available data sources

Figure 75: Largest Manufacturing and Distribution Facilities



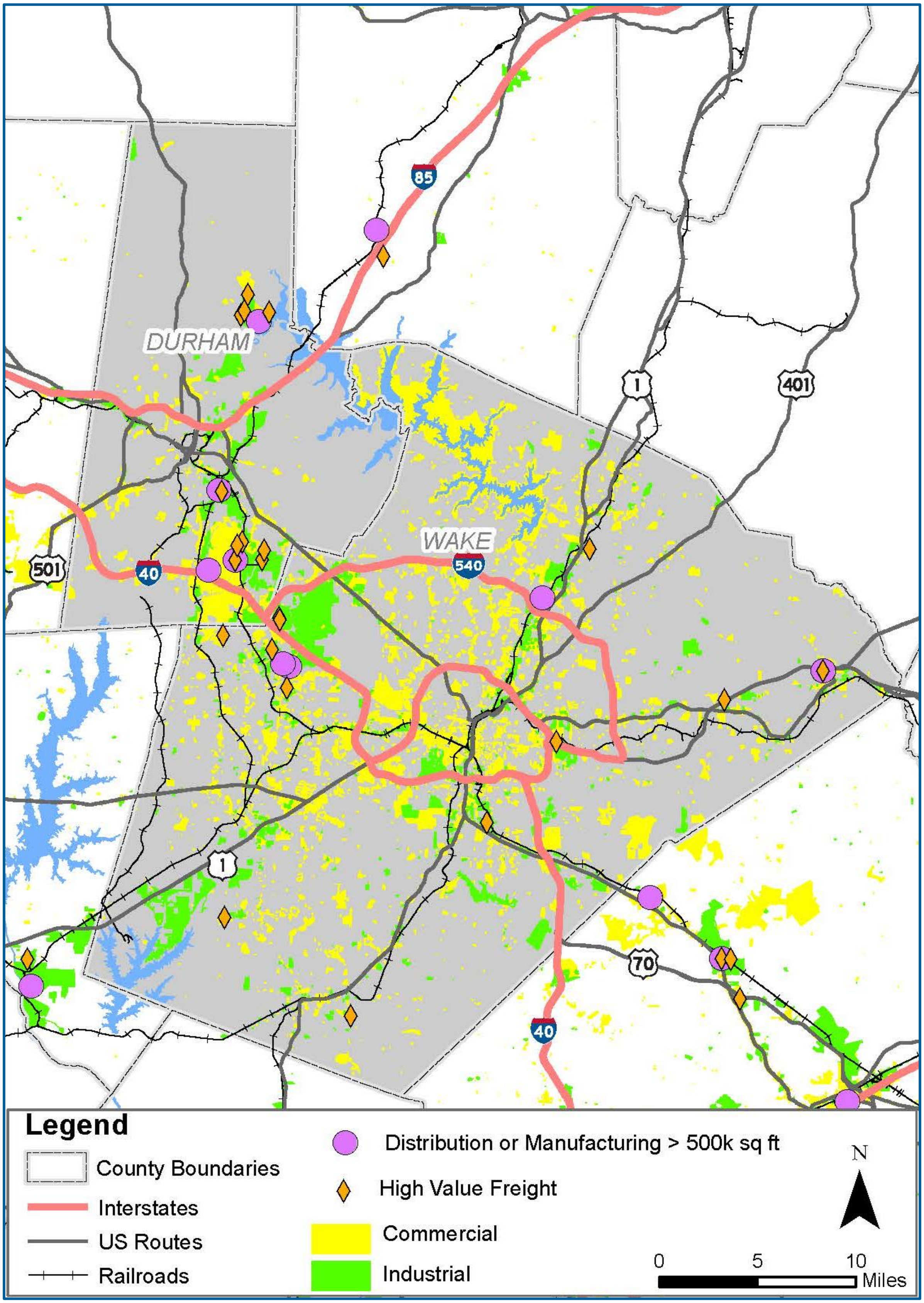
Source: Development & Analysis by WSP from publicly available data sources

Figure 76: High Value Freight Facilities



Source: Development & Analysis by WSP from publicly available data sources

Figure 77: Land Uses Surrounding High Value and Larger Distribution and Manufacturing Freight Facilities



Source: Development & Analysis by WSP from publicly available data sources

The result of this analysis is depicted in Figure 77 by juxtaposing Durham and Wake County's commercial and industrial land use data around the critical freight facilities. This map highlights the sparse distribution of commercial parcels and limited availability of industrial parcels in Durham and Wake counties, which have the largest number of high value freight facilities. Based on the parcel level analysis, it was determined that the majority of freight facilities are located within an appropriate land use classification relative to their activities. While the current operations generate substantial economic benefits to a region, a majority of these facilities may not have adequate square footage to grow at their current location. For any future expansions, these freight sites could require mitigation strategies to offset any negative impacts associated with freight operations such as air quality, noise and traffic safety. This reflects the need to have appropriate zoning overlay districts (e.g., Freight Village, Warehousing and Logistics), as well as designated truck routes, access to intermodal facilities, and sharing of real-time traffic congestion information with shippers and receivers, especially for the high-value and logistics freight clusters in the region.

Existing Freight-Oriented Industries

In order to explore the type of jobs and wages that freight-oriented industries bring to the region, the study reviewed wages of the top five freight-oriented industries in each county of the region. The purpose was to assess the existing level of economic benefits for having freight-oriented industries in the region. This analysis is summarized in Table 29 using year 2010 wage data (latest available for this category) for each county and Metropolitan Statistical Area (MSA) in the region. This analysis was done at the four-digit NAICS level so that detailed industry patterns can be observed. The analysis reveals several notable patterns:

- Durham County has the highest amount of wages from the top five freight-oriented industries, generating approximately $4.62 billion, followed by Wake County's $2.5 billion, and Johnston County's $269 million in 2010.
- For the Durham-Chapel Hill MSA, the total wages from the top five freight-oriented industries added to $6.5 billion in 2010. In comparison, the Raleigh-Cary MSA generated $2.6 billion in 2010. For the two MSAs combined, the top five freight-oriented industries generated approximately $9.1 billion of wages in 2010. In essence, the region's freight-oriented industries are a major contributor to the regional economy and generate high-salary jobs in desirable industry sectors.
- With only 7 establishments, Durham County's General Medical and Surgical Hospitals category had the highest overall rank at $1.44 billion in salary for any county within the two MSAs. This obviously reflects the employees at the Duke Hospitals.
- The number 2 rank, also within Durham County, Computer and Peripheral Equipment Manufacturing generated $1.1 billion in wages.
- Wake County's Computer Systems Design and Related Services category had the single largest number of establishments (1,249) of the freight-oriented industry categories. This was the highest wage earning group for the County at $979 million.
- Wake's General Medical and Surgical Hospital category had only 3 establishments but generated $670 million in wages for a number 2 county ranking. This reflects the jobs at the WakeMed Hospitals.

Table 29: Top Industries with Significant Freight Movement by Total Wages ($) in 2010

County /Region	NAICS Code	Industry	Total 2010 Wages	# of Establishments	Overall Rank in County/Region
Chatham County	3116	Animal Slaughtering and Processing	$30,507,888	4	2
	3212	Veneer, Plywood, and Engineered Wood Product Manufacturing	$21,729,392	3	3
	1123	Poultry and Egg Production	$14,014,579	4	5
	7221	2007 NAICS Full-Service Restaurants	$7,570,700	38	8
	3271	Clay Product and Refractory Manufacturing	$7,471,263	4	9
Durham County	6221	General Medical and Surgical Hospitals	$1,445,659,201	7	1
	3341	Computer and Peripheral Equipment Manufacturing	$1,126,900,331	9	2
	5417	Scientific Research and Development Services	$899,206,990	165	3
	3254	Pharmaceutical and Medicine Manufacturing	$896,200,735	19	4
	4234	Professional and Commercial Equipment and Supplies Merchant Wholesalers	$253,781,874	54	7
Franklin County	5617	Services to Buildings and Dwellings	$6,558,289	51	5
	4451	Grocery Stores	$5,804,601	19	6
	7222	2007 NAICS Limited-Service Restaurants	$4,887,028	35	9
	4441	Building Material and Supplies Dealers	$4,056,829	8	12
	3211	Sawmills and Wood Preservation	$3,971,665	3	13
Granville County	4539	Other Miscellaneous Store Retailers	$14,416,354	5	4
	7222	2007 NAICS Limited-Service Restaurants	$7,976,460	33	6
	3273	Cement and Concrete Product Manufacturing	$7,038,688	4	8
	4841	General Freight Trucking	$5,772,008	11	10
	3261	Plastics Product Manufacturing	$5,757,874	3	11
Harnett County	7222	2007 NAICS Limited-Service Restaurants	$13,902,384	64	5
	4461	Health and Personal Care Stores	$12,903,791	22	7
	4529	Other General Merchandise Stores	$10,199,667	19	8
	4451	Grocery Stores	$9,944,858	25	9
	5617	Services to Buildings and Dwellings	$9,504,678	59	10
Johnston County	3254	Pharmaceutical and Medicine Manufacturing	$169,906,746	7	1
	5617	Services to Buildings and Dwellings	$30,341,215	89	5
	7222	2007 NAICS Limited-Service Restaurants	$25,538,996	117	7
	4244	Grocery and Related Product Merchant	$24,644,570	9	8

County /Region	NAICS Code	Industry	Total 2010 Wages	# of Establishments	Overall Rank in County/Region
		Wholesalers			
	7221	2007 NAICS Full-Service Restaurants	$18,348,504	71	9
Orange County	4541	Electronic Shopping and Mail-Order Houses	$34,037,318	7	5
	4451	Grocery Stores	$33,579,184	41	6
	5417	Scientific Research and Development Services	$31,968,102	54	7
	7222	2007 NAICS Limited-Service Restaurants	$30,628,806	117	9
	7221	2007 NAICS Full-Service Restaurants	$30,543,439	108	10
Wake County	5415	Computer Systems Design and Related Services	$979,290,554	1249	1
	6221	General Medical and Surgical Hospitals	$670,339,929	3	5
	4234	Professional and Commercial Equipment and Supplies Merchant Wholesalers	$298,534,457	230	16
	4251	Wholesale Electronic Markets and Agents and Brokers	$276,615,491	802	19
	5417	Scientific Research and Development Services	$274,709,456	188	20
Durham-Chapel Hill MSA	6221	General Medical and Surgical Hospitals	$1,880,680,127	10	1
	6113	Colleges, Universities, and Professional Schools	$1,659,044,019	13	2
	3341	Computer and Peripheral Equipment Manufacturing	$1,127,120,761	11	3
	5417	Scientific Research and Development Services	$938,240,994	233	4
	3254	Pharmaceutical and Medicine Manufacturing	$896,903,534	20	5
Raleigh-Cary MSA	5415	Computer Systems Design and Related Services	$990,131,007	1291	2
	6221	General Medical and Surgical Hospitals	$736,080,505	7	5
	4234	Professional and Commercial Equipment and Supplies Merchant Wholesalers	$299,466,791	238	17
	184251	Wholesale Electronic Markets and Agents and Brokers	$291,655,385	871	18
	7221	2007 NAICS Full-Service Restaurants	$281,767,565	824	19

Source: U.S. Census Bureau Economic Census 2010 County Business Patterns: Geography Area Series: Data using Level 4 NAICS

Supply Chains: Issues and Opportunities

This section describes in detail the supply-chains used by several of the key industries identified in the previous section. Supply chains can be broadly divided into supporting: industrial production, retail distribution, or service provision. Four retail supply chains and one production supply chain are described and analyzed to understand better freight demand patterns, trends, and issues. The supply chains analyzed are: high-tech manufacturing, gasoline distribution, grocery store distribution, home deliveries (Amazon), and soft drinks (Pepsi). These five examples cover a wide range of freight movements. Together, they incorporate a spectrum of multimodal activity, although particular attention is placed on trucks because of their importance in urban movements.

For each supply chain, this section first describes the companies and industries typically involved and the characteristics of the commodities moved. Then, the various steps involved in the staging and transportation of the commodities are detailed, focusing on the urban distribution strategies employed. Local data is used to identify the distribution facilities and transportation infrastructure used within the Triangle Region. After presenting this background information, the performance of these supply chains is assessed in the urban context, identifying expectations, issues, and risks faced by shippers and carriers. This discussion is limited by the fact that extensive interviews of individual supply chain decision makers and participants were not conducted as part of this analysis. However combining local information with an understanding of how these supply chains operate nationally[14] allows for a clear picture to emerge about how they are likely to be structured in the Triangle Region. This naturally informs a discussion about opportunities to support and enhance these supply chains, which are both critical to the region.

High-Tech Manufacturing Supply Chains

Commodities

High-tech manufacturing encompasses a wide range of companies and products. As described in Chapter 3, this sector is one of the most vibrant and fastest growing in the Triangle Region. The commodities produced by this sector range from advanced electronics (boosted by the recently established Next Generation Power Electronics Innovation Institute) to advanced industrial equipment. While very different from each other, these commodities have in common the characteristic that they have the highest value to weight ratios and require high timeliness and reliability in production and delivery. As seen below, this characteristic leads to specific demands on the freight transportation system.

Staging and Transportation

Many factors influence the location decisions of high-tech manufacturers. Figure 78 shows the factors that influence the location of businesses in general, listed by importance. Manufacturers observe these same general criteria, except that workforce considerations likely rank higher. High-tech industries are also influenced by these factors, although for the Triangle Region in particular the quality and education levels of the labor force likely play a more important role in their location decisions. The existence of world-class universities and research centers is a key attractor of many industries, particularly those at the cutting edge of technology. In Figure 78, the ability to access markets and customers should also include the ability to source inputs for production. In high-tech manufacturing, this often involves the products of other high-tech firms, leading to agglomeration economies from colocation in the Triangle Region.

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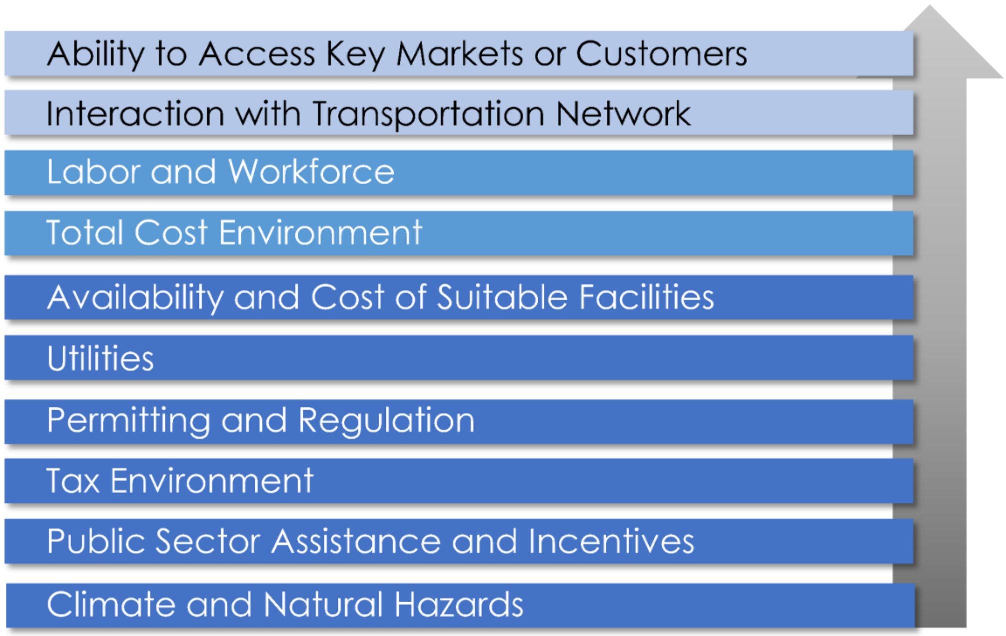
[14] The analyses draw from the NCFRP Report 14 "Guidebook for Understanding Urban Goods Movement", which contains an extensive treatment of supply chain patterns for industries common in metropolitan areas.

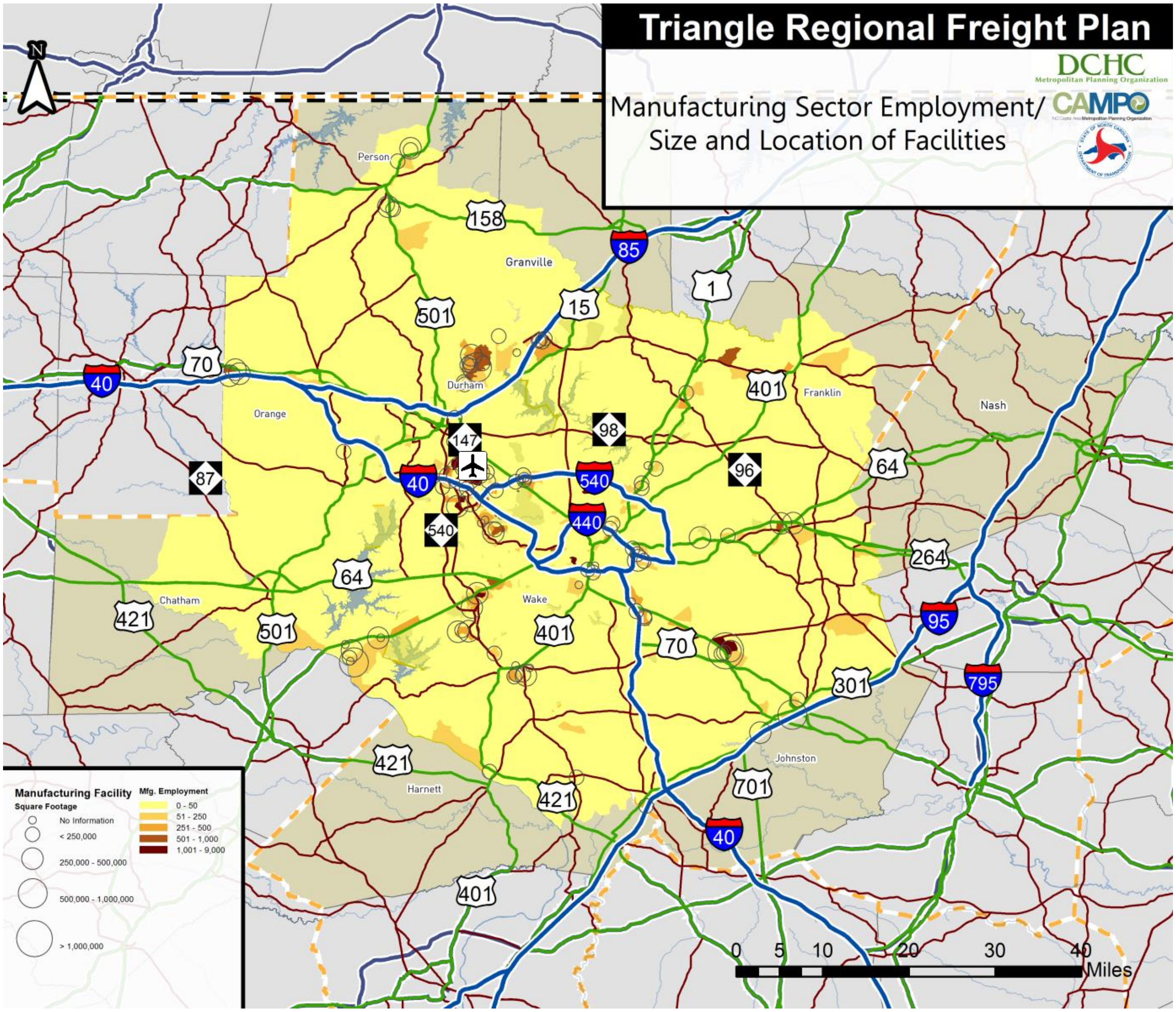
Figure 78: Key Business Location Criteria



Source: NCFRP Report 13 "Freight Facility Location Selection: A Guide for Public Officials"

Because of the high value and customizability of products in this sector, it is common for shippers to maintain small to no inventories and rely on rapid production and transportation to meet the demands of customers. This places a premium on being located near transportation infrastructure that provides quick and reliable access to intercity modes of transportation, to reach potential markets. As can be seen from Figure 79, in the Triangle Region this involves being located along key highways, providing access to the broader interstate highway network and intermodal gateways. The destination of shipments is likely to be spread-out domestically and internationally, and can vary significantly from week to week. The high degree of specialization can result in many one-off orders, leading flexibility and the availability of transportation alternatives to be important for shippers.

Figure 79: Manufacturing Sector Employment/ Size and Location of Facilities



Source: InfoUSA (2013); Westat (2015).

Market access is also greatly facilitated by RDU, which is located near the interchange between I-40 and I-540. As can be seen in Figure 79 the RTP cluster of manufacturing establishments lies within a couple of miles from the airport, benefiting from easier access to the airport for inbound and outbound expedited shipments, and providing employees with more seamless business travel. Overall, high-tech commodities have a higher propensity to be shipped by air cargo because of the higher values involved.

Performance and Opportunities

The performance of high-tech supply chain depends critically on the speed and reliability of shipments, potentially more than any other supply chain. The high costs of the products combined with the high degree of customizability lead shippers to maintain low inventories and rely on fast manufacturing and deliveries to satisfy orders. Many of these products also have high rates of obsolescence and can be potentially fragile in transportation, placing an additional premium on their safe and speedy delivery. Transportation costs are usually a small proportion of commercialized prices, allowing for higher resources to be spent ensuring that the supply chains are uneventful and fast.

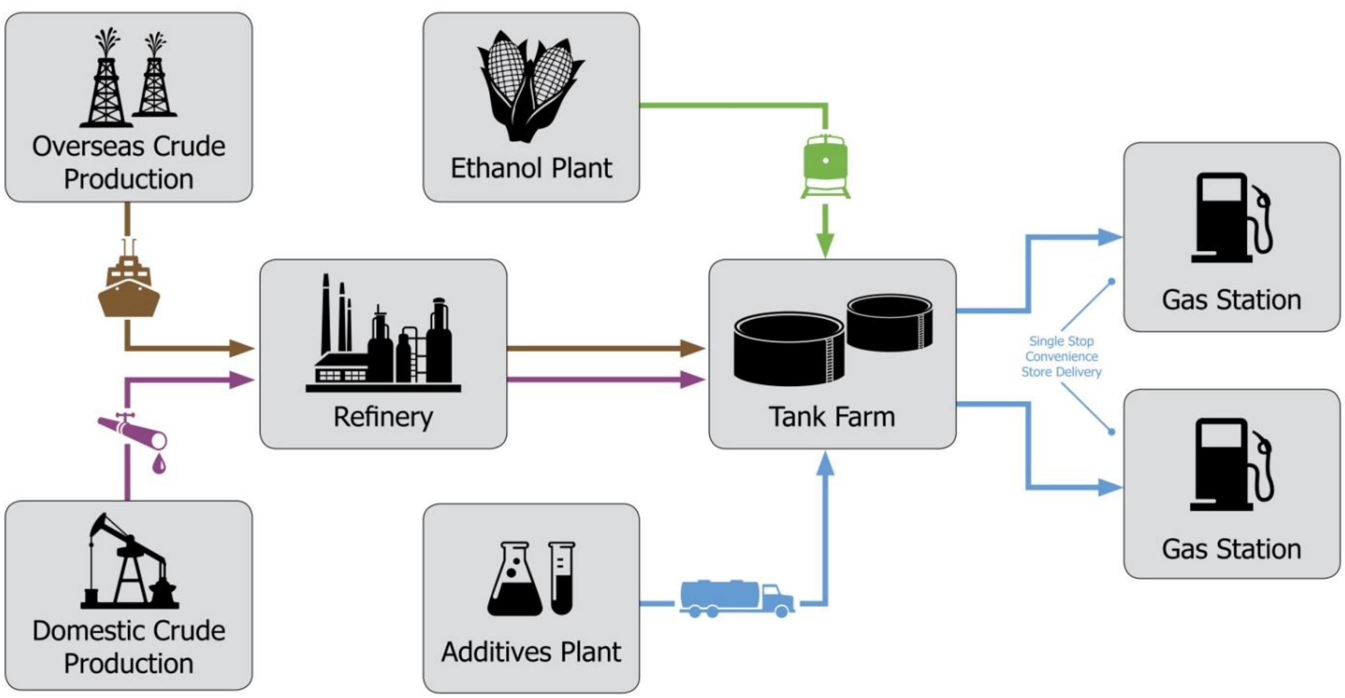
A substantial proportion of the value moved by trucks along key corridors corresponds to the high-tech manufacturing sector. From Figure 45 it can be seen that 5 out of the top 10 commodities by value are typically associated with the high-tech manufacturing sector, including precision instruments, electronics and pharmaceuticals. It is valuable shipments such as these that are disproportionally impacted by congestion and unreliability on the highway network. Not just is the time value of these shipments high, but often they are heading to an airport for transfers onto a scheduled flight. Metropolitan areas such as the Triangle Region that have the human and physical capital required by these high-tech business stand to benefit greatly by improving the transportation infrastructure that serves these important sectors.

Gasoline Supply Chains

Commodities

After refinement, gasoline is differentiated primarily by octane rating. Before reaching gas stations, the generic wholesale gasoline is blended with additives to distinguish between branded products. Ethanol is also mixed in, typically representing around 10 percent by volume. Other refined crude products are often also transported through similar supply chains, such as jet fuel, diesel, and kerosene.

Figure 80: Typical Gasoline Supply Chain



Source: NCFRP 15

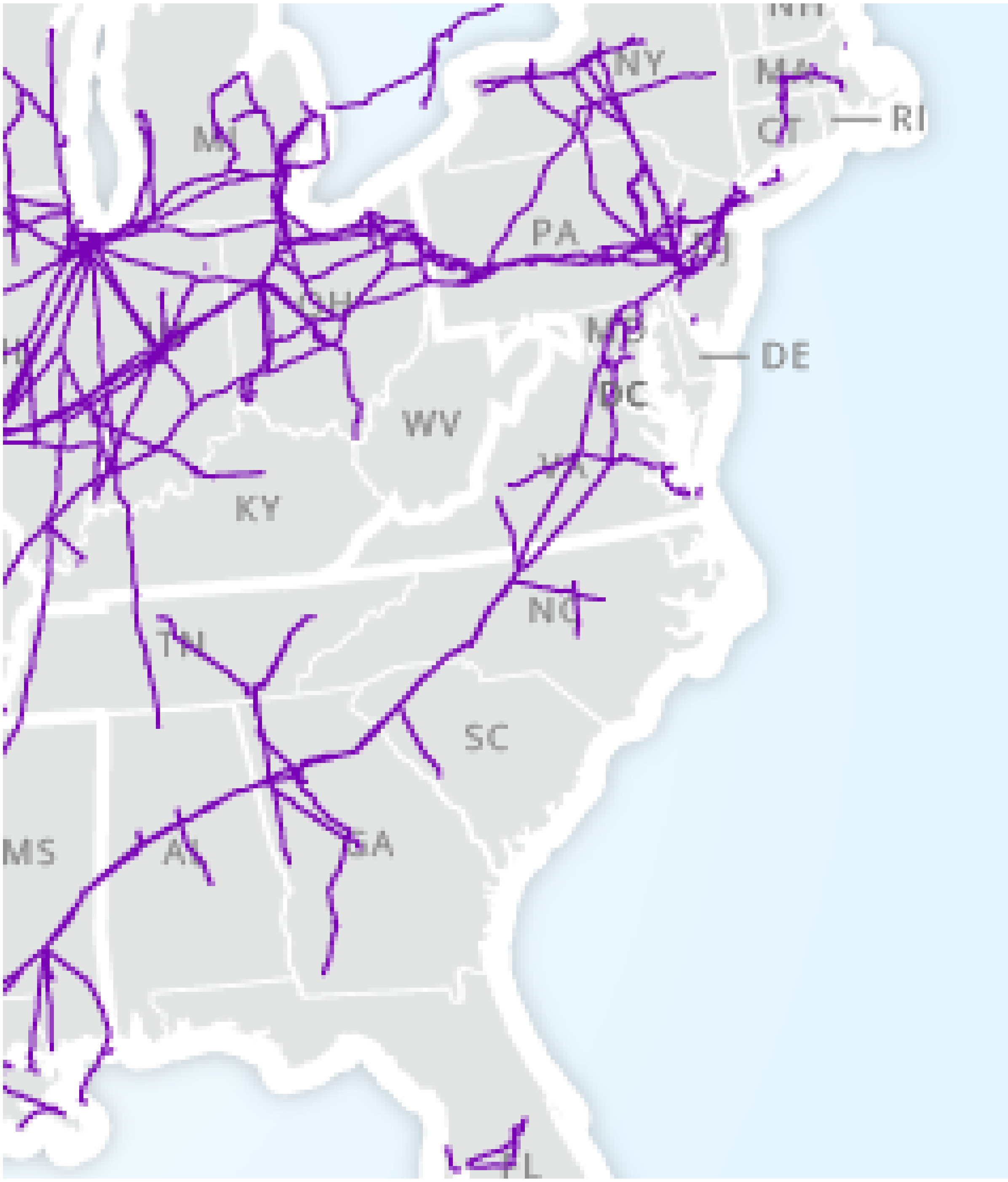
Staging and Transportation

Domestic crude oil production is primarily concentrated in Texas, Alaska, and North Dakota. This production is supplemented with imports from around the world. Pipelines and tanker ships are used to transport crude oil to refineries in the U.S., which are primarily located along the Gulf Coast between

New Orleans and Houston. Even though there are some refineries in the Northeast, Midwest, and West Coast, most refining capacity exists in the Gulf Coast. Gasoline consumed in the Triangle Region most likely comes from this source. Some refineries specialize in sour crude while others specialize in light sweet crude, a distinction based on sulfur content. Figure 80 outlines the main steps typically involved in gasoline supply chains.

Once crude is refined into gasoline products, it is transported to consumers around the U.S. through pipelines, ships, barges, trucks and rail. Trucks are used primarily for short trips and rail is used for land-locked regions that don't have access to pipelines. Pipelines and ships are the cheapest ways to move gasoline. As can be seen from Figure 81, North Carolina is crossed by a gasoline pipeline that connects to both the Gulf Coast and Norfolk. An off-shoot of this major pipeline delivers gasoline directly to the Triangle Region.

Figure 81: Refined Petroleum Pipelines in the East Coast



Source: Pipelines 101, American Energy Mapping (AEM) 2013[15]

In the Triangle Region, pipelines deliver gasoline to storage terminals called "tank farms". Figure 82 shows where these facilities are located; a list of these facilities follows in Table 30. A larger cluster is located around 30 miles southeast of Raleigh, close to Selma NC, and a smaller cluster is located southwest of Raleigh. Several companies operate storage terminals at these locations, usually 24 hours a day. At the storage terminals gasoline is blended with ethanol and other fuel additives.

[15] http://www.pipeline101.com/where-are-pipelines-located

Ethanol comes from agricultural regions of the U.S., primarily by rail but also by truck (ethanol does not transport well by pipeline). Currently ethanol represents around 10 percent of all gasoline volume purchase in the U.S., generating a significant amount of truck and rail shipments. In the Triangle Region these ethanol shipments would affect the most the area surrounding the storage terminals. Other fuel additives such as detergents come by truck from several large national producers.

Gasoline and diesel are distributed to gas stations in the Triangle Region by tanker trucks. Usually each truck serves a single gas station per trip (seldom do trips involve multiple stops). Each driver performs 3 to 4 trips a day, and often a second driver is employed for night time deliveries. The typical tanker truck used for final distribution can hold 9,400 gallons of gasoline and can measure up to 60 feet in length (including tractor and trailer). Other states allow heavier and longer trucks to operate on public roads. Replenishment decisions are made by an automated system that tracks gasoline levels at multiple stations and anticipates year-dependent demand. Modern tank trucks have 4 or 5 compartments to transport different types of gasoline products.

Figure 82: Location of Petroleum Distribution Centers

Source: Westat Data

Table 30: Refined Petroleum Distribution Centers

Name	Description	Observed Acres	Address
Motiva Enterprises	Fuel distribution center	6	2232 Ten-Ten Road, Apex, NC 27539
ARC Terminals	Petroleum distribution center	7	Buffalo Road, Selma, NC 27576
BP	Petroleum distribution center	15	3707 Buffalo Road, Selma, NC 27576
CITGO Petroleum Corporation	Petroleum distribution center	6.5	4095 Buffalo Road, Selma, NC 27576
Colonial Pipeline Co	Petroleum distribution center	20	2335 West Oak Street, Selma, NC 27576
Dixie Pipeline Company	Petro refueling station	9	1521 E Williams St Apex, NC 27539
Kinder Morgan Inc.	Petroleum distribution center	15	2200 West Oak Street, Selma, NC 27576
Magellan	Petroleum distribution center	6	4414 Buffalo Road, Selma, NC 27576
Marathon	Petroleum distribution center	27	2555 West Oak Street, Selma, NC 27576
Transmontaigne	Petroleum distribution center	7.5	2600 West Oak Street, Selma, NC 27576

Source: Westat Data

Performance and Opportunities

Gasoline supply chains operate 24/7, every day of the year. They allow gasoline to be moved hundreds, if not thousands of miles to consumers, with virtually no disruptions. These supply chains are typically cheap and efficient, which is the case for the Triangle Region. Pipelines are the most efficient way to ship gasoline, and the Triangle Region counts with pipeline access to both the Gulf Coast and East Coast Ports (for international shipments). The storage terminals that transload the gasoline from pipelines to truck are located within a one hour drive of most of the Triangle Region, providing responsive and fast replacement of gas stations.

Gasoline supply chains are not particularly sensitive to travel times and reliability for all stages except for the distribution to gas stations. As mentioned before, replenishment decisions are made by an automated system that considers demand patterns and other factors. The objective of this automated system is to minimize the number of trips required to replenish stations, while considering both the risk of running out of gasoline and the risk that trucks return to the storage terminal with excess gasoline. Inventory decisions for this final leg of the supply chain are made just-in-time to optimize these parameters based on the latest information available.

A key performance dimension of gasoline supply chains is ensuring that gasoline is delivered safely. This involves minimizing the risk of accidents and environmental damage from leaks. Gasoline supply chains have been designed with safety in mind, from the layout of gas stations to the operations of the vehicles.

Gasoline and diesel supply chains are critical in that they provide the energy that runs all other supply chains. Interruptions to the fuel supply, caused by severe weather events for example, can shut down much of the economy. This vulnerability was demonstrated dramatically in the New York region in the aftermath of Superstorm Sandy in 2012, when basic supplies could not be delivered because trucks (and automobiles) could not refuel. For the Triangle region, this consideration means that the routes from the tank farms to the industrial and population centers are vital facilities, as are the pipelines that feed the tanks.

Soft Drink Beverages Supply Chains

Commodities

PepsiCo produces a wide variety of branded beverage products, including carbonated soft drinks, juices, sports drinks, bottled water, etc. They also produce several non-beverage products such as chips, although the supply chains used for these products are different and independent from those used for beverage products. Beverage products come in glass, aluminum or plastic bottles, in a wide range of shapes and sizes. Concentrate is also distributed to fountain dispensers.

Staging and Transportation

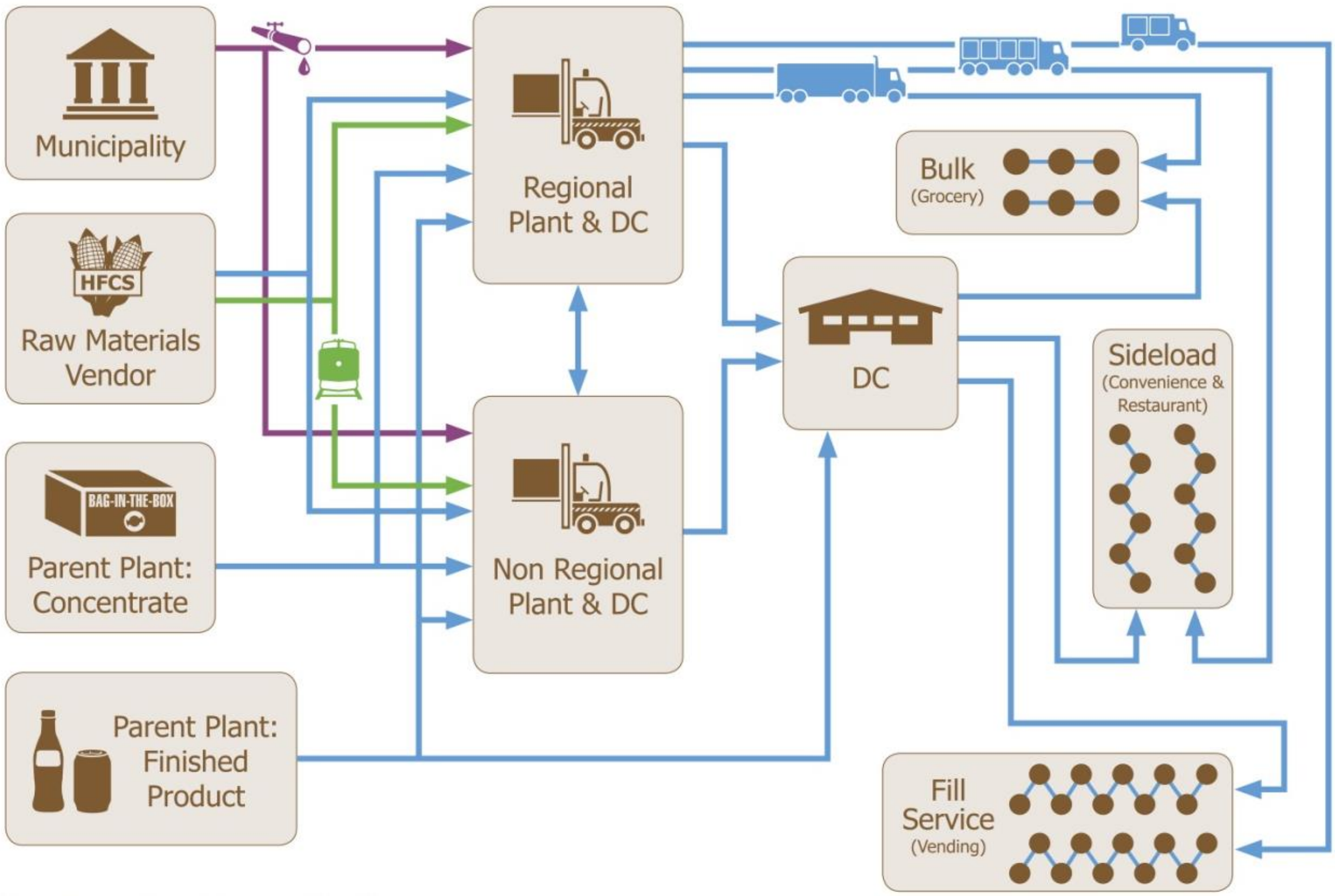
Soft drink supply chains have two key players: the companies that manufacture concentrates and commercialize the product, and the companies that manufacture the finished product and distribute to customers. These latter companies are the main generators of freight activity in the sector and have the greatest control over how supply-chains are structured. On the other hand, the former companies are concerned primarily with enhancing the appeal of the brand and designing the products.

As can be seen from Figure 83, manufacturing plants (inside or outside the Region) receive inputs from a variety of sources. Water is obtained locally from city pipes, and sometimes additives or sweeteners are added to it. Raw materials such of high fructose corn syrup are received from a wide range of vendors. Finally, concentrates and finished products are received from the parent manufacturing plants. Most of these inbound shipments are made using truckload service. Bottling plants function as both factories and DCs, delivering products made onsite or at other manufacturing facilities. Pepsi Cola is produced locally in the Triangle Region while other products such as Gatorade are shipped in.

There principal Pepsi bottling facility in the Triangle Region (see Figure 84) is located in Garner NC, just south of Raleigh, and is operated by Pepsi Bottling Ventures. This facility serves as the main manufacturing and DC for Raleigh, producing about two-thirds of the company's beverages consumed in the regional market. A facility such as this one would not typically receive cross-shipping from other DCs unless there is a special situation where backup is needed. Distribution decisions and the sorting of deliveries are done automatically according to supply chain management systems. Replenishment decisions for vending machines are made automatically based on stock levels. Bulk customers are grocery and warehouse stores that usually receive predictable and recurrent deliveries each week, typically around one every 2-3 days. Some larger customers receive bulk shipments daily.

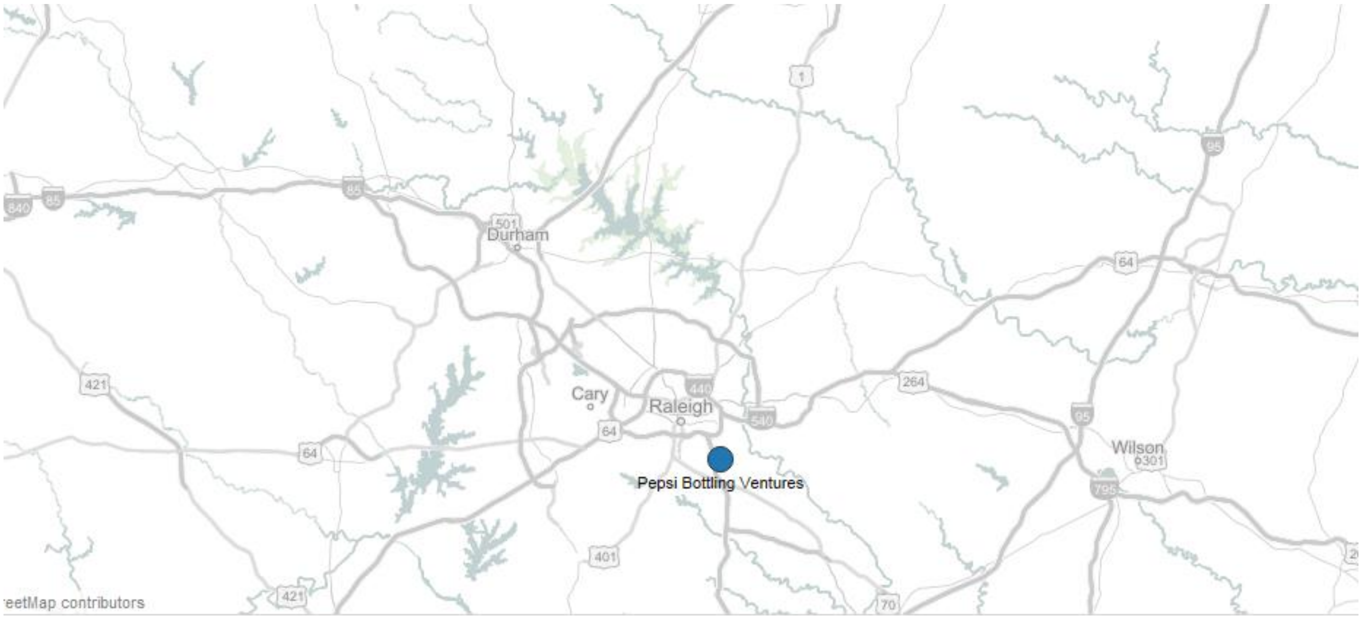
Deliveries to customers are made almost exclusively by a fleet of company trucks that vary in size depending on their function. Small trucks are used to replenish vending machines throughout the city, medium size trucks (28' – 35') that can be unloaded sideways are used to supply restaurants and convenience stores, and large single-unit or combination trucks (45' – 53') are used to resupply high volume grocery stores and supermarkets. Truck tours are optimized centrally to best meet customer's delivery schedule needs and minimize supply chain costs. Trucks typically make stops every 2 and 5 miles. Tours for restaurants and convenient stores make on average 12 stops while tours for fill service make on average 20 stops.

Figure 83: Typical Soft Drink Beverages Supply chains



Source: NCFRP 15

Figure 84: Location of Pepsi Facilities



Source: Westat Data

Performance and Opportunities

The performance of soft drink supply chains is defined by the ability to deliver products to customers within pre-specified delivery windows. Routing software develops tours and schedules to optimize the sequence of deliveries while minimizing transportation costs. Pepsi trucks typically are on the road by 6 AM and finish their shifts by 5PM, leading them to be exposed to rush hour traffic at both ends of weekdays. Most customers prefer day deliveries, but for some customers windows can be flexible as long as delivery occurs by close of business. Nevertheless, some customers require early morning delivery, bars and restaurants may prefer afternoon deliveries, and warehouse stores demand specific appointments. This part of the supply chain is sensitive to unreliability as delays can cascade from stop to stop, potentially leading to several missed delivery windows in a row. The goal of route planning is to achieve full utilization of each vehicle while meeting all customer delivery windows, which can mean that trucks are not sent out completely full unless there is time to deliver the entire load.

To maintain schedule, drivers in difficult downtown locations judge whether to search for close-by legal parking spots, park in a legal spot farther away and use a hand cart for delivery, or risk a fine by parking illegally next to the delivery location. Most of these parking fines are paid by the companies and are seen as a cost of doing business. When delivery windows are missed—most often because of traffic congestion or full parking lots—the driver will attempt to arrange redelivery later in the day. If the product must be brought back to the distribution facility and the delivery re-set, the company incurs additional distribution costs.

Grocery Store Supply Chains

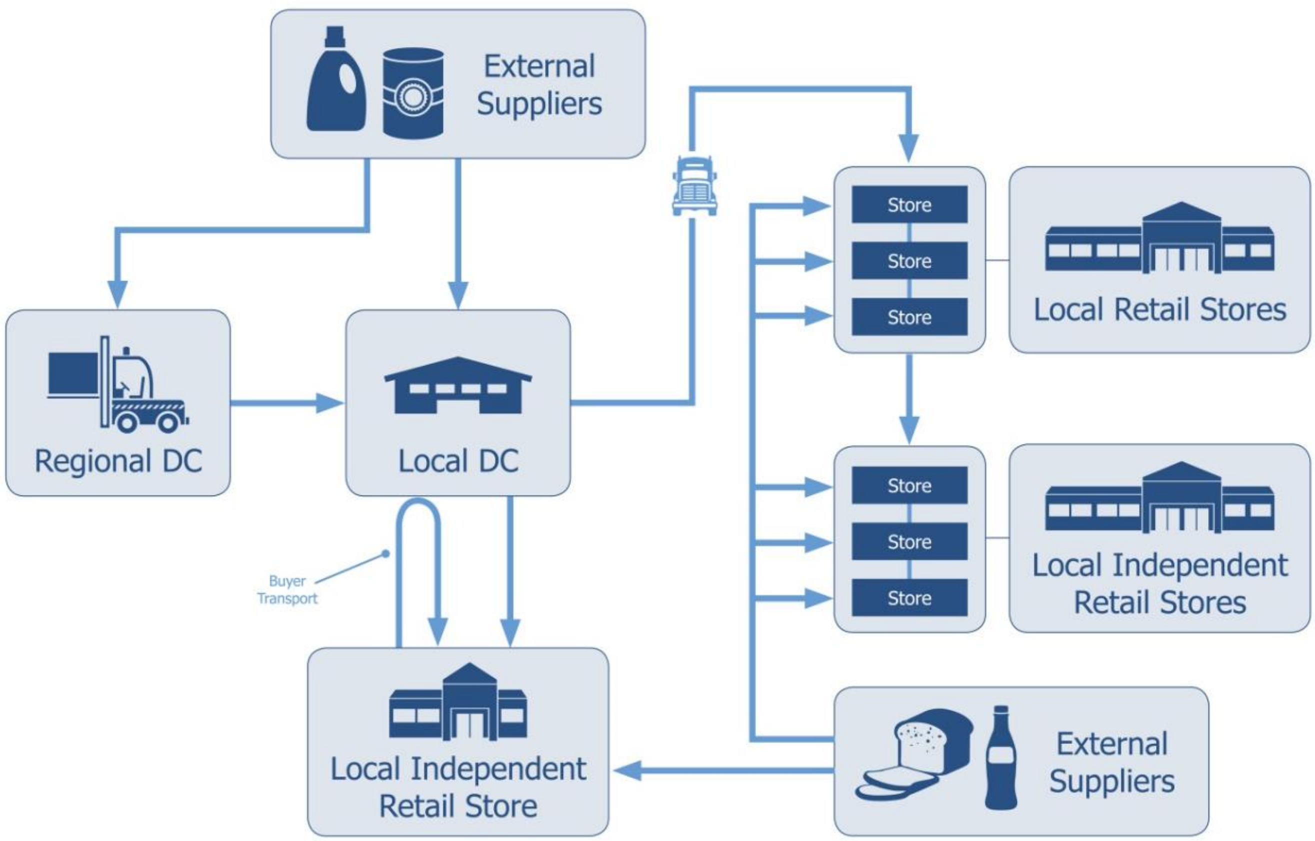
Commodities

Grocery stores handle thousands of different products of varying characteristics. The primary products handled are "dry goods" (canned goods and boxed product), frozen foods such as vegetables and meats, and prepared items. Most of these products come from a wide range of suppliers, although many grocery store chains also have their own store-brand products.

Staging and Transportation

Grocery store chains can serve as both retailers and wholesalers, as shown in Figure 85. They can have a large scale distribution business supplying independent retailers in addition to supplying their own stores. Grocery stores can specialize in serving different markets, however the variety of products offered are often comparable. Products are received from suppliers at one of the company's regional distribution facilities and then transported to local DCs. These facilities then provide products to both the company's retail stores and wholesale customers.

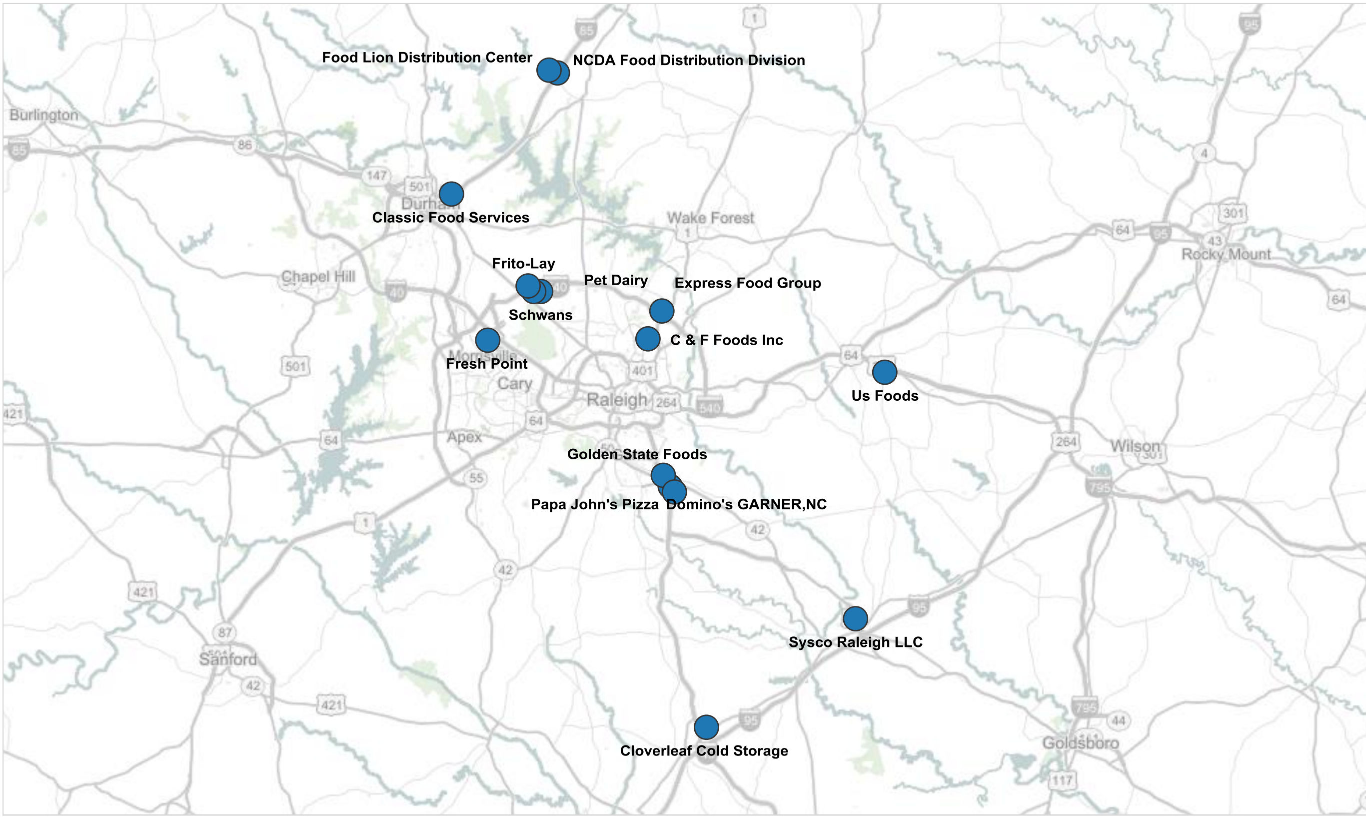
Figure 85: Typical Grocery Supply chains



Source: NCFRP 15

Many grocery stores use supply chains that can be best described as a hub and spoke network, with a regional distribution facility at the center and local DCs and stores at the periphery. Products are transported from regional distribution facilities to specific local DCs by over the road service, and then ultimately to local retail and wholesale. Some slower moving products are stored at and distributed directly from the regional facilities. Figure 86 shows the food DCs identified in the Westat data set, which includes food service (such as Sysco and U.S. Foods), fast food (Dominos) and producer DCs (Frito Lay), as well as groceries (Food Lion), as listed in Table 31. The data covers larger facilities in the Triangle region, so there will be others serving local outlets from smaller facilities or from outside the region (the Harris Teeter DC in Greensboro is an example).

Figure 86: Food Distribution Centers



Source: Westat Data

Table 31: Food Products Distribution Centers

Name	Observed SF	Address
C & F Foods Inc.	120,000	5201 Departure Drive, Raleigh, NC 27616
Classic Food Services	40,000	1716 Camden Avenue, Durham, NC 27704
Cloverleaf Cold Storage	68,000	444 Gilbert Road, Benson, NC 27504
Domino's GARNER, NC	30,000	3100 Waterfield Drive, Garner, NC 27529
Express Food Group	217,000	3401 Gresham Lake Road # 118, Raleigh, NC 27615
Food Lion Distribution Center	375,000	1703 East D Street, Butner, NC 27509
Fresh Point	30,000	203 Trans Air Dry, Morrisville, NC 27560
Frito-Lay	35,000	7504 Precision Dr., Raleigh, NC 27617
Golden State Foods	140,000	1400 North Greenfield Parkway, Garner, NC 27529
NCDA Food Distribution Division	70,000	2582 West Lyon Station Road, Creedmoor, NC 27522
Papa John's Pizza	54,000	5301 Waterfield Drive, Garner, NC 27529
Pet Dairy	10,000	8816 Midway West Road, Raleigh, NC 27617
Schwan's	20,000	8851 Westgate Park Dry Raleigh NC
Sysco Raleigh LLC	160,000	1032 Baugh Road, Selma, NC 27576
U.S. Foods	377,000	1500 North Carolina 39, Zebulon, NC 27597

Source: Westat Data

Most movements throughout the grocery supply chain are handled by truck, although a small fraction of inbound deliveries from suppliers are carried by rail. Most of the inbound transportation to DCs is managed by suppliers, while store deliveries from the DC are arranged by the grocery company itself. A few product types (such as bread, chips, and soft drinks) are delivered by vendors directly to stores. The trucks used provide of a mix of dry van and reefer service, with containers measuring 42' to 53'. Trucks delivering to stores may make a single stop for larger recipients, or make several consecutive stops for smaller outlets. Speed and reliability have a direct effect on the number of deliveries. Delivery trucks typically are only loaded to less than two-thirds the maximum weight capacity due to the wide range of densities and stack-ability of the products carried. Most shipments are loaded to maximum cubic capacity. Truck load deliveries are arranged on the truck by pallet and by stop to increase efficiencies.

Performance and Opportunities

Unlike in the other supply chains discussed where schedule reliability and delivery speed are the main determinants of performance, with grocery supply chains the main focus is on reducing transportation costs by maximizing the utilization of trucks. As mentioned before, trucks are almost always loaded to cube capacity, so as to minimize the transportation cost per grocery item sold. Many grocery store chains also continuously seek new technologies to boost fleet performance. Truck fleets are equipped with satellite devices to record arrival and departure times, travel speed, idle time and other critical information. This technology can also be used to reduce idling and fuel combustion.

The emphasis on costs is only in relative terms; on-time performance remains essential for two reasons. First, cost is partly a function of speed and reliability, because they have a direct effect on the number of deliveries a truck can make in a work shift—in other words, they affect utilization and productivity. Second, essentially all of the inventory in a store is kept on the shelves, in quantities sufficient for only a few days' sales. The typical days of supermarket in-store stocks is shown in Figure 87. Without frequent truck deliveries, the perishables stock out within a couple of days, and the shelves are empty of all goods within a week. The availability of everyday goods that Triangle Region households depend on is sustained by daily truck traffic. Transportation performance on truck routes from DCs within and outside the region affects the prices that residents pay for goods and their ability to put food on the table.

Figure 87: Supermarket In-Store Supplies

There are many external forces that impact fleet performance over which companies have little control. Traffic congestion in the metropolitan area causes delays on deliveries. Lane closures, ramp closures and merging lanes on major corridors also cause numerous delays. Since access to delivery destinations can be restricted during certain times of the day by law, drivers may be forced to make deliveries under less than optimal traffic conditions. Additional performance constraints can be caused by physical impediments to reaching delivery locations, such as utility poles, medians or other physical structures. All of these represent opportunities for enhancing the performance of grocery supply chains, and of others in food distribution.

Home Delivery Supply Chains

Commodities

Supply chains designed for home deliveries have grown in importance over the last two decades with the explosion of e-commerce. Companies such as Amazon.com, Overstock.com, and Zappos.com have revolutionized how consumers search and shop for goods. In response, legacy big-box retailers such as Walmart, Target and Best Buy have innovated their business models to participate in the e-commerce revolution. The proliferation of online retailers ensures that almost any good can be purchased on the web, from mattresses to precise electronic components. In fact, there is a greater variety of goods available online than in stores because consolidated distribution from fulfillment centers keeps inventory costs lower (fulfillment centers are large national and regional DCs designed to serve and deliver the great numbers of small orders typical of on-line and mail-order retail). This implies that home delivery supply chains need to be flexible and adaptable to a wide variety of products, conditions, and service requirements.

Staging and Transportation

As can be seen in Figure 88, e-commerce supply chains replace regional DCs in traditional retail supply chains with fulfillment centers. From these fulfillment centers goods are delivered to customers through package carriers such as FedEx, UPS and U.S.PS. This distribution model can provide customers with a greater range of products at potentially lower prices, but at the expense of longer lead times. Reduction in lead times has become a main focus for competitive improvement of service offerings, especially as e-retailers go up against store-front merchants.

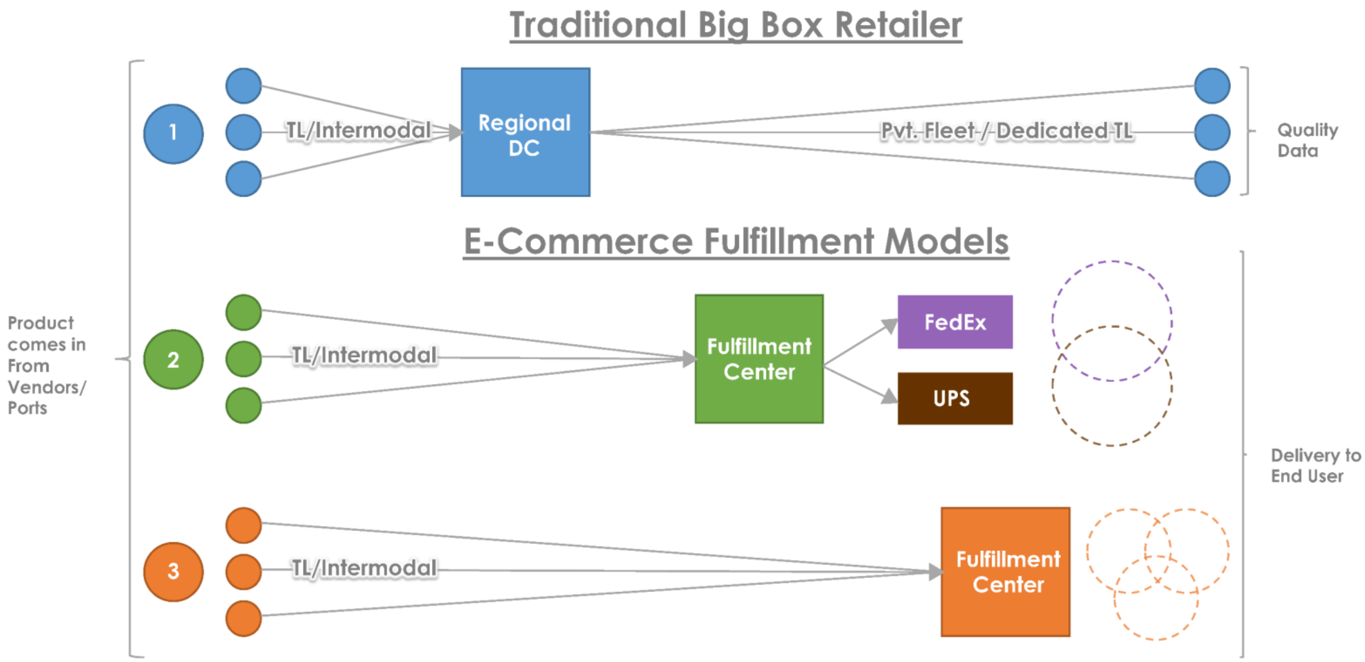
E-commerce supply chains are similar to traditional retail supply chains in getting goods from producers to fulfillment centers. For international shipments, this typically involves waterborne travel to ports in the West Coast or East Coast, followed by inland travel by train or truck depending on the distance and type of markets being served. The Triangle Region is likely to be served by both West Coast ports (primarily in Los Angeles) and East Coast ports (primarily Norfolk, Savannah, and others).

The Triangle Region is served by DCs and fulfillment centers up to hundreds of miles away. Within the Triangle Region there are several FedEx, UPS and USPS DCs, as can be seen from Figure 88. Some of these are customer centers, while others are sorting and distribution facilities. Amazon currently does not operate fulfillment centers in North Carolina (the large warehouses that contain the full spectrum of products available on the retailer's website). The closest fulfillment center is located in Richmond, VA about 160 miles away. A second fulfillment center is located in Spartanburg, SC around 240 miles away.

Amazon has evolved their distribution system considerably since 2013. Before then, Amazon's predominant distribution strategy was to reduce the amount of taxes paid by customers. However, changes in how states tax these types of transactions led Amazon to focus on increasing shipment speeds instead, often by having a greater control over parts of the supply chains that before were outsourced to UPS and FedEx (as can be seen in the difference between 2 and 3 in Figure 88). By doing this, Amazon has focused on providing better service to customers to increase engagement and loyalty, and compete with the convenience of in-store purchasing. In achieving this, Amazon continues to innovate with the rollout in many markets of Amazon 'Fresh', 'Prime Now', and 'Same Day Delivery'. In these distribution schemes Amazon has assumed the responsibility of delivering goods directly to consumers, which has involved the establishment of additional fulfillment centers and adapting the concept of sorting centers.

Amazon is building several sorting centers around the U.S. to sort orders in-house, instead of relying on traditional shipping companies, in order to speed up home deliveries and get more control over its distribution system. Packages would be transported to sort facilities from fulfilment centers around the country, and then handed over to U.S.PS for last-mile service. USPS service enables Sunday deliveries, which UPS and FedEx currently do not support, becoming an important strategy for Amazon in the U.S. One of these sort facilities was recently constructed by Amazon in Concord, NC, roughly 140 miles southwest of the Triangle Region.

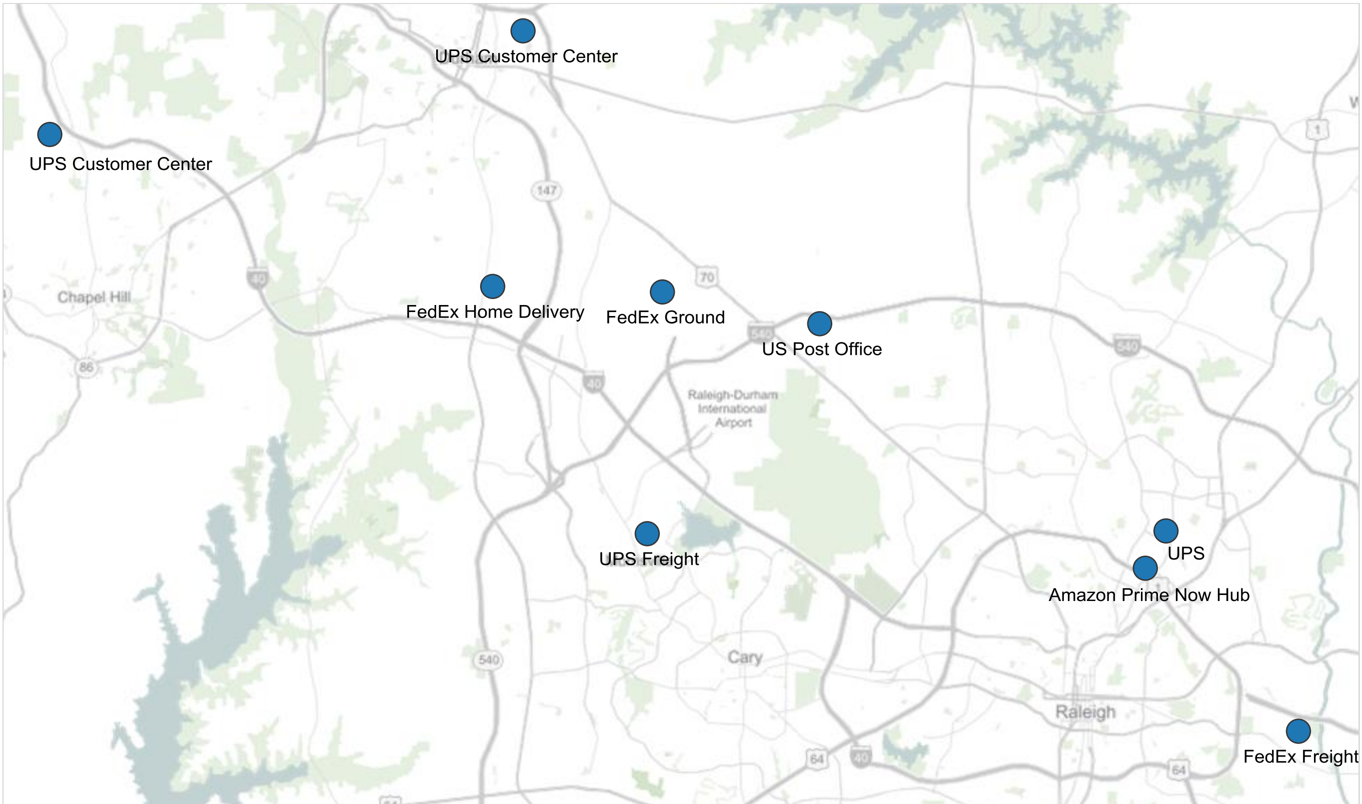
Figure 88: Traditional vs. E-Commerce Supply chains



Source: STIFEL

In early 2016, Amazon located a 'Prime Now Hub' in the Triangle Region, at 3200 Bush St, as shown in Figure 89 and Table 32. This became one of the first 30 such facilities that Amazon has opened in the U.S. with the intention of providing exceptionally fast delivery service for commonly purchased items. Deliveries within two hours of purchase are free for Prime members, and even one-hour delivery is available at a price. Once the purchase has been submitted, a team of contracted drivers deliver the merchandise to customers all over the Triangle Region. The service is currently available from 8 a.m. to 10 p.m., seven days per week.

Figure 89: Home Delivery Staging



Source: Westat Data

Table 32: FedEx and **UPS Distribution Centers**

Name	Description	Observed SF	Address
FedEx Freight	Package Distribution Center	20,000	5210 Trademark Drive, Raleigh, NC 27610
FedEx Ground	Package Distribution Center	130,000	2600 Page Road, Durham, NC 27703
FedEx Home Delivery	Package delivery	80,000	2530 South Tricenter Boulevard, Durham, NC
UPS	Package Delivery	170,000	Singleton Industrial Dr., Raleigh, NC
UPS Customer Center	Package Distribution Center	20,000	2008 Fay Street, Durham, NC 27704
UPS Customer Center	Package Distribution Center	20,000	7411 Rex Road, Chapel Hill, NC 27516
UPS Freight	Freight and logistics	50,000	150 International Drive, Morrisville, NC 27560

Source: Westat Data

The effect of these developments on traditional store-front merchants is profound, and has given rise to so-called omni-channel retail, which denotes the attempt to merge in-store with on-line shopping. As noted above, a great advantage to on-line retail is that very large and diverse inventory can be maintained in a central location (or in vendor warehouses), pooling goods to satisfy the spectrum of local demand. The store-front retailer strives to compete with this by maintaining a custom blend of fast-moving goods in each store, making a greater range of choices available on-line and visible from mobile devices while shopping, and including in the accessible inventory merchandise from every store as well as from warehouses. This gives the customer as much selection as possible, gets the most utilization from every form of inventory, and manages delivery costs by satisfying demand from the closest location with stock. However, it forces retailers to maintain stock closer to consumption in order to reduce time to market. The emphasis on faster time to market has led to tripling of the number of DCs used by U.S. supply chains just in the past four years, as can be seen in Figure 90. Added DCs can be smaller, signifying that they can be located on smaller land parcels, and with warehouse automation, relatively small facilities can have high throughput. The graphic reflects manufacturers as well as retailers; Tompkins reports the trend among retailers alone is even more pronounced.

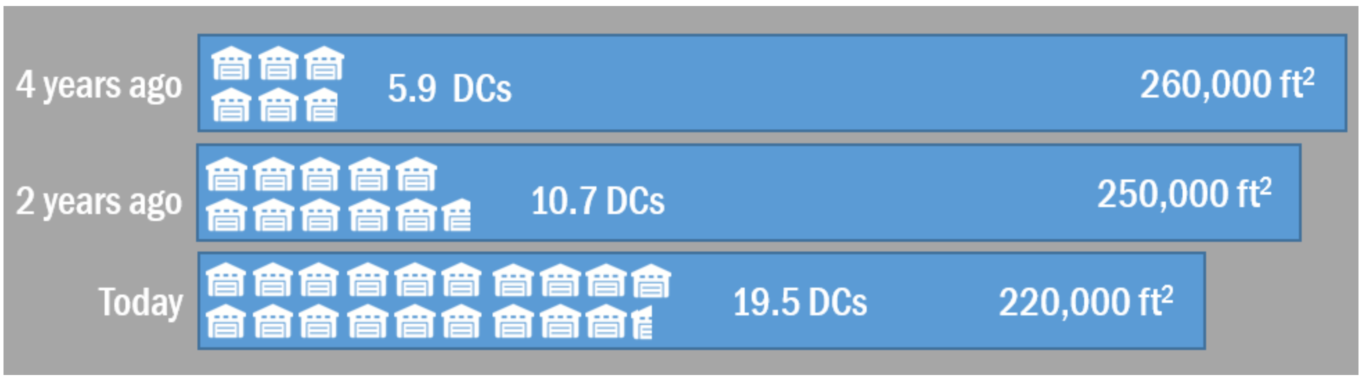


Figure 90: Trend in Average Number of Company Distribution Centers

Source: Tompkins International: Supply Chain Consortium

Moreover, delivery speeds are under pressure because of the competition for convenience. A principal benefit from in-store shopping is the ability to examine merchandise and carry it home. Electronic retailers contend with this particularly through the aggressive home delivery services exemplified above by Amazon. With the incremental cost of home delivery at zero for many consumers doing business with Amazon and others, delivery companies report that home deliveries now include such ordinary and bulky household items as pet food and paper products. Store-front retailers in turn are obliged to match the fast delivery service for customers who prefer it. For both electronic and store-front merchants, the goods have to be positioned to fulfill the time commitment, requiring facilities—DCs, stores, Prime Now Hubs and other staging points—close enough to accomplish this. The more volume retailers are able to command in the light density lanes serving neighborhoods, the lower their cost and the less room there is for competitors, because the dominant player in light density lanes is best able to attain volume economies. The same logic applies to rapid delivery: only a few competitors can attract the volume to afford it.

Performance and Opportunities

Home delivery supply chains are designed to be highly responsive and flexible to the demands of consumers. Online and store-front retailers and the truck delivery companies who serve them are constantly finding ways of optimizing their supply chains to deliver goods as quickly and cheaply as possible. The driving performance factor is more speed than price, especially when shipping is offered free to consumers. Nevertheless, costs have to support the price, which means the competition for delivery economies and productivity is a matter of commercial survival. While consolidation of next day and same day deliveries can be achieved through the networks of the major package carriers, the smaller time windows associated with faster speeds reduce the opportunity for it. There are at least two implications for transportation planning in the Triangle

Region. First, traffic, access and parking conditions affect the ability to meet time commitments and thus influence the number of staging points required. Second, these same conditions affect the productivity and thus the cost of delivery operations, suggesting that the intense pressure on retailers and carriers to improve those costs will be conveyed to public agencies and elected officials. It is important to recognize that these are new developments: same day delivery is a recent phenomenon and e-commerce is by far the fastest growing segment of retail. Three-quarters of Tompkins' Supply Chain Consortium members indicate that direct to consumer sales increased for their business in the past three years, but one hundred percent expect them to increase in the next three years. The effects of this have only begun to be felt, and the opportunity is to anticipate effects with appropriate transportation and land use planning.

In addition, there is an effect on neighborhoods. More trucks will deliver more goods. Vehicles like UPS package cars are not especially large, but as a greater variety of household goods enters the home delivery stream, bigger vehicles may be required – and LTL carriers (typically operating 28' delivery trucks) already report significant growth in their Triangle Region home deliveries. Safety will be an overriding concern, and adoption of the sensing and driver-assist technologies associated with CAV will offer a solution. Emissions will matter, so that natural gas powered and hybrid-electric trucks will be more desirable. Finally, consumers will be directly exposed to the consequences of delay: the household ordering pet food for tonight will notice when it is not delivered. In a traditional store-front model, the retailer buffers the customer from delivery problems; in home delivery, the consumer contends with them face-to-face. The long-standing assumption that "freight doesn't vote" may be upended by this change, and lead to citizen demands on elected officials for transportation improvements.

6 FREIGHT FORECASTS

The purpose of this chapter is to present the findings of comparing FAF annual growth forecasts to other forecasts for maritime, rail, and air freight transportation in the Triangle Region. Since the FAF forecasts are current (2016 release), comprehensive, and bear FHWA's stamp of approval, there is strong reason to adopt them. Nonetheless, it is well to check them against other regional sources. The findings below summarize as this: the maritime outlook should be regarded as an update to previous forecasts. It is more moderate for trade tons, stronger for trade value, and much more positive for domestic activity. Rail projections align reasonably well with the state rail plan outlook, but FAF air forecasts probably run high and the more conservative outlook from RDU may be a better gauge.

As part of the planning effort, the study team also developed a regional truck forecasting model that was delivered to the agency partners and documented separately. The model produces projected truck volumes by roadway, and output from the model is used in the development of the SFC network and the project recommendations that appear in Chapters 8 and 9. The model is consistent with other forecasts presented in these pages, although its form is different.

Maritime Freight

FAF4.1 figures for maritime freight were compared to forecasts developed as part of the North Carolina Maritime Strategy Report (2012), which used a combination of FAF3.1.2 data and IHS Global forecasts for South Atlantic waterborne trade. A comparison summary of forecasts derived from FAF4.1, FAF3.1.2, and the IHS Global are presented in Table 33. The FAF4.1 figures projected maritime freight growth for the State of North Carolina, as opposed to the Triangle Region, to align with the Maritime Strategy report. FAF4.1 forecasts considered annual growth between 2012 and 2040, FAF3.1.2 considered years 2007-2040, and IHS Global considered years 2009-2029.

When comparing the forecasts for maritime freight tonnage, FAF4.1 was notably more conservative in its growth estimates for imports and exports than FAF3.1.2. However, the opposite was true for import/export value estimates; FAF4.1 estimates were significantly more aggressive, and predicted import value increasing annually at 4.5 percent and export value increasing at 5.1 percent annually. Import and export tonnage estimates from IHS Global were higher than both FAF versions, at 3.3 percent and 5.3 percent, respectively. Forecasts for maritime freight value in North Carolina were not available from IHS Global. However, as FAF 4.1 is the more recent FAF forecast, and considering that IHS Global is the producer of FAF projections, the 4.1 forecast can be considered a current outlook updating and replacing earlier ones.

For domestic maritime freight in North Carolina, there were differences between FAF4.1 and FAF3.1.2 forecasts for domestic inbound traffic; FAF4.1 forecasted growth in both tonnage and value while FAF 3.1.2 forecasted rapid decline (-4.9 percent). Overall, FAF4.1 predicted weaker growth in tonnage between 2012 and 2040 compared to FAF3.1.2, but stronger growth in maritime freight value.

Table 33: Annual Growth Statistics for Maritime Modes in North Carolina, Tons and Value

Data Source		Compound Annual Growth Rate (CAGR)			
		Imports	Exports	Domestic	Total
FAF4.1 (2012-2040)	Tons	1.4%	3.1%	I/B: 1.7%	I/B: 1.6%
				O/B: 2.5%	O/B: 3.0%
	Value	4.5%	5.1%	I/B: 3.2%	I/B: 3.9%
				O/B: 6.4%	O/B: 5.5%
FAF3.1.2 (2007-2040)	Tons	2.2%	3.7%	I/B: -4.9%	I/B: 2.2%
				O/B: 2.9%	O/B: 3.7%
	Value	2.9%	3.1%	I/B: -4.9%	I/B: 2.9%
				O/B: 2.9%	O/B: 3.1%
IHS Global (2009-2029)	Tons	3.3%	5.3%	N/A	N/A

Note: I/B = Inbound, O/B = Outbound

Rail Freight

For rail freight activity, FAF4.1 figures for the State were compared to forecasts developed as part of the North Carolina Comprehensive State Rail Plan (2015), which featured tonnage and value forecasts from 2011 to 2040 for intermodal and carload rail traffic combined. A comparison summary of forecasts derived from FAF4.1 and the State Rail Plan for both tonnage and value are displayed in Table 2. FAF publishes rail data for both carload traffic (mode selection is "Rail") and intermodal traffic, which is integrated in the mode selection "multiple modes & mail". As such, Table 34 features projected annual growth rates for carload traffic, intermodal traffic, and carload-intermodal combined from FAF4.1. The "intermodal" component is decidedly imperfect, since FAF combines rail-truck activity with other types, including parcel shipping. In addition, the forecast method is econometric and would not capture sectoral shifts, such as the new CSX intermodal hub planned for Rocky Mount. Nevertheless, the forecast provides a useful baseline projection, and it is important to somehow reflect the faster-growing intermodal traffic in the rail outlook.

Local tonnage estimates are for FAF4.1 combined traffic and the State Rail Plan were similar, 1.5 percent and 1.7 percent, respectively. The two sources also predicted similar annual growth rates for inbound tonnage, but FAF4.1 outbound tonnage estimates are more conservative, 1.1 percent compared to 2.4 percent in the State Rail Plan. For rail freight value growth estimates, FAF4.1 predicted slightly higher growth rates in nearly every instance. Overall, the State Rail Plan forecast and the FAF4.1 forecast aligned well in future rail freight tonnage growth, and for future rail freight value growth the State Rail Plan forecast was more conservative compared to the FAF4.1 forecast.

Table 34: Annual Growth Statistics for Rail Modes in North Carolina, Tons and Value

Data Source		Compound Annual Growth Rate (CAGR) Local	Inbound	Total
FAF4.1 Carload (2012-2040)	Tons	1.6%	0.2%	0.7%
	Value	3.1%	1.9%	1.4%
FAF4.1 Intermodal (2012-2040)	Tons	1.1%	1.7%	1.6%
	Value	2.1%	2.4%	2.5%
FAF4.1 Carload + Intermodal (2012-2040)	Tons	1.5%	0.4%	1.1%
	Value	2.2%	2.3%	2.3%
North Carolina State Rail Plan 2015 (2011-2040)	Tons	1.7%	0.3%	2.4%
	Value	1.5%	1.7%	2.2%

Note: FAF data includes intermodal rail in the mode classification "multiple modes and mail," which includes other multiple modes combinations such as water-truck, as well as all non-air parcel shipments, such as those carried by UPS.

Air Freight

Finally, air freight FAF4.1 figures were compared to estimates from the Raleigh-Durham International Airport (RDU) Master Plan, FAA Aerospace Forecasts, and Boeing World Air Cargo Forecasts, as shown in Table 35. For each of these sources, the annual growth rates were derived for total air cargo growth. FAF4.1 and RDU Master Plan estimates were specific to RDU Airport, while FAA and Boeing forecasts provided forecasts for the United States and worldwide. Annual growth rates are available between 2012 and 2035/2040 for FAF4.1 and the RDU Master Plan, while FAA forecasted from 2015 to 2036 and Boeing forecasted from 2013 to 2033.

Compared to RDU Master Plan forecasts, FAF4.1 was substantially higher, 4.3 percent annual growth between 2012 and 2040 compared to 0.8 percent. It was also higher than FAA and Boeing's domestic and total air cargo estimates for the U.S. However, the forecasts were slightly lower than Boeing's global estimate for air cargo growth, which was 4.7 percent between 2013 and 2033. Since FAF is fundamentally an econometric rather than a modal forecast, and affects modes because of differential growth rates in commodities and trade lanes, it may be best to view FAF as an indication of market opportunity, and the more conservative RDU projections as closer to the local modal outlook.

Table 35: Annual Growth Statistics for Air Modes in Raleigh-Durham, Tons

Data Source	Years	Compound Annual Growth Rate (CAGR)
FAF4.1	2012-2035	4.1%
	2012-2040	4.3%
RDU Master Plan Forecast	2012-2035	0.8%
	2012-2040	0.8%
FAA Aerospace Forecast[16]	2015-2036	Domestic (U.S.): 0.5%
		Total (Domestic & International): 3.6%
Boeing World Air Cargo Forecast[17]	2013-2033	Domestic (U.S.): 2.1%
		World: 4.7%

[16] Available from: https://www.faa.gov/data_research/aviation/aerospace_forecasts/media/FY2016-36_FAA_Aerospace_Forecast.pdf

[17] Available from: http://www.boeing.com/commercial/market/cargo-forecast/

7 FUTURE FREIGHT CAPACITY CONDITIONS

This chapter uses freight forecasts (outlined in Chapter 6) as the foundation for determining industrial, locational, and modal demand, which respectively reflect service requirements and economic import, geographic volume and concentration, and freight system usage. In this assessment of future capacity implications, the report focuses on roadway and rail as the principal modes of freight traffic, but also covers other freight transportation modes such as air freight and pipeline.

The purpose of the highway element of this chapter is to assess the effects of forecast truck volume on the Triangle Region's highway system. As truck volumes on the region's highways grow, poor performance at existing bottlenecks will be exacerbated while new bottlenecks may emerge. Using the Truck Flow Forecasting Model (TFFM) developed for the Triangle Region as part of this study, this analysis examines where growth is expected on the region's network and uses the results of the highway freight performance analysis to understand the implications of growth on future performance. In addition, as part of the assessment of future conditions the analysis tests for the effects of disruptions on the highway freight system. Disruptions may include incidents such as weather events or infrastructure outages, among others. The supply chain community is increasingly interested in the implications of disruptive events on the freight network.

In the rail capacity assessment section, the relative competitiveness of rail as a freight mode has been discussed. In addition, infrastructure investments that are necessary to improve rail service, open new markets for rail, and increase mode share in several commodities have been identified.

The report also provides an assessment of several other freight modes that are integral part of the Triangle region's economy such as freight moving by air, water, and pipeline. The Air Cargo section provides volume projections and airport master plan findings. The Ports section provides forecasts for freight headed to ports, in light of import, export, and domestic activity changes, and bulk and containerized traffic volumes. In the Pipeline section, the future conditions of freight activity by pipeline have been reviewed, including pipeline flow projections, trade partners, future demand volumes, top commodities, and capacity on pipelines in and around the Triangle Region.

Future Conditions for the Highway Freight Network

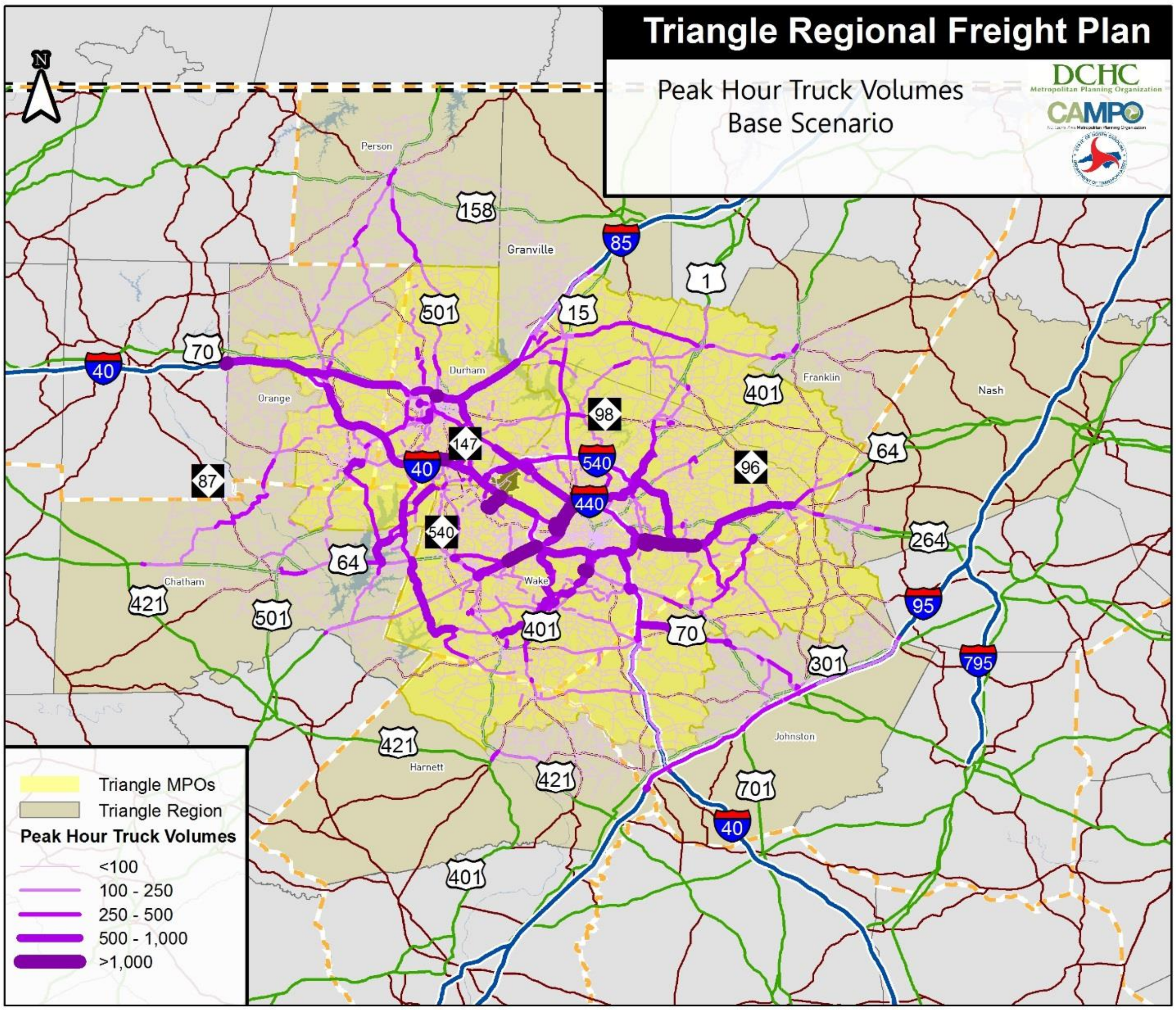
This section of the report provides an assessment of the effects of forecast truck volume on the Triangle Region's highway system.

Future Truck Volumes and Performance

The Triangle Region's TFFM was utilized to gauge the future use and performance of the highway freight system. The TFFM uses 2040 as the forecast year and incorporates the existing plus committed projects in the Capital Area and DCHC MPO FY2016-17 transportation improvement plans. The results produced for the model are for the evening peak hour, 4:30 PM to 5:30 PM, as illustrated in Figure 91.

Generally, the model indicates future peak hour truck volumes in several locations that are intuitive based on current system use. For instance, some of the heaviest predicted truck volumes are along U.S. 264/I-495, I-40, I-440, and I-85. Each of these roadways has segments where peak hour truck volumes exceed 500 trucks. Other roadways predicted to have significant peak hour truck volumes include U.S. Highways 1, 64, 70, and 264 as well as SR 55. Based on 2014 NCDOT AADTT data, these highways already carry significant amounts of highway freight in the Triangle Region. The model indicates that this is not likely to change given projected future conditions.

Figure 91: 2040 Peak Hour Truck Volumes



Along the major routes identified as having significant peak hour truck volumes, there are some specific segments that are predicted to have considerable truck demand relative to other portions of those routes. For instance, U.S. 264/I-495 between I-440 and Smithfield Road to the east of Raleigh is predicted to exhibit peak hour truck volumes that range from 900 – 1,200 trucks per hour. I-440 between Wade Avenue and U.S. 70/Glenwood Ave. is expected to have hourly truck volumes of approximately 1,220 trucks per hour. Truck volumes of this magnitude can have substantial impacts on performance as captured by volume-to-capacity (V/C) ratios and other measures.

Figure 92 shows the 2040 V/C ratios on the Triangle Region roadway network. The map is limited to interstate highways, arterials, U.S. routes, and NC routes since these are the primary facilities for providing regional travel. The results indicate that while the interstate highway system within the Triangle Region is not expected to exhibit capacity-constrained conditions, much of the region's arterial network is predicted to approach capacity limits. In addition, these capacity constraints are expected to materialize on routes identified as carrying significant truck volumes both currently and in the forecast year.

SR 55 is predicted to exhibit peak hour truck volumes that range from 250 – 500 trucks per hour as well as V/C ratios that exceed 1.0. This would indicate gridlock for the motor carriers that utilize this roadway. U.S. Highways 1, 401, and portions of U.S. 70/Glenwood Avenue are also predicted to have V/C ratios that approach or exceed 1.0. These highways are all predicted to have peak hour truck volumes that range from 800 – 900 trucks per hour along certain portions. The primary implication of these results is that while the Triangle Region's interstate highway system is likely to continue to facilitate a reasonable level of service for regional and statewide travel, the first and last miles will become more difficult for motor carriers. It is often those portions of truck trips that determine whether or not a carrier can deliver on-time performance.

When the results of the 2040 run of the Triangle Region travel demand model are compared to the contemporary results of truck performance analysis, the implications for growth on other performance measures can be inferred. Table 36 shows the April 2015 truck TTI and BTI along some corridors the travel demand model predicted to have significant peak hour truck volumes and/or capacity-constrained conditions. The truck TTI, shown in Figure 93 for roadways in the Triangle Region, indicates the intensity of congestion given observed travel times on the highway network. While the data currently indicates that the overall intensity of congestion is relatively moderate, the travel demand model results suggest that is not likely to be the case in the forecast year. Some key truck routes, such as U.S. 264/I-495 and U.S. 1, already exhibit truck congestion. Performance on these routes is likely to worsen with growth.

The reliability analysis (Figure 94) conducted as part of the existing conditions performance analysis indicated that much of the Triangle Region's highway network was challenged in its ability to provide reliable truck travel times. This is likely to be exacerbated by increased traffic volumes and the growing prevalence of capacity-constrained conditions throughout the region. The effects of growth on truck travel time reliability are likely to be most acute on the Triangle Region's arterial network. As predicted by the travel demand model, these routes will experience capacity-constrained conditions to a greater extent than the interstate highway system.

Figure 92: 2040 Volume-to-Capacity Ratios

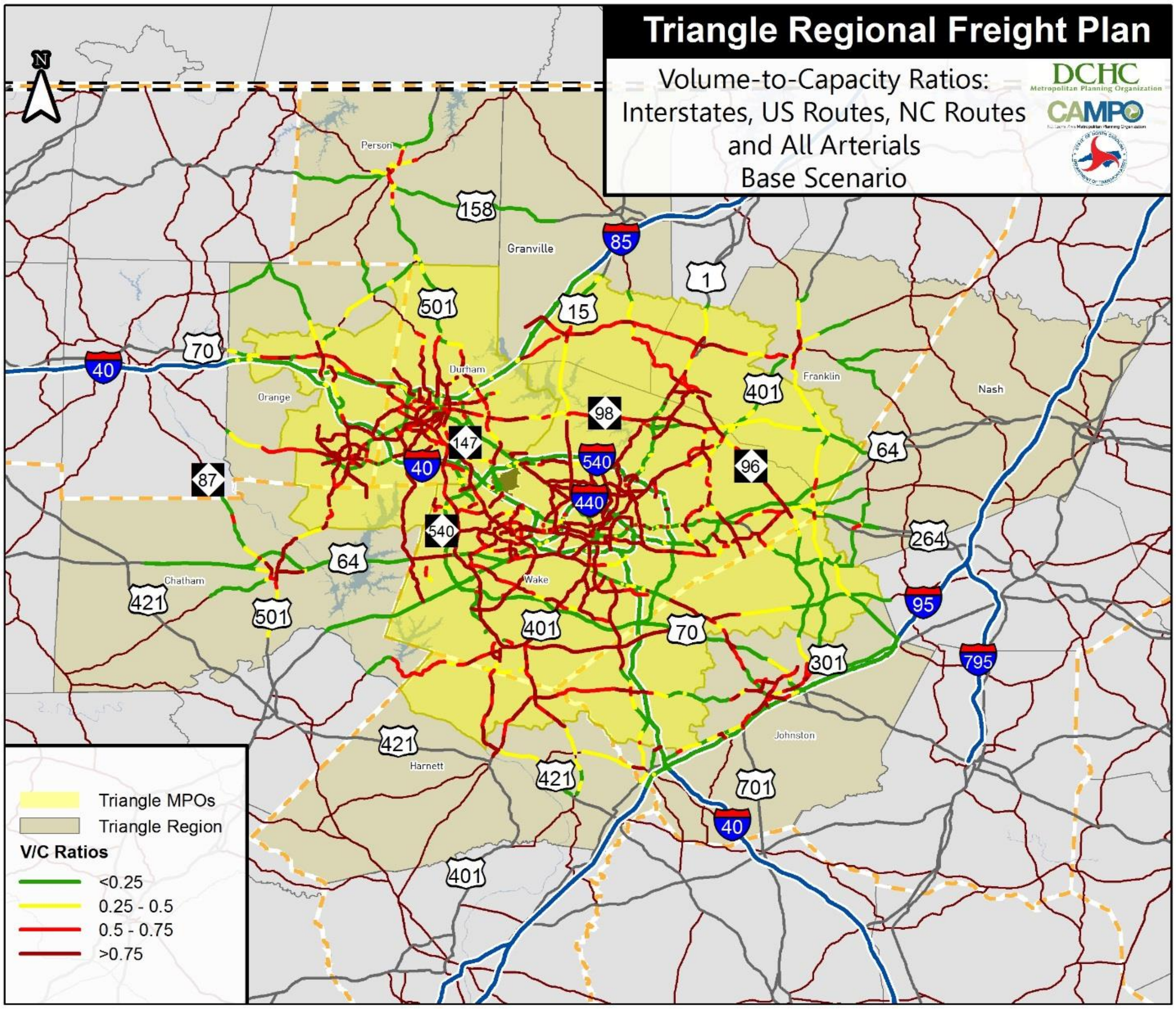


Table 36: Potential Freight Bottlenecks

Corridor	Peak Hour Truck Volumes (2040)	V/C Ratio (2040)	Truck Travel Time Index (2015)	Truck Buffer Time Index (2015)
U.S. 264/I-495: I-440 to Smithfield Road	990 – 1,200	0.10 – 0.15	1.0 – 2.0	0.1 – 3.0
I-440: Wade Avenue to U.S. 70/Glenwood Avenue	1,220 – 1,230	0.19 – 0.20	1.1 – 3.4	0.1 – 5.2
SR 55: SR 540 to U.S. 1	250 - 500	>1.0	1.2 – 5.0	0.4 – 2.7
U.S. 70: SR 50/Creedmoor Rd. to Duraleigh Rd./West Millbrook Rd.	450 - 820	>1.0	1.4 – 4.4	0.8 – 4.0
U.S. 1: I-540 to U.S. 1 ALT/Main Street	400 - 800	0.07 – 0.11	1.6 – 2.3	1.3 – 4.0

Source: Triangle Region TFFM; NPMRDS; Consultant analysis.

Figure 93: Truck Travel Time Index

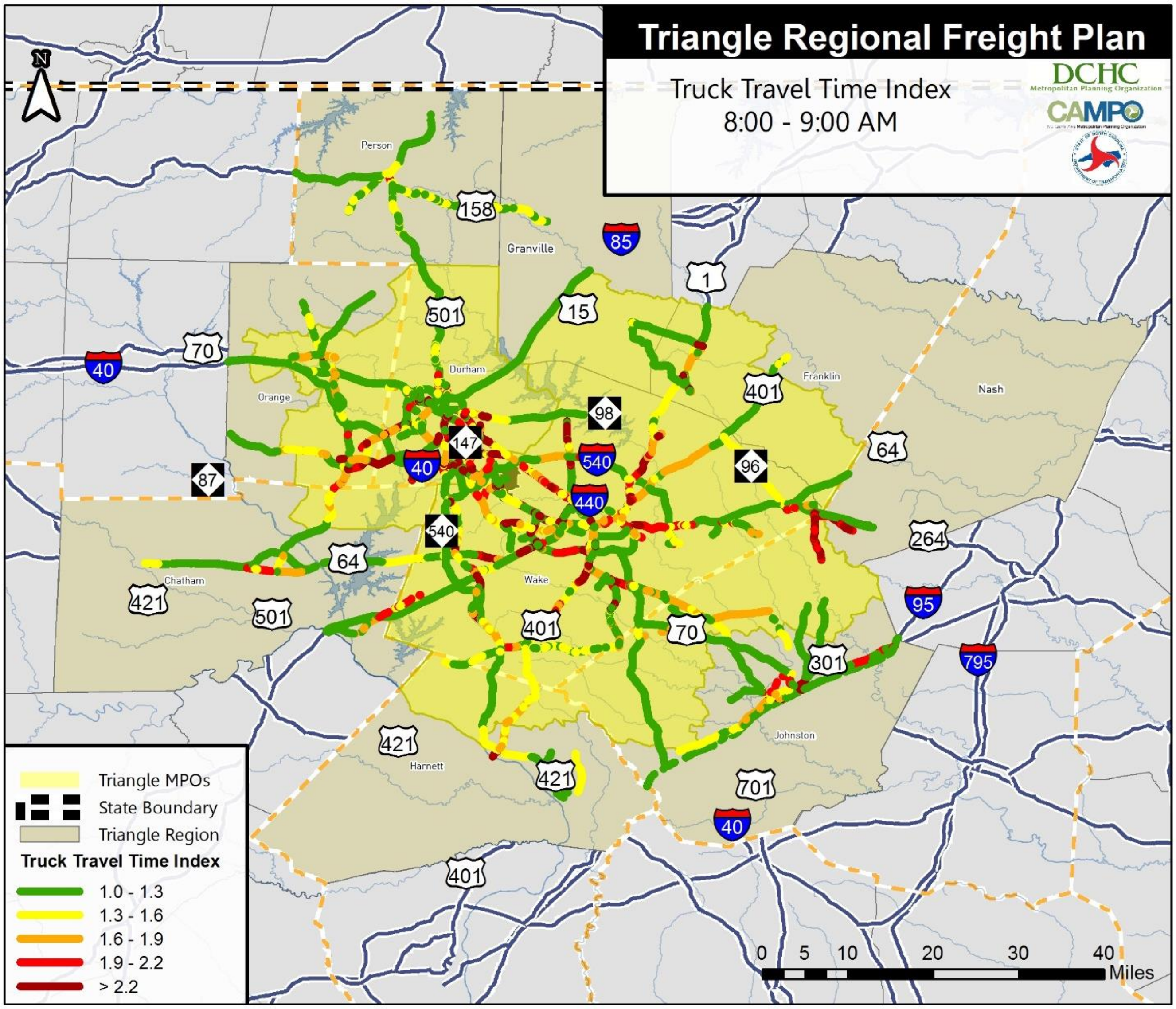
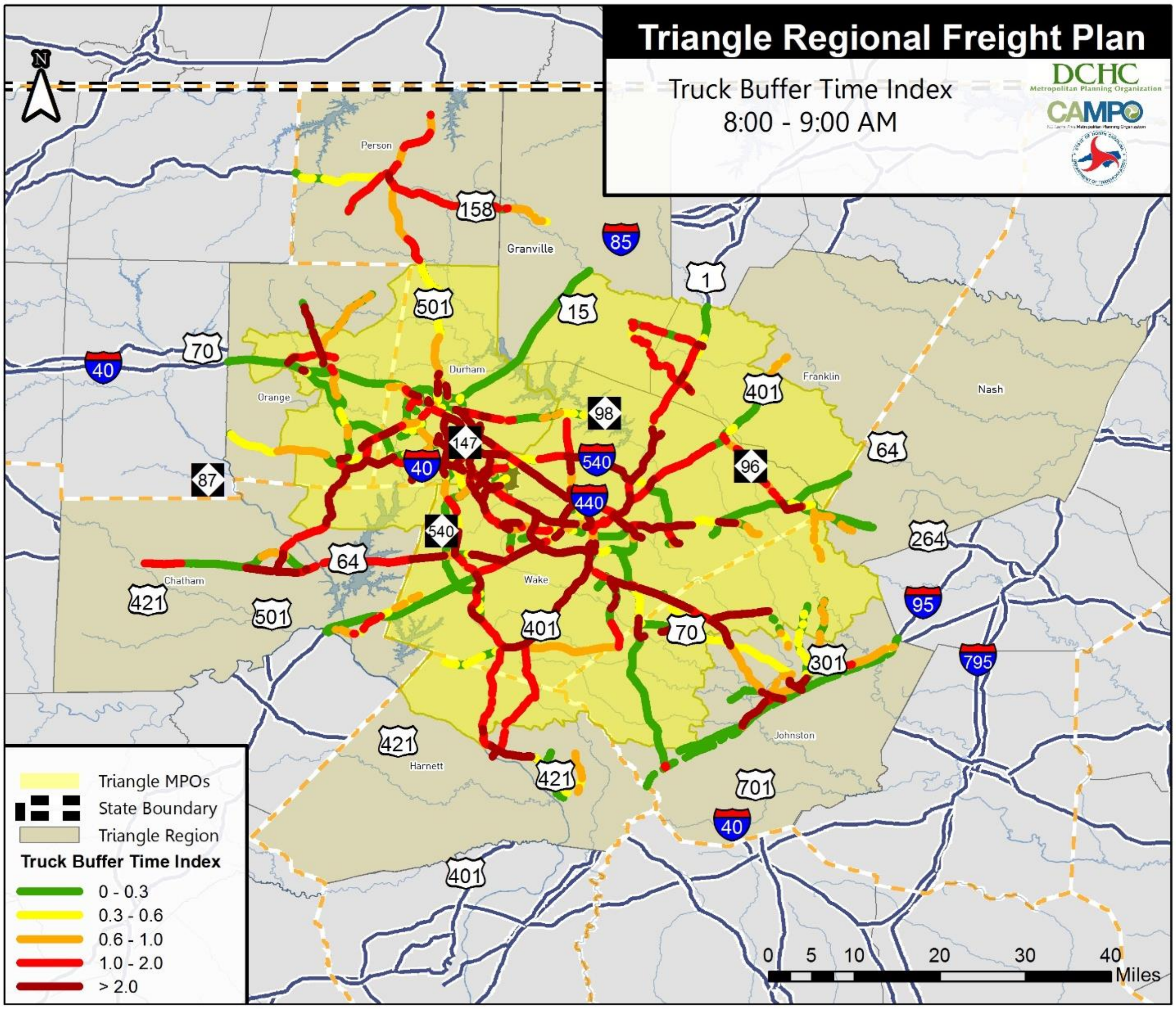


Figure 94: Truck Travel Time Reliability

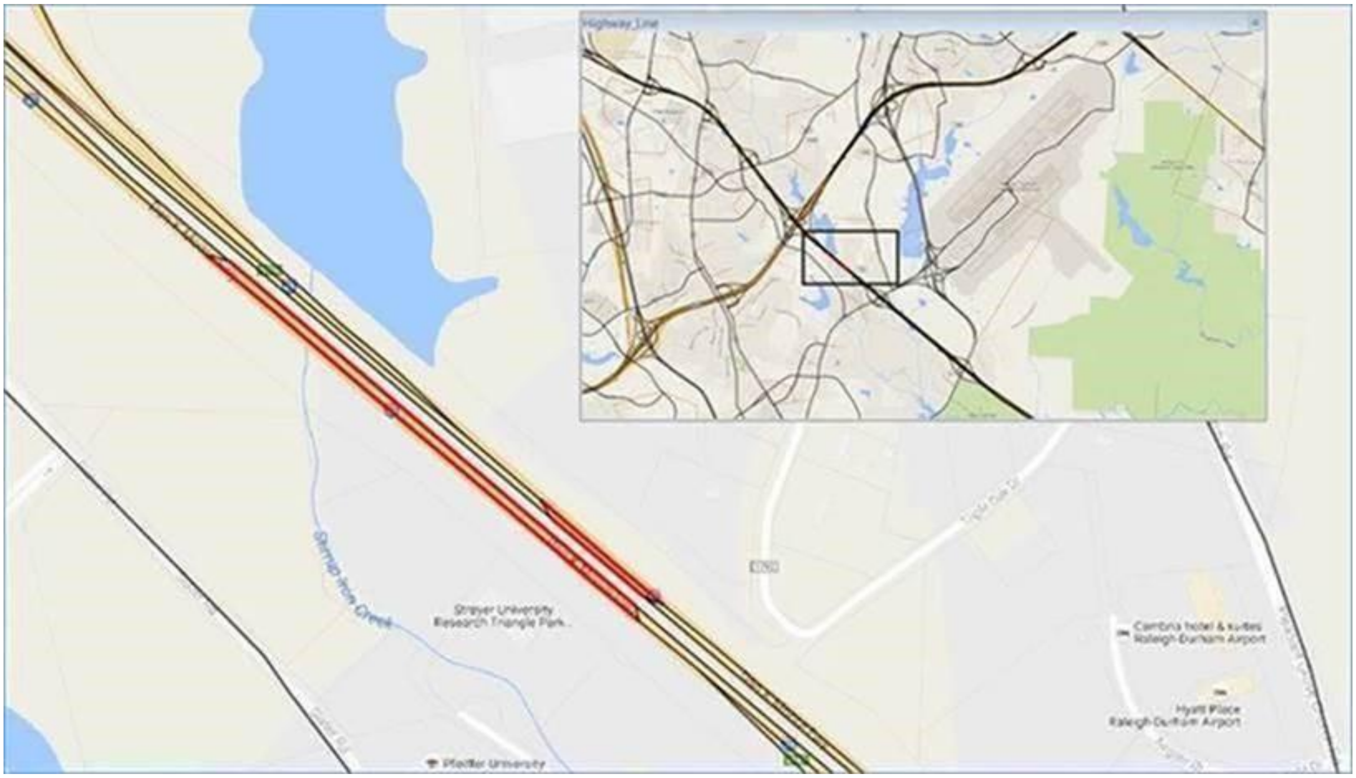


Highway Network Disruptions

There are numerous instances, such as weather events and infrastructure outages among others, that can disrupt supply chains by effectively removing a key link in the multimodal freight system. The ability of the freight network to absorb and respond to these disruptions indicates the degree to which the system is resilient. One method of testing for how the freight system may respond to various types of disruptions is to remove key network links in a modeling environment and observe how the system changes relative to a baseline scenario.

This analysis tests the resiliency of the highway freight system by closing two links on I-40 near RDU for truck movements during the evening peak hour (see Figure 95). This is one of the primary highways of the region near one of its principal freight facilities, and lying between the region's main urban centers. The potential effects of link closures on the highway freight system were estimated using the TFFM. The analysis was conducted by first estimating truck flows on the Triangle Region highway network under a baseline scenario in which all links are available to truck traffic. Then, the model was re-estimated after restricting truck traffic from two links on I-40. The system-wide difference in peak hour truck volumes and V/C ratios was measured in order to assess the effects of the closure.

Figure 95: I-40 Link Closures



Source: Environmental Systems Research Institute (ESRI); Consultant analysis.

By measuring the difference in peak hour truck volumes between the baseline and disruption scenarios, the analysis indicates which routes would handle the bulk of truck diversion due to the link closures. In Figure 96, only links in which there is a difference between peak hour truck volumes in baseline and disruption scenarios are shown. Links that realized a reduction in truck volumes are plotted in the color red while those realizing an increase are shown in green.

Unsurprisingly, as shown in Table 37 and Figure 96, the largest peak hour truck volume decreases were on I-40 near RDU (about 200 to 900 trucks). This is the portion of the network on which two links were assumed to be unavailable to truck demand due to disruptions. Roadways in the surrounding vicinity were also predicted to have decreased truck volumes. Miami Blvd. was predicted to have decreased truck volumes of about 100 to 180 during the evening peak hour. I-540, SR 147, and I-440 were also predicted to have significant decreases in demand. The traffic has not been diminished, needless to say; rather, it has routed differently.

Perhaps more important than the roadways predicted to have decreased truck volumes are those expected to have increased demand (Table 37 and Figure 96). The largest increases in peak hour volumes due to a disruption are expected to occur on Airport Blvd. and Slater Road, both of which are predicted to have volume increases of nearly 900 trucks. Aviation Pkwy. is also expected to have a significant increase in truck volumes due to a disruption on I-40 near RDU. Nearly 800 additional trucks in the evening peak hour are predicted to utilize this roadway as an alternate route. U.S. 70 and I-540 would be forced to carry up to an additional 300 trucks in the case of a disruption.

It is important to note that the roadways predicted by the model to be the primary alternate routes in the case of a disruption to I-40 – Airport Blvd., Slater Road, and Emperor Blvd. – are all functionally classified as local roads. While the remaining routes (I-540, U.S. 70, and Aviation Pkwy.) are all interstate highways and principal arterials with greater potential to handle surges in demand, these local roadways cannot. In part, this is evident in the V/C ratios (shown in Figure 97) that result from the disruption scenario. Airport Blvd. has V/C ratios that range from 1.4 – 1.5 over the segments that incurred the largest increase in truck traffic under the disruption scenario. Under baseline conditions its V/C ratio ranged from 1.1 – 1.3. The Slater Road/Emperor Blvd. route exhibits V/C ratios that increased to 0.6 – 1.1 from 0.3 – 0.5 under the baseline. Delays and missed deliveries for trucks that face these conditions are inevitable.

In contrast, the roadways with higher functional classifications realized increases to their V/C ratios that would still allow for a relatively high level of service given that is the evening peak period. For instance, under baseline conditions segments of Aviation Parkway had V/C ratios that ranged from 0 – 1.1. In the disruption scenario these increased to 0.2 – 1.3. V/C ratios on U.S. 70 increased from 0.9 – 1.4 to 1 – 1.45 while I-540 increased from 0.01 – 0.06 to 0.03 – 0.09. Though some of the higher classified roadways have segments at or near capacity-constrained conditions, it is not to the extent of the lower class roadways. In addition, there are likely to be operational issues (namely intersections pushed beyond capacity) on the local roadways not captured in the model that would further degrade the network around RDU.

Table 37: Predominant Routes Affected by RDU Disruption

Decreases in Truck Volumes		Increases in Truck Volumes	
Corridor	**Truck Volume Decrease**	**Corridor**	**Truck Volume Increase**
I-40 (South Miami Blvd. to Airport Pkwy.)	200 – 900	Airport Blvd. (Slater Road to Aviation Pkwy.)	315 – 870
Miami Blvd. (T. W. Alexander Blvd. to I-40)	100 – 180	Slater Road/Emperor Blvd. (I-40 to Airport Blvd.)	510 – 855
I-540 (I-40 to Airport Pkwy.)	115 – 220	Aviation Pkwy. (I-40 to Brier Creek Pkwy.)	105 - 770
SR 147 (Briggs Avenue to I-40)	70 – 170	U.S. 70/Glenwood Ave. (I-540 to Duraleigh Rd./Millbrook Rd.)	135 – 310
I-40 (South Miami Blvd. to Airport Pkwy.)	200 – 900	Airport Blvd. (Slater Road to Aviation Pkwy.)	315 – 870

Source: TFFM; Consultant analysis.

This is a single example, of course, but it indicates the vulnerability of local routes when main corridors fail. While the affected roads in this case are in commercial areas, it is easy to imagine disruptions elsewhere that would push trucks into residential areas, with a concomitant risk to safety. The implication of this is that redundant routes with an appropriate functional class are essential for managing the risk from roadway disruption and should be a basic requirement for the core system of SFC defined in Chapter 8.

Figure 96: Diverted Truck Traffic

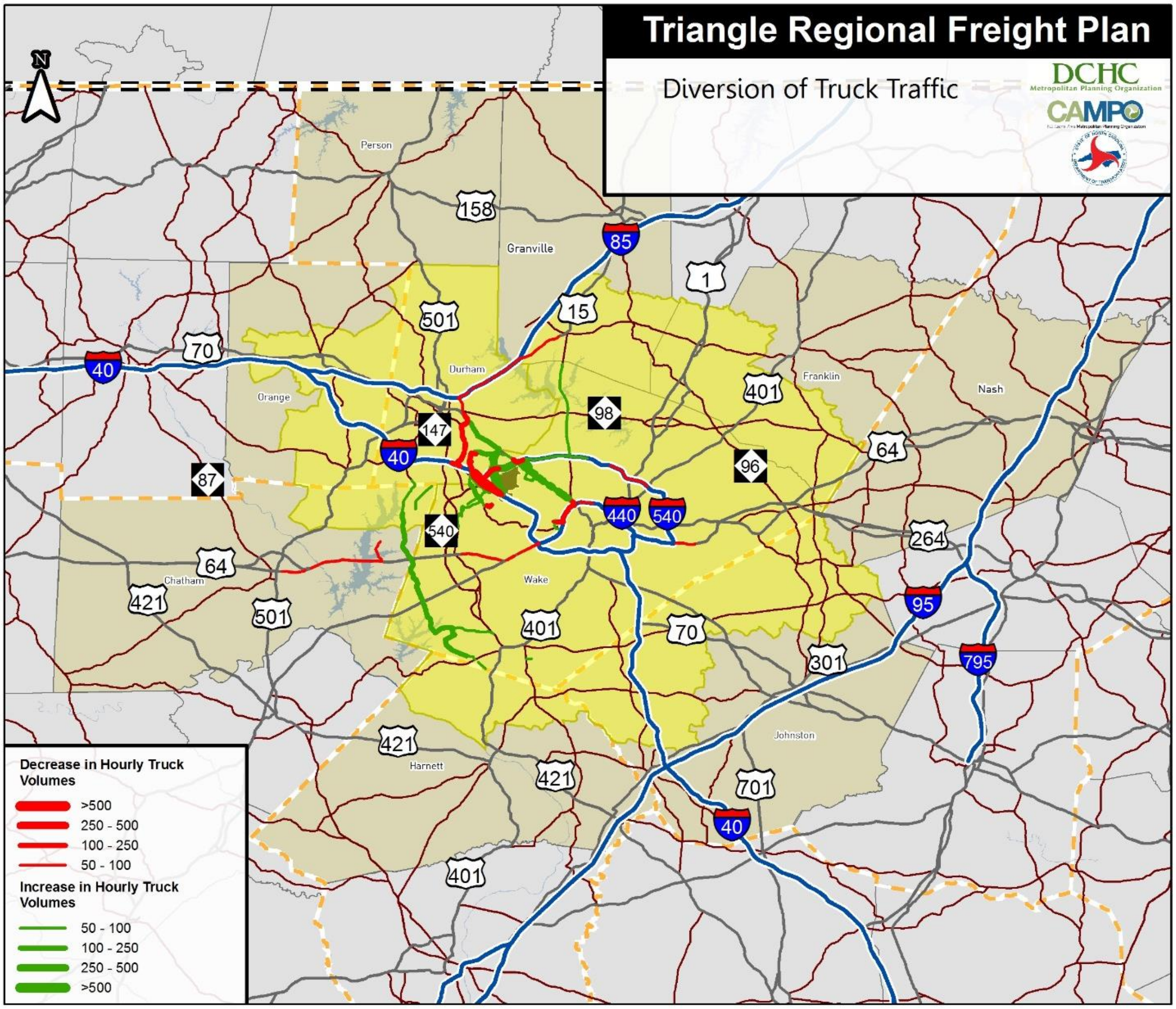
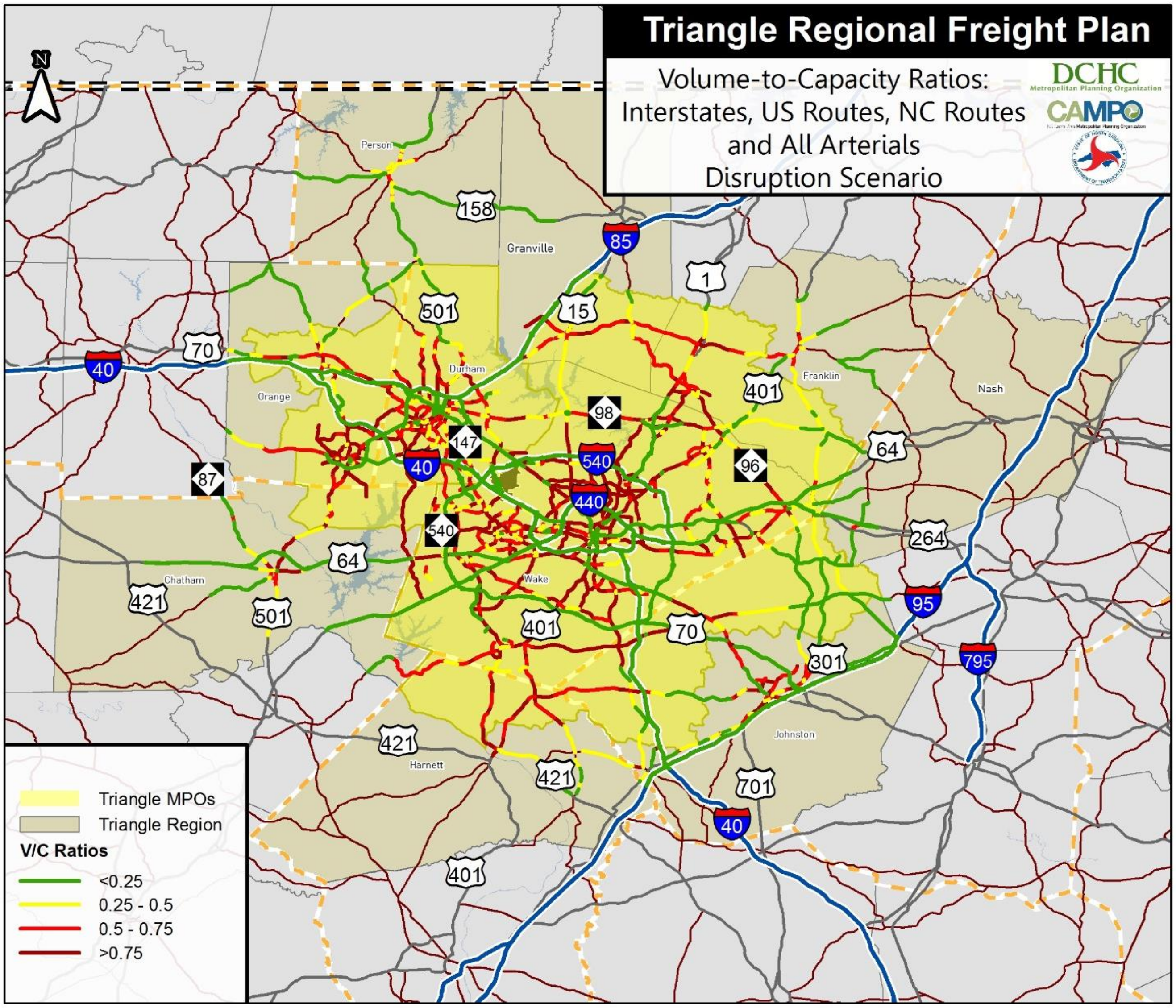


Figure 97: 2040 Volume-to-Capacity Ratios under the Disruption Scenario



Future Conditions for the Rail Freight Network

This section provides an analysis of future freight volumes by rail. In addition, an assessment about the ability of the rail network in the Triangle region to accommodate additional traffic is provided to identify potential bottlenecks. Potential opportunities to divert freight from truck to rail are discussed based on current services and the proposed new terminal in Rocky Mount.

Future Demand

Total freight rail volumes are forecasted to have minimal growth in the Triangle Region over the coming decades; this is chiefly due to the decline in coal, which offsets growth in other areas. As shown in Table 38, total tonnage is expected to remain roughly constant out to 2045, with outbound shipments increasing at 0.54 percent per year and the much larger inbound shipments decreasing at 0.07 percent per year. Shipments by rail within the Triangle Region are insignificant. These growth rates correspond to a decrease in 270,300 tons in inbound shipments and an increase in 241,300 tons in outbound shipments. Changes in tonnages will correlate strongly with train volumes because the productivity of the mode is unlikely to change considerably over the coming decades. It is important to keep in mind that these forecasts do not reflect changes in the competitiveness of rail, and instead are driven entirely by changes in the production and consumption of products that are typically shipped by rail. Capacity constraints and infrastructure investments will have a large impact on rail traffic levels over the coming decades, however, these factors are not included in generating these forecasts.

The value of commodities shipped by rail is expected to increase at a moderate pace of 1.77 percent per year in real terms. Observing increases in value while tons stay constant indicates that the rail commodity mix moved by rail is shifting towards higher value commodities. Overall, value is expected to growth faster for outbound shipments than inbound shipments. Inbound shipments will grow $1.7 billion out to 2045, while outbound shipments will grow $390 million.

Table 38: Rail Forecasts 2012 to 2045

Commodity Group	Inbound	Outbound	Within	Total
Growth Rate Tons 2012 to 2045	-0.07%	0.54%	-1.31%	-0.01%
Incremental Tons (000') 2012 to 2045	-270.3	241.3	-9.5	-38.5
Growth Rate M$ 2012 to 2045	1.64%	2.69%	-1.31%	1.77%
Incremental M$ 2012 to 2045	1,697.00	389.4	-0.2	2,086.30
Growth Rate Tons 2012 to 2045	-0.07%	0.54%	-1.31%	-0.01%

Source: BTS and FHWA, FAF4.1, 2016.

The drivers of the trends observed for rail traffic are shown in Table 39. The tepid growth of total rail shipments is caused by a large decline in coal of almost three million tons per year from 2012 to 2045. These declines are almost overcome by significant increases in shipments of fertilizers, nonmetal min. products, basic chemicals, and alcoholic beverages, among others. These increases are almost all inbound shipments, although it is clear that outbound shipments of fertilizers and other commodities are expected to grow. Coal production and consumption is projected to decrease substantially, and it could decrease even further if additional environmental regulations, such as the Clean Power Plan, are fully implemented and prices of competing sources of energy, particularly natural gas remain low.

Table 39: Increase in Tons from 2012 to 2045 To, From and Within Raleigh-Durham by Rail

Commodity Group	Inbound Tons (000')	Outbound Tons (000')	Within Tons (000')	Total Tons (000')
Fertilizers	677	101		778
Nonmetal min. prods.	396	2		398
Basic chemicals	330	44		374
Alcoholic beverages	354	0		354
Wood prods.	310	28		338
Plastics/rubber	137	5		142
Natural sands	141	0		141
Other Commodities	372	259	0	631
Gravel		-198	-10	-208

Commodity Group	Inbound Tons (000')	Outbound Tons (000')	Within Tons (000')	Total Tons (000')
Coal	-2,987			-2,987
Total Change	**-270**	**241**	**-10**	**-39**

Source: BTS and FHWA, FAF4.1, 2016.

Future Capacity – CSX Intermodal Terminal at Rocky Mount

The forecasts presented above assume that the relative competitiveness of rail as a freight mode remains unchanged. However, there are several significant infrastructure investments planned to improve rail service that are anticipated to open new markets for rail and increase mode share in several commodities. One of the most important of these investments is CSX's plan to develop an intermodal terminal at Rocky Mount, east of the Triangle Region.

CSX's plans for this intermodal terminal to be used as a hub for container train operations in the east "Hubbing" will allow CSX to cost effectively increase container shipments on large parts of its network, permitting more frequent and more competitive service to a broader range of smaller markets around the U.S. (just like airport hubs have led to cost-effectively provide service to smaller markets in air travel). With traditional intermodal service enough demand is required on specific corridors to fill up enough trains per week that an acceptable level of frequency is offered to shippers. Shippers prefer that at least 2 intermodal trains are scheduled per week, which gives them the flexibility to meet their logistic requirements. With a hub, medium-size markets can be served as well as all outbound cargo can be combined into a single train that is heading to the intermodal terminal, providing an acceptable level of service and frequency to shippers

The proposed CSX Carolina Connector intermodal terminal at Rocky Mount (CCX) has the potential to generate specific benefits for the Triangle Region. Shippers will have improved intermodal service and intermodal access to more markets at a lower cost than trucking.

Besides, benefits to shippers, the terminal will benefit the public. An analysis was conducted by NCDOT that estimated the potential demand of the proposed CSX terminal. After four years of ramp-up, the facility is expected to handle 271,500 containers, of which 119,400 are local heading to the area surrounding Raleigh and Greensboro. As shown in Table 40, this will result in substantial decreases of truck miles throughout the U.S. and in North Carolina. However, the roads connecting the connecting the proposed terminal to shippers in Raleigh and Greensboro are expected to see an increase in truck traffic as described in the following section.

Table 40: Forecasted CSX Terminal Volume after 4-Year Ramp-up Period

Type	Units Diverted per year	Net Truck Miles Reduced (millions)	Net Truck Miles Reduced in NC (millions)	% of Truck Miles Diverted in NC
Raleigh + Greensboro	119,443	94.73	2.73	2.9%
Pass-through	152,103	99.22	13.18	13.3%
Total	**271,547**	**193.95**	**15.91**	**8.2%**

Source: NCDOT, 2016, Evaluation of a Proposed Intermodal Terminal (CCX) in Rocky Mount

Access Roads

The proposed CSX intermodal facility will be located across U.S.-301 adjacent to the North Carolina Wesleyan College in Rocky Mount. Even though the facility will operate as a hub for containers moving by rail throughout the U.S., a significant portion of cargo at this facility will have local origins or destinations. It is estimated that in 2035 a total of around 660 truck trips will involve the facility each day, half inbound and half outbound. It is estimated that 35 percent of inbound trucks will be empty and 30 percent of outbound truck will leave empty.

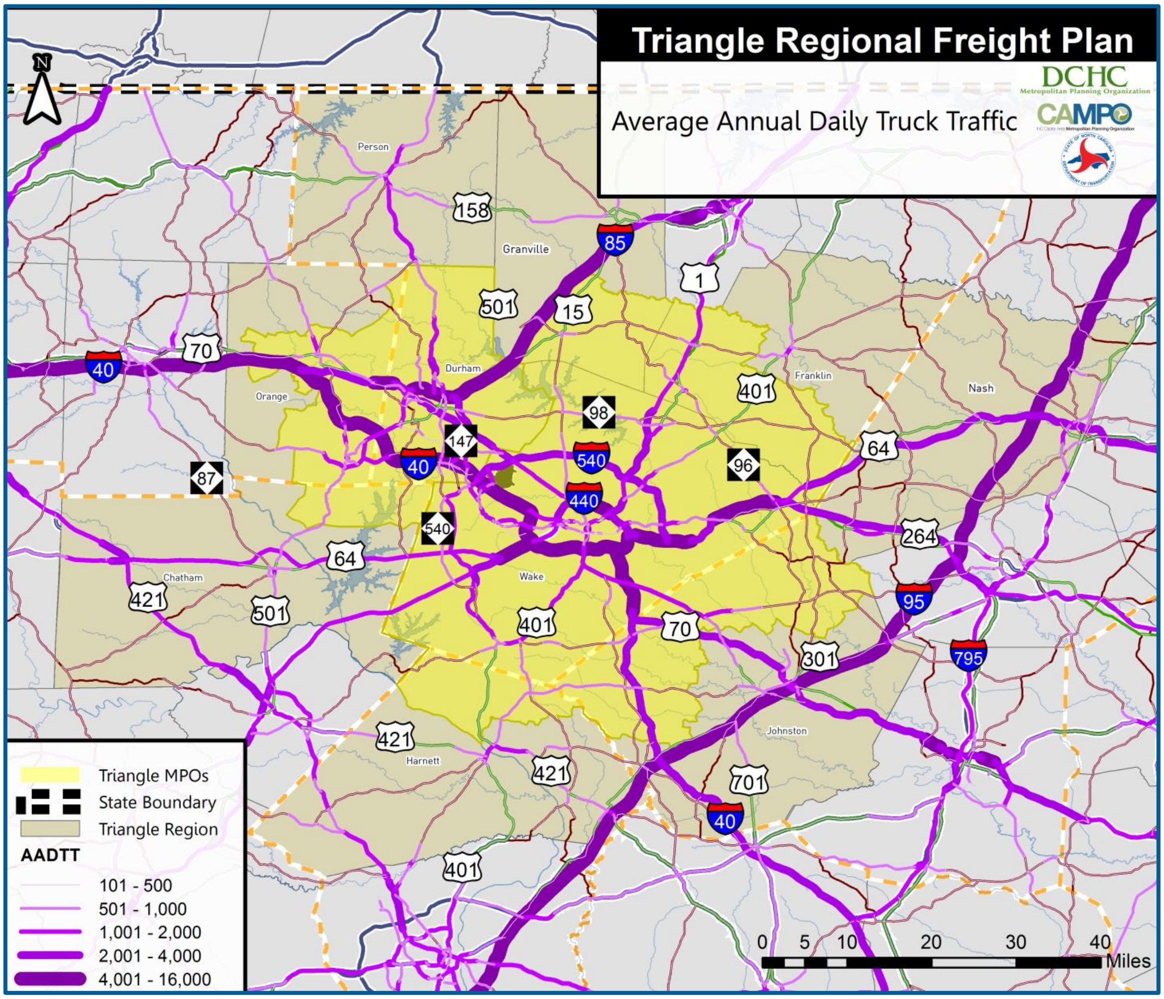
The roads that will be used by these trucks depend on their exact origins or destinations within the region, but based on the orientation of the facility the study found several roads in the neighborhood of the I-95/U.S. 64 interchange will carry most of this truck volume.

Truck routes between the Triangle Region and the proposed facility will likely include a combination of U.S. 64, I-95, and/or U.S. 264. The projected increase in truck volumes is likely to be insignificant on I-95, which carries thousands of trucks each day as seen in Figure 98. However, U.S. 64 and U.S. 264 currently carry much fewer trucks. The incremental truck traffic from the proposed facility could increase congestion on these roads or might even warrant improvements to intersections or the roadway geometry to better accommodate higher truck traffic.

A preliminary evaluation conducted by NCDOT found that additional investments along these and other roads would be warranted, although a detailed engineering analysis is needed to know the parameters of these needed investments. The following would be considered when evaluating the capacity of U.S. 64 and U.S. 264 over the coming decades:

- Generation of 670 trucks per day, most of which head between the proposed facility and the Triangle Region or Greensboro (driving through the Triangle Region) through U.S. 64 and U.S. 264.
- Generated truck trips are expected to increase at 2.6 percent per year over the coming decades.
- A significant proportion of employees at the proposed CSX facility will live in or near the Triangle Region and will therefore use U.S. 64 and U.S. 264 to commute each day.
- The proposed intermodal terminal is expected to lead to adjacent economic development opportunities. These have been estimated to generate up to 4,000 additional jobs from businesses opening facilities near the intermodal terminal. This will likely generate additional truck and passenger vehicle traffic in the surrounding area, particularly on U.S. 64 and U.S. 264 as it is the main route to reach the Triangle Region.

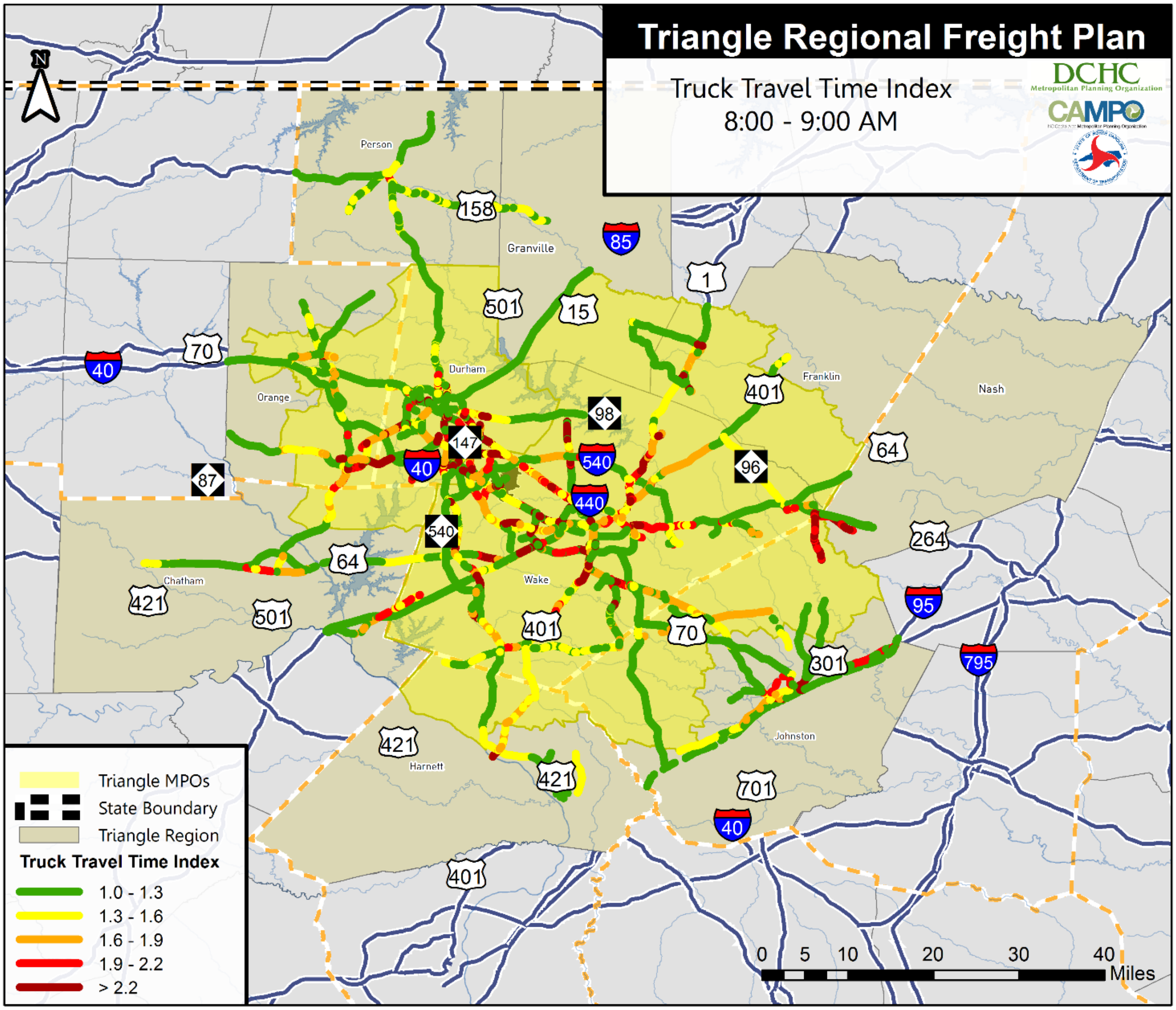
Figure 98: Average Annual Daily Truck Traffic, 2014



Source: NCDOT.

As can be seen in Figure 99 the levels of congestion on U.S. 64 and U.S. 264 are low compared to other roads in the region. The travel time analysis was also conducted for other periods of the day where a similar result was observed. On U.S. 264 there appears to be unreliable travel times approaching the Triangle Region. The analysis did not show significant unreliability on U.S. 64, although only part of this road shows up in the analysis.

Figure 99: Truck Travel Time Index, April 2015 (8:00 – 9:00 AM)



Source: NPMRDS; Consultant analysis.

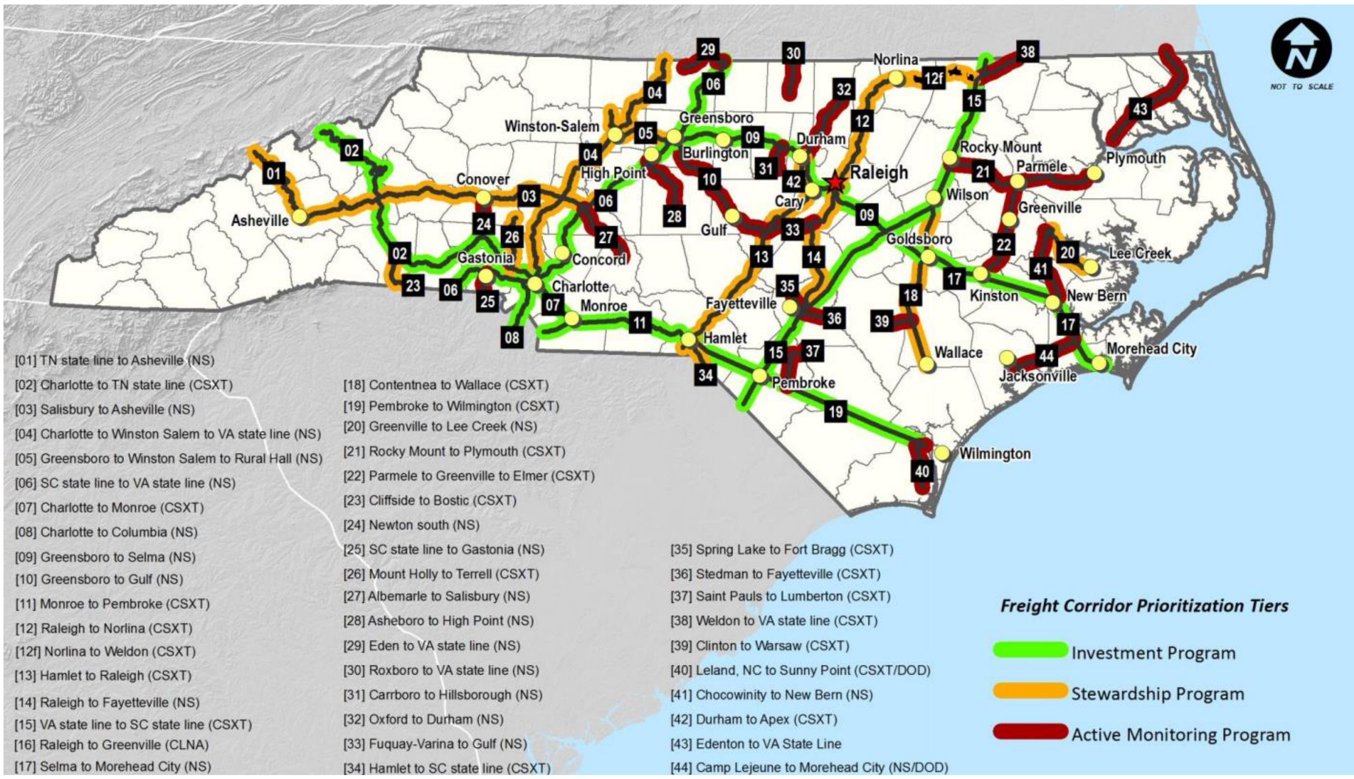
Future Capacity – Other Rail Projects

In addition to the high-profile CSX intermodal project, the North Carolina Comprehensive State Rail Plan[18] described several other projects that could improve considerably rail operations in the Region. The Plan also prioritized rail corridors as shown in Figure 100. The corridors with the highest relative ranking were included in the 'Investment Program', corridors with medium relative ranking were included in the 'Stewardship Program', and corridors with the lowest relative ranking were included in the 'Active Monitoring Program'. This approach was defined to identify investments that would have the greatest positive impact on rail operations and offer the high returns. In Figure 100, it can be seen that corridor 9 from Greensboro to Selma, owned by NS, has been designated as part of the

[18] https://connect.ncdot.gov/resources/RailPoliciesDocument/2015%20Comprehensive%20State%20Rail%20Plan-%20Full%20Report.pdf

Investment Program. Also, the CSX mainline east of Raleigh through Rocky Mount, termed corridor 15, has also been designated as part of the Investment Program. Corridors 12 (CSX), 13 (CSX), and 14 (NS) leading into and out of Raleigh have been categorized as part of the Stewardship Program. Table 41 lists the proposed projects from the Comprehensive State Rail Plan in the vicinity of the Triangle Region.

Figure 100: North Carolina's Prioritized Freight Rail Corridors



Source: NCDOT North Carolina Comprehensive State Rail Plan, 2015

Table 41: Proposed Rail Projects in and around Triangle Region

Corridor	Priority	Projects
Corridor 09 – Greensboro to Selma	Investment	Replace existing grade separation along the NCRR and Mainline at Aycock Street, in Greensboro, Guilford County, to improve safety. Grade separate Ellis Road (735236Y) in Durham, Durham County, to improve safety. Grade separation at Ward Road crossing (722962H) in Greensboro, Guilford County and close Maxfield Road (722964W) to improve safety. Grade separate Franklin Boulevard crossing (722959A) in Greensboro, Guilford County and close O'Ferrell Street (722961B) to improve safety. Grade separate Wagoner Bend Rd crossing (722966K) in Greensboro, Guilford County and close Buchanan Church Rd (722965D) to

Corridor	Priority	Projects
		improve safety. Grade separate Walker Street in Cary, Wake County, to improve safety. Grade separate Harrison Avenue crossing (734755X) in Cary, Wake County, to improve safety and mobility. Grade separate South West Street in Raleigh, Wake County and close West Cabarrus Street (735488A) to improve safety and mobility. Extend East Durham siding in Durham, Durham County, to improve safety and mobility. Includes a combination of grade separations and closure at three crossings: Ellis Road - south end (734737A), Glover Road (734735L), and Wrenn Road (734736T). Evaluate the development of an intermodal facility to serve the Triangle Region and eastern North Carolina either along Corridor 09, 15, or 17.
Corridor 15 - SC state line to VA state line	Investment	Evaluate the development of an intermodal facility to serve the Triangle Region and eastern North Carolina either along Corridor 09, 15, or 17. In partnership with CSX, evaluate capacity improvements to Corridor 15 (A Line) that would increase freight capacity and efficiencies and help address interoperability issues with passenger services. Evaluate the feasibility of returning service to SA Line (Corridor 12f) between Norlina and Roanoke Rapids. Would provide a connection between Corridors 12 and 15.
Corridor 12 - Raleigh to Norlina	Stewardship	Grade separate Rogers Road Extension crossing (633905Y) in Wake Forest, Wake County, to increase safety and use for future passenger rail service. Grade separate Northside Loop (Harris Road) in Wake Forest, Wake County, and close Brick St. crossing (630582V).
Corridor 13 - Hamlet to Raleigh	Stewardship	Construction of an approximately 40 acre automotive terminal facility in close proximity to the Piedmont area of North Carolina to handle 60 railcars and 2,000 vehicles. Grade separate Apex Peakway at South Salem Street in Apex, Wake County, and close Tingen Rd crossing (630696H) to provide connectivity and increase safety. Grade separate Walker Street in Cary, Wake County, to improve safety. Monitor shale gas exploration and potential infrastructure needs in the

Corridor	Priority	Projects
		Piedmont region to support the developing market and associated transportation needs.
Corridor 14 - Raleigh to Fayetteville	Stewardship	Monitor shale gas exploration and potential project needs in the Piedmont region to support the developing market and associated transportation needs.

Source: NCDOT North Carolina Comprehensive State Rail Plan, 2015

Growth Recommendations

While rail volumes are not forecasted to grow over the coming decades, the demands placed on the rail network will undoubtedly change. The rail network will be increasingly used to ship commodities that are more time sensitive, as opposed to bulk shipments such as coal. Coal tends to be shipped by slower unit trains providing a steady stream of coal feeds power plants Reliability is important for these shipments, albeit potentially less than for other types of industries. A shift away from these types of trains to intermodal trains or merchandize trains means that a higher priority will be placed on network reliability and speeds. Moreover, the construction of the CSX intermodal hub in Rocky Mount will further increase dramatically the proportion of intermodal shipments through this part of the network, and place an even higher burden on speeds and travel time reliability.

Because of these changes in rail operations and service requirements, investments will be needed. The expectation is that railroads will make greater use of public private partnerships to improve the reliability and speeds of the rail network and entice diversion from trucking. Rail investment benefits the public as because it removes trucks from congested toads, reduces air pollution, and even reduce costs for shippers.

In response to declines in coal, railroads are changing their operations to increase the productivity of their assets. One of the main strategies implemented by CSX in particular is to increase the size of trains and decommission locomotives. Operating these longer trains will reduce the costs of moving freight by rail, but in many parts of the network this will require making investments to increase siding lengths. This could represent important investment opportunities in North Carolina.

Future Conditions for Air Cargo

The Raleigh-Durham International Airport (RDU) is the primary airport in the Triangle Region with both passenger and freight operations, and is the third-busiest airport in North Carolina in terms of cargo volumes. RDU has two designated areas for air cargo operations totaling over 672,000 SF of cargo space. The North Cargo facilities house RDU’s two all-cargo carriers, FedEx and UPS, who carry most of the domestic cargo. The South Cargo facilities are located near Aviation Pkwy, and are reserved for cargo shipped via commercial airlines, which chiefly carry international cargo via direct flights or connections. Although there is no direct rail connection to either CSX or NS at RDU, both rail lines pass through Raleigh and near to RDU. The following sections will highlight findings for future demand and capacity at RDU.

Future Demand

Air cargo projections at RDU have been developed by the airport and approved by the FAA. Total air cargo volumes and all-cargo operations statistics for 2015, 2035, and 2045 are shown in Table 42. Overall, total cargo volumes are expected to increase 18 percent (0.8 percent annually) from nearly 85,000 tons to over 100,000 tons by 2035. All cargo operations, which are flights that carry only cargo without any passengers onboard, are also expected to increase between the same period, a 15 percent increase from nearly 4,400 to over 5,000 flights (0.7 percent annually). By 2045, total cargo volumes are expected to grow to nearly 110,000 tons (29 percent increase from 2015), and all cargo operations to nearly 5,500 flights (25 percent increase from 2015).

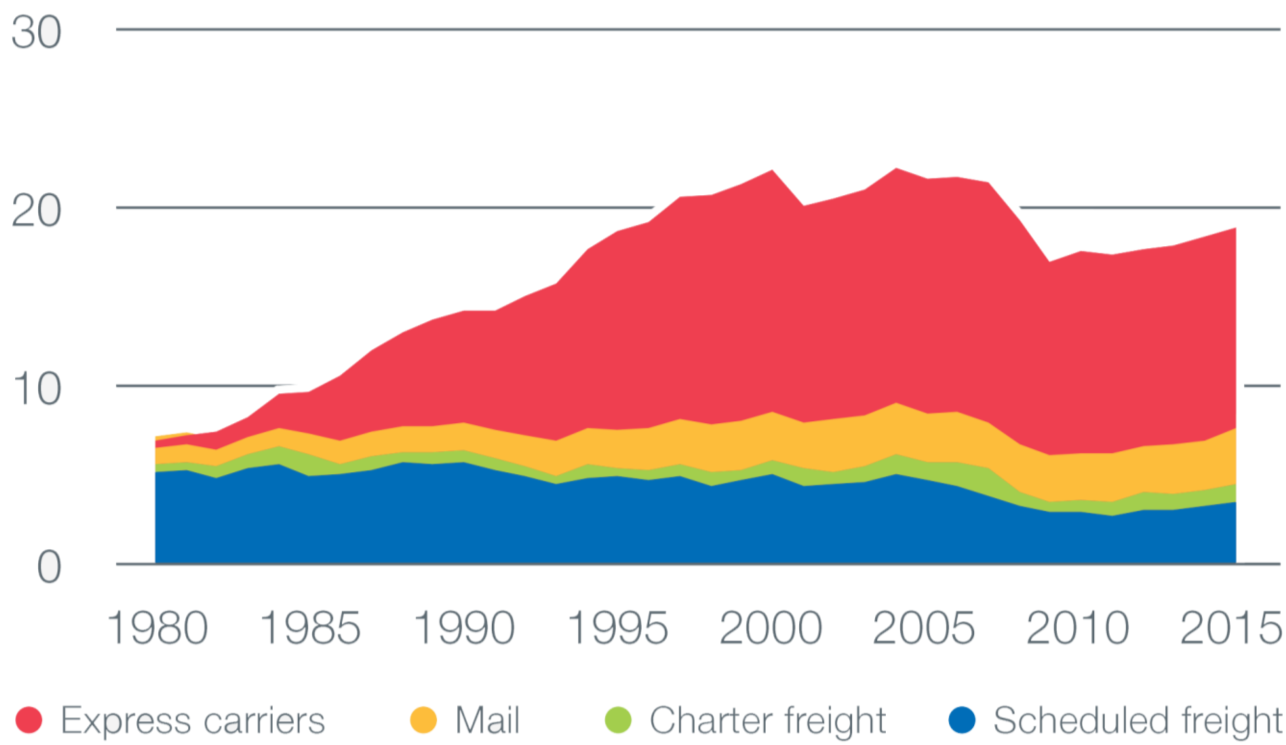
Table 42: Projected Air Cargo Activity at Raleigh-Durham International, 2015-2035 and 2015-2045

Air Cargo Activity	2015	2035	2045	Total Growth (2015-2035)	Annual Growth (2015-2035)	Total Growth (2015-2045)	Annual Growth (2015-2045)
Total Cargo Volumes (tons)	84,680	100,253	109,586	18%	0.8%	29%	0.9%
All Cargo Operations	4,376	5,049	5,466	15%	0.7%	25%	0.7%

Source: Raleigh-Durham Airport Authority, September 2015; Ricondo & Associates, Inc., September 2015 (Forecast)

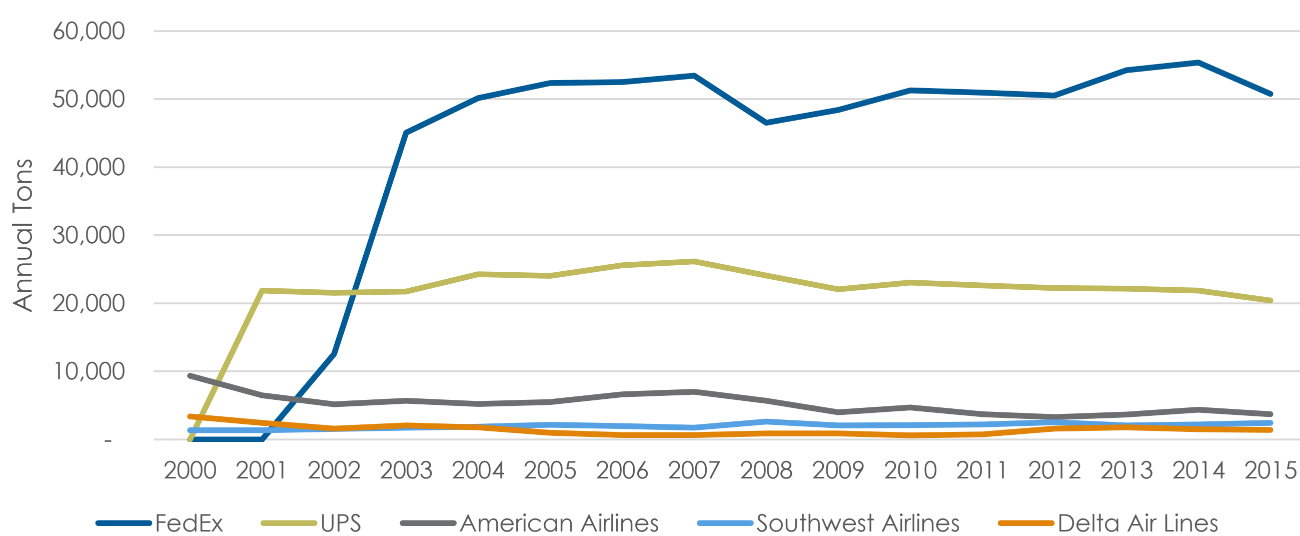
These projections are consistent with national air cargo trends. Since the September 11th terror attacks in 2001, the airline industry has undergone a dramatic transformation. It has consolidated, restructured, and changed fleet in light of a difficult economic climate and strict cargo regulations administered by FAA and Transportation Security Administration (TSA). Overall, air cargo carriers are experiencing price competition from other freight modes such as trucks, container ships, and railroads, while demand for all-cargo carrier express services (i.e. UPS and FedEx) has exploded in recent years as consumers increasingly purchase their goods online. Figure 101 presents the breakdown in domestic U.S. air cargo service from 1979 to 2015, with express carrier service comprising the largest share of revenue ton-kilometers (RTK) since the mid-90s. At RDU, FedEx and UPS have consistently been the top air cargo carriers since 2001-2002 and belly cargo has remained relatively flat in the last decade, as shown in Figure 102. As a result of all of the aforementioned market shifts, air cargo activity forecasts have been conservative for many airports across the nation.

Figure 101: U.S. Air Cargo Service, in Revenue Ton-Kilometers (billions), 1979-2015



Source: Boeing World Air Cargo Forecast, 2014-2015.

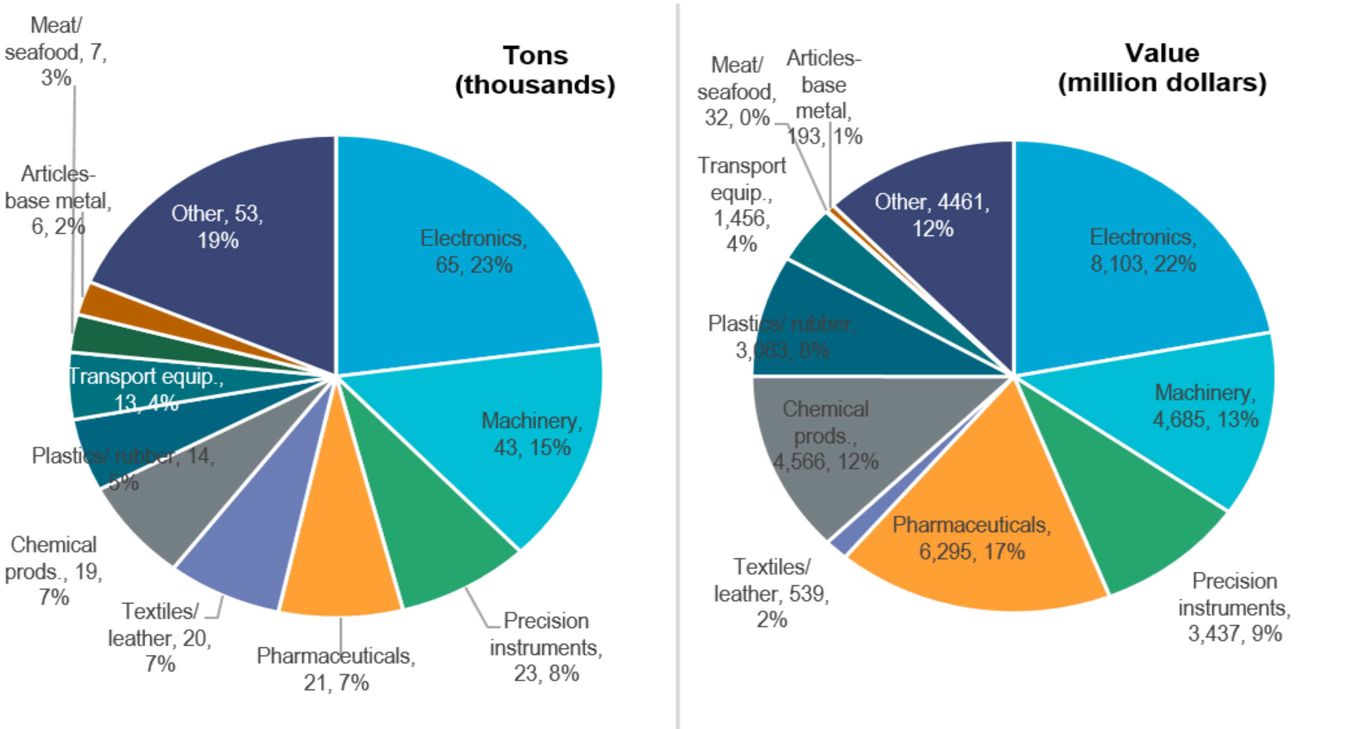
Figure 102: Top 5 Carriers at Raleigh-Durham International, in Tons, 2000-2015



Source: BTS TranStats Database, T-100 Market (All Carriers), 2000-2015

Air freight tends to receive the highest proportion of high-value, low-weight commodities compared to surface transportation modes. At RDU, the projected top commodities by weight are electronics and machinery, which are expected comprise 38 percent of total tonnage by 2045, as shown in Figure 103. When considering the value of air commodities, electronics and pharmaceuticals emerge as the top goods. Combined with machinery, these three commodities are expected to comprise 52 percent of total value by 2045.

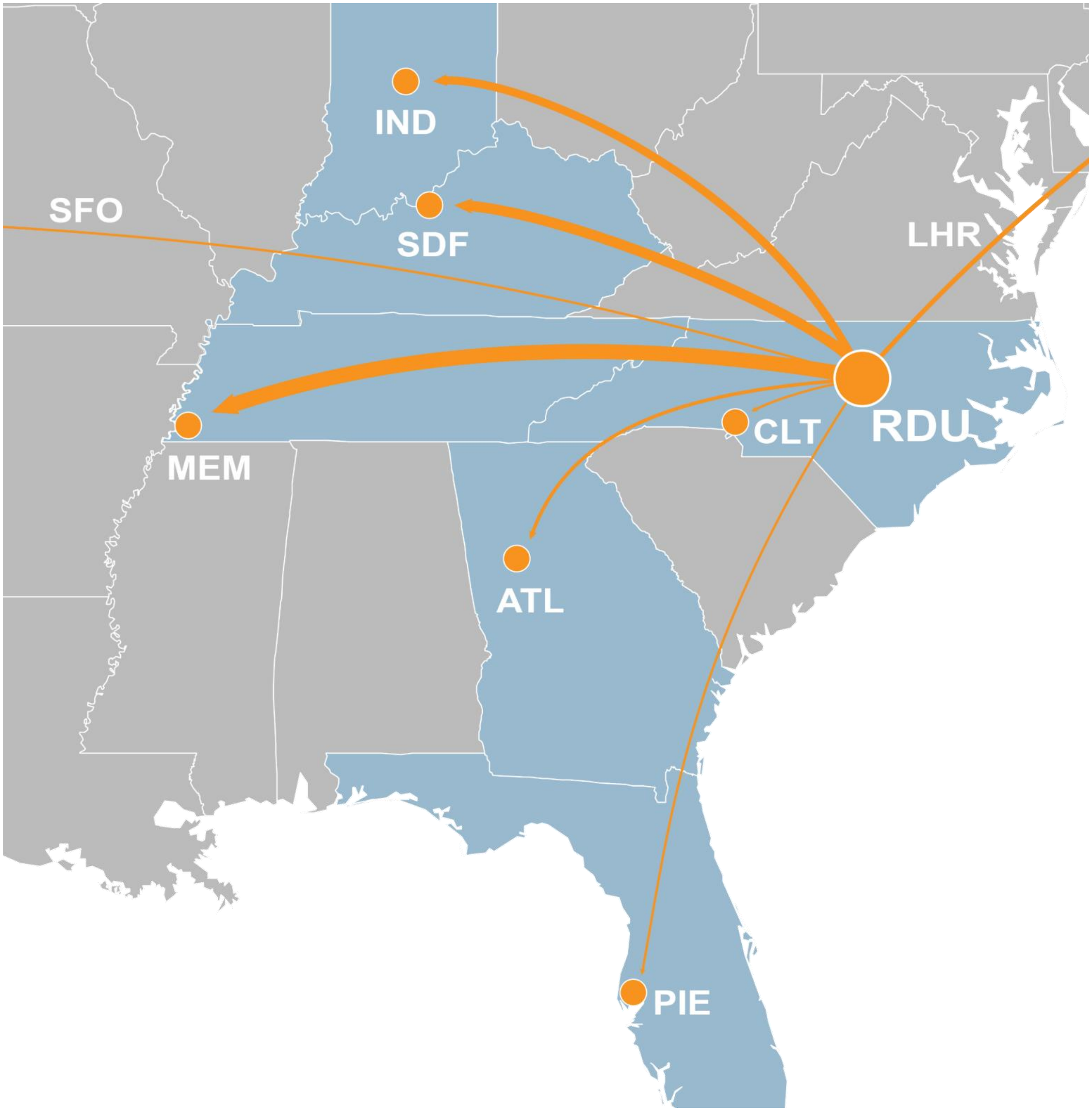
Figure 103: Projected Top 10 Commodities at Raleigh-Durham International, by Tons and Value, 2045



Source: FHWA FAF4, processed by Cambridge Systematics.

RDU is expected to exchange air cargo with primarily domestic airports, specifically Memphis International, Louisville International, and Indianapolis International, which is expected to comprise 45 percent of air cargo trade in 2035 and 2045. Louisville is the main U.S. hub for UPS; Memphis and Indianapolis are FedEx hubs. Figure 104 illustrates the total tonnage at RDU's top trade partners for both forecast years. London Heathrow is the only top airport based internationally, although there are also routes to Paris via Delta and Cancun (seasonal) for belly freight.

Figure 104: Projected Top Trade Partners at Raleigh-Durham International, 2035 and 2045



Source: BTS TranStats Database, T-100 Market (All Carriers), 2015; Forecast developed using Boeing World Air Cargo Forecast (2014-2015).

Future Capacity

Both UPS and FedEx are situated on airport-owned cargo facilities at RDU, and have separate access routes north of RDU's campus. DHL also has a facility near to RDU, but typically transports freight by truck to Charlotte-Douglas International Airport for air transport.

Currently, there are no plans to expand capacity at RDU. However, in 2014, the Raleigh-Durham Airport Authority along with the Urban Land Institute (ULI) reviewed the airport's physical assets and developed a set of recommendations that would benefit the greater region.[19] The report identified several opportunities for cargo expansion on-site, including setting aside 50 acres for the development of cargo operations in the northeast part of RDU's campus, which would include refrigerated space and other amenities. The report also suggested that RDU increase efforts to expand international cargo operations, specifically for furniture and pork products, both of which are major products manufactured in North Carolina.

Based on stakeholder interviews and outreach, there do not appear to be any concerns with future conditions at RDU. The current air cargo volumes, coupled with relatively low projected growth, suggest that RDU has sufficient cargo processing space and is adept at managing air cargo operations alongside passenger operations.

Growth Recommendations

Conservative growth projections and sufficient capacity at RDU suggest that its infrastructure is sufficient through forecast year 2045. However, RDU can focus on growing current volumes with increased international traffic and expanding the types of commodities processed and transported through RDU facilities.

RDU is home to Foreign Trade Zone (FTZ) #93, which is designated port of entry free of customs or taxes/duties. FTZ 93 includes Chatham, Durham, Johnston, Lee, Moore, Orange and Wake Counties, in addition to seven counties surrounding the Triangle Region.[20] The primary goal of FTZs is to increase international trade throughout the region; shipments entering the FTZ at RDU can be stored, processed, sorted, manufactured, and re-exported without payment of duty. The wide geographic coverage of FTZ #93 allows for many opportunities for warehouses, DCs, and other manufacturing sites to receive and transport goods from international locations. There are currently several notable freight-intensive companies operating in FTZ #93 in varying industries, including those at World Trade Park (operated by Longistics International), Holly Springs Business Park (featuring Novartis Vaccines), Imperial Center Business Park (featuring Glaxo Smith Kline, Quintiles, and MetLife), Merck Sharp & Dohme Corporation (pharmaceuticals manufacturing and distribution), Revlon (cosmetics and beauty products manufacturing), and Cormetech (energy/utilities), among others. However, there is room to continue recruiting companies to FTZ #93 to take advantage of the proximity to RDU and global markets.

Future Conditions for Ports

Future Demand

As described previously, the Triangle Region is served by multiple ports along the East Coast, and even West Coast. West Coast ports are used primarily for imports from Asia and East Coast ports for imports from Europe. Exports from the Triangle Region are also sent abroad through these ports.

The economic dynamics of trade point towards imports and exports playing a greater and greater role over time in the Triangle Region. The FAF4.2 was used to forecast Triangle Region imports and exports handled at U.S. ports. For international shipments, this data set indicates the gateway city of international moves and the mode used to reach the U.S. Therefore, by selecting international moves that arrive or leave by water it is possible to isolate the ports that serve the Triangle Region.

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[19] An Urban Land Institute (ULI) Advisory Services Panel Report. http://connect.rdu.com/wp-content/uploads/2015/01/ULIfinal.pdf

[20] http://www.tjcog.org/foreign-trade-zone-93.aspx

These results are presented in Table 43. Note that the FAF analysis zone 'Raleigh-Durham' differs slightly from the boundaries of the Triangle Region. However, the differences are small, leading the trends and findings found from FAF to be representative of the Triangle Region. Throughout this report both terms are used interchangeably.

Over the coming decades both imports and exports are expected to grow in tons at a combined growth rate of 3.9 percent per year. This is significantly faster than the growth expected for other types of shipments. From 2012 to 2045, this fast growth rate will generate 2.4 million additional tons per year heading to the Triangle Region entering through ports, and 1.4 million additional tons per year existing through ports for exports. The value of cargo is expected to grow at an even faster pace, of 4.9 percent per year.

Table 43: Forecasts of Marine International Shipments To/From the Triangle Region, 2012 to 2045

Commodity Group	Inbound	Outbound	Total
Growth Rate Tons 2012 to 2045	3.81%	3.90%	3.86%
Incremental Tons (000') 2012 to 2045	2,378.0	1,393.0	3,771.0
Growth Rate M$ 2012 to 2045	4.57%	5.28%	4.93%
Incremental M$ 2012 to 2045	14,003.6	7,759.7	21,763.3

Source: BTS and FHWA, FAF4.2, 2016.

The commodities that will be driving these fast increases in exports and imports through ports are textiles/leather, other agricultural products, basic chemicals, machinery, pharmaceuticals, electronics, and chemical products (as shown in Table 44). Note that these commodities are ranked by increasing tonnage, which makes it even more impressive that commodity groups such as pharmaceuticals and electronics show up given their low weight to value ratios. Most of these commodities are expected to grow faster for inbound shipments than outbound shipments, with the exception of other agricultural products.

Table 44: Change in Marine International Tons To/From the Triangle Region, 2012 to 2045

Commodity Group	Inbound	Outbound	Total
Textiles/leather	236	174	410
Other ag prods.	191	194	385
Basic chemicals	271	77	348
Machinery	234	102	336
Pharmaceuticals	205	119	324
Electronics	191	30	221
Chemical prods.	119	76	195
Plastics/rubber	161	18	179
Wood prods.	48	93	141
Furniture	131	6	137
Precision instruments	85	36	121
Waste/scrap	-3	117	114

Commodity Group	Inbound	Outbound	Total
Other Commodities	518	365	883
Fertilizers	-4	3	-1
Tobacco prods.	0	-3	-3
Gasoline	-5	0	-5
Coal		-14	-14
Total	**2,378**	**1,393**	**3,771**

Source: BTS and FHWA, FAF4.2, 2016.

As Table 45 illustrates, most of the growth in imports will come through ports in Norfolk, VA. The weight of maritime shipments entering Norfolk for the Triangle Region will quadruple out to 2045, increasing by 781,000 tons. Similar rates of growth are predicted for shipments handled through Savannah, Charleston, New York, `and Miami. At the same time, the forecast predicts that Baltimore and Philadelphia will see substantially smaller growth for import commodities. The second largest increase in tonnage, however, goes to ports in the 'Rem of North Carolina' zone, which includes mostly Wilmington and Morehead City.

Table 45: Forecasts for Ports Handling Triangle Region Imports

Gateway Ports	Tons 2012 (000')	Tons 2045 (000')	Incremental Tons (000') 2012 to 2045	Growth Rate Tons 2012 to 2045
Norfolk	234	1,014	781	4.6%
Rem. of North Carolina	193	530	337	3.1%
Savannah	113	428	315	4.1%
Baltimore	109	168	59	1.3%
Philadelphia	83	98	16	0.5%
Other	70	281	211	4.3%
Charleston	68	315	247	4.8%
Miami	43	262	218	5.6%
Los Angeles	40	158	118	4.3%
New York	22	99	76	4.6%
Total	**976**	**3,354**	**2,378**	**3.8%**

Source: BTS and FHWA, FAF4.2, 2016.

Table 46 shows the ports that are handling marine exports from the Triangle Region. Norfolk is forecasted to see a substantial increase, in tonnage, just like with imports. Savannah and Charleston are also ports that will see increases of over 100,000 tons by 2045. The fastest growth rate, however, goes to ports in the 'Remainder of North Carolina' zone. These are expected to grow at an average rate of 5.5 percent per year.

Table 46: Forecasts for Ports Handling Triangle Region Exports

Gateway Ports	Tons 2012 (000')	Tons 2045 (000')	Incremental Tons (000') 2012 to 2045	Growth Rate Tons 2012 to 2045
Norfolk	267.2	884	617	3.7%

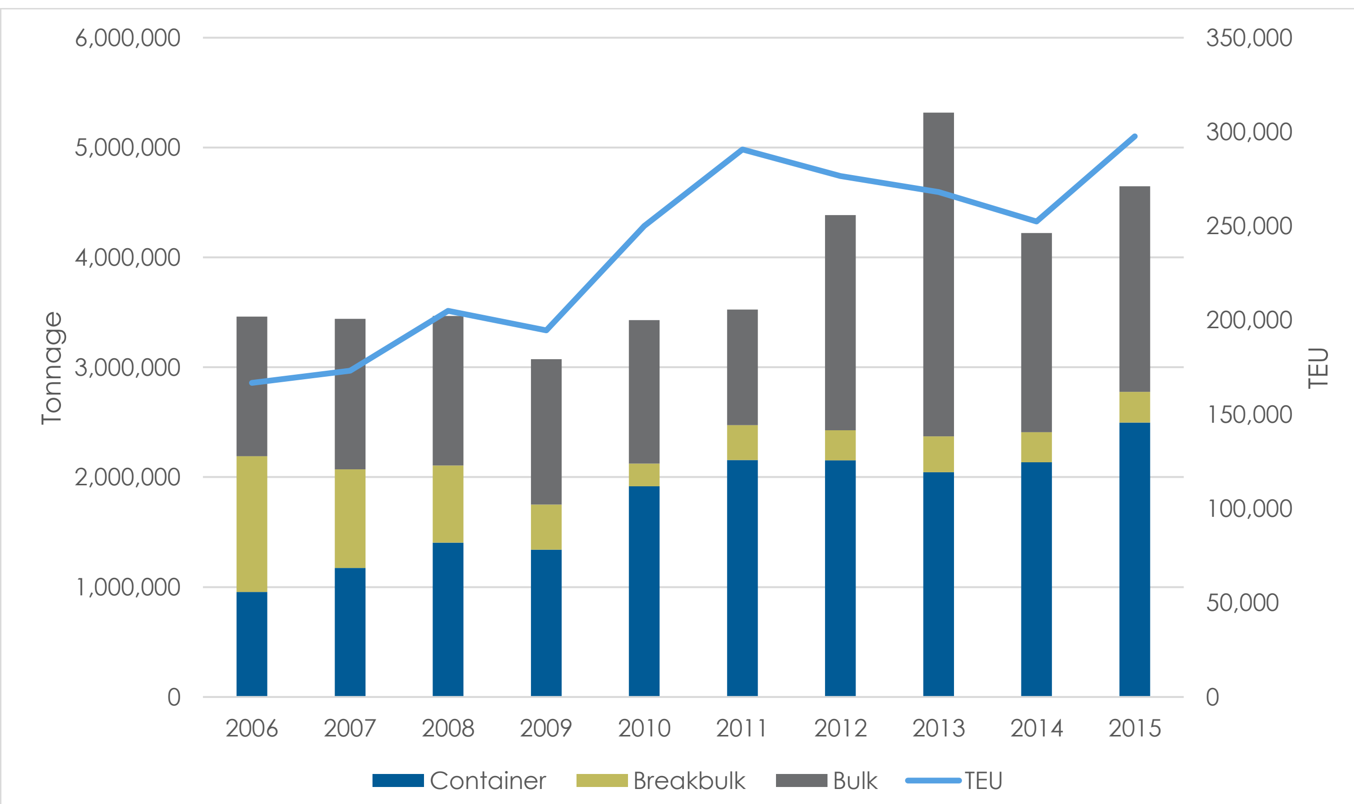
Gateway Ports	Tons 2012 (000')	Tons 2045 (000')	Incremental Tons (000') 2012 to 2045	Growth Rate Tons 2012 to 2045
Savannah	72.8	233	160	3.6%
Rem. of North Carolina	66	385	319	5.5%
Miami	45	129	84	3.2%
Other	34.4	63	29	1.9%
Charleston	32.6	177	144	5.3%
Baltimore	18.3	21	3	0.4%
New York	11.7	36	25	3.5%
Los Angeles	1.7	10	8	5.5%
Philadelphia	0.2	4	4	9.3%
Total	**550**	**1,943**	**1,393**	**3.9%**

Source: BTS and FHWA, FAF4.2, 2016.

Future Capacity

The tonnages moved by the Port of Wilmington are shown in Figure 105. Container operations accounts for 53.7 percent of all tonnages in 2015, with bulk cargo accounting for 40.2 percent. As shown in this table, tonnages at the port have increased quickly since 2006, averaging a rate of 3 percent per year. Most of this growth has been concentrated in container cargo, which grew at an average rate of over 10 percent per year over that time period.

Figure 105: Port of Wilmington Cargo Tonnages

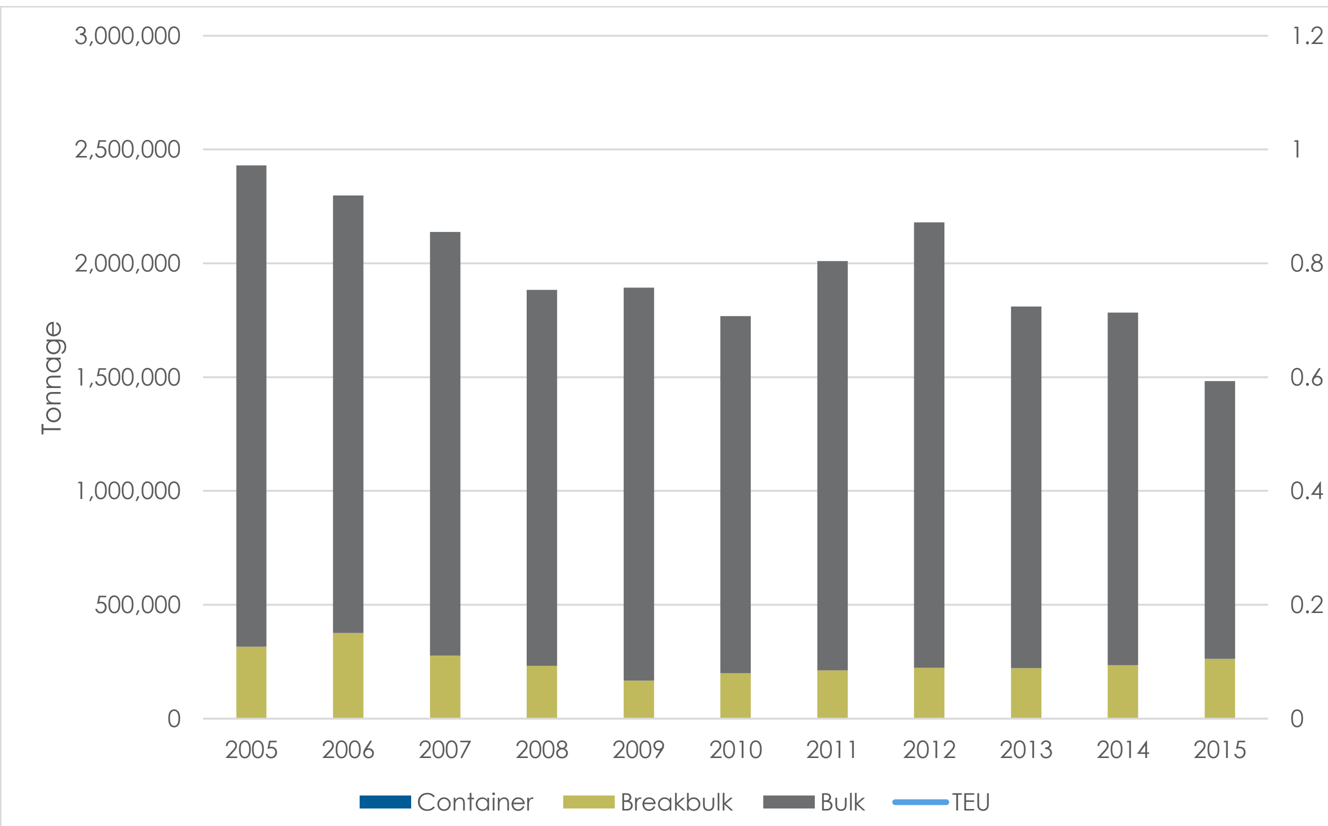


Source: NCDOT Port Statistics 2015

The containers handled at the Port have increased from 166,600 Twenty-foot Equivalent Units (TEUs) in 2006 to 297,612 TEUs in 2015. The 2015 Strategic Plan for the North Carolina State Port Authority[21] indicated the objective to increase this volume of containers to 530,000 TEUs by 2020. The Port is currently evaluating different investments to increase its capacity to handle containers, and take advantage of the CSX rail connection it currently has. It is also making in investments to widen and deepen navigable channels in order to accommodate larger ships[22]. These investments would benefit from the construction of the proposed CSX Intermodal Facility in Rocky Mount, which could serve as a hub to serve markets around the U.S. Therefore, looking into the future it is likely that bulk, breakbulk, and container cargo will increase at Wilmington, and much of this traffic will have origins and destinations in the Triangle Region.

The port of Morehead City handles the second largest tonnages in North Carolina as can be seen in Figure 106, however it currently does not handle any container traffic. Tonnages at this port appear to be decreasing over the last decade, leading there to not be capacity issues at this port.

Figure 106: Port of Morehead City Cargo Tonnages



Source: NCDOT Port Statistics 2015

21 http://savethecape.org/stcwp1/wp-content/uploads/PDFs/2015%20Strategic%20Plan.pdf

22 http://www.starnewsonline.com/news/20160808/port-of-wilmingtons-turning-basin-project-wraps-up

Access Roads

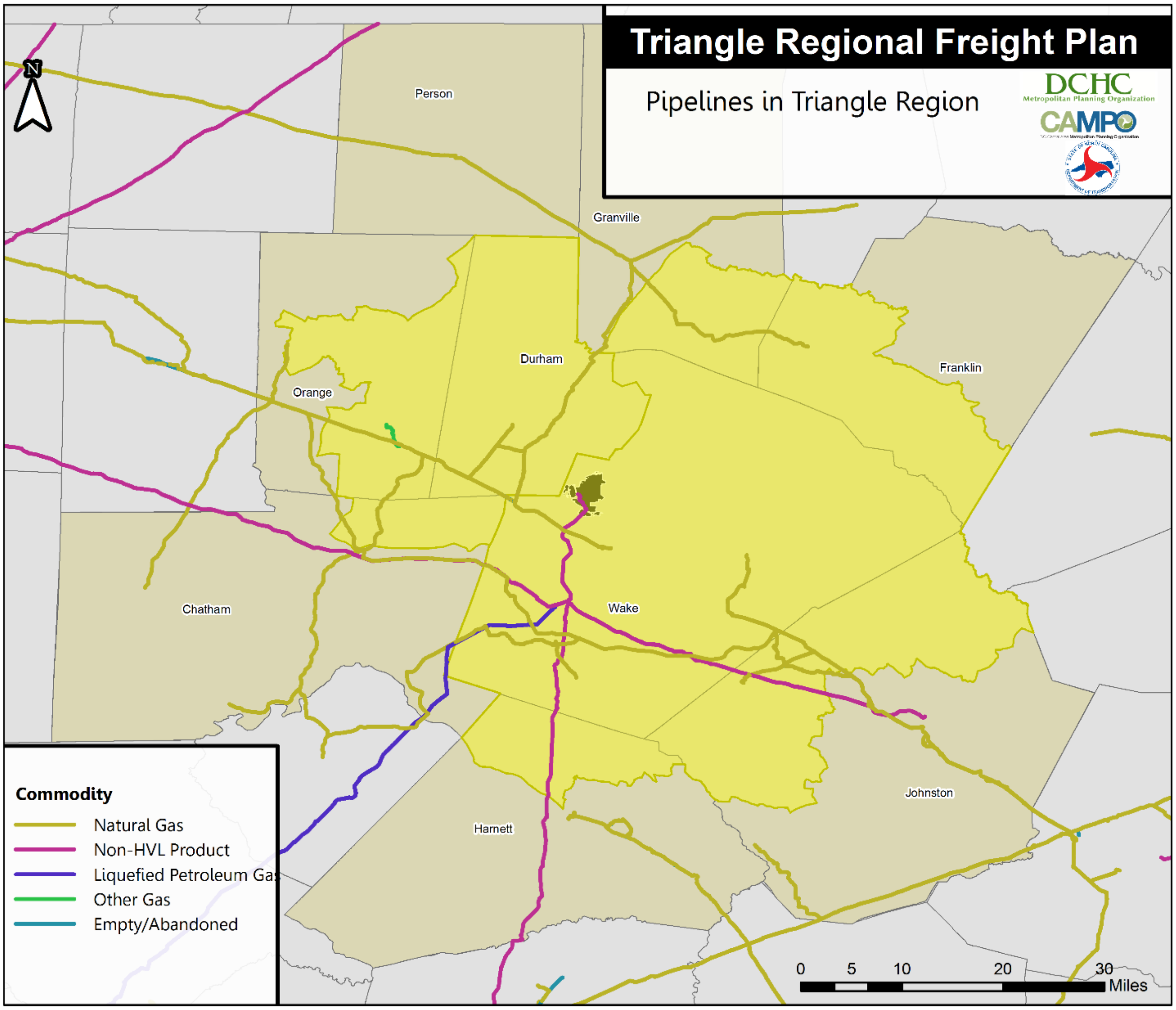
The Port of Wilmington is located just over 100 miles southeast of the Triangle Region, along I-40. As the flow of containers and tons at the port increases, truck volumes on this highway are expected to increase considerably.

Future Conditions for Pipelines

There are approximately 750 miles of pipelines running through all nine counties in the Triangle Region, as shown in Figure 107. The three counties with the most number of pipeline miles are Wake (24 percent of total), Johnston (22 percent), and Chatham (19 percent). These pipelines carry three major commodity types: natural gas, non-highly volatile liquid (HVL) petroleum products (including products such as refined blended gasoline, jet fuel, ethanol-blended gasoline, biodiesel, and other refined products), and liquefied petroleum gas (butane and propane sold in liquid form, also known as bottled gas and tank gas).[23] The Triangle Region also has a small amount of empty or abandoned pipeline infrastructure, as well as pipelines carrying other gas products. Sixty-five percent of the pipelines carry natural gas, while 32 percent carry non-HVL products.

[23] "National Pipeline Mapping System: Standards for Pipeline, Liquefied Natural Gas and Breakout Tank Farm Operator Submissions". March 2016. Available from: https://www.npms.phmsa.dot.gov/documents/Operator_Standards.pdf

Figure 107: Pipelines in Triangle Region, by Commodity



Source: North Carolina State Freight Plan Hazardous Material Modal Profile (2016)

The largest pipeline operator by mileage is Public Service Company of North Carolina (known as PSNC Energy), comprising 38 percent of total mileage and carrying exclusively natural gas, as shown in Figure 108. PSNC Energy purchases, sells, transports, and distributes natural gas to approximately 530,000 customers throughout North Carolina.[24] Colonial Pipeline is another major operator, comprising 32 percent of total mileage for non-HVL products only. The Colonial Pipeline system runs 5,500 miles from Houston, Texas to Linden, New Jersey and carriers a variety of gasoline, diesel, home heating oil, jet fuel, and other petroleum products.[25] Other pipeline operators include Piedmont Natural Gas Company, Cardinal Operating Company (natural gas), Dixie Pipeline Company (liquefied petroleum gas only), Plantation Pipeline (non-HVL products only), and Douglas Pipeline (other gas products only).

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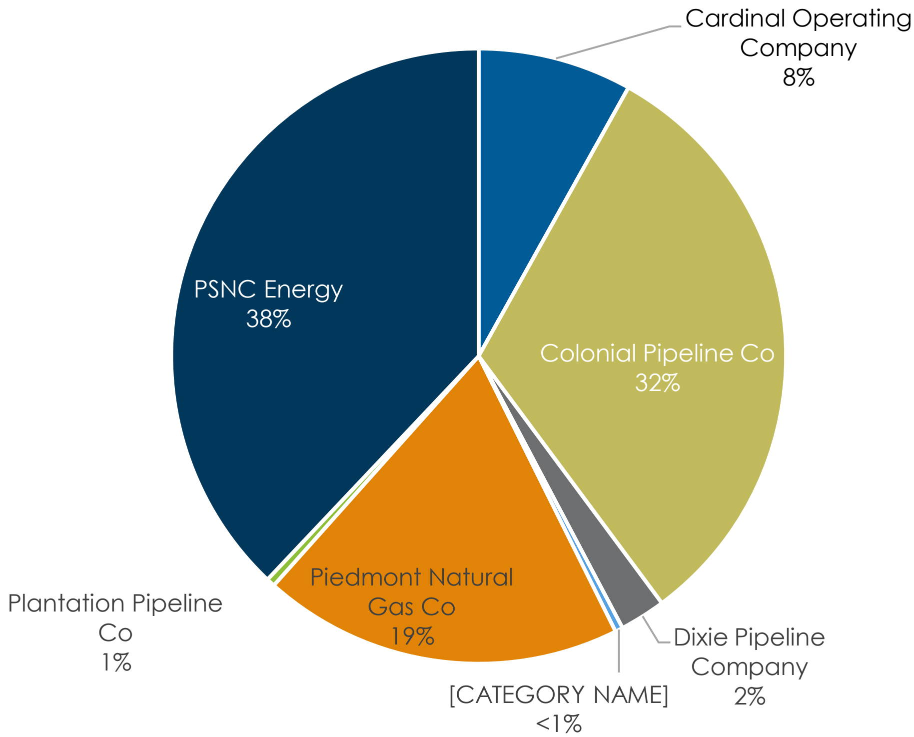
[24] "Company Overview of Public Service Company of North Carolina, Incorporated". Bloomberg. Accessed October 4, 2016. Available from: http://www.bloomberg.com/Research/stocks/private/snapshot.asp?privcapid=298528

[25] Colonial Pipeline Company. 2013. Accessed October 4, 2016. Available from: http://www.colpipe.com/home/about-colonial/frequently-asked-questions

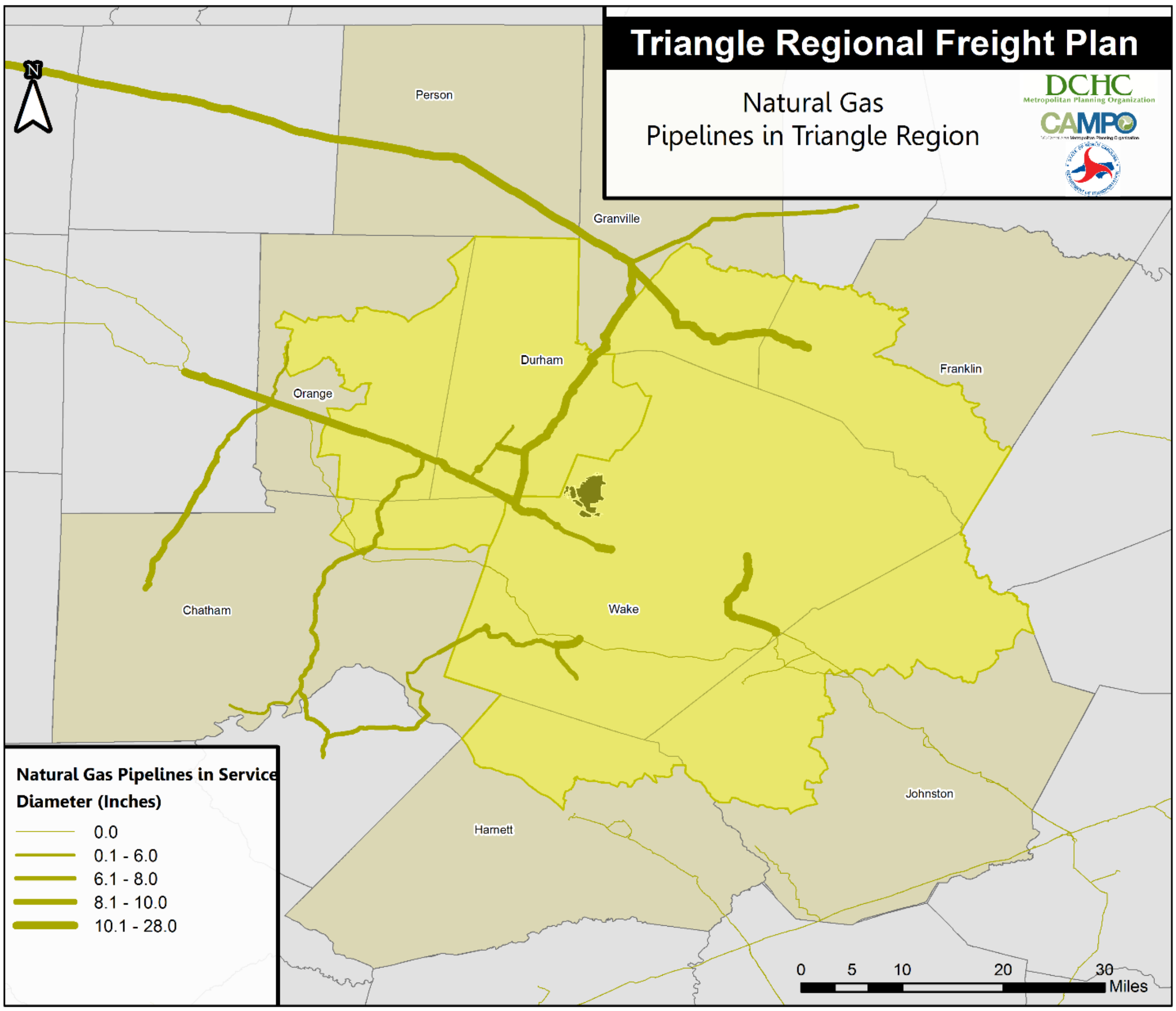
Figure 108: Pipeline Operators in Triangle Region, by Mileage



Source: North Carolina State Freight Plan Hazardous Material Modal Profile (2016)

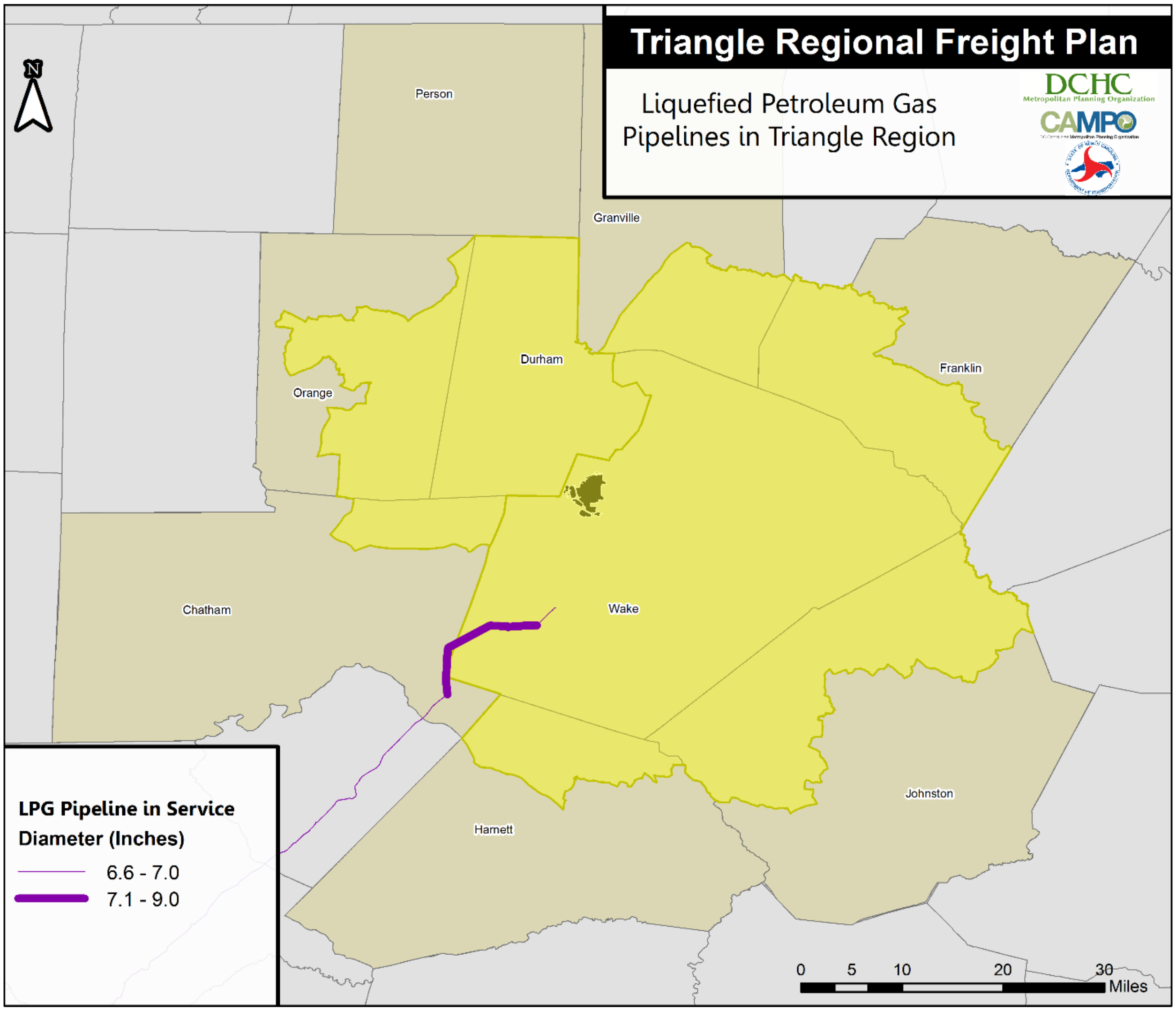
Natural gas pipelines comprise 65 percent of the Triangle Region's pipeline infrastructure, passing through every county, as shown in Figure 109. The diameter of these natural gas pipelines are as wide as 28 inches, particularly in the north and northwest portion of the region. Additionally, Figure 110 presents a map of the liquefied petroleum gas (LPG) pipeline infrastructure and Figure 111 presents the non-highly volatile liquid (HVL) pipeline infrastructure in the Triangle Region. LPG pipeline runs a single line south through Wake and Chatham counties, while non-HVL pipeline crosses through Wake, Johnston, Harnett, and Chatham counties, in addition to the northwest corner of Person County. For all of the maps, the pipeline mileage with a 0-inch diameter indicates that the actual diameter is unknown.

Figure 109: Pipeline Diameter of Natural Gas Pipelines in Triangle Region



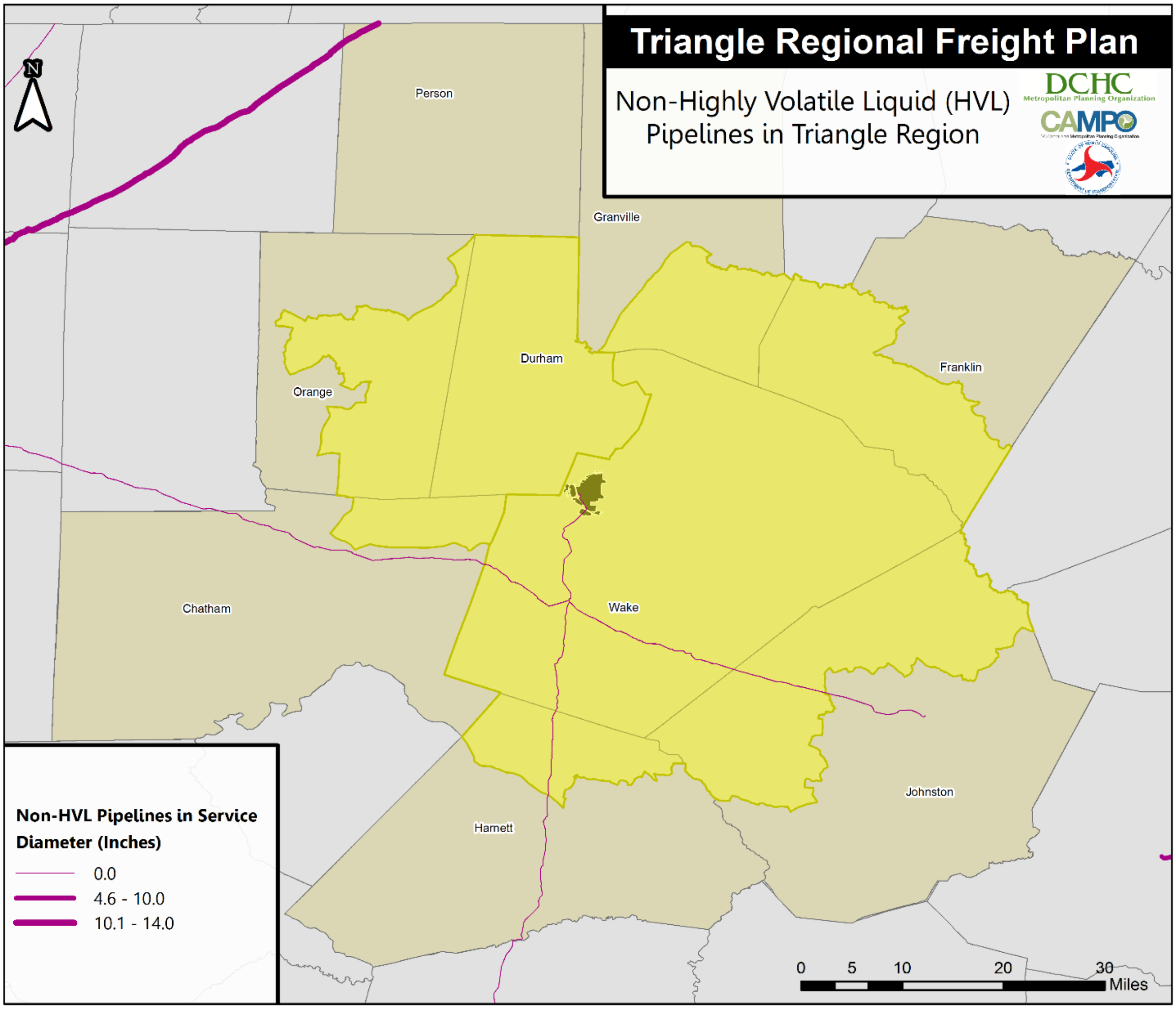
Source: North Carolina State Freight Plan Hazardous Material Modal Profile (2016)

Figure 110: Pipeline Diameter of Liquefied Petroleum Gas (LPG) Pipelines in Triangle Region



Source: North Carolina State Freight Plan Hazardous Material Modal Profile (2016)

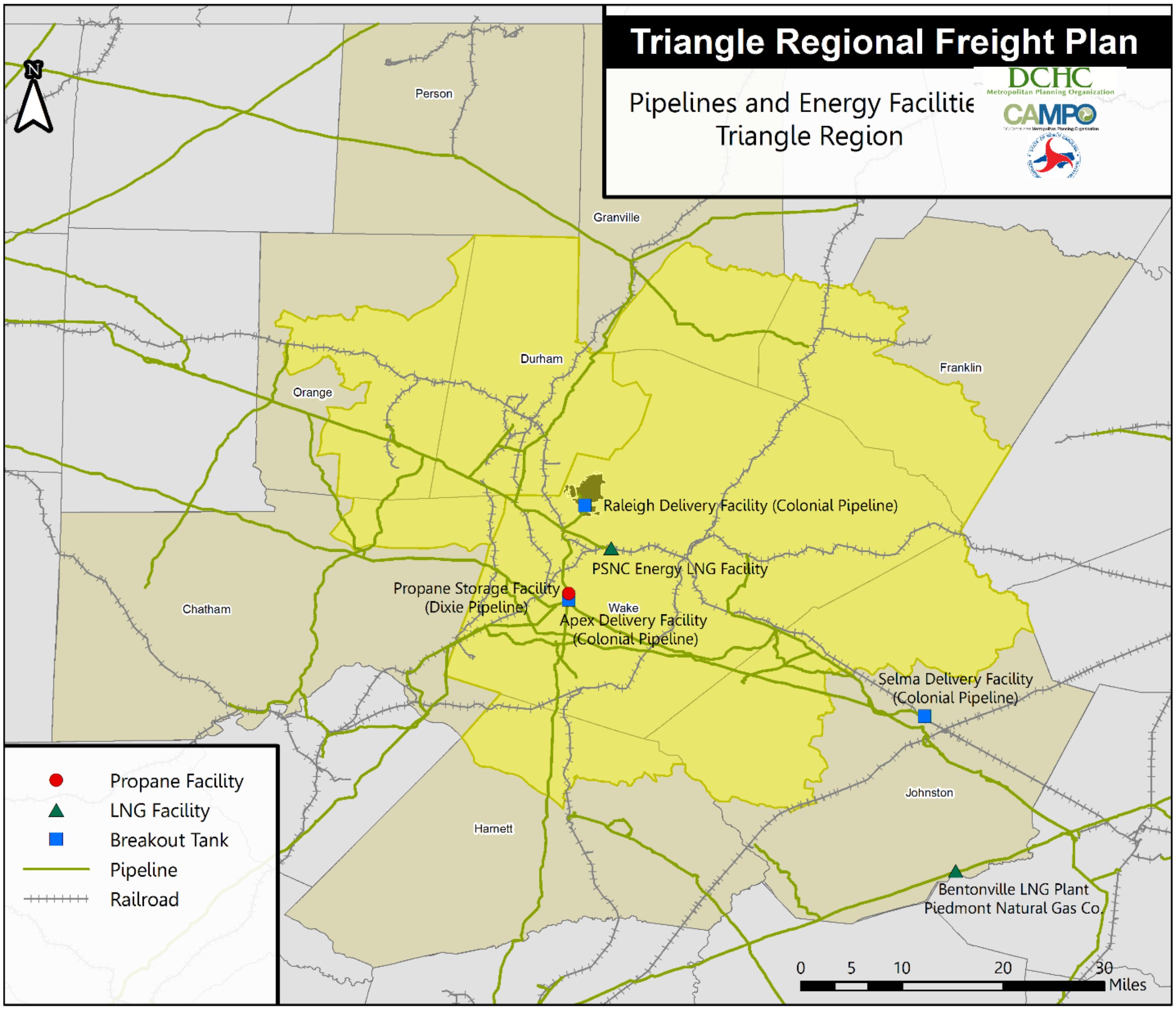
Figure 111: Pipeline Diameter of Non-Highly Volatile Liquid (HVL) Pipelines in Triangle Region



Source: North Carolina State Freight Plan Hazardous Material Modal Profile (2016)

In addition to the pipeline infrastructure, there are several liquefied natural gas (LNG) facilities and breakout tanks for petroleum products in the Triangle Region, as shown in Figure 112. There are two LNG facilities to note: PSNC Energy's facility in Cary and Piedmont Natural Gas Company's plant in Bentonville. PSNC's facility has an LNG storage tank with both truck and rail access.

Figure 112: Pipelines and Energy Facilities in Triangle Region



Source: North Carolina State Freight Plan Hazardous Material Modal Profile (2016)

Additionally, Dixie Pipeline has pipeline that originates in Louisiana and terminates in Apex, which is where Dixie has significant tankage for propane. There is a 17 million gallon refrigerated storage tank and 10 bullet tanks (90,000 gallons each), as shown in Figure 113.

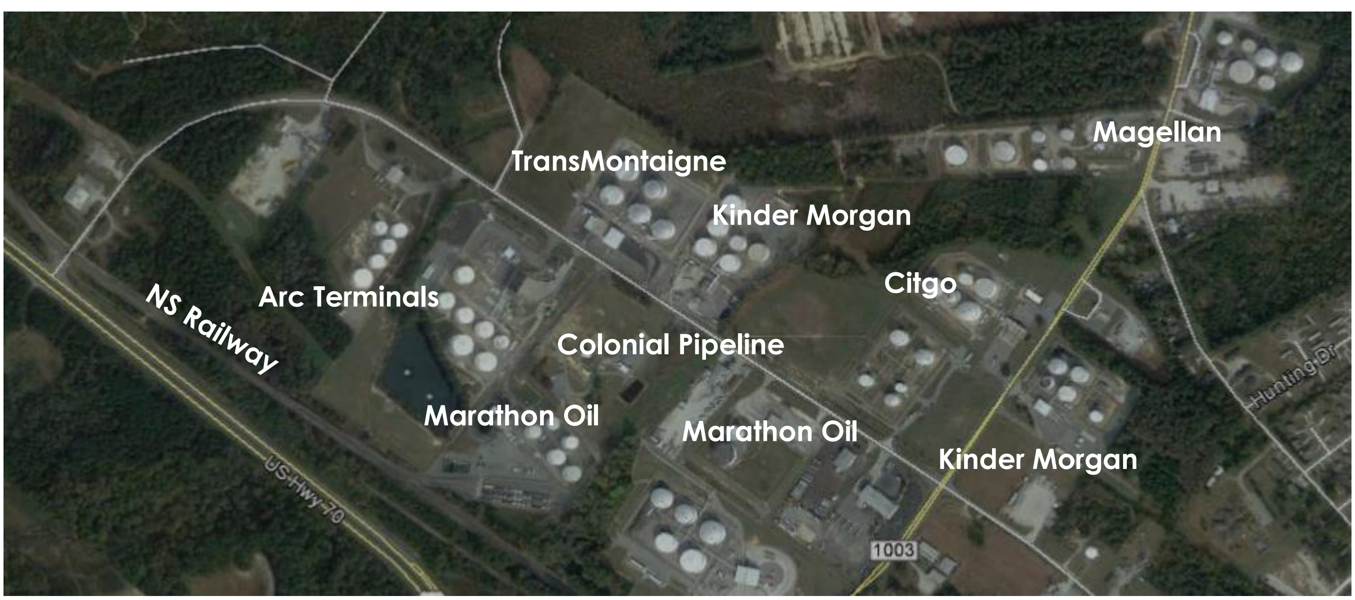
For petroleum products, Colonial Pipeline has several breakout tanks in the Triangle Region that are used to receive and store liquids transported by pipeline. One of these tanks is in Raleigh, just south of RDU. The facility has racks for tanker trucks to receive oil and transport it via truck to other destinations. Colonial Pipeline also owns another breakout tank in Apex, which is situated on the intersection of two non-HVL pipelines. This facility also has a set of racks for tanker trucks, with no rail access. Piedmont Natural Gas Company's facility is on the outskirts of the Triangle Region, and features storage capacity for LNG products accessible by truck.

Figure 113: Dixie Pipeline Propane Facility in Apex

Source: Google Earth Pro (2016)

The last Colonial Pipeline facility is located in Selma, which is the southeastern part of the Triangle Region, as shown in Figure 114. The delivery facility itself features a breakout tank and tanker truck racks, but there is also a significant number of terminals for a variety of different oil companies, including Magellan Pipeline, TransMontaigne, Citgo, Kinder Morgan, Marathon Oil, and Arc Logistics Partners, all of which have direct access to Colonial pipeline infrastructure in addition to their own tanker truck racks. The Marathon Oil facility also has access to NS Railway track, which was projected to receive 96 tank cars per day before its completion in 2014.[26]

Figure 114: Oil Tank Infrastructure at Colonial Pipeline Delivery Facility in Selma



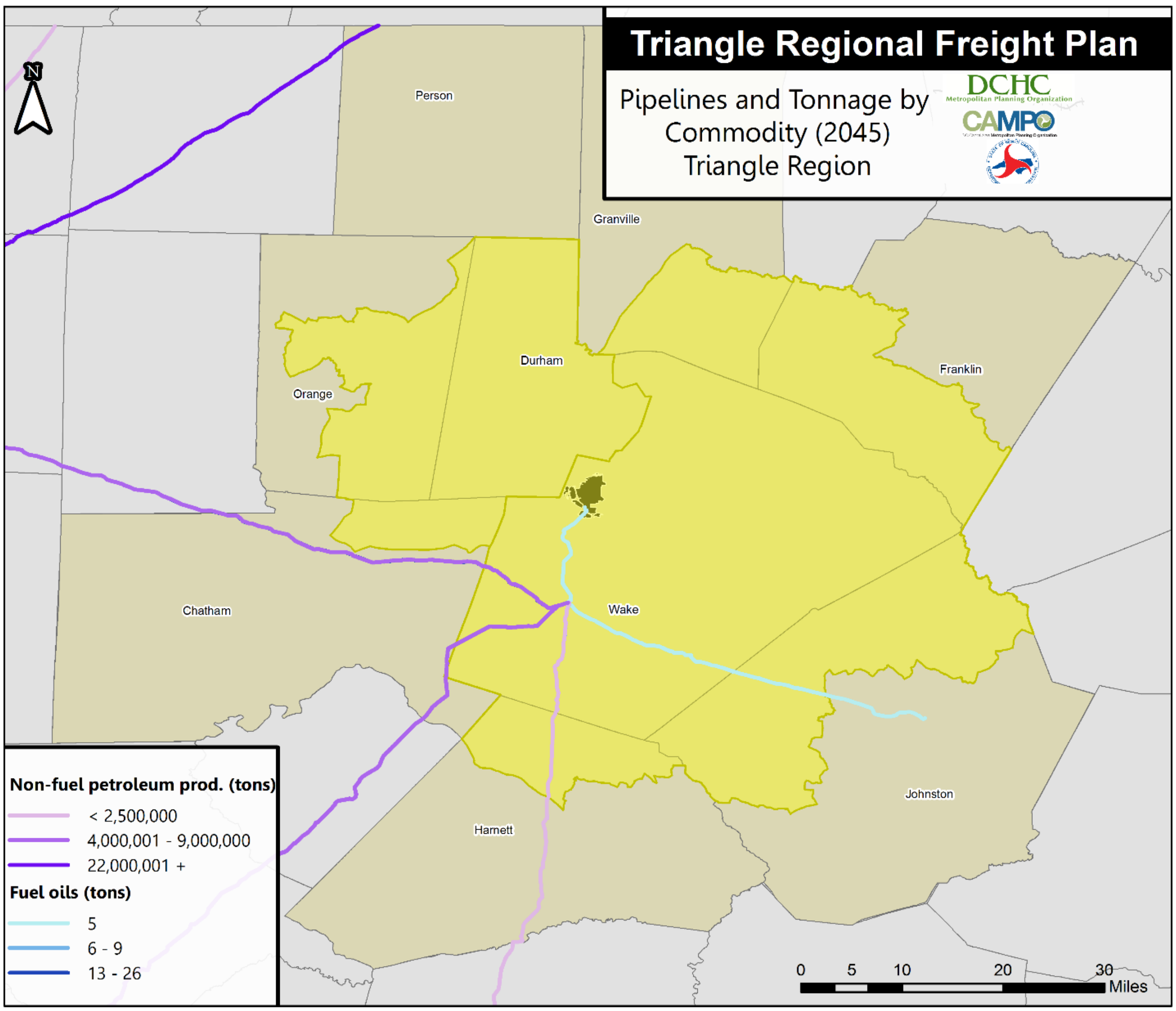
[26] "Selma petroleum complex to expand". The New & Observer. November 27, 2015. Accessed October 4, 2016. Available from: http://www.newsobserver.com/news/local/counties/johnston-county/article46708130.html

Source: Google Earth Pro (2016)

Future Demand

Future pipeline demand data in the Triangle Region is available from the North Carolina State Freight Plan Hazardous Materials Modal Profile, though it is limited. Volume estimates exist for two Standard Classification of Transported Goods (SCTG) commodity codes: fuel oils (SCTG 18) and other petroleum products (SCTG 19). In the context of pipeline flows, "other petroleum products" refers to non-fuel petroleum products, which includes lubricating oils and grease, gaseous hydrocarbons (liquefied natural gas, liquefied propane, and liquefied butane), and other products of petroleum refining. Figure 115 shows the annual tonnage of non-fuel petroleum products and fuel oils on pipeline segments in the Triangle Region. In total, over 30 million tons of non-fuel petroleum products and 5 tons of fuel oils are expected to pass through pipelines in the Region in 2045.

Figure 115: Pipeline Commodity Flow and Annual Tonnage, Triangle Region (2045)



Source: North Carolina State Freight Plan Hazardous Material Modal Profile (2016)

Future Capacity

According to the Federal Energy Regulatory Commission (FERC), the only project pending in North Carolina is the Atlantic Coast Pipeline (ACP) Project.[27] The purpose of this project is to transport natural gas over 600 miles intrastate from the Marcellus and Utica shale formations, an area stretching through New York, New Jersey, Pennsylvania, Ohio, West Virginia, and Maryland, forming one of the largest natural gas supplies in the world. The ACP will originate in Harrison County, West Virginia, run through Greensville County, Virginia, and then run south through eastern North Carolina, including Johnston County, which is part of the Triangle Region. Figure 116 presents a map of the proposed route of the ACP in Johnston County. This additional natural gas service in Virginia and North Carolina will be operated by Duke Energy, Piedmont Natural Gas, and AGL Resources. In Johnston County alone, there will be 37 miles of new pipeline infrastructure, with estimated property tax revenue of $1 million in 2022.[28]

Figure 116: Proposed Route of Atlantic Coast Pipeline in Triangle Region

Source: https://www.dom.com/corporate/what-we-do/atlantic-coast-pipeline/maps

FERC expects to issue a Draft Environmental Impact Statement (EIS) in December 2016 and a Final EIS in June 2017. Once issued, construction is projected for 2017 and 2018, with the pipeline in service by late 2018. The completion of the ACP will increase the pipeline capacity in the region, and may lead to more storage facilities or energy plants in Johnston County, near to the ACP.[29]

27 "Major Pipeline Projects Pending (Onshore)". Federal Energy Regulatory Commission. June 22, 2016. Accessed October 4, 2016. Available from: http://www.ferc.gov/industries/gas/indus-act/pipelines/pending-projects.asp

28 "Community Benefits." Atlantic Coast Pipeline. Available from: https://www.dom.com/library/domcom/pdfs/gas-transmission/atlantic-coast-pipeline/acp-economic-benefits-nc-handout-072215.pdf?la=en

29 "Powering the Future: Driving Change Through Clean Energy". Atlantic Coast Pipeline. Available from: https://www.dom.com/library/domcom/pdfs/gas-transmission/atlantic-coast-pipeline/acp-factbook.pdf?la=en

The construction of the ACP suggests that capacity is limited in the Triangle Region, as well as in other parts of North Carolina.

Projected Growth

Almost all of the petroleum and natural gas delivered via pipeline in North Carolina is used as fuel, and the Triangle Region is no exception. North Carolina does not have any crude oil reserves, refineries, or natural gas reserves or production. As a result, pipeline volume growth in the Triangle Region will be based largely on local demand. Presently, 85 percent of the petroleum consumed in North Carolina is used by the transportation sector (primarily gasoline) and one-quarter of all North Carolina households use natural gas for home heating.[30] The ACP will bring a surge in natural gas capacity to the region through Johnston County, and may result in additional pipeline-related infrastructure constructed in this area. It does not appear that any petroleum products pipelines will be constructed in the Triangle Region in the foreseeable future.

Nationwide, falling oil prices has negatively impacted domestic pipeline markets since July 2014, with many pipeline construction projects facing delays. However, U.S. natural gas production is forecasted to increase by 44 percent by 2040, specifically from the Marcellus and Utica Shale formations on the east coast.[31] This major domestic source of inexpensive natural gas could supply more homes and businesses in North Carolina, and could result in increased demand for capacity in the Triangle Region.

Future Market for Freight-Oriented Developments and Supply Chain Logistics

This section describes the economic outlook for the Triangle region to assess economic development opportunities with recognition to external threats and regional competitions. This assessment considered the following factors that could impact the Triangle region's freight related development projects:

- Timing of U.S. and global freight infrastructure developments relative to economic recovery.
- Federal government export and freight infrastructure initiatives.
- Changes in trucking regulations and fluctuating fuel prices.
- Environmental regulations and initiatives affecting freight flows.
- Emerging energy markets and their impacts on freight transportation capacity and services.
- Sourcing manufacturing at new global locations which may impact the routes used to deliver goods from global origins to local consumers.

These economic and policy factors and manufacturing trends are discussed next to assess how these macro-level trends could affect freight flows in the Triangle region. This assessment helps in anticipating freight-oriented industrial development opportunity areas in the region and understanding how that freight-oriented development can drive economic development.

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[30] "North Carolina State Profile and Energy Estimates". U.S. Energy Information Administration. August 18, 2016. Accessed October 4, 2016. Available from: https://www.eia.gov/state/analysis.cfm?sid=NC

[31] "2016 North American Pipeline Outlook". Underground Construction. January 2016 Vol. 71 No. 1. Accessed October 4, 2016. Available from: https://ucononline.com/2016/01/12/2016-north-american-pipeline-outlook/

Economic Trends

According to the Federal Reserve Bank data, the State of North Carolina had a nominal Gross Domestic Product (GDP) of 499.4 billion dollars in 2015[32]. It accounted for 2.8 percent of output in the nation, ranking as the ninth largest economy in the country. The statewide real GDP in North Carolina grew at a robust rate of 2.7 percent in 2015, ranking 10th in the nation and outpacing the national growth of 2.4 percent. The same economic profile shows that manufacturing and financial services accounted for the largest shares of the state's economy and economic outputs rose in every industry sector except utilities, transportation and warehousing, and government in 2015.

North Carolina also has a growing bioscience industry that has grown 6.6 percent from 2012 to 2014. According to reports from Bio (the bioscience industry association)[33], the state has employed more than 70,000 in 2014 in the bioscience sector with specialization in drugs and pharmaceuticals; research, testing, and medical labs; and agricultural feedstock and chemicals.

Among the North Carolina metropolitan areas, Raleigh's non-farm payroll employment grew 3.8 percent in 2015, compared to Charlotte-Concord-Gastonia's 3.7 percent, Durham-Chapel Hill's 2.1 percent, Greensboro-High Point's 2.0 percent, and Winston-Salem's 1.8 percent. Raleigh also posted the highest population growth among North Carolina MSAs in 2015, growing 2.5 percent from 2014. In comparison, Charlotte-Concord-Gastonia MSA population grew by 2 percent, and Durham-Chapel Hill MSA grew by 1.7 percent.

These economic indicators reflect positive outlook for the Triangle region in terms of jobs and population growth within the broader context of a healthy statewide economy, multiple centers of growth along the I-85 corridor, and specialized industry clusters such as biotechnology.

U.S. and Global Freight Infrastructure Developments

In 2015, the FAST Act was enacted to build on the transportation policy changes that were put forth in its predecessor 2012 law -- MAP-21. The FAST Act funds surface transportation programs at over $305 billion for fiscal years 2016 through 2020. It is a transportation authorization that provides long-term funding certainty for surface transportation projects. The FAST Act established and funded new programs to support critical transportation projects to ease congestion and facilitate the movement of freight on the Interstate System and other major roads. A new National Multimodal Freight Policy was adopted to allocate $4.5 billion for fiscal years 2016 through 2020 through a new Nationally Significant Freight and Highway Projects (NSFHP) program. This program administers discretionary grants referred to as **F**ostering **A**dvancements in **S**hipping and **T**ransportation for the **L**ong-term **A**chievement of **N**ational **E**fficiencies (FASTLANE) grants. The FASTLANE grants[34] will be awarded to projects that align with the following NSFHP program goals:

- improve safety, efficiency, and reliability of the movement of freight and people;
- generate national or regional economic benefits and an increase in global economic competitiveness of the U.S;
- reduce highway congestion and bottlenecks;
- improve connectivity between modes of freight transportation;
- enhance the resiliency of critical highway infrastructure and help protect the environment;
- improve roadways vital to national energy security;

[32] North Carolina Regional Profile, July 2016, Federal Reserve Bank of Richmond (https://www.richmondfed.org/-/media/richmondfedorg/research/regional_economy/reports/regional_profiles/pdf/nc_regional_profile.pdf)

[33] https://www.bio.org/about

[34] https://www.transportation.gov/buildamerica/FASTLANEgrants

- address the impact of population growth on the movement of people and freight, and
- mitigate the impacts of freight movements on communities.

The inaugural FASTLANE Grants awarded a total of $800 million in September 2016 for 18 projects of national or regional significance spread across the country (see Table 47). For fiscal year 2017, the FASTLANE authorization has been set for $850 million, or an increase of $50 million. The application deadline for the 2017 FASTLANE grants will likely be in April, 2017. Similarly, FASTLANE authorizations for subsequent fiscal years (2018-2020) will be $900 million, $950 million, and $1.00 billion respectively.

The FASTLANE program provides a good opportunity for the Triangle region to advance large-scale freight projects with costs greater than $100 million. The FASTLANE encourages collaboration and will fund up to 60 percent of the project costs. The freight and freight-related projects would need to have gone through preliminary engineering so that the projects can reasonably be expected to begin construction within 18 months of funding obligation. Also, these projects can have an additional 20 percent of project costs funded with other Federal assistance, bringing total Federal participation in these projects to a maximum of 80 percent. For the purposes of FASTLANE grants, the Urbanized Areas, as designated by the U.S. Census Bureau, with a population of 200,000 or more, are considered urban. All other areas, including Urbanized Areas with populations fewer than 200,000, are considered rural.

Table 47: FASTLANE Awards for FY 2016

State	Urban or Rural	Project Name	Applicant	Project Size	FASTLANE Award (Million $)	Award % of Project Cost
AZ	Rural	I-10 Phoenix to Tucson Corridor Imp.	Arizona DOT	Large	54.00	34%
CA	Urban	SR-11 Segment 2 and Southbound Connectors	California DOT	Large	49.28	29%
DC	Urban	Arlington Memorial Bridge Reconstruction Project	National Park Service	Large	90.00	54%
GA	Urban	Port of Savannah International Multi-Modal Connector	Georgia Ports Authority	Large	44.00	35%
LA	Rural	I-10 Freight Core	Louisiana DOT and Development	Large	60.00	31%
MA	Urban	Conley Terminal Intermodal Improvements and Modernization	MA Port Authority	Large	42.00	41%
NY	Urban	I-390/I-490/Route 31 Interchange, Lyell Avenue Corridor Project	New York State DOT	Large	32.00	20%
OK	Rural	U.S. 69/75 Bryan County	Oklahoma DOT	Large	62.00	51%
VA	Urban	Atlantic Gateway: Partnering to Unlock the I-95 Corridor	Virginia DOT	Large	165.00	18%
WA	Urban	South Lander Street Grade Separation and Railroad Safety Project	City of Seattle	Large	45.00	32%
WI	Rural	I-39/90 Corridor Project	Wisconsin DOT	Large	40.00	3%
FL	Rural	Truck Parking Availability System (TPAS)	Florida DOT	Small	10.78	45%

State	Urban or Rural	Project Name	Applicant	Project Size	FASTLANE Award (Million $)	Award % of Project Cost
IA	Rural	Cedar Rapids Logistics Park	Iowa DOT	Small	25.65	55%
ID	Rural	U.S 95 North Corridor Access Improvement Project	Idaho Transp. Depart.	Small	5.10	60%
ME	Urban	Maine Intermodal Port Productivity	Maine DOT	Small	7.72	50%
NY	Urban	Cross Harbor Freight Program (Rail)	The Port Authority of NY and NJ	Small	10.67	60%
OR	Rural	Coos Bay Rail Line - Tunnel Rehabilitation Project	Oregon Int'l Port of Coos Bay	Small	11.00	56%
WA	Urban	Strander Boulevard Extension and Grade Separation Phase 3	City of Tukwila	Small	5.00	13%
		TOTAL			**759.20**	

Source: FHWA FASTLANE Grants (https://www.transportation.gov/buildamerica/FASTLANEgrants)

Panama Canal Expansion

For global freight infrastructure, the most significant and notable project is the Panama Canal Expansion[35] that was officially opened for business on June 26, 2016. The Panama Canal Expansion project will provide greater economies of scale to global commerce as bigger ships can now use the new locks that are 70 feet wider and 18 feet deeper, and also use a new third lane. As of August 2016, the Expanded Panama Canal has transited 69 post-Panamax vessels since the inauguration. Specifically, 40 containerships, 24 LPG carriers, three vehicle carriers and two LNG carriers have transited the Expanded Canal. In addition, major liners have rerouted service to the Panama Canal to take advantage of the significant time savings the waterway provides. For example, shipping liners Maersk and Mediterranean Shipping Co. recently announced that they are rerouting Asia to U.S. East Coast service from the Suez Canal route to the Panama Canal route. In essence, Panama Canal Expansion is allowing cargo ships that are one-third larger than before, and opened up a cost-efficient trade link between the ports in Asia and the ports in the U.S. East and Gulf Coasts that are already or soon be capable of handling post-Panamax ships.

In North Carolina, Port of Wilmington recently welcomed the largest containership to ever dock at the Port -- the Hanjin Baltimore. It is the first of many larger post-Panamax vessels expected at the recently updated and modernized container port. The Hanjin Baltimore line serves various Far East trade lanes, and has a holding capacity of 7,500 20-foot equivalent units (TEUs). The North Carolina State Ports Authority estimated the impact of future changes in Port Activity as shown in Table 48. This shows that the Ports of Wilmington and Morehead City are a critical link in the supply chain which can be a tool for economic growth and job creation throughout the state.

Table 48: Estimated Impact of Future Changes in Port Activity

Detail of Opportunity	Line of Business	Facility	Estimated Direct Impact (2014 dollars)
One new Far East super post- Panamax service	Containers	Wilmington	$3.77 Billion

[35] http://www.acp.gob.pa/eng/pr/press-releases/2016/06/26/pr597.html

Detail of Opportunity	Line of Business	Facility	Estimated Direct Impact (2014 dollars)
One new Far East Panamax service	Containers	Wilmington	$ 1.95 Billion
One new Trans-Atlantic service	Containers	Wilmington	$ 820 Million
New wood pellet exporting facility (1.5M tons)	Bulk/Breakbulk	Wilmington	$ 780 Million
One new South Atlantic container service	Containers	Wilmington	$ 560 Million
15% growth (or decline)	Bulk/Breakbulk	Wilmington	$ 400 Million
15% growth (or decline)	Bulk/Breakbulk	Morehead City	$ 100 Million

Source: NCSPA 2014

A recent report from the Boston Consulting Group and C.H. Robinson[36] estimated that as much as 10 percent of container traffic between East Asia and the U.S. could shift from West Coast ports to East Coast ports by the year 2020. This has implications for the Triangle region as it is likely to have more regional warehousing DCs that will need to handle the shifts in container cargo. However, high-value, time-sensitive products, such as electronics, will still likely use U.S. West Coast ports and rail. Also, it should be mentioned that the cost savings from larger ships do not necessarily reach shippers because of the facts that Panama Canal assesses tolls and the Western railroads are using pricing strategy to retain rail intermodal traffic.

U.S. Export Initiatives

The U.S. Census Bureau's Foreign Trade Data[37] was reviewed to explore the import-export trends to and from the state of North Carolina in terms of top 10 commodities and top 10 countries based on 2015 dollar values. The results of this review are depicted in Figure 117 for top 10 exported commodities and Figure 118 for top 10 imported commodities. These trends show that *Civilian Aircraft, Engines and Parts* leads the export commodities, followed by *Medicaments Nesoi, Measured Doses, Retail Pk*; and *Tobacco, Partly or Wholly Stemmed/Stripped* commodities. For imports, the *Medicaments Nesoi, Measured Doses, Retail Pk* commodity leads, followed by *Turbojet and Turboproller Parts*; and *Port Digtl Automatic Data Process Mach Not* commodities.

Similarly, Figure 119 depicts recent export trends from North Carolina to top 10 export countries, and Figure 120 shows import trends from top 10 import countries. Canada continues to be North Carolina's largest export destination, followed by Mexico, China and Japan. Canada maintained its position as North Carolina's largest export destination by a large margin in 2015, receiving more than $6.8 billion in exports. In imports, China continues to be the largest trading partner with $11 billion in 2015 value, followed by Mexico, Canada, and Germany.

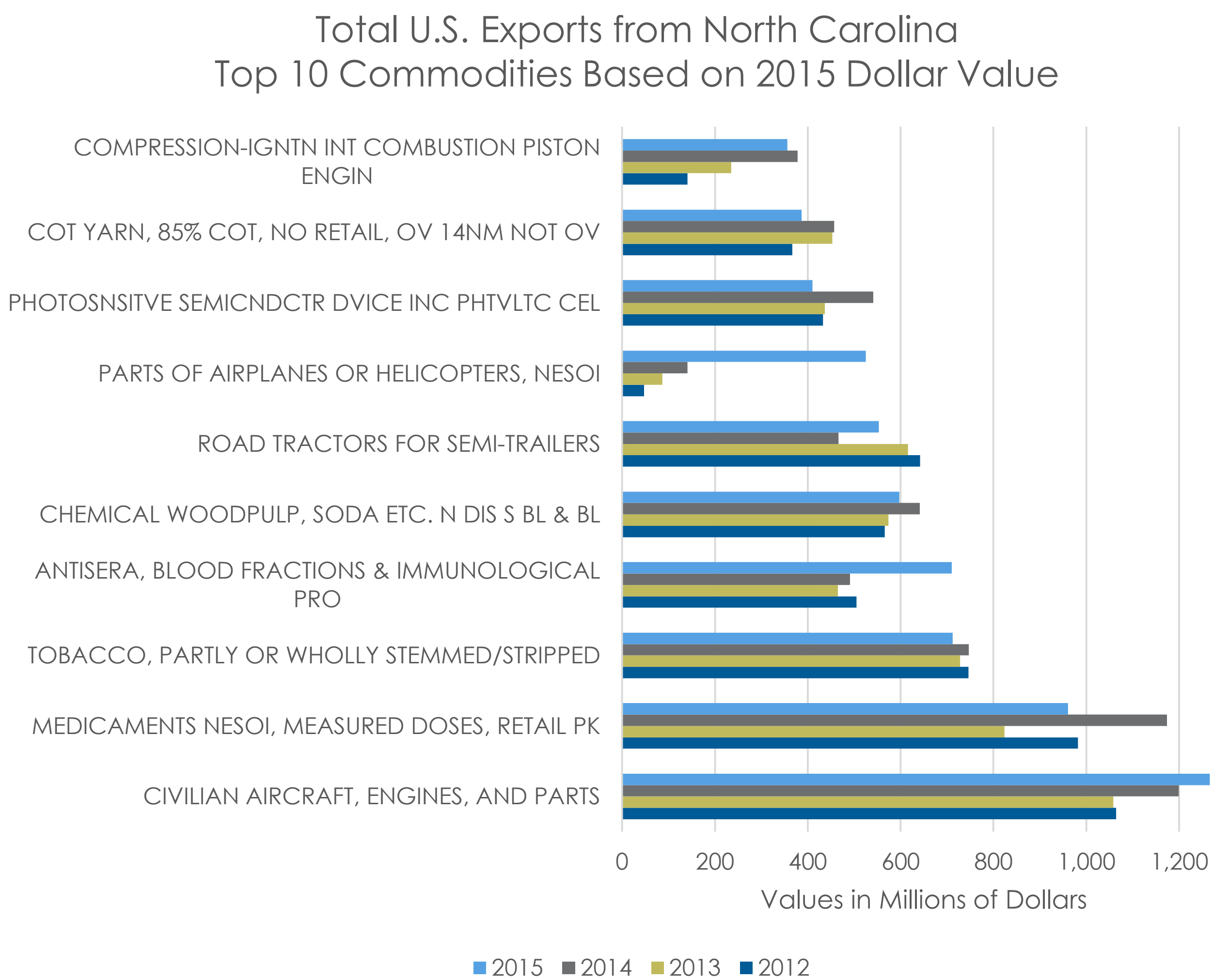
The export-import trends with partner countries will likely be influenced by the Panama Canal shifts from the West Coast ports to the East Coast ports as well as the recent Trans-Pacific Partnership Agreement (TPP Agreement, February 2016) with Australia, Brunei, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore, and Vietnam.

[36] Wide Open, How the Panama Canal Expansion is Redrawing the Logistics Map, The Boston Consulting Group and C.H. Robinson Worldwide, Inc., June 2015

[37] U.S. Census Bureau's Foreign Trade Data (https://www.census.gov/foreign-trade/statistics/state/data/imports/nc.html), Consultant Analysis

A recent economic impact study on TPP[38] estimated that TPP would have positive effects on the U.S. economy, although small as a percentage of the overall size of the U.S. economy. By year 2032, U.S. annual real income would be $57.3 billion (0.23 percent) higher than the baseline projections, real GDP would be $42.7 billion (0.15 percent) higher, and employment would be 0.07 percent higher (128,000 full-time equivalents). U.S. exports and U.S. imports would be $27.2 billion (1.0 percent) and $48.9 billion (1.1 percent) higher, respectively, relative to baseline projections. U.S. exports to new FTA partners would grow by $34.6 billion (18.7 percent); U.S. imports from those countries would grow by $23.4 billion (10.4 percent).

Figure 117: Total Exports from North Carolina by Commodity



38 Trans-Pacific Partnership Agreement: Likely Impact on the U.S. Economy and on Specific Industry Sectors, United States International Trade Commission, May 2016 https://www.usitc.gov/publications/332/pub4607.pdf

Figure 118: Total Imports to North Carolina by Commodity

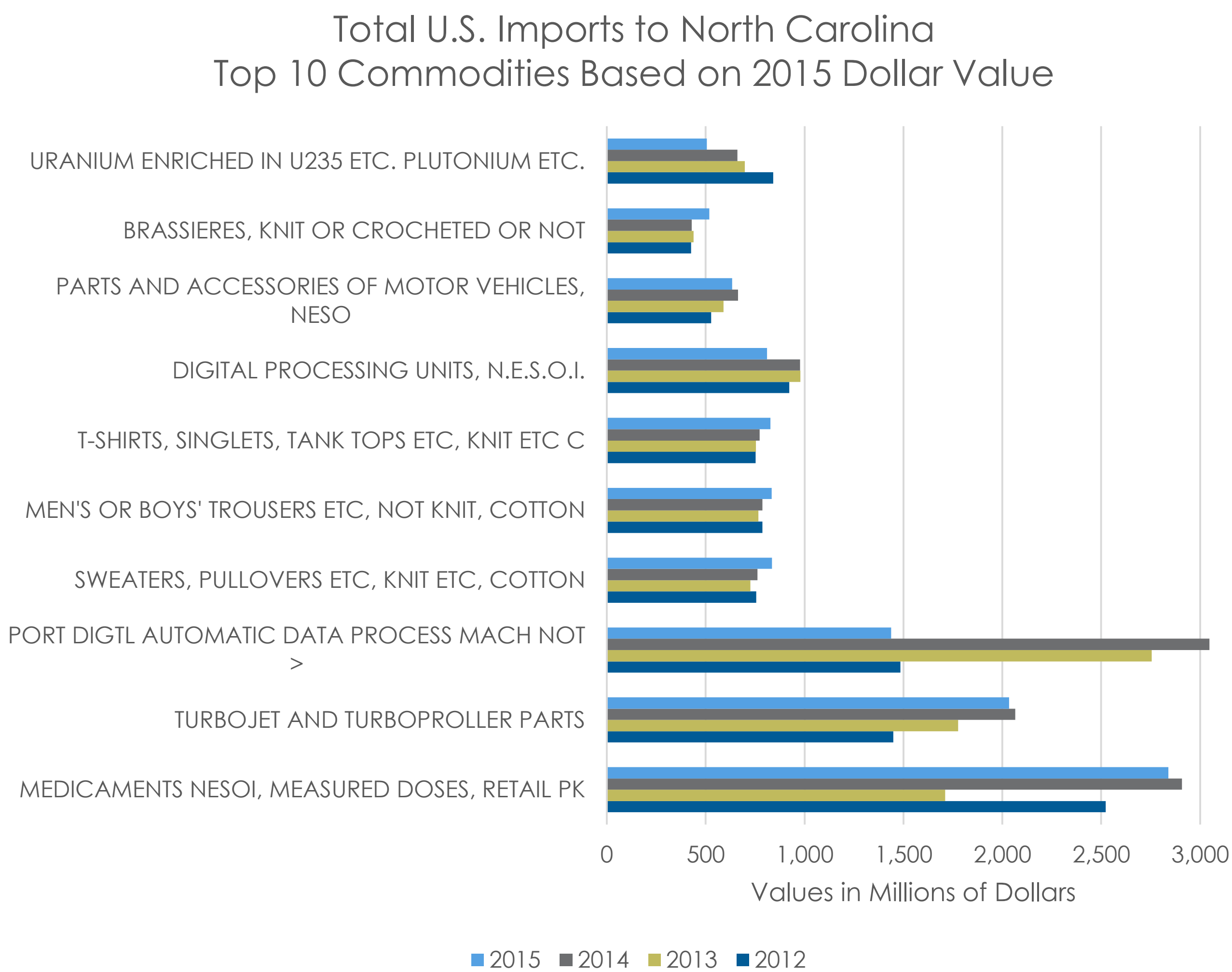


Figure 119: Exports from North Carolina by Country

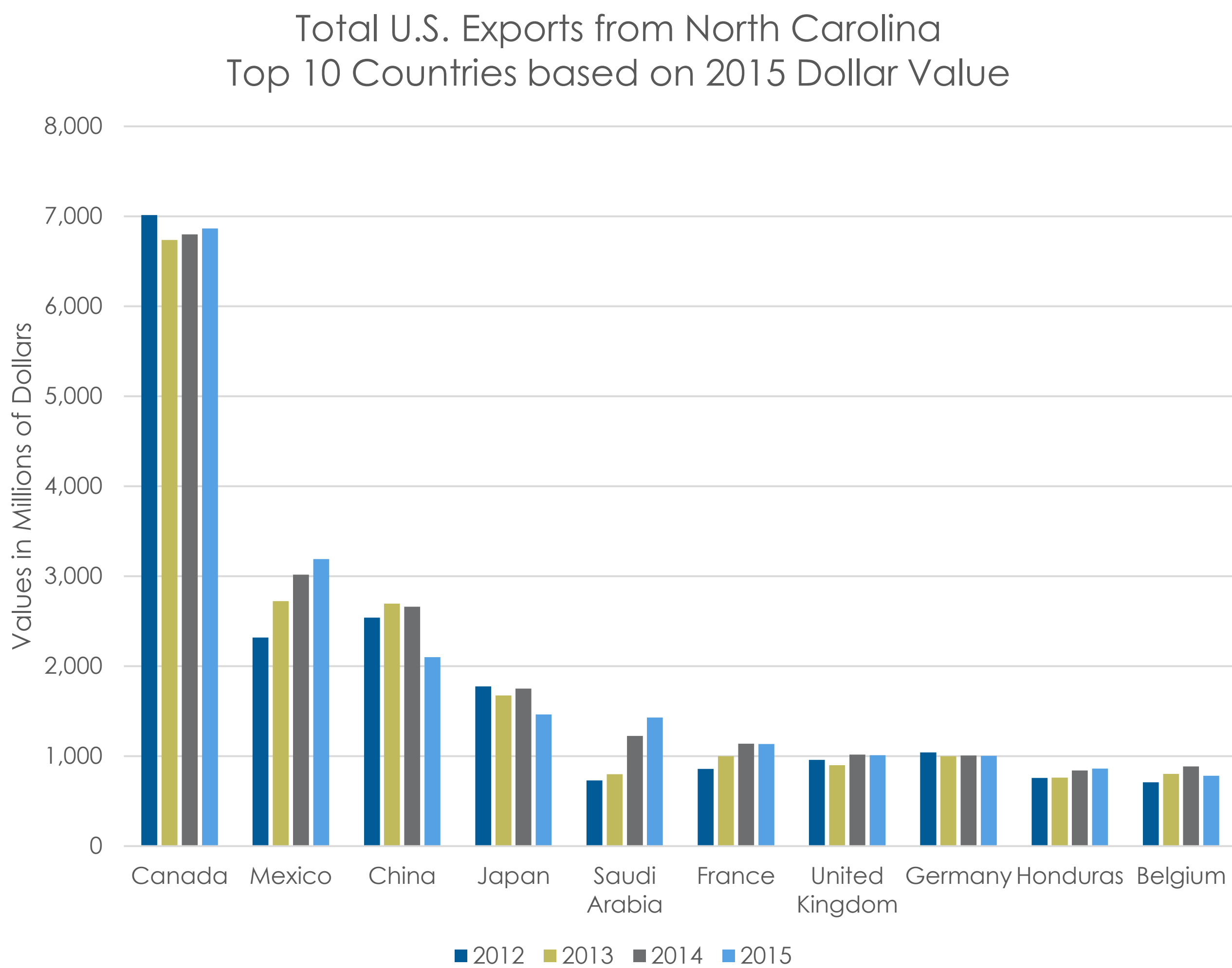
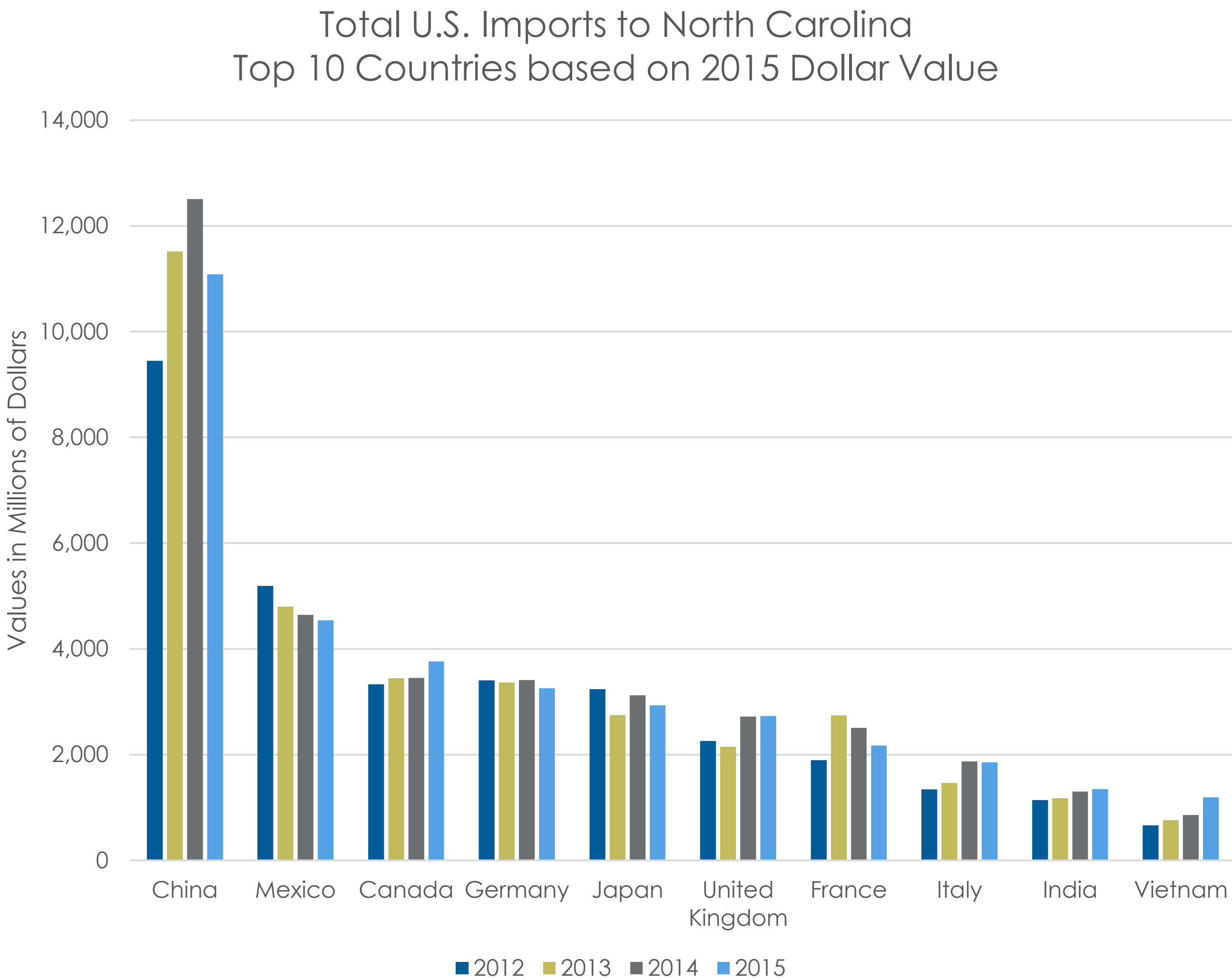


Figure 120: Imports to North Carolina by Country



Trucking Regulations and Diesel Fuel Prices

A recent report by the American Transportation Research Institute (ATRI)[39] listed *Transportation/ Infrastructure/Congestion/Funding* as the Ninth ranked issue by ATRI membership. ATRI research documented that it costs around $9.2 billion to the trucking industry associated with traffic congestion in 2013. Their top ten issues included negative impacts of traffic congestion, failing infrastructure and the need for a long-term transportation funding solution. The ATRI report also shows that the trucking industry supports increasing the fuel tax as a funding source, the national freight policy and development of a national freight network, and elimination of truck bottlenecks on major freight routes.

The trucking industry is very sensitive to traffic congestion and bottlenecks because of the regulations that they need to comply. Changes to the U.S. hours-of-service rules for truck drivers that went into effect in 2016 will require use of Electronic Logging Device (ELD) within 2 years to track hours of service by truck drivers. It is likely that this may reduce weekly driving time for some truckers, especially long-haul tractor-trailer operators. Although truckers will still be able to drive 11 hours and

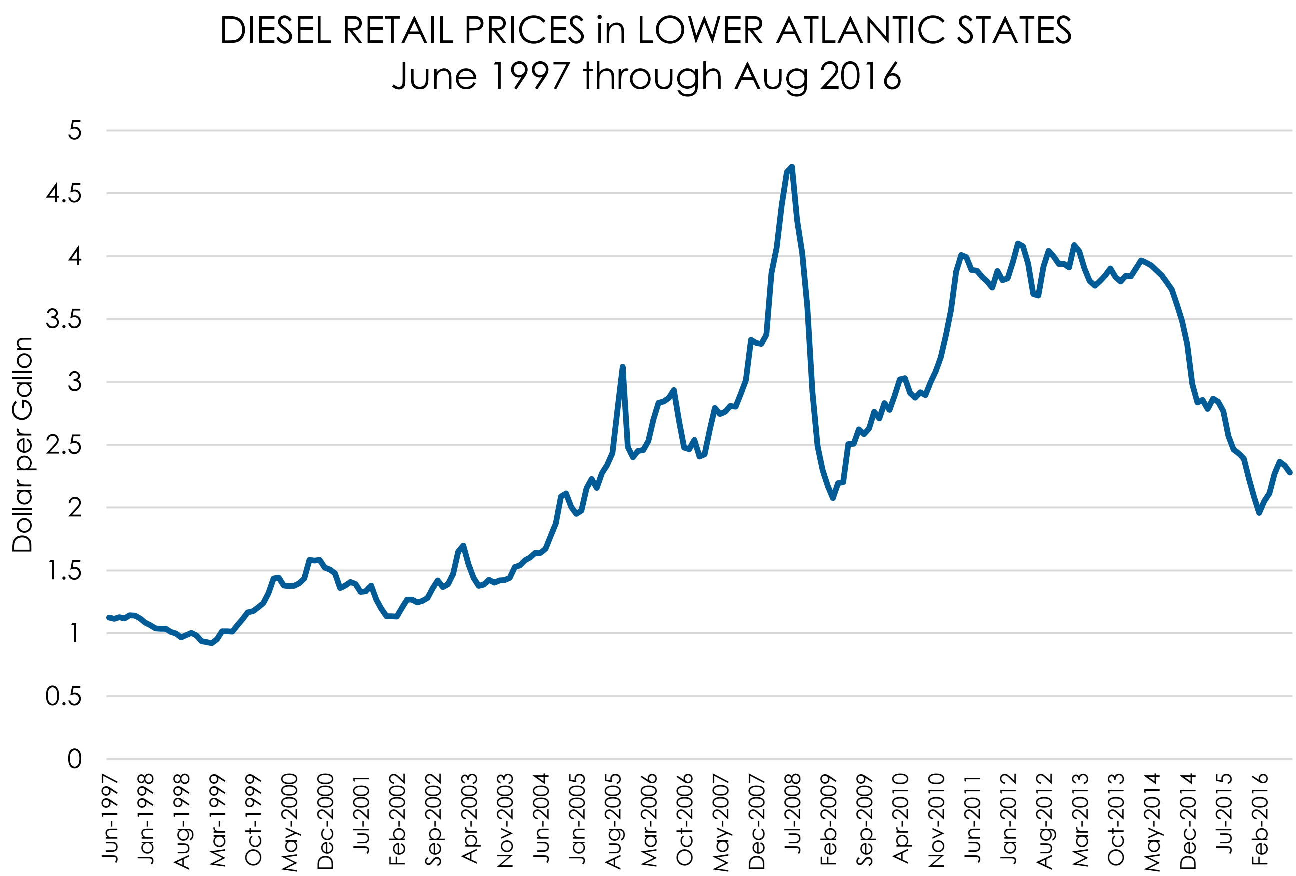
[39] http://atri-online.org/wp-content/uploads/2015/10/ATRI-2015-Top-Industry-Issues-FINAL-10-2015.pdf

work 14 hours per day, their ability to use a 34-hour restart may be restricted.[40] Increased traffic congestion reduces the mileage that a truck driver can log and thereby reduces his or her earnings. This has several downstream implications as motor carriers will be pressured to increase driver pay to compensate and to keep drivers. Drivers may become even harder to hire and keep on the payroll. Shippers may have to adjust their supply chains and cooperate more closely with carriers or pay higher rates.

Another important element that affects the freight supply chain is the fluctuation of diesel prices. Although the recent data shows a downward trend in diesel prices (see Figure 121), the cost of shipping using the trucking mode is highly correlated with diesel prices. For the most part, the freight transportation sector has been a beneficiary of recent lower diesel prices. The benefits were direct savings derived from lower fuel prices as well as from the increased consumer spending due to lower fuel prices. But the benefits aren't distributed equally across all modes of freight transportation. The air cargo and trucking modes stand to gain the most from reduced fuel prices, given that a significant part of their costs are associated with fuel. But rail operators may not benefit as much as they typically face competitive challenge from trucking industry due to low fuel prices. In general, it is true that rail is more appealing than trucking, especially for long-haul routes because of low costs. But as diesel prices fall, shippers consider trade-offs regarding price, reliability, speed, and convenience and may favor trucking. On the other hand, when the diesel prices go up, the trucking mode will become expensive which may in turn cause modal shifts back to rail for some commodities, and local- or near-sourcing for some other commodities such as fresh produce.

[40] https://www.fmcsa.dot.gov/regulations/hours-service/summary-hours-service-regulations

Figure 121: Fluctuation of Diesel Fuel Prices



Source: U.S.EIA Fuel Prices (http://www.eia.gov/petroleum/gasdiesel/)

Environmental Regulations

The Corporate Average Fuel Economy (CAFE) Standards, regulated by U.S.DOT's National Highway Traffic and Safety Administration (NHTSA) under the Energy Policy and Conservation Act (EPCA) of 1975 and the Energy Independence and Security Act (EISA) of 2007, requires automakers to create more fuel-efficient vehicles every year so that the impacts on GHG emissions are reduced through lower energy consumption. While NHTSA sets and enforces the CAFE standards, the Environmental Protection Agency (EPA) calculates average fuel economy levels for auto manufacturers and sets related GHG standards under the Clean Air Act.

In August 2016, the EPA and the NHTSA[41] jointly finalized CAFE standards for medium-duty (MD) and heavy-duty (HD) vehicles to improve fuel efficiency, reduce emissions, promote energy security, and catalyze manufacturing innovation. These new CAFE standards promotes cleaner, more fuel efficient trucks by encouraging application of existing and new technologies through model years (MYs) 2018-2027. These MYs 2018-2027 CAFE standards for MD and HD vehicles, when implemented, are expected to lower carbon emissions by approximately 1.1 billion metric tons, and save vehicle owners fuel costs of about $170 billion. Overall, this new program was estimated to provide $230 billion in net social benefits, including clean air and public health. The MYs 2018-2027 program is also estimated to provide favorable payback for truck owners. For example, the buyer of a new long-

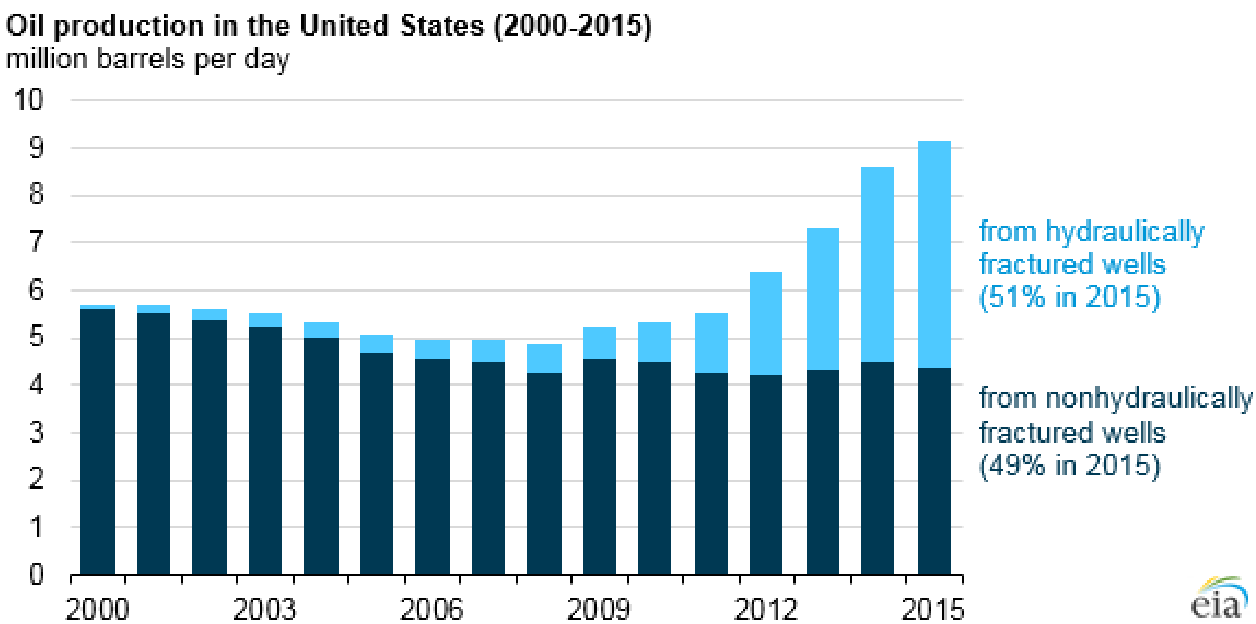
[41] http://www.nhtsa.gov/fuel-economy

haul truck in 2027 would recoup the investment in fuel-efficient technology in less than two years through fuel savings. This means that the next generation of trucks is anticipated to be significantly cleaner and as a result will have much less environmental and land use impacts.

Emerging Energy Markets

In U.S., hydraulic fracturing (aka fracking[42]) now accounts for 51 percent of all U.S. oil output, according to the Energy Information Administration[43] (see Figure 122).

Figure 122: Recent Changes in Crude Oil Production in the U.S.



Source: U.S. Energy Information Administration, IHS Global Insight, and DrillingInfo

This is a significant change in 15 years as fracking made up less than 2% of American oil production in year 2000. This dramatic shift was caused by new fracking technology and the rise of crude oil prices in the global markets. However, there is now excess oil supply in the world which caused a crash in crude oil prices as much as 75 percent since mid-2014. This crude oil price crash has since then practically halted the growth of this industry. Also, fracking has been criticized for its potential environmental consequences, including water contamination and earthquakes.

In U.S. and other developed countries, there is a significant momentum building for clean energy sources as the solar power, wind turbines, and the electric/hybrid vehicle sectors start scaling up to serve a growing demand. Overall, the energy market in U.S. is still undergoing rapid and possibly dramatic changes. It is very likely that the freight transportation industry will look very different from how it is operated, fueled, and managed in the future.

Nearshoring of Manufacturing

Stifel, a wealth management and investment banking firm, recently conducted a conference call with AlixPartners, a leading global consulting firm, to survey global trends in production sourcing,

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[42] Fracking involves shooting a mixture of mostly water and sand under high pressure against a shale rock formation until it fractures. The sand fills the fracture, forcing crude oil out of the shale rock formation.

[43] http://www.eia.gov/todayinenergy/detail.php?id=25372

specifically as it relates to what has been called nearshoring, re-shoring, on-shoring, and next-shoring. The term "Nearshoring" is defined as relocating manufacturing closer to domestic demand (e.g., from China to Mexico for serving U.S. demand). They referred to this trend as similar to globalization and off-shoring. The nearshoring trend is fueled by higher transportation costs, dynamic consumer demand patterns, demographic shifts, economic growth, and better service and security. The AlixPartners' survey showed that North American companies, roughly 1/4 of respondents cited improved intellectual property security as a reason for near-shoring. The survey also identified likely industries to nearshore that in many ways depend on the industry, product, and regulation. The auto industry has been re-shoring and realigning production capacity lately (e.g., smaller vehicles moving to Mexico, larger vehicles such as trucks, vans, and SUVs to the U.S.). The high-tech industry was also cited as an early mover in nearshoring. This trend was deemed as positive for 3PLs serving the nearshoring industry sectors. This nearshoring trend was also deemed as positive for ground transportation companies, truck brokers, and north/south rail operators. Consequently, this trend was considered to have negative financial impacts to ocean carriers, West Coast ports, international freight forwarders, and international air cargo.

In the retail sector, there is a big push for the "Made in the U.S.A" label. For example, Walmart has initiated a $250 billion commitment in 2013 to buy products supporting American jobs. These campaigns of fostering local manufacturing jobs are having a tangible impact on communities across the country.

Freight-Oriented Development Opportunity Areas

The process of identifying potential freight-oriented development areas started with a review of the Seven Portals Study that was conducted in 2011 by the NCDOT[44]. The Seven Portals Study identified four freight logistics villages:

- Logistics Village 1 - RDU Airport Area
- Logistics Village 2 - Triangle North Properties
- Logistics Village 3 - Johnston County Jetport Area
- Logistics Village 4 - Sanford-Lee County Executive Jetport Area

The RDU Airport Area includes several parcels and vacant buildings in and around the RDU Airport and within the RTP. This area has also been targeted for significant redevelopment as part of the $1.0 billion Park Center development plan outlined in the recent RTP Master Plan.[45] The RDU Airport Area also serves as a central location for the Triangle region with good highway and airport access. This area already has a significant freight presence and is the prime area for further freight-related development and infrastructure projects.

The Triangle North Properties identified in the NCDOT Seven Portals Study included four different sites:

1) A 250-acre site in Franklin County which is ready for development and has good access from the U.S. 401 corridor and is adjacent to the General Aviation airport. The site was 8-mile away from the CSX rail corridor. This site was viewed suitable for Tier 2 Technology and Aviation industries.
2) A 527-acre certified site in Granville County with 1-mile of roadway and utilities in place. The site has access to I-85 and a frontage road, and 3-mile away from the General Aviation

[44] https://connect.ncdot.gov/projects/planning/RNAProjDocs/2010-34-4TriangleRegionReport.pdf
[45] http://www.rtp.org/rtp-reveals-park-center-plan/

airport. The site is 2-mile away from the CSX rail corridor. This site was deemed suitable for Tier 2 Life Science and Technology industries.

3) A 422-acre certified site in Vance County. The site has access to I-85 and a frontage road, and 5-mile away from the General Aviation airport. The site is 3-mile away from the CSX rail corridor. This site was deemed suitable for Tier 1 Technology and Manufacturing industries.
4) A 1,000-acre site in Warren County. The site has access to U.S. 1/158 corridor, and 3-mile half-mile away from the CSX rail corridor. This site was deemed suitable for Tier 1 Logistics, Distribution and Manufacturing industries.

These Triangle North Properties are located far north of the Triangle region and outside the MPO boundaries. These sites remain viable for freight-oriented developments in the future, but will need to be further explored with local planners and economic development staff to assess feasibility.

The Sanford-Lee County Logistics Village was defined as a general area surrounding the General Aviation airport and accessed by U.S. 1, U.S. 501 and U.S. 64. The area has good highway and rail accessibility and was deemed suitable for Pharmaceuticals, Aviation-related, and Manufacturing industries. This area could also serve as viable future freight DCs for not only the Triangle region, but also for the Greensboro and the Charlotte regions.

The Johnston County Logistics Village referred to two sites: a 350-acre certified Four Oaks site in Johnston County and a 250-acre site in Selma with rail access. This area had good access to I-40 and I-95 corridors along with NS and CSX rail lines. The area is also to military installations. This area was deemed suitable for Aviation-related, Manufacturing, and Logistics industries. This area was the target for the new CSX terminal initially, but was later shifted to the Rocky Mount site due to local oppositions.

In addition to these four development zones, there appears to be local development interests in North Durham surrounding the Merck Pharmaceuticals company. It is plausible that the North Durham area becoming a mini-biotech hub for the region. However, the area currently has limited roadway and interstate access. In the past, NCDOT had a roadway project titled Northern Durham Parkway[46] to improve access to this area. The roadway project is not a high priority project in current adopted plans. This are will need to be further explored with local planners, economic development staff, and the freight advisory council to identify specific opportunity areas and assess feasibility.

The NCDOT is currently moving forward with the implementation of the Southern Wake Expressway project[47] that will complete the outer loop of the Triangle region providing Interstate access to Holy Springs, Fuquay Varina, south Garner and Clayton. It is plausible that this new expressway will open up development opportunities in the Fuquay Varina/South Garner area. This Southern Wake Expressway corridor will need to be explored with local planners, economic development staff, and the freight advisory council to identify specific opportunity areas.

[46] https://www.ncdot.gov/projects/ndp/download/EnvironmentalConstraintsMap.pdf

[47] https://www.ncdot.gov/projects/complete540/download/Complete540PreferredAlt2.pdf

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8 FREIGHT CORRIDORS AND DEVELOPMENT ZONES

This chapter documents the technical approach and the stakeholder engagement process utilized in developing the SFC network for the Triangle region. The technical approach involved first reviewing current year (2014) truck volumes and future forecast year (2040) truck volumes on the roadway network to identify high truck volume roads, and then overlaying the high truck volume network with freight-related industries, connections to intermodal terminals and seaports, airports, commercial and retail centers to develop the necessary connectivity of the routes. The SFC network was reviewed against the origin-destination pattern of the top commodities by value for outbound shipping such as pharmaceuticals, machinery, chemicals, motorized vehicles, and electronics. The SFC network was also reviewed against the travel time reliability performance data to select higher-performing and redundant routes, whenever such multiple options were available. Overall, the goal was to define a SFC network that can serve the region's industries and supply the population centers with high efficiency. While the SFC network mainly lies within the joint MPO boundary, some extension of the SFC network was allowed outside the joint MPO region. The draft SFC network was reviewed by local governments, economic development officials, and the RFSAC members over a period of four months from October, 2016 through January, 2017 to identify compatibility with local land use plans, development ordinances, and freight distribution routing plans. The result of this stakeholders' review process resulted in the current version of the SFC network, labeled as SFC 4.0 in this chapter. The stakeholder process also resulted in developing a tier system for the SFC network, *SFC-Regional* and *SFC-Local* routes in order to accommodate local freight distribution needs.

This chapter also discusses the expansion plans of the North Carolina ports, airports and railroad freight carriers, and the implications of those expansion plans for the Triangle region. In addition, this chapter documents the likely development opportunity zones in the region based on the recommendations from the Statewide Logistics Plan, available industrial site data from the Economic Development Partnership of North Carolina, and the year 2040 land use modeling and forecasts from the region's CommunityViz model. These development opportunity zones are identified to support the region's freight-related industries.

This chapter also reviewed the land use conflicts and community issues, particularly Environmental Justice (EJ) concerns. This EJ analysis documents the areas of community concerns.

Strategic Freight Corridors (SFC)

This section of the report summarizes the technical approach and the stakeholder engagement process utilized in developing the SFC network for the Triangle region.

Basic Premise

Freight transportation principally does two things:

- it provides service to industry, and
- it provides service to population.

From this perspective, it is critical to have a good freight transportation network to maintain efficiencies of our local industries, attract new businesses, supply goods and products to the region's commercial centers, and provide home delivery services to households. In essence, a good public-sector freight transportation network that connects region's commercial and intermodal centers with private-sector manufacturing and distribution facilities is essential for a healthy and competitive regional economy. Also, it is necessary to take advantage of the emerging trends of supply-chain logistics and export-import traded goods to attract industry expansion and upgrades in the region. For example, approximately 44 percent of the nation's population is within 20 miles of an Amazon DC in 2016, compared to five percent in 2010. This explains how the goods and products are flowing in today's economy from factories overseas through U.S. ports to sprawling suburban warehouses and neighborhood package-sorting centers to households. This trend also explains how the private industries are solving the problem of so-called last mile (the final and most expensive leg of the package delivery business) by locating DCs closer to the population centers and building their own last-mile and even one-hour delivery network.

A high-quality freight transportation network has to be multimodal in nature because private industry supply chains use a portfolio of modal options to manage a diversity of needs. However, the connective tissue of this network is motor carriage, because the linkage from airports and rail terminals to business sites is supplied most frequently by trucks. In addition, the efficiency, flexibility and pervasiveness of trucking make it the mode of choice for the majority of supply chain transport. The regional roadway freight network therefore provides the principal means of serving business and population, and of supporting the regional economy. A core network of SFC captures and combines the highways, arterials and connectors that are most needed to accomplish all of this.

Rationale for Defining an SFC Network

There are three major advantages to utilizing an SFC system for the assurance of service and the provision of economic and multimodal support. The first is that it allows limited financial and management resources to be concentrated on facilities where they can generate the greatest private and social returns. This involves capital and operational investment, and also policies designed to protect the network from detrimental encroachment by competing uses.

The second advantage is effective preparation for the future. A 21st Century system seeks to anticipate and shape (a) development in new areas and growth in old ones; (b) new supply chain patterns; whether from resurgent manufacturing, changes in trade, or different methods of staging consumer goods; and (c) new technology, such as lower emissions vehicles, unmanned aerial vehicles, or CAV that interact with infrastructure and each other. These types of technology developments have the potential to make freight activity safer, more efficient, and more acceptable in communities.

The third advantage concerns supply chain performance, which affects the attraction, retention and growth of industry, and the cost of goods to consumers. Time and cost are the crucial logistics drivers of supply chain performance. These factors face the greatest challenges in metropolitan environments such as the Triangle region, because speeds are slower and risks are higher: from congestion and bottlenecks; from disruption, due to accidents, public events, and other causes; and from facilities and development that are not well planned for contemporary freight operations. This results in diminished productivity, necessitating the use of more trucks, drivers, and other resources to move a given quantity of freight. Nevertheless, metropolitan environments are the chief consumer markets, the leading centers for manufacturing capacity, and (for related reasons) the frequent location of logistics facilities for the staging of goods. This makes them home to most of the last, first and transfer miles in a supply chain operation, and the challenging conditions make those miles the least productive ones in the journey to market and homes. A network designed with the goal of keeping industry competitive and consumer costs down will recognize this.

Criteria for Defining an SFC Network

In defining an SFC system, the overarching objective is to designate a forward-looking core roadway freight network for long-term protection and investment that will attract industry and support household needs through better performance in terms of speed, reliability, cost, productivity, and safety. The network should provide rapid accessibility—within approximately fifteen minutes—to major clusters of freight generation and consumption, including future ones. It should also facilitate cross-town travel so that clusters and multimodal facilities are well connected, and afford route redundancy to reduce the risk from delay and disruption. To the extent possible, the network should also anticipate the introduction of new technologies. Defining such a network will greatly facilitate freight planning in the region, particularly in establishing candidate facilities for designation as Critical Urban Freight Corridors as required of CAMPO and DCHC MPO under the FAST Act.

This network should focus on existing and future forecast truck volumes in the region, future freight related improvement projects, and efficient routes to support first miles, last miles, and cross-town travel. This network should accommodate trucks, be feasible, suitable and safe for truck movements; and be monitored for traffic speed, reliability and safety. This SFC network was defined to have two designations – Regional (SFC-R) and Local (SFC-L) to allow regional versus local freight distribution needs.

Development of the SFC Network

In order to develop the SFC network for the Triangle region, a series of attribute maps were developed using the following data and threshold values:

- Base Year (2014) Truck Volumes greater than 400 trucks per day
- Forecast Year (2040) Truck Volumes from the NC Statewide Travel Demand Model, greater than 1,000 trucks per day
- Forecast Year (2040) Truck Volumes from the Triangle Freight Forecasting Model, Greater than 1,000 trucks per day
- Access to Freight-Related Industries
- Service to Freight Employment Clusters
- Supply to Commercial Centers
- Multi-Modal Connectivity to the Airports, Seaports, and the Railroad Intermodal Terminals

- Route Reliability for Truck Movements During AM Peak Hour, Mid-Day Peak Hour and PM Peak Hour as defined by BTI greater than 1.0 using NPMRDS Travel Time Data
- Truck-Related Crashes using Last 5 Years Crash Data from NCDOT's Traffic Safety Unit
- Land Use Conflicts and Environmental Justice Concerns as defined by the Capital Area and DCHC MPOs as Six Communities of Concerns (Zero-Car Households; Individuals making less than 150% of the federal poverty rate; Non-White Race; Linguistic Isolation - Speak English "Not at all" or "Not very well"; Hispanic/Latino Origin; Age 70 and over)

These variables served as the building blocks for defining the first version of the SFC network. These single criteria building block maps are presented in Figure 123 through Figure 134. These maps served as the basis for defining the first version of the SFC network, as shown in Figure 135. This draft SFC 1.0 network was submitted to the RFSAC and the MPOs in October, 2016 for independent reviews and discussions with local jurisdictions.

The Capital Area MPO and the DCHC MPO staff members conducted several workshops with local jurisdictions during the months of October, 2016 through January 2017 to obtain feedback on adequacy and reasonableness of the SFC network. In many instances, additional roadway network was added to the SFC network to be compatible with local land use plans, comprehensive transportation plans, and local development ordinances. In other instances, roadway segments were suggested for deletions due to residential land uses and pedestrian and bicycle usage of urban area and/or Main Street corridors. The resulting SFC network that emerged from this stakeholder engagement process is shown in Figure 136, which represents the fourth version of the SFC network including changes based on a local staff, MPO board and public review. It is plausible that this network will be further refined and adjusted in the future based on new community needs, new business locations, and travel demand changes on the region's multi-modal freight transportation system.

Figure 123: Roadways with 2014 Average Daily Truck Traffic > 400

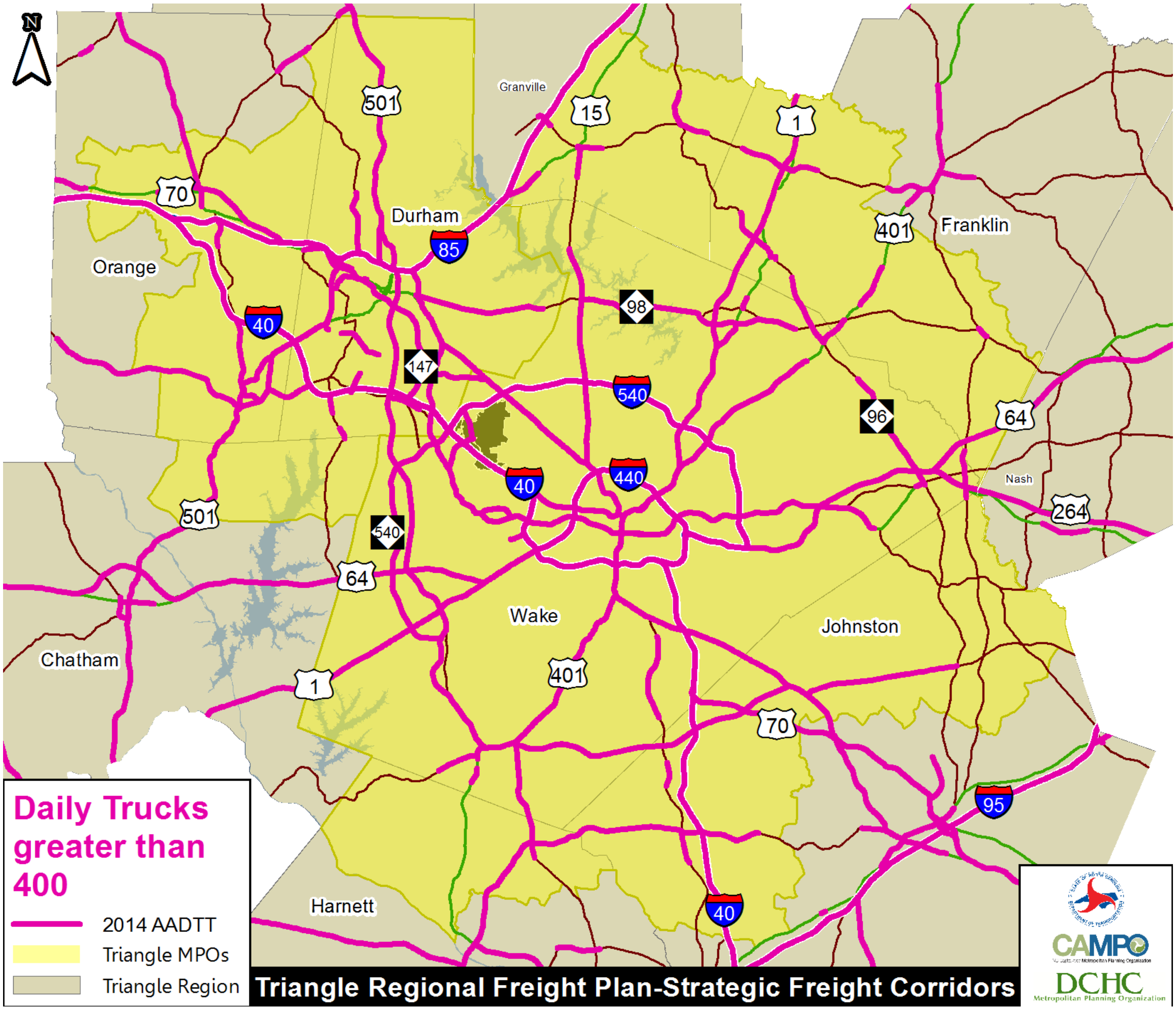
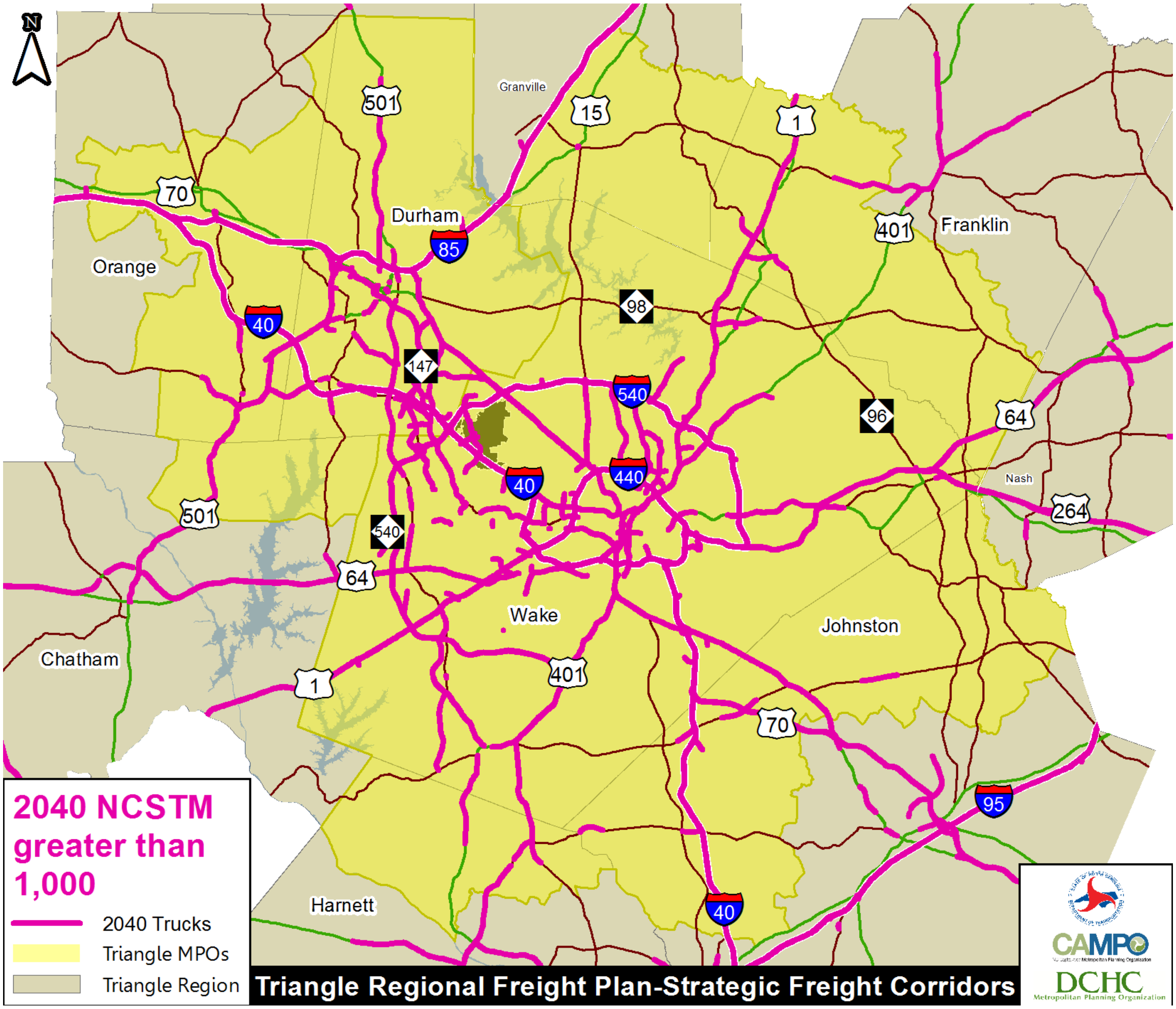
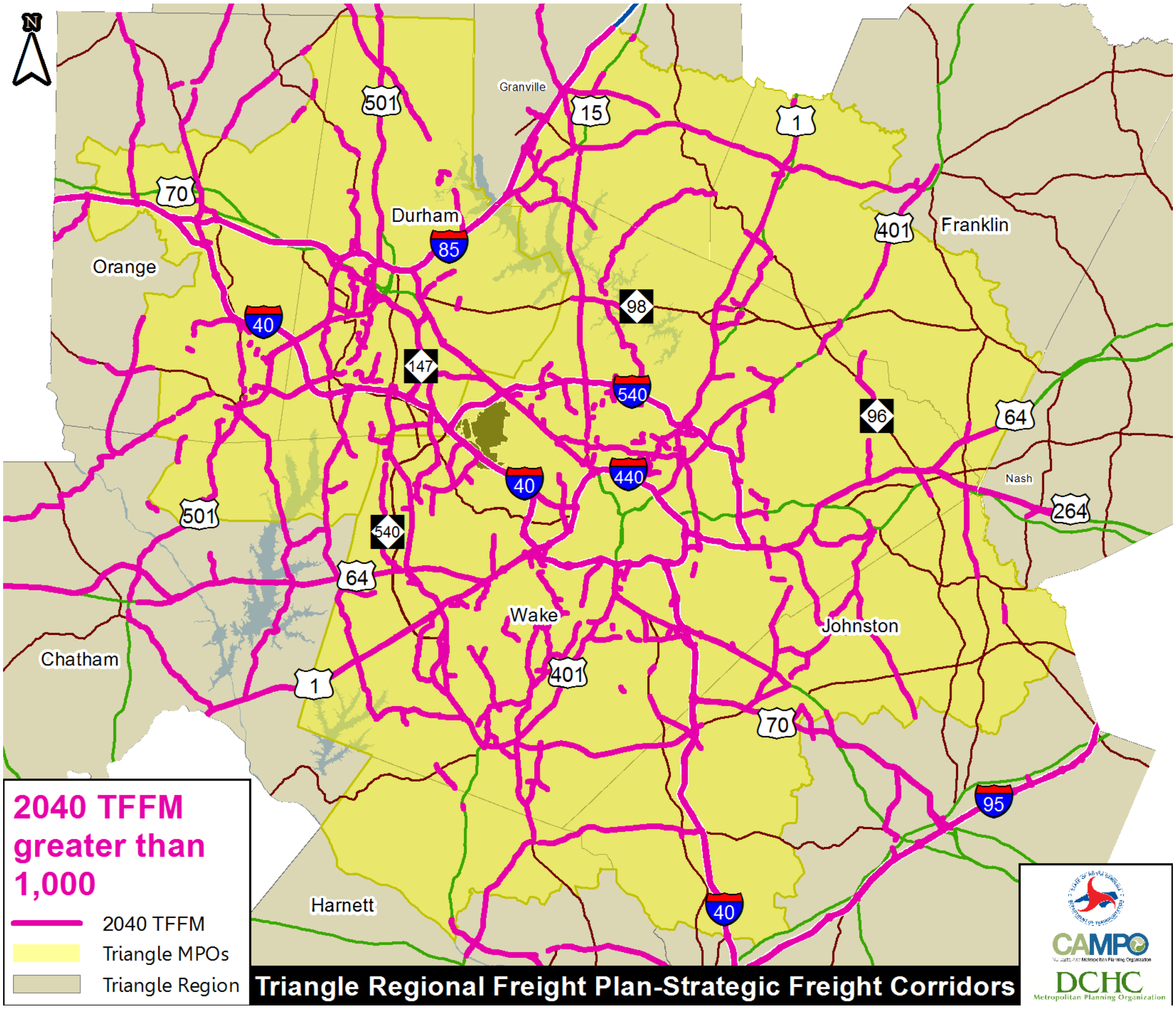


Figure 124: Roadways with 2040 Daily Truck Traffic > 1,000 (NC Statewide Travel Demand Model)



Source: NCSTM

Figure 125: Roadways with 2040 Daily Truck Traffic > 1,000 (Triangle Freight Forecasting Model)



Source: Triangle Freight Forecasting Model (TFFM)

Figure 126: Access to Freight Intensive Firms

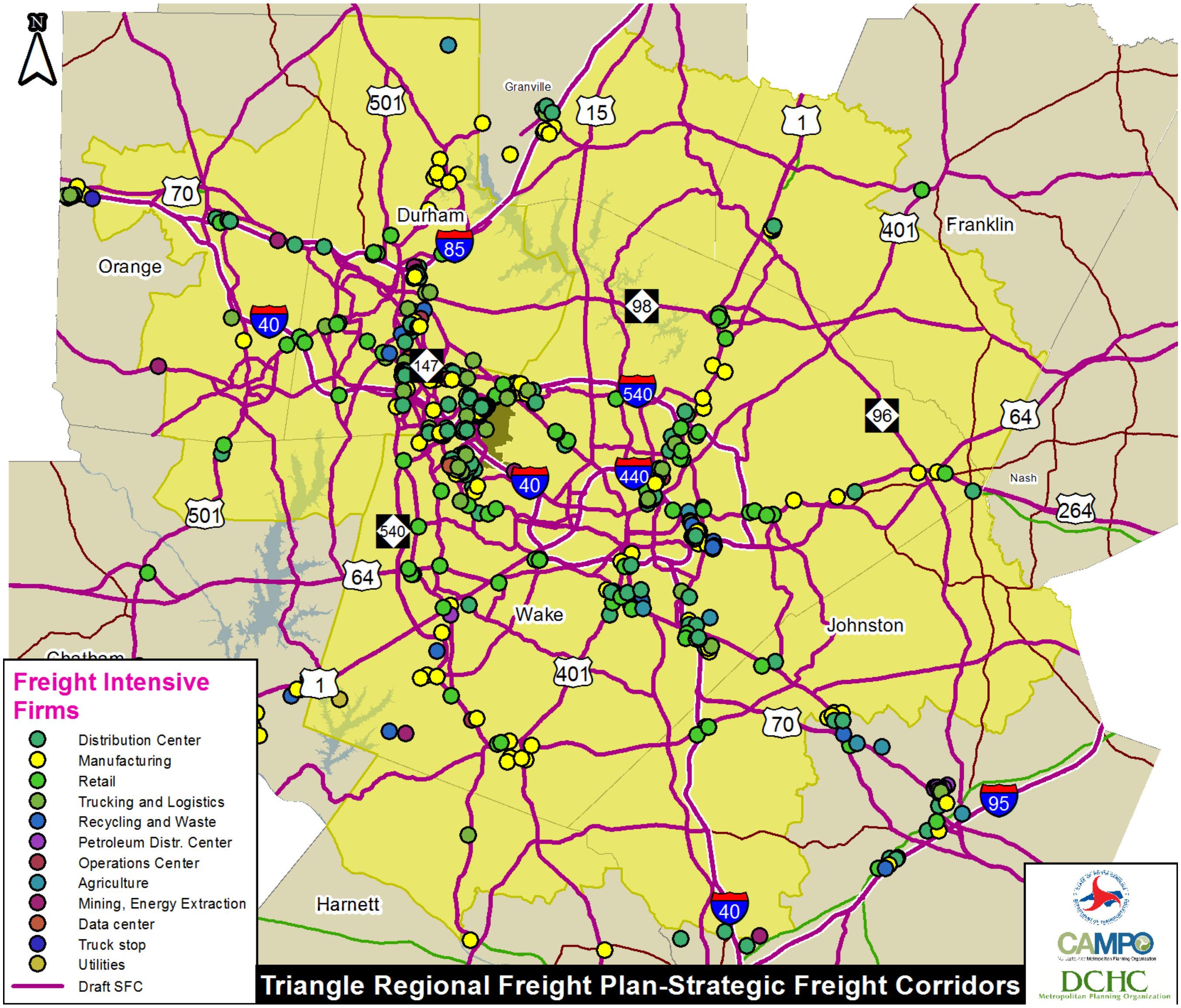


Figure 127: Access to Freight Clusters and Freight-Related Employment

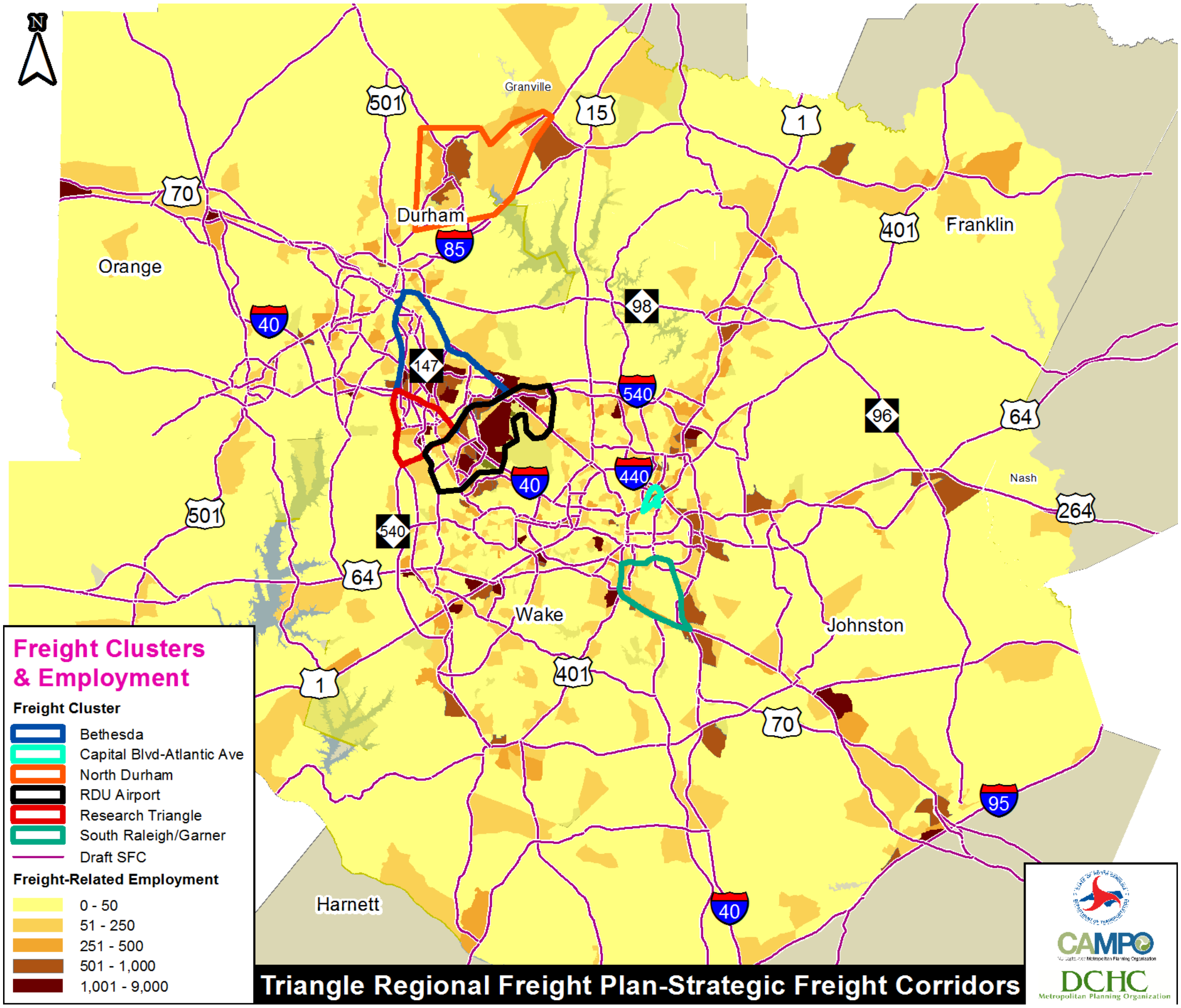


Figure 128: Access to Commercial Centers

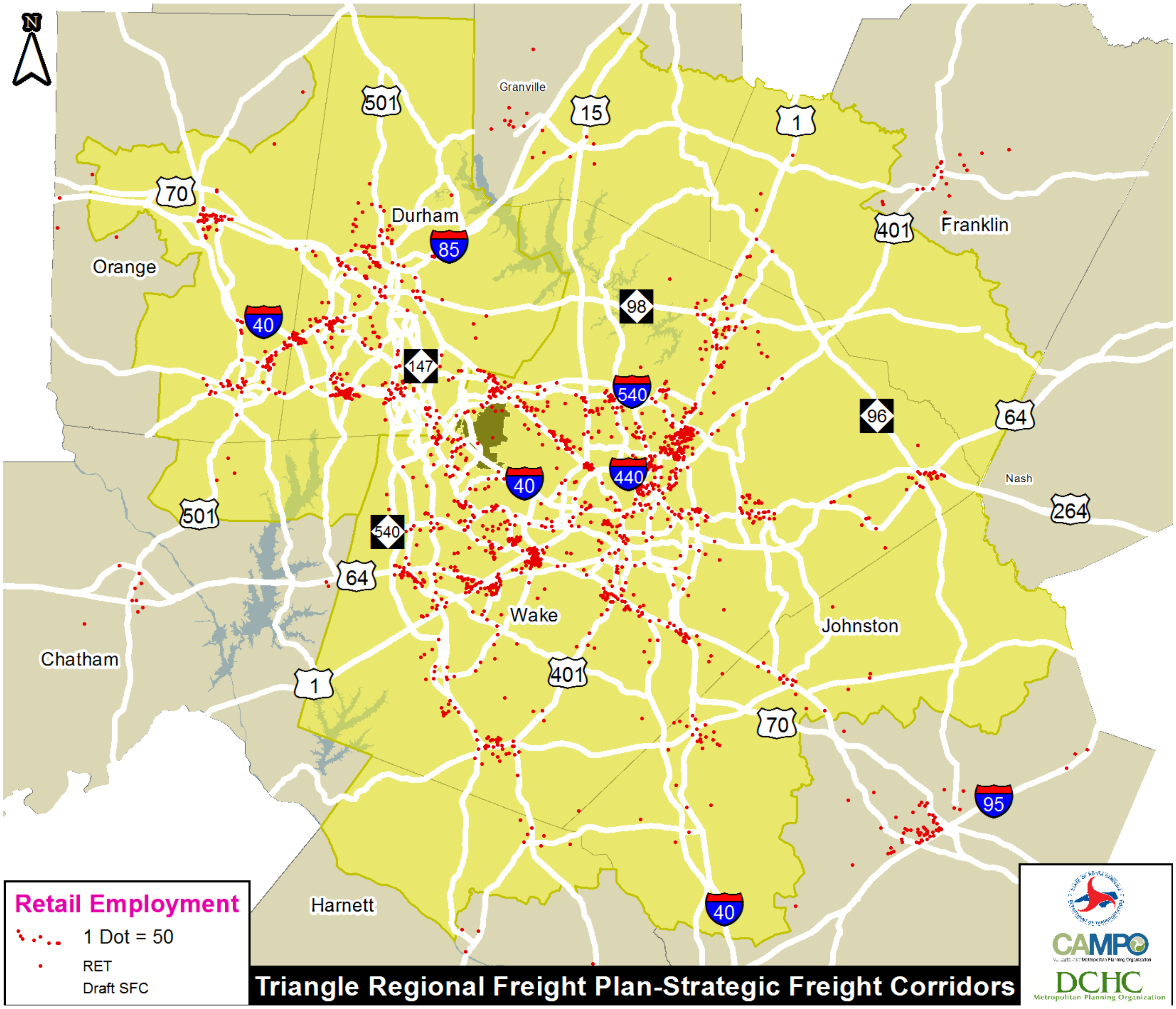


Figure 129: Access to RDU Airport, Seaports and Railroad Intermodal Terminals

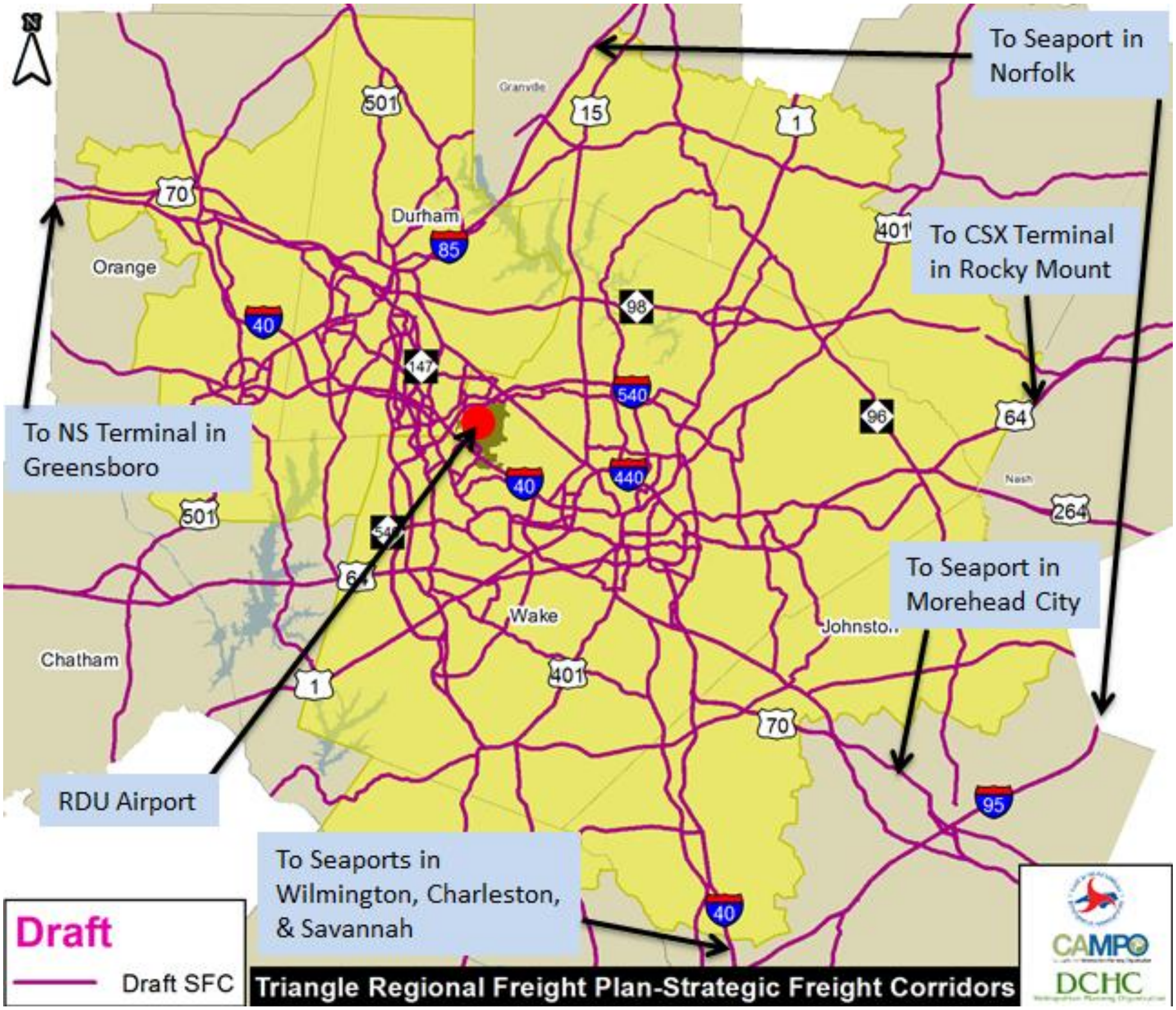
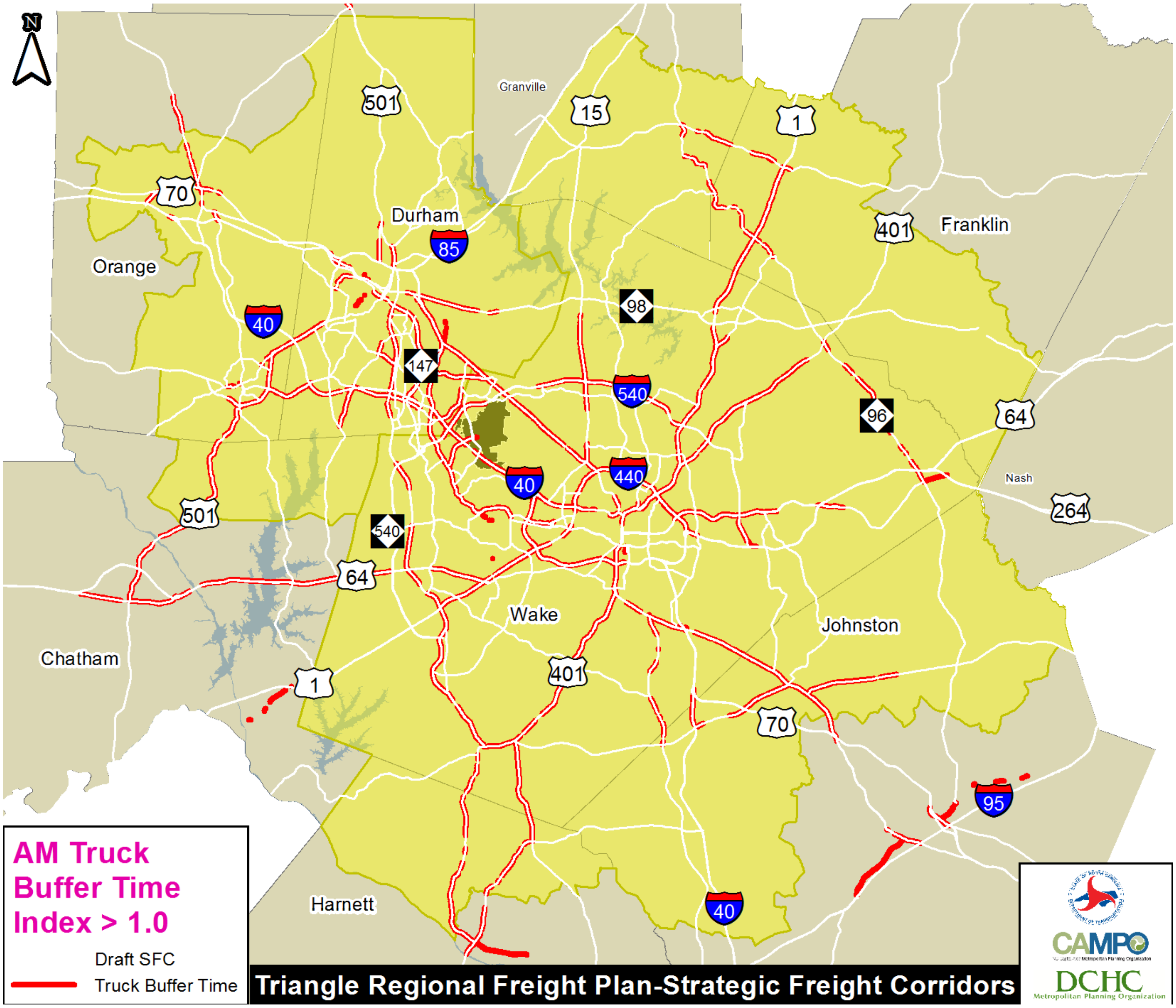
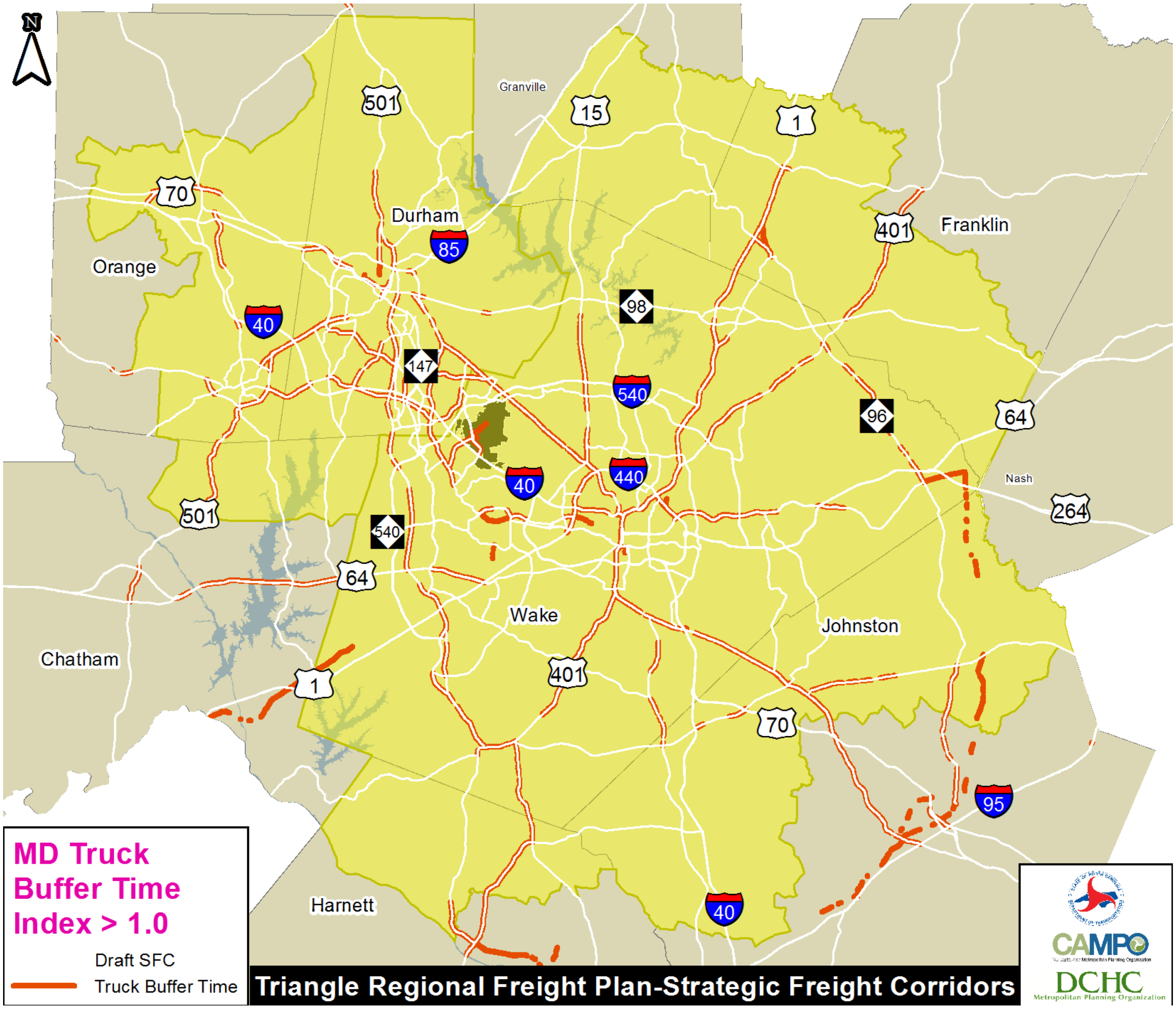


Figure 130: AM Peak Hour Buffer Time Index for Trucks



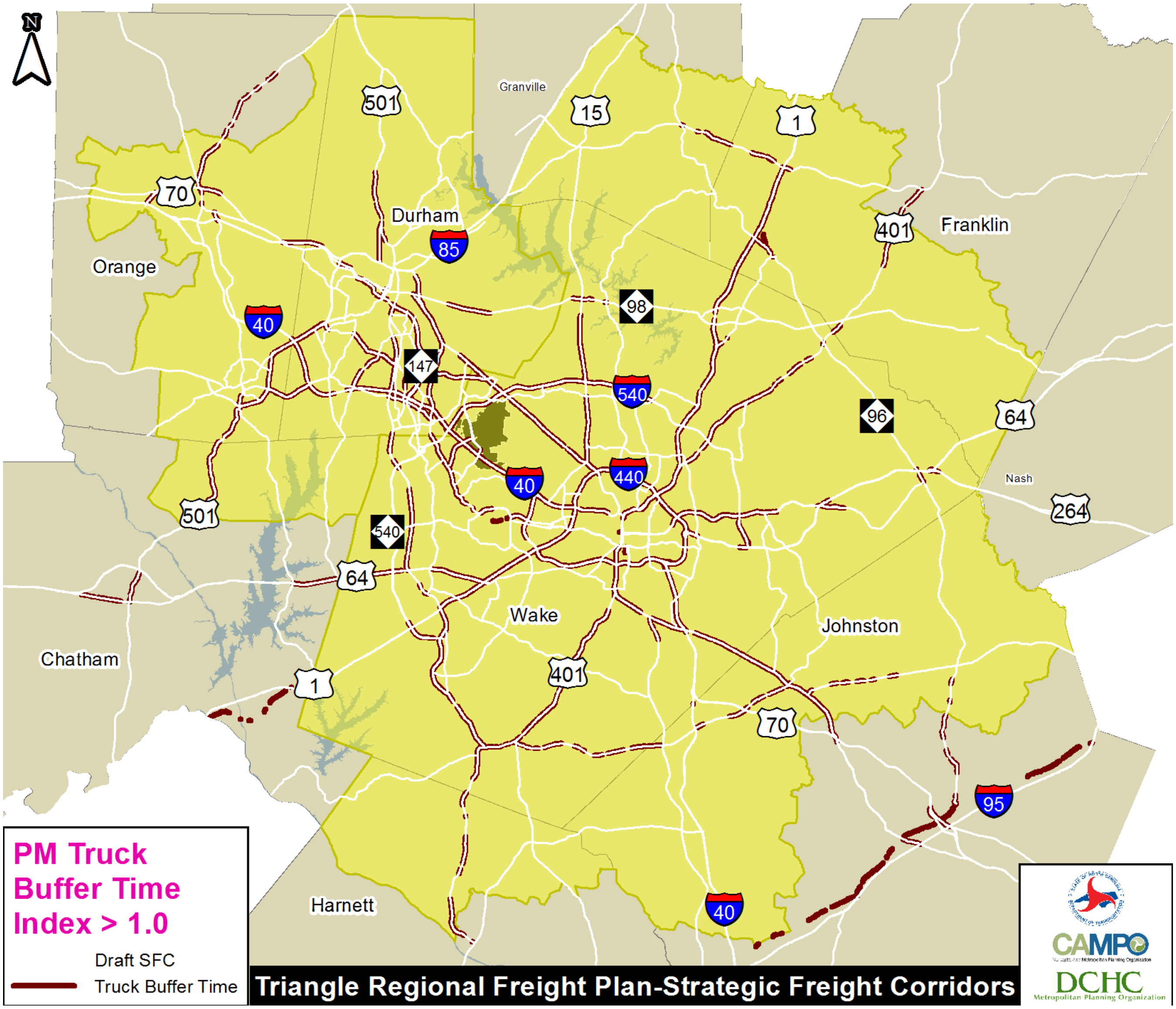
Source: NPMRDS Data

Figure 131: Mid-Day Peak Hour Buffer Time Index for Trucks



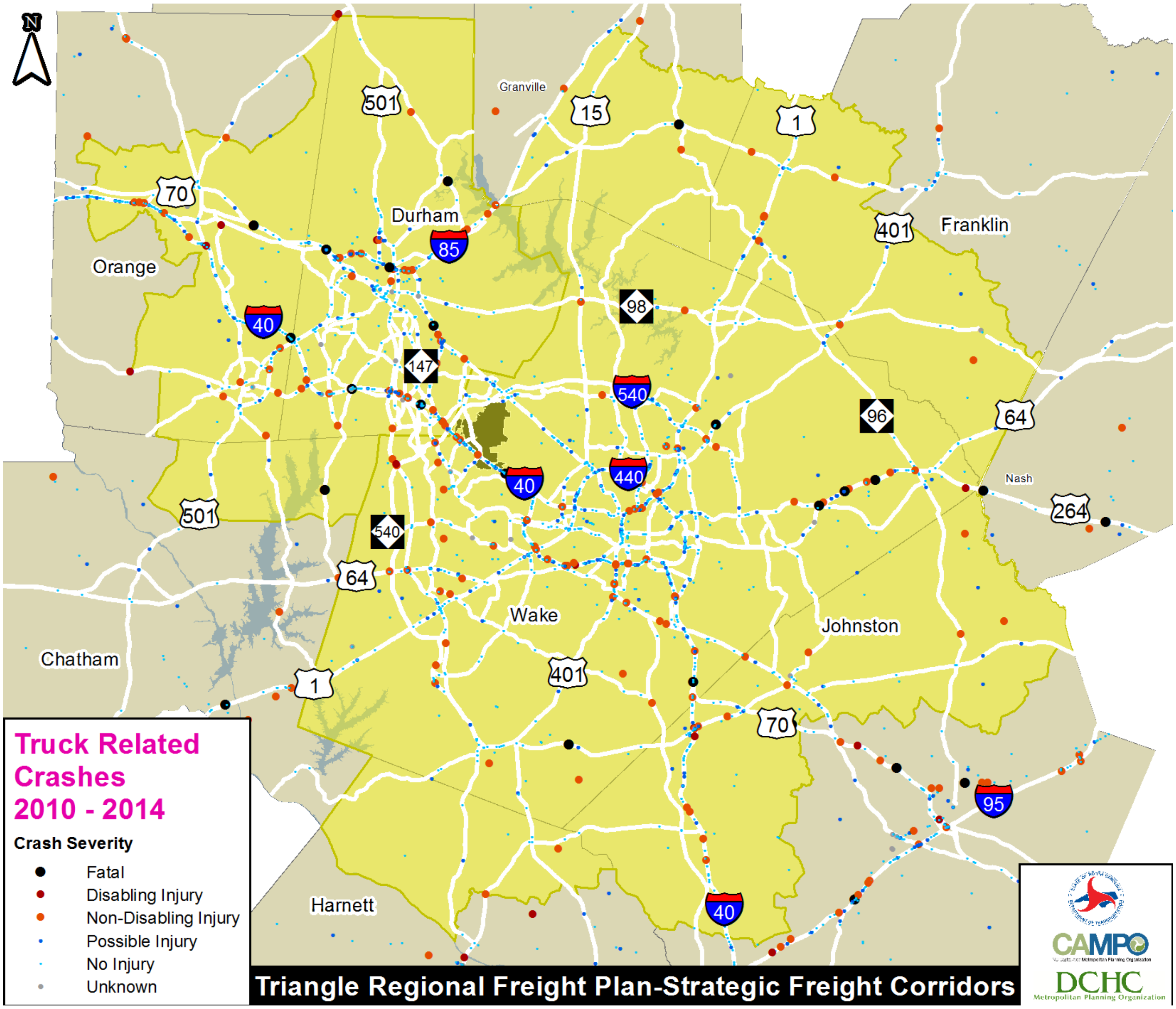
Source: NPMRDS Data

Figure 132: PM Peak Hour Buffer Time Index for Trucks



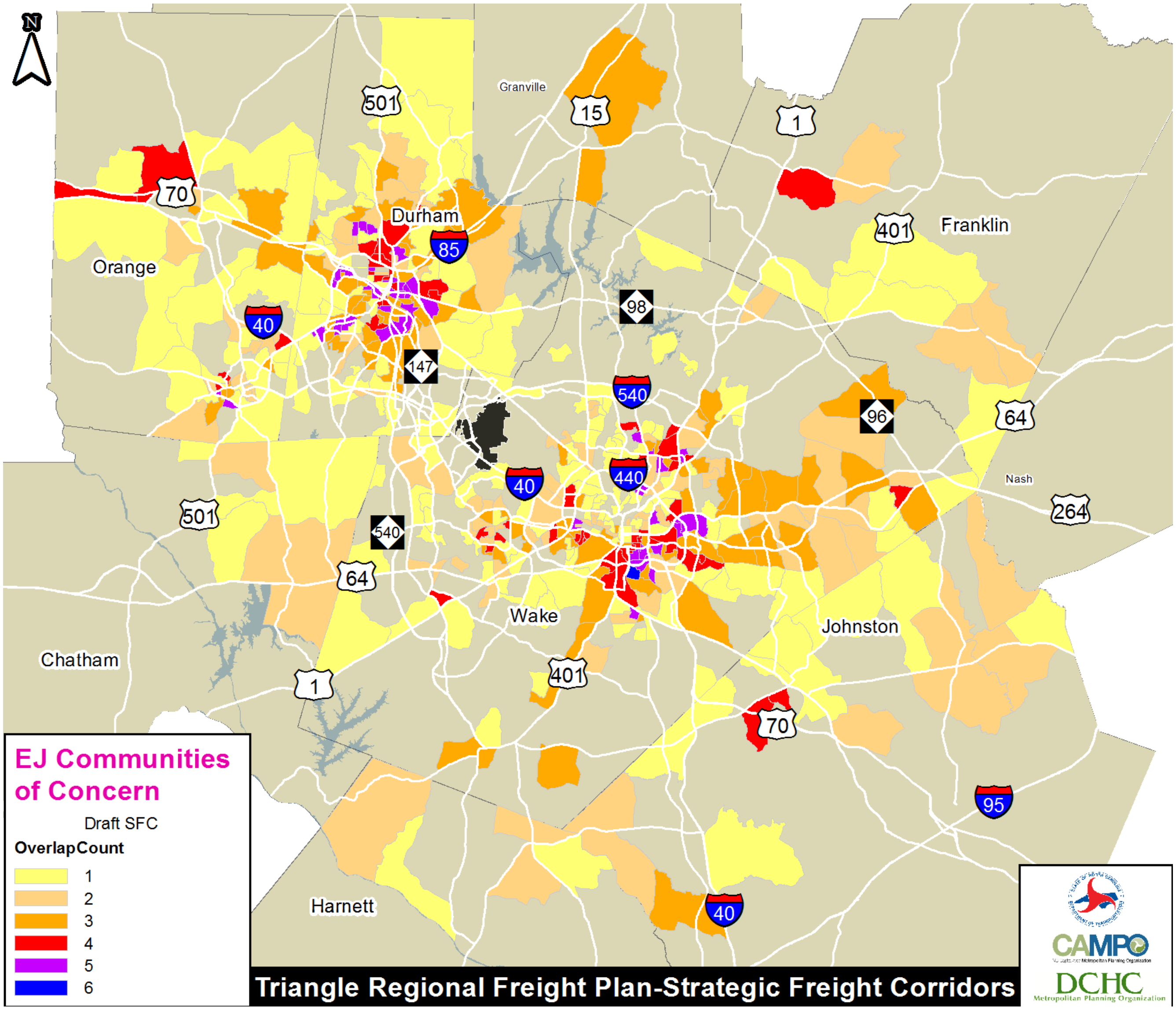
Source: NPMRDS Data

Figure 133: Location of Truck-Related Crashes



Source: NCDOT Crash Records

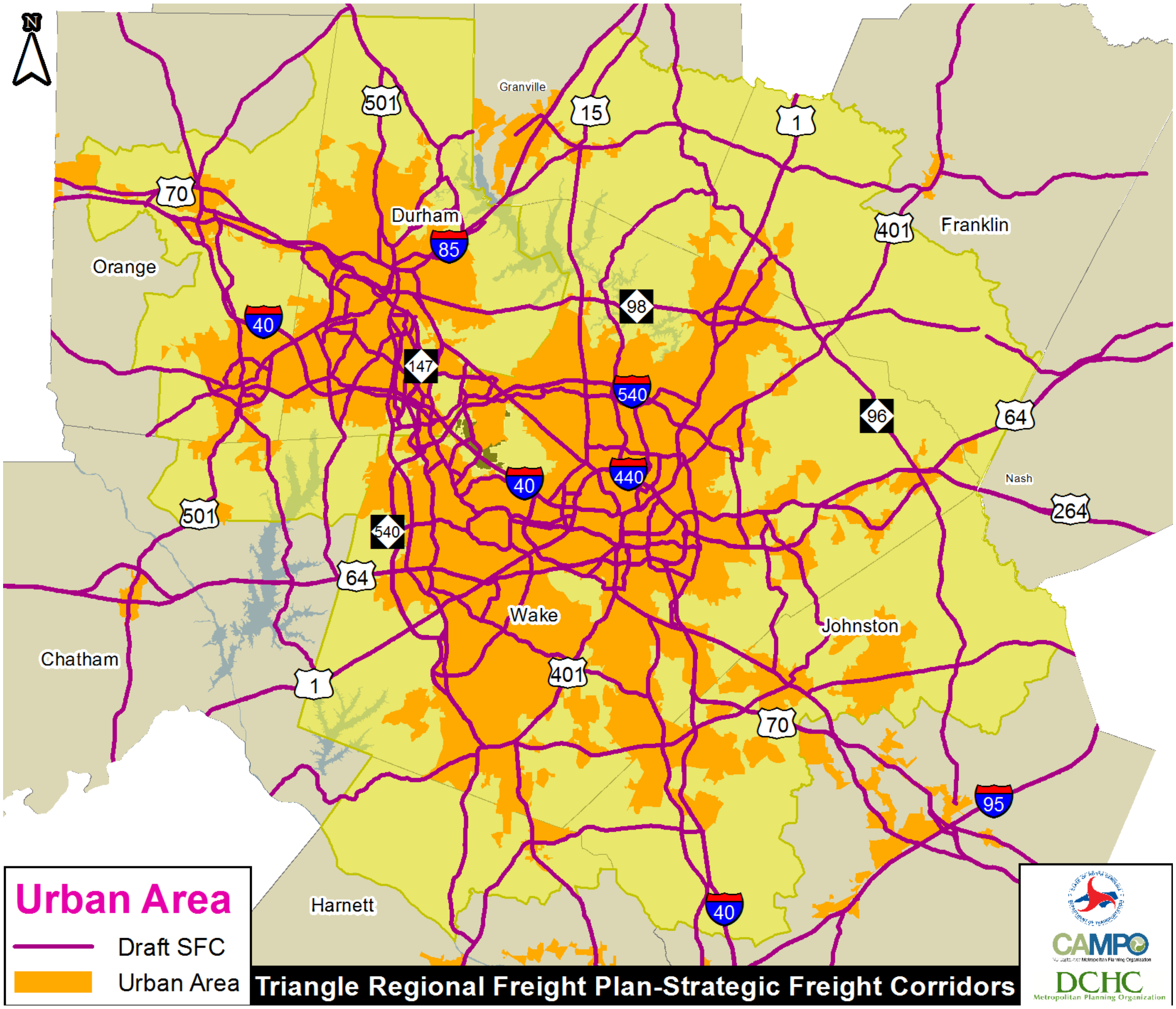
Figure 134: Land Use Impacts and Environmental Justice or Communities of Concerns



Source: Capital Area and DCHC MPO Data

Note: Six Communities of Concern were defined by the MPOs. These were: 1) Zero-Car Households; 2) Individuals making less than 150% of the federal poverty rate; 3) Non-White Race; 4) Linguistic Isolation - Speak English "Not at all" or "Not very well"; 5) Hispanic/Latino Origin; and 6) Age 70 and over. The heat map shows the areas with multiple communities of concern in darker colors. For example, the dark blue areas have all six communities of concern based on the demographics data from the American Community Survey. In contrast, the light-yellow areas have any one of the community of concern.

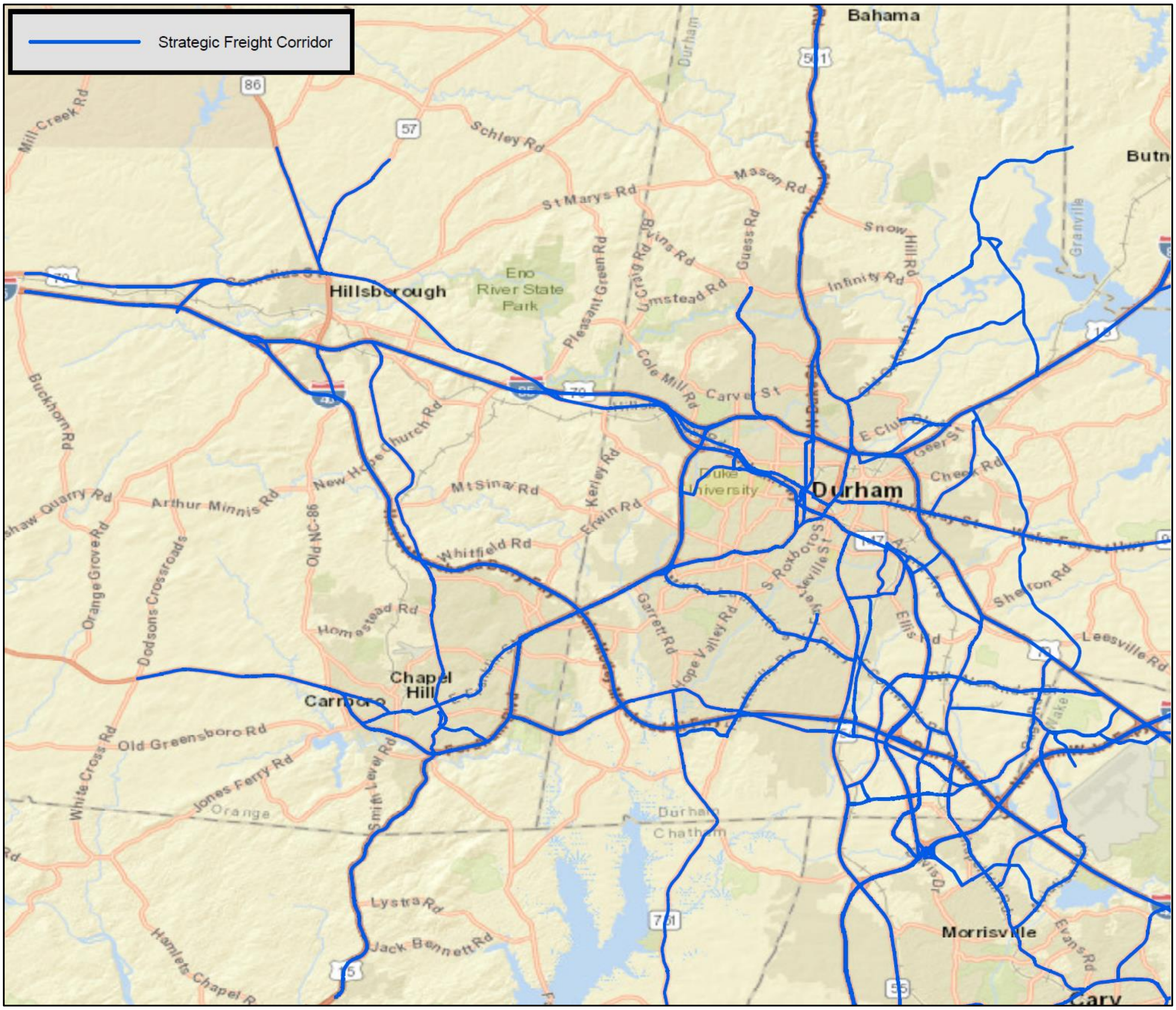
Figure 135: Strategic Freight Corridors, Version 1.0



Note 1: SFC 1.0 Network includes 1,040 miles within the Urban Area and 110 miles within the Rural Area for a total of 1,150 miles within the two MPO boundaries (DCHC MPO and CAMPO). This total mileage includes 155 miles of Interstates.

Note 2: Urban Area is the term for urbanized areas (UAs) and urban clusters (UCs). UAs consist of densely developed areas that contain 50,000 or more people. UCs consist of densely developed areas that have at least 2,500 people but fewer than 50,000 people. The Census Bureau defines urban areas once a decade after the population totals for the decennial census are available, and classifies all territory, population, and housing units located within a UA or UC as urban and all areas outside of a UA or UC as rural.

Figure 136: Strategic Freight Corridors, Version 4.0 (DCHC MPO version)



Note: The SFC 4.0 Network includes approximately 1,250 miles of network, including 155 miles of Interstates, 277 miles of U.S. Routes, 359 miles of NC Routes, 348 miles of SR Routes, 63 miles of Other Routes, and 48 miles of future proposed roads.

Modal Freight Gateway Expansion Plans

The demand for freight transportation is expected to evolve considerably over the coming decades, as described in Chapter 7. Manufacturing, especially in high-tech sectors, will place increased demands on inbound and outbound supply-chains serving the Triangle Region. At the same time, rapid population and employment growth will increase demand for retail goods and construction materials, as consumer demand keeps up with economic growth. These and other trends described previously will require changes and improvements to the existing freight infrastructure.

The owners and operators of freight facilities in the state are making investments and developing projects to better meet these changes in demand patterns. Providing enough capacity and meeting increasingly higher service standards will ensure continued regional competitiveness. This section describes several key ongoing and proposed freight projects that will have an impact on supply-chains in the Triangle Region. Focus is placed on major projects in rail, air, and ports.

Rail Developments

In response to the growth in demand for intermodal rail service, freight railroads are investing heavily in their intermodal infrastructure around the U.S. In North Carolina, the largest of these investments is the planned construction by CSX of an intermodal terminal near Rocky Mount, which is located just over 50 miles from the Triangle Region. The construction of this project, called the Carolina Connector, is expected to begin in mid-2018 and cost $270 million. No additional information has been made publicly available beyond what has been reported elsewhere in this plan.

CSX recently announced another component of their strategy to improve intermodal service in North Carolina. The Queen City Express will be introduced soon as a new double-stack intermodal service connecting the Port of Wilmington with the existing intermodal terminal in Charlotte and the planned Carolina Connector. This signifies the return of intermodal service to the Port. State and port officials indicate that this would allow the port to serve North Carolina markets better, particularly for imports from Asia. However, because the Port of Wilmington only recently re-established service to Asia, it is likely it will only remain a minor gateway for Asian imports to the Triangle Region in the medium term.

Port Developments

Ports in North Carolina are also making critical investments to meet changing supply-chains. The Port of Wilmington continues to see increases in cargo. From 2014 to 2015 the Port saw an 18 percent year-over-year increase in containerized cargo volumes, leading it to become one of the fastest growing ports on the East Coast (albeit compared to a relatively small base). The latest figures show this growth continuing into 2016. The 2015 Strategic Plan of the North Carolina State Ports Authority estimated that from 2015 to 2020 tonnages at the Port of Wilmington are likely to increase by 131 percent while tonnages at the Port of Morehead increase by 181 percent. The goal of the Port Authority is to double container volumes over this time period.

To meet this growth, the Port of Wilmington is currently investing more than $120 million to modernize key facilities. The objective of this investment is to speed up the loading and unloading of vessels, by enhancing multiple berths, purchasing post-Panamax container cranes, and installing a submerged toe wall in anticipation of future investments. The Port is also undergoing a harbor deepening project to accommodate post-Panamax ships in the 8,000-TEU to 10,000-TEU range. The Port recently completed an expansion of the turning basin on the port side of Cape Fear River from 1,200 ft. to 1,400 ft., allowing ships to make three point turns to get in and out of the port. This project also involved removing an existing bulk pier.

Together with the new CSX stack train service described above, these and other investments are targeted at making the Port of Wilmington more competitive in several international markets, particularly in Asia. In 2016 the Port initiated container transatlantic service with Asia through a partnership with Mediterranean Shipping Co. and Maersk Line. In order to complement these new services, the port is also investment in improving and expanding its land-side facilities. In 2015 the Port inaugurated the first cold storage facility at a port in North Carolina. This private-public investment has the potential to attract clients that move poultry, pork, fish and vegetables, who today use ports in Georgia and Virginia with similar facilities. These types of enhancements will become more common as the port seeks to continue growing in tonnages and regional importance, particularly for containerized cargo.

The second largest port in the state, at Morehead City, has also seen substantial growth in recent years. Total tonnage is up 19 percent year-over-year through February of 2016, primarily due to an influx of new accounts, especially for grain imports. The Port currently does not have the capacity to handle intermodal cargo, and according to the Eastern Infrastructure Study (AECOM, 2015), significant investment would be required to permit the port to handle containerized cargo. Even though the port counts with one containerized crane, standing areas for ships are limited. This study found that even though the channel is comparatively deep at 45 feet, there is not enough quay length to accommodate ships with more than 5,000 TEUs. There is currently no proposed project to remove these constraints so that containerized cargo could be handled at this port. Currently the port serves as a large gateway for rubber and other bulk and breakbulk products. On-dock rail access is provided by NS.

The draft NC Freight Plan found in discussions with key stakeholders the needs outlined in Table 49.

Table 49: North Carolina Port Infrastructure Needs

Type	Port of Wilmington[48]	Port of Morehead City[49]
On-Site	Complete turning basin expansion Complete cold storage facility Finish wood pellet export facility Expand container yard to service longer intermodal trains, adding trackage[50] Purchase additional cranes (2 Ship to Shore container cranes, 100-gauge rail mounted in current budget)[51]	Further develop Radio Island (Ro/Ro or containers would be good cargo here) Expand wood pellet export facility Create and partially fund an ongoing dredging agreement with USACE[52] Replace aging cranes, add more (in near-term, purchase one $6M crane for breakbulk cargo) Purchase a rail loader Relocate scales, minimize need for re-weighing Extend track into warehouse north of Arendell St. Replace aging warehouses and transit sheds Increase building setbacks near lower-numbered berths (for better rail access, crane movement) Cover a portion of the rail yard to handle unloading of cargo in wet weather to enable Morehead City to better capitalize on its certification to handle organic grains
Roads	Retrofit on-ramp from northbound U.S. 17/421 onto I-140 for safety Complete design/ construction of fourth river crossing Pursue highway-railroad grade separated	Complete Gallants Channel Bridge project Push for Northern Carteret Bypass and/or Havelock Bypass so there is an alternate route to U.S. 70 Redesign intersection at Port's main gate (Arendell St / Port Terminal Rd) to reduce and/or eliminate

48 Interview with NCSPA on 8/17/2016

49 Interview with NCSPA on 9/2/2016

50 Interview with G&W on 7/27/2016

51 2015 Strategic Plan of the NCSPA, NCSPA FY17 Capital Budget

52 2015 Strategic Plan of the NCSPA

	access at the North Gate since separated access would improve safety, reduce vehicular congestion, and significantly increase rail capacity Pursue select STIP projects	oversized trucks' maneuvering issues upon exit that require blocking of on-coming traffic to complete a turn Pursue select STIP projects
Off-Site	In Charlotte, potentially use the inland port as an additional place to build intermodal trains since CSX wants trains in/out in one day at Charlotte Intermodal Terminal[53]	
Type	**Port of Wilmington[54]**	**Port of Morehead City[55]**
Rail	Remove clearance issues that limit heavy lift and project cargo Open Wallace-Castle Haynes track to improve connection to CSX's new CCX intermodal terminal in Rocky Mount Investigate the feasibility of a new rail bridge across the Cape Fear River from the port connecting to the Brunswick County rail network. to remove port rail traffic from Wilmington as flows grow	Study at-grade crossings for identifying improvements, reducing their numbers, and prioritizing implementation. Raise the Arendell Street bridge in front of the main port property to enable railroad car access underneath it to the north side of the port property, thereby creating a rail loop

Source: Draft NC Statewide Multi-Modal Freight Plan

Airport Developments

RDU is planning to improve and expand runway 5L/23R to provide better service for larger planes, particularly on international trips.[56] This will enable the airport to better accommodate air freighter planes that are important for domestic and international shipping. There is also a proposal being studied to construct a cargo aircraft apron and space for commercial vehicle staging, which would also improve the competitiveness of the airport in freight markets. As noted in Chapter 7, RDU cargo is expected to grow less than one percent annually, with an 18% total increase through 2035.

According to RDU's Vision 2040 Master Plan, the roads that provide access to the airport for all traffic – passenger and cargo - will need to be improved because otherwise two-thirds will be highly congested by 2040.

Freight-Oriented Development Opportunity Zones

In Chapter 7, four logistics sites were reviewed for freight-related developments. These four sites for potential logistics villages were the Raleigh-Durham (RDU) International Airport area, Triangle North Properties, Johnston County, and Sanford-Lee County Executive Jetport area. Those sites were identified by the State in the Seven Portals Study to support economic development goals for the Triangle region. In current conditions, three of these sites (RDU Airport area, Johnston County and the Sanford-Lee County Executive Jetport area) remain viable.

[53] 2015 Strategic Plan of the NCSPA

[54] Interview with NCSPA on 8/17/2016

[55] Interview with NCSPA on 9/2/2016

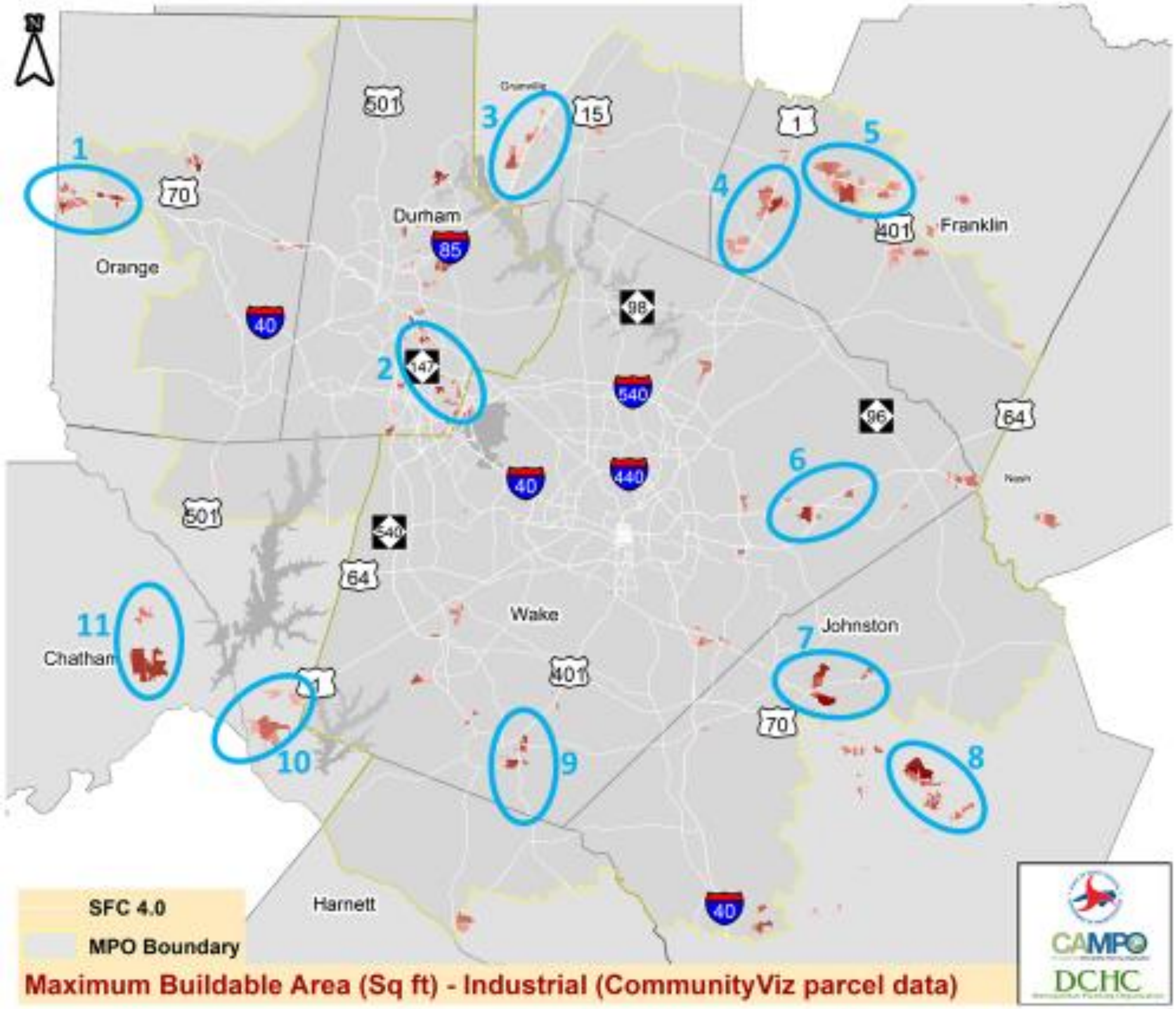
[56] RDU Vision 2040 Master Plan

As part of this effort, we reviewed the latest long-range land use forecasts for the Triangle region to identify potential industrial sites that are closer-in or near the heart of the population centers and that could support the recent supply chain trends. The land use forecasts became available in February, 2017 from the Triangle J Council of Governments (TJCOG) for the horizon year 2045. The land use forecasts were prepared using the Triangle CommunityViz Model, Version 2 (TCV2.0) for a 10-county area of the Triangle region. This TCV2.0 model considers five key land use forecasting elements at the parcel-level resolution:

1) Development Constraints - the location of features that constrain development, such as water bodies, wetlands, stream buffers, and permanent conservation areas;
2) Place Types - the type of place each parcel is today and will likely become in the future based on 30 different categories including light industrial, heavy industrial and mixed use center, and the average density or intensity of each place type for each jurisdiction;
3) Development Status - the current development status of each parcel, defined with five attributes: developed, committed, undeveloped, under-developed, or re-developable;
4) Land Suitability - the 14 different factors that determine the attractiveness of each parcel for new growth and development; and,
5) County Control Totals - the amounts of regional growth control totals by county that will need to be allocated to parcels for seven land use categories (single family residential, multi-family residential, office, industrial, retail, service with high visitor rate, and service with low visitor rate).

The TCV2.0-based land use forecasts (2045) were reviewed for maximum buildable industrial square footage data for each parcel in the Triangle region to prepare a heat map. This is depicted in Figure 137. The heat map was used to identify eleven development opportunity zones based on availability of large industrial parcels with good highway access. These development opportunity zones are labeled 1 through 11 in Figure 137. The scale and size of these development opportunity zones are described in Table 50.

Figure 137: Freight-Oriented Development Opportunity Zones



Source: Triangle CommunityViz 2.0 Model, TJCOG's Connect 2045 Community Plan Scenario, Industrial Square Footage Data

Table 50: Long-Range Freight-Oriented Development Opportunity Zones

Zone#	Description	Location	# of Large Industrial Parcels	Buildable Industrial Square Footage	
1	I-40 and U.S. 70 Corridors in Mebane	Orange County	61	Total:	**19,580,000**
				Average:	321,000
				Maximum:	1,181,000
2	NC 147 and South Miami Blvd Corridors and RDU Airport Vicinity	Durham and Wake Counties	50	Total:	11,590,000
				Average:	232,000
				Maximum:	892,000

Zone#	Description	Location	# of Large Industrial Parcels	Buildable Industrial Square Footage	
3	I-85 Corridor in Butner	Granville County	7	Total:	1,740,000
				Average:	248,000
				Maximum:	682,000
4	U.S. 1 Corridor in Franklinton	Franklin County	19	Total:	5,340,000
				Average:	281,000
				Maximum:	1,197,000
5	NC 56 Corridor in Franklinton	Franklin County	12	Total:	3,750,000
				Average:	312,000
				Maximum:	860,000
6	U.S. 64 Business and U.S. 64-264 Corridors in Knightdale	Wake County	5	Total:	2,160,000
				Average:	432,000
				Maximum:	1,019,000
7	U.S. 70 and NC 42 Corridors in Clayton	Johnston County	5	Total:	4,770,000
				Average:	**954,000**
				Maximum:	1,940,000
8	U.S. 70 and I-95 Corridors in Selma	Johnston County	14	Total:	9,560,000
				Average:	683,000
				Maximum:	**2,838,000**
9	NC 55 and NC 42 Corridors in Fuquay-Varina	Wake County	14	Total:	6,570,000
				Average:	469,000
				Maximum:	1,137,000
10	U.S. 1 and Old U.S. 1 Corridors in Moncure / Executive Jetport Area	Chatham County	5	Total:	920,000
				Average:	183,000
				Maximum:	410,000
11	U.S. 501 Corridor between Sanford and Pittsboro	Chatham County	4	Total:	1,730,000
				Average:	431,000
				Maximum:	923,000
	ALL		**196**	**Total:**	**67,680,000**
				Average:	**345,000**
				Maximum:	**2,838,000**

Source: Triangle CommunityViz 2.0 Model, TJCOG's Connect 2045 Community Plan Scenario, Industrial Square Footage Data

In addition, currently available buildings and sites were reviewed based on data from the Economic Development Partnership of North Carolina (EDPNC). The purpose was to identify more near-term development opportunities based on available market and real estate broker information. This market analysis for freight industry locations is summarized in Table 51 for available buildings with ceiling heights suitable for freight-related industries, in Table 52 for available tracts of land in established Business Parks, and in Table 53 for large or mega sites that are available for sale. These tables show that the region has a robust supply of buildings and shovel-ready lands spread across the region to accommodate industrial growth in the near future.

Table 51: Available Buildings Suitable for Freight-Related Industries

Name	City	County	Building Size(SF)
Alamance Center	Burlington	Alamance	38,012
Haw River Industrial Park Historic Section	Haw River	Alamance	46,800
Cobb Avenue Plant	Burlington	Alamance	63,111
2390 Park Center Dr	Mebane	Alamance	84,060
2208 Airpark Dr	Burlington	Alamance	103,000
Cedar Crest Dr	Burlington	Alamance	500,000
Liberty Ridge	Durham	Durham	325,000
132 Franklin Park Drive	Youngsville	Franklin	20,216
North Raleigh Airport	Franklinton	Franklin	22,600
279 S. Bickett Blvd.	Louisburg	Franklin	60,170
913-915 NC Hwy 98	Bunn	Franklin	85,800
Franklinton Commerce Center	Franklinton	Franklin	100,000
Piedmont Refrigeration Building	Oxford	Granville	25,000
Burlington Plant	Oxford	Granville	177,000
1000 N Horner Blvd former Lee Builder Mart	Sanford	Lee	114,990
Harvey Faulk Road	Sanford	Lee	341,250
Ikex Building	Middlesex	Nash	31,500
Carolina Building	Rocky Mount	Nash	34,000
Crown LSP - Thorpe Rd.	Rocky Mount	Nash	185,861
Airport Road	Rocky Mount	Nash	266,252
W & H Associates 2	Roxboro	Person	75,000
W&H Associates Warehouse	Roxboro	Person	85,456
8013 Purfoy Road	Fuquay-Varina	Wake	141,000
American Tire Company	Wilson	Wilson	102,450
NBTY Manufacturing	Wilson	Wilson	125,000
Total			**3,153,528**

Source: Economic Development Partnership of NC Website - https://edpnc.com/relocate-or-expand/available-sites-location-data/

Table 52: Available Sites in Business Parks for Freight-Related Industries

Name	City	County	Tract Size (Acres)
North Carolina Industrial Center	Mebane	Alamance	550
Siler Business Park	Siler City	Chatham	50.6
Central Carolina Business Campus	Siler City	Chatham	380
Expressway Commerce Center	Durham	Durham	36.71
Treyburn Corporate Park - 38 Acre Site	Durham	Durham	38
Research TriCenter East	Durham	Durham	101.82
4111 Teknika Parkway	Durham	Durham	109.05
Treyburn Corporate Park - 162 Acre Site	Durham	Durham	162
Louisburg Industrial Park - 5 tracts	Louisburg	Franklin	40.15
Louisburg Industrial Park	Louisburg	Franklin	72.71
Louisburg Industrial Park	Louisburg	Franklin	156
Triangle North Franklin	Louisburg	Franklin	200
Triangle North Granville	Oxford	Granville	510
Tract 5 at Four Oaks Business Park	Four Oaks	Johnston	34.19
Tract 7 at Four Oaks Business Park	Four Oaks	Johnston	45.87
South Park	Sanford	Lee	400
South Tract (WB&IC)	Battleboro	Nash	38.1
West Nashville Commerce Center	Nashville	Nash	58.28
Cobb-Pearce Site	Battleboro	Nash	82.63
Middlesex Corporate Centre	Middlesex	Nash	322
7618 East Washington Street	Mebane	Orange	57.69
Trace Site	Roxboro	Person	690
Garner Industrial Site-Greenfield Park South	Garner	Wake	151.2
Wilson Corporate Park	Wilson	Wilson	350
Total			**4,637**

Source: Economic Development Partnership of NC Website - https://edpnc.com/relocate-or-expand/available-sites-location-data/

Table 53: Available Large and Mega Sites for Freight-Related Industries

Name	City	County	Tract Size (Acres)
Whites Kennel 90	Burlington	Alamance	90
Edith Caviness Estate	Pleasant Garden	Chatham	94.42
Carbonton-Kelly-ACWR Tract	Carbonton	Chatham	200
Aero Industrial Park	Siler City	Chatham	234
Moncure Industrial Site	Moncure	Chatham	946
Chatham-Siler City Advanced Manufacturing Site	Siler City	Chatham	1802.181
Bordon Business Park	Durham	Durham	100
Gentry Site	Durham	Durham	113.94
Junction East	Durham	Durham	710
Stroud	Youngsville	Franklin	78
Burns, David	Youngsville	Franklin	86.51
Holder	Franklinton	Franklin	88.47
Cedar Creek Development	Franklinton	Franklin	119
Watson Farm	Franklinton	Franklin	278.55
Winston Site	Oxford	Granville	87
Belltown Road	Stem	Granville	118
Large Tract at SW of U.S. 70-Swift Creek Rd	Wilsons Mills	Johnston	81.39
Large Tract at W Oak St-U.S. 70	Selma	Johnston	113.29
Large Tract at SW of Elevation Rd-Telfer Ln	Benson	Johnston	200
Industrial Parcels SE of Hwy 42-U.S. 70 Business	Clayton	Johnston	466.69
General Shale	Sanford	Lee	79.5
Central Carolina Enterprise Park (CCEP)	Sanford	Lee	241
Highway 97 Tract	Wilson	Nash	142
Spring Hope Rail	Spring Hope	Nash	214.29
Old NC Highway 86 Tract	Hillsborough	Orange	82
Industrial Drive - Woody	Roxboro	Person	83.6
Garner Technology Center	Garner	Wake	98
Greenfield Business Park	Garner	Wake	100
Friendship Site	Holly Springs	Wake	130
Wiggs Property	Wilson	Wilson	86.16
Northside Business Park	Wilson	Wilson	658
Woodard Parkway	Wilson	Wilson	830
Norwood Tract	Saratoga	Wilson	1315
Total			**10,067**

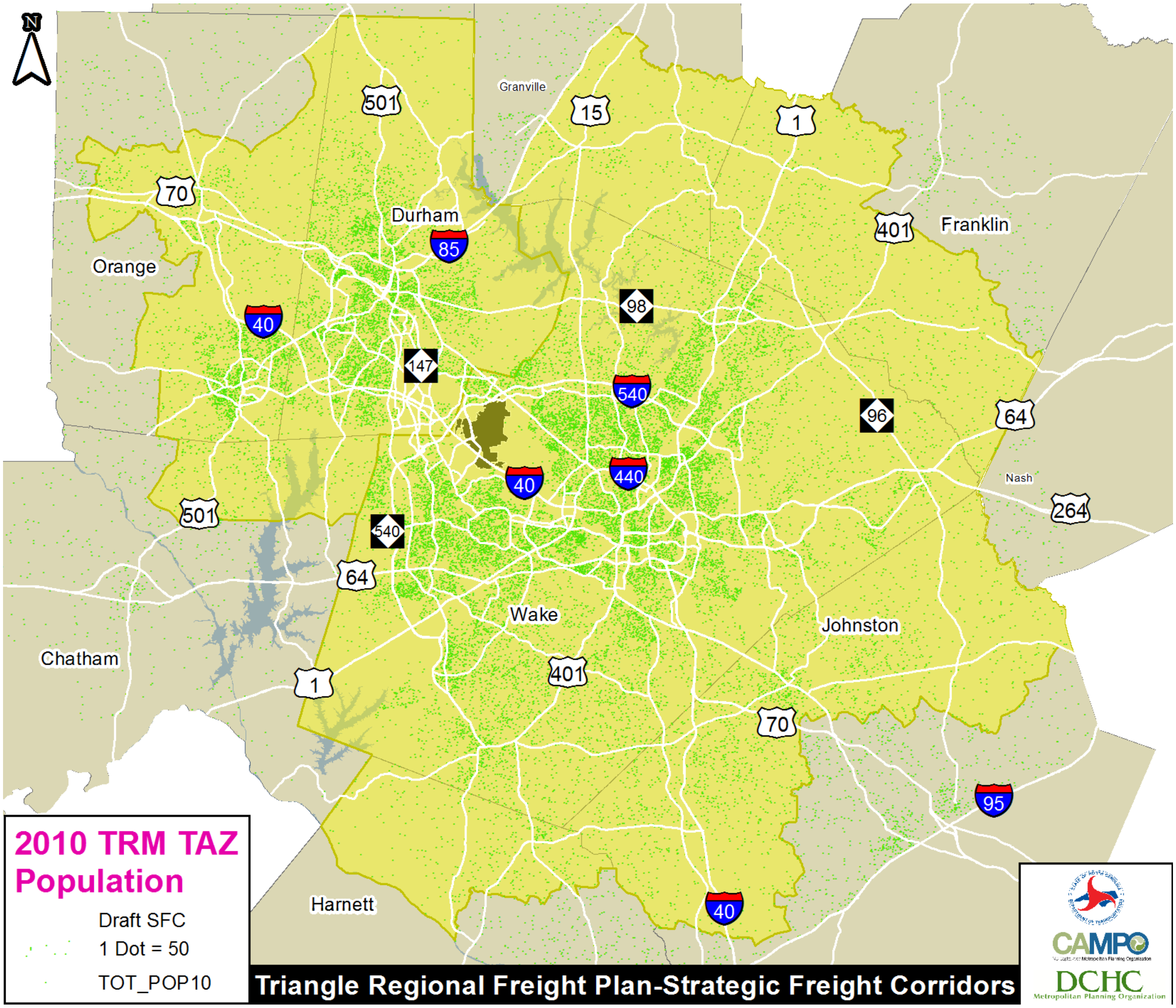
Source: Economic Development Partnership of NC Website - https://edpnc.com/relocate-or-expand/available-sites-location-data/

Land Use Conflict Areas

This chapter presents an illustration of land use conflict areas by overlaying base year (2010) and forecast year (2040) population figures on to the draft SFC network. These overlay maps are presented in Figure 138 for year 2010 population and in Figure 139 for year 2040 population. The population figures are presented in terms of density dots, one dot representing 50 people.

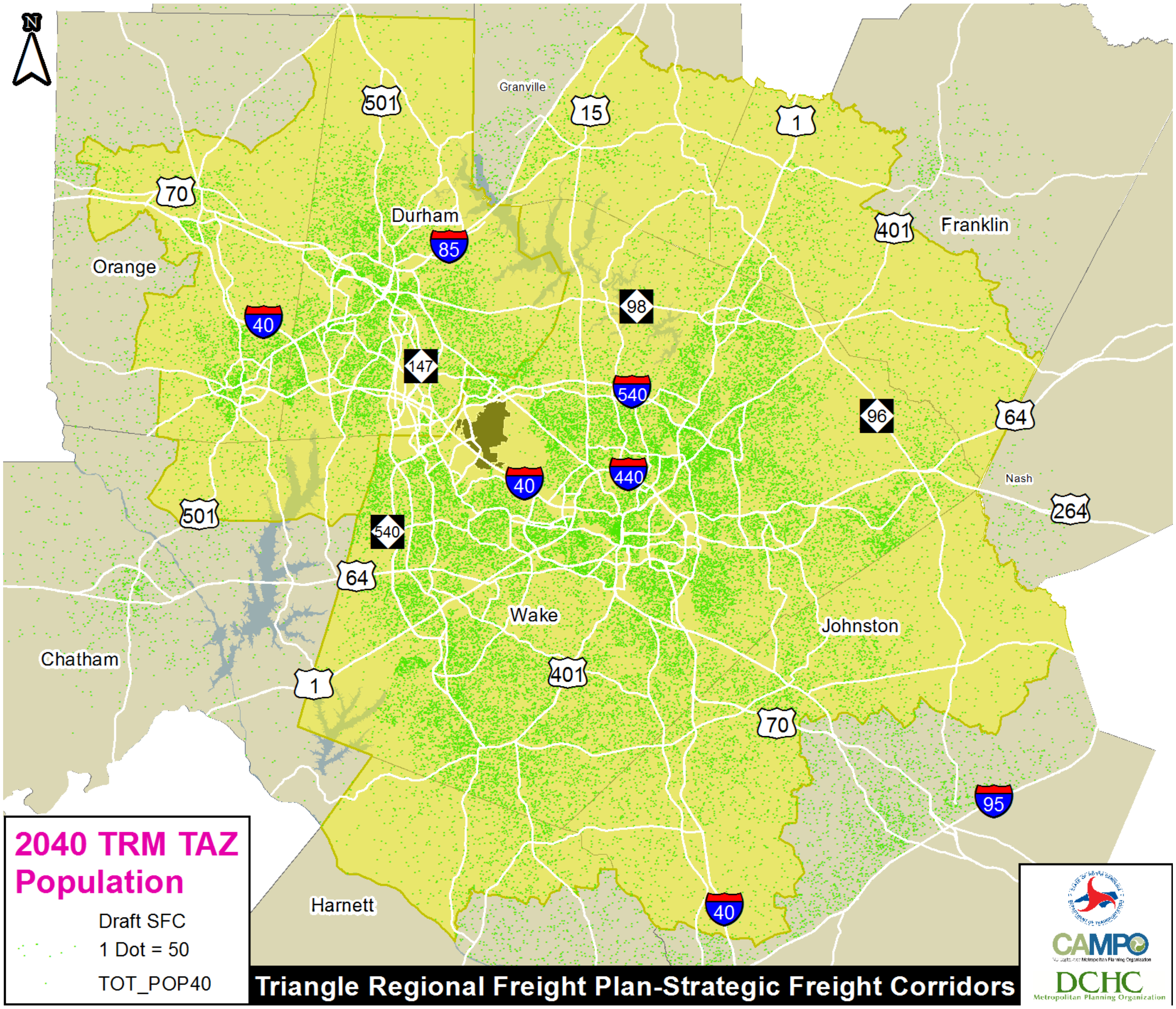
These two maps show that the SFC network have higher accessibility to higher density population areas, which is a positive feature for providing goods and services efficiently. However, on the flip side, the SFC network provides a challenge to the communities when some of these routes are used for any hazardous freight movements. Consequently, the local land use and development permitting process will need to carefully assess compatibility of proposed developments for safety and security of residential communities.

Figure 138: Draft SFC Network with 2010 Population Density Dots Overlay



Source: Triangle Regional Model (TRM)

Figure 139: Draft SFC Network with 2040 Population Density Dots Overlay



Source: Triangle Regional Model (TRM)

Freight-induced Negative Effects and EJ Population Groups

This section provides an assessment of EJ characteristics of the Triangle Region by focusing on major freight corridors and freight distribution center clusters as employment hubs. EJ is the term used to describe the condition that over time, communities with large proportions of disadvantaged populations tend to suffer disproportionate negative environmental impacts. In 1994, Executive Order 12898 defined EJ as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group should bear a disproportionate share of the negative consequences resulting from industrial, municipal, and commercial operations. The U.S. Department of Transportation (U.S. DOT) therefore requires MPOs and other government agencies to identify and address potential or actual disproportional adverse environmental effects on minority and low-income populations.

CAMPO has identified six indicators of EJ groups for the purpose of regional-scale planning and regional-scale outreach. These six indicators are as follows:

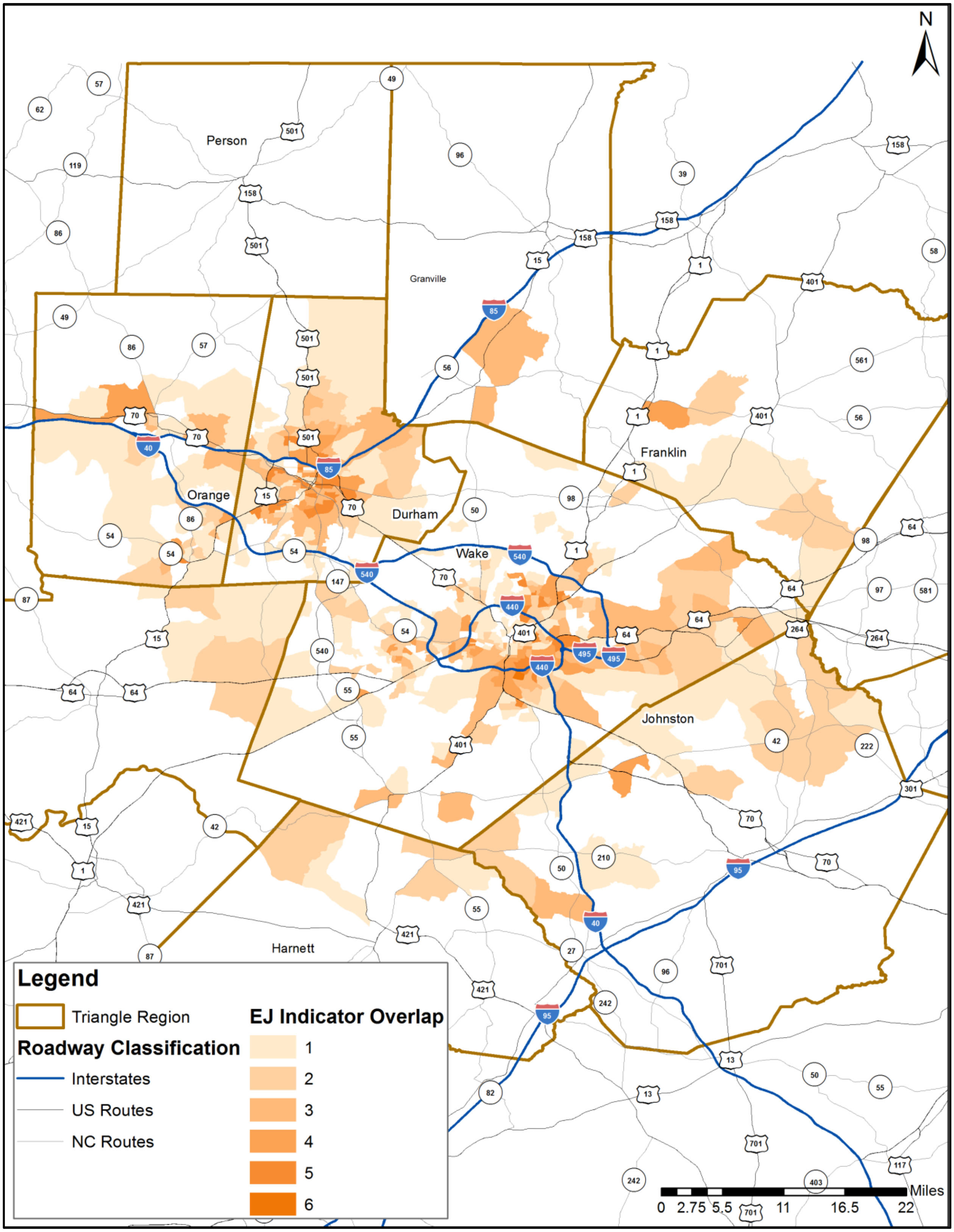
1) Zero-Car Households: Households without access to automobile
2) Near Poor Population: Individuals making less than 150% of the federal poverty rate
3) Minority Population: Non-white race
4) Linguistic Isolation Population: Population that speak English "Not at all" or "Not very well"
5) Hispanic and Latino Population: Population with Hispanic/Latino origin
6) Elderly: Age 70 and over

Figure 140 shows the map of EJ population at the block group level for the Triangle region. Each indicator has a threshold calculated for the 75th percentile (top 25%), and any Block Group that meets or exceeds the threshold is included. The EJ categories overlap across the census block groups. Hence, the map is color-coded based for the number of EJ categories in each census block group.

As it can be seen from Figure 140, a significant number of EJ block groups are located in eastern Raleigh adjacent to I-440, Millbrook between I-440 and I-540, and southern Raleigh in proximity to I-40 at I-440. Further, several EJ block groups are also located in Durham mainly adjacent to SR-147 and SR-55. Finally, a few block groups are also observed in Hillsborough west of Durham adjacent to I-85 and U.S.-70. In order to assess if EJ communities are disproportionately impacted by freight movement an overlay of freight clusters, DCs' square footage, and manufacturing activity relative to EJ block groups is developed. Distribution centers and manufacturing square footage drive the majority of freight activity in the Triangle region. Hence, communities located in proximity to these distribution and manufacturing centers have the highest potential of being disproportionately affected. These impacts may include air, water, noise and light pollution, congested roadways, safety hotspots and encroachment and loss of green space.

Overlap of sensitive EJ block groups (the ones with higher number of EJ indicators) in Figure 141 shows that freight activity in Durham and Raleigh is significant in proximity to some block groups. Most notably are the Bethesda, South Raleigh/Garner, and North Durham freight clusters. The Bethesda freight cluster covers U.S.-70, SR-147, and SR-55 corridors. As mentioned earlier this area includes a significant number of EJ block groups. The South Raleigh/Garner freight cluster covers I-40, U.S.-401, and U.S.-70 corridors in south Raleigh and perhaps comes second in terms of the EJ block groups affected. Finally, the North Durham cluster between I-85 and U.S.-501 includes some sensitive block groups. It is likely that residents surrounding these industrial (distribution and manufacturing) land uses tend to be exposed to light and noise pollution at a higher rate than other areas in the Triangle region.

Figure 140: Map of Environmental Justice Block Groups in the Triangle Region



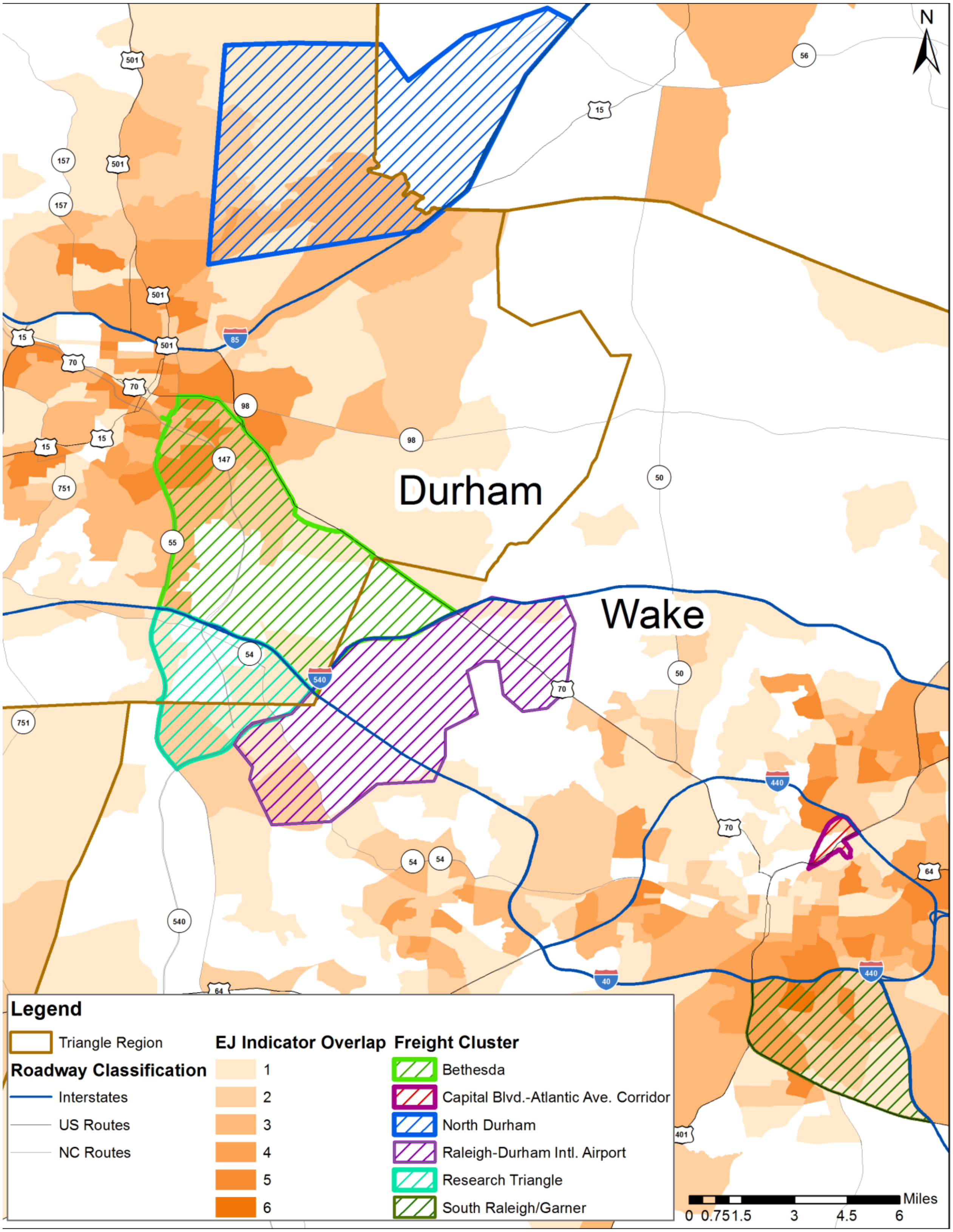
Source: CAMPO 2016

The distribution and manufacturing sectors' activity drives much freight activity, and thus itself can affect EJ population groups in the Triangle region. Figure 142 and Figure 143 present the overlap of existing DCs in the Raleigh and Durham area respectively. Figure 144 and Figure 145 present the overlap of existing manufacturing centers and EJ block groups in the Raleigh and Durham area respectively. The red labels on the map indicate significant overlap of manufacturing/distribution centers with EJ block groups. As it can be seen, several DCs are located in the South Raleigh/Garner area and also North Raleigh Millbrook area. The South Raleigh/Garner area hosts some manufacturing facilities as well. The North Raleigh/Millbrook area adjacent to U.S.-401 and U.S.-1 has some DCs present while hosting several sensitive EJ block groups. The East Raleigh area, at the intersection of I-495 and I-440 hosts several DCs and manufacturing activity

In the Durham area, the Bethesda corridor, particularly, adjacent to SR-55 and SR-147 hosts significant DC square footage. This area falls within the Bethesda freight cluster and hosts several significant EJ block groups. The East Durham area, at the intersection of I-85 and U.S.-70 also hosts some DCs. Finally, in the North Durham area (i.e. North Durham Cluster) the manufacturing centers drive freight activity. This manufacturing activity is occurring in proximity to several EJ block groups between U.S.-15 and U.S.-501.

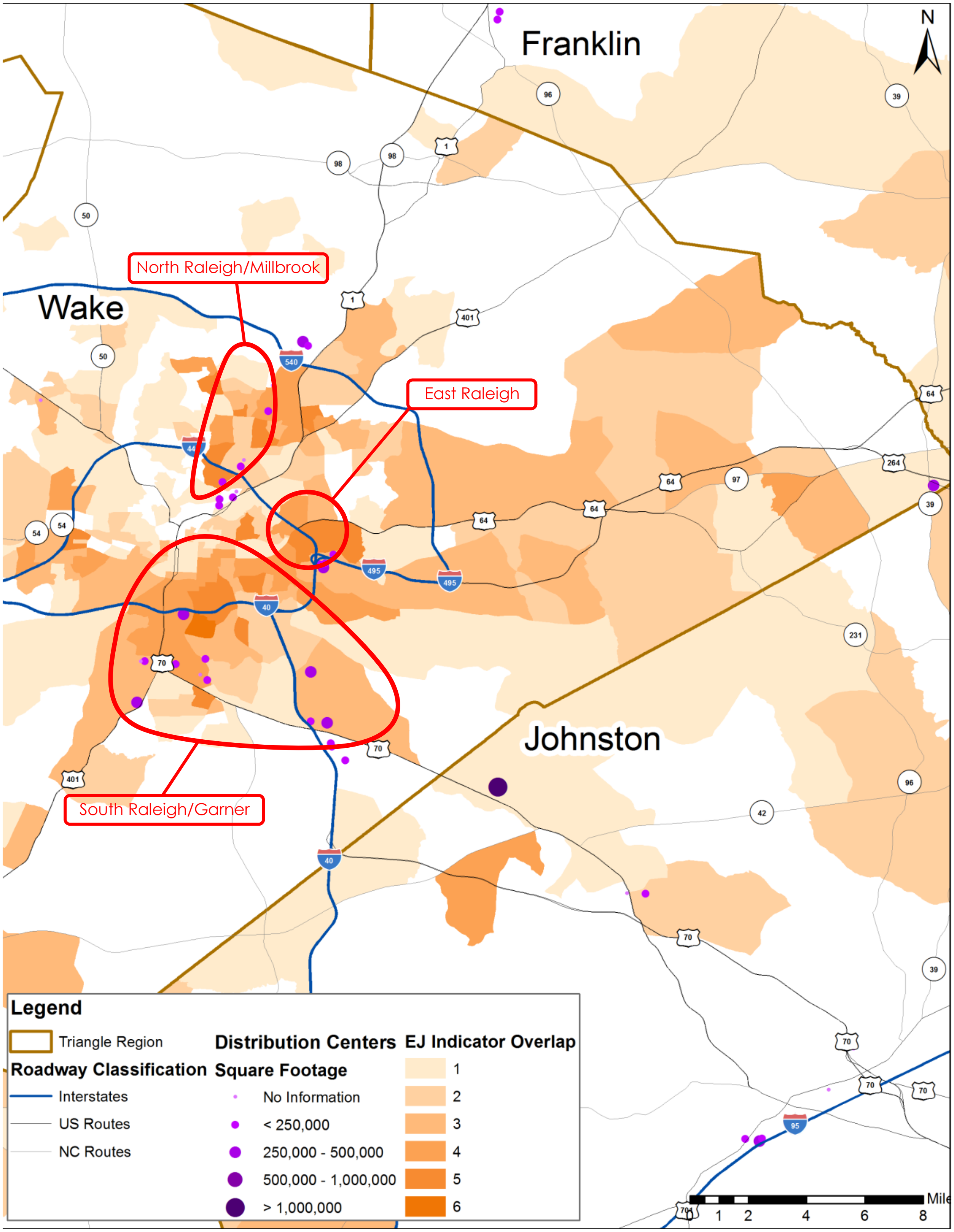
Freight transportation has the potential to result in negative reaction from communities leading to concerns about the location of freight facilities and the movement of cargo. Despite community apprehension, there is a mutual understanding that freight transportation plays a vital role in the economic well-being of communities and businesses. Nationally, efforts have been made to balance the movement of freight with community goals by making freight transportation operations and facilities "good neighbors." Analysis of EJ block groups in the triangle region shows that the top three major freight clusters, notably Bethesda, South Raleigh/Garner, and North Durham also host significant EJ communities. Further, manufacturing and DC activity in the Millbrook, Bethesda, and North Durham areas have the potential to disproportionately affect EJ communities. The six categories of EJ communities are separately presented in six maps along with DCs and manufacturing activity in the Triangle region. These maps appear in Figure 146 through Figure 152.

Figure 141: Overlap of Freight Clusters and EJ Block Groups



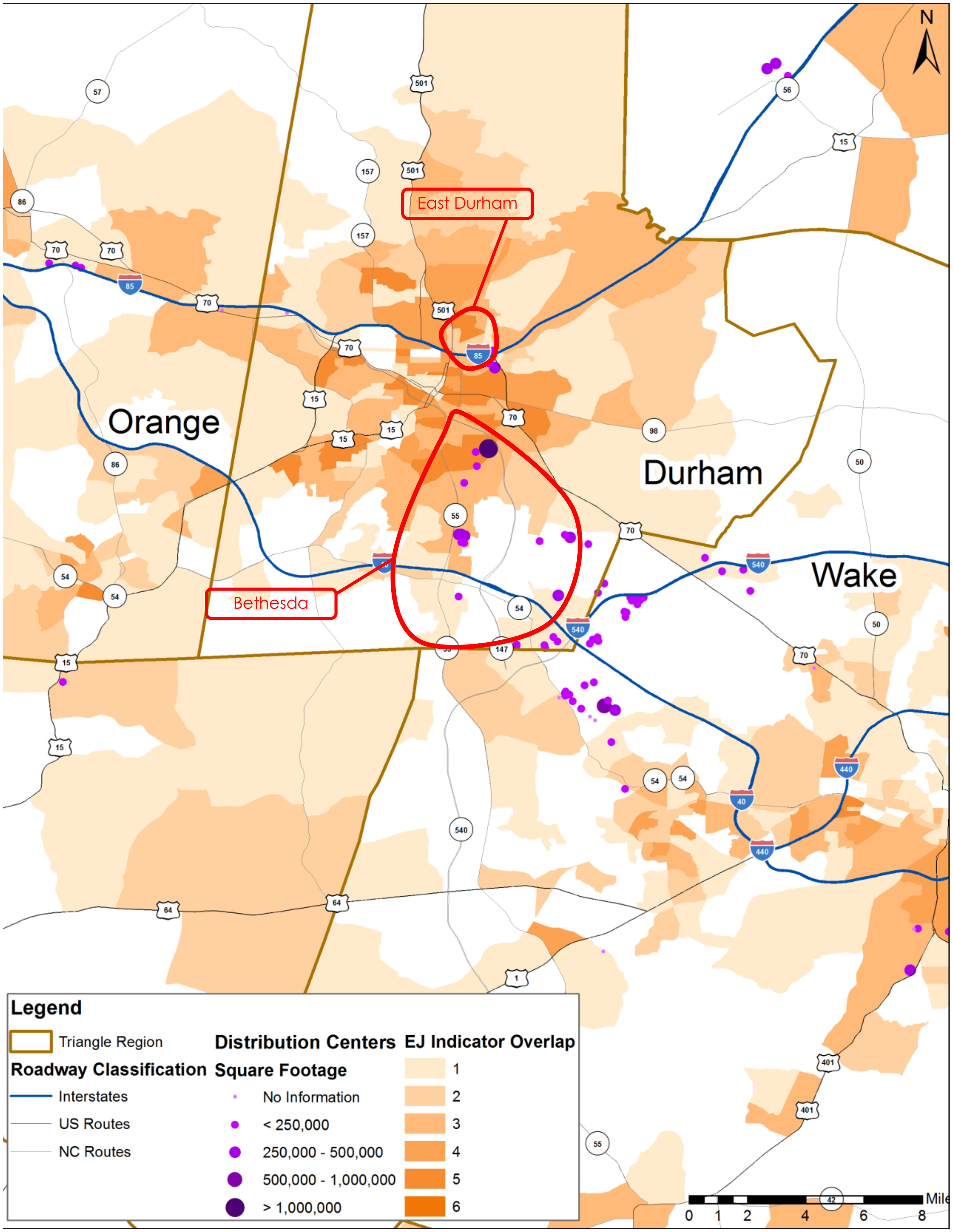
Source: CAMPO 2016 and Westat Freight Data

Figure 142: Overlap of Distribution Sector Activity and EJ Block Groups



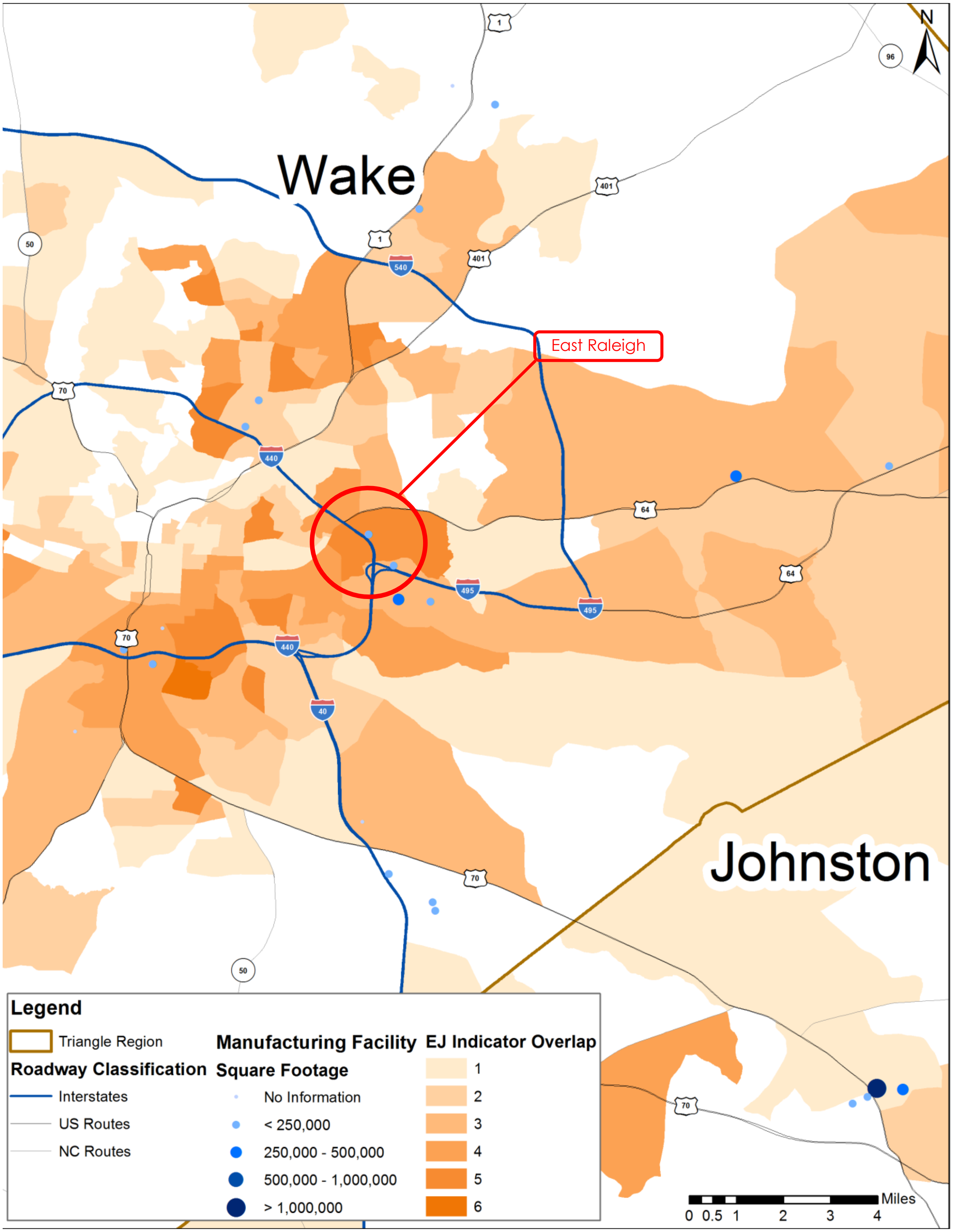
Source: CAMPO 2016 and Westat Freight Data

Figure 143: Overlap of Distribution Sector Activity and EJ Block Groups



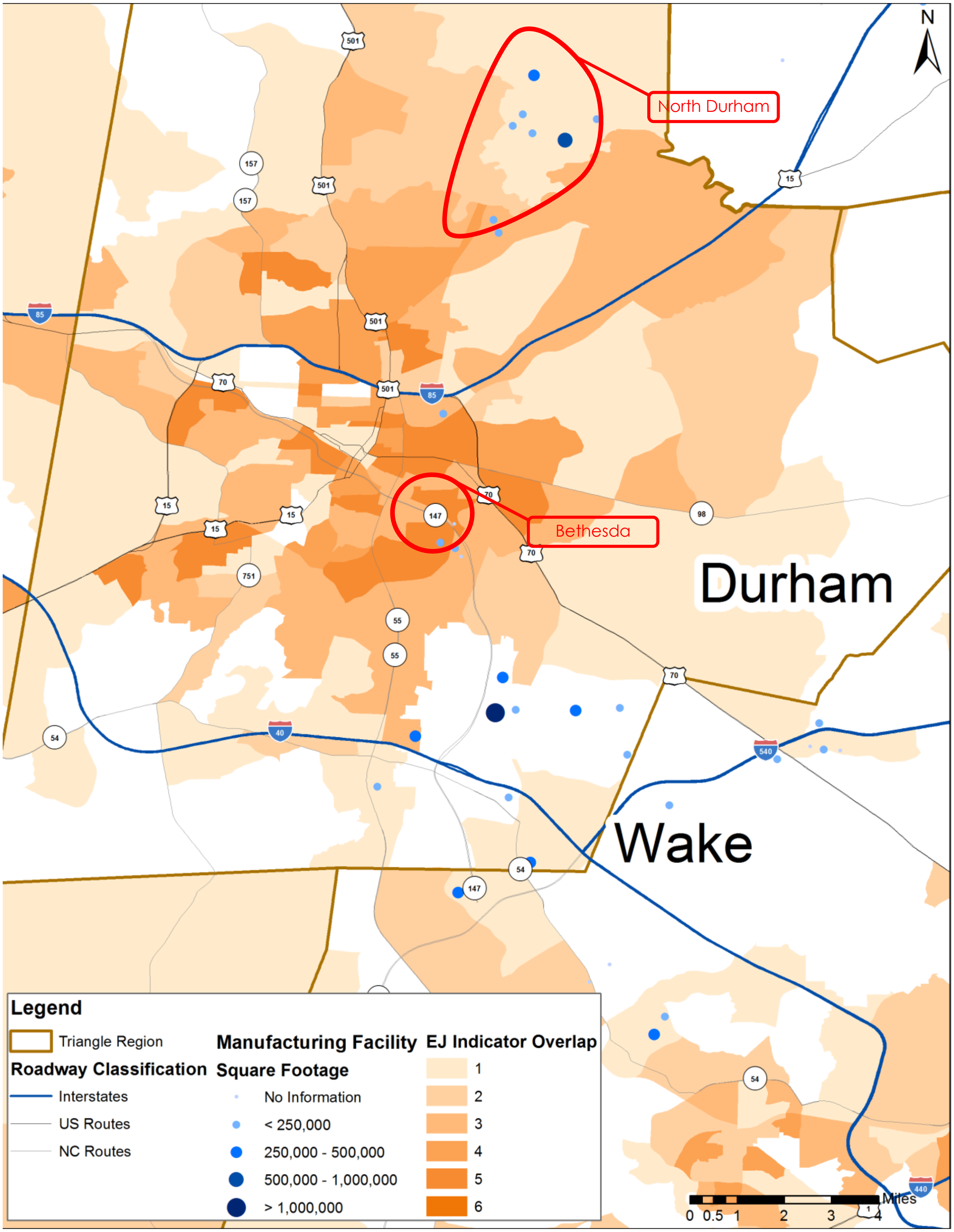
Source: CAMPO 2016 and Westat Freight Data

Figure 144: Overlap of Manufacturing Sector Activity and EJ Block Groups



Source: CAMPO 2016 and Westat Freight Data

Figure 145: Overlap of Manufacturing Sector Activity and EJ Block Groups



Source: CAMPO 2016 and Westat Freight Data

Figure 146: EJ Indicators Overlap in the Triangle Region

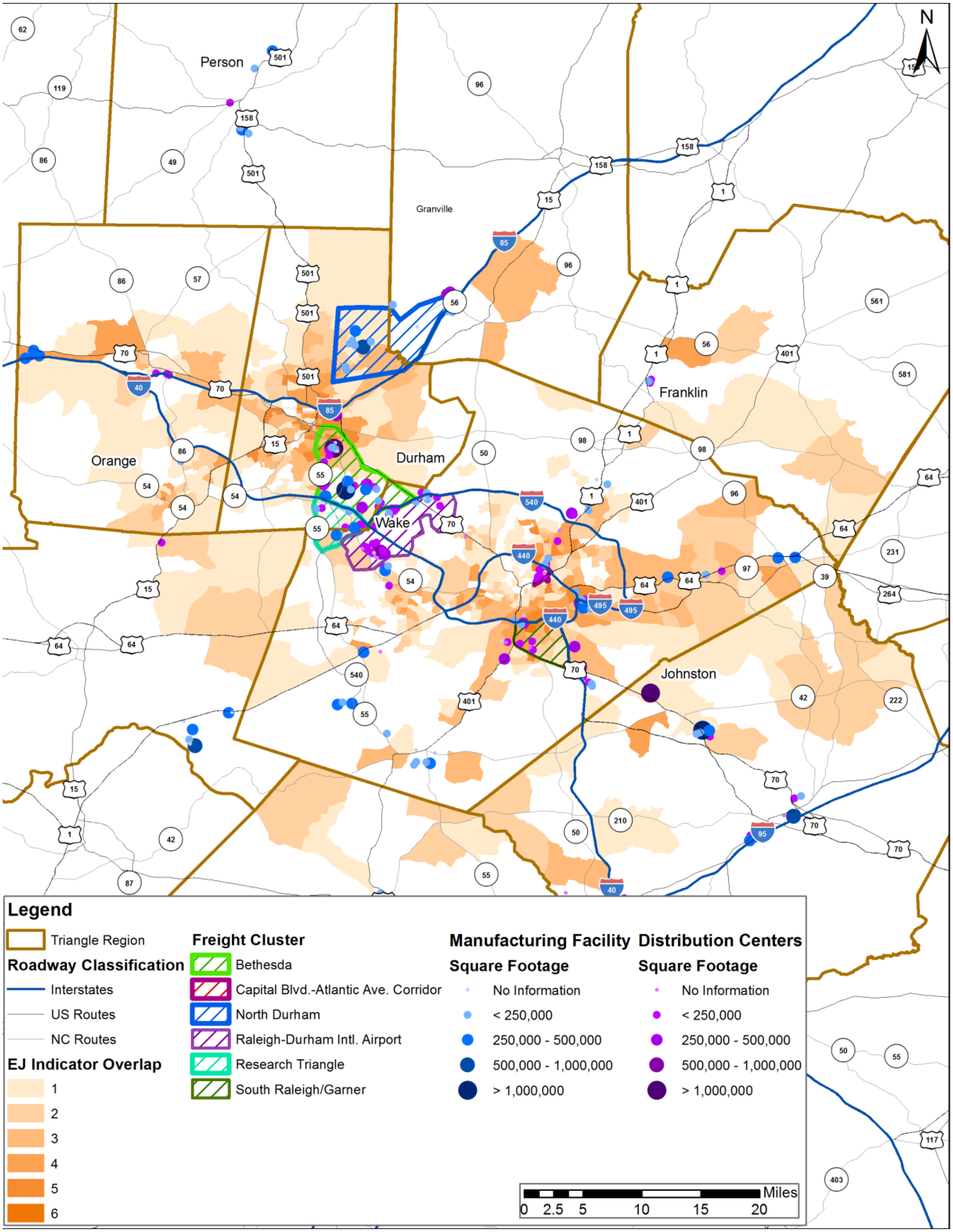


Figure 147: Age 70 and Older EJ Communities in the Triangle Region

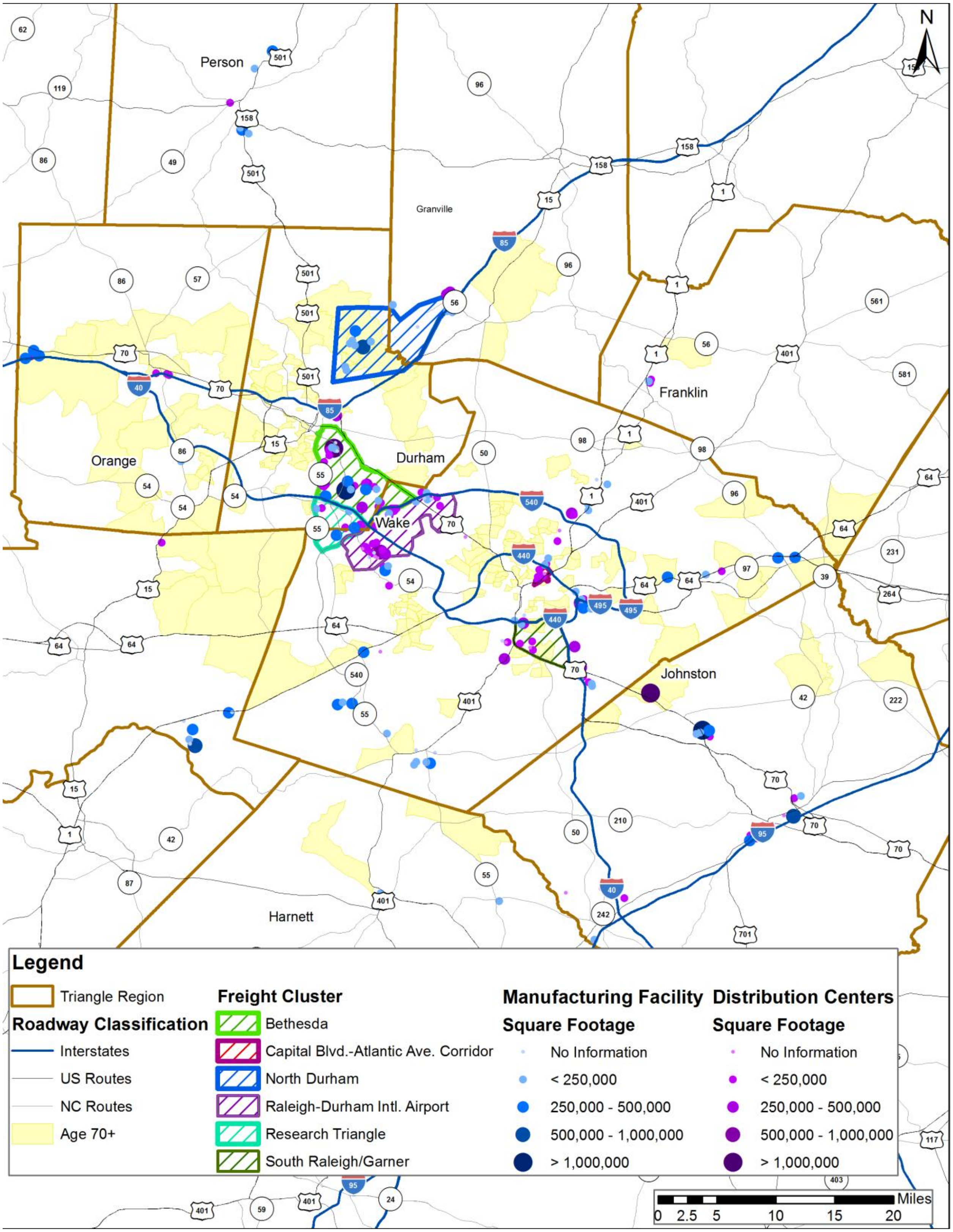


Figure 148: Hispanic/Latino Origin EJ Communities in the Triangle Region

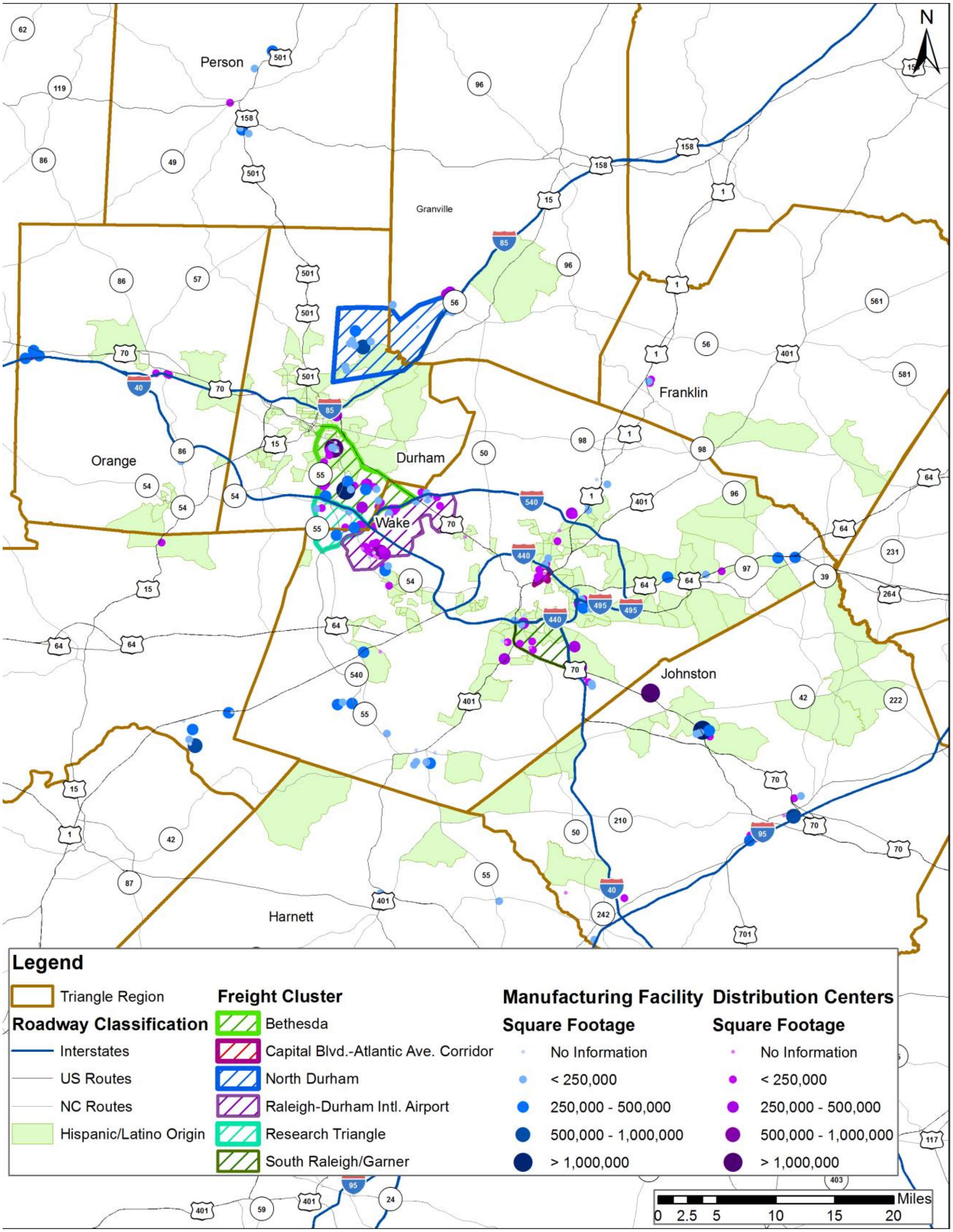


Figure 149: Linguistic Isolated EJ Communities in the Triangle Region

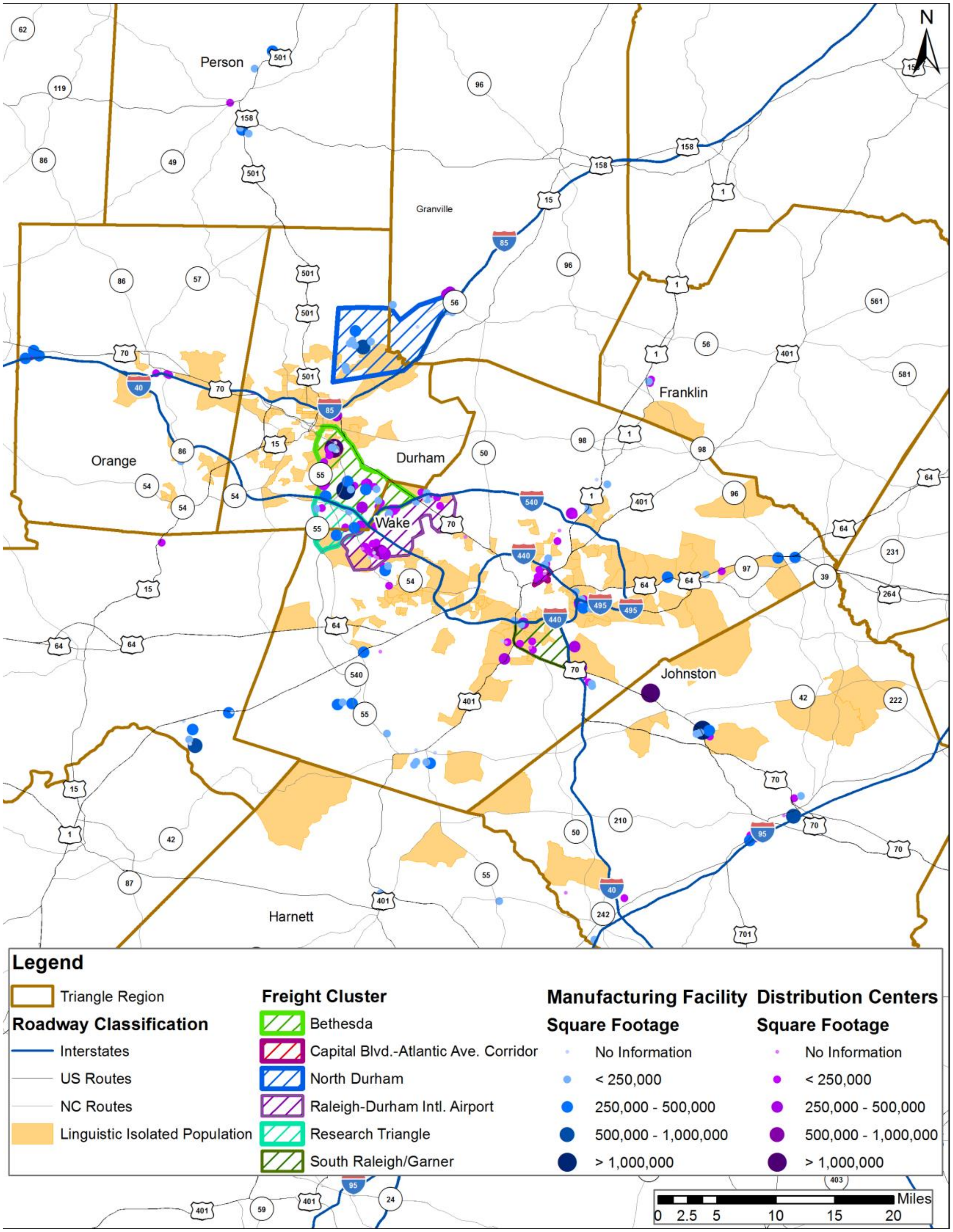


Figure 150: Minority Non-White EJ Communities in the Triangle Region

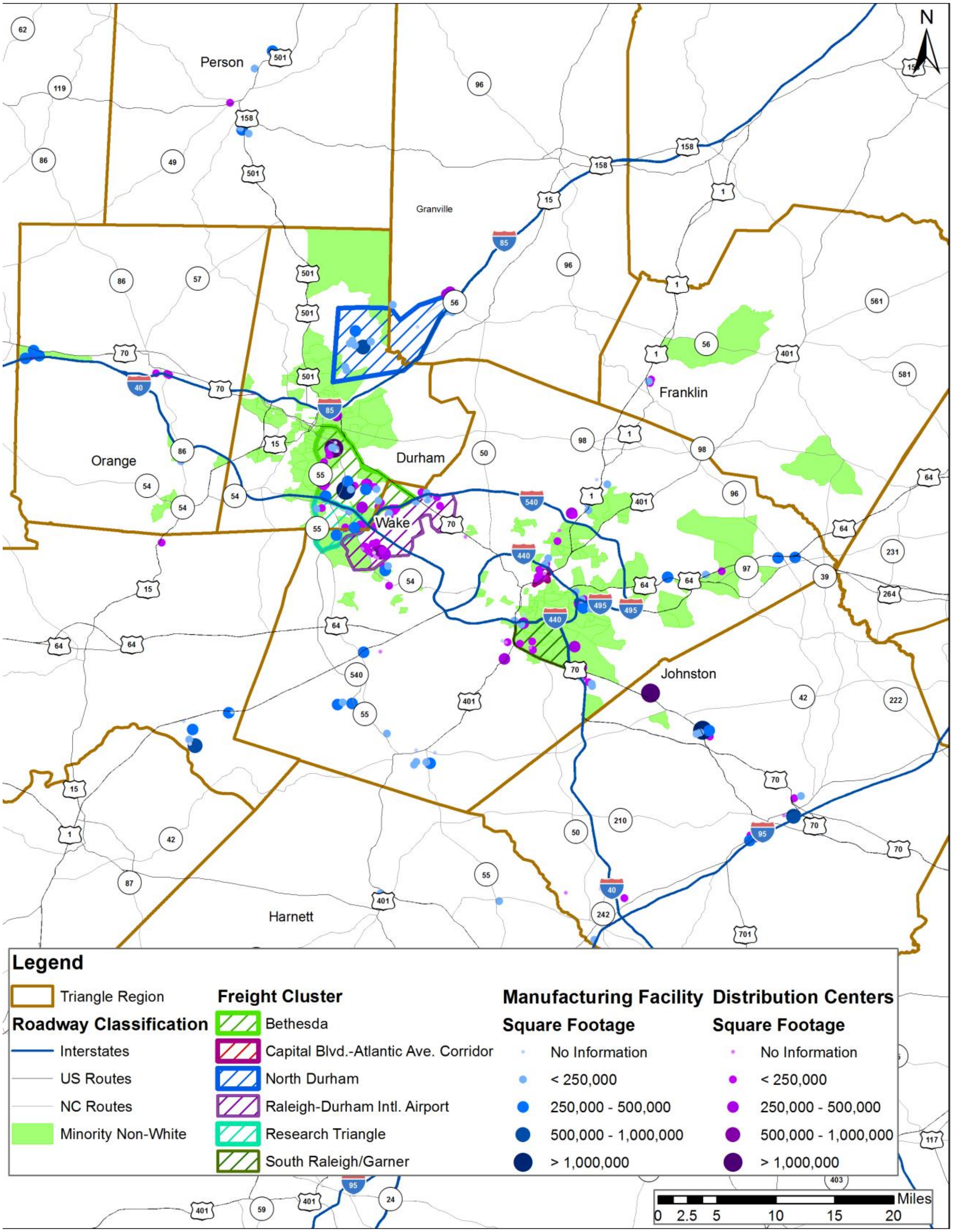


Figure 151: Near Poor EJ Communities in the Triangle Region

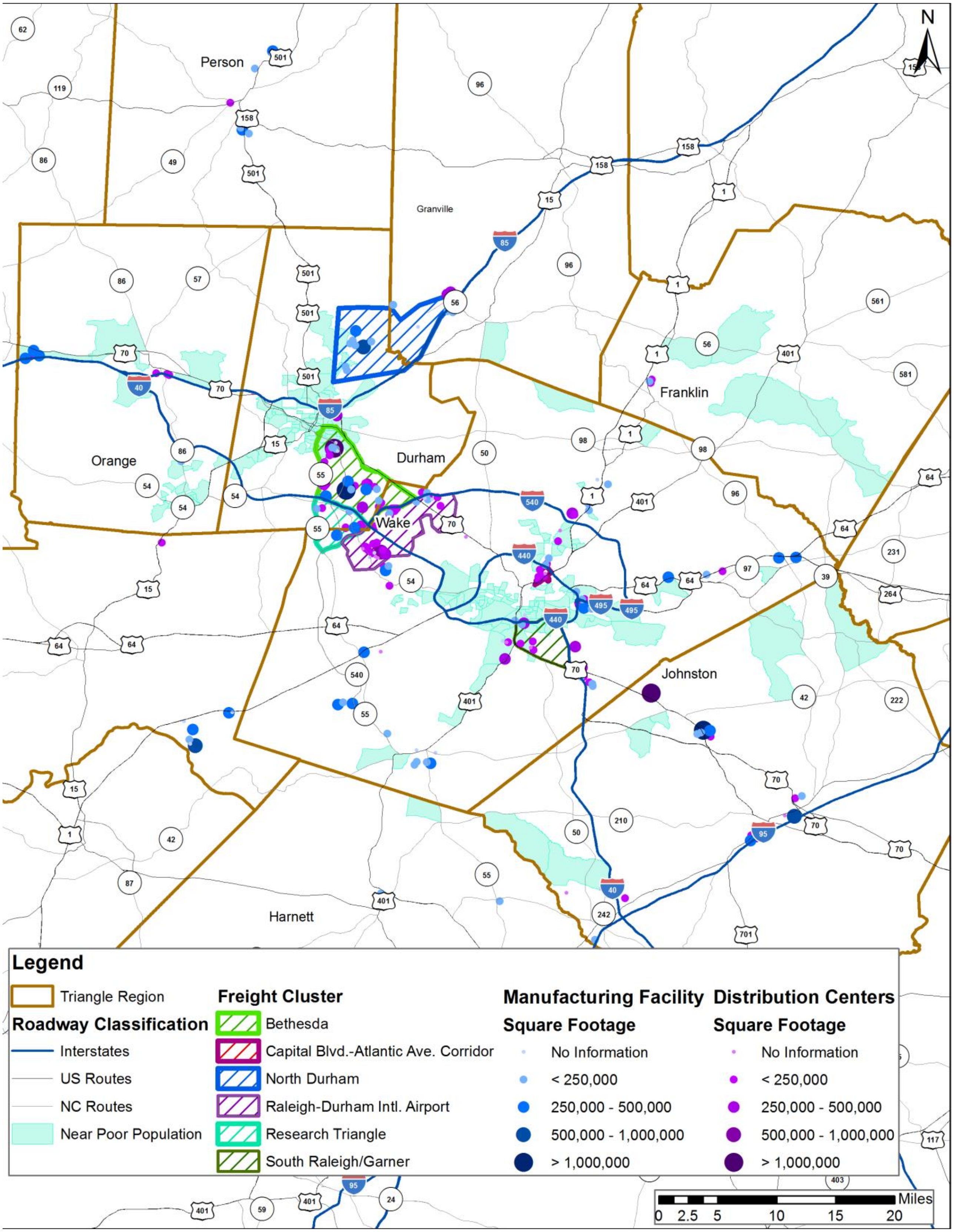
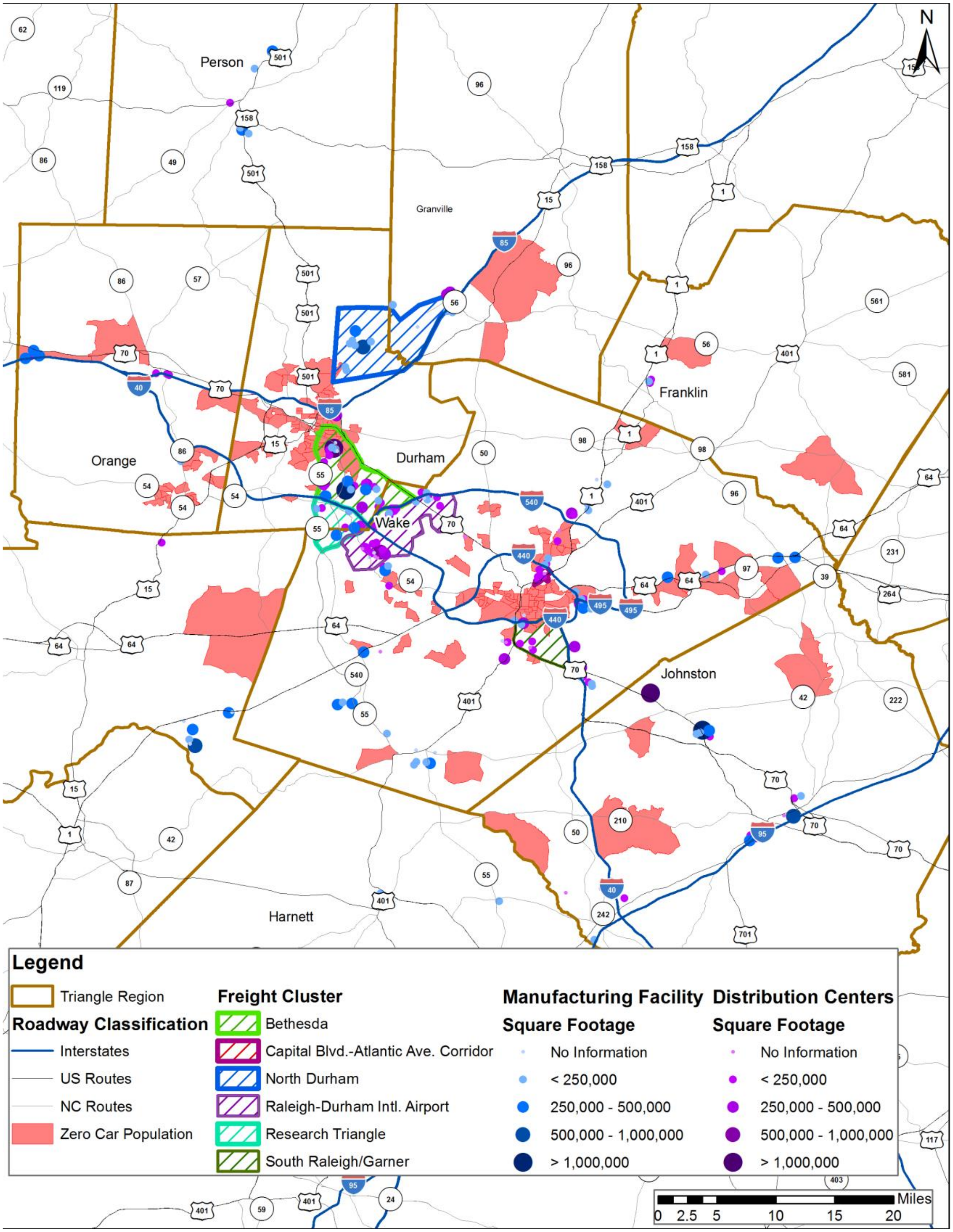


Figure 152: Zero Car EJ Communities in the Triangle Region



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9 RECOMMENDATIONS AND IMPLEMENTATION PLAN

This chapter puts forward a set of project and policy recommendations to change the status quo of freight mobility in the region, support the local $21 billion freight-intensive industries, and help make this region more economically competitive and attractive in the new era of online shopping, same-day/next-day goods delivery, and connected-automated world. The $7.2 billion in project recommendations were developed based on the findings of detailed technical analysis, stakeholder workshops, online survey, supply chain industry survey, and workshops and interviews with the RFSAC. The project recommendations are primarily focused on achieving the goals and objectives of this regional freight plan, but also support the goals adopted in the MTP of DCHC MPO, CAMPO, and in the NCDOT Statewide Multimodal Freight Plan. Recommendations for freight policies, programs and land use follow the description of projects. The chapter concludes with a presentation of three stratetgy packages, which combine all elements into coherent sets of actions that answer the goals of the Triangle Region and prepare it for the years ahead.

SFC Project Recommendations

This section of the report first illustrates the approach to developing project recommendations for the SFC network that was defined based on technical analysis and engagement with the project steering committee members. The approach was based on a host of quantitative criteria that were modeled and analyzed for the SFC network to establish freight accessibility, mobility, reliability and safety needs. In addition, the project development approach also relied on land use analysis findings that identified future development or redevelopment opportunity zones for freight-supportive industries. In summary, this project development approach focused on three tiers of SFC corridors and their roles in supporting the underlying local, regional and statewide freight economy:

- **Trade Routes** – Routes that connects the region with other regions and statewide and external freight facilities such as the Ports of Wilmington, Norfolk, Charleston, Savannah, and Jacksonville, and the planned CSX intermodal terminal in Rocky Mount. These routes are the critical economic links to our region's trading partners within North Carolina, and top trading partners in the Southeast and Mid-Atlantic regions.
- **Distribution/Connectivity Routes** – Routes that connects the freight industry clusters, freight-intensive industries, future Freight-Oriented Development (FOD) opportunity areas, and urban activity centers such as Central Business Districts (CBDs), universities, hospitals and large shopping centers. These routes serve as the backbone of efficient navigation of the supply chain and freight distribution network, now and in the future.
- **Critical Access Routes** – Local routes that are expected to have significant truck movements for access to existing industrial sites and potential redevelopment areas. These routes provide critical local access to existing freight or freight-related facilities and industries.

These three tiers of SFC corridors were targeted for mobility, safety, connectivity, and economic development improvements based on technical analysis results reported in previous chapters and stakeholders input obtained throughout the study. It should be noted that some of the SFC corridors serve multiple functions and go across MPO or County boundaries.

The project recommendations are summarized for the two MPOs in terms of recommended multiple implementation time frames:

- Year 2025 (short-term priority improvements)
- Year 2030 (mid-term improvements)
- Years 2035 and 2040 (long-term improvements)

Within each implementation horizon, the project recommendations are also categorized to highlight the dominant goal of the improvement using the following four attributes:

- Mobility (address both roadway capacity and truck travel time reliability)
- Safety (address truck related injury and fatal crashes)
- Connectivity (address routing efficiency, route alternatives, and route resiliency)
- Economic Development (address freight-oriented land use issues and opportunities)

Overall, the project recommendations are expected to improve freight mobility and safety in the region by providing good route alternatives to limit the effects of traffic jams and other disruptions, providing active freeway operations management through truck wayfinding and real-time travel condition information, and concentrating capacity enhancement resources for the greatest effect. The projects are derived from state and metropolitan plans (specified further below) but include new recommendations where there were gaps compared to stakeholder and analytical findings on freight needs. Planning-level cost estimates are provided in every case, and the year for implementation is accelerated for some projects where the need may become acute sooner. Project definitions may be somewhat larger than in state and metropolitan plans due usually to the size of route segments; costs and implementation years have been adjusted to reflect this.

The three tiers of SFC corridors in the DCHC MPO and CAMPO regions are identified in Table 54 in a matrix format to show the land use-transportation interactions related to freight mobility. These SFC corridors were further broken down into segments for implementable projects based on type and extent of improvement needs. These project recommendations are summarized in Table 55 for the DCHC MPO region and in Table 56 for the CAMPO region. Generally, the tables are organized by implementation year, MPO, category of need, and county. The recommended improvement packages are estimated to cost approximately $2.2 billion for the DCHC MPO region and $5.3 billion for the CAMPO region. Because there is some overlap of projects between the two MPOs, the grand total is $7.2 billion for the Triangle Region.

The rationales for these freight project recommendation packages are summarized in Table 57 for the DCHC MPO projects, and in Table 58 for the CAMPO projects, with qualitative assessments of the technical analysis findings.

In order to evaluate the overlaps, gaps and project acceleration needs within the SFC network, the recommended freight projects were compared and mapped with the NCDOT's latest 10-year STIP (2018-2027) projects, DCHC MPO's Draft 2045 MTP Preferred Option projects, and the CAMPO's Draft 2045 MTP Traditional Funding Scenario projects. The results of this comparison are summarized in Table 59 for DCHC MPO region and in Table 60 for the CAMPO region. Appearing in this table are all projects where the STIP and MTPs overlap, all new project recommendations, and all projects where earlier implementation years are recommended.

In order to define implementation packages, the project recommendations are grouped by the SFC Route tiers (e.g., Trade, Distribution, and Access) for the joint DCHC and CAMPO region and sorted by implementation year under each package. The implementation package sets are shown in

Table 61, and are discussed in additional detail later in this chapter.

Table 54: Project Development Framework for Strategic Freight Corridors

		Strategic Freight Corridors (SFC) Trade Routes	Distribution/ Connectivity Routes	Critical Access Routes
Freight Industry Cluster	RDU Airport-Morrisville	I-40	I-540	Aviation Pkwy, McCrimmon Pkwy
	Research Triangle Park	I-40	I-540, NC 147	
	North Durham	I-85	US 501	Northern Durham Pkwy (Future), Old Oxford Rd, Hamlin Rd
	Capital Blvd-Atlantic Ave Area		I-440, US 1, US 401 (North)	Atlantic Ave, Wake Forest Rd, Falls of Neuse Rd
	South Raleigh-Garner Area	I-40	Us 401 (South), US 70	US 70 Business
FOD Opportunity Area	Mebane-Efland-Buckhorn	I-40/I-85	US 70	
	RDU Airport Vicinity	I-40	I-540, NC 147, NC 55	S Miami Blvd, S Alston Ave, TW Alexander Dr, Globe Rd
	Butner-Creedmoor	I-85	NC 56, NC 50 (Creedmoor Rd)	
	Wake Forest-Youngsville		US 1 (Capital Blvd)	
	East Franklinton		US 1, NC 56	
	Knightdale-Wendell-Zebulon	I-87, US 64-264 (Future I-87)	US 64 Business	
	Clayton	I-40	US 70	US 70 Business, NC 42
	Smithfield-Selma	I-95, US 70	US 70	US 70 Business
	Apex, Holly Springs and Fuquay-Varina		I-540, NC 540 (Future Southern Wake Expwy and E. Wake Expwy)	US 64, US 1, US 401 (South), NC 55,
	Moncure-Executive Jetport Area-Sanford		US 1	
	Pittsboro-Siler City		US 64	
ity Cent	CBDs In Raleigh, Durham, Chapel Hill, Cary and Apex	I-40, I-85	US 501 (Roxboro Rd), US 401 (S Saunders St), US 64 (Apex)	US 1 (Capital Blvd), New Bern Ave, S Saunders St

Duke, UNC, and NC State Universities		US 15-501, NC 54, I-440, NC 147	
Duke, UNC, Rex and WakeMed Hospitals		I-440, NC 147, US 15-501, NC 54, US 1/US 64	US 64 Business (New Bern Ave)
Shopping Centers at South Square, Southpoint, Brier Creek, Crossroads, Crabtree, and Triangle Town Center	I-40	I-440, I-540	US 1, US 70, NC 50

A map of the recommended freight projects in the Triangle region are depicted in Figure 153 along with the overlapping STIP and MTP projects. The detailed project maps for individual projects are included in Appendix B (Project Maps). These tables and maps show that there are significant overlaps between the freight project needs and general mobility needs in the region. They also show gaps in the network where freight mobility needs require improvements but there have been no currently planned or programmed projects. In some other cases, freight rationales justify acceleration of certain projects in the region to earlier implementation.

Table 55: Highway Freight Project Recommendations for the DCHC MPO Region

Freight Project MapID	Route Name	From	To	Project Description	Category	Implement By	Length (Miles)	Planning Level Cost Est (Million $)	County	MPO
23	NC 147	East End Conn. ((Fut. I-885)	I-40	Add Lanes; Improve merge and diverge operations at interchange areas	Mobility	2025	4.7	$179.3	Durham	DCHC
3	I-40	NC 86	US 15-501	Add Lanes; Improve merge and diverge operations at interchange areas	Mobility and Safety	2025	4.1	$34.7	Durham , Orange	DCHC
4	I-40	US 15-501	NC 54	Add Lanes; Improve merge and diverge operations at interchange areas	Mobility and Safety	2025	2.8	$86.7	Durham , Orange	DCHC
6	I-40	NC 55	Aviation Pkwy	Add Lanes; Improve merge and diverge operations at interchange areas, and improve interchange bottlenecks	Mobility, Safety and Connectivity	2025	6.8	$271.9	Durham , Wake	DCHC, Capital Area
34	Old Oxford Rd	N Roxboro St	Hebron Rd	Widen lane width, add shoulders, and turn lanes	Econ. Dev.	2030	2.2	$17.6	Durham	DCHC
35	Hamlin Rd	Old Oxford Rd	Red Mill Rd	Widen lane width, add shoulders, and turn lanes	Econ. Dev.	2030	3.4	$27.3	Durham	DCHC
22	NC 147	US 15-501	East End Conn. (Future I-885)	Add Lanes; Improve merge and diverge operations at interchange areas	Mobility	2030	6.3	$213.6	Durham	DCHC
24	NC 55	Sedwick Rd	Riddle Rd	Add Lanes; Improve turning radii at intersections	Mobility	2030	4.7	$47.0	Durham	DCHC
25	S. Alston Ave	NC 54	Riddle Rd	Add Lanes; Improve turning radii at intersections and freight access driveways	Mobility and Econ. Dev.	2030	3.9	$39.3	Durham	DCHC
27	S Miami Blvd	Hopson Rd	I-40	Add Lanes; Improve turning radii at intersections	Mobility and Econ. Dev.	2030	0.9	$9.4	Durham	DCHC
31	US 70	S Miami Blvd	I-85	Add Lanes; Upgrade to freeway	Mobility and Safety	2030	5.2	$309.6	Durham	DCHC
2	I-40	I-85	NC 86	Add lanes; Improve truck safety with wayfinding, incident management, dynamic message signs on road conditions, and/or accel/decel lanes	Mobility and Safety	2030	8.1	$69.0	Orange	DCHC
21	NC 54	US 15-501	I-40	Widen lanes; Improve the US 15-501 interchange; Improve signal coordination, and truck signage	Mobility and Safety	2030	2.9	$43.0	Orange	DCHC
26	S Miami Blvd	I-40	US 70	Add Lanes; Improve turning radii at intersections and freight access driveways	Mobility, Safety and Econ. Dev.	2030	4.2	$42.2	Durham	DCHC
5	I-40	NC 54	NC 55	Add Lanes; Improve truck safety with wayfinding, incident management, dynamic message signs on road conditions, and/or accel/decel lanes	Safety	2030	5.2	$208.8	Durham	DCHC
1	I-40 / I-85	Buckhorn Rd	I-40 / I-85 Split	Improve truck safety with wayfinding, incident management, dynamic message signs on road conditions, and/or accel/decel lanes	Safety	2030	5.1	$30.8	Orange	DCHC, BGUA
30	US 70	I-540	S Miami Blvd	Add Lanes; Upgrade to freeway	Mobility	2030	4.8	$86.7	Durham , Wake	DCHC, Capital Area
12	I-85	US 70	Redwood Rd	Add lanes; Improve truck safety with wayfinding, incident management, dynamic message signs on road conditions, and accel/decel lanes	Mobility and Safety	2035	5.5	$169.0	Durham	DCHC
32	US 501 (N Duke St / N Roxboro St)	I-85	Snow Hill Rd / Mason Rd	Widen lane width; Add turn lanes; Upgrade roadway; Wayfinding for trucks	Mobility and Safety	2035	6.8	$68.3	Durham	DCHC
10	I-85	US 70 Business (Exit 170)	US 15-501	Add lanes; Improve truck safety with wayfinding, incident management, dynamic message signs on road conditions, and accel/decel lanes	Mobility and Safety	2035	4.1	$56.8	Durham , Orange	DCHC
11	I-85	US 15-501	US 70	Improve truck safety with wayfinding, incident management, dynamic message signs on road conditions, and/or accel/decel lanes	Safety	2035	4.2	$25.1	Durham	DCHC
28	Patriot Dr / Globe Rd Ext	Page Rd	S Miami Blvd	Build new connector roadway	Connectivity and Econ. Dev.	2040	2.3	$16.2	Durham	DCHC

Freight Project MapID	Route Name	From	To	Project Description	Category	Implement By	Length (Miles)	Planning Level Cost Est (Million $)	County	MPO
29	N. Durham Pkwy	US 70	I-85	Build new connector roadway	Connectivity and Econ. Dev.	2040	8.1	$72.7	Durham	DCHC
33	US 501 (N Roxboro Rd)	Snow Hill Rd / Mason Rd	Durham County Line	Add Lanes; Add turn lanes; Upgrade roadway; Wayfinding for trucks	Mobility and Connectivity	2040	9.0	$72.4	Durham	DCHC
							TOTAL	**$2,197.4**		

Table 56: Highway Freight Project Recommendations for the CAMPO Region

Freight Project MapID	Route Name	From	To	Project Description	Category	Implement By	Length (Miles)	Planning Level Cost Estimate (Million $)	County	MPO
13	I-440	US 64 / US 1	Wade Ave	Add Lanes; Improve merge and diverge operations at interchange areas	Mobility	2025	3.78	$348.0	Wake	Capital Area
14	I-440	Wade Ave	I-495 / US 64 / US 264	Improve merge and diverge operations at interchange areas	Mobility	2025	10.32	$154.8	Wake	Capital Area
16	I-540	NC 54	Leesville Rd	Add lanes; Improve merge and diverge operations at interchange areas	Mobility	2025	7.95	$127.2	Wake	Capital Area
40	US 1 (Capital Blvd)	I-540	NC 98	Add lanes; Upgrade to freeway; Wayfinding for trucks	Mobility	2025	6.86	$329.3	Wake	Capital Area
60	US 64 / US 1	I-40 / I-440	US 64 / Tryon Rd	Incident management, Wayfinding for trucks, Dynamic message signs on travel conditions	Mobility	2025	3.80	$11.4	Wake	Capital Area
65	Aviation Pkwy	NC 54	I-40	Add lanes; Improve intersection turning radii; Improve signal timing; Wayfinding for trucks	Mobility	2025	2.45	$34.3	Wake	Capital Area
66	McCrimmon Pkwy	Airport Blvd	Aviation Pkwy	Build new connector road; Add turn lanes; Improve intersection turning radii; Improve signal timing; Wayfinding for trucks	Mobility and Connectivity	2025	1.43	$12.2	Wake	Capital Area
67	New Connector Rd	McCrimmon Pkwy	NC 540	Build new connector toll road to extend NC 147 to McCrimmon Pkwy	Mobility and Connectivity	2025	1.31	$24.8	Wake	Capital Area
52	NC 42	US 70 Business	Buffalo Rd	Add lanes; Manage Access; Improve turning radii at intersections	Mobility and Econ. Dev.	2025	5.70	$57.0	Johnston	Capital Area
18	NC 540	NC 55	US 401 (South)	New Toll Road (Southern Wake Expressway)	Mobility and Econ. Dev.	2025	8.35	$192.1	Wake	Capital Area
19	NC 540	US 401 (South)	I-40	New Toll Road (Southern Wake Expressway)	Mobility and Econ. Dev.	2025	8.54	$444.0	Wake	Capital Area
54	US 401 (S Saunders St)	I-40	Garner Station Rd	Add lanes; Manage Access; Improve turning radii at intersections/interchanges; Improve signal timing; Wayfinding for trucks	Mobility and Safety	2025	2.00	$12.0	Wake	Capital Area
62	US 64	Tryon Rd	NC 55	Add lanes; Upgrade to expressway; Wayfinding for trucks	Mobility and Safety	2025	4.78	$148.2	Wake	Capital Area
7	I-40	Aviation Pkwy	I-440 / US 64 / US 1	Add Lanes; Improve merge and diverge operations at interchange areas, and improve interchange bottlenecks	Mobility, Safety and Connectivity	2025	7.94	$317.8	Wake	Capital Area
8	I-40	I-440 / US 64 / US 1	I-40 / I-440 Split	Add Lanes; Improve merge and diverge operations at interchange areas, and improve interchange bottlenecks	Mobility, Safety and Connectivity	2025	8.29	$257.1	Wake	Capital Area
6	I-40	NC 55	Aviation Pkwy	Add Lanes; Improve merge and diverge operations at interchange areas, and improve interchange bottlenecks	Mobility, Safety and Connectivity	2025	6.80	$271.9	Durham, Wake	DCHC, Capital Area
17	I-540	Leesville Rd	US 401 (North)	Add lanes; Improve merge and diverge operations at interchange areas	Mobility	2030	11.45	$183.2	Wake	Capital Area
36	US 70	I-540	Lynn Rd	Add Lanes; Upgrade to Superstreet	Mobility	2030	3.58	$114.5	Wake	Capital Area

Freight Project MapID	Route Name	From	To	Project Description	Category	Implement By	Length (Miles)	Planning Level Cost Estimate (Million $)	County	MPO
38	NC 50 (Creedmoor Rd)	US 70	I-540	Add lanes; Coordinate signals; Wayfinding for trucks	Mobility	2030	4.95	$49.5	Wake	Capital Area
55	US 401 (Fayetteville Rd)	Garner Station Blvd	Ten Ten Rd	Add lanes; Manage Access; Improve turning radii at intersections/interchanges; Improve signal timing; Wayfinding for trucks	Mobility	2030	5.06	$101.3	Wake	Capital Area
61	US 1	US 64 / Tryon Rd	NC 55	Add lanes; Wayfinding for trucks	Mobility	2030	3.13	$119.0	Wake	Capital Area
63	NC 55	Carpenter Fire Station Rd	US 64	Add turn lanes; Improve intersection turning radii; Improve signal timing; wayfinding for trucks	Mobility	2030	5.23	$62.8	Wake	Capital Area
64	NC 54	NC 540	Aviation pkwy	Add lanes; Improve intersection turning radii; Improve signal timing; Wayfinding for trucks	Mobility	2030	2.89	$53.4	Wake	Capital Area
57	NC 55 (N Raleigh St)	US 401 (N Main St)	NC 210 (Depot St)	Add lanes; Manage Access; Improve turning radii at intersections/interchanges; Improve signal timing; Wayfinding for trucks	Mobility	2030	6.42	$89.8	Wake, Harnett	Capital Area
20	NC 540	I-40	US 64 / US 264	New Toll Road (Eastern Wake Expressway)	Mobility and Econ. Dev.	2030	10.80	$324.0	Wake	Capital Area
46	Atlantic Ave	Whitaker Mill Rd	E Millbrook Rd	Add lanes; Manage access driveways; Improve signal timing; Wayfinding for trucks	Mobility and Econ. Dev.	2030	3.25	$39.0	Wake	Capital Area
49	US 64 / US 264 (Future I-87)	Rolesville Rd	US 64 / US 264 Split	Add Lanes; Upgrade to freeway	Mobility and Econ. Dev.	2030	6.89	$89.5	Wake	Capital Area
9	I-40	I-40 / I-440 Split	US 70 (Clayton Bypass)	Add lanes; Improve truck safety with wayfinding, incident management, dynamic message signs on road conditions, and accel/decel lanes	Mobility and Safety	2030	8.45	$168.9	Wake	Capital Area
41	US 1 (Capital Blvd)	I-440	I-540	Add lanes; Upgrade to freeway; Wayfinding for trucks	Mobility and Safety	2030	4.91	$58.9	Wake	Capital Area
48	US 64 Business (New Bern Ave)	I-440	N Smithfield Rd	Add turn lanes; Manage access driveways; Improve signal timing; Wayfinding for trucks	Mobility and Safety	2030	5.68	$45.4	Wake	Capital Area
50	US 70 / NC 50	Mechanical Blvd	I-40	Add lanes; Manage Access; Improve turning radii at intersections, Improve signal timing	Mobility and Safety	2030	4.69	$77.5	Wake	Capital Area
47	Wake Forest Rd / Falls of Neuse Rd	I-440	E Millbrook Rd	Add turn lanes; Manage access driveways; Improve signal timing; Wayfinding for trucks	Safety	2030	1.94	$15.5	Wake	Capital Area
30	US 70	I-540	S Miami Blvd	Add Lanes; Upgrade to freeway	Mobility	2030	4.82	$86.7	Durham, Wake	DCHC, Capital Area
15	I-440	I-495 / US 64 / US 264	I-40	Improve merge and diverge operations at interchange areas	Mobility	2035	2.70	$40.6	Wake	Capital Area
37	US 70	Lynn Rd	I-440	Add turn lanes; Coordinate signals; Wayfinding for trucks	Mobility	2035	3.93	$47.2	Wake	Capital Area
39	NC 50 (Creedmoor Rd)	I-540	NC 98	Add lanes; Coordinate signals; Wayfinding for trucks	Mobility	2035	5.06	$83.5	Wake	Capital Area
56	US 401 (Fayetteville Rd / N Main St)	Ten Ten Rd	Judd Pkwy	Add lanes; Manage Access; Improve turning radii at intersections/interchanges; Improve signal timing; Wayfinding for trucks	Mobility	2035	7.13	$85.6	Wake	Capital Area
59	NC 55	Avent Ferry Rd	Judd Pkwy / Wilbon Rd	Add lanes; Manage Access; Improve turning radii at intersections/interchanges; Improve signal timing; Wayfinding for trucks	Mobility	2035	3.49	$41.9	Wake	Capital Area
42	US 1	NC 98	NC 56	Add lanes; Upgrade to freeway; Wayfinding for trucks	Mobility and Econ. Dev.	2035	10.56	$147.9	Wake,	Capital Area

Freight Project MapID	Route Name	From	To	Project Description	Category	Implement By	Length (Miles)	Planning Level Cost Estimate (Million $)	County	MPO
									Franklin	
43	US 401 (North)	I-540	NC 96	Add lanes; Upgrade to expressway; Wayfinding for trucks	Mobility and Safety	2035	10.02	$130.3	Wake	Capital Area
58	NC 55 / NC 55 Bypass	US 1	Avent Ferry Rd	Add lanes; Manage Access; Improve turning radii at intersections/interchanges; Improve signal timing; Wayfinding for trucks	Mobility and Safety	2035	5.50	$66.0	Wake	Capital Area
51	US 70 Business	I-40	NC 42 (S Lombard St)	Add lanes, Manage Access; Improve turning radii at intersections; Improve signal timing	Mobility, Safety and Econ. Dev.	2035	7.23	$72.3	Wake, Johnston	Capital Area
53	US 70 (Clayton Bypass)	I-40	US 70 Business	Add lanes; Upgrade to expressway; Wayfinding for trucks	Mobility, Safety, and Econ. Dev.	2035	7.17	$86.1	Johnston	Capital Area
44	NC 56	US 1	Peach Orchard Rd	Add lanes; Upgrade and wayfinding for trucks	Mobility and Safety	2040	6.87	$51.5	Franklin	Capital Area
45	NC 56	NC 96	US 1	Add lanes; Upgrade and wayfinding for trucks	Mobility and Safety	2040	6.76	$50.7	Franklin, Granville	Capital Area
							TOTAL	**$5,324.7**		

Table 57: Freight Rationales for the DCHC MPO Projects

Freight Project MapID	Route Name	From	To	Project Rationales
23	NC 147	East End Connector (Future I-885)	I-40	Access to RTP, RDU, and future urban logistics/industrial sites; Moderately high forecast truck volumes; Highly unreliable truck travel times during AM and PM
3	I-40	NC 86	US 15-501	Access to Retail along US 15-501; Moderately High Forecast Truck Volumes; Traffic congestion and highly unreliable truck travel time during PM; Recent truck-related fatal crash near the US 15-501 interchange
4	I-40	US 15-501	NC 54	Access to Retail along US 15-501; Moderately High Forecast Truck Volumes; Traffic congestion and highly unreliable truck travel time during PM; Recent truck-related fatal crash near the US 15-501 interchange
6	I-40	NC 55	Aviation Pkwy	Access to Freight industry clusters at RTP and RDU Airport; High Forecast Truck Volumes; Highly unreliable truck travel times during PM; Recent truck-related fatal crash near the Davis Dr interchange
34	Old Oxford Rd	N Roxboro St	Hebron Rd	Access to future industrial sites in North Durham; Low forecast truck volumes
35	Hamlin Rd	Old Oxford Rd	Red Mill Rd	Access to future industrial sites in North Durham; Low forecast truck volumes
22	NC 147	US 15-501	East End Connector (Future I-885)	Access to Duke Univ, downtown Durham and NCCU; Access to future development urban logistics centers; Medium forecast truck volumes; Highly unreliable truck travel times during AM and PM
24	NC 55	Sedwick Rd	Riddle Rd	Access to RTP and future urban logistics/industrial sites; Medium forecast truck volumes; Unreliable truck travel times during AM and PM
25	S. Alston Ave	NC 54	Riddle Rd	Access to RTP and future urban logistics/industrial sites; Medium forecast truck volumes
27	S Miami Blvd	Hopson Rd	I-40	Access to RTP and future urban logistics/industrial sites; Medium forecast truck volumes; Unreliable truck travel times during AM and PM
31	US 70	S Miami Blvd	I-85	Access to East Durham industrial sites; High forecast truck volumes; Highly unreliable truck travel times during AM and PM; Recent fatal crash near Pleasant Dr
2	I-40	I-85	NC 86	Moderately High Forecast Truck Volumes; Recent truck-related injury crashes
21	NC 54	US 15-501	I-40	Access to UNC-Chapel Hill; Low forecast truck volumes; Highly unreliable truck travel times during AM; Recent truck related injury crashes
26	S Miami Blvd	I-40	US 70	Access to RTP and future urban logistics/industrial sites; Medium forecast truck volumes; Recent truck related injury crashes; Unreliable truck travel times during AM and PM
5	I-40	NC 54	NC 55	Access to Retail along NC 751 and Fayetteville Rd and to Distribution facilities along NC 55; Moderately High Forecast Truck Volumes; Unreliable truck travel times during AM and PM; Recent truck-related fatal crash near the Fayetteville Rd interchange

Freight Project MapID	Route Name	From	To	Project Rationales
1	I-40 / I-85	Buckhorn Rd	I-40 / I-85 Split	Access to Freight-intensive firms in Mebane and the Triad and Metrolina regions to the west; High Forecast Truck Volumes; Recent truck-related injury crashes; Traffic congestion at I-85/I-40 split during AM
30	US 70	I-540	S Miami Blvd	Access to RDU and future industrial sites; Moderately high forecast truck volumes; Highly unreliable truck travel times during AM and PM
12	I-85	US 70	Redwood Rd	Access to freight cluster in North Durham; Moderately High Forecast Truck Volumes; Recent truck-related injury crashes
32	US 501 (N Duke St / N Roxboro St)	I-85	Snow Hill Rd / Mason Rd	Access to future industrial sites in North Durham; Medium forecast truck volumes; Unreliable truck travel times during AM and PM; Recent truck-related crashes
10	I-85	US 70 Business (Exit 170)	US 15-501	Access to freight industries along US 70 Business and NC 86 in Hillsborough; Unreliable truck travel times during PM near NC 147 merge; Recent truck-related fatal crash near the NC 147 interchange
11	I-85	US 15-501	US 70	Access to freight industries in Downtown Durham; Moderately High Forecast Truck Volumes; Recent truck-related fatal crash near the Duke St interchange
28	Patriot Dr / Globe Rd Extension	Page Rd	S Miami Blvd	Access to RTP and future urban logistics/industrial sites; Low forecast truck volumes; Congestion relief to TW Alexander Dr
29	Northern Durham Pkwy	US 70	I-85	Access to future industrial sites in East Durham; Low forecast truck volumes; Congestion relief to US 70
33	US 501 (N Roxboro Rd)	Snow Hill Rd / Mason Rd	Durham County Line	Access to future industrial sites in North Durham; Medium forecast truck volumes; Connectivity to Roxboro, NC and South Boston, VA

Table 58: Freight Rationales for the CAMPO Projects

Freight Project MapID	Route Name	From	To	Project Rationales
13	I-440	US 64 / US 1	Wade Ave	Access to NCSU and downtown Raleigh; Moderately High Forecast Truck Volumes; Highly unreliable truck travel times during AM and PM
14	I-440	Wade Ave	I-495 / US 64 / US 264	Access to Capital Blvd-Atlantic Ave Freight Cluster, Crabtree and North Hills Retail centers and Regional Medical Hospitals (Rex, Duke and WakeMed); Moderately High Forecast Truck Volumes; Highly unreliable truck travel times during AM and PM
16	I-540	NC 54	Leesville Rd	Access to RDU Freight Cluster; Moderately High Forecast Truck Volumes; Highly unreliable truck travel times during AM and PM
40	US 1 (Capital Blvd)	I-540	NC 98	Access to freight industries, future development sites in Franklin County; Connection to I-85; High forecast truck volumes; Highly unreliable truck travel times during AM and PM
60	US 64 / US 1	I-40 / I-440	US 64 / Tryon Rd	Access to industrial development sites in Chatham County, High forecast truck volumes; Highly unreliable truck travel times during AM and PM
65	Aviation Pkwy	NC 54	I-40	Access to Morrisville freight industry cluster, High forecast truck volumes; Recent truck-related crashes
66	McCrimmon Pkwy	Airport Blvd	Aviation Pkwy	Access to Morrisville freight industry cluster, High forecast truck volumes; Recent truck-related crashes
67	New Connector Rd	McCrimmon Pkwy	NC 540	Access to Morrisville freight industry cluster, High forecast truck volumes; Recent truck-related crashes
52	NC 42	US 70 Business	Buffalo Rd	Access to manufacturing industry and industrial development sites along NC 42, Low forecast truck volumes; Highly unreliable truck travel times during AM
18	NC 540	NC 55	US 401 (South)	Provide congestion relief to I-40 in RTP and to I-440 through Downtown Raleigh; Ensure reliable truck route to Ports in NC, SC and GA; Reduce truck movements on arterials; Improve connectivity of southern Wake County development opportunity zones with RDU Airport and RTP
19	NC 540	US 401 (South)	I-40	Provide congestion relief to I-40 in RTP and to I-440 through Downtown Raleigh; Ensure reliable truck route to Ports in NC, SC and GA; Reduce truck movements on arterials; Improve connectivity of southern Wake County development opportunity zones with RDU Airport and RTP
54	US 401 (S Saunders St)	I-40	Garner Station Rd	Access to downtown Raleigh, Moderately high forecast truck volumes; Highly unreliable truck travel times during AM and PM; Recent truck-related injury crashes
62	US 64	Tryon Rd	NC 55	Access to downtown Apex, Cary and industrial development sites in Chatham County, Moderately high forecast truck volumes; Highly unreliable truck travel times during AM and PM; Recent truck-related injury crashes
7	I-40	Aviation Pkwy	I-440 / US 64 / US 1	Access to Retail centers in Cary; Moderately High Forecast Truck Volumes; Highly unreliable truck travel times during AM; Recent truck-related fatal crash near the Harrison Ave interchange

Freight Project MapID	Route Name	From	To	Project Rationales
8	I-40	I-440 / US 64 / US 1	I-40 / I-440 Split	Access to Freight cluster in South Raleigh-Garner area and downtown Raleigh; Moderately High Forecast Truck Volumes; Highly unreliable truck travel times during AM and PM; Recent truck-related injury crashes
6	I-40	NC 55	Aviation Pkwy	Access to Freight industry clusters at RTP and RDU Airport; High Forecast Truck Volumes; Highly unreliable truck travel times during PM; Recent truck-related fatal crash near the Davis Dr interchange
17	I-540	Leesville Rd	US 401 (North)	Access to Freight industries along Capital Blvd; Moderately High Forecast Truck Volumes; Highly unreliable truck travel times during AM
36	US 70	I-540	Lynn Rd	Access to retail; High forecast truck volumes; Highly unreliable truck travel times during AM and PM
38	NC 50 (Creedmoor Rd)	US 70	I-540	Access to retail; Medium forecast truck volumes; Highly unreliable truck travel times during AM and PM
55	US 401 (Fayetteville Rd)	Garner Station Blvd	Ten Ten Rd	Access to industrial development sites in Fuquay-Varina, Moderately high forecast truck volumes; Highly unreliable truck travel times during AM and PM
61	US 1	US 64 / Tryon Rd	NC 55	Access to industrial development sites in Chatham County, Moderately high forecast truck volumes; Highly unreliable truck travel times during PM
63	NC 55	Carpenter Fire Station Rd	US 64	Access to Cary and Apex retail, Medium forecast truck volumes; Unreliable travel times during AM and PM
64	NC 54	NC 540	Aviation pkwy	Access to Morrisville freight industry cluster, Medium forecast truck volumes; Highly unreliable truck travel times during AM and PM; Recent truck-related crashes
57	NC 55 (N Raleigh St)	US 401 (N Main St)	NC 210 (Depot St)	Access to industrial development sites in Fuquay-Varina, Medium forecast truck volumes; Unreliable truck travel times during AM
20	NC 540	I-40	US 64 / US 264	Provide congestion relief to I-440 through Downtown Raleigh; Ensure reliable truck route to Ports in NC, SC, GA and VA; Reduce truck movements on arterials; Improve connectivity of eastern Wake County development opportunity zones with RDU Airport and RTP
46	Atlantic Ave	Whitaker Mill Rd	E Millbrook Rd	Access to freight industries, Medium forecast truck volumes
49	US 64 / US 264 (Future I-87)	Rolesville Rd	US 64 / US 264 Split	Access to future industrial sites in Knightdale-Wendell-Zebulon area, Route to CCX intermodal terminal in Rocky Mount, Connectivity with I-95, Moderately high forecast truck volumes; Recent truck related multiple fatal crashes
9	I-40	I-40 / I-440 Split	US 70 (Clayton Bypass)	Access to freight industries along US 70 Business in Garner; Truck route to Ports in NC , SC and GA; Moderately High Forecast Truck Volumes; Unreliable truck travel times during PM near I-440 merge; Recent truck-related fatal crash near the US 70 Bypass interchange
41	US 1 (Capital Blvd)	I-440	I-540	Access to freight industries, Medium forecast truck volumes; Highly unreliable truck travel times during AM and PM; Recent truck related injury crashes
48	US 64 Business (New Bern Ave)	I-440	N Smithfield Rd	Access to retail, freight industries, and WakeMed Hospital; Low forecast truck volumes; Highly unreliable truck travel times during AM and PM; Recent truck related injury crashes
50	US 70 / NC 50	Mechanical Blvd	I-40	Access to retail in Garner, Medium forecast truck volumes; Recent truck related injury crashes
47	Wake Forest Rd / Falls of Neuse Rd	I-440	E Millbrook Rd	Access to Retail and Duke Hospital, Medium forecast truck volumes, Recent truck-related injury crashes
30	US 70	I-540	S Miami Blvd	Access to RDU and future industrial sites; Moderately high forecast truck volumes; Highly unreliable truck travel times during AM and PM
15	I-440	I-495 / US 64 / US 264	I-40	Access to WakeMed Regional Medical Hospital; Moderately High Forecast Truck Volumes; Unreliable truck travel times during PM
37	US 70	Lynn Rd	I-440	Access to retail; High forecast truck volumes; Highly unreliable truck travel times during AM and PM
39	NC 50 (Creedmoor Rd)	I-540	NC 98	Connection to I-85; High forecast truck volumes; Unreliable truck travel times during AM and PM
56	US 401 (Fayetteville Rd / N Main St)	Ten Ten Rd	Judd Pkwy	Access to industrial development sites in Fuquay-Varina, Medium forecast truck volumes; Highly unreliable truck travel times during AM and PM
59	NC 55	Avent Ferry Rd	Judd Pkwy / Wilbon Rd	Access to industrial development sites in Apex and Holly Springs, Moderately high forecast truck volumes; Unreliable truck travel times during AM and PM
42	US 1	NC 98	NC 56	Access to future development sites in Kerr-Tar RPO; Connection to I-85; Medium forecast truck volumes; Unreliable truck travel times during AM

Freight Project MapID	Route Name	From	To	Project Rationales
43	US 401 (North)	I-540	NC 96	Access to future industrial sites in Kerr-Tar RPO; Medium forecast truck volumes; Unreliable truck travel times during AM and PM; Recent truck related fatal crash
58	NC 55 / NC 55 Bypass	US 1	Avent Ferry Rd	Access to industrial development sites in Apex and Holly Springs, Medium forecast truck volumes; Unreliable truck travel times during AM and PM; Recent truck-related injury crashes
51	US 70 Business	I-40	NC 42 (S Lombard St)	Access to downtown Clayton and industrial development sites along NC 42, Low forecast truck volumes; Recent truck related injury crashes
53	US 70 (Clayton Bypass)	I-40	US 70 Business	Access to industrial development sites in Smithfield-Selma area, Route to Morehead City Port, Medium forecast truck volumes; Recent truck related fatal crash
44	NC 56	US 1	Peach Orchard Rd	Access to future industrial sites in Kerr-Tar COG; Medium forecast truck volumes; Unreliable truck travel times during PM; Recent truck related crashes
45	NC 56	NC 96	US 1	Access to future industrial sites in Kerr-Tar COG; Medium forecast truck volumes; Recent truck related fatal crash

Table 59: Overlaps and Gaps Between Freight, STIP and MTP Projects in the DCHC MPO Region

Freight Project MapID	Route Name	From	To	Implement By	Overlapping STIP ID	STIP Improvement	STIP Construction Year	Overlapping MTP ID	MTP Improvement	MTP Completion Year
23	NC 147	East End Connector (Future I-885)	I-40	2025	U-5934	Add lanes and pavement rehab	2022	H24	Widen to 8 lanes (for possibly Managed Lanes)	2025
3	I-40	NC 86	US 15-501	2025	I-5822	Interstate Maintenance	2019	H77	Widen to 6 lanes	2035
4	I-40	US 15-501	NC 54	2025	I-5822, I-5702A	Interstate Maintenance, Add Managed Lanes Design-Build	2019, 2026	H84	Widen to 8 lanes for Managed Lanes	2045
6	I-40	NC 55	Aviation Pkwy	2025	I-5702A	Add Managed Lanes Design-Build	2027	H85	Widen to 10 lanes for Managed Lanes	2035
34	Old Oxford Rd	N Roxboro St	Hebron Rd	2030						
35	Hamlin Rd	Old Oxford Rd	Red Mill Rd	2030						
22	NC 147	US 15-501	East End Connector (Future I-885)	2030	U-5937	Auxiliary lane and operational improvements	2023	H88	Modernization/Operational Improvements	2025
24	NC 55	Sedwick Rd	Riddle Rd	2030						
25	S. Alston Ave	NC 54	Riddle Rd	2030						
27	S Miami Blvd	Hopson Rd	I-40	2030						
31	US 70	S Miami Blvd	I-85	2030	U-5720A	Upgrade Roadway Corridor to Freeway	2022	H78	Convert to 6-lane freeway	2025
2	I-40	I-85	NC 86	2030	I-3306AC	NC 86 Interchange Improvement	2023	H18	Widen to 6 lanes	2035
21	NC 54	US 15-501	I-40	2030	U-5774C	Upgrade Roadway Corridor	2024	I2	Upgrade interchange with US 15-501; Modernization; Widen to 6 lanes Superstreet	2027
26	S Miami Blvd	I-40	US 70	2030						
5	I-40	NC 54	NC 55	2030	I-5702A	Add Managed Lanes Design-Build	2026	H85	Widen to 10 lanes for Managed Lanes	2045
1	I-40 / I-85	Buckhorn Rd	I-40 / I-85 Split	2030	I-5958	Interstate Maintenance	2023			
30	US 70	I-540	S Miami Blvd	2030	U-5720C	Upgrade Roadway Corridor to Freeway	2027	A412	Convert to 6-lane freeway	2035
12	I-85	US 70	Redwood Rd	2035	I-5942	Interstate Maintenance	2024	H21	Widen to 6 lanes	2045
32	US 501 (N Duke St / N Roxboro St)	I-85	Snow Hill Rd / Mason Rd	2035	U-5516	Intersection Improvements at Latta Rd / Infinity Rd	2019	H6, H43	Modernization/Operational Improvements	2045
10	I-85	US 70 Business (Exit 170)	US 15-501	2035	I-5941, I-5983	Interstate Maintenance, Widen to 6 lanes	2024, 2027	H76	Widen to 6 lanes	2045

Freight Project MapID	Route Name	From	To	Implement By	Overlapping STIP ID	STIP Improvement	STIP Construction Year	Overlapping MTP ID	MTP Improvement	MTP Completion Year
11	I-85	US 15-501	US 70	2035						
28	Patriot Dr / Globe Rd Extension	Page Rd	S Miami Blvd	2040				H82	New 2-lane roadway	2045
29	Northern Durham Pkwy	US 70	I-85	2040				H41	New 4-lane roadway	2045
33	US 501 (N Roxboro Rd)	Snow Hill Rd / Mason Rd	Durham County Line	2040						

Note: This comparison is based on NCDOT's latest STIP 2018-2027, DCHC MPO's Draft 2045 MTP, Preferred Option Scenario, and CAMPO's Draft 2045 MTP, Traditional Funding Scenario.

Table 60: Overlaps and Gaps Between Freight, STIP and MTP Projects in the CAMPO Region

Freight Project MapID	Route Name	From	To	Implement By	Overlapping STIP ID	STIP Improvement	STIP Construction Year	Overlapping MTP ID	MTP Improvement	MTP Completion Year
13	I-440	US 64 / US 1	Wade Ave	2025	U-2719, I-5703	Widen to 6 lanes Design-Build; Interchange improvements at I-440 / US 1 / US 64	2018	F10	Widen to 6 lanes	2025
14	I-440	Wade Ave	I-495 / US 64 / US 264	2025	I-5870, I-5708, I-5970	Interstate Maintenance, New Interchange at Ridge Rd and Modify Interchange with US 70; Improve Interchange at Wake Forest Rd; Improve Interchange at Capital Blvd	2022, 2020, 2024	A79a, F83	New interchange access to Crabtree Mall; Interchange improvements at Wake Forest Rd	2035, 2025
16	I-540	NC 54	Leesville Rd	2025	I-5968, I-5982	EB Auxiliary Lane; Managed Shoulders	2021, 2025	F42b	Widen for Managed Lanes	2035
40	US 1 (Capital Blvd)	I-540	NC 98	2025	U-5307A		2021	F11-1a-d	Widen for freeway upgrade	2025
60	US 64 / US 1	I-40 / I-440	US 64 / Tryon Rd	2025	U-2719	Widen to 6 lanes	2018			
65	Aviation Pkwy	NC 54	I-40	2025	U-5811	Widen to multilane with interchange mod at I-40	2023	A64b, A64a	Widen to 4 lanes	2025
66	McCrimmon Pkwy	Airport Blvd	Aviation Pkwy	2025	U-5828	Widen to multilane, part on new location	2018	A26a	New 2-lane roadway	2025
67	New Connector Rd	McCrimmon Pkwy	NC 540	2025	U-5966	Construct multilane facility on new location	2023	F13	New 4-lane Toll Rd	2025
52	NC 42	US 70 Business	Buffalo Rd	2025				Jhns1b	Widen to 4 lanes	2025
18	NC 540	NC 55	US 401 (South)	2025	R-2721	Southern Wake Freeway Design-Build	2020	F5	New 6-lane freeway	2025
19	NC 540	US 401 (South)	I-40	2025	R-2828	Southern Wake Freeway Design-Build	2020	F6	New 6-lane freeway	2025
54	US 401 (S Saunders St)	I-40	Garner Station Rd	2025						
62	US 64	Tryon Rd	NC 55	2025	U-5301	Corridor upgrade and improvements	2022	F15a3, F15a	Widen to 6-lane Superstreet; Widen to 6 lanes	2025, 2035
7	I-40	Aviation Pkwy	I-440 / US 64 / US 1	2025	I-5943, I-5702A	Interstate Maintenance, Add Managed Lanes Design-Build	2021, 2027	F40, F41, F81a	Widen for Managed Lanes; Widen to 8 lanes	2035
8	I-40	I-440 / US 64 / US 1	I-40 / I-440 Split	2025	I-5701	Add Lanes	2022	F41, F43	Widen for Managed Lanes; Widen to 8 lanes;	2035, 2025
6	I-40	NC 55	Aviation Pkwy	2025	I-5702A	Add Managed Lanes Design-Build	2027	H85	Widen to 10 lanes for Managed Lanes	2035
17	I-540	Leesville Rd	US 401 (North)	2030	I-5945, I-5982	Interstate Maintenance; Managed Shoulders	2022, 2025	F42b	Widen for Managed Lanes	2035
36	US 70	I-540	Lynn Rd	2030	U-2823	Add lanes and convert to superstreet	2023	A101	Widen to 6 lanes with interchange at Lynn Rd	2035
38	NC 50	US 70	I-540	2030				A195	Widen to 6 lanes	2035

Freight Project MapID	Route Name	From	To	Implement By	Overlapping STIP ID	STIP Improvement	STIP Construction Year	Overlapping MTP ID	MTP Improvement	MTP Completion Year
	(Creedmoor Rd)									
55	US 401 (Fayetteville Rd)	Garner Station Blvd	Ten Ten Rd	2030	U-5302	Convert to Superstreet	2020	A635a, A635b, A480a, A678	Convert to Superstreet; Convert to Superstreet; Widen to 6 lanes; Interchange at Ten Ten Rd	2025, 2025, 2035, 2035
61	US 1	US 64 / Tryon Rd	NC 55	2030	U-6066	Add lanes	2026	F110	Widen to 6 lanes	2035
63	NC 55	Carpenter Fire Station Rd	US 64	2030				A440c	Convert Carpenter-Fire Station Rd intersection to interchange	2035
64	NC 54	NC 540	Aviation pkwy	2030	U-5750	Add lanes	2021	A222c, A222b	Widen to 6 lanes; Widen to 4 lanes	2025, 2035
57	NC 55 (N Raleigh St)	US 401 (N Main St)	NC 210 (Depot St)	2030	R-5705B, U-5705A	Roadway Improvements	2022	A118a, A118b, Hrnt4a	Widen to 4 lanes	2045, 2025
20	NC 540	I-40	US 64 / US 264	2030	R-2829	Eastern Wake Freeway Design-Build	2027	F3	New 6-lane freeway	2035
46	Atlantic Ave	Whitaker Mill Rd	E Millbrook Rd	2030				A686	Widen	2025
49	US 64 / US 264 (Future I-87)	Rolesville Rd	US 64 / US 264 Split	2030				F7a	Widen to 6 lanes freeway	2035
9	I-40	I-40 / I-440 Split	US 70 (Clayton Bypass)	2030	I-5111	Add Lanes and ITS Design-Build	Planning/Design	F44a	Widening to 8 lanes	2025
41	US 1 (Capital Blvd)	I-440	I-540	2030	I-5970	Interchange improvements at I-440/US 401 Capital Blvd	2024	F86	Widen for freeway upgrade	2035
48	US 64 Business (New Bern Ave)	I-440	N Smithfield Rd	2030						
50	US 70 / NC 50	Mechanical Blvd	I-40	2030	U-5744	Convert intersection to interchange at Hammond Rd	2021	A300	Widen to 6 lanes	2035
47	Wake Forest Rd / Falls of Neuse Rd	I-440	E Millbrook Rd	2030	I-5708	Interchange improvements at I-440/Wake Forest Rd	2020			
30	US 70	I-540	S Miami Blvd	2030	U-5720C	Upgrade Roadway Corridor to Freeway	2027	A412	Convert to 6-lane freeway	2035
15	I-440	I-495 / US 64 / US 264	I-40	2035						
37	US 70	Lynn Rd	I-440	2035						
39	NC 50 (Creedmoor Rd)	I-540	NC 98	2035	U-5891	Widen to multi-lane divided highway	2025	A444	Widen to 4 lanes	2035
56	US 401 (Fayetteville Rd / N Main St)	Ten Ten Rd	Judd Pkwy	2035	U-5746, U-5980	Add lanes near future NC 540; Access management along Main St	2019, 2025	A480b, A619a, A619b, A619c	Widen to 6 lanes; Widen to 6 lanes; Widen to 6 lanes; Provide Median	2025, 2035; 2035; 2025
59	NC 55	Avent Ferry Rd	Judd Pkwy / Wilbon Rd	2035				A98	Widen to 6 lanes	2035
42	US 1	NC 98	NC 56	2035				F11-1e1, F11-1e2	Widen for freeway upgrade	2035
43	US 401 (North)	I-540	NC 96	2035	U-5748	Convert Mitchell Mill intersection to interchange	2022	A130c, A90b, A90c	Convert Mitchell Mill intersection to interchange; Rolesville Bypass; Widen to 4 lanes	2025
58	NC 55 / NC 55 Bypass	US 1	Avent Ferry Rd	2035	U-5981	Interchange improvements at US 1 / NC 55	2026	A98	Widen to 6 lanes	2035

Freight Project MapID	Route Name	From	To	Implement By	Overlapping STIP ID	STIP Improvement	STIP Construction Year	Overlapping MTP ID	MTP Improvement	MTP Completion Year
51	US 70 Business	I-40	NC 42 (S Lombard St)	2035				A301	Widen to 6 lanes	2035
53	US 70 (Clayton Bypass)	I-40	US 70 Business	2035				F14	Widen to 6-lane freeway	2035
44	NC 56	US 1	Peach Orchard Rd	2040				Frnk4b	Widen to 4 lanes	2045
45	NC 56	NC 96	US 1	2040				Frnk4a	Widen to 4 lanes	2045

Note: This comparison is based on NCDOT's latest STIP 2018-2027, DCHC MPO's Draft 2045 MTP, Preferred Option Scenario, and CAMPO's Draft 2045 MTP, Traditional Funding Scenario.

Table 61: Project Implementation Packages for the Joint DCHC and CAMPO Region

Freight Project MapID	Route Name	From	To	Project Description	Implement By	Planning Level Cost Estimate (Million $)	MPO	Freight Clusters	Freight Development Areas	Activity Centers
				TRADE ROUTES						
7	I-40	Aviation Pkwy	I-440 / US 64 / US 1	Add Lanes; Improve merge and diverge operations at interchange areas, and improve interchange bottlenecks	2025	$317.8	Capital Area	RDU-Morrisville		CBD, Univ, Shopping
8	I-40	I-440 / US 64 / US 1	I-40 / I-440 Split	Add Lanes; Improve merge and diverge operations at interchange areas, and improve interchange bottlenecks	2025	$257.1	Capital Area	South Raleigh-Garner		CBD
3	I-40	NC 86	US 15-501	Add Lanes; Improve merge and diverge operations at interchange areas	2025	$34.7	DCHC			Shopping
4	I-40	US 15-501	NC 54	Add Lanes; Improve merge and diverge operations at interchange areas	2025	$86.7	DCHC			Shopping
6	I-40	NC 55	Aviation Pkwy	Add Lanes; Improve merge and diverge operations at interchange areas, and improve interchange bottlenecks	2025	$271.9	DCHC, Capital Area	RTP, RDU	RDU Vicinity	Shopping
9	I-40	I-40 / I-440 Split	US 70 (Clayton Bypass)	Add lanes; Improve truck safety with wayfinding, incident management, dynamic message signs on road conditions, and accel/decel lanes	2030	$168.9	Capital Area	South Raleigh-Garner		
2	I-40	I-85	NC 86	Add lanes; Improve truck safety with wayfinding, incident management, dynamic message signs on road conditions, and/or accel/decel lanes	2030	$69.0	DCHC		Mebane-Efland-Buckhorn	
5	I-40	NC 54	NC 55	Add Lanes; Improve truck safety with wayfinding, incident management, dynamic message signs on road conditions, and/or accel/decel lanes	2030	$208.8	DCHC		RDU Vicinity	Shopping
1	I-40 / I-85	Buckhorn Rd	I-40 / I-85 Split	Improve truck safety with wayfinding, incident management, dynamic message signs on road conditions, and/or accel/decel lanes	2030	$30.8	DCHC, Burlington-Graham		Mebane-Efland-Buckhorn	
49	US 64 / US 264 (Future I-87)	Rolesville Rd	US 64 / US 264 Split	Add Lanes; Upgrade to freeway	2030	$89.5	Capital Area		Knightdale-Wendell-Zebulon	
12	I-85	US 70	Redwood Rd	Add lanes; Improve truck safety with wayfinding, incident management, dynamic message signs on road conditions, and accel/decel lanes	2035	$169.0	DCHC	North Durham	Butner-Creedmoor	
10	I-85	US 70 Business (Exit 170)	US 15-501	Add lanes; Improve truck safety with wayfinding, incident management, dynamic message signs on road conditions, and accel/decel lanes	2035	$56.8	DCHC		Mebane-Efland-Buckhorn	

Freight Project MapID	Route Name	From	To	Project Description	Implement By	Planning Level Cost Estimate (Million $)	MPO	Freight Clusters	Freight Development Areas	Activity Centers
11	I-85	US 15-501	US 70	Improve truck safety with wayfinding, incident management, dynamic message signs on road conditions, and/or accel/decel lanes	2035	$25.1	DCHC			CBD
53	US 70 (Clayton Bypass)	I-40	US 70 Business	Add lanes; Upgrade to expressway; Wayfinding for trucks	2035	$86.1	Capital Area		Smithfield-Selma	
DISTRIBUTION/CONNECTIVITY ROUTES										
13	I-440	US 64 / US 1	Wade Ave	Add Lanes; Improve merge and diverge operations at interchange areas	2025	$348.0	Capital Area			CBD, Univ
14	I-440	Wade Ave	I-495 / US 64 / US 264	Improve merge and diverge operations at interchange areas	2025	$154.8	Capital Area	Capital Blvd-Atlantic Ave		Shopping, Hospitals
16	I-540	NC 54	Leesville Rd	Add lanes; Improve merge and diverge operations at interchange areas	2025	$127.2	Capital Area	RDU	RDU Vicinity	Shopping
23	NC 147	East End Connector (Future I-885)	I-40	Add Lanes; Improve merge and diverge operations at interchange areas	2025	$179.3	DCHC	RTP, RDU	RDU Vicinity	
18	NC 540	NC 55	US 401 (South)	New Toll Road (Southern Wake Expressway)	2025	$192.1	Capital Area		Apex-Holly Springs-Fuquay Varina	
19	NC 540	US 401 (South)	I-40	New Toll Road (Southern Wake Expressway)	2025	$444.0	Capital Area		Apex-Holly Springs-Fuquay Varina	
40	US 1 (Capital Blvd)	I-540	NC 98	Add lanes; Upgrade to freeway; Wayfinding for trucks	2025	$329.3	Capital Area	Capital Blvd-Atlantic Ave	Wake Forest-Youngsville, East Franklinton	Shopping
62	US 64	Tryon Rd	NC 55	Add lanes; Upgrade to expressway; Wayfinding for trucks	2025	$148.2	Capital Area		Pittsboro-Siler City	CBD, Shopping
60	US 64 / US 1	I-40 / I-440	US 64 / Tryon Rd	Incident management, Wayfinding for trucks, Dynamic message signs on travel conditions	2025	$11.4	Capital Area		Pittsboro-Siler City	Shopping
17	I-540	Leesville Rd	US 401 (North)	Add lanes; Improve merge and diverge operations at interchange areas	2030	$183.2	Capital Area		RDU Vicinity	
22	NC 147	US 15-501	East End Connector (Future I-885)	Add Lanes; Improve merge and diverge operations at interchange areas	2030	$213.6	DCHC		RDU Vicinity	CBD, Univ, Hospital

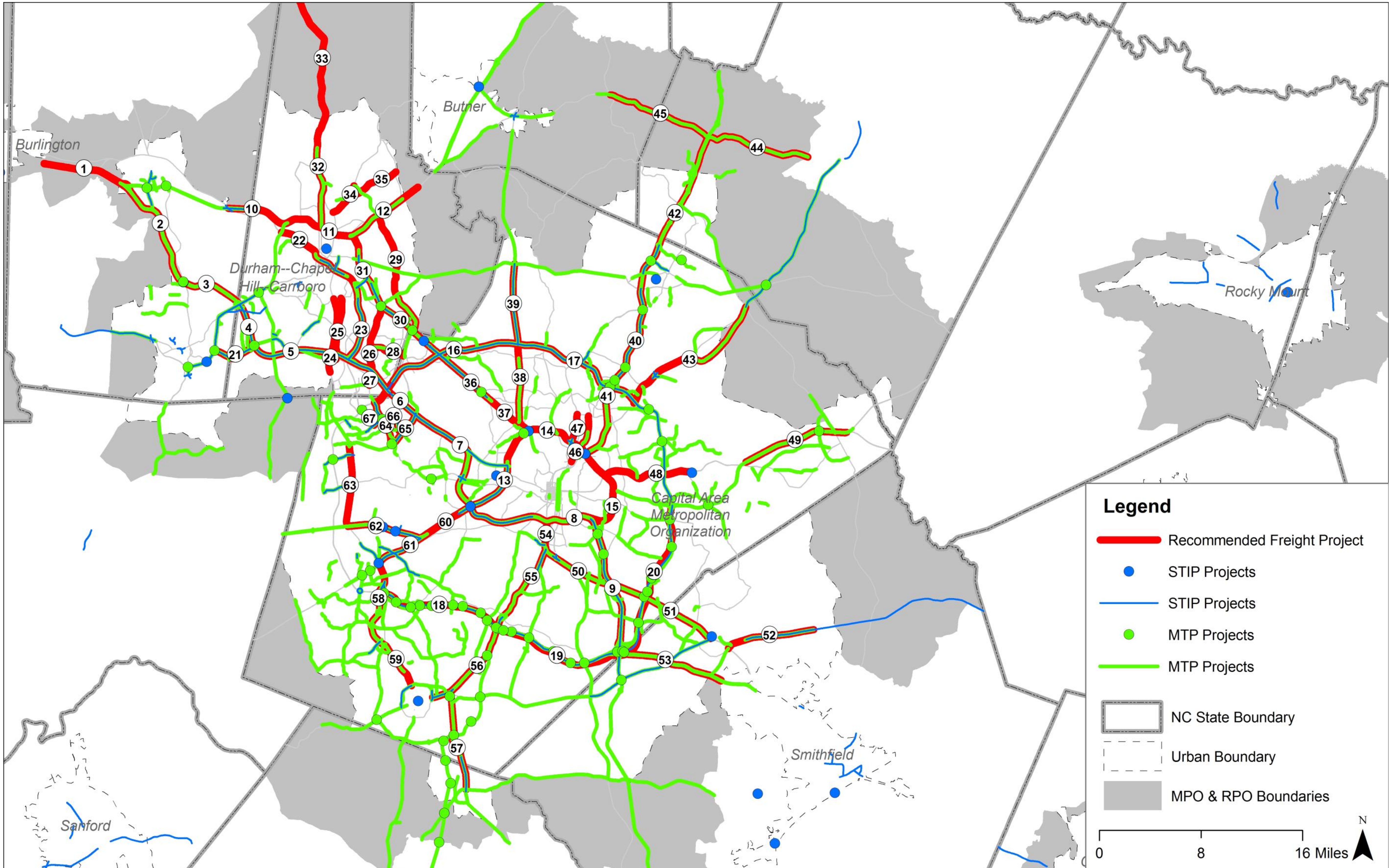
Freight Project MapID	Route Name	From	To	Project Description	Implement By	Planning Level Cost Estimate (Million $)	MPO	Freight Clusters	Freight Development Areas	Activity Centers
38	NC 50 (Creedmoor Rd)	US 70	I-540	Add lanes; Coordinate signals; Wayfinding for trucks	2030	$49.5	Capital Area			Shopping
21	NC 54	US 15-501	I-40	Widen lanes; Improve the US 15-501 interchange; Improve signal coordination, and truck signage	2030	$43.0	DCHC			Univ, Hospital
20	NC 540	I-40	US 64 / US 264	New Toll Road (Eastern Wake Expressway)	2030	$324.0	Capital Area		Knightdale-Wendell-Zebulon	
24	NC 55	Sedwick Rd	Riddle Rd	Add Lanes; Improve turning radii at intersections	2030	$47.0	DCHC	RTP	RDU Vicinity	
57	NC 55 (N Raleigh St)	US 401 (N Main St)	NC 210 (Depot St)	Add lanes; Manage Access; Improve turning radii at intersections/interchanges; Improve signal timing; Wayfinding for trucks	2030	$89.8	Capital Area		Apex-Holly Springs-Fuquay Varina	
61	US 1	US 64 / Tryon Rd	NC 55	Add lanes; Wayfinding for trucks	2030	$119.0	Capital Area		Moncure-Jetport Area-Sanford	
41	US 1 (Capital Blvd)	I-440	I-540	Add lanes; Upgrade to freeway; Wayfinding for trucks	2030	$58.9	Capital Area	Capital Blvd-Atlantic Ave	Wake Forest-Youngsville, East Franklinton	
55	US 401 (Fayetteville Rd)	Garner Station Blvd	Ten Ten Rd	Add lanes; Manage Access; Improve turning radii at intersections/interchanges; Improve signal timing; Wayfinding for trucks	2030	$101.3	Capital Area		Apex-Holly Springs-Fuquay Varina	
36	US 70	I-540	Lynn Rd	Add Lanes; Upgrade to Superstreet	2030	$114.5	Capital Area			Shopping
31	US 70	S Miami Blvd	I-85	Add Lanes; Upgrade to freeway	2030	$309.6	DCHC		RDU Vicinity	
30	US 70	I-540	S Miami Blvd	Add Lanes; Upgrade to freeway	2030	$86.7	DCHC, Capital Area	RTP, RDU	RDU Vicinity	Shopping
50	US 70 / NC 50	Mechanical Blvd	I-40	Add lanes; Manage Access; Improve turning radii at intersections, Improve signal timing	2030	$77.5	Capital Area	South Raleigh-Garner		
15	I-440	I-495 / US 64 / US 264	I-40	Improve merge and diverge operations at interchange areas	2035	$40.6	Capital Area			Hospital
39	NC 50 (Creedmoor Rd)	I-540	NC 98	Add lanes; Coordinate signals; Wayfinding for trucks	2035	$83.5	Capital Area		Butner-Creedmoor	
59	NC 55	Avent Ferry Rd	Judd Pkwy / Wilbon Rd	Add lanes; Manage Access; Improve turning radii at intersections/interchanges; Improve signal timing; Wayfinding for trucks	2035	$41.9	Capital Area		Apex-Holly Springs-Fuquay Varina	
58	NC 55 / NC 55 Bypass	US 1	Avent Ferry Rd	Add lanes; Manage Access; Improve turning radii at intersections/interchanges; Improve signal timing; Wayfinding for trucks	2035	$66.0	Capital Area		Apex-Holly Springs-Fuquay Varina	
42	US 1	NC 98	NC 56	Add lanes; Upgrade to freeway; Wayfinding for trucks	2035	$147.9	Capital Area		Wake Forest-Youngsville, East	

Freight Project MapID	Route Name	From	To	Project Description	Implement By	Planning Level Cost Estimate (Million $)	MPO	Freight Clusters	Freight Development Areas	Activity Centers
									Franklinton	
56	US 401 (Fayetteville Rd / N Main St)	Ten Ten Rd	Judd Pkwy	Add lanes; Manage Access; Improve turning radii at intersections/interchanges; Improve signal timing; Wayfinding for trucks	2035	$85.6	Capital Area		Apex-Holly Springs-Fuquay Varina	
43	US 401 (North)	I-540	NC 96	Add lanes; Upgrade to expressway; Wayfinding for trucks	2035	$130.3	Capital Area		East Franklinton	
32	US 501 (N Duke St / N Roxboro St)	I-85	Snow Hill Rd / Mason Rd	Widen lane width; Add turn lanes; Upgrade roadway; Wayfinding for trucks	2035	$68.3	DCHC	North Durham		
37	US 70	Lynn Rd	I-440	Add turn lanes; Coordinate signals; Wayfinding for trucks	2035	$47.2	Capital Area			Shopping
44	NC 56	US 1	Peach Orchard Rd	Add lanes; Upgrade and wayfinding for trucks	2040	$51.5	Capital Area		East Franklinton	
45	NC 56	NC 96	US 1	Add lanes; Upgrade and wayfinding for trucks	2040	$50.7	Capital Area		Butner-Creedmoor, East Franklinton	
33	US 501 (N Roxboro Rd)	Snow Hill Rd / Mason Rd	Durham County Line	Add Lanes; Add turn lanes; Upgrade roadway; Wayfinding for trucks	2040	$72.4	DCHC	North Durham		

				ACCESS ROUTES						
65	Aviation Pkwy	NC 54	I-40	Add lanes; Improve intersection turning radii; Improve signal timing; Wayfinding for trucks	2025	$34.3	Capital Area	RDU-Morrisville	RDU Vicinity	
66	McCrimmon Pkwy	Airport Blvd	Aviation Pkwy	Build new connector road; Add turn lanes; Improve intersection turning radii; Improve signal timing; Wayfinding for trucks	2025	$12.2	Capital Area	RDU-Morrisville	RDU Vicinity	
52	NC 42	US 70 Business	Buffalo Rd	Add lanes; Manage Access; Improve turning radii at intersections	2025	$57.0	Capital Area		Clayton	
67	New Connector Rd	McCrimmon Pkwy	NC 540	Build new connector toll road to extend NC 147 to McCrimmon Pkwy	2025	$24.8	Capital Area	RDU-Morrisville	RDU Vicinity	
54	US 401 (S Saunders St)	I-40	Garner Station Rd	Add lanes; Manage Access; Improve turning radii at intersections/interchanges; Improve signal timing; Wayfinding for trucks	2025	$12.0	Capital Area	South Raleigh-Garner		CBD, Shopping
46	Atlantic Ave	Whitaker Mill Rd	E Millbrook Rd	Add lanes; Manage access driveways; Improve signal timing; Wayfinding for trucks	2030	$39.0	Capital Area	Capital Blvd-Atlantic Ave		
35	Hamlin Rd	Old Oxford Rd	Red Mill Rd	Widen lane width, add shoulders, and turn lanes	2030	$27.3	DCHC	North Durham		
64	NC 54	NC 540	Aviation pkwy	Add lanes; Improve intersection turning radii; Improve signal timing; Wayfinding for trucks	2030	$53.4	Capital Area	RDU-Morrisville	RDU Vicinity	
63	NC 55	Carpenter Fire Station Rd	US 64	Add turn lanes; Improve intersection turning radii; Improve signal timing; wayfinding for trucks	2030	$62.8	Capital Area			Shopping

Freight Project MapID	Route Name	From	To	Project Description	Implement By	Planning Level Cost Estimate (Million $)	MPO	Freight Clusters	Freight Developmen t Areas	Activity Centers
34	Old Oxford Rd	N Roxboro St	Hebron Rd	Widen lane width, add shoulders, and turn lanes	2030	$17.6	DCHC	North Durham		
27	S Miami Blvd	Hopson Rd	I-40	Add Lanes; Improve turning radii at intersections	2030	$9.4	DCHC	RTP	RDU Vicinity	
26	S Miami Blvd	I-40	US 70	Add Lanes; Improve turning radii at intersections and freight access driveways	2030	$42.2	DCHC	RTP	RDU Vicinity	
25	S. Alston Ave	NC 54	Riddle Rd	Add Lanes; Improve turning radii at intersections and freight access driveways	2030	$39.3	DCHC	RTP	RDU Vicinity	
48	US 64 Business (New Bern Ave)	I-440	N Smithfield Rd	Add turn lanes; Manage access driveways; Improve signal timing; Wayfinding for trucks	2030	$45.4	Capital Area			Shopping, Hospitals
47	Wake Forest Rd / Falls of Neuse Rd	I-440	E Millbrook Rd	Add turn lanes; Manage access driveways; Improve signal timing; Wayfinding for trucks	2030	$15.5	Capital Area			Shopping, Hospitals
51	US 70 Business	I-40	NC 42 (S Lombard St)	Add lanes, Manage Access; Improve turning radii at intersections; Improve signal timing	2035	$72.3	Capital Area		Clayton	
29	Northern Durham Pkwy	US 70	I-85	Build new connector roadway	2040	$72.7	DCHC	North Durham	RDU Vicinity	
28	Patriot Dr / Globe Rd Extension	Page Rd	S Miami Blvd	Build new connector roadway	2040	$16.2	DCHC	RTP	RDU Vicinity	

Figure 153: Map of Recommended Freight Projects



Policy and Program Recommendations

The central challenges for freight transportation in the Triangle region stem from population growth rates among the fastest in the country. Residents are drawn to and remain in the region because of its quality of life and affordability, its institutions of higher learning, and the industry and jobs those institutions have helped to nurture. Population and industry are the two primary constituencies for freight transportation. Population is served through the distribution of household goods from local and global producers via retail channels, and through the construction trade as homes, workplaces, and infrastructure are built and maintained. Industry is served through inbound supply lines and outbound connections to markets, in both cases relying on the multimodal freight network to perform these functions.

The freight profile for the region depicts the fastest growth coming from high value goods shipped outbound, including products such as machinery and electronics, chemicals and pharmaceuticals. Slower growth comes from heavy goods shipped locally, including fuel and minerals like sand and gravel used in construction. Growth for inbound goods supplying residents and businesses falls in between. Trucking is the dominant mode in all areas, but the high value goods driving industrial growth and employment are far more likely to require multiple modal options because they trade in markets across the country and world.

Industrial growth enables population growth. It requires high performance on trade routes, and equally on the local routes used for first and last miles and for circulation in regional service. Like an ellipse, the Triangle region has the two focal points of Raleigh and Durham. RTP and RDU lie in the middle – an efficient location for commuting to work and distributing goods, yet inevitably at the center of traffic congestion, too. Clusters of freight-dependent businesses are situated mainly around the same focal and central points: adjacent to the I-440/40 loop and the interstate highway portions of the 540 loop, with another cluster northeast of Durham along I-85. Activity centers important for freight deliveries encompass central business districts, retail malls, universities and hospitals; these are usually on major arteries, yet they are spread around the region. New industrial development is expected to come at the region's periphery, pushing outward, but with infill and redevelopment occurring in interior locations like RTP. The trend in warehouse automation implies that older facilities may face obsolescence, yet automated replacements could generate considerably more freight without enlarging the facility footprint. Meanwhile, the typical response in logistics when a central location becomes too congested to serve a whole region efficiently is to substitute multiple locations away from the center.

This plan will have a broad policy to build resiliency into the freight system. Resiliency can generally be defined as the ability to prepare and plan for, absorb, respond to, recover from, adapt to, and prevent adverse events. The greatest risks are related to weather events such as extreme storms, flooding, landslides and wildfires that cause roads to wash out, crack or cave, signal systems to fail, and vehicles to crash. However, non-weather events such as hazardous chemical spills and catastrophic crashes can be just as impactful. These disruptions can have significant economic impacts on freights services, producer industries and communities. This plan recommends that resiliency be built into all freight investments, policies and coordination.

Institutional coordination and awareness are very important. In general, resiliency should be a recurring issue for the newly formed Regional Freight Stakeholders Advisory Council (RFSAC). The Council and state, regional and local agencies, and the private sector should consider resiliency in all of their policy approaches, planning, and investments, and in their relationship and coordination with one another. There are three specific recommendations:

- Plan for disruptions – The region needs to plan and practice the activities that need to take place to close, reroute and repair roads and adjacent infrastructure. Agencies can take advantage of small scale disturbances to prepare for larger disruptions and to assess what changes need to occur to avoid future disturbances.
- Develop tools to assess the dynamic performance of the transportation system – The regional travel demand model could build the capability to show the impacts of incidents and the subsequent mitigation of those impacts through infrastructure and operational improvements.
- Support prevention programs and policies – The MPO should support programs that reduce crashes, freight mishaps and chemical spills, and policies that encourage the construction of an infrastructure that is resilient to the increasingly frequent and violent weather events.

The SFC system developed in this Plan is designed to accommodate the requirements, pressures and vectors of the growth just described. This section expands the policy and strategic context for the SFC system, and presents recommendations for roadway, development, and multimodal programs, illustrated in

Table 62, that advance the region's overarching goals for safety, equity, livability, sustainability, productivity and economic competitiveness.

Table 62: Summary of Recommended Programs to Advance Regional Goals

Recommended Programs		
Roadway	**Development**	**Multimodal**
SFC System	Foster Development of DCs	Marine
Truck Parking Signage	Support Redevelopment	Rail
Intelligent Transportation Systems	Expand Access to Compressed Natural Gas Fueling Stations	Air

Roadway Programs

SFC System

Roadway programs begin with elements specifically focused on the SFC system, supporting and enhancing the $7.2 billion in SFC investment outlined earlier in this chapter. The policy of the Triangle Region should be to protect and advance the condition and performance of the SFC system. First of the several actions the Region should take is the codification of truck route design standards to apply throughout the SFC network. Standards should incorporate:

- Lane and shoulder widths and overhead clearances;
- Intersection design criteria;
- Recognition of the upcoming requirements for vehicle automation, such as maintenance of lane markings;

- Specifications on signaling to enable fluid truck movement; and ideally,
- Some form of control on the frequency of curb cuts.

Implementation should begin in connection with new construction, roadway widening projects, and major site developments. Looking forward, the Region should conduct a comprehensive assessment of the conformance to standards of the full SFC network, develop plans for improvements over time wherever practical, and execute improvements as facets of projects or as projects themselves.

Additional steps the Region should take include:

- Evaluation of tolling opportunities, with revenue tied to reinvestment in the SFC system. The largest project affecting SFC distribution routes is the NC 540/Southern Wake Expressway toll road. The trucking industry typically views fuel taxes as preferable to tolling, but fleets and drivers make rational trade-offs between the speed, reliability and distance of alternative routes and will accept tolls when the net cost favors them. Managed lanes are a variant form of tolling and encounter similar carrier responses. If tolled lanes enable faster and more certain travel, trucks will use them when their schedules justify it; examples are high service fleets handling express packages or carriers committed to pick-up or delivery appointments during rush hours.
- Monitoring of bridge volumes and conditions. The projected growth of truck traffic throughout the SFC system will increase the load of heavy vehicles on bridge structures. Presently there are just two identified bridge projects intersecting with the SFC (shown in Table 63). Neither is specifically a freight project (and they do not appear in the SFC project recommendations in this chapter), although freight traffic will benefit. Needs on the SFC nevertheless should be expected to rise, and since deferral of bridge maintenance can lead to lowered weight limits and circuitous routing of trucks, bridge condition can be a productivity and emissions issue as well as a safety concern.
- Annual assessments of safety on the SFC system should be undertaken to recognize, diagnose and rectify developing hot spots, as truck and passenger traffic continue to grow. Alertness to hazardous material incidents should be an aspect of the assessment.

Table 63: Bridge Projects

Bridge Project	Bridge ID	Improvement	Cost Estimate (Million $)	STIP ID	STIP Construction Year	MPO
US 15-501 Northbound Bridge over Cornwallis Rd	310080	Replace	2.4	B-5674	2024	DCHC
US 401 (Capital Blvd) Bridge over Crabtree Creek	910146	Replace	9.2	B-5684	2025	Capital Area

Truck Parking

There are two general categories of truck parking needs: locations for long haul drivers to stop for sleep, and locations for drivers making local deliveries or pickups to rest while awaiting appointment times. Both needs will become more acute when the federal requirement for Electronic Log Books (ELBs) takes effect at the end of 2017. The purpose of ELBs is more accurate recording of driver hours of service, and thus tighter enforcement. The benefit is greater safety, but the downside is less flexibility in work hours. Drivers who cannot find parking at efficient times in their work schedule may need to get off the clock sooner, thus forfeiting work hours and reducing productivity. While the needs of long haul drivers passing through the region is chiefly a NCDOT responsibility, the needs of long haul and regional drivers making local deliveries and pickups should be addressed by the Triangle Region. A key consideration is that multiple parking locations dispersed through the region are apt to work best, because they enable drivers to position themselves near the place of their next appointment and reduce the risk of late arrivals.

The policy of the Triangle Region should be to ensure the adequacy of truck parking throughout its territory for the sake of safety and productivity. Action steps should begin with a study to inventory truck parking capacity throughout the region, but especially in its freight clusters. The inventory should encompass formal facilities such as truck stops, and informal capacity such as commercial lots that allow use by trucks, Electrification of lots is an important feature to capture, because electric connections reduce truck idling and diesel emissions. The study should design a truck parking program to enlarge capacity where warranted and facilitate its use. Potential elements to evaluate include:

- Specification of truck parking in development and redevelopment plans, both for industrial and for commercial areas. The latter is desirable because commercial districts depend on the supply of goods, and safe locations for trucks to park improves the livability of the area.
- Allowance for truck parking by businesses benefitting from access improvements. Better access supports the commercial prospects of businesses. In return for public expenditures to make such improvements, businesses could be expected to identify parking spaces for trucks at their facilities.
- Mobile apps for smart phones exist today that indicate truck parking availability. The next step beyond a simple inventory is an electronic monitoring system to report the availability of open spaces in real time via such apps. The cost of establishing such a system and how much of the inventory it needs to cover are questions to be answered by the evaluation.
- Related is the option of an on-line reservation system for truck parking spaces. The advantage for the user is that prepaid parking means space is sure to be available. However, because fleets with ample financial resources could buy up capacity to disrupt competitors, the equity of such systems needs careful assessment.
- Parking lots double as staging points. An operating innovation seen in Canada involves long combination vehicles moving trailers from Distribution Centers (DCs) to secure downtown drop lots during uncongested night hours. Delivery drivers collect the trailers in the morning and avoid the “stem” travel from the DC during peak hours. Combination vehicles are essential to the economics of this operating model, and while they are not an option in the Triangle Region, the use of truck platoons (discussed below) could offer another means to the same end. However, because drivers in the trailing vehicles of platoons would need to be off duty to yield enough cost savings, the feasibility of this approach appears several years away.

Truck parking overlaps with the question of loading zones, which effectively are parking spots of shorter duration with a critical need for proximity to businesses. Curb space typically is an issue for urban districts, yet as the region grows, the centers of surrounding towns can evolve into urban districts themselves and face the same challenges. In addition, the demand for curb space adequate for truck deliveries will proliferate throughout the region from the influence of internet home delivery. This affects universities as well, since their growth not only increases the supply of goods the schools use themselves, but also the internet orders placed by an expanding student body. University deliveries were one of the burgeoning difficulties cited by freight carriers contacted for this Plan.

The Region should evaluate all of its activity centers for hot spots affecting truck loading today and tomorrow – a topic where local truck lines and the Triangle RFSAC can offer insight and guidance – and should develop responses to its challenges. A common method for managing curb capacity is to vary the allowed uses by time of day, designating space as a loading zone at some hours and as automobile parking or a bike or bus lane at others. Real time reporting of available space is a useful enhancement that makes variable uses more practical and easier to enforce, and reservation systems can help preserve space for larger vehicles. In high activity locations, package delivery companies have even expressed an interest in leasing space, which offers revenue to municipalities in exchange for certainty and efficiency for the carrier.

Signage

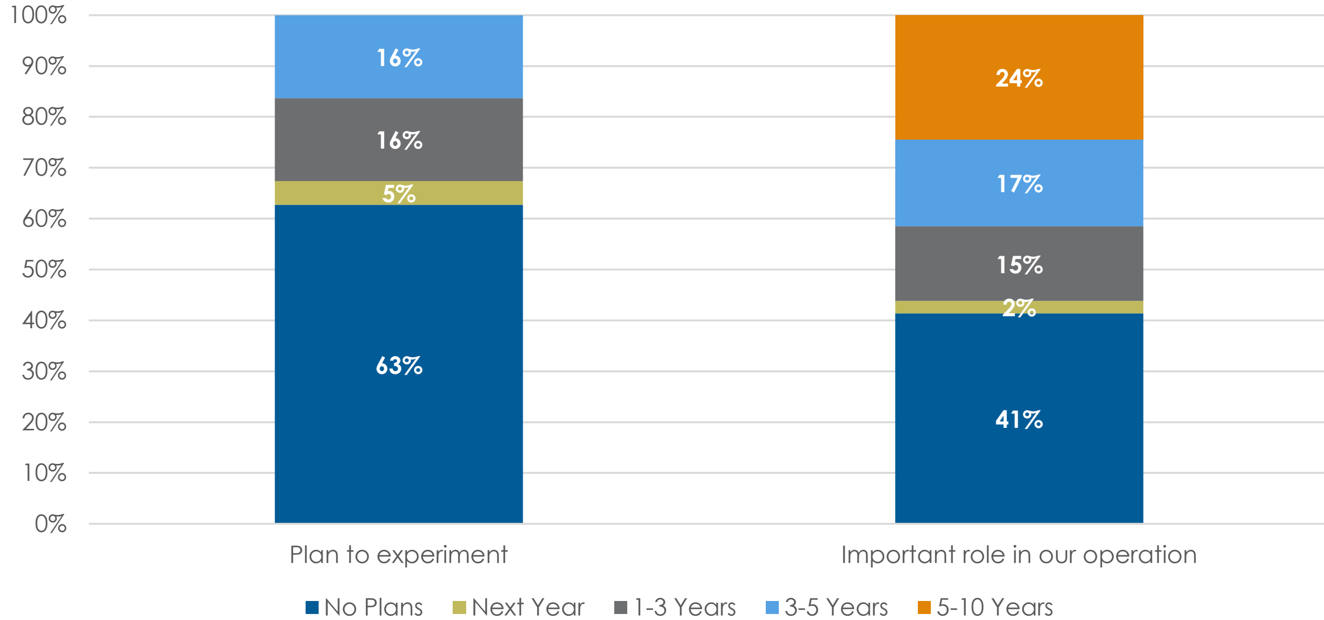
Wayfinding is especially needed in growing areas because their districts and routes are changing, and new drivers are arriving with new volume. Signage also is a straightforward mechanism for publicizing and reinforcing the SFC as a system for trucks, and many of the SFC projects recommended in this chapter incorporate wayfinding. The policy of the Region should be provision of effective signage on the SFC system, and in freight clusters, FOD opportunity areas, and activity centers. The key action is to assess the adequacy of signage through an inventory taken in each of the clusters, areas and centers and across the SFC, identifying the types and visibility of signs posted now, the gaps in communication, and any outdated messaging. Contemporary technology makes this a reasonably practical and affordable effort. Cameras mounted on the roof of an automobile can capture signs and other road conditions as the vehicle moves along. Image recognition software then can report and categorize the signage and other findings. This establishes a data base that can be analyzed by route and cluster, enabling recommendations to be made for improvements. A corollary benefit is that the complete visual record of the SFC and cluster facilities obtained by this means provides a resource for ITS deployment, particularly in respect to vehicle-to-infrastructure technology, and for the implementation of truck route design standards.

Intelligent Transportation Systems (ITS)

The first driverless freight delivery was a truckload of beer that rolled off a Colorado production line in the fall of 2016 and reached destination over 100 miles away with no direct involvement of labor at all. This was a controlled demonstration, yet it is easy to imagine it duplicated at bottling plants in the Triangle Region. Moreover, the fact that automated delivery served as an extension of an automated production line suggests a coming paradigm shift in what constitutes a competitive manufacturing operation.

Tompkins International of Raleigh conducted a national survey of supply chain managers in the first quarter of 2017 on behalf of the Triangle Region. The survey found that one in five respondents planned to experiment with automated trucks within the next 3 years, over one-third saw an important supply chain role for the technology within 5 years, and almost 60 percent envisioned an important role with 5-10 years (see Figure 154).

Figure 154: Expected Use of Automated Truck in the Years Ahead



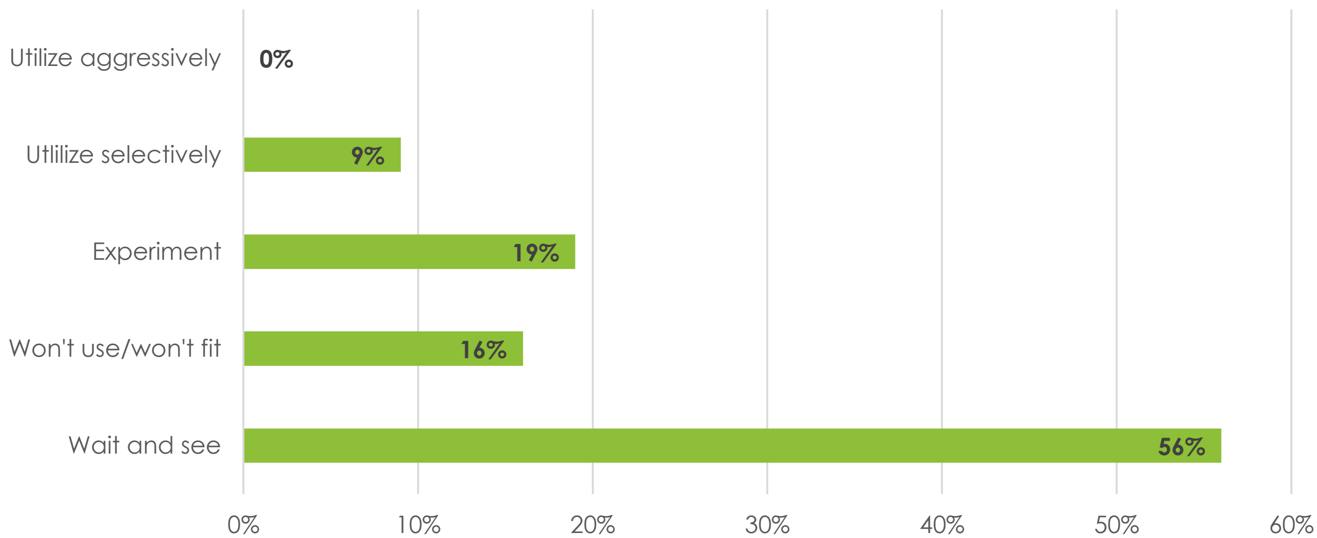
Source: Tompkins International

These are not long time frames in the context of this Plan. The policy the Region should adopt is to prepare itself for automation in freight transportation, and the initial action it should take is to convene a Task Force to research and respond to the technology. This should be coordinated with and act as an adjunct to other efforts pertaining to this technology in passenger vehicles, but freight deserves a special focus and there are opportunities to evaluate in the near term:

- Vehicle-to-infrastructure technology is bidirectional communication between roadways and motor vehicles. It can be as simple as maintaining lane markings to be certain sensors in trucks can detect them, and can extend to more sophisticated interactions. Monitors in trucks today are capturing braking behavior, which can be a valuable signal to other vehicles not in the line of sight, and braking could be automated to slow down trucks as they approach slick or icy pavement. The point is that worthwhile applications already exist and more are coming. The Task Force should examine options for pilot deployment along the SFC, looking for example at safety hot spots and at the routes into freight clusters and FOD opportunity areas.
- Signal prioritization is used now to expedite travel through intersections by emergency vehicles. Selective application to trucks should be considered by the Task Force in circumstances where speed and reliability are especially acute requirements. One example is air cargo trucks hurrying to meet airplane departure schedules at RDU Airport at congested times of day. A different example concerns the fact that many delivery trucks make a practice of departing their domiciles in the early morning, so as to travel across town and commence drop offs before rush hour. Signal prioritization might be used in some locations during the early hours to help drivers complete more deliveries before the roads and intersections are full of commuter traffic.

The Tompkins survey found that most supply chain managers were not planning to employ truck platoons, and only 19 percent expected even to experiment with them (see Figure 155). Even so, industry commentators report that a commercial vendor already is making an inexpensive retrofit that permits two manned trucks to move together safely with the headway between them shortened enough to achieve significant improvements in fuel efficiency from air drafting. Investment could be recouped within 18 months at current fuel prices, implying that fleets can test the technology at low cost and derive benefits rather quickly. Interstate travel on major routes such as I-40 and I-85 are obvious places where this could appear, and NCDOT in its Statewide Multimodal Freight Plan highlights truck platoons as a key technology strategy. The Task Force should coordinate with the State and remain abreast of developments.

Figure 155: Expected Use of Truck Platoons

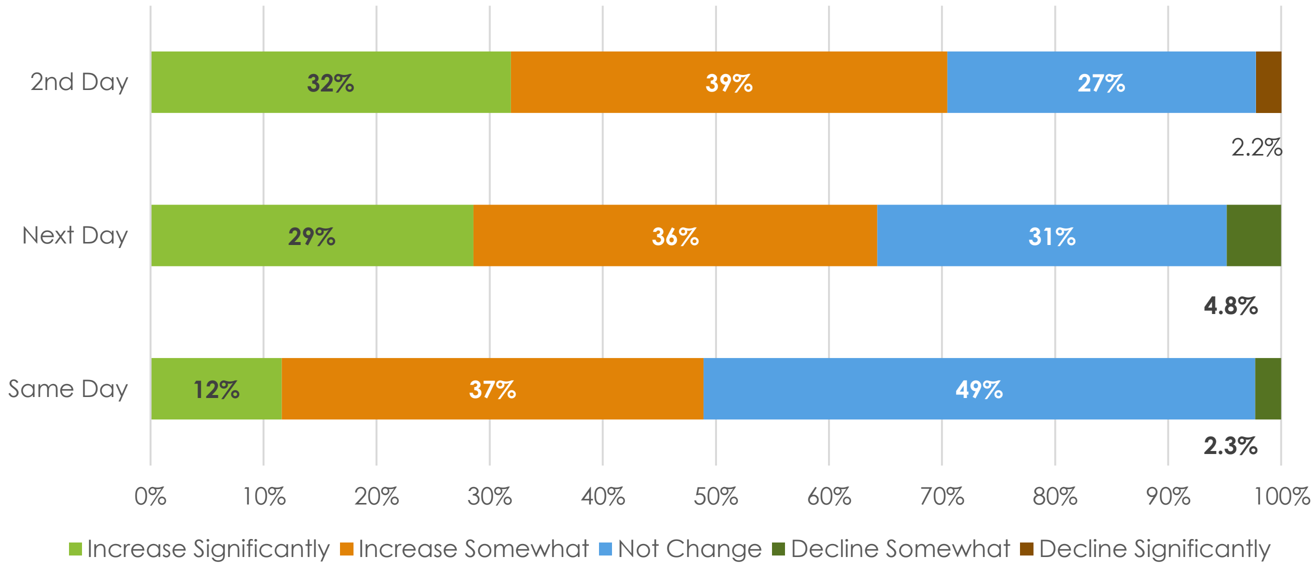


Source: Tompkins International

Development Programs

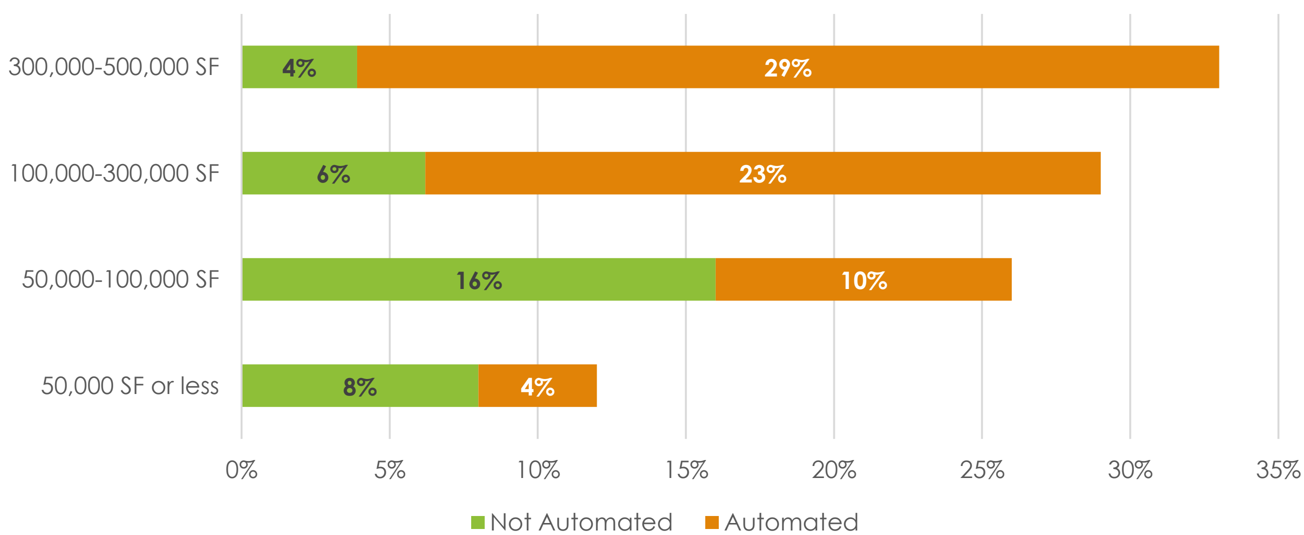
The location and character of DCs is changing markedly. This is due principally to the expansion of e-commerce, which is affecting retailers and manufacturers alike. The Tompkins survey found that nearly two-thirds of supply chain managers expect their need for next day deliveries to increase, and almost half expect an increase for same day deliveries (see Figure 156). Facilities able to support service at these speeds must be closer to delivery points than was necessary in the past. Moreover, Tompkins found that two-thirds of the DCs closest market will be under 300,000 SF, and most of those will be automated (see Figure 157). Size and automation are related: an automated 250,000 SF facility can match the throughput of a 750,000 SF traditional facility, and can fit on a 20-acre site. The implications are a) higher freight generation per acre, and more value per acre from the property; b) new demand for industrial sites within short distance of delivery points; c) new viability of industrial land parcels that previously were too small; and d) obsolescence of older facilities unable to suit new requirements, and a consequent need for redevelopment.

Figure 156: 3 Year Outlook - Truck Delivery Range of Distribution Centers



Source: Tompkins International

Figure 157: 3 Year Outlook for Size & Automation of DCs Closest to Market



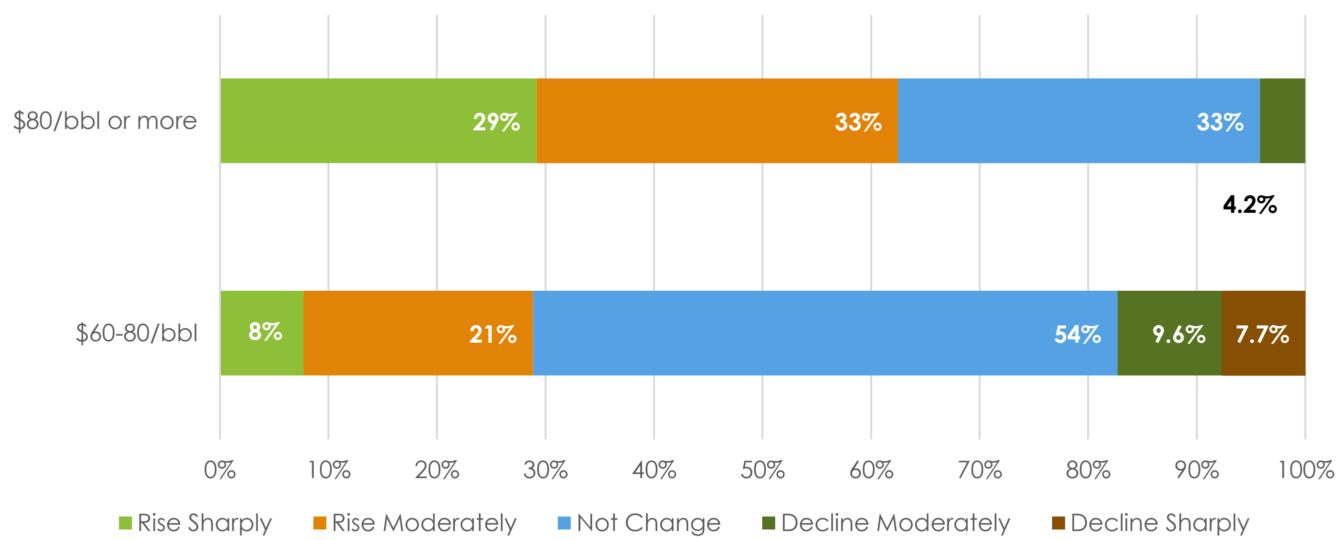
Source: Tompkins International

These considerations give rise to three policies the Region should adopt:

- Foster development in multiple areas to support diverse points of access to the regional market. Given the market emphasis on fast, reliable delivery, the congestion that comes with growth and the difficulties it brings for long travel distances across the region, and the viability of smaller parcels, it makes sense to enable distribution from many points of the compass.

- Support redevelopment in older freight clusters, especially those in close-in locations. The stress on delivery speed coupled with the need and opportunity for renewing obsolete properties provide the rationale for this policy.
- Encourage expansion of Compressed Natural Gas (CNG) fueling stations to protect air quality. More freight per acre means greater concentration of diesel emissions. Availability of alternative fuels helps control emissions, and CNG is the most widely used form. Findings from Tompkins (see Figure 158) indicate that CNG adoption is strongly influenced by oil prices. Usage rates double when oil reaches $80 per barrel because natural gas has large and less expensive domestic supplies. While the oil price today is below $60, it has approached $100 in the not distant past; as an abundant and environmentally cleaner fuel, NG is both healthier for the community and a hedge against oil prices for Triangle Region supply chains.

Figure 158: Effect of Oil Price on Use of CNG Vehicles in Supply Chain



Source: Tompkins International

A key action the Region should take is to develop a series of small area plans for freight clusters and the FOD opportunity areas (which include new and re-development in RTP). The purpose of the plans is to anticipate and shape the type of development each area may see, and prepare programs and timelines for freeway access, frontage and backage roads, signage and ITS applications, and safe, productive internal circulation for freight and passenger vehicles.

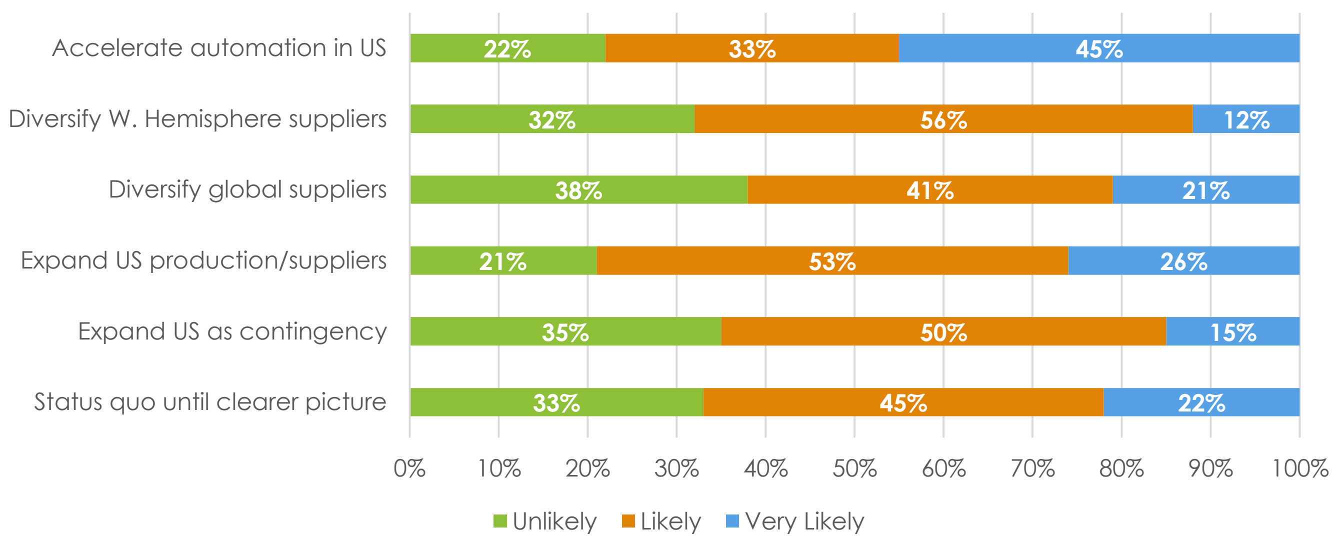
Multimodal Programs

Marine

The Triangle Region lies inland, yet one of its advantages for business location is its proximity to seaports: it falls within a 3-hour drive of the North Carolina ports of Wilmington and Morehead City, and within overnight delivery distance of the three principal container ports of the Southeast at Norfolk, Charleston and Savannah. Indeed, the Region is close enough to Norfolk to enable same day round trip truck service, and could perform even better under development of I-87. Foreign trade is important for the Region's supply of consumer goods and for export access to global markets for Triangle industry.

The foreign trade outlook for the U.S. is clouded by the uncertain course of national trade policy. The Tompkins survey questioned supply chain managers as to their plans amidst this uncertainty (see Figure 159). The findings revealed multiple strategies in use: the strongest was accelerated automation in U.S. facilities coupled with more domestic production and sourcing, yet foreign trade in the western hemisphere and around the world remained very much in play. The implication is that trade routes will remain essential to the Triangle economy even as domestic activity (but less so domestic employment) may grow.

Figure 159: 3 Year Outlook for Sourcing/Siting under Uncertain Trade Conditions



Source: Tompkins International

The key policy for the Region should be advancement of improvements on access corridors to ports, which for most of them means I-40 south of Raleigh. The salient exception is the U.S. 64/I-87 corridor to Norfolk, which also provides access to new domestic and international rail service (as discussed below); north of Durham, I-85 is used to reach Norfolk as well.

Rail

Freight investments along the NCRR should clearly demonstrate how they accommodate the NCRR's 4-track footprint, that the investments are the most cost-effective use of taxpayer money for freight and passenger rail service in adopted NCDOT and MPO Plans, and briefly address future investments that would likely need to be made for adopted NCDOT and MPO plans to be implemented

The two transformative rail developments in the Region are the aggressive growth plans for Go Triangle passenger service and the construction of the CSX Carolina Connector intermodal freight facility at Rocky Mount. Both should be supported as a matter of freight policy. The passenger rail program involves up to 44 new trains daily to operate over the right-of-way of the North Carolina Railroad, which is a freight carrier in its own right as well as a provider of track to NS. However, the Go Triangle plan is predicated on the avoidance of impedance to freight service, producing substantial expansion of transit without diminishing cargo operations. Freight shippers and logistics service providers around the country tend to favor transit because it releases highway capacity for motor carriage; the issue usually is that shared right-of-way between passenger and freight service constrains the latter. Go Triangle's ability to avoid such conflicts promises a win-win outcome for the region.

The Carolina Connector will bring CSX intermodal service to the Triangle Region, competing with the NS facility in Greensboro from a new Intermodal Logistics Center (ILC) in Rocky Mount. CSX operations are expected to include service in shorter distance domestic lanes. Findings from the Tompkins survey indicate there is real demand for domestic services of this type, with nearly two-thirds of shippers showing interest and two out of five expecting moderate or aggressive use in lanes that fit their supply chains (see Figure 160). Like NS, CSX will support international service as well.

Figure 160: Expected Use of Shorter Distance (≥ 550 miles) Rail Intermodal Service - Next 3 Years

Source: Tompkins International

The benefits of the Rocky Mount facility go beyond new transportation alternatives, because the ILC is designed as a catalyst for industrial development on large and adjacent property. Looking further into the future, the Triangle Region can expect industrial growth to extend along the U.S. 64/I-87 corridor, adding truck traffic but also providing jobs to the region. One of the Triangle FOD opportunity areas lies on this corridor and offers a west-end counterpart to the Rocky Mount properties.

In addition to a policy of supporting access to rail intermodal service – at Greensboro via I-85 as well as Rocky Mount – the Region should seek to retain rail carload service. With the intermodal terminals lying outside Triangle boundaries, the freight rail activity inside the region in fact is entirely of this type, and it is valuable to the typically heavy industry that uses it. Maintenance of direct rail access to existing industrial sites is one facet of service retention, and the Region should make this a factor in redevelopment plans. Similarly, inclusion of rail sidings for new development in FOD opportunity areas should be sought, where proximity to freight rail lines renders this feasible.

Improvements at railway-roadway at-grade crossings are another form of support to carload service, since they improve its safety and can reduce travel delays for both rail and road. Ten projects for grade separation have been identified in Triangle Region plans, as shown in Table 64. Four are scheduled by 2025, but several have timing that is much further out. The separations are in central business districts and so have not been included in the SFC project recommendations presented in this chapter; nevertheless, they are important to multimodal freight movement and its compatibility with growing communities.

Table 64: Railway-Roadway Grade Separation Projects

Rail Road Grade Crossing	Grade Crossing ID	Improvement	Cost Estimate (Million $)	STIP or MTP ID	STIP Construction Year	MPO
Mangum St and Blackwell St	735231P, 735229N	Grade Separation	100	P-5710	Post 10-yr	DCHC
Ellis Rd	735236Y	Grade Separation	5.3	P-5716	2026	DCHC
Cornwallis Rd	734742W	Grade Separation	13.7	P-5717	2020	DCHC
Maynard Rd	643351A	Grade Separation	38	P-5718	2024	Capital Area
New Hope Church Rd	630607N	Grade Separation	15.4	P-5715	2020	Capital Area
Gresham Lk Rd	636602E	Grade Separation	11	P-5729	2027	Capital Area
Durant Rd	630601X	Grade Separation	12.5	P-5720	2019	Capital Area
E Milbrook Rd	n.a.	Grade Separation	n.a.	A657	Post 2045	Capital Area
NC 96 (Main St) in Youngsville	n.a.	Grade Separation	n.a.	A663	Post 2045	Capital Area
NC 56 in Franklinton	n.a.	Grade Separation	n.a.	Frnk4b1	Post 2045	Capital Area

A different kind of development initiative is build-over projects, where the air rights over rail properties are leased for new uses. Construction takes place over track or yards without detriment to rail service, thus creating new acreage. While the Triangle Region is not so land constrained that a relatively expensive option like this is critical to consider, it is worthwhile to recognize it as an alternative as the region continues to grow, and the revenue available from air rights can benefit railroads and municipalities.

Specific actions in support of these policies include roadway investments on the intermodal access routes I-85 and U.S. 64/I-87 (involving projects cited earlier in this chapter), implementation of grade crossing projects, and continuance of Go Triangle programs for their indirect benefits to freight.

Air

Air freight service from RDU Airport is primarily domestic. International cargo mainly moves in the bellies of overseas passenger flights in wide body aircraft. Many more of these flights are available to the south at Atlanta and Charlotte, and to the north at New York's JFK and Washington's Dulles airport. Triangle companies utilizing overseas air service will truck their cargo between the region and one or more of these distant facilities. Domestic cargo is handled in dedicated freighter aircraft at RDU operated chiefly by the integrated carriers FedEx and UPS, with daily service available.

The consequence of these points is that reliable road access to all of these airports is a central need for the freight sector, and it should be the Triangle Region's policy to enable it. Air cargo is time sensitive freight and its connections by truck must satisfy the fixed departure and arrival schedules of aircraft. Frequently, this puts cargo trucks on the road at congested times of day, and the expansion of next day and same day e-commerce delivery schedules heightens the challenge. The key action is to advance the mobility projects described elsewhere in this chapter that affect road access. For the external airports, these are on I-85 heading north and south; for RDU, they are on I-40, I-540 and U.S. 70.

Because of the congestion surrounding RDU Airport, an additional action to introduce signal prioritization should be adopted. As mentioned above under ITS, it is possible to help expedite air cargo trucks through intersections on the approaches to the airport. This would be limited to times of day when aircraft are scheduled to depart and land, and when the risk of travel delay is high. The time windows in domestic air freight service suggest this is going to be during the morning and evening peak hours.

Summary of Policies and Programs

Table 65 summarizes the policies and programs outlined in the preceding sections.

Table 65: Summary of Freight Policies and Programs.

Type		Policies		Actions
Roadway Program	R1	Protect and advance the condition and performance of the SFC system	**R1-A1**	Codify truck route design standards for the SFC
			R1-A2	Assess conformance to design standards for the SFC network
			R1-A3	Evaluate tolling opportunities
			R1-A4	Monitor bridge volumes and conditions
	R2	Ensure the adequacy of truck parking throughout the Region	**R2-A1**	Inventory truck parking capacity throughout the region Specify truck parking in development and redevelopment plans Seek allowance for truck parking by businesses benefitting from access improvements Develop real time electronic reporting of available truck parking, accessible from smart phones Assess on-line reservation system for truck parking spaces
			R2-A2	Evaluate activity centers for hot spots affecting truck loading
	R3	Provide effective signage on the SFC system, and in clusters, FOD opportunity areas, and activity centers	**R3-A1**	Prepare visual inventory of signage in freight clusters, FOD opportunity areas, activity centers and across the SFC
	R4	Prepare for automation in freight transportation	**R4-A1**	Convene a Task Force to research and respond to freight vehicle automation, including: • Pilot deployment of Vehicle to Infrastructure technology on the SFC • Signal prioritization • Coordination with NCDOT on truck platooning
pm ent Pro	D1	Foster development in multiple areas to support diverse points of access to	**D1-A1**	Develop small area plans for FOD opportunity areas

Type		Policies		Actions
		the regional market		
	D2	Support redevelopment in older freight clusters	**D2-A1**	Develop small area plans for freight clusters
	D3	Encourage expansion of CNG fueling stations	**D3-A1**	Require natural gas options at new and reestablished fueling stations
Multimodal Program	**M1**	Advance improvements on access corridors to ports	**M1-A1**	Make roadway investments on port access routes; I-40 south of Raleigh, I-85 north of Durham, U.S. 64/I-87
	M2	Support transformative passenger and freight rail developments	**M2-A1**	Continue Go Triangle programs
			M2-A2	Make roadway investments on U.S. 64/I-87
	M3	Support access to rail intermodal service	**M3-A1**	Make roadway investments on intermodal access routes I-85 and U.S. 64/I-87
	M4	Retain rail carload service	**M4-A1**	Maintain direct rail access to existing industrial sites in redevelopment plans
			M4-A2	Include feasible rail sidings in development of FOD opportunity areas
			M4-A3	Implement grade crossing projects
	M5	Enable reliable road access to local and external cargo airports	**M5-A1**	Make roadway investments on I-85 for external cargo airport access
			M5-A2	Make roadway investments on I-40, I-540 and U.S. 70 for RDU airport access
			M5-A3	Introduce peak hour signal prioritization for cargo on the approaches to RDU airport

Land Use and Economic Development Recommendations

The two MPOs (DCHC and Capital Area) in the Triangle area have a collaborative agreement to work with TJCOG for land use planning and scenario analysis using the region's CommunityViz model. The parcel-based 2045 forecast data from this CommunityViz land use model were utilized in identifying eleven Freight-Oriented Development (FOD) opportunity areas that are located in and around the region's population and activity centers and that could support the recent supply chain trends. These development opportunity areas are described in Chapter 8 of this report. These FOD opportunity areas generally belong to two categories:

- Infill and adaptive redevelopment sites that are located within existing freight clusters
- Greenfield new development sites that are located around the region's periphery

This section puts forward policy recommendations related to these two categories of FOD areas.

Infill and Adaptive Reuse FOD Areas

The following land use and economic development strategies are recommended for the infill and adaptive reuse type FOD opportunity areas such as the RDU Vicinity and RTP areas:

- Adopt access management strategies along the corridors that serve the infill and adaptive reuse type FOD areas.

- Adopt zoning ordinances to preserve the industrial sites that have existing rail access or good access to trade routes or distribution routes.
- Collaborate with the EDPNC to promote and support reuse of available buildings for freight-related industries, develop available tracts of land in established Business Parks, and attract major employers for their designated large or mega sites.
- Monitor truck traffic from the existing freight clusters and transportation system performance to reduce delays for truck movements.
- For high-value freight clusters such as the RTP, monitor transportation system performance in real time and disseminate truck time reliability data to freight operators and recommend freight routing to maximize efficiency.
- Adopt roadway and pavement design standards in the infill and reuse FOD areas that are adequate for heavy truck movements.
- Discourage new housing developments in close proximity to the FOD areas to reduce negative neighborhood impacts.
- Discourage location of facilities that ship hazardous materials.
- Encourage use of new technology or new vehicle types for reduced truck-related emissions, noise and safety and security incidents.
- Protect rail freight corridors from encroachment by incompatible land uses.
- Protect communities of concern from the freight-induced negative impacts through urban design, streetscape, and other design standards.

Greenfield FOD Areas

The following land use and economic development strategies are recommended for the Greenfield FOD opportunity areas:

- Conduct a market study and environmental reviews of the FOD areas that are located around the outskirts of the region to ensure that these areas are appropriate for development.
- Provide infrastructure and utility services necessary to support the future FOD areas.
- Collaborate with state and local agencies to identify funding sources for improving the FOD areas.
- Adopt special freight zoning districts for the future FOD areas to guide freight-intensive industry growth allocations and to define freight priority areas and preserve the region’s industrial land base for long-term growth and competitiveness.
- Establish criteria to ensure that these FOD areas are developing as connected and automated freight industries with adequate market incentives to attract new jobs with higher pay and benefits.
- Provide consistent zoning designation of these FOD areas across the joint DCHC and Capital Area MPO region.
- Address size and density requirements for defining new FOD areas.

STI Prioritization Process

NCDOT has developed a project prioritization process which became the Strategic Transportation Investments (STI) Law in 2013. In general, this new STI process now allows for a more transparent and data-driven process for project selection, and allocates funding based more on need-based criteria and less on equity-based criteria that existed prior to STI.

The transportation projects recommended in this plan have been prioritized based on the freight mobility, safety, and economic development needs, and are closely aligned with the regional, statewide, and national freight plan goals and objectives. Consequently, the freight plan's project prioritization process can be deemed as a subset of the full STI prioritization process. Many of these recommended freight projects also overlap with other mobility and safety projects that have already been programmed in the STIP (2018-2027) or planned as part of the Draft 2045 MTP of the two MPOs. Consequently, these project recommendations will require further coordination between NCDOT and the two MPOs in order to finalize the projects into more refined segments and to combine with other overlapping MTP projects during the next round of STI process.

Strategy Packages

Previous sections of this chapter laid out recommendations for project investments in the SFC system, and recommendations for policies, programs, and actions to implement them. This section combines these elements into strategy packages. The packages are organized around the three tiers of the SFC network – trade routes, distribution routes, and access routes – which in turn correspond to distinct functions of the freight system: interstate and global trade by Triangle industry, distribution to companies and communities across the region, and access to deliver and pick up shipments at businesses and in neighborhoods. Each set of investments is accompanied by relevant actions from the three programs: roadway, development, and multimodal programs, with land use actions treated as part of development.

Adoption of the SFC system itself is a central strategy of this plan. It is the focus of investment because the SFC is designed as a comprehensive and effective network on which the dimensions of freight performance can be managed and improved. In other words, the SFC is designed to be the most productive place to spend roadway resources. Many of the program actions then develop the system further, or take advantage of its capabilities.

Investment in each of the packages is summarized in Table 66, which depicts total expenditure by implementation period and identifies the major corridors affected. The specific projects involved and the agencies responsible can be found in

Table 61 earlier in this chapter. Overall, 80 percent of the total $7.2 billion investment occurs by 2030, in roughly equal portions in the periods through 2025 and from 2025 to 2030.

Table 66: Strategy Package Project Investments

	Project Costs by Implementation Year ($Millions)					
Strategy Package	**By 2025**	**By 2030**	**By 2035**	**By 2040**	**Total**	**Major Corridors**
Trade Routes	$968.2	$567.0	$337.0	-	$1,872.2	I-40, I-85, US64/I-87, US 70
Distribution Routes	$1,934.3	$1,817.6	$711.3	$174.6	$4,673.8	NC 540, US 1, US 70, I-440, US 401
Access Routes	$140.3	$351.9	$72.3	$88.9	$653.4	Mixed local
Total	**$3,024.8**	**$2,736.5**	**$1,120.6**	**$263.5**	**$7,163.4**	

The Distribution Routes package accounts for $4.7 billion and 65 percent of the investment because of the number and variety of its roadways, and their role in penetrating and connecting the region. Thirteen routes are affected, of which the largest are the new NC 540 toll road projected at nearly $1 billion, along with freeway upgrades and other improvements on U.S, 1, U.S. 70, I-440, and U.S. 401. Investments in three of the four latter corridors total over half a billion dollars each. Most of the expenditures are scheduled by 2030, with about half of those before 2025.

Trade Routes account for $1.9 billion and 26 percent of investment; Access Route investment represents $0.6 billion and 9 percent of the total. I-40 is due for the lion's share of the trade package at $1.4 billion because it is the interstate backbone of the region, connecting Raleigh and Durham through RTP and continuing to both the Atlantic and Pacific coasts. I-85, the future I-87, and U.S. 70 are the other trade corridors. Trade Route expenditures are largest through 2025, and do not extend beyond 2035. Access Routes are scattered by nature because of their local purpose, with 18 projects affecting 17 different facilities. Half of these investments are scheduled between 2025 and 2030.

The actions that implement recommended freight policies to add potency to investments are displayed for each of the strategy packages in Table 67. Actions appear by program; some serve the purposes of several packages and others only one. Each action is denoted by a reference number, which corresponds to the numbers assigned in Table 65 earlier in this chapter; the numbers LU-A1 and LU-A2 reflect the Land Use recommendations, pertaining respectively to infill and to new development.

Table 67: Strategy Package Program Actions

		Actions by Program		
Strategy Package	**Major Corridors**	**Roadway Program**	**Development Program**	**Multimodal Program**
Trade Routes	I-40, I-85, US64/I-87, US 70	R1-A1, R1-A2, R1-A3, R1-A4, R4-A1	D3-A1, LU-A1, LU-A2	M1-A1, M2-A1, M2-A2, M3-A1, M5-A1, M5-A2
Distribution Routes	NC 540, US 1, US 70, I-440, US 401	R1-A1, R1-A2, R1-A3, R1-A4, R2-A1, R3-A1, R4-A1	D1-A1, D2-A1, D3-A1, LU-A1, LU-A2	M2-A1, M2-A2, M4-A3, M5-A2
Access Routes	Mixed local	R1-A1, R1-A4, R2-A2, R3-A1, R4-A1	D1-A1, D2-A1, LU-A1, LU-A2	M4-A1, M4-A2, M5-A2, M5-A3

Actions under the Multimodal program are associated most broadly with Trade Routes, simply because rail, marine and air connections are used mainly or exclusively to connect the Triangle Region to markets around the country and world. Conversely, Roadway program actions are associated most heavily with Distribution Routes because they represent the majority of facilities. The Distribution Route package also calls upon every action in the Development program. The Access Route package employs a smaller number of actions, but they are balanced among the three programs.

Responsibility for taking these actions is shared among the Triangle agency partners, and the effect in fact will be stronger if action is taken jointly. The timeframe for actions is before 2025, but as a matter of strategy all programs should be put in motion in the next two years because of their influence on the productivity of investments, and because they respond to trends shaping the region today.

Conclusion

This concludes the Triangle Regional Freight Plan. The actions described in this chapter will put the region on a path that preserves and strengthens the contribution of freight transportation to the region's economy, keeps its households supplied with the goods for everyday life, and helps maintain the character and attractiveness of the region for years to come.