NCDOT Rail Division

COMPREHENSIVE STATE RAIL PLAN

Appendices

Appendix A
Rail Division NEPA Activities, 2000-2014

TIP NUMBER	PROJECT DESCRIPTION	COUNTY	DOCUMENT TYPE	DOCUMENT APPROVAL STATUS
	Southeast High Speed Rail Corridor			
	Southeast High Speed Rail Corridor (Charlotte to Washington, DC)	Various	Tier I EIS/ROD	Approved October 2002
	Southeast High Speed Rail Corridor (Raleigh to Richmond)	Various	Tier II Final EIS	Environmental Studies In-Progress
	Piedmont Improvement Program			
C-4901	Bowers to Lake Rail and Crossing Safety Improvements	Davidson	EA/FONSI	Approved March 2012
I-2304AE	NCRR Duke Curve Realignment	Davidson	CE	Approved August 2011
P-2909AA	Burlington Train Station Rehabilitation	Alamance	CE	Approved August 2010
P-2918F	Charlotte Locomotive and Railcar Maintenance Facility	Mecklenburg	EA/FONSI	Approved May 2014
P-2918H	Capital Yard Phase 1 Improvements	Wake	CE	Approved August 2010
P-2918I	PIDS Installation	Various	CE	Approved April 2011
	High Point Station Improvements	Guilford	EA/FONSI	Approved August 2010
	Cary Depot Improvements	Wake	EA/FONSI	Approved August 2010
P-4010	Kannapolis Station Canopy Improvements	Cabarrus	CE	Approved July 2011
P-5002	CSXT/NS Mainline Grade Separation, Charlotte	Mecklenburg	EA/FONSI	Approved April 2013
P-4405B	Thomas Howard Grade Separation	Orange	EA/FONSI	Approved June 2013
P-4405F	Lloyd Private Crossing Closure	Orange	EA/FONSI	Approved November 2012
P-4405I/J/K	Orange County Private Crossing Closures	Orange	EA/FONSI	Environmental Studies In-Progress
P-5005A	CSXT A line Crossovers (Enfield)	Halifax	CE	Approved September 2010
P-5005B	CSXT A line Crossovers (Armstrong)	Nash	CE	Approved September 2010
P-5201	Morrisville Parkway Grade Separation	Wake	EA/FONSI	Approved January 2013
P-5204	McLeansville Road Grade Separation, McLeansville	Guilford	EA/FONSI	Approved November 2013
P-5205	Graham to Haw River Siding and Track Realignment	Alamance	EA/FONSI	Approved March 2012
P-5206	Reid to North Kannapolis Rail and Crossing Safety Improvements	Rowan	EA/FONSI	Approved July 2012
P-5208	Haydock to Junker Rail and Crossing Safety Improvements	Cabarrus - Mecklenburg	EA/FONSI	Approved July 2012
P-5500	Raleigh Union Station – Phase 1 and Associated Track Improvements	Wake	EA / FONSI	Approved March 2014
P-5500A	CSXT Boylan Wye Improvements	Wake	CE	Approved August 2012
U-3459	Klumac Road Grade Separation, Salisbury	Rowan	EA/FONSI	Approved September 2011
U-4716AB	Hopson Road Grade Separation and Track Realignment	Durham	EA/FONSI	Approved February 2012
U-5008	Sugar Creek Road Grade Separation, Charlotte	Mecklenburg	EA/FONSI	Environmental Studies In-Progress
	Municipal Crossing Closure Program			
Y-4802J	River Street Crossing Closure (Grimesland)	Pitt	PCE	Approved March 2011

TIP NUMBER	PROJECT DESCRIPTION	COUNTY	DOCUMENT TYPE	DOCUMENT APPROVAL STATUS
Y-4803A	George Street Crossing Closure, Warsaw	Duplin	PCE	Approved March 2011
Y-4803C	Morris Street Crossing Closure, Teachey	Duplin	PCE	Approved March 2011
Y-4804A	Clark Street Municipal Crossing Closure, Rocky Mount	Nash	PCE	Approved February 2011
Y-4806	Brooklyn Street Municipal Crossing Closure, Maxton	Robeson	PCE	Approved July 2010
Y-4806A	Rankin Street Municipal Crossing Closure, Fayetteville	Cumberland	PCE	Approved March 2011
Y-4806G	Mills Street Municipal Crossing Closure, Rowland	Robeson	PCE	Approved March 2011
Y-4808C	West End Corridor Improvements	Moore	CE	Approved December 2010
Y-4808J	Birkhead Municipal Crossing Closure, Asheboro	Randolph	PCE	Approved March 2011
Z-5206J	Malloy Street Municipal Crossing Closure, Maxton	Robeson	PCE	Approved July 2010
	Private Crossing Closure Crossing Initiative			
P-4405A	Ethel Lane/Jukebox Road Private Crossing Closure	Rowan	CE	Approved December 2010
P-4405E	Doster Drive Private Crossing Closure	Cabarrus	PCE	Approved December 2010
P-4405M	Frank Freeman Private Crossing Closure, Hillsborough	Orange	PCE	Approved March 2011
	Other Projects			
P-3309AB	CSXT Greenville Yard Relocation	Pitt	FONSI	Approved December 2011
P-4900	Pembroke Connector Track	Robeson	EA	Approved March 2014
P-4901	Fayetteville Downtown Rail Improvements	Cumberland	CE	Approved June 2010
P-5004	Goldsboro Connector Track	Wayne	EA/FONSI	Environmental Studies In-Progress
P-5100	Goldsboro Union Station Rehabilitation	Wayne	PCE	Approved October 2011
P-5200	Piedmont and Northern Railway Rehabilitation	Gaston	CE	October 2010
P-5200EA	Thrift Depot Relocation and Refit	Mecklenburg	PCE	Approved August 2012
TD-4721	Wilmington Multi-modal Transportation Center	New Hanover	EA/FONSI	Environmental Studies In-Progress
U-2928B	Global TransPark Connector Track	Lenoir	EA/FONSI	Approved July 2009
U-5012	CSXT Charlotte Intermodal Yard Expansion	Mecklenburg	CE	Approved December 2010
	Traffic Separation Studies			
	Durham Traffic Separation Study	Durham		March 2014
	Goldsboro Traffic Separation Study	Wayne		March 2012
	Hillsborough Traffic Separation Study	Orange		October 2014
	Lexington Traffic Separation Study	Davidson		October 2011
	West Charlotte Area Study	Mecklenburg		October 2012
	Wilmington Traffic Separation Study	New Hanover		In-Progress

Guide:
CE: Categorical Exclusion
EA: Environmental Assessment
EIS: Environmental Impact Statement
FONSI: Finding of No Significant Impact
NEPA: National Environmental Policy Act
PCE: Programmatic Categorical Exclusion
ROD: Record of Decision

Appendix B
Demographic and Economic Trends

DEMOGRAPHIC AND ECONOMIC TRENDS

Understanding existing demographic and economic conditions and projected trends is an essential step in evaluating how North Carolina's rail system currently supports passenger and freight movement, identifying where there are gaps in rail service, and anticipating future needs. The following report provides data that will help in the identification of rail service needs and opportunities in Chapter 2 of the Comprehensive State Rail Plan (State Rail Plan).

Demographics

Demographic trends and projections including growth trends, density, race and ethnic composition, age, and other demographic variables are described in the context of how they relate to North Carolina's rail system.

Population Trends

North Carolina continues to experience substantial population growth and urbanization. The State population increased by 49 percent over the last 23 years, from 6.6 million people in 1990 to 9.8 million people in 2013. The State population is expected to grow an additional 22 percent, to 12 million people, in 2033.[1] All regions of North Carolina have grown in population over the same time period, with the most dramatic growth in the Triangle (Raleigh-Durham-Chapel Hill) and Charlotte. Counties home to North Carolina's other urban centers have experienced moderate growth and include Asheville, Winston-Salem, Greensboro, Fayetteville, Wilmington, and Jacksonville. Slow growth or population loss is projected for several rural counties across the state, particularly those in the northeast. Historic regional and statewide population trends are shown in Figure B - 1. The geographic extent of North Carolina's regions is shown in Figure B - 2. Projected population changes between 2012 and 2033 for each county are shown in Figure B - 3.

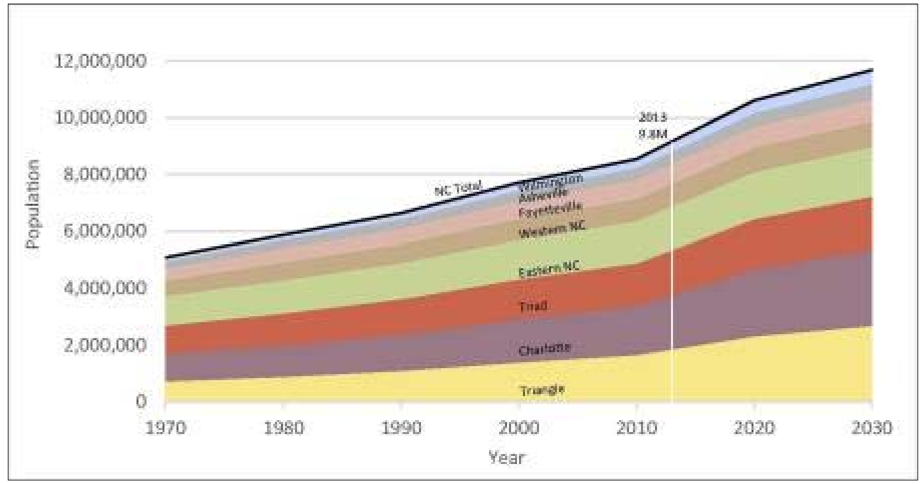

Figure B - 1 **North Carolina and Regional Population Trends and Projections (1970-2030)[2]**

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[1] NC Office of State Management and Budget. 2033 County Population Projections. Accessed April 2, 2014. http://www.osbm.state.nc.us/ncosbm/facts_and_figures/socioeconomic_data/population_estimates/demog/countytotals_2030_2033.html

[2] North Carolina Office of State Management and Budget, North Carolina Population Estimates and Projections. http://www.osbm.state.nc.us/ncosbm/facts_and_figures/socioeconomic_data/population_estimates.shtm

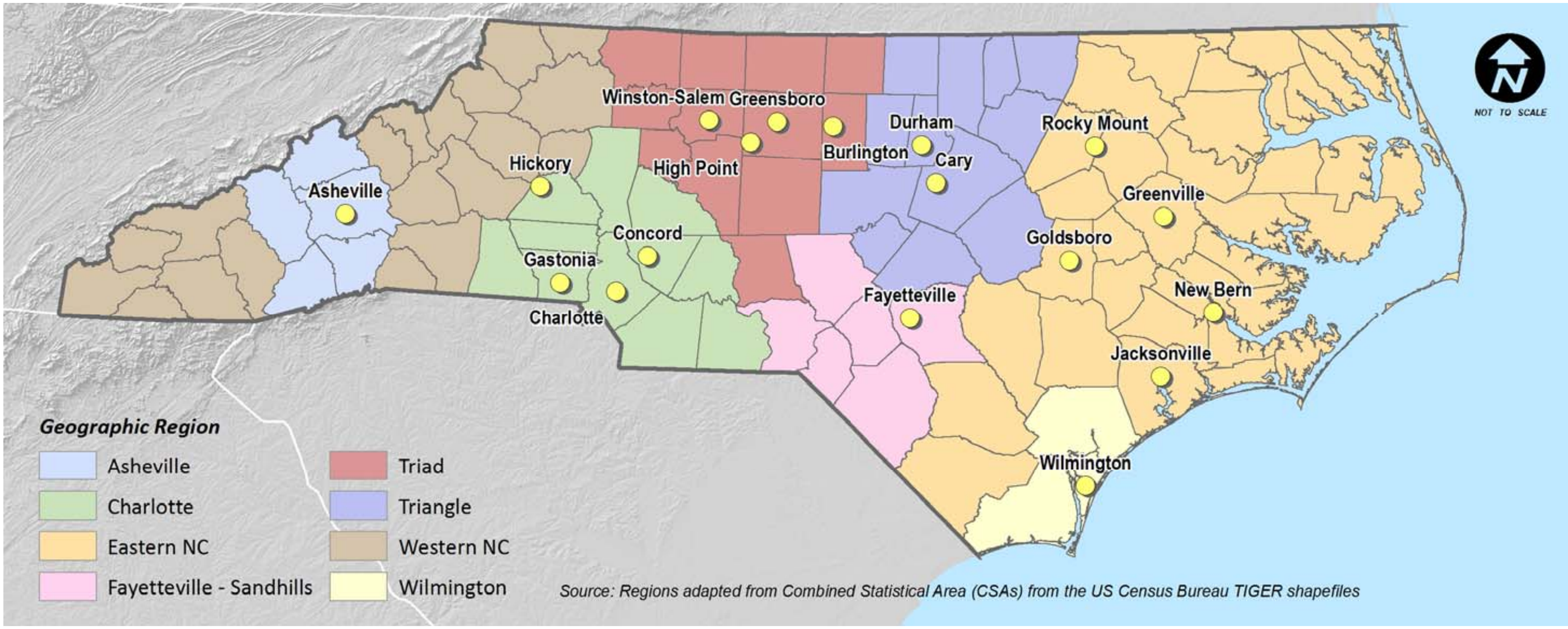

Figure B - 2 Geographic Extent of North Carolina Regions

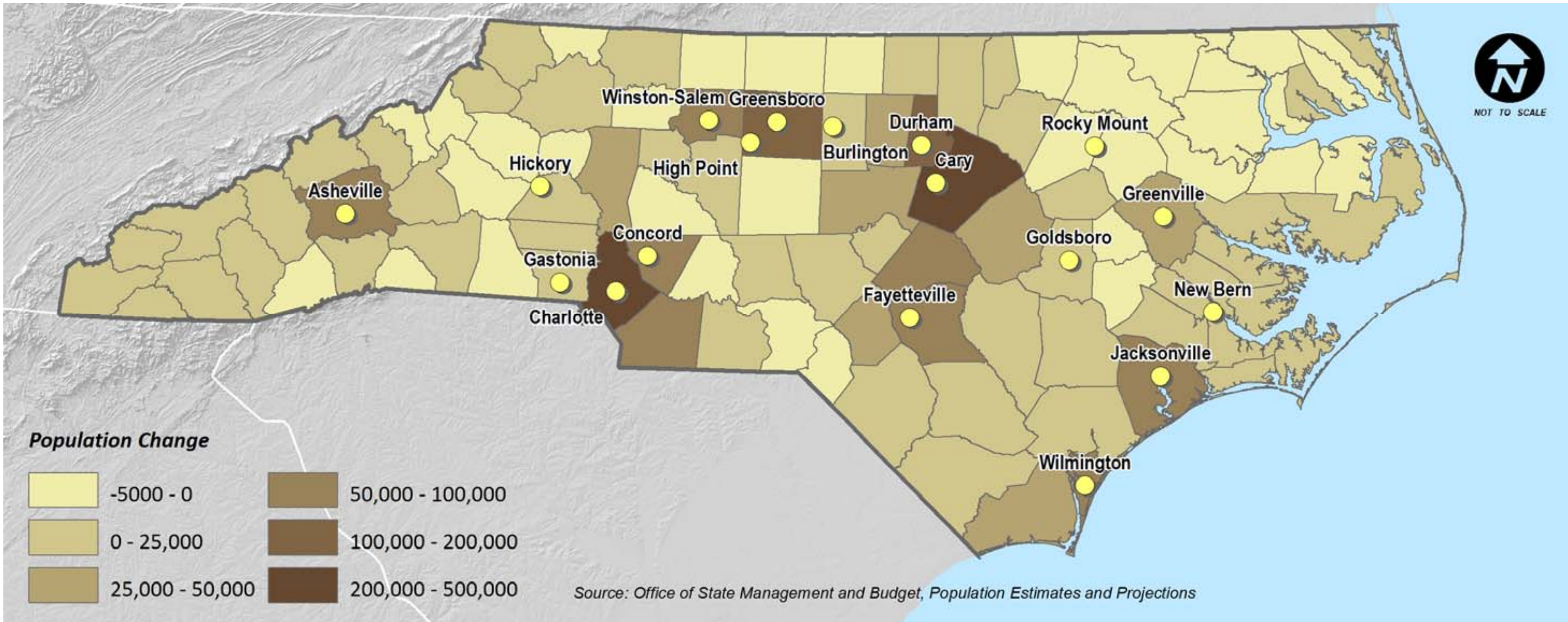

Figure B - 3 Projected Change in County Population (2012-2033)

Population Density

North Carolina's population is concentrated in the "Piedmont Crescent," the urbanized arch that follows Interstates 40 and 85 as they connect Charlotte, the Triad (Greensboro, Winston-Salem, and High Point) and the Triangle. These three regions account for 60 percent of the state's population.[3] Populations are also concentrated in and around the cities of Fayetteville, Asheville, Wilmington, Hickory, Greenville, and Jacksonville. Figure B - 4 shows 2012 population by square mile and Figure B-5 shows 2012 population by county, as well as passenger rail ridership by station. The Amtrak stations with the greatest ridership numbers are located in areas with the highest population densities.[4]

Existing intercity and commuter rail systems are shown in Figure B - 6 with projected county populations for 2033.

[3] US Census. American Community Survey 5 Year Estimates, 2008-2012. Total Population, Table B01003. Data analyzed to calculate percentage.

[4] Amtrak. North Carolina 2013 Amtrak Fact Sheet. http://www.amtrak.com/pdf/factsheets/NORTHCAROLINA13.pdf

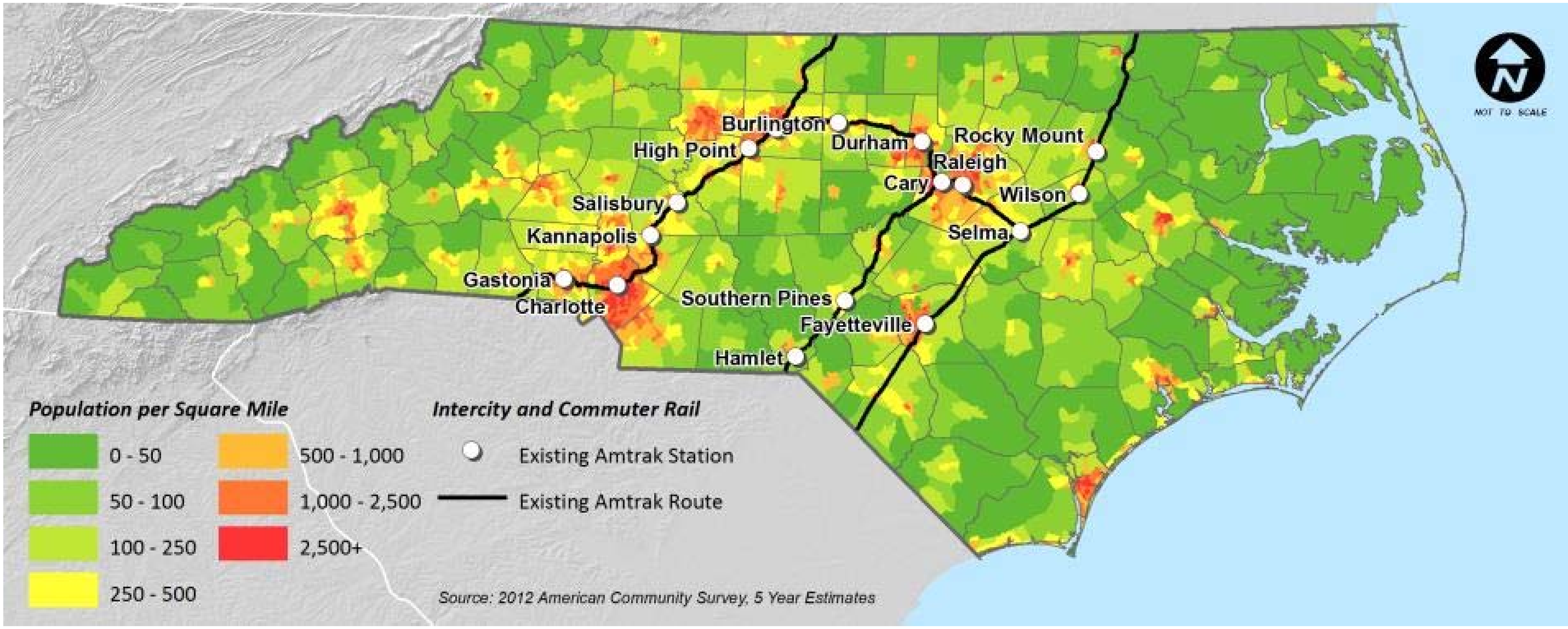

Figure B - 4 North Carolina Population Density by Square Mile (2012)

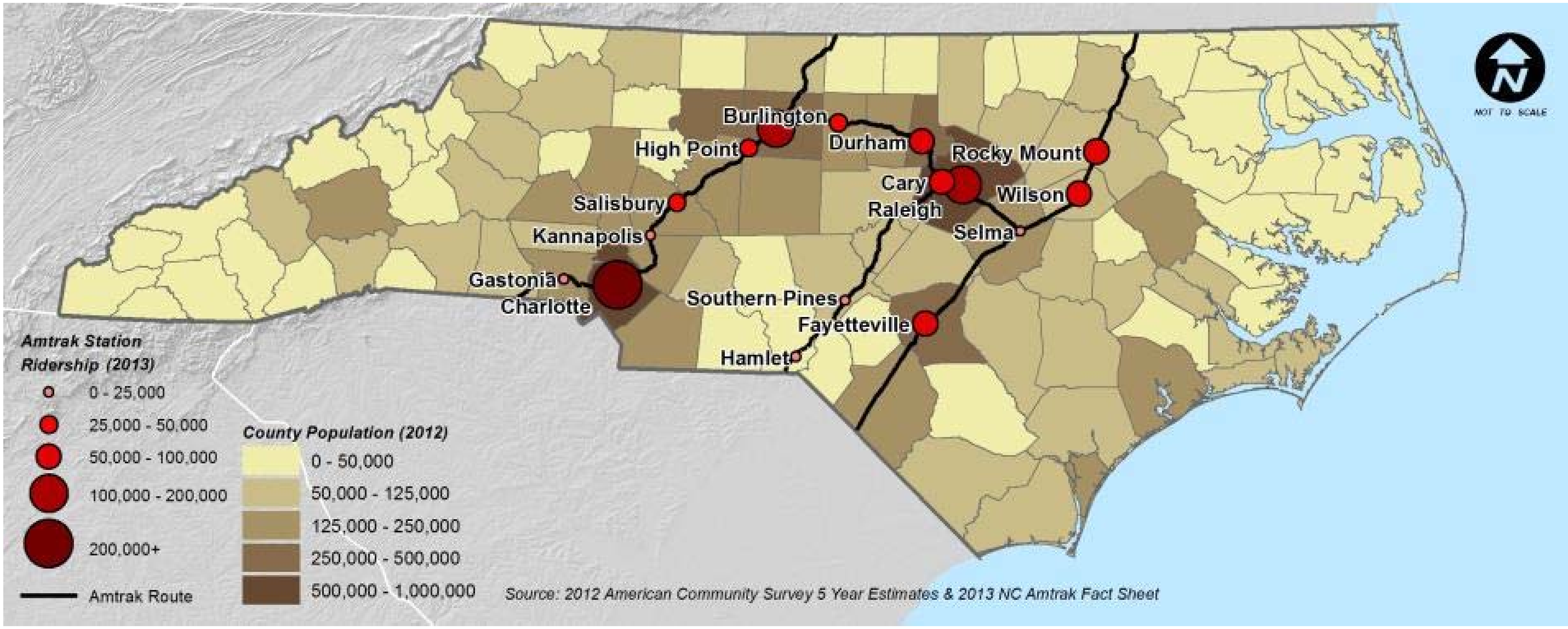

Figure B - 5 Population Density (2012) and Passenger Rail Ridership (2013)

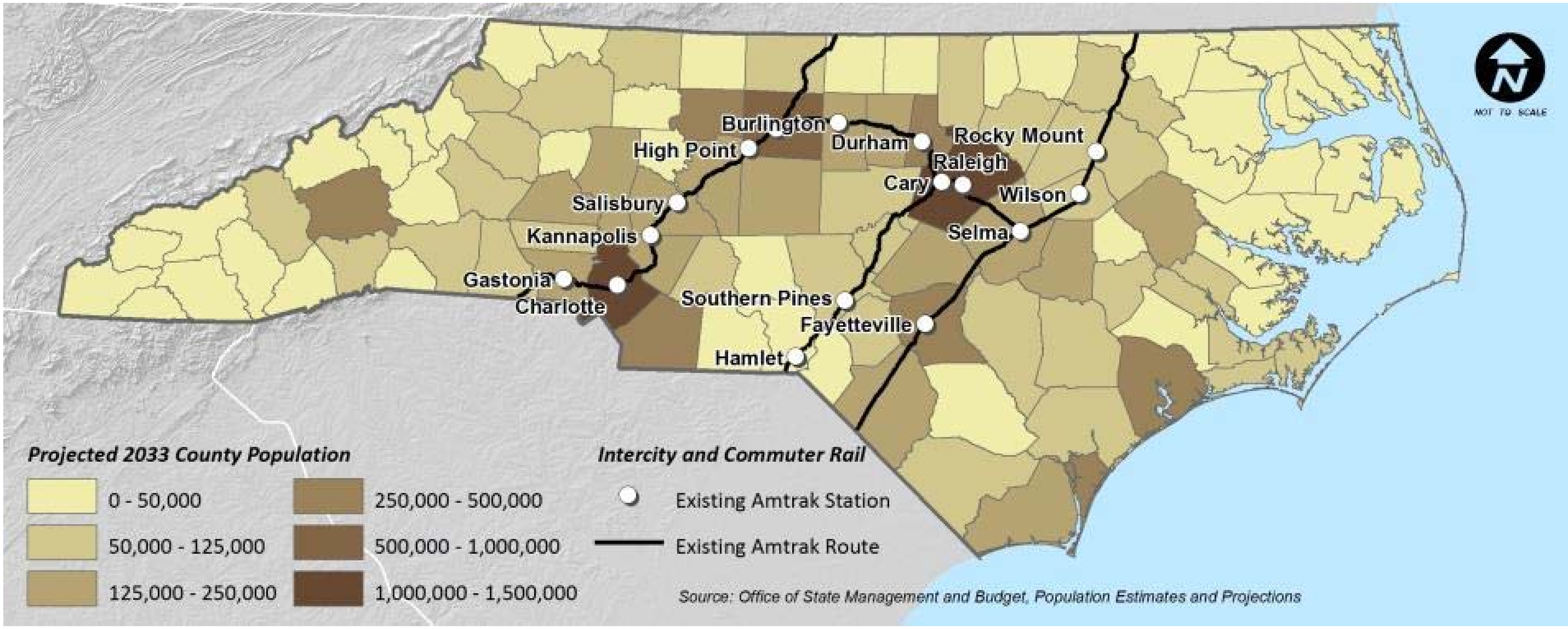

Figure B - 6 **Projected Population by County (2033) and Passenger Rail Facilities**

Commuting Patterns

Figure B - 7 shows the average travel time for each county in North Carolina. The greatest average travel times are in the northeast, especially in the counties belonging to the Virginia Beach – Norfolk metropolitan area. The other noticeable pattern is that the suburban counties of the Triad, the Triangle, and Charlotte regions have relatively longer average commute times than the urban counties of their regions. This is likely due to the longer distances traveled and congestion encountered to access the employment centers in each region's urban counties. Lastly, there are some rural counties with relatively longer average commutes likely due to the need to drive further to access employment opportunities.

A review of census data from the state's largest metropolitan areas show that more workers are commuting across county and state boundaries. Over the past 20 years, the number and percent of workers who cross county lines and state lines in their daily commutes has increased. Table B-1 shows the percent of employees who work outside of the state and county of residence in the Charlotte, Triad and Triangle regions since 1990.

Table B-1 Percent of Employees who Work Outside of County of Residence [5]

	1990	2000	2011
Triangle Region	22.1%	27.6%	27.8%
Triad Region	23.8%	27.9%	30.0%
Charlotte Region	20.7%	25.1%	27.7%

Source: US Census Data compiled by the North Carolina Department of Commerce

[5] Analysis of 1990, 2000 and 2011 Census Data for the Council of Governments boundary areas for Centralina, Triangle and Triad. North Carolina Department of Commerce AccessNC website. September 2014. http://accessnc.commerce.state.nc.us/EDIS/demographics.html

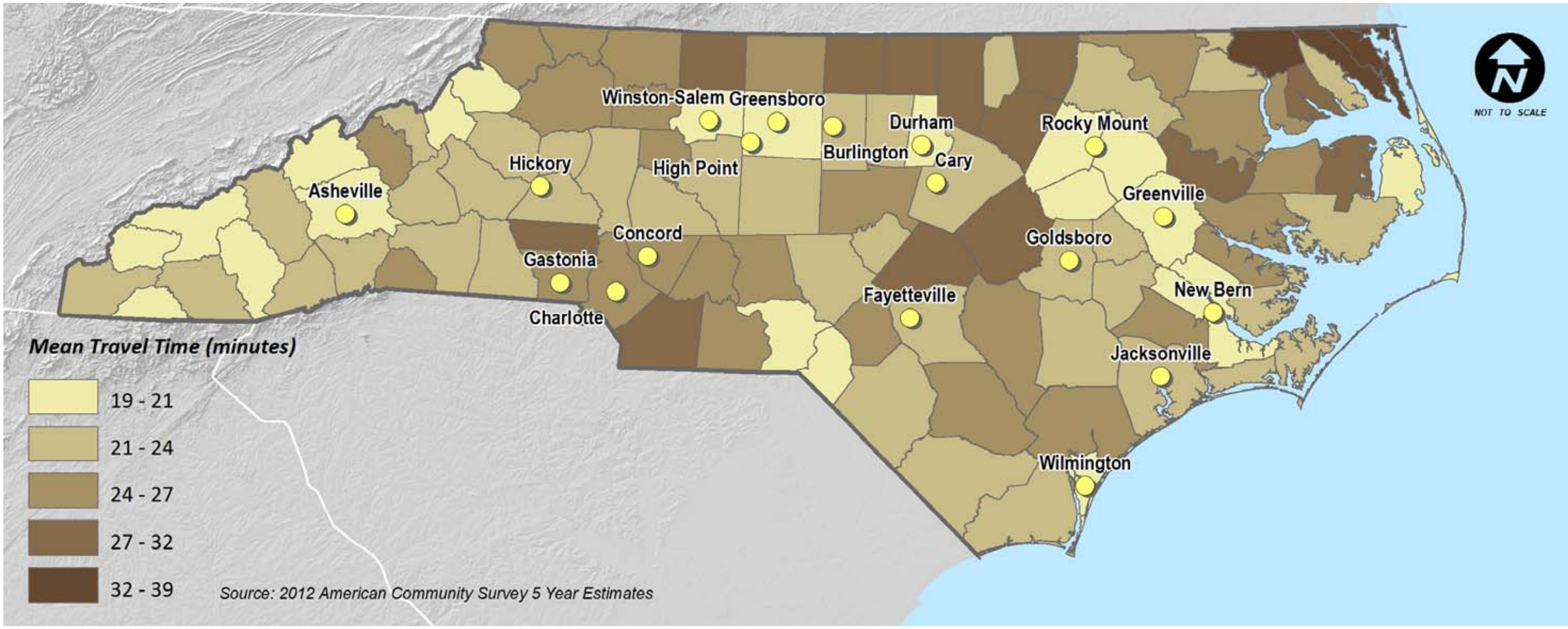

Figure B - 7 Mean Travel Time by County (2012)

Population Characteristics

Trends in North Carolina's population characteristics contribute to the State's rail needs and opportunities. Certain characteristics may indicate a greater demand for passenger or commuter rail services. For example, older populations, disadvantaged populations (low-income and minority), and limited English proficiency populations may be more likely to depend on rail due to health, cost, convenience, or language barriers to owning and operating a personal vehicle. This section examines some of the population characteristics that may indicate a higher need or demand for rail services.

Similar to national trends, North Carolina has become more diverse over the last two decades. Table B - shows the Hispanic, Asian and the Other Race population percentages increased the most between 1990 and 2010. Minority residents are primarily concentrated in urban areas and in the rural areas in the south-central and northeastern portions of the state (Figure B - 8). Trends of increased ethnic and racial diversity are expected to continue as North Carolina's population continues to grow.

Table B - 2 Race Percentage Trends[6]

RACE/ETHNICITY	1990	2000	2010	CHANGE (%)
White	75.6	72.1	68.5	- 7.1
African American	22.0	21.6	21.5	- 0.5
Asian	0.8	1.4	2.2	+ 1.4
Native American	1.2	1.2	1.3	+ 0.1
Other Race	0.5	2.3	4.3	+ 3.8
Hispanic[7]	1.2	4.7	8.4	+ 7.2

Approximately 8.4 percent of North Carolina residents identify as ethnically Hispanic (2012).[8] An estimated 6.5 percent of North Carolina's adult population speaks Spanish. Roughly 3.9 percent speak English "less than very well" as estimated by the 2012 American Community Survey. Figure B - 9 shows that most of this population is in urban areas or in the piedmont and coastal plain agricultural and manufacturing areas.[9]

An estimated 16.8 percent of North Carolina's population is below the federal poverty threshold.[10] While poverty is more concentrated in urban areas, the counties with the highest overall percent of residents below poverty thresholds are in rural counties in the mountains and in the south-central and eastern counties of North Carolina (Figure B - 10).

[6] US Census, Summary File 1 for 1990, 2000 and 2010 Censuses.

[7] The US Census identifies five race categories (White, African American, Asian, Native American, Other) and identifies Hispanic as an ethnicity that can belong to any of the five race categories.

[8] US Census. 2012 American Community Survey 5 Year Estimates, 2008-2012. Demographic and Housing Estimates, Table DP05.

[9] US Census. 2012 American Community Survey 5 Year Estimates, 2008-2012. Table B16004 Age by language spoken at home by ability to speak English for the population 5 years and over.

[10] US Census. American Community Survey 5 Year Estimates, 2008-2012. Table C17002 Ratio of Income to Poverty Level in the Past 12 Months.

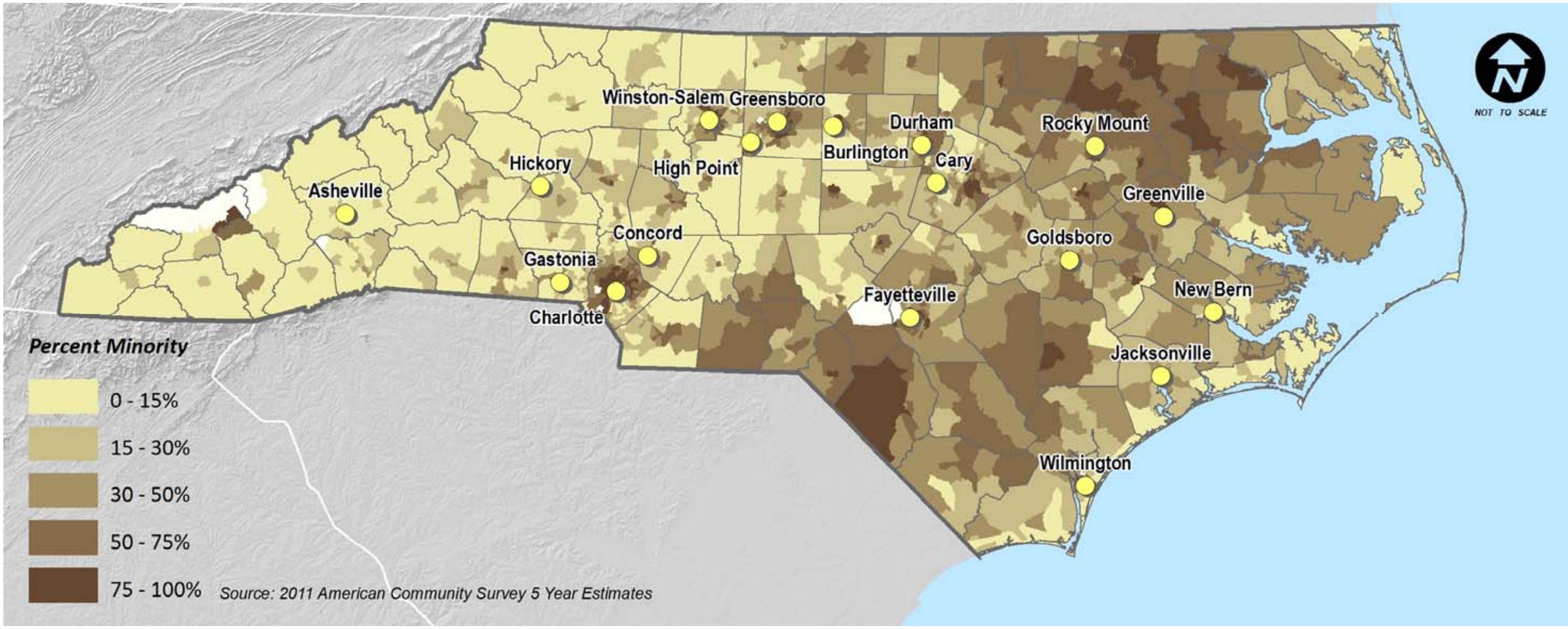

Figure B - 8 Minority Populations in North Carolina shown by US Census Tracts

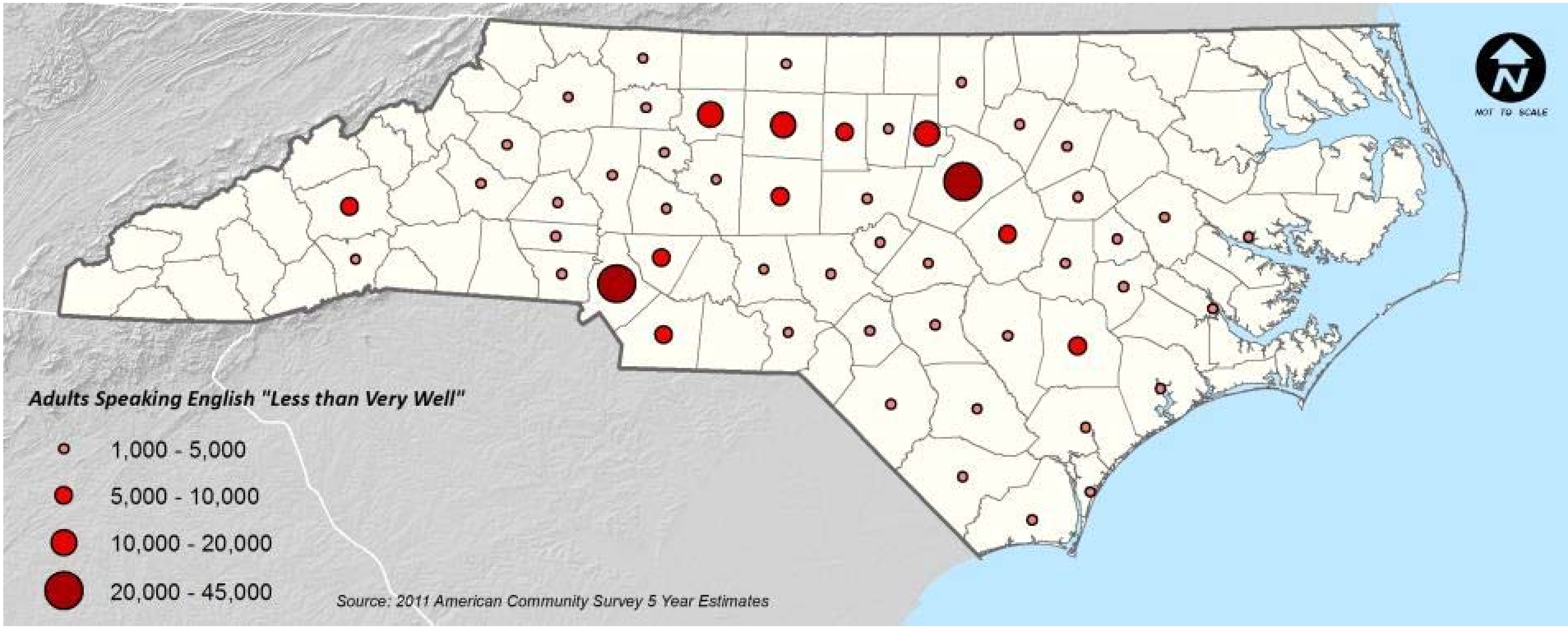

Figure B - 9 **Adults Speaking English "Less than Very Well"**

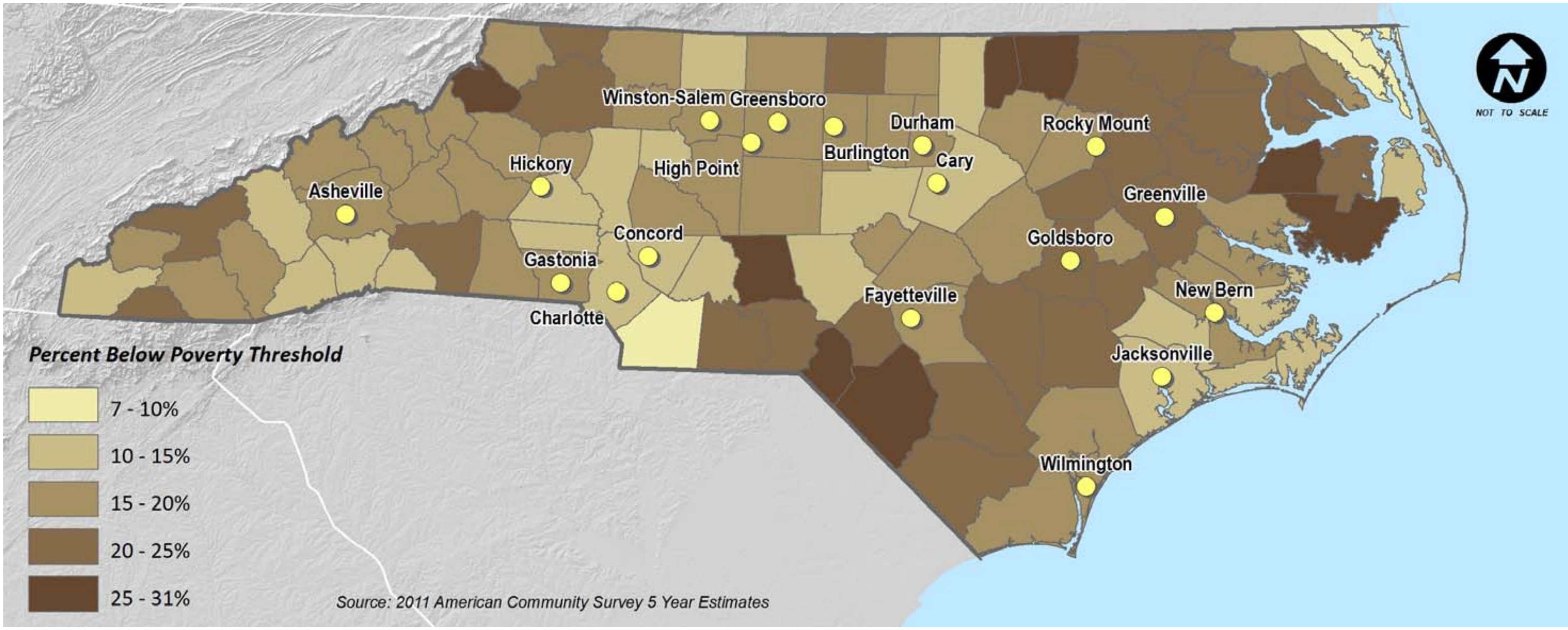

Figure B - 10 Percent of Population below Poverty Thresholds by County

Figure B - 11 shows that median household income in North Carolina has steadily increased from 1990 to 2012 with some fluctuations that mirror national economic trends. Census-estimated median household income in North Carolina adjusted to 2012 dollars (Figure B - 12) has been relatively constant over the last two decades.[11]

The population pyramid of North Carolina (Figure B - 13) shows the percent of the population over 65 will increase substantially in coming years given the large proportion of middle-aged residents in North Carolina. Older adults are less likely to drive in their later years and stand to benefit from increased mobility options provided by intercity passenger rail.

[11] US Census. Estimated Household Income 1984 – 2012. https://www.census.gov/hhes/www/income/data/statemedian/

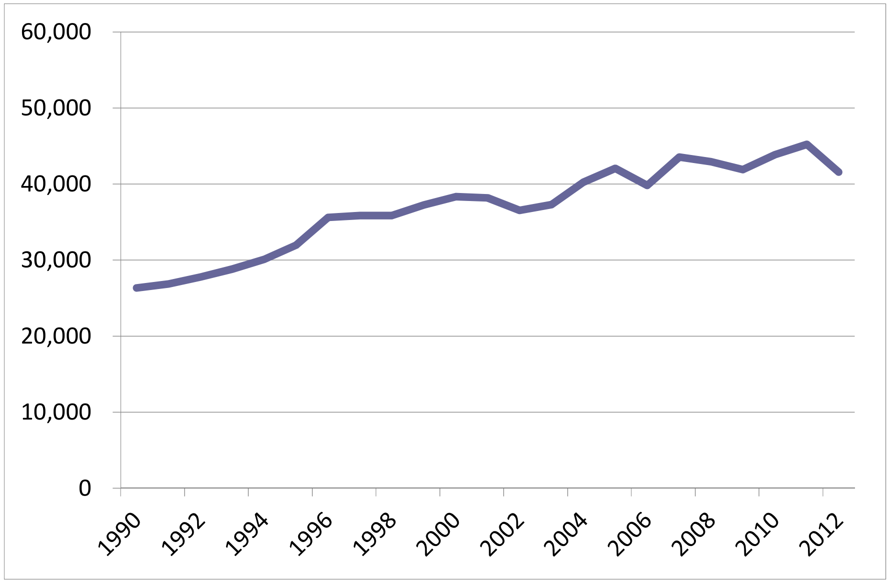

Figure B - 11 Median Household Income 1990 – 2012

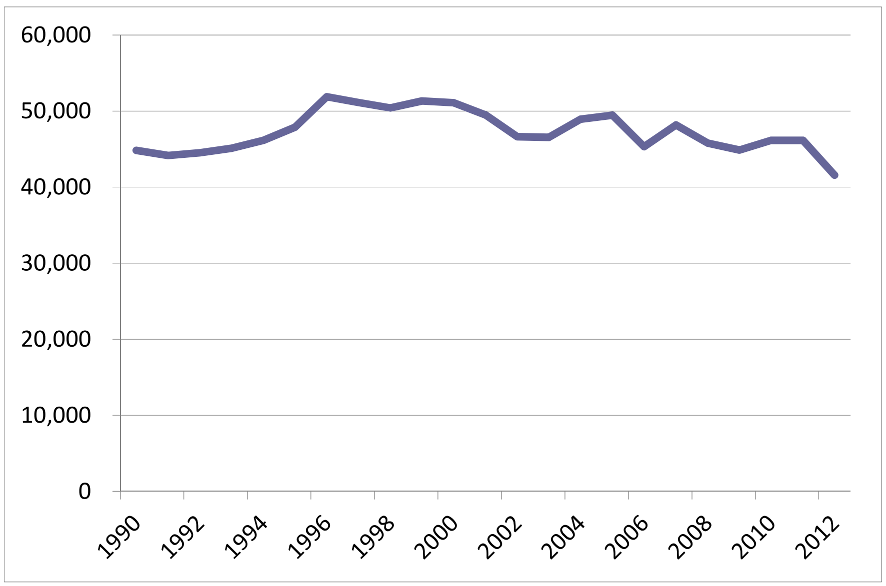

Figure B - 12 Adjusted Median Household Income 1990 – 2012 (2012 dollars)

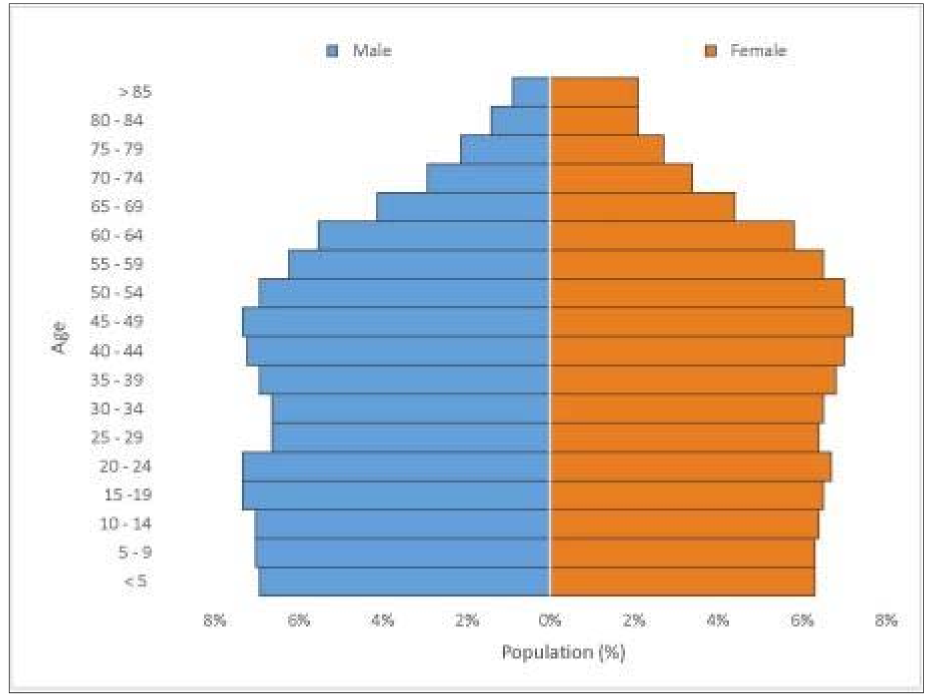

Figure B - 13 Population Pyramid showing Age and Gender for North Carolina's Population in 2012

Economics

Employment trends and projections for economic sectors in North Carolina as well as analysis of economic conditions in North Carolina between 2013 and 2014 are addressed in the next sections.

Employment by Sector

A comparison of employment by sector for North Carolina and the nation is provided in Table B-3. North Carolina has higher employment in industries that potentially use rail such as construction, manufacturing, trade/transportation/utilities and leisure and hospitality. The only potential rail-dependent industry where North Carolina is below the national percentage is mining and logging.

Table B-3 NC and US Industry Sector Comparison[12]

INDUSTRY SECTOR	PERCENT OF TOTAL EMPLOYMENT	
	NC %	US %
Mining and Logging	0.1%	0.6%
Construction	4.4%	3.9%
Manufacturing	10.8%	8.2%
Trade, Transportation, and Utilities	18.6%	17.5%
Information	1.7%	1.8%
Financial Activities	5.1%	5.4%
Professional & Business Services	13.7%	12.3%
Education & Health Services	13.9%	14.0%
Leisure & Hospitality	10.5%	9.5%
Other Services	3.7%	4.2%
Government	17.5%	15%

Figure B - 14 shows trends in North Carolina's Gross Domestic Product (GDP) by industry sector. Manufacturing continues to be the top industry by GDP. Trends in other potential rail-dependent industries include modest increases in construction and agriculture after the economic recession. Mining output is relatively stable over the last decade.

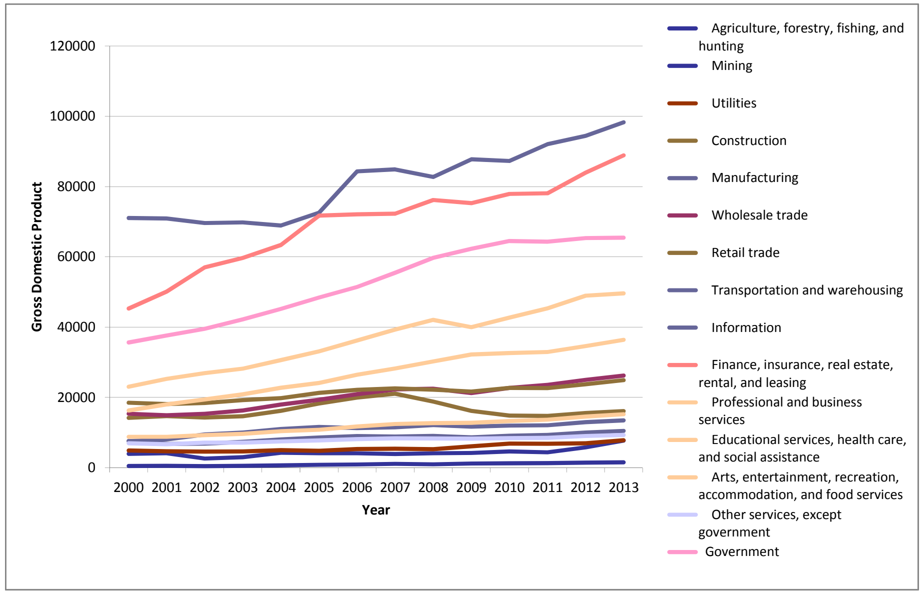

Figure B - 14 Trends in North Carolina's Gross Domestic Product (GDP)

Looking at the state's metropolitan areas demonstrates that each region has one or more industries that are substantially higher than the state average (Figure B - 15). Charlotte and the Triangle lead the state in Professional and Business Services. The Triad, the Triangle, and Asheville all have large Education and Health Services employment percentages. Asheville and Wilmington's thriving tourism industries explain their region's larger percentages in the Leisure and Hospitality sectors. Other industry sector concentrations include Government in Fayetteville due to Fort Bragg, Financial Activities in Charlotte due to the banking industry, and Manufacturing in the Triad due to its historic manufacturing industries of furniture, tobacco, and textiles among other manufactured goods.[13]

[12] Bureau of Labor Statistics. North Carolina Economy at a Glance. January 2014. Accessed March 31, 2014. http://www.bls.gov/eag/eag.nc.htm

[13] Bureau of Labor Statistics. Economy at a Glance for select NC Metropolitan Areas. http://www.bls.gov/eag/eag.nc.htm

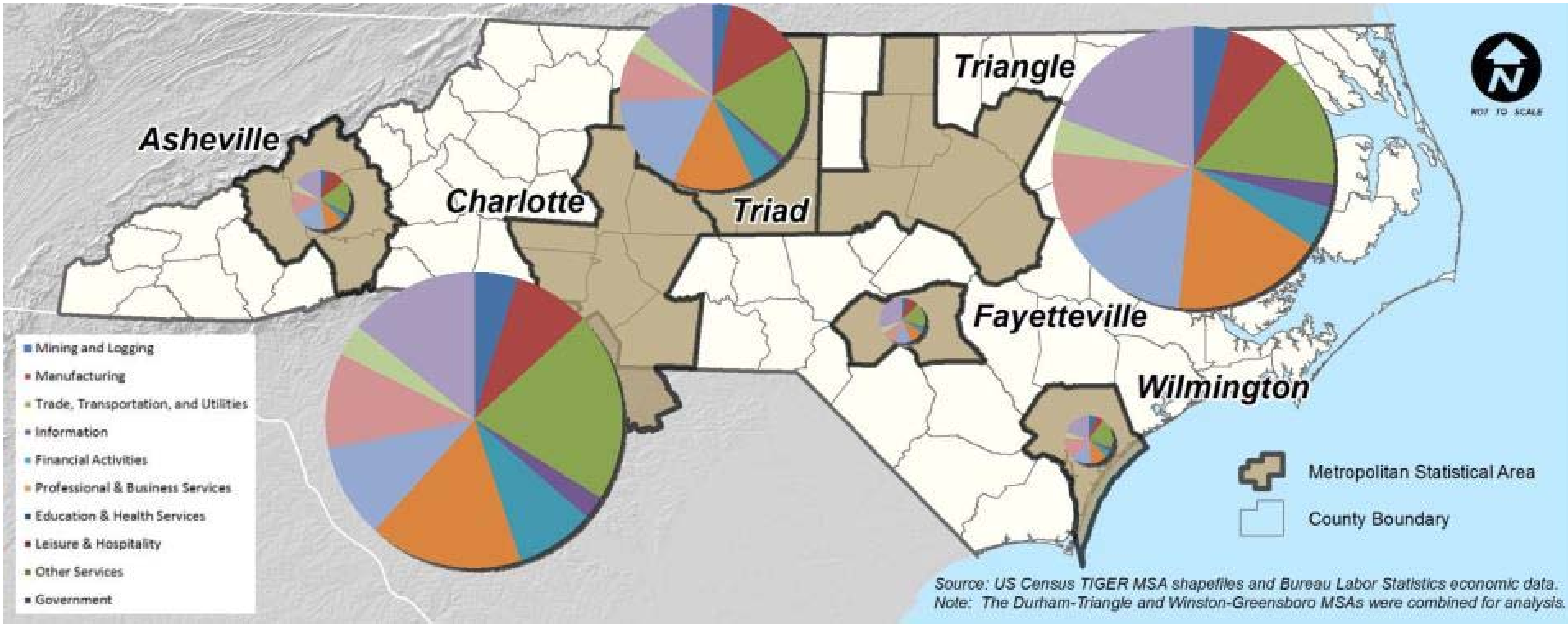

Figure B - 15 Employment Percentages by Sector in North Carolina Metropolitan Areas

A notable change in the state's employment over the past two decades is the transition from manufacturing employment to service and professional industries. In 1990, North Carolina was the most manufacturing-intensive state, with this sector employing 26 percent of all workers. North Carolina currently ranks 12th in the country for manufacturing employment, with 10.8 percent of the state's workers employed in manufacturing.[14] Manufacturing remains important to North Carolina's economy, constituting 20 percent of the state's Gross Domestic Product.[15]

Figure B - 16 shows employment trends in North Carolina over the last decade.[16] Manufacturing employment continued declining until leveling off around 2010. Several sectors were negatively impacted during the economic recession, particularly Construction; Professional and Business Services; and Trade,

[14] National Association of Manufacturers. Manufacturing Employment by State. Accessed April 10, 2014. http://www.nam.org/~/media/B8256B00DE1E48BAADC4A24166BF8B67/MFG_employment_NOV2013.pdf

[15] North Carolina Economic Development Board. North Carolina Jobs Plan. December 2013. Accessed April 9, 2014. http://www.nccommerce.com/Portals/0/Documents/AboutOurDepartment/BoardsCommissions/NC%20Jobs%20Plan%20Report_Final.pdf

[16] Bureau of Labor Statistics. Economy at a Glance employment data from 2004-2013. http://www.bls.gov/eag/eag.nc.htm

Transportation and Utilities sectors. Of these sectors, the Professional and Business Services sector has seen the most growth since 2009 and has surpassed pre-recession employment levels. Most of the sectors appear to have either surpassed or have almost returned to pre-recession levels except for Manufacturing and Construction. Manufacturing is less apt to fully recover due to outsourcing and manufacturing trends that favor high-skill, capital-intensive manufacturing.[17] Construction will likely continue to improve at a slow rate as the state's economy continues recovering.

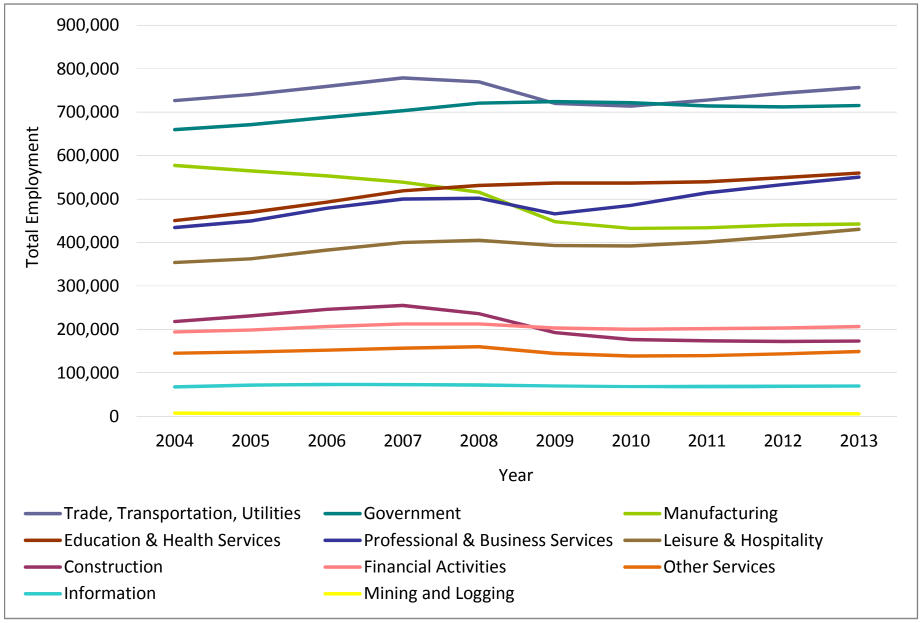

Figure B - 16 North Carolina Employment Trends by Industry (2004-2013)

Despite years of manufacturing job losses, North Carolina is beginning to see modest manufacturing growth. More than 40 new manufacturing facilities were announced during 2013. Many of the announcements were for western North Carolina. Manufacturing still employs 18.4 percent of all workers in this region despite losses to furniture and textiles in recent years. While the high-skill and capital-intensive jobs are not a substitute for jobs lost, they are still important for maintaining the region's manufacturing economic base. North Carolina's future manufacturing growth will likely continue to be in high-skill, capital-intensive industries such as chemicals and polymers, pharmaceuticals, aviation equipment, computers and electronics, and industrial machinery.[18]

Other potential rail-dependent industries are seeing recoveries as well. Construction employment is beginning to rise due to increased commercial and residential building activities. The majority of new construction is concentrated in Charlotte and the Triangle where there has been recent growth in multi-family housing and to a lesser extent, single-family homes. The Greensboro and Winston-Salem regions are challenged with past manufacturing losses and have not returned to post recession employment levels. As the overall economic climate continues to recover in North Carolina, growth will continue to spill over to residents' discretionary income and boost employment in the Trade, Transportation and Utilities and the Leisure and Hospitality sectors.[19]

Figure B - 17 shows the projected economic trends until 2040.

[17] Wells Fargo Securities. North Carolina Economic Outlook: April 2014. April 3, 2014. Accessed April 9, 2014.

[18] Wells Fargo Securities. North Carolina Economic Outlook: April 2014. April 3, 2014. Accessed April 9, 2014.

[19] Wells Fargo Securities. North Carolina Economic Outlook: April 2014. April 3, 2014. Accessed April 9, 2014.

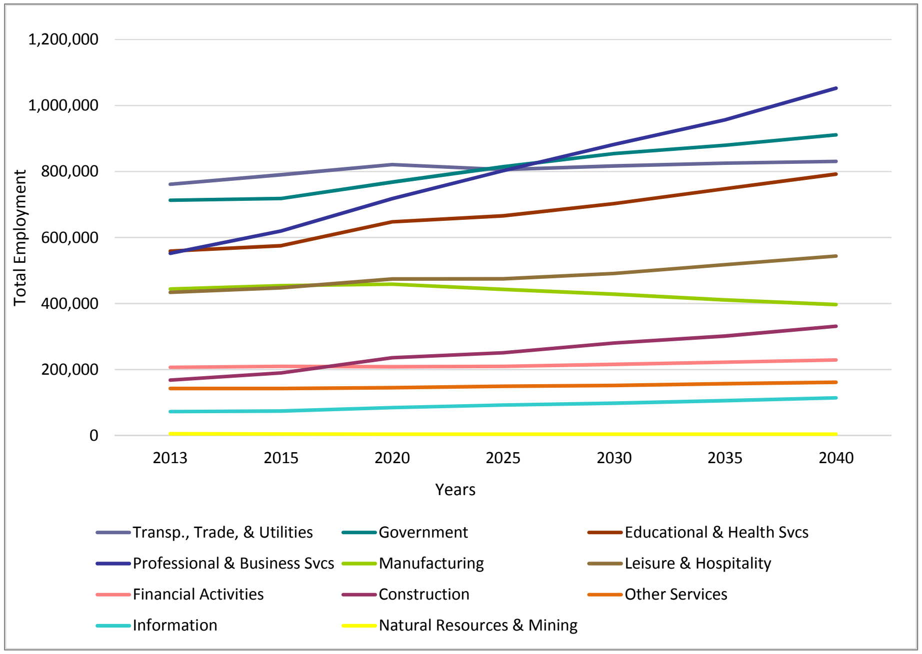

Figure B - 17 North Carolina Employment Projections by Industry (2015-2040)

Geographic Distribution of Rail-Dependent Sectors

Manufacturing is a major generator of rail freight. As Figure B - 18 shows, manufacturing employers are located throughout the state, with the greatest concentrations in Hickory, Charlotte, the Triad and the Triangle. Manufacturers are responsible for generating the majority of commodities within and from North Carolina. The top commodities by value produced in North Carolina include machinery, tobacco, textiles, pharmaceuticals, electronics, gasoline, and plastics/rubber.[20] Additionally, manufactured foodstuffs, nonmetal mineral products, and wood products are top manufacturing commodities shipped within or from North Carolina by weight. Freight rail typically ships a number of these commodities or their product inputs, particularly machinery, chemicals, and minerals.[21]

The Agriculture, Forestry, Fishing and Hunting sector and Mining and Quarrying sector are other industries that utilize rail.[22] The map of Agriculture, Forestry, Fishing and Hunting in Figure B - 18 shows a concentration of employers in the eastern part of the state where logging, hog farming, fishing and crop production are present. Several of the top commodities shipped within or from North Carolina by weight include agricultural products such as timber, wood pellets, soybeans, cereal grains, animal feed and meat and seafood.[23] Freight rail typically transports bulk agricultural products such as grains and lumber as well as meats, prepared food, and other farm products.[24] Figure B - 18 shows the concentration of mining and quarrying employers in North Carolina. Gravel is the top commodity shipped within North Carolina by weight. Several mining operations are located on rail lines.

The energy market is one of the shifts underway that will directly affect the current petrochemical and petroleum resource / production / processing alignment. Crude oil by rail is only one dimension of the change. The emergence of Québec and Louisiana as trading partners with North Carolina is due to the major shifts underway in crude oil and natural gas markets. The well documented long term supply sources are now coming online at stable to increasing product prices. North Carolina is home to a niche chemicals industry, principally manufacturing packaging film converters and rigid packaging. Other products include synthetic fibers. Some of the plastics manufacturing is located in Asheville NC at Printpack, which manufactures rigid plastics packaging; CMI Plastics at Ayden, NC which manufactures plastics for consumer products; Arclin in Moncure, NC which manufactures building and construction plastic products,

[20] NCDOT Rail Division Presentation to State Rail Plain Technical Advisory Committee. April 17, 2014. Data from Bureau of Transportation Statistics, Freight Data and Statistics.

[21] Federal Railroad Administration. Freight Rail Background. March 1, 2012. http://www.fra.dot.gov/eLib/Details/L03011

[22] National Cooperative Freight Research Program. Freight Trip Generation and Land Use Report. Table 9 – NAICS Codes for freight-related sectors. 2012. http://onlinepubs.trb.org/onlinepubs/ncfrp/ncfrp_rpt_019.pdf

[23] NCDOT Rail Division Presentation to State Rail Plain Technical Advisory Committee. April 17, 2014. Data from Bureau of Transportation Statistics, Freight Data and Statistics.

[24]Union Pacific Railroad. Commodities Shipped website. Accessed April 11, 2014. https://www.uprr.com/customers/businessgroups.htm

agriculture products and floor surfaces. These are some of the many plastics manufacturers in North Carolina, and each of them has good rail connection.

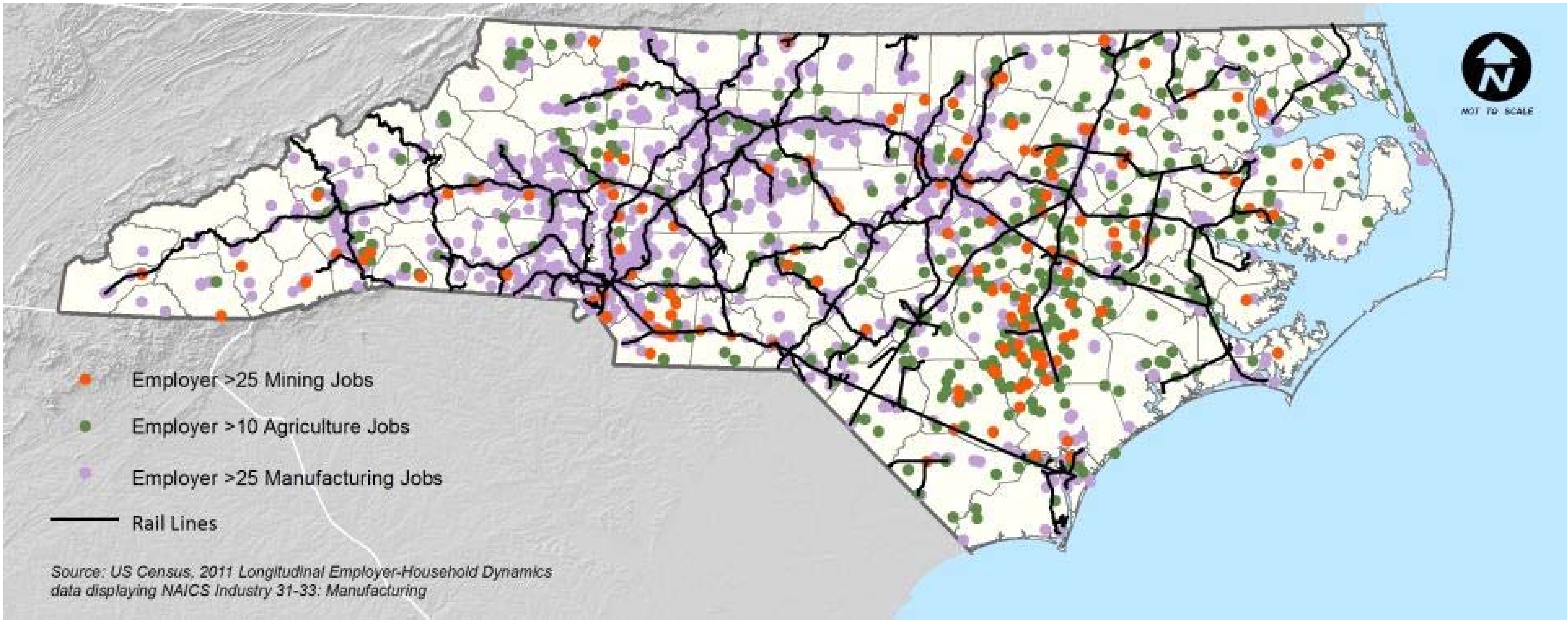

Figure B - 18 Employers in North Carolina (Manufacturing, Agriculture, Mining)

For intermodal container traffic, California and Illinois are the two most significant trading partners for North Carolina by volume and value. Each represents significant rail network connections. We also see the growth in importance for North Baltimore, Columbus, Nashville, Memphis and Atlanta that are cities with strategic rail facilities and network connections.

The needs and opportunities in freight rail arise from the supply chain focus associated with goods movement. The infrastructure conditions affect how much and how fast. The freight supply chain necessitates the State monitor the effectiveness of Origin - Destination pairs, both railroad and industry perspectives, by velocity, timeliness and efficiency. Outbound rail freight movements are important to distinguish whether the move is ultimately to ports or industrial sites. The distinction helps to develop closer ties to attraction and retention for industrial companies in the State.

Rail offers a mix of volume, speed and value for transporting goods long distances across networks with a well-defined operational history. Many of the raw materials required to produce energy, supply food, and construction rely on rail for at least one step of the resource to consumption production cycle. North Carolina is in a position to verify potential changes in freight flows with the

Class I, regional and short line railroads, as well as potential adaptive strategies for handling the volumes.

Chemicals constitute an important share of non-container freight, especially when measured by value (accounting for approximately 10% of the total value). North Carolina plays an important role in chemical supply chains as a consumer of chemical feedstocks for manufacturing inputs (e.g., plastics, packaging and fertilizer).

North Carolina can also explore opportunities for expanding high-value chemicals manufacturing. The overall energy market contributes significantly to the shifts in petrochemical and petroleum resource / production / processing. Crude oil by rail is has received substantial attention but is only one dimension.

North Carolina: Trends in the Rail Freight Industry

Prepared for

AECOM

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Introduction

North Carolina Department of Transportation (NCDOT) is conducting short and long-term planning to strengthen freight transportation. Rail has been identified as a mode that is consequential to the economic health of the state. There is interest in examining the rail freight forecasts for North Carolina. Important to this assessment is evaluating the current and future demand for rail service throughout the state. This requires freight forecasts identifying those industry sectors for which rail service will continue to be the most cost effective mode for moving commodities from points of production to final destinations.

In support of freight planning being conducted by AECOM for NCDOT, IHS Global Inc. was requested to:

- Identify and provide rail freight forecasts for products moving to, from and through North Carolina; and
- Identify freight forecasts associated with emerging industry sectors that will require rail service to transport raw materials and finished goods within and through the state, and enhance the state's intermodal capacity to accommodate national and international supply chains.

This document provides summary overview of inbound, outbound and through commodity flows for the State of North Carolina, and includes freight forecasts by commodity and mode through 2040. Additional insights regarding industry sector trends affecting commodity and goods movement are provided. Key commodities addressed include agriculture, wood and forest products, plastics and resins, coal, and natural gas.

This analysis also included examining intermodal connectivity of rail inbound, outbound and through traffic to identify prospective national and international supply chains. This included examining the origins and destinations of commodities. This provided greater insight as to production – consumption relationships for raw materials and finished goods, thus, establishing a geographical perspective as to the state's trading partners. It also provides to a limited extent insight as to the port capacity for handling different commodities within the state versus ports located in other states, particularly South Carolina.

North Carolina and Rail Freight Overview

Railway infrastructure provides the backbone for goods movement in North America. Rail offers a mix of speed and value for transporting goods long distances. Today, overall tonnage is higher on trucks, due in large part to their flexibility and the fact that goods shipped by other means often must be trucked the "last mile." Waterborne transportation and, for some liquid goods, pipeline transportation hold the distinction of being the overall cheapest modes of bulk freight movement. Nevertheless, rail plays a critical role specializing in moving bulk goods long distances and across land routes that lack sufficient access to inland waterway infrastructure, and at much cheaper rates than truck transportation. Many of the raw materials required to produce energy, supply food, and construct buildings and infrastructure depend on rail transportation.

Comprehensive State Rail Plan

North Carolina is served by two Class I railroads, including CSX and Norfolk Southern (NS) and a variety of short lines. CSX and Norfolk Southern (NS) run north and south connecting portions of the eastern U.S., and east and west connecting to North Carolina ports. East and west rail lines allow for rail access at the ports of Wilmington and Morehead City. Overall, the combination of the state's central location along the east coast, its rail and highway infrastructure, and intermodal options make North Carolina an important origin and destination for rail movements.

Almost 84 million tons of rail cargo (excluding intermodal, which is analyzed in a separately) was transported within North Carolina in 2011. Table 1 highlights that about 60% of this tonnage was inbound traffic. Through traffic accounted for roughly 28% of the total, while outbound traffic accounted for only 8%. Local rail transport within the region makes up a very small percentage of the total, as truck transport is typically a more flexible and appropriate method for moving freight to destinations within the study area. This distribution is projected to remain relatively constant through 2040. Outbound rail tonnage will grow quicker than inbound tons, at 2.3% and 0.3% respectively. Slow growth in inbound tons is majorly a result of a drop in coal tons. Total traffic growth will be mostly flat over the long term. In fact, compound annual growth of tonnage will be only 0.8% per year from 2011 to 2040, and about 0.7% from 2015-2040.

	2011	2012	2014	2015	2020	2025	2030	2035	2040	CAGR[1]
Outbound	6,578	6,553	7,124	7,560	8,844	9,777	10,540	11,638	12,897	2.3%
Inbound	51,167	48,019	51,230	52,310	53,359	51,875	52,450	53,790	55,996	0.3%
Through	23,371	22,625	24,120	25,006	26,575	26,907	27,484	28,510	30,306	0.9%
Local	2,515	2,464	2,683	2,877	3,278	3,422	3,600	3,839	4,212	1.8%
Total	83,578	81,673	87,171	87,752	92,056	91,981	94,073	97,777	105,452	0.8%

Table 1: North Carolina Rail Flows, 2011-2040 (Thousand Tons)

A slightly different picture emerges when rail freight is measured by value of cargo. As illustrated in Table 2, value grows at a higher rate than tonnage, suggesting that the value of per ton is increasing in time, particularly for inbound and outbound traffic. This is consistent with trends suggesting increases in higher-value imported goods from Asia moving across the country as well as possibly among North American Free Trade Agreement (NAFTA) signees.

	2011	2012	2014	2015	2020	2025	2030	2035	2040	CAGR
Outbound	4,127	4,118	4,419	4,636	5,447	6,036	6,380	6,830	7,471	2.1%
Inbound	16,724	17,570	19,094	19,889	23,200	25,287	25,778	25,873	26,967	1.7%
Through	12,189	12,391	13,220	13,888	16,074	17,547	18,253	19,120	20,642	1.8%
Local	1,070	1,054	1,117	1,166	1,368	1,475	1,526	1,584	1,672	1.5%
Total	34,110	37,145	39,863	39,579	46,089	50,346	51,936	53,407	59,791	1.9%

Table 2: North Carolina Rail Flows, 2011-2040 ($ Millions[2])

Several additional trends bear mentioning. Inbound traffic accounts for the lion's share of the region's rail cargo traffic whether measured by tonnage or value. This demonstrates North Carolina's particular importance in national goods movement. It is also interesting to note that inbound cargo tends to be,

[1] CAGR = Compound Annual Growth Rate
[2] $ Millions = millions of US dollars

overall, less valuable (per ton) than other goods movement. Whereas inbound rail freight makes up 61% of total tonnage, it only accounts for about 49% of value in 2011. This should not be too surprising given that North Carolina is a major manufacturing and business center where ostensibly cheaper raw goods are converted into value-added products and services. A considerable amount of the inbound cargo is coal, which is consumed in the state for power generation, fueling manufacturing as well as commercial and domestic activities

Total rail tonnage will increase, but cargo values will increase even more rapidly. These trends for rail can be attributed in large part to North Carolina's role in the movement and distribution of manufactured products, such as plastics, fertilizer, paper and steel to and from Southeast and Midwest locations.

The following sections provide more in-depth analysis of rail freight data; thus, lending additional insight to the economic and transportation factors driving statewide freight and goods movement trends. These observations also offer possible considerations for sustaining and growing North Carolina's economy and further investing in transportation infrastructure that would strengthen the state's role vis-à-vis freight movement and regional, national and international supply chains.

North Carolina Rail Through Traffic

Through traffic makes up about a third of total rail traffic in the state. Estimating the quantity and value of commodities passing through the region through the forecast period is critical to understanding the economic opportunities for North Carolina.

Figure 1 illustrates the relative share of rail freight tonnage passing through North Carolina between key origins and destinations. By far the heaviest tons of through traffic in 2011 originated in Kentucky and were destined to states along the U.S. East Coast closest to North Carolina. This represents about 35% of the total tonnage.

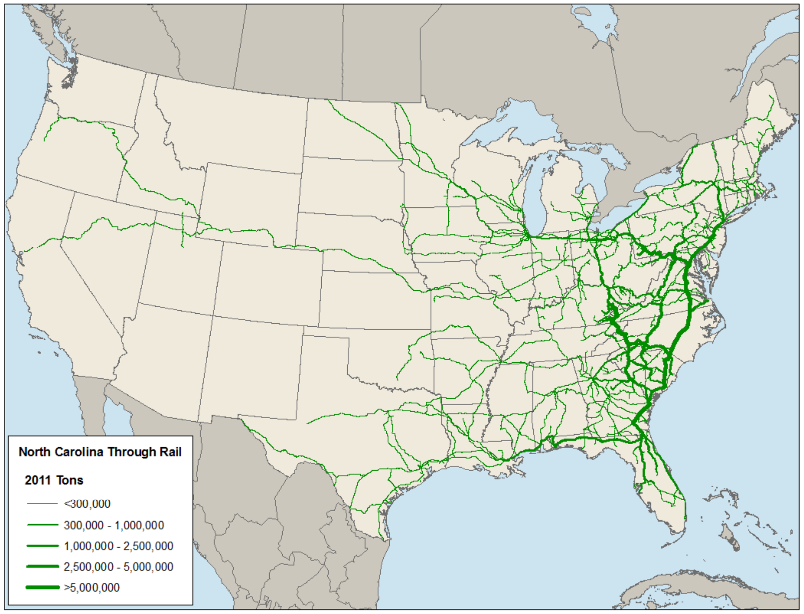


Figure 1: North Carolina Through Traffic Rail Flows, 2011

To better understand these freight flows it is helpful to break the figures down by origin and destination pairs. The top ten origin and destination pairs by freight tonnage are listed in Table 3. What emerges is a clear pattern of goods movement from the west to North Carolina, before being redistributed widely to states on the East Coast, particularly South Carolina, Georgia and Florida.

Origin State	Destination State	Tons (000s)[3]
Kentucky	South Carolina	4,027
Pennsylvania	South Carolina	1,556
Kentucky	Georgia	1,163
Kentucky	Florida	1,111
Florida	New Jersey	706
West Virginia	South Carolina	557
Virginia	Virginia	493
Kentucky	Virginia	452
West Virginia	Florida	429
Ohio	Virginia	382

Table 3: North Carolina Through Traffic Rail Flows by Top O/Ds[4] and Tonnage, 2011

Ranking origin-destination pairs by value rather than weight reveals very different patterns, as illustrated in Table 4. This is not altogether surprising, as coal has a very low value per ton. South Carolina accounts for six of the top origins, while Pennsylvania and New Jersey account for top destinations. There is a clear trend of north-to-south and south-to-north flows between South Carolina and several states in the North East. High-value goods also flow between Florida, Louisiana and Georgia to states in the Northeast.

Origin State	Destination State	$ Millions
South Carolina	Pennsylvania	877
Florida	New Jersey	618
Louisiana	Virginia	425
South Carolina	Ohio	485
South Carolina	Connecticut	369
South Carolina	New Jersey	355
South Carolina	Virginia	332
South Carolina	Maryland	262
Georgia	Pennsylvania	243
Georgia	Virginia	229

Table 4: North Carolina Through Traffic Rail Flows by Top O/Ds and Value, 2011

[3] Tons (000s) = Thousands of Tons
[4] O/Ds = Origin-Destination pairs

Examining top origin-destination-commodity combinations by commodity illustrates the significance of coal shipments. When measuring by tonnage, coal is driving most of the rail through traffic in North Carolina. As summarized in Table 5, seven out of the top ten combinations involve bituminous coal originating in Central Appalachian states. Coal is shipped by rail from the Central Appalachia mines, to final destinations across the country. Much of the coal shipments moving through North Carolina are originating in Kentucky, West Virginia and Pennsylvania to North Carolina and South Carolina power plants.

Another commodity group of significance is Canned Fruits and Vegetables, which is actually orange juice produced in Florida destined to New Jersey and redistributed throughout the Northeast. Stone and riprap shipments from Vulcan, VA to Portsmouth, VA move along the CSX line, which crosses the border into North Carolina before returning to Virginia. Soybean shipments also are relatively significant. They originate in Ohio, and are moved through North Carolina to Virginia destinations.

Origin State	Destination State	Commodity	Tons (000s)
Kentucky	South Carolina	Bituminous Coal	4,027
Pennsylvania	South Carolina	Bituminous Coal	1,556
Kentucky	Georgia	Bituminous Coal	1,163
Kentucky	Florida	Bituminous Coal	1,111
Florida	New Jersey	Canned Fruits, Vegetables, Etc.	706
West Virginia	South Carolina	Bituminous Coal	557
Virginia	Virginia	Broken Stone or Riprap	493
Kentucky	Virginia	Bituminous Coal	452
West Virginia	Florida	Bituminous Coal	429
Ohio	Virginia	Oil Kernels, Nuts or Seeds	382

Table 5: North Carolina Through Traffic Rail Flows by Top O/Ds and Commodity (Tonnage), 2011

Despite the overall pessimistic outlook for the U.S. coal industry as a whole, the relative competitiveness of Central Appalachia region North Carolina should still play a prominent role in coal shipment throughout the forecast period. The most likely scenario is that North Carolina will experience flat or slightly declining growth in coal volumes in the foreseeable future.

An examination of top origin-destination-commodity combinations by value helps explain the divergence in logistics patterns vis-à-vis tonnage measures. Table 6 illustrates the importance of rail for high-value iron and steel product shipments, mostly steel sheets and beams from Nucor Steel in Berkley, SC. Shipments of high-value plastics from South Carolina and Louisiana to Midwest and Northeast states, includes plastic film covers, packaging, resins and fibers and are shipped mainly for consumption. Flows from Florida to New Jersey are principally orange juice shipments.

Origin State	Destination State	Commodity	$ Millions
Florida	New Jersey	Canned Fruits, Vegetables	576
South Carolina	Pennsylvania	Primary Iron or Steel Products	381
South Carolina	Connecticut	Primary Iron or Steel Products	357
Georgia	Ohio	Misc Indus Inorganic Chemicals	221
Virginia	Texas	Primary Iron or Steel Products	197
South Carolina	Ohio	Plastic Mater or Synth Fibers	192
South Carolina	Virginia	Plastic Mater or Synth Fibers	164
Louisiana	Pennsylvania	Plastic Mater or Synth Fibers	134
Virginia	Dist. Of Columbia	Electrical Transformers	131
Louisiana	Virginia	Chemical Preparations	126

Table 6: North Carolina Through Traffic Truck Flows by Top O/Ds and Commodity (Value), 2011

In summary, substantial quantities of rail freight move through North Carolina. Coal is by far the most important driver of rail freight by weight, whereas steel materials, orange juice and plastics constitute the major sources of goods movement by value. The dependence on coal carries a risk, as U.S. energy plants increasingly retire coal-fired plants in favor of natural gas facilities. This is a trend that is expected to continue due to environmental concerns, emission regulations and the increasing availability of low priced natural gas. Plastics and steel offer more upside potential, as automotive manufacturing returns to North America, particularly to states located in the Southeast U.S.

North Carolina Rail Outbound Traffic

Although outbound freight makes up a relatively small percentage of total regional rail transportation, it is nonetheless an important mode of transport for numerous North Carolina industries. Rail freight moves in large quantities to nearby Atlantic and Midwestern Appalachian states. Texas and Tennessee also are major destinations for commodities originating in and/or trans-shipped via North Carolina. Figure 2 illustrates the routing associated with these tonnages and it also highlights the economic relationships that exist in different U.S. regions.

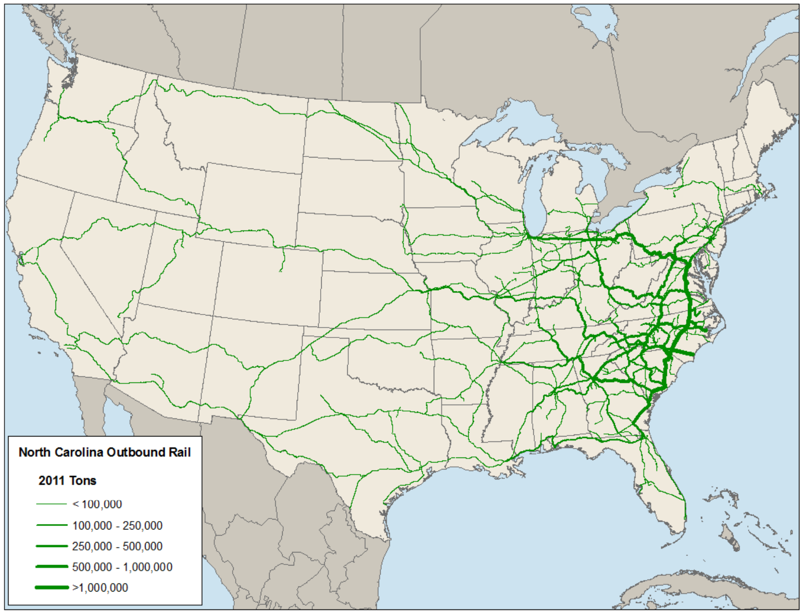


Figure 2: North Carolina Outbound Rail Flows, 2011

Destination State	Tons (000s)
South Carolina	2,028
Georgia	669
Illinois	376
Ohio	366
Florida	356
Tennessee	352

Destination State	$ Millions
South Carolina	749
Georgia	429
Ohio	301
Illinois	262
Florida	252
Tennessee	245

Destination State	Tons (000s)		Destination State	$ Millions
Virginia	322		Virginia	200
Pennsylvania	285		Pennsylvania	199
Missouri	201		Texas	184
New Jersey	164		Missouri	135

Table 7 summarizes the top outbound rail freight destinations, ranked by both weight and value. South Carolina receives the largest share of the total weight of outbound rail freight, in particular Charleston and Georgetown. Georgia receives the second largest tonnage while Illinois and Ohio rank third and fourth. The remaining top destinations are further south along the East Coast, and to states in the Northeast and the Midwest. Hence, beyond major centers of international trade on the coasts, outbound tonnage tends to move to adjacent and nearby states, and states, such as Missouri and New Jersey, which are important freight hubs with strong intermodal connectivity.

Destination State	Tons (000s)		Destination State	$ Millions
South Carolina	2,028		South Carolina	749
Georgia	669		Georgia	429
Illinois	376		Ohio	301
Ohio	366		Illinois	262
Florida	356		Florida	252
Tennessee	352		Tennessee	245
Virginia	322		Virginia	200
Pennsylvania	285		Pennsylvania	199
Missouri	201		Texas	184
New Jersey	164		Missouri	135

Table 7: North Carolina Outbound Rail Flows by Top Destination, 2011

When the outbound destinations are ranked by freight value, an almost identical pattern emerges. Texas gains in importance with 4% of the value of rail freight leaving North Carolina. South Carolina receives 31% of outbound rail freight by weight, whereas it represents 18% of the outbound freight when measured in dollars.

Table 8 summarizes the forecasted top rail outbound destinations by both tonnage and freight in 2040. Figure 3 illustrates the anticipated outbound tonnage flows through 2040. Similar top origin-destination pairs persist, with minor reshuffling at the top. For example Virginia moves ahead by tonnage and value due to the growth in metal scrap shipments to Roanoke and plastics being shipped to Winchester, VA. Alabama emerges as a top 10 destination when measuring shipments by tonnage. This is mainly due to metal scraps and steel products used in the automotive industry.

Destination State	Tons (000s)		Destination State	$ Millions
South Carolina	4,127		South Carolina	1,449
Georgia	1,531		Georgia	833
Virginia	1,032		Ohio	556
Pennsylvania	689		Virginia	503
Ohio	670		Florida	438
Florida	620		Pennsylvania	418
Tennessee	533		Tennessee	379
Illinois	498		Illinois	353
Alabama	420		Texas	297
New Jersey	355		New Jersey	247

Table 8: North Carolina Outbound Rail Flows by Top Destination, 2040

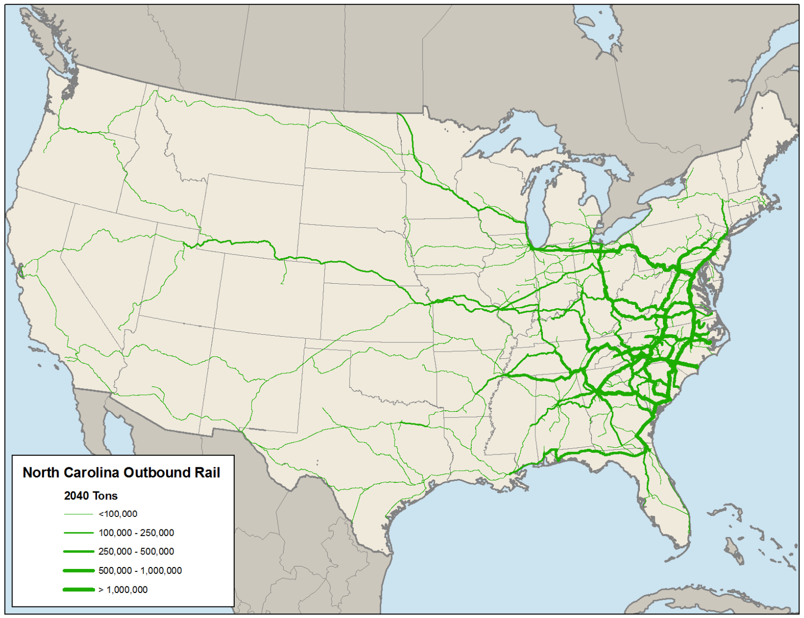


Figure 3: North Carolina Outbound Rail Flows, 2040

More than 80% of North Carolina's outbound rail freight tonnage falls into 13 major commodity groups as shown in

Commodity	Tons (000s)	Percentage of Total
Fertilizers	1,053	16%
Broken Stone or Riprap	821	12%
Metal Scrap or Tailings	519	8%
Fiber, Paper or Pulpboard	473	7%
Primary Forest Materials	410	6%
Misc Industrial Organic Chemicals	333	5%
Plastic Mater or Synth Fibers	322	5%
Cyclic Intermediates or Dyes	279	4%
Nonmetal Minerals, Processed	271	4%
Wet Corn Milling or Milo	253	4%
Primary Iron or Steel Products	247	4%
Pulp or Pulp Mill Products	205	3%

Commodity	Tons (000s)	Percentage of Total
Misc Wood Products	140	2%
All Others	901	14%
Total	6,578	

Table 9. Fertilizers make up the largest share with about 16% of the total. Much of this freight is accounted for by fertilizer production in Aurora, NC produced at the PCS Phosphates mine, which has an annual capacity of 6 million tons of phosphate ore. Broken stone, metal scrap, paper, forest materials and organic chemicals combine to account for about 40% of the total outbound freight. North Carolina is home to significant crushed stone production used in the construction industry. Wood pellets are manufactured at the Enviva facility in Ahoskie, NC, and are currently being exported to Europe through ports in North and South Carolina due to increased biomass demand in Europe. North Carolina is home to a niche chemicals industry, principally manufacturing packaging film converters and rigid packaging. Low value bulk commodities such as corn milling, pulp and wood products make up about 10% of the total by weight. Other smaller but significant product groups include dyes, nonmetal minerals and steel products. As illustrated in Figure 4, the majority of the state's outbound chemical related commodities are originating in Beaufort, New Hanover and Brunswick counties.

Commodity	Tons (000s)	Percentage of Total
Fertilizers	1,053	16%
Broken Stone or Riprap	821	12%
Metal Scrap or Tailings	519	8%
Fiber, Paper or Pulpboard	473	7%
Primary Forest Materials	410	6%
Misc Industrial Organic Chemicals	333	5%
Plastic Mater or Synth Fibers	322	5%
Cyclic Intermediates or Dyes	279	4%
Nonmetal Minerals, Processed	271	4%
Wet Corn Milling or Milo	253	4%
Primary Iron or Steel Products	247	4%
Pulp or Pulp Mill Products	205	3%
Misc Wood Products	140	2%
All Others	901	14%
Total	6,578	

Table 9: North Carolina Outbound Rail Flows by Commodity and Tonnage, 2011

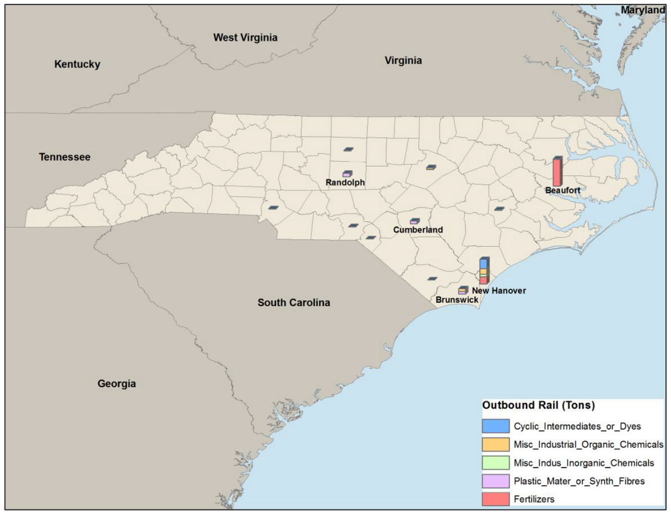


Figure 4: Originations of North Carolina Chemical-Related Outbound Rail Flows, 2011

Commodity	$ Millions	Percentage of Total
Plastic Mater or Synth Fibers	696	17%
Fertilizers	472	11%
Misc Industrial Organic Chemicals	415	10%
Primary Iron or Steel Products	381	9%
Fiber, Paper or Pulpboard	340	8%
Cyclic Intermediates or Dyes	332	8%
Misc Indus Inorganic Chemicals	204	5%
Metal Scrap or Tailings	154	4%
Wet Corn Milling or Milo	142	3%
Pulp or Pulp Mill Products	80	2%
Paper	78	2%
Misc Wood Products	75	2%
All Others	536	13%
Total	4,127	100%

Table 10 illustrates the divergence between tonnage and value for outbound rail cargo originating or trans-shipped through North Carolina, with twelve categories accounting for 82% of value. Plastics and

synthetic fibers make up the largest share by value at 17%, as plastics products are high value products. As in the case of top commodities by tonnage, fertilizers constitute the largest share of outbound commodities by volume at 11%. This share is slightly lower than that for tonnage. Fertilizers are relatively high-value products but also relatively heavy to ship. Other products, which represent higher valued commodities, appearing in Table 10 are organic chemicals, steel products and dyes. Overall plastics, dyes and chemicals products make up about 40% of outbound cargo by value, which is higher than their share in terms of tons at 14%.

Commodity	$ Millions	Percentage of Total
Plastic Mater or Synth Fibers	696	17%
Fertilizers	472	11%
Misc Industrial Organic Chemicals	415	10%
Primary Iron or Steel Products	381	9%
Fiber, Paper or Pulpboard	340	8%
Cyclic Intermediates or Dyes	332	8%
Misc Indus Inorganic Chemicals	204	5%
Metal Scrap or Tailings	154	4%
Wet Corn Milling or Milo	142	3%
Pulp or Pulp Mill Products	80	2%
Paper	78	2%
Misc Wood Products	75	2%
All Others	536	13%
Total	4,127	100%

Table 10: North Carolina Outbound Rail Flows by Commodity and Value, 2011

The major difference between the top ten commodities by tonnage and value occurs with several higher-value manufacturing products. In particular, the plastics group skyrockets to the first spot by value on account of both high value-materials and high manufacturing value-added. Plastics account for only a 5% share of the total tonnage but 17% of the total by value. Some of the plastics manufacturing is located in Ashville NC at Printpack, which manufactures rigid plastics packaging; CMI Plastics at Ayden, NC which manufactures plastics for consumer products; Arclin in Moncure, NC which manufactures building and construction plastic products, agriculture products and floor surfaces. These are some of the many plastics manufacturers in North Carolina, and each of them has good rail connection. Most of the manufacturers are expanding; therefore, volumes are likely to increase.

As illustrated previously in Table 1, outbound rail tonnage is expected to grow through 2040. The distribution across commodities will remain relatively similar to the 2011 distribution summarized in

Commodity	Tons (000s)	Percentage of Total
Fertilizers	1,053	16%
Broken Stone or Riprap	821	12%
Metal Scrap or Tailings	519	8%

Commodity	Tons (000s)	Percentage of Total
Fiber, Paper or Pulpboard	473	7%
Primary Forest Materials	410	6%
Misc Industrial Organic Chemicals	333	5%
Plastic Mater or Synth Fibers	322	5%
Cyclic Intermediates or Dyes	279	4%
Nonmetal Minerals, Processed	271	4%
Wet Corn Milling or Milo	253	4%
Primary Iron or Steel Products	247	4%
Pulp or Pulp Mill Products	205	3%
Misc Wood Products	140	2%
All Others	901	14%
Total	6,578	

Table 9. Metal scrap, broken stone and fertilizers will be the top three outbound commodities by weight (Table 11). The share of weight attributed to fertilizers is expected to decrease from 16% in 2011 to 8% in 2040. This can be explained in part by the fact that increased production at PCS Phosphates could occur due to low natural gas prices in the US. This development could dampen fertilizer imports and but also stimulate an increase in exports via the Port of Morehead City. Moreover phosphates from the Aurora mine are barged to the Port of Morehead City for export, and this may attribute to reduced share of fertilizer shipments on rail. Moreover, scrap, stone, and various types of paper and pulp are forecasted to remain important lower-value bulk outbound commodities through 2040.

Commodity	Tons (000s)	Percentage of Total
Metal Scrap or Tailings	2,427	19%
Broken Stone or Riprap	1,422	11%
Fertilizers	1,094	8%
Fiber, Paper or Pulpboard	800	6%
Primary Forest Materials	741	6%
Plastic Mater or Synth Fibers	633	5%
Cyclic Intermediates or Dyes	585	5%
Pulp or Pulp Mill Products	553	4%
Paper Waste or Scrap	540	4%
Misc Industrial Organic Chemicals	456	4%
All Others	3,644	28%
Total	12,897	

Table 11: North Carolina Outbound Rail Flows by Commodity and Tonnage, 2040

Metal scrap will have an increased share of total commodities by weight in 2040 of 19%, compared to 8% share in 2011. This is mainly due to increased need for scrap metals to feed steel production. Nucor has corporate office in Charlotte and two locations in Winton and Hertford, NC. It also recently acquired Metal Recycling Services in Monroe, NC. Other locations with scrap metal concentrations in the state include Wilmington and Raleigh. Increasing demand for scrap metal is occurring in the vicinity of auto manufacturing, principally in the Southeast and Midwest. Scrap exports to Asia will account for smaller share of overall outbound flows; although scrap metal exports via West Coast ports to Asia (e.g., China, Japan and South Korea) are increasing.

The total value of outbound shipments from North Carolina is expected to increase by about 80% between 2011 and 2040.The projected distribution of outbound rail freight value by commodity in 2040 is shown in

Commodity	Tons (000s)	Percentage of Total
Plastic Mater or Synth Fibers	1,371	18%
Metal Scrap or Tailings	719	10%
Cyclic Intermediates or Dyes	697	9%
Fiber, Paper or Pulpboard	576	8%
Misc Industrial Organic Chemicals	568	8%
Primary Iron or Steel Products	545	7%
Fertilizers	490	7%
Wet Corn Milling or Milo	235	3%
Misc Indus Inorganic Chemicals	220	3%
Pulp or Pulp Mill Products	215	3%
All Others	1,835	24%
Total	7,471	

Table 12. Plastics and synthetic fibers remains the top commodity group, and the total value of shipments nearly doubles due to continued need for consumer plastics and packaging materials. Primary iron and steel products remains in the top ten commodity group, fueled by continuing industrial growth in the U.S. South, Mexico and Asia. Total value of outbound steel grows in absolute terms by about 40%. The total share of fertilizers drops; its total value will grow slightly due to anticipated investment in fertilizer production domestically and a slowdown of fertilizer imports. There is some re-allocation within the organic chemicals and dyes products categories, but their overall shares are anticipated to remain about the same through 2040.

Commodity	Tons (000s)	Percentage of Total
Plastic Mater or Synth Fibers	1,371	18%
Metal Scrap or Tailings	719	10%
Cyclic Intermediates or Dyes	697	9%

Commodity	Tons (000s)	Percentage of Total
Fiber, Paper or Pulpboard	576	8%
Misc Industrial Organic Chemicals	568	8%
Primary Iron or Steel Products	545	7%
Fertilizers	490	7%
Wet Corn Milling or Milo	235	3%
Misc Indus Inorganic Chemicals	220	3%
Pulp or Pulp Mill Products	215	3%
All Others	1,835	24%
Total	7,471	

Table 12: North Carolina Outbound Rail Flows by Commodity and Value, 2040

Combining the top destination and commodity pairs provides further insight on how these forecasts impact overall freight movement originating in or trans-shipped through North Carolina. The top ten destination-commodity combinations by tonnage are presented in Table 13. Broken stone or riprap heading to South Carolina tops the list. Not only is broken stone very heavy, North Carolina produces significant amounts of crushed stone used in the construction industry. Broken stone is shipped to Vulcan Materials facility in Rains, SC where it is further crushed into construction aggregate.

Large quantities of commodities classified as Primary Forest Materials are being shipped to South Carolina. Wood pellets, which are being produced in North Carolina, are being exported via the Port of Charleston to Europe, where the demand for biomass to fuel manufacturing and provide heating has been growing as need an alternative to coal.

Metal scrap is being shipped to more close by destinations in South Carolina and Virginia. This is being driven in part by automobile manufacturing and growth in construction.

The top commodity-destination pairs also highlight the importance of North Carolina the agriculture industry. Fertilizer products are being shipped to the Midwest (e.g., Ohio, Illinois and Missouri) for agricultural production. South Carolina receives large quantities of cyclic intermediates and dyes and organic chemicals, most of which are resins used as inputs for polyester fibers in textile and plastics manufacturing, principally for plastic bottles.

Destination State	Commodity	Tons (000s)
South Carolina	Broken Stone or Riprap	782
South Carolina	Primary Forest Materials	365

Destination State	Commodity	Tons (000s)
South Carolina	Cyclic Intermediates or Dyes	249
South Carolina	Metal Scrap or Tailings	180
Ohio	Fertilizers	169
Georgia	Nonmetal Minerals, Processed	165
Virginia	Metal Scrap or Tailings	164
Illinois	Fertilizers	160
Missouri	Fertilizers	142
South Carolina	Misc Industrial Organic Chemicals	138

Table 13: North Carolina Outbound Rail Flows by Destination and Commodity (Tonnage), 2011

Ranking the destination-commodity pairs by value (Table 14) illustrates again the importance of plastics, resins and polyester manufacturing in North Carolina, and the importance of trade relations with a number of states - South Carolina, Georgia, Ohio and Texas. Plastics are used for retail and consumer packaging, automotive interior and exterior manufacturing and as fabrics dyes. Iron and steel are being shipped in large quantities to Florida for steel construction, while not surprisingly, fertilizers are being shipped to Midwestern states for agricultural production.

Destination State	Commodity	$ Millions
South Carolina	Cyclic Intermediates or Dyes	296
South Carolina	Misc Industrial Organic Chemicals	171
Ohio	Plastic Mater or Synth Fibers	155
Georgia	Plastic Mater or Synth Fibers	103
South Carolina	Fiber, Paper or Pulpboard	80
Florida	Primary Iron or Steel Products	77
Ohio	Fertilizers	76
Georgia	Misc Industrial Organic Chemicals	73
Illinois	Fertilizers	72
Texas	Plastic Mater or Synth Fibers	68

Table 14: North Carolina Outbound Rail by Destination and Commodity (Value), 2011

Table 15 summarizes the top-ranked combinations of destination and commodity for 2040 by tonnage. Overall there is a slight re-shuffling of the top ten rankings from 2011 with the inclusion of Georgia as a destination for paper and metal scrap shipments.

Destination State	Commodity	Tons (000s)
South Carolina	Broken Stone or Riprap	1,355

Destination State	Commodity	Tons (000s)
South Carolina	Metal Scrap or Tailings	841
Virginia	Metal Scrap or Tailings	768
South Carolina	Primary Forest Materials	659
South Carolina	Cyclic Intermediates or Dyes	522
Georgia	Pulp or Pulp Mill Products	307
Georgia	Nonmetal Minerals, Processed	279
Georgia	Metal Scrap or Tailings	277
Georgia	Paper Waste or Scrap	194
Pennsylvania	Lumber or Dimension Stock	191

Table 15: North Carolina Outbound Rail Flows by Destination and Commodity (Tonnage), 2040

Table 16 summarizes the top-ranked combinations of destination and commodity for 2040 by value. Again, regional origin-destination pairs remain stable, although the rankings change slightly. This is mostly driven by the increased demand for of plastics and metal scrap at various destinations.

Destination State	Commodity	$ Millions
South Carolina	Cyclic Intermediates or Dyes	622
Ohio	Plastic Mater or Synth Fibers	325
South Carolina	Metal Scrap or Tailings	249
South Carolina	Misc Industrial Organic Chemicals	237
Virginia	Metal Scrap or Tailings	228
Georgia	Plastic Mater or Synth Fibers	216
Texas	Plastic Mater or Synth Fibers	143
Virginia	Plastic Mater or Synth Fibers	142
Florida	Primary Iron or Steel Products	141
Georgia	Pulp or Pulp Mill Products	120

Table 16: North Carolina Outbound Rail Flows by Destination and Commodity (Value), 2040

In summary, outbound freight movements are expected to increase slightly faster in terms of total weight, and at a slightly slower rate in terms of value from 2011 to 2040. The growth is being driven primarily by steel and iron, broken stone and riprap, primary forest materials, and, especially plastics and chemicals products, which represent relatively higher value. This growth is important to the region; it contributes to the health of the region's manufacturing and transportation sector and related employment. It also creates demand for capital investments in infrastructure and a stronger regional manufacturing base. This calls for efficient rail connections to a wide variety of destinations both nearby and to more distant but major trading centers of the U.S. to further support North Carolina industries.

North Carolina Rail Inbound Traffic

Analyzing inbound rail freight transport patterns helps complete the logistics picture of rail freight movement in North Carolina. Figure 5 illustrates the primary routing of inbound cargo. The picture that emerges is much different than that for outbound rail. Essentially, substantial quantities of inbound freight come from the Northeast portions of the US, particularly from mining regions in Appalachia. Much of the inbound cargo comes from more proximate areas, as would be expected in an inter-regional goods movement model.

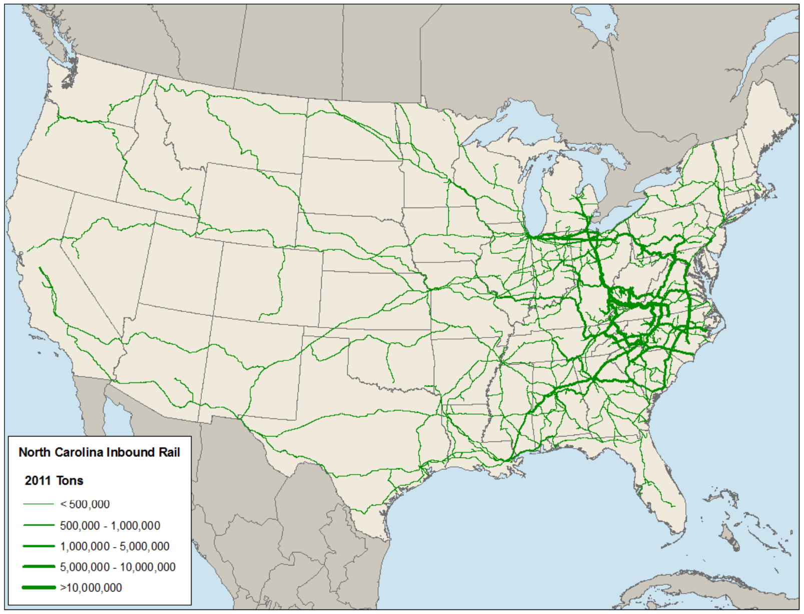


Figure 5: North Carolina Inbound Rail Flows, 2011

Table 17 summarizes the top origin States by weight and value. West Virginia is easily the largest inbound shipping origin by weight, accounting for 37% of total freight. Kentucky is second, with 16% of the total. The remaining origins are distributed among Midwest and neighboring states. The value of inbound freight is more evenly dispersed across origins. Illinois is the number one origin with 18% of total value, followed by Louisiana at 13%. Most of the remaining top origins are in the Midwest and Plains states, Southern states, in particular Louisiana, South Carolina, Alabama and Kentucky Texas also factors more prominently when viewed through the lens of value rather than tonnage.

Origin State	Tons (000s)		Origin State	$ Millions
West Virginia	19,103		Illinois	2,949
Kentucky	8,348		Louisiana	2,136
Illinois	4,411		Ohio	1,792
Ohio	3,110		Indiana	1,459
Virginia	2,592		Michigan	1,174
Indiana	2,574		West Virginia	703
South Carolina	1,648		South Carolina	691
Michigan	1,596		Alabama	685
Tennessee	1,595		Kentucky	672
Louisiana	1,173		Texas	582

Table 17: North Carolina Inbound Rail Flows by Origin, 2011

Table 18 summarizes the relative rankings of the top destinations for North Carolina inbound rail freight in 2040. One of the more interesting differences compared to 2011 data is that Canada rises in importance in terms of value, and West Virginia drops in the ranking. As this sub-section will demonstrate, much of this tonnage and value is the result of decreased coal tonnage, and increased overall weight and value of chemical shipments. This sub-section will demonstrate that the ascendancy of Louisiana, in particular New Orleans will be on account of increased plastics production in the North Carolina. Figure 6 illustrates the geographical market relationships with West Virginia, Virginia, Tennessee, Ohio, Illinois and Louisiana.

Origin State	Tons (000's)		Origin State	$ Millions
West Virginia	14,940		Louisiana	5,033
Kentucky	6,375		Illinois	4,610
Illinois	6,035		Ohio	2,528
Ohio	3,853		Indiana	1,953
Indiana	3,421		Michigan	1,866
Virginia	3,197		South Carolina	1,198
South Carolina	3,125		Quebec (Canada)	1,120
Tennessee	2,610		Alabama	1,004
Louisiana	2,515		Texas	907
Michigan	2,025		Kentucky	821

Table 18: North Carolina Inbound Rail Flows, 2040

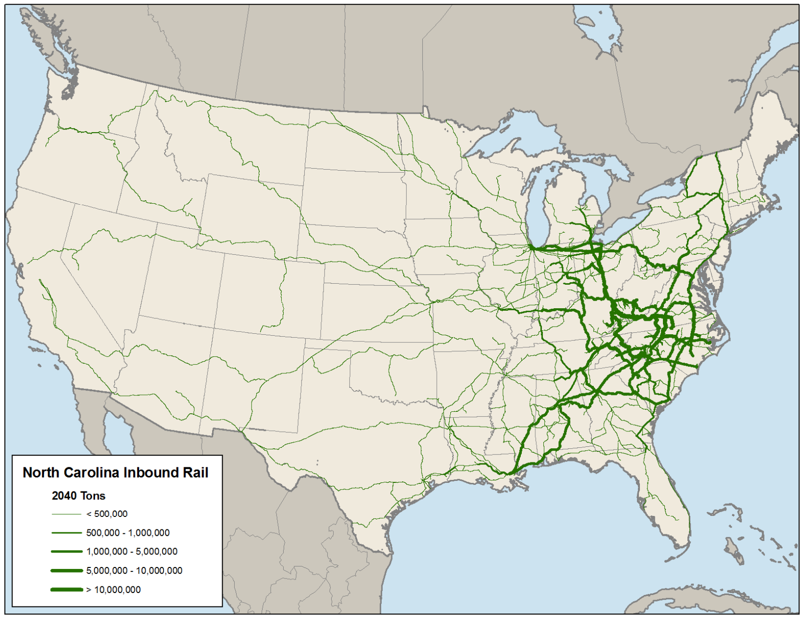


Figure 6: North Carolina Inbound Rail Flows by Origin, 2040

Over 55% of the total inbound tonnage falls into ten major product categories, as shown in Table 19. Bituminous coal dominates inbound rail freight shipments, making up more than half of the total. Coal is destined to numerous North Carolina power generating facilities operated by the Duke Energy in Belews Creek, Hyco Creek, Marshall and Mayo Creek. Duke Energy provides electricity to 7.2 million customers in the U.S. Grain is the second largest commodity by weight. Most of the grain originates in Midwestern states and it is destined to North Carolina for local consumption. Grain, soybean oil, oil kernel, nuts and seeds and other agricultural products are mainly used for consumption in North Carolina. These goods constitute about 14% of total inbound rail cargo. Organic Chemicals, ostensibly used in the production of the outbound plastics or as input for fertilizers produced in North Carolina. Chemicals needed as regional industry inputs (or possibly trans-shipment) also constitute a major share of inbound goods at about 9% of the total. Chemical Fertilizer or Mineral Crude is mostly sulfur inputs used for fertilizer production in Aurora, NC. Figure 7 identifies the destination by county of inbound chemical related commodities. Destinations include Mecklenburg, Guilford, Randolph, New Hanover and Beaufort counties.

Commodity	Tons (000s)	Percentage of Total
Bituminous Coal	28,028	55%
Grain	4,955	10%
Misc Industrial Organic Chemicals	2,418	5%
Portland Cement	1,466	3%
Chem or Fertilizer Mineri Crude	1,443	3%
Broken Stone or Riprap	1,380	3%
Soybean Oil or By-products	1,211	2%
Plastic Mater or Synth Fibers	1,132	2%
Primary Forest Materials	942	2%
Potassium or Sodium Compound	838	2%
Oil Kernels, Nuts or Seeds	781	2%
Others	6,572	13%
Total	51,167	

Table 19: North Carolina Inbound Rail Flows by Top Commodity and Tonnage, 2011

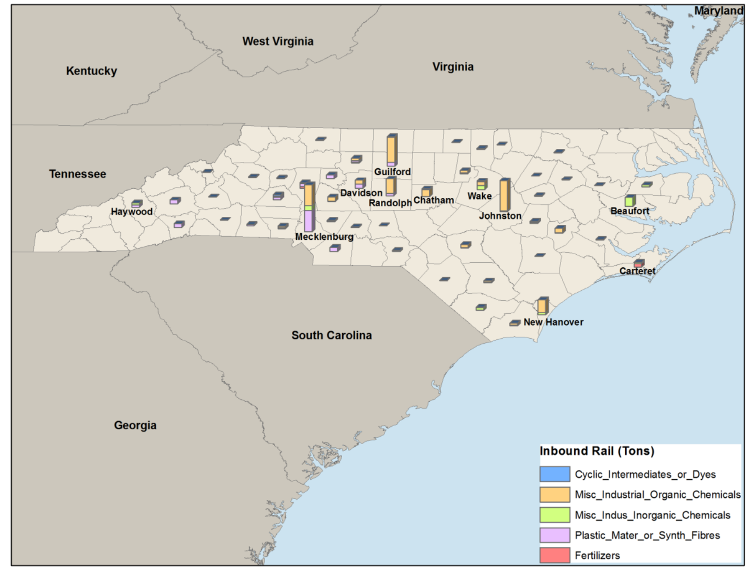


Figure 7: Destinations of North Carolina Chemical-Related Inbound Rail Flows, 2011

The importance of North Carolina's role in industrial chemical logistics suggested by the region's outbound shipment data is also evident in Table 20, which shows the top inbound commodities by value. Industrial organic chemicals account for 18% of total inbound freight value, while plastics accounts for 15%. Chemicals, in general, account for about 25% of the total. Chemicals and plastics are shipped to North Carolina as inputs to plastics in packing, consumer, and automotive manufacturing.

Motor vehicles account for 11% of the value of inbound rail freight. Motor vehicles are shipped to an automotive distribution facility in Winston-Salem operated by Norfolk Southern. North Carolina is ideally situated in close proximity to heavy auto-producing states and provides trans-shipment connectivity.

Grain, soybeans and beverage products again factor prominently, with the grains being used to produce higher-value distilled and blended liquors.

Commodity	$ Millions	Percentage of Total
Misc Industrial Organic Chemicals	3,011	18%
Plastic Mater or Synth Fibers	2,452	15%
Motor Vehicles	1,801	11%
Misc Indus Inorganic Chemicals	1,207	7%
Bituminous Coal	1,024	6%
Distilled or Blended Liquors	748	4%
Petroleum Refining Products	714	4%
Grain	705	4%
Soybean Oil or By-products	605	4%
Fiber, Paper or Pulp board	453	3%
All Others	3,577	21%
Total	16,724	

Table 20: North Carolina Inbound Rail Flows by Top Commodity and Value, 2011

Table 21 summarizes the forecasted outbound tonnage and distribution by commodity for 2040. In the future, bituminous coal will continue to account for the majority of inbound rail freight by weight, albeit a smaller share. Although still the top commodity, inbound coal shipments are forecasted to decrease in absolute terms and as a share of the total. Coal will continue to decline relative to gas as a source of domestic energy generation, and while export markets have helped support the industry in recent years it is not clear that these trends will continue in the future. Meanwhile, industrial organic chemicals and plastic matter and synthetic fibers continue to grow, consistent with gains in outbound tonnage. Inbound organic chemicals and plastics tonnages are and will continue to be higher than outbound, with North Carolina manufacturing for outbound balance. Grains and soybeans will have almost identical share of total tons, but tonnage will increase to feed growing need of local consumption. Primary forest materials inbound share will slowly increase to North Carolina as outbound shipments from ports are planned to increase.

Commodity	Tons (000s)	Percentage of Total
Bituminous Coal	20,672	37%
Grain	5,574	10%
Misc Industrial Organic Chemicals	4,265	8%
Portland Cement	3,337	6%
Plastic Mater or Synth Fibers	2,600	5%
Broken Stone or Riprap	2,391	4%
Soybean Oil or By-products	2,033	4%
Primary Forest Materials	1,702	3%
Chem or Fertilizer Mineri Crude	1,405	3%
Potassium or Sodium Compound	1,039	2%
All Others	10,978	20%
Total	55,996	

Table 21: North Carolina Inbound Rail Flows by Top Commodity and Tonnage, 2040

Table 22 summarizes the top inbound rail commodities by value forecasted for 2040. The increase in the share of chemicals and plastics complements a similar trend in outbound rail traffic. Inbound motor vehicle shipments will also increase in absolute and relative terms. Grain, soybeans and beverages will grow as a percent share of the total and in absolute values, as demand for these commodities increases. Consistent with the drop in inbound cargo tonnage, the share of inbound freight value attributed to bituminous coal is also expected to decline by 2040.

Commodity	$ Millions	Percentage of Total
Plastic Mater or Synth Fibers	5,630	21%
Misc Industrial Organic Chemicals	5,311	20%
Motor Vehicles	2,907	11%
Misc Indus Inorganic Chemicals	1,382	5%
Soybean Oil or By-products	1,017	4%
Chemical Preparations	1,001	4%
Distilled or Blended Liquors	858	3%
Grain	793	3%
Petroleum Refining Products	789	3%
Bituminous Coal	755	3%
All Others	6,522	25%
Total	26,967	

Table 22: North Carolina Inbound Rail Flows by Top Commodity and Value, 2040

To further illustrate the dynamics of commodity supply chains, Table 23 illustrates the top combinations of origins and commodities for inbound rail cargo. Not surprisingly, bituminous coal from West Virginia, Kentucky and Virginia contributes by far the largest inbound share. Grain and soybeans, from the

Midwest states is the second largest commodity in terms of tons shipped to North Carolina. They are used mostly for local consumption, or as an input to a growing food industry. Chemical or Fertilizer Mineral Crude is shipped to phosphate mines in Aurora, NC for fertilizer production.

Origin State	Commodity	Tons (000s)
West Virginia	Bituminous Coal	18,306
Kentucky	Bituminous Coal	8,102
Ohio	Grain	1,665
Virginia	Bituminous Coal	1,291
Illinois	Misc Industrial Organic Chemicals	1,128
Michigan	Grain	1,107
Illinois	Chem or Fertilizer Mineri Crude	936
Indiana	Grain	900
Indiana	Soybean Oil or By-products	763
Illinois	Grain	738

Table 23: North Carolina Inbound Rail Flows by Top Origin and Commodity (Tonnage), 2011

An analysis of the top ten origin-commodity pairs by value yields different picture than origin commodity pairs by weight (Table 24). Bituminous coal from West Virginia and Kentucky drops in the ranking as coal is a lower value commodity. Plastic Matter and Organic Chemicals make up most of the share of inbound commodities by value. Plastic inputs for plastic manufacturing in North Carolina are shipped from Louisiana, mainly New Orleans, where chemical industry growth is very strong lately due to cheaper natural gas which is a feedstock to chemical plastics industry. Organic chemicals are sent on rail from Illinois and Texas as resin inputs for mainly plastics and packaging manufacturing in North Carolina. Soybean, beverages and other food items are remaining in the top ten of inbound commodities.

Origin State	Commodity	$ Millions
Louisiana	Plastic Mater or Synth Fibers	1,447
Illinois	Misc Industrial Organic Chemicals	1,404
Michigan	Motor Vehicles	765
West Virginia	Bituminous Coal	669
Indiana	Distilled or Blended Liquors	386
Indiana	Soybean Oil or By-products	382
Ohio	Motor Vehicles	350
Kentucky	Bituminous Coal	296
Texas	Misc Industrial Organic Chemicals	288
Ohio	Bread or Other Bakery Prod	261

Table 24: North Carolina Inbound Rail Flows by Top Origin and Commodity (Value), 2011

Table 25 summarizes the forecasted top-ranked combinations of destination and commodity for 2040. The tonnage of Appalachian coal shipped from West Virginia, Virginia and Kentucky falls significantly, as these states are facing declining reserves, higher production costs and competition from other coal mines and the increasing availability of natural gas. Grain and soybeans remain high on the list in 2040, as need for agricultural commodities grow due to growing local consumption. Plastic mater or synthetic fibers from Louisiana were not on the top ten 2011 list, but their importance grows significantly in 2040, as manufacturing of plastics and packaging materials in North Carolina increases. Forest materials inbound flows from South Carolina grow, as the need for wood for furniture manufacturing and/or wood pellets for exports increases.

Origin State	Commodity	Tons (000s)
West Virginia	Bituminous Coal	13,501
Kentucky	Bituminous Coal	5,976
Illinois	Misc Industrial Organic Chemicals	1,889
Ohio	Grain	1,845
Louisiana	Plastic Mater or Synth Fibres	1,697
Indiana	Soybean Oil or By-products	1,282
Michigan	Grain	1,254
Virginia	Broken Stone or Riprap	1,237
South Carolina	Portland Cement	1,186
South Carolina	Primary Forest Materials	1,151

Table 25: North Carolina Inbound Rail Flows by Top Origin and Commodity (Tonnage), 2040

Table 26 summarizes the top-ranked combinations of destination and commodity for 2040 by value, illustrating the increases importance of chemical and motor vehicle freight as a share of total inbound rail. Top origins for these products in 2011 further solidify their positions in 2040. Quebec and Louisiana enter the top ten on account of significant increases in chemicals shipments and motor vehicles to North Carolina. Soybeans oils retain their importance in 2040, as need for soybeans oil for local consumption grows. Soybean oil also is used as input in the biofuels industry.

Origin State	Commodity	$ Millions
Louisiana	Plastic Mater or Synth Fibers	3,675
Illinois	Misc Industrial Organic Chemicals	2,352
Michigan	Motor Vehicles	1,231
Quebec (Canada)	Motor Vehicles	689
Indiana	Soybean Oil or By-products	641
Louisiana	Misc Industrial Organic Chemicals	589
Ohio	Bituminous Coal	563
West Virginia	Chemical Preparations	493
Texas	Misc Industrial Organic Chemicals	484
Indiana	Motor Vehicles	384

Table 26: North Carolina Inbound Rail Flows by Top Origin and Commodity (Value), 2040

The dynamics of chemicals transportation emerging from this analysis is eminent. In the case of rail, reported inbound chemicals rail shipments are double those of outbound shipments; however, outbound chemicals volumes also move on truck and waterborne freight modes. In the case of rail, reported inbound chemicals rail shipments are double those of outbound shipments; however, outbound chemicals volumes also move on truck and waterborne freight modes. Thus, North Carolina sits in the middle of a dynamic supply chain for chemicals, especially plastics, bringing in many items for local manufacturing and/or trans-shipment, while also manufacturing some chemical products locally for both consumption and export to other regions.

North Carolina Rail Intermodal (Container) Traffic

This section analyzes intermodal, or container, goods movement separately for other rail commodity flows. Intermodal traffic is an important additional source of rail freight movement into, out of, and through North Carolina. Moreover, it represents a significant source of long-term rail freight growth. Absent further capital investment and/or improvements in rail infrastructure management and operations, growth in container traffic could lead to increased network congestion and bottlenecks.

Table 27 illustrates the current and long-term forecasts of intermodal rail for North Carolina. As the table suggests, container tonnage is forecasted to grow at approximately 2% per year over the next 24 years. Over half of this will be through traffic, although inbound and outbound traffic will grow faster.

	2011	2012	2014	2015	2020	2025	2030	2035	2040	CAGR
Outbound	1,115	1,136	1,212	1,257	1,401	1,530	1,670	1,840	2,059	2.1%
Inbound	1,408	1,460	1,525	1,580	1,750	1,908	2,053	2,218	2,449	1.9%
Through	2,990	3,047	3,213	3,330	3,680	3,986	4,262	4,560	4,949	1.8%
Total	5,513	5,643	5,950	6,166	6,831	7,424	7,984	8,618	9,457	1.9%

Table 27: North Carolina Intermodal Rail Flows, 2011-2040 (Thousand Tons)

The importance of rail intermodal container traffic takes on even greater economic significance when viewed through the prism of value. Table 28 shows the current and forecasted values of rail intermodal goods moving to, from, and through North Carolina. That containers tend to carry higher-value consumer and business products is evidenced by the fact that the total value of intermodal rail goods associated with North Carolina will approximately equal that of all other rail freight combined by 2040 (see Table 2 for comparison).

	2011	2012	2014	2015	2020	2025	2030	2035	2040	CAGR
Outbound	5,706	5,786	6,276	6,494	7,481	8,401	9,495	10,910	12,538	2.8%
Inbound	6,776	6,993	7,322	7,596	8,448	9,298	10,138	11,313	12,795	2.2%
Through	11,854	12,138	12,795	13,246	14,612	15,752	16,711	17,731	19,082	1.7%
Total	24,336	24,918	26,393	27,336	30,541	33,451	36,344	39,954	44,415	2.1%

Table 28: North Carolina Intermodal Rail Flows, 2011-2040 ($ Millions)

For inbound and outbound traffic, much of this container freight volume moves from North Carolina to the West Coast and Midwestern states and from states south of North Carolina. Los Angeles and Chicago are the highest-volume destinations outbound in terms of weight and value. Other major cities in the Northeast and Southeast are also important. Florida tops the list in terms of inbound intermodal traffic, followed by Chicago and Louisiana. This should not be surprising, as these regions represent major international port and trade gateways. For through traffic, however, the north-south connection takes on greater importance with North Carolina being a conduit linking New York, New Jersey, Florida and Georgia.

Table 29 and Figure 8 summarize the top destinations for outbound intermodal freight in 2011.

Destination State	Tons (000s)		Destination State	$ Millions
Illinois	296		California	1,839
California	249		Illinois	1,469
Georgia	193		Georgia	571
Tennessee	112		Tennessee	392
New Jersey	51		Florida	307
Florida	45		New Jersey	256
Louisiana	31		Pennsylvania	218
South Carolina	28		Oregon	135
Oregon	19		Louisiana	129
Oklahoma	16		Washington	99

Table 29: North Carolina Outbound Intermodal Rail Flows by Top Destination, 2011

Combined, Illinois and California (principally, Chicago and Los Angeles, respectively) receive around 50% of the intermodal freight originating or trans-shipped through North Carolina whether measured by weight or value. Eastbound and westbound destinations are well-represented among the top ten with a slightly higher proportion by value of outbound intermodal freight headed west of North Carolina. Other important destinations when measured by container weight and value are Tennessee, Georgia, New Jersey and Florida (the principal cities of interest are Memphis, Atlanta, the NS Croxton Intermodal terminal located in New Jersey and Miami).

Figure 8: North Carolina Intermodal Rail Outbound Flows, 2011

Table 30 presents forecasts that the top intermodal outbound freight destinations in 2040, suggesting a similar geographic distribution as in 2011. This also illustrated in Figure 9. Intermodal freight will be slightly less concentrated among the top ten destinations in 2040. The top destinations will receive 91% of the total tonnage and 95% of total freight value compared with 93% and 95%, respectively, in 2011.

Destination State	Tons (000s)		Destination State	$ Millions
Illinois	465		California	4,440
California	430		Illinois	2,505
Georgia	382		Pennsylvania	1,186
Tennessee	234		Georgia	1,058
New Jersey	100		Florida	736
Florida	86		Tennessee	698
Louisiana	67		New Jersey	508
South Carolina	50		Oregon	275
Alberta (Canada)	34		Louisiana	263
Oklahoma	33		Washington	228

Table 30: North Carolina Outbound Intermodal Rail Flows by Top Destination, 2040

Figure 9: North Carolina Outbound Intermodal Rail Flows, 2040

Many of the top outbound intermodal freight destinations are also top origination points for inbound intermodal containers bound for North Carolina, as illustrated in Figure 10 and Table 31. However, Florida, in particular Miami and Ft. Lauderdale, plays a much larger role, accounting for more than 25% of total inbound intermodal freight weight and over 23% of total value. Illinois, Louisiana, California and Texas (principally, Chicago, New Orleans, Los Angeles and Dallas) account for more than 50% of total weight and value.

Origin State	Tons (000s)		Origin State	$ Millions
Florida	347		Florida	1,639
Illinois	253		Illinois	1,127
Louisiana	201		California	938
California	136		Louisiana	868
Texas	136		Texas	662
Georgia	120		Georgia	521
Tennessee	89		Tennessee	435
New Jersey	36		Kentucky	188
Pennsylvania	29		Oklahoma	108
Utah	11		New Jersey	94

Table 31: North Carolina Inbound Intermodal Rail Flows by Top Origin, 2011

Figure 10: North Carolina Intermodal Rail Inbound Flows, 2011

Table 32 illustrates similar trends for forecasted freight values with almost the same origins for intermodal traffic with Florida still dominating intermodal traffic by weight and value in 2040. Similar to the outbound intermodal freight forecasts, the total tonnage and value of inbound freight will become more concentrated among the top origins. Figure 11 illustrates the geographic significance of the Midwest, the South and Gulf Coast states.

Origin State	Tons (000s)		Origin State	$ Millions
Florida	584		Florida	2,702
Illinois	398		Illinois	1,839
Louisiana	354		California	1,479
California	245		Louisiana	1,448
Texas	237		Texas	1,175
Georgia	211		Kentucky	1,018
Tennessee	152		Georgia	895
New Jersey	89		Tennessee	737
Pennsylvania	58		Oklahoma	570
Oklahoma	18		Alabama	353

Table 32: North Carolina Inbound Intermodal Rail Flows by Top Origin, 2040

Figure 11: North Carolina Inbound Intermodal Rail Flows, 2040

In contrast to the trends in outbound and inbound intermodal traffic patterns, container through traffic is dominated by North-South and South-North movement of goods between primarily New Jersey to Miami or Jacksonville or from Atlanta via Harrisburg (the location of intermodal rail terminals) to New Jersey. Figure 12 vividly illustrates this trend and Table 33 presents more detailed data.

Figure 12: North Carolina Intermodal Rail Through Flows, 2011

A large share of the intermodal rail freight passing through North Carolina either originates in or is destined for Atlanta, Harrisburg and parts of New Jersey. Flows between Atlanta and Harrisburg alone account for 28% of total container tonnage and 26% of total freight by value. Miami, Jacksonville, Ft. Lauderdale and Baltimore are additional origins and destinations for freight transiting through North Carolina.

Origin	Destination	Tons (000s)	Origin	Destination	$ Millions
Georgia	Pennsylvania	441	Georgia	Pennsylvania	1,926
Pennsylvania	Georgia	393	New Jersey	Florida	1,638
Georgia	New Jersey	345	Georgia	New Jersey	1,395
New Jersey	Florida	341	Pennsylvania	Georgia	1,192
Florida	New Jersey	220	Florida	New Jersey	882
Pennsylvania	Florida	165	Pennsylvania	Florida	714
New Jersey	Georgia	152	Maryland	Florida	644
Maryland	Florida	140	New Jersey	Georgia	523
Florida	Pennsylvania	108	New York	Florida	336
Ohio	Virginia	80	Illinois	Virginia	325

Table 33: North Carolina Intermodal Through Traffic Flows by Top O/D Pairs, 2011

Table 34 presents forecasts for rail intermodal through traffic in 2040. The overall pattern of North-to-South and South-to-North flows is expected to continue as illustrated in Figure 13, with traffic between Atlanta and Harrisburg and New Jersey expected to dominate. By 2040, New Jersey to Florida gains in importance as it moves to second place in terms of tons, and first place in terms of value, due to growth in CSX and NS intermodal traffic and facilities.

Origin	Destination	Tons (000s)	Origin	Destination	$ Millions
Georgia	Pennsylvania	699	New Jersey	Florida	3,088
Pennsylvania	Georgia	654	Georgia	Pennsylvania	3,064
New Jersey	Florida	651	Pennsylvania	Georgia	1,951
Georgia	New Jersey	502	Georgia	New Jersey	1,946
Florida	New Jersey	358	Florida	New Jersey	1,366
New Jersey	Georgia	279	New Jersey	Georgia	936
Pennsylvania	Florida	234	Pennsylvania	Florida	833
Florida	Pennsylvania	194	Ohio	Florida	704
Ohio	Virginia	160	Maryland	Florida	671
Ohio	Florida	149	Illinois	Virginia	516

Table 34: North Carolina Intermodal Through Traffic Flows by Top O/D Pairs, 2040

Figure 13: North Carolina Intermodal Through Traffic Flows, 2040

Summary of North Carolina Rail Freight

Having reviewed the long-term rail forecasts for the North Carolina region, several key trends emerge. Key observations include.

- Inbound traffic makes up the largest share of rail freight movement within the North Carolina, accounting for almost two-thirds of non-container tonnage.
- Outbound traffic is expected to grow much faster than inbound non-container traffic, and only slightly faster than container inbound traffic over the next twenty-four years. Outbound tonnage will grow by 2.3% per year between 2011 and 2040 (total value will grow by 2.1%); while inbound tonnage remains relatively flat. Container outbound tons will grow faster than inbound tons, especially in terms of value at 2.8% compared to 2.2% for inbound value. This is due to significant amounts of heavy weight coal moved in 2011, which is forecasted to decline significantly by 2040.
- Through traffic makes up about third of non-container traffic, both in terms of tons and value, about 50% of container traffic. Through traffic will grow at about 1.8% both in terms of tons and value for container and 0.9% in terms of tons and 1.8% in terms of value for non-container traffic. Most of the container traffic is north-south traffic or south-north traffic.
- Illinois, Louisiana and Canada grow in importance for plastics and chemical products shipped to support a growing plastics and packaging industry.
- North Carolina rail freight will experience increased rail flows to South Carolina and Georgia. Some of these flows, such as plastics, dyes, metal scrap and broken stone relate to increased production in North Carolina.
- With the exception of coal, most other inbound non-container traffic originates from nearby states in the Northeast and Southern states, while non-container outbound cargo follows a different pattern. More proximate States are still among the most important destinations, especially South Carolina, Georgia and Virginia, but other large international trade centers such as Chicago, ports in Virginia, and Midwest states receive substantial flows originating in North Carolina. The top outbound goods, respectively to these destinations, are metal scrap, plastics, chemicals, dyes and wood products.
- Chemicals constitute an important and share of non-container freight, especially when measured by value (accounting for approximately 10% of the total value). North Carolina plays an important role in chemical supply chains as a consumer of chemical feedstocks as manufacturing inputs (e.g., plastics, packaging and fertilizer).
- North Carolina can also explore opportunities for expanding high-value chemicals manufacturing. Currently there is a strong base in North Carolina for plastics and rigid packaging manufacturing. Due to natural gas developments in Marcellus shale, especially in very active area at the southern tip of the area closest to West Virginia and developments in Utica markets, North Carolina will enjoy benefits of cheaper natural gas in close proximity. This will help fuel up the development in chemical manufacturing with the low cost of operating facilities as natural gas prices are currently low.

- Within the context of declining U.S. coal demand and natural gas replacement, it is unlikely that inbound and outbound coal shipments will grow substantially, if at all. North Carolina has depended a lot on coal-fired generation for its electricity, but due to dispatch economics and environmental regulations, many big units will retire and will be replaced mostly by gas. Thus, new gas-fired plants will open in North Carolina. Moving coal to plants – will be negatively impacted. Not all coal plants will retire, and we are currently forecasting a drop in total coal shipments on rail at 1 % CAGR up to 2040.
- Shale formations are most likely present in North Carolina's Deep River Basin, a 150 mile long fault in central North Carolina. Legislation was passed in North Carolina in 2012 to allow hydraulic fracturing. Currently there is no available commercial investment and drilling most likely won't happen 5 to 10 years from now. However, the Marcellus Shale's southern tip extends deep into West Virginia. Potential exists with further investments in rail and pipelines to move Marcellus/Utica gas to markets in the Southeast. A lot of activity now and in the near future will be centered on upgrading/extending/reversing interstate gas pipelines to allow north-to-south flows. Several extensions are targeting North Carolina in particular.
- Scrap metal rail flows in North Carolina are increasing. This is mainly due to increased need for scrap metals to feed steel production. Nucor has its corporate office in Charlotte and three other locations in North Carolina. Other locations with scrap metal concentrations in the state include Wilmington and Raleigh. Increasing demand for scrap metal is occurring in the vicinity of auto manufacturing, principally in the Southeast and Midwest. Scrap exports to Asia will account for smaller share of overall outbound flows. However, Metal Scrap rail flows are forecast to grow at 5.5% CAGR from 2011 to 2040.
- Many of the recent investments in wood pellet capacity in the U.S. have occurred along the Atlantic coast, with Enviva and Fram Renewables expanding production in North Carolina, Georgia and Virginia. Wood pellet industry expansion is primarily driven by demand for biomass in Europe. The demand is driven based on the need to find alternatives to coal, due to strict environmental regulations in Europe. In 2013 Europe imported about 3 million tons of wood pellets, and by 2020 that number is expected to grow rapidly to 20 million tons. Wood pellet production levels are, however, subject to a range of external risks such as raw material supply. Wood pellets are closely interlinked with other industries, as they are produced from sawmill and forestry residue—a by-product of other non-energy markets and supply chains. For example, US wood pellet production is strongly led by the country's demand for timber, which is subject to construction industry activity. Enviva and International Wood Fuel are expanding wood pellet production terminal capacity at the ports of Wilmington and Morehead City. Wood pellet rail flows in North Carolina are expected to grow at 2.1% CAGR from 2011 to 2040.
- Auto manufacturing is currently growing in South Carolina, Georgia, Alabama and other southern states. Currently North Carolina is not very active in the auto manufacturing industry, as manufacturers are choosing to locate production in states with better tax rates and incentives.
- Development of intermodal traffic in North Carolina will more than likely intensify with the development of the Crescent Corridor. The Crescent Corridor is more than a $2.5 billion rail

infrastructure project that spans 11 states (Figure 14). It was proposed by Norfolk Southern (NS) in 2007, as a means of reducing truck traffic on I-81. In its initial stages NS had to build intermodal terminals along the corridor so that it can handle increases in intermodal traffic. Charlotte Regional Intermodal Facility was built in 2014, and it is capable of handling 200,000 lifts per year.

Figure 14: Crescent Corridor

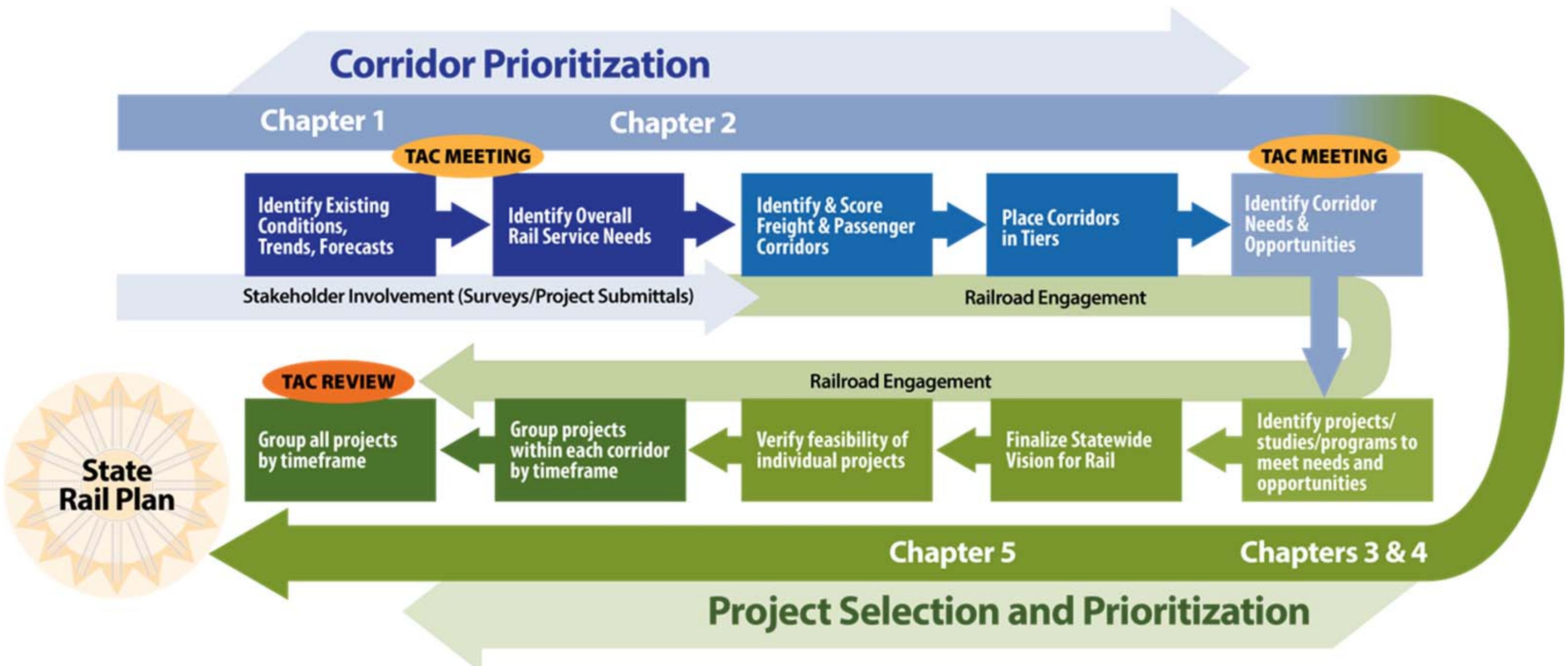
Charlotte is a key hub on the Norfolk Southern intermodal system. The Crescent Corridor provides benefits to North Carolina, as it helps with job creation, reduces long-haul truck movements, and reduces congestion on the highways. As Norfolk Southern invests more money into the Crescent Corridor, with rehabilitation of rail tracks to achieve faster delivery times and improve capacity and run more efficient trains, North Carolina will experience growth in intermodal traffic. Currently intermodal traffic is forecasted to grow at 2% CAGR from 2011 to 2040.

Appendix D
Prioritization Methodology

INTRODUCTION

This Appendix provides a working documentation of the methods used to evaluate and prioritize the various corridors and projects as part of the North Carolina Comprehensive State Rail Plan (State Rail Plan). The information described here was used to evaluate corridors and projects and the results included in Chapters 2 through 5 of the State Rail Plan.

The process consists of five steps for corridor evaluation/prioritization and five steps to evaluate and prioritize projects to meet the needs identified in the corridors (See Figure below). This Appendix describes the data used for **the first four** steps shown. The remaining six steps are described in Chapters 2 through 5 of the State Rail Plan.



IDENTIFY EXISITNG CONDITIONS, TRENDS, FORECASTS AND IDENTIFY OVERALL RAIL SERVICE NEEDS

The identification of existing conditions, trends, forecasts, and the identification of rail service needs was completed using data provided by the North Carolina Department of Transportation (NCDOT) Rail Division, IHS Global, the Freight Analysis Framework data from the US Department of Transportation, Amtrak, Norfolk Southern (NS) and CSX Transportation (CSXT), various short line railroads, and others. The details of this analysis are provided in Chapters 1 and 2 of the State Rail Plan.

IDENTIFY AND SCORE CORRIDORS

After evaluating the existing conditions data, and trends for rail, and developing the general service needs for commuter, passenger, and freight rail, the State Rail Plan team conducted a more specific evaluation and analysis of the various rail corridors in the state.

The first step in this corridor prioritization process was to define the various rail corridors across North Carolina. The corridors were defined by reviewing their ownership and end points of freight services within the state. Short lines were not included in the evaluation unless they were known to be under consideration for new passenger services or were the primary connection to a port or intermodal facility.

The corridor prioritization program serves two purposes. First, it allows the rail needs to be further refined and spatially defined within corridors. For example, serving emerging freight markets has been identified as a need, and the corridor prioritization process accounts for which emerging markets are most significant for the state and are served by specific corridors. Secondly, the corridor prioritization process helps define more specific programs and projects that are opportunities to meet those needs. For example, once key passenger and commuter rail corridors are identified, specific studies or improvement programs for those corridors are identified and evaluated in Chapter 3. Table D-1 lists the corridors evaluated. The corridors are also shown in Figure D-1.

Each of the rail corridors were analyzed using a variety of data to determine the overall significance of their needs for both freight and passenger service. The data used were based upon the FRA State Rail Plan Guidance and upon readily available data that could help differentiate conditions along each corridor. Different data were used to prioritize freight and passenger corridors, as seen in Table D-2. A relative score was assigned for each corridor within each category, where 0 represented the lowest score and 5 represented the highest score. The scores help to show the importance of the freight or passenger corridor to the State.

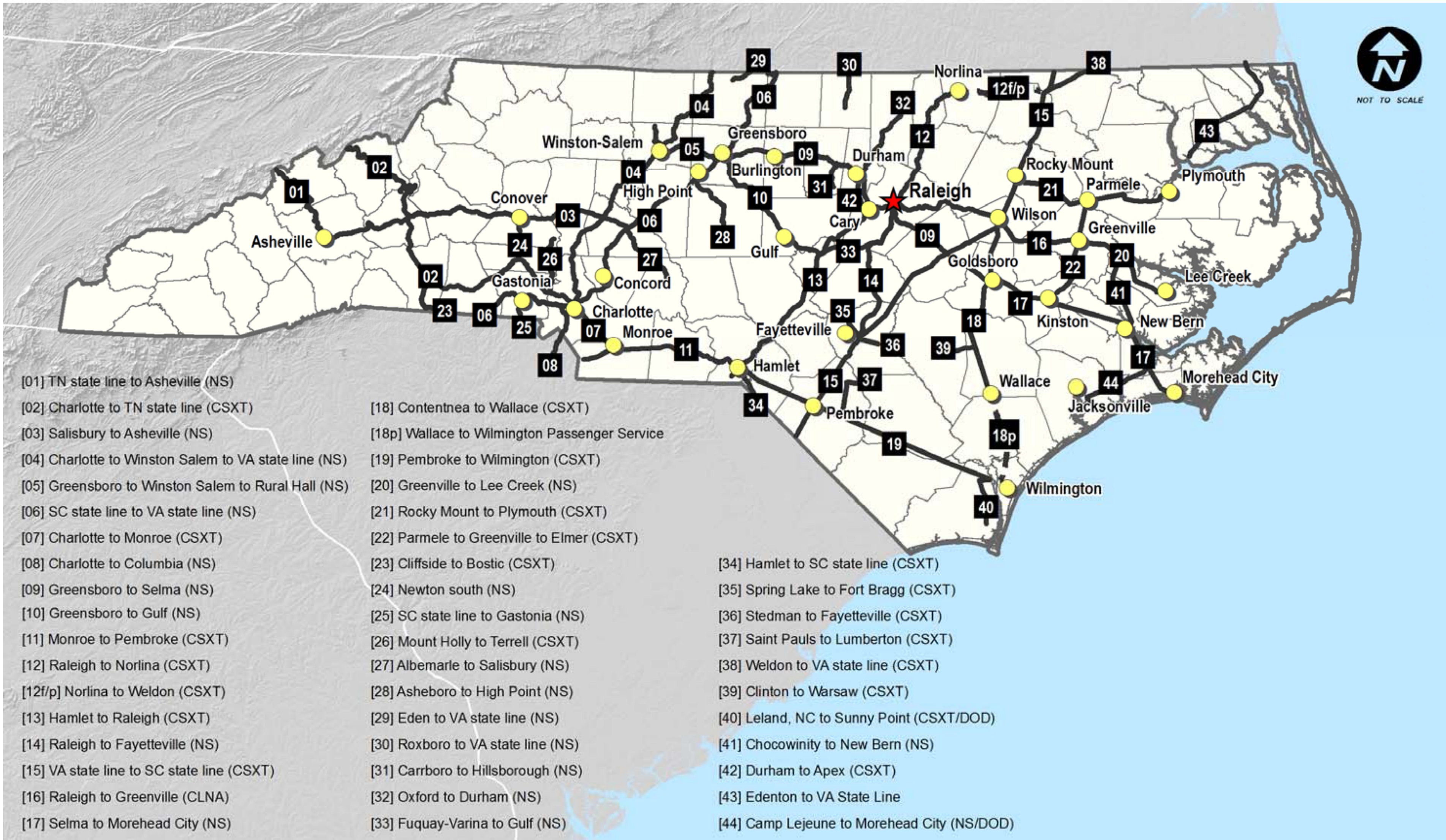


Figure D-1 North Carolina Rail Corridors

Table D-1 Rail Corridors in North Carolina

Corridor	Route	Railroad	Parallel Highway Route	Length (miles)
01	Tennessee state line to Asheville	NS	I-40	46
02	Tennessee state line to Charlotte	CSXT	I-85, US 221, US 321	173
03	Asheville to Salisbury	NS	I-40, US 70	148
04	Charlotte to Winston-Salem to VA state line	NS	I-40, I-77, US 311	129
05	Rural Hall to Winston-Salem to Greensboro	NS	I-40, US 52	39
06	SC state line to VA state line	NCRR/NS*	I-85, US 29	188
07	Charlotte to Monroe	CSXT	US 74, I-277	29
08	SC state line (from Columbia) to Charlotte	NS	I-77	25
09	Greensboro to Selma	NCRR/NS*	I-40, US 70	115
10	Greensboro to Gulf (Sanford)	NS	US 421	43
11	Monroe to Pembroke	CSXT	US 74	84
12	Raleigh to Norlina	CSXT	US 1	58
12f/p	Norlina to Weldon	CSXT	US 158	33
13	SC state line to Hamlet to Raleigh	CSXT	US 1, I-440, NC 177	102
14	Raleigh to Fayetteville	NS	US 401	63
15	SC state line to VA state line	CSXT	I-95	182
16	Raleigh to Greenville	CLNA	US 64, US 264	81
17	Selma to Morehead City	NCRR/NS*	US 70	113
18p	Contentnea (Wilson) to Wallace	CSXT	US 117, US 13	105
19	Pembroke to Wilmington	CSXT	US 74	73
20	Greenville to Lee Creek	NS	NC 33	45
21	Rocky Mount to Plymouth	CSXT	US 13, US 64	65
22	Parmele to Greenville to Elmer	CSXT	NC 11, US 13	39
23	Cliffside to Bostic	CSXT	US 221	19
24	Newton south	NS	US 321	3
25	SC state line to Gastonia	NS	US 29, US 321	8
26	Mount Holly to Terrell	CSXT	I-485, I-77, NC 150, NC 27	24
27	Albemarle to Salisbury	NS	US 29, US 52	29
28	Asheboro to High Point	NS	I-73, US 220, US 311, US 64	27
29	Eden to VA state line	NS	NC 14, NC 49, S 87, US 220, US 58	12
30	Roxboro to VA state line	NS	US 158, US 501	14
31	Carrboro to Hillsborough	NS	I-85, US 15, US 501	11
32	Oxford to Durham	NS	I-85, US 15, US 70	31
33	Fuquay Varina to Gulf	NS	NC 55, US 1, US 421	38
34	Hamlet to SC state line	CSXT	NC 79, US 74	11
35	Spring Lake to Fort Bragg	CSXT	NC 87	7
36	Stedman to Fayetteville	CSXT	NC 24	8
37	Saint Pauls to Lumberton	CSXT	I-95, US 301, NC 87	22
38	Weldon to VA state line	CSXT	NC 35, US 158	18
39	Clinton to Warsaw	CSXT	NC 24	10
40	Leland NC to Sunny Point	CSXT/DOD	US 17, US 421, US 74	22
41	Chocowinity to New Bern	NS	US 17	32
42	Durham to Apex	CSXT	I-40, NC 147, NC 55, US 1	20
43	Edenton to VA state line	C&A	US 17, NC 168	56
44	Camp Lejeune to Morehead City	NS	US 70, NC 24	29

*NCRR owns the corridor from Charlotte to Greensboro to Morehead City, with operating rights leased to NS. NS owns the Mainline corridor south of Charlotte and north of Greensboro.

Table D-2 Data Used to Prioritize Corridor Needs

Freight Corridors	Passenger Corridors
Current Data	***Current Data***
• Truck volumes on parallel highways	• Population within 10 and 30 miles of corridor
• Train volumes on corridor – inbound, outbound and through	• Volumes on parallel highways
• Commodities important to NC economy	• Congestion on parallel highways
• Connections to intermodal facilities, ports, major transloads	• Connections to major activity centers
• Connections to major activity centers	• Passenger trains volumes in corridor
• Location within Strategic Corridor network (STRACNET)	
Future Data	***Future Data***
• 2040 truck volumes on parallel highways	• 2030 population within 30 miles of corridor
• Future train volumes on corridor – inbound, outbound and through	• 2040 volumes on parallel highways
• Emerging commodities important to NC economy	• 2040 congestion on parallel highways
	• Inclusion along federally-designated Southeast Corridor

The following describes the methods used to select, analyze and normalize the data used to prioritize the corridors.

Census Criteria

Existing Population (10 mi): Existing populations within a 10 mile buffer of the corridors were averaged based on 2010 Census tract and block group populations; census tract boundaries were used to calculate the population for corridors with buffers located within Virginia, South Carolina, and Tennessee, while block group boundaries were used to calculate the population for corridor buffers located within North Carolina. The values of each corridor were then compared relatively and assigned a value on a 1-5 point scale. Source: 2010 US Census TIGER/Line GIS Shapefile data; 2010 U.S. Census, census track and block group data.

Existing Population (30 mi): Existing populations within a 30 mile buffer of the corridors were averaged based on 2010 Census tract and block group populations; census tract boundaries were used to calculate the population for corridors with buffers located within Virginia, South Carolina, and Tennessee, while block group boundaries were used to calculate the population for corridor buffers located within North Carolina. The values of each corridor were then compared relatively and assigned a value on a 1-5 point scale. Source: 2010 US Census TIGER/Line GIS Shapefile data; 2010 U.S. Census, census track and block group data.

Projected Population (30 mi): Projected populations within a 30 mile buffer of the corridors were averaged based on 2030 county population projections. The values of each corridor were then compared relatively and assigned a value on a 1-5 point scale. Source: North Carolina Office of State and Budget Management, South Carolina Budget and Control Board, University of Virginia Weldon Cooper Center for Public Service, Tennessee Advisory Commission on Intergovernmental Relations.

For calculating normalized population along a rail corridor, the following methods were used.

Source layer – Existing population: 2010 US Census Tract and Block Group TIGER/Line GIS shapefile

Source layer – Projected population: 2030 County Population Projections, North Carolina Office of State and Budget Management, South Carolina Budget and Control Board, University of Virginia Weldon Cooper Center for Public Service, Tennessee Advisory Commission on Intergovernmental Relations

Process 1 - Selection: Compare the 2010 Census Tract (Virginia, South Carolina, and Tennessee; block group data for a GIS application was not available for these states) and 2010 Census Block Group (North Carolina) data to the appropriate rail corridor. Select all census tract/block groups that intersect with each rail corridor. Calculate the total area and the total population for the selected boundaries. Clip the boundaries with each rail corridor. Calculate the total area and the total population for the clipped boundaries. Calculate what percent the area of the clipped boundary is of the total boundary. Take the total population of the corridor and multiply by the percent of clipped boundary. This process is also applied to the projected population calculation.

Process 2 - Normalization: Divide the population of the corridor within the clipped block groups by the total length of the corridor. This process is also applied to the projected population calculation.

Vehicular Traffic Criteria

2007 AADT: The 2007 Annual Average Daily Traffic (AADT) volumes were determined for highway routes parallel to each rail corridor. The volumes of each route were relatively compared and assigned a value on a 1-5 point scale. Source: 2007 AADT volumes, Freight Analysis Framework Network (FAF) data set, 2014.

2040 AADT: The 2040 AADT volumes were determined for highway routes parallel to each rail corridor. The volumes of each route were relatively compared and assigned a value on a 1-5 point scale. Source: 2040 AADT volumes, FAF data set, 2014

2007 V/C: The 2007 Volume to Capacity (V/C) ratios were determined for highway routes parallel to each rail corridor. The volumes of each route were relatively compared and assigned a value on a 1-5 point scale. Source: 2007 V/C volumes, FAF data set, 2014.

2040 V/C: The 2040 V/C ratios were determined for highway routes parallel to each rail corridor. The volumes of each route were relatively compared and assigned a value on a 1-5 point scale. Source: 2040 V/C volumes, FAF data set, 2014.

2007 Trucks: The 2007 Total Truck Volumes were determined for highway routes parallel to each rail corridor. The volumes of each route were relatively compared and assigned a value on a 1-5 point scale. Source: 2007 Total Truck Volumes, FAF data set, 2014.

2040 Trucks: The 2040 Total Truck Volumes were determined for highway routes parallel to each rail corridor. The volumes of each route were relatively compared and assigned a value on a 1-5 point scale. Source: 2040 Total Truck Volumes, FAF data set, 2014.

For calculating normalized traffic criteria along a rail corridor, the following methods were used.

Source layer: FHWA FAF road network.

Process 1 - Selection: Compare the FAF road network to the appropriate rail corridor. Choose the parallel roadway route that approximates the same origin and destination as the rail corridor. Ideally, use primary routes first (interstates, then US routes, then other routes). Select the routes and save them as a shapefile or feature class, associating the name with the rail corridor number.

Process 2 - Normalization: The normalization or average statistic must be calculated for 2007 AADT, 2040 AADT, 2007 V/C ratio, 2040 V/C ratio, 2007 AADTT (trucks), 2040 AADTT. To normalize, the value of each statistic must be multiplied by the segment length; the sum of these must be divided by the total road length. For example:

[AADT071 X Segment Length1 + AADT072 X Segment Length2 + AADT073 X Segment Length3]/Total Road Length

Freight Rail Volume Criteria

2011 IHS_Inbound: The 2011 North Carolina inbound freight volumes were determined for each rail corridor. The volumes of each corridor were relatively compared and assigned a value on a 1-5 point scale. Source: IHS_Global freight volumes for North Carolina, 2011.

2011 IHS_Outbound: The 2011 North Carolina outbound freight volumes were determined for each rail corridor. The volumes of each corridor were relatively compared and assigned a value on a 1-5 point scale. Source: IHS_Global freight volumes for North Carolina, 2011.

2011 IHS_Through: The 2011 North Carolina through freight volumes were determined for each rail corridor. The volumes of each corridor were relatively compared and assigned a value on a 1-5 point scale. Source: IHS_Global freight volumes for North Carolina, 2011.

2035 IHS_Inbound: The 2035 North Carolina inbound freight volumes were determined for each rail corridor. The volumes of each corridor were relatively compared and assigned a value on a 1-5 point scale. Source: IHS_Global freight volumes for North Carolina, 2035.

2035 IHS_Outbound: The 2035 North Carolina outbound freight volumes were determined for each rail corridor. The volumes of each corridor were relatively compared and assigned a value on a 1-5 point scale. Source: IHS_Global freight volumes for North Carolina, 2035.

2035 IHS_Through: The 2035 North Carolina through freight volumes were determined for each rail corridor. The volumes of each corridor were relatively compared and assigned a value on a 1-5 point scale. Source: IHS_Global freight volumes for North Carolina, 2035.

For calculating normalized freight volumes criteria along a rail corridor, the following methods were used.

Source layer: IHS_Global Freight data.

Note: A .csv file must be joined to this shapefile to distinguish between INGOING, OUTGOING, and THROUGH freight for years 2011 and 2035.

Process 1 - Selection: Compare the freight layer to the appropriate rail corridor. Choose the freight lines that closest approximate the rail corridor. (It is notable that the 2035 outgoing and ingoing layers are the most comprehensive sets, and with careful observation, may be used to select the other data sets, rather than repeating the manual line selection.) Select the freight routes and save them as a shapefile or feature class, associating the name with the rail corridor number.

Process 2 - Normalization: The normalization or average statistic must be calculated for 2011 and 2035 freight volumes to include INGOING, OUTGOING, and THROUGH networks (6 total data sets). To normalize, the value of each statistic must be multiplied by the segment length; the sum of these must be divided by the total rail length. For example:

[Volume1 X Segment Length1 + Volume2 X Segment Length2 + Volume3 X Segment Length3]/Total Rail Length

Passenger Rail Criteria

Existing Passenger Service: Those corridors with existing passenger service on a majority of the corridor received points. Motor coach or van services were assigned 1 point; one daily round trip train, 2 points; two daily round trip trains, 3 points, three daily round trip trains, 4 points; four or more daily round trip trains, 5 points. Source: Amtrak and NCDOT.

Southeast Corridor: The corridors were compared against the maps for the federally-designated Southeast Corridor. Those corridors that are part of the Southeast Corridor were assigned 2.5 points. Any corridor that is along the federally-designated Southeast Corridor is also placed in the top passenger tier. Source: Southeast High Speed Rail Corridor map, NCDOT.

Facilities and Commodities Criteria

STRACNET: The rail corridors were compared to the Strategic Rail Corridor Network (STRACNET). Corridors identified as part of the STRACNET were assigned a value of 2.5; corridors that are not part of the STRACNET were assigned a value of 0. Source: STRACNET, globalsecurity.org, 2014.

Intermodal Corridor: The rail corridors were compared to the Norfolk Southern and CSX Transportation Intermodal Corridors (Class I intermodal network). Corridors identified as part of the Class I intermodal network were assigned a value of 2.5; corridors that are not part of the Class I intermodal network were assigned a value of 0. Source: Intermodal Networks, NS & CSXT, 2014.

Waybill/IHS_Global Commodities: Principle On-Line Commodities were identified along each rail corridor. Each commodity identified on a corridor, and falling within Agricultural, Chemical, Manufacturing, and Plastics categories, was assigned 1 point. Additionally, corridors identified within close proximity to Natural Gas/Fracking last mile locations were assigned 2.5 points. The total points for each corridor were relatively compared and assigned a value on a 1-5 point scale. Source: 2011 Principal On-Line Commodities, Rail Corridor Summary (2001-2011), NC Waybill.

Facilities: Intermodal facilities (intermodals), transload facilities (transloads), and rail yards (yards) were identified on each rail corridor. The total intermodals, transloads, and yards were assigned multipliers of 50, 10, and 10 respectively (thus weighing intermodal facilities the highest). For each corridor, the weighted sums of all facilities were relatively compared and assigned a value on a 1-5 point scale. Source: NCDOT Rail Facility Shapefile, NCDOT Rail Division Data, 2014.

Activity Centers: Statewide and regional activity centers were identified on each rail corridor. The total statewide and regional centers were assigned a multiplier of 2 and 1 respectively (thus weighing statewide centers more heavily). For each corridor, the weighted sums of all centers were relatively compared and assigned a value on a 1-5 point scale. Source: 2011 Seven Portals Study, NCDOT.

Corridor Tier Scoring and Rankings

As described above, for each criterion, a point value from 0 through 5 was assigned to each corridor.

The corridors were scored for freight and passenger existing and future services using these criteria.

Existing Freight Corridor Rankings: STRACNET, Intermodal Corridor, Waybill/IHS_Global Commodities, Facilities, Activity Centers, Truck Volumes 2007, IHS_Global Inbound 2011, IHS_Global Outbound 2011, IHS_Global Through 2011.

Future Freight Corridor Rankings: STRACNET, Intermodal Corridor, Waybill/IHS_Global Commodities, Facilities, Activity Centers, Truck Volumes 2040, IHS_Global Inbound 2035, IHS_Global Outbound 2035, IHS_Global Through 2035.

Existing Passenger Corridor Rankings: Existing Population 10 mi, Existing Population 30 mi, AADT 2007, V/C 2007, Activity Centers, Existing Passenger Rail service.

Future Passenger Corridor Rankings: Projected Population 30 mi, AADT 2040, V/C 2040, Activity Centers, Southeast Corridor.

Tables at the end of this Appendix show the numerical score results for all corridors.

4. TIER CORRIDORS

After the corridors were scored, the State Rail Plan team combined the existing and future rankings since there were only minor differences between the two.

For both freight and passenger, the corridors were then placed in tiers 1 through 5, similar to the five point scale that were used for scoring, with tier 5 for those corridors with the high point totals.

The corridors were then grouped into three Program tiers, based upon their comparative scores.

- Investment Program – corridors with the highest relative ranking
- Stewardship Program – corridors with a medium relative ranking
- Active Monitoring Program – corridors with the lowest relative ranking

The **Investment Program** category indicates those corridors with existing and proposed traffic that will likely see a sustained commitment for maintenance and capital investments, by either the railroad and/or the state. Continued investments may include expansion of intermodal services and networks and ensuring North Carolina industries have access to these high capacity corridors, and capacity improvements for congestion. These are also the passenger rail corridors that are along the federally-designated Southeast Corridor, or which show the highest scores for investigation of future passenger rail and/or commuter rail services.

The **Stewardship Program** level is indicative of those corridors where existing and future traffic has the potential to grow and may be advanced by joint railroad and state strategies. These strategies should capitalize on public-private partnerships to ensure that infrastructure health is maintained and corridors are ready to capitalize on economic opportunities. These are also the corridors that show promise for connecting metropolitan areas, either through commuter rail or new intrastate services (motor coach and rail).

The **Active Monitoring Program** level is established to watch how current conditions track over time. Freight movement is very dynamic, reacting to price changes and supplier/customer choices as seen by North Carolina industries. Passenger rail is not as feasible in the near-term to mid-term for these corridors, though further study may show a combination of these Active Monitoring Program tiered corridors might connect important passenger markets for future expansion.

Passenger Rail Corridor Tier Modifications

After evaluating the various passenger rail scores the following modifications were made. Corridors 01 and 02 were moved from the Stewardship Program to the Active Monitoring Program for passenger rail. Corridor 01 serves a small portion of the state, north of Asheville, and does not connect to any other existing passenger rail services, does not connect to another town or community with enough density to warrant study for commuter rail, and is not under consideration by others for commuter rail. Corridor 02 connects with the Charlotte region, but serves mostly rural areas outside of Charlotte, and thus are not populated enough to warrant passenger rail and is not under consideration by Charlotte for commuter rail. Corridor 12 was placed in the Investment Tier, since the Corridor makes up part of the federally-designated Southeast Corridor for future passenger service. Corridor 12p was placed in the Stewardship

Final Results

Table D-3 below shows the total points and tiers for the corridors for passenger and Table D-4 shows the total points and tiers for freight.

Table D-3 Passenger Rail Corridor Tiers

Corridor	Route	Total Points	Program Tier
1	Tennessee state line to Asheville	20.0	3
2	Tennessee state line to Charlotte	21.0	3
3	Asheville to Salisbury	20.0	3
4	Charlotte to Winston-Salem to VA state line	21.0	3
5	Rural Hall to Winston-Salem to Greensboro	25.0	4
6	SC state line to VA state line	33.5	5
7	Charlotte to Monroe	21.0	3
8	SC state line (from Columbia) to Charlotte	27.0	4
9	Greensboro to Selma	32.5	5
10	Greensboro to Gulf (Sanford)	16.0	2
11	Monroe to Pembroke	17.0	2
12	Raleigh to Norlina	21.5	3
12p	Norlina to Weldon	-	*
13	SC state line to Hamlet to Raleigh	20.0	3
14	Raleigh to Fayetteville	19.0	3
15	SC state line to VA state line	26.0	4
16	Raleigh to Greenville	18.0	3
17	Selma to Morehead City	18.0	3
18p	Contentnea (Wilson) to Wallace	15.0	2
19	Pembroke to Wilmington	17.0	2
20	Greenville to Lee Creek	17.0	2
21	Rocky Mount to Plymouth	13.0	2
22	Parmele to Greenville to Elmer	15.0	2
23	Cliffside to Bostic	15.0	2
24	Newton south	17.0	2
25	SC state line to Gastonia	16.0	2
26	Mount Holly to Terrell	23.0	4
27	Albemarle to Salisbury	17.0	2
28	Asheboro to High Point	17.0	2
29	Eden to VA state line	14.0	2
30	Roxboro to VA state line	15.0	2
31	Carrboro to Hillsborough	21.0	3
32	Oxford to Durham	18.0	3
33	Fuquay Varina to Gulf	19.0	3
34	Hamlet to SC state line	15.0	2
35	Spring Lake to Ft. Bragg	24.0	4
36	Stedman to Fayetteville	17.0	2
37	Saint Pauls to Lumberton	17.0	2
38	Weldon to VA state line	12.0	1
39	Clinton to Warsaw	15.0	2
40	Leland NC to Sunny Point	17.0	2
41	Chocowinity to New Bern	17.0	2
42	Durham to Apex	25.0	4
43	Edenton to VA State Line	16.0	2
44	Camp Lejeune to Morehead City	-	*

*Denotes an assigned tier or override.

Key:

Green	Investment Program –corridors with the highest relative ranking
Yellow	Stewardship Program –corridors with a medium relative ranking
Red	Active Monitoring Program –corridors with the lowest relative ranking

Table D-4 Freight Rail Corridor Tiers

Corridor	Route	Total Points	Tier/ Program
1	Tennessee state line to Asheville	30.0	3
2	Tennessee state line to Charlotte	36.0	4
3	Asheville to Salisbury	32.0	3
4	Charlotte to Winston-Salem to VA state line	29.0	3
5	Rural Hall to Winston-Salem to Greensboro	28.0	3
6	SC state line to VA state line	49.0	5
7	Charlotte to Monroe	38.0	4
8	SC state line (from Columbia) to Charlotte	41.0	5
9	Greensboro to Selma	43.0	5
10	Greensboro to Gulf (Sanford)	22.0	2
11	Monroe to Pembroke	36.0	4
12	Raleigh to Norlina	21.0	2*
12f	Norlina to Weldon	-	*
13	SC state line to Hamlet to Raleigh	27.0	3
14	Raleigh to Fayetteville	30.0	3
15	SC state line to VA state line	47.5	5
16	Raleigh to Greenville	32.5	4
17	Selma to Morehead City	33.5	4
18f	Contentnea (Wilson) to Wallace	27.0	3
19	Pembroke to Wilmington	40.5	4
20	Greenville to Lee Creek	24.0	3
21	Rocky Mount to Plymouth	23.0	2
22	Parmele to Greenville to Elmer	21.0	2
23	Cliffside to Bostic	25.0	3
24	Newton south	17.0	2
25	SC state line to Gastonia	17.0	2
26	Mount Holly to Terrell	24.0	3
27	Albemarle to Salisbury	21.0	2
28	Asheboro to High Point	22.0	2
29	Eden to VA state line	20.0	2
30	Roxboro to VA state line	20.0	2
31	Carrboro to Hillsborough	15.0	1
32	Oxford to Durham	20.0	2
33	Fuquay Varina to Gulf	22.0	2
34	Hamlet to SC state line	29.0	3
35	Spring Lake to Ft. Bragg	20.0	2
36	Stedman to Fayetteville	23.0	2
37	Saint Pauls to Lumberton	17.0	2
38	Weldon to VA state line	22.5	2
39	Clinton to Warsaw	17.0	2
40	Leland NC to Sunny Point	23.0	2
41	Chocowinity to New Bern	20.0	2
42	Durham to Apex	25.0	3
44	Camp Lejeune to Morehead City	-	*

*Denotes an assigned tier or override.

Key:

- (green) Investment Program –corridors with the highest relative ranking
- (yellow) Stewardship Program –corridors with a medium relative ranking
- (red) Active Monitoring Program –corridors with the lowest relative ranking

Appendix E
North Carolina's Rail Visions, Goals, Objectives, Strategies and Success Criteria

Definitions:

- **State Rail Plan Goal Area:** Goal areas are a way of organizing NCDOT's objectives for the state rail system. Goal areas are: Safety and Security, Stewardship, Preservation, System/Interoperability, Freight, Passenger, Commuter, Planning.
- **Vision Statement:** Vision statements capture a shared understanding for the direction of planning and policies in each goal area. All objectives should support the overall vision for the goal area.
- **Objective:** Objectives describe the desired outcomes or progress under each goal area.
- **Strategies:** Strategies describe specific actions that will be taken to achieve an objective.
- **Possible Success Criteria:** Success criteria describe what constitutes achieving the objective. When possible, success criteria should be quantifiable measures, but can also be a qualitative description of what success looks like for a specific objective. Success criteria can cover more than one vision and objective.
- **Timeframe:** Timeframes are a categorization of whether each goal area and objective is prioritized for the short-, mid- , or long-term (e.g., 0-5 years, 5-10 years or 10 or more years).

State Rail Plan Goal Area - 1. **Safety & Security**

Vision Statement: A rail system that safely moves people and products.

Department Goals Supported: Safe, Works

OBJECTIVE	STRATEGIES	TIMEFRAME	POSSIBLE SUCCESS CRITERIA
1.1 Reduce the number of rail-related crashes, including pedestrian trespassers	A. Continue to identify and support rail-highway crossings, signal, and track improvements	0-5 years	Decrease in the number of rail incidents (auto/train crashes, pedestrian/train crashes, trespassing incidents) Decrease in the number of rail incidents per train volume Increase in the implementation of signal integration/positive train control (PTC) (miles of PTC and signalized trackage/railroad) Number of outreach events conducted The number and percent of high schools students reached with educational sessions in counties with rail service Decrease in the number of at-grade crossings and unprotected crossings
	B. Conduct outreach about rail safety and security to law enforcement agencies, community organizations, (including mental health) shippers, and railroads	0-5 years	
	C. Conduct school-based education programs about rail safety	0-5 years	
	D. Identify locations, patterns of trespassers and possible methods to discourage trespassing	0-5 years	
1.2 Maintain safety and mobility during emergencies	A. In conjunction with local and state agencies, ensure rail safety is included in local emergency plans	0-5 years	Rail aspect included in county emergency plans completed and adopted Emergency plan tested through practice Alternative routes for temporary crossing closures include coordination with state's emergency evacuation routes
	B. Develop a list of temporary rail-highway grade crossing closures and alternative routes in the event of natural and manmade disasters	5-10 years	
	C. Identify alternative methods for mobility in the event of loss of electricity at signalized rail-highway crossings	5-10 years	

State Rail Plan Goal Area - 1. **Safety & Security**

Vision Statement: A rail system that safely moves people and products.

Department Goals Supported: Safe, Works

OBJECTIVE	STRATEGIES	TIMEFRAME	POSSIBLE SUCCESS CRITERIA
1.3 Prevent harm from train crashes and incidents and, when incidents occur, address them safely and efficiently	A. Work with first responders to address derailments and hazardous material incidents (see 1.2 A above)	0-5 years	Decrease in the number of hazardous material incidents Decrease in the response time to hazardous material incidents Decrease in the clean-up time of hazardous material incidents Point local and regional land use planners to resources such as the FHWA Freight and Land Use Handbook Evaluate freight land use best practices across the US
	B. Raise awareness for local planners, developers on compatible and less suitable land uses around freight railroads, esp. along corridors with airborne hazardous materials	5-10 years	
1.4 Improve the security of North Carolinas rail system	A. Identify and implement rail security measures with guidance from existing Federal Law (P.L. 110-432), Federal Railroad Administration (FRA), Federal Transit Administration (FTA), the Department of Homeland Security, the State Emergency Response Team, Amtrak, local law enforcement agencies and railroads	5-10 years	Stations meet Homeland Security or Amtrak security requirements Rail Division facilities meet Department of Homeland Security requirements
1.5 Maintain equipment properly	B. Develop and practice documented procedures to ensure rail equipment is maintained	0-5 years	FRA/Amtrak standards for equipment maintenance are met or exceeded

State Rail Plan Goal Area - 2. **Stewardship**

Vision Statement: A rail system that is operated and improved with the greatest benefit and the least impact feasible to the natural and human environment.

Department Goals Supported: Efficient, Works

OBJECTIVE	STRATEGIES	TIMEFRAME	POSSIBLE SUCCESS CRITERIA
2.1 Minimize the negative impacts of rail operations and new rail projects on the natural and human environment	A. Reduce hazardous material incidents (see Safety)	0-5 years	Increase in the Tier IV compliant locomotives used by NCDOT/Amtrak Decrease in energy use at stations and Rail Division facilities No. of BMPs at NCDOT Rail facilities All facilities meet current state/federal requirements for stormwater
	B. Use Tier IV compliant locomotives	5-10 years	
	C. Implement energy-saving strategies at existing stations and Rail Division facilities	5-10 years	
	D. Implement best management practices (BMPs) for stormwater at stations and facilities	5-10 years	
2.2 Maximize the positive impacts of new rail projects on the natural and human environment	A. Prioritize rail enhancement projects (passenger and commuter) in non-attainment areas	0-5 years	Increase in passenger and rail service (frequency and ridership), especially in non-attainment air quality regions Number of stations and facilities that implement energy-saving strategies Point local and regional land use planners to resources such as the FHWA Freight and Land Use Handbook Evaluate freight land use best practices across the US
	B. Implement energy-saving strategies at new and enhanced stations and Rail Division facilities	5-10 years	
	C. Conduct direct coordination with local and regional planners and economic developers to ensure the compatibility of rail projects with local and regional land use, transportation, and economic development plans	5-10 years	
	D. Review and implement best national and state practices on integrating state transportation plans with land use decisions	0-5 years	

State Rail Plan Goal Area - 2. **Stewardship**

Vision Statement: A rail system that is operated and improved with the greatest benefit and the least impact feasible to the natural and human environment.

Department Goals Supported: Efficient, Works

OBJECTIVE	STRATEGIES	TIMEFRAME	POSSIBLE SUCCESS CRITERIA
2.3 Increase the understanding and support of rail among policy makers and the public as a mode of transportation that supports economic growth while limiting the impact of increased transportation demand on air quality, energy use, and safety	A. Identify and publicize the environmental benefits, including smaller environmental footprint, and lower energy use of rail when compared to highways	0-5 years	Where feasible, ensure quantitative measures of energy use and other environmental measures are used when comparing transportation modes
	B. Use the environmental and safety benefits of rail as explicit factors in the project assessment	0-5 years	Environmental impacts are included in project cost/benefit analysis, e.g., air quality, energy use

State Rail Plan Goal Area - 3. **Preservation**

Vision Statement: A rail system that is preserved for current and future use.

Department Goals Supported: Lasts longer

OBJECTIVE	STRATEGIES	TIMEFRAME	POSSIBLE SUCCESS CRITERIA
3.1 Maintain and improve the viability of short line railroads and associated industries	A. Support short line railroad efforts to improve infrastructure	0-5 years	Number of short lines receiving NCDOT funds for upgrades Total funding per mile of s Increase in traffic volume on short lines, or number of customers on short lines Number of short lines meeting class II standards
	B. Support short line railroad efforts to retain and attract customers	0-5 years	
3.2 Preserve opportunities for future passenger or freight rail service to leverage existing corridor assets and capacity **3.3** Preserve railroad corridors for future transportation use	A. Acquire rail corridors scheduled for abandonment that provide opportunities for future passenger or freight rail service	0-5 years	Establishment of state funding for corridor preservation Zero railroad miles abandoned Number of railroad miles banked Number of railroad miles returned to active use Adopt policy for evaluating and assisting corridors with abandonment threat Adopt NCDOT policy on clearances around railroads (per type of corridor and operations) Zero substandard clearances on new structures over or adjacent to railroads, both used and unused
	B. Manage state-owned railroad corridors and return them to active service as soon as feasible	5-10 years	
	C. Add "hot spot" analysis to target new/rehab of track or bridges that could threaten closure of entire corridor, using railroad industry information	5-10 years	
	D. Protect railroad clearances	0-5 years	

State Rail Plan Goal Area - 4. **System/Interoperability**

Vision Statement: A rail system with connecting corridors and facilities that promotes the efficient movement of people and goods and supports economic growth and development.

Department Goals Supported: Efficient, Works Well

OBJECTIVE	STRATEGIES	TIMEFRAME	POSSIBLE SUCCESS CRITERIA
4. 1 Move people and goods efficiently	A. Continue partnerships with NS, CSXT and NCRR on shared passenger/freight corridors	0-5 years	Increased Amtrak on-time performance Number of sites and businesses marketed for and partnered with freight rail by NC Department of Commerce or others Number of passenger stations that have direct transit/multi-modal connections(local bus hubs, fixed guideway connections, intercity bus connections)
	B. Develop partnerships to promote rail and have rail support economic development	5-10 years	
	C. Develop partnerships with regional planning and transit agencies on connections to passenger rail stations	0-5 years	
4.2 Maintain and improve connectivity of the rail system, supporting economic growth	A. Work across state lines	0-5 years	Rail Division participation in North Carolina Transportation Network (NCTN) plans, local transit and transportation plans, interstate rail plans Preservation/increase in rail connections with military bases Increase in rail port traffic (volume, type, mode share)
	B. Ensure rail is part of multimodal corridor planning	0-5 years	
	C. Ensure rail connections with state ports	5-10 years	

State Rail Plan Goal Area - 5. **Freight**

Vision Statement: A rail system that provides safe, reliable, efficient, and well-used rail freight service.

Department Goals Supported: Efficient, Works Well

OBJECTIVE	STRATEGIES	TIMEFRAME	POSSIBLE SUCCESS CRITERIA
5.1 Increase the efficient use of freight rail service	A. Identify and implement freight capacity improvement projects	5-10 years	Miles of capacity improvements Increase in intermodal traffic to/from NC (volume, type, mode share) Increase in rail freight traffic to/from NC (volume, type, mode share) Increase in rail port traffic (volume, type, mode share) Increase in unit train traffic in NC (volume, type, mode share) Establish communication and coordination with regional freight users
	B. Develop partnerships with Class I railroads	0-5 years	
	C. Support short line railroads that link to NC industries	0-5 years	
	D. Improve connections to ports and intermodal terminals	5-10 years	
	E. Support regional agencies and communicate to identify freight users' needs	0-5 years	
5.2 Increase the freight customer base	A. Develop and implement strategies to improve partnerships in support of freight movement	0-5 years	Increase in traffic volumes on short lines, or number of customers on short lines and Class I railroads Qualitative assessment on railroad partnerships Preservation/increase in rail connections with military bases Increase in rail port traffic in NC (volume, type, mode share)
	B. Support Class I and short line railroad efforts to retain and attract customers	5-10 years	
	C. Market sites for freight access and support sites for freight use	0-5 years	

State Rail Plan Goal Area - 5. Freight

Vision Statement: A rail system that provides safe, reliable, efficient, and well-used rail freight service.

Department Goals Supported: Efficient, Works Well

OBJECTIVE	STRATEGIES	TIMEFRAME	POSSIBLE SUCCESS CRITERIA
5.3 Promote economic development	A. Estimate and publicize public economic benefits that result from investment in the rail network	0-5 years	Number of jobs created by rail investments Increase in freight rail service to emerging markets (volume, type, mode share) Preservation/increase in rail connections with military bases Increase in rail port traffic in NC (volume, type, mode share) Publicized benefits of using rail for transport (website, fact sheet, etc.)
	B. Partner with railroads to develop corridors	5-10 years	
	C. Integrate decisions with NC and regional economic strategies and economic development plans	5-10 years	
	D. Provide access to domestic and international markets	5-10 years	
	E. Provide access to emerging markets	5-10 years	

State Rail Plan Goal Area - 6. **Passenger**

Vision Statement: Provide a system of conventional and higher speed intercity passenger services connecting North Carolina's major metropolitan areas and other communities to destinations within the state and along the East Coast.

Department Goals Supported: Efficient, Works Well

OBJECTIVE	STRATEGIES	TIMEFRAME	POSSIBLE SUCCESS CRITERIA
6.1 Increase ridership and enhance the economic performance of the state's passenger rail network	A. Provide a travel experience that will satisfy the customer	0-5 years	Minimum number of customer satisfaction surveys completed, and service changes made based on surveys Increase in on-time performance (to Amtrak/FRA objectives or better) Increase in annual ridership and in service frequency Reductions in state support for train operations Completed and published study quantifying economic impacts of passenger rail Increase in the percent of state's population within 30 minutes access to intrastate and interstate service Number of passenger stations that have direct transit/multi-modal connections(local bus hubs, fixed guideway connections, intercity bus connections)
	B. Provide intercity passenger service of the appropriate frequency to major metropolitan areas and secondary markets	10+ years	
	C. Expand intercity passenger service	10+ years	
	D. Market passenger rail as an alternative to congested highways	0-5 years	
	E. Conduct customer satisfaction surveys, evaluate and address feedback	0-5 years	
	F. Improve connectivity and amenities at passenger rail stations	5-10 years	
	G. Study emerging passenger rail markets	5-10 years	

State Rail Plan Goal Area - 6. **Passenger**

Vision Statement: Provide a system of conventional and higher speed intercity passenger services connecting North Carolina's major metropolitan areas and other communities to destinations within the state and along the East Coast.

Department Goals Supported: Efficient, Works Well

OBJECTIVE	STRATEGIES	TIMEFRAME	POSSIBLE SUCCESS CRITERIA
6.2 Provide passenger service or connections to intercity passenger service, from large growth areas to major East Coast destinations and feeder stops	A. Develop Southeast Corridor as an interstate spine that also connects intrastate markets	10+ years	Increase in the percent of state and Metropolitan Statistical Areas (MSAs) population within 30 min. access to Southeast Corridor service Airport study completed and published Completion of Southeast Corridor planning and environmental documents that finalize route
	B. Study passenger rail access to major airports	5-10 years	

State Rail Plan Goal Area - 7. **Commuter**

Vision Statement: A rail system that connects suburbs and bedroom communities of major employment centers with commuter rail service.

Department Goals Supported: Efficient, Works Well

OBJECTIVE	STRATEGIES	TIMEFRAME	POSSIBLE SUCCESS CRITERIA
7.1 Support local plans and policies to implement commuter rail service	A. Support the development, by transit organizations, of commuter services needed to more efficiency move the traveling public	5-10 years	Increase in route miles of active and planned commuter rail service Increase in number of planned /active commuter rail lines Increase in percent of state's or MSA population within 20 min. access to commuter rail station All planned commuter rail lines provide access to local intercity rail station, where feasible Local transit shared use of right-of-way does not conflict with intercity passenger rail service
	B. Work with Metropolitan Planning Organization/Rural Planning Organizations (MPOs/RPOs) to identify future commuter rail corridors and associated plans to allow/encourage transit supportive development and land use planning	0-5 years	
	C. Work with local agencies to ensure commuter rail and other transit plans support intercity/intrastate passenger rail	0-5 years	

State Rail Plan Goal Area - 8. Planning

Vision Statement: State rail planning addresses the collective needs of the State, its citizens, industries, traveling public, and transportation providers.

Department Goals Supported: Efficient, Works Well

OBJECTIVE	STRATEGIES	TIMEFRAME	POSSIBLE SUCCESS CRITERIA
8.1 Provide a comprehensive plan that incorporates the needs of today and address the demands of a growing State and region	A. Partner with other states, multi-state organizations, and State planning organizations to address interstate transportation issues and needs, and develop solutions	0-5 years	Input received from stakeholders, industries, the travelling public, transportation providers and an advisory committee were used in development of the state rail plan List of prioritized rail corridors and projects and services adopted Possible funding needs and sources identified Passenger Level of Service (LOS) measures developed and implemented, where feasible Publish annual state of rail report evaluating progress towards objectives with action plan
	B. Develop and vet criteria for prioritizing corridors and projects	0-5 years	
	C. Develop and vet goals, strategies, and projects with a 5, 10, and 20 year horizon	0-5 years	
	D. Determine funding needed and identify potential sources	0-5 years	
	E. Include strategies that are measurable and identify metrics	0-5 years	
	F. Regularly assess goals, objectives and strategies	0-5 years	

Appendix F
Benefit Cost Analysis

INTRODUCTION

As part of the Comprehensive State Rail Plan (State Rail Plan), the candidate improvements were prioritized in order to develop a program that was implementable, delivered the highest return on investment, and had dedicated funding sources in the near-term, while delaying the projects without identified funding sources or that address longer-term needs for the future. As part of this process, the projects were prioritized based on a two-tiered approach: first, whether they were technically feasible and had dedicated funding, and second, whether they provided greater benefits than costs. Projects that satisfied the two factors were considered implementable in the near-term; the others were part of the mid- and long-term programs.

The prioritization methodology was applied to the full list of 134 projects submitted for the State Rail Plan. All projects, no matter the time-frame, were then categorized by the types of projects: passenger, freight, or grade crossing. Some projects may overlap any combination of those categories; for example, freight capacity projects may also allow for more passenger trains. Within the freight and passenger categories, projects were subdivided into track and structures or facilities and stations. Within grade crossings, projects included grade separations or grade crossing improvements.

After categorizing the projects, they were analyzed to understand the types of possible benefits to the broader state. Benefits identified for the project categories included:

- Capacity benefits for passenger and freight projects result in diversions of auto and truck traffic to rail.
  - Auto diversions result in four benefits: emissions cost savings, congestion savings, pavement savings, and safety incidents avoided.
  - Truck diversions result in five benefits: emissions cost savings, shipper savings that consider the lower price shippers pay for rail instead of trucking goods, congestion savings, pavement savings, and safety incidents avoided.
- Shorter Path benefits result from trains being able to travel in a more direct path than they currently use.
  - Passenger savings include operating cost savings on the part of the service operator, and travel time savings and increased mobility for passengers.
  - Freight savings include operating cost savings and shipper inventory savings, which results from shippers not needing to keep as much product in inventory due to more efficient, faster shipments.
- Grade Crossing improvements and separations are associated with a number of benefits, including safety, emissions, vehicle operating cost, and travel time savings.

If projects were feasible, had dedicated funding sources, and also yielded more benefits than costs over the 30-year analysis period, they were defined as near-term projects. Near-term projects were analyzed quantitatively to the extent possible. The costs and benefits of the mid- and long-term projects were described qualitatively because the required data were not available to do a detailed analysis.

BENEFIT COST ANALYSIS FOR NEAR-TERM PROJECTS

The projects prioritized as near-term were analyzed in detail to compare the benefits of each project to its capital and operating costs. In this section, the costs and benefits of the near-term freight and passenger rail projects in the State Rail Plan are described. The assumptions outlined in this section are consistently applied to the analysis of each individual project depending on whether the benefit is relevant. The section concludes with summary tables for each project, displaying the total net present value (at 7% and 3% discount rates) of the costs and benefits over a 30-year horizon. The BCA ratios for all near-term projects are displayed in Table F-1 below.

Table F-1 BCA Ratios of All Near-Term Projects, in Millions of $2014

	Benefit Cost Ratio	
	Discounted at 7%	**Discounted at 3%**
Clanton Road Grade Separation	0.28	N/A
Walker Street Grade Separation	0.09	N/A
Harrison Avenue Grade Separation	0.34	N/A
Wilmington Container Yard Grade Separation	0.15	N/A
Wilmington Port North Gate Grade Separation	3.37	N/A
Front Street Crossing Improvement	0.76	N/A
Add Wi-Fi to *Piedmont* Trains	2.44	3.15
Greensboro Roundhouse Property	10.22	13.11
Charlotte Thoroughbred Bulk Terminal Facility	1.70	1.97
Hillsborough Station	0.52	0.69
Stouts Siding Extension	9.87	14.77
Upgrade Rail for Freight	1.10	1.39
4^{th} Frequency	5.44	5.16
5^{th} Frequency	6.63	9.25

In addition, there were passenger and freight projects for which no quantifiable benefits were able to be estimated, though there is a clear and defined need and dedicated funding for these projects. As a result, these projects and their benefits are presented qualitatively in the sections that follow.

Quantitative Analysis of Near-Term Projects

The assumptions used to quantitatively analyze the State Rail Plan near-term projects in a benefit cost analysis (BCA) are described below over a 30-year analysis period. A BCA is a ratio that compares the sum of a project or program's benefits to its cost. Typically, a BCA ratio of 1.0 says that the benefits and costs are equal over the analysis period, and a BCA ratio over 1.0 demonstrates that there are more quantifiable benefits than costs for the project or program. Alternately, a BCA ratio of less than 1.0 may indicate that there are not enough benefits to outweigh the costs, or that all of the benefits are not quantifiable at this time. The difference between a BCA of 0.99 and 1.01 does not amount to a meaningful difference and could amount to nothing more than rounding error in the long-term. Given the risks associated with forecasting costs and benefits, a successful project or program generally has a BCA ratio over 1.0. The greater the ratio is over 1.0, the more downside risk the project or program can absorb. The qualitative benefits should also be considered when evaluating BCA results. As markets and conditions change, some projects may need to be reevaluated to capture all available benefits. Following the assumptions, descriptions of the projects and tables summarizing the costs and benefits are displayed.

Cost Analysis

There are two aspects of costs included in a BCA: construction or capital costs, and operating and maintenance costs. Specifics of each cost are covered in the individual option descriptions.

Capital Costs

Construction costs are distributed over time according to the construction schedule for expenditures. This stream of costs is then discounted to a net present value using discount rates of 7% and 3%. Discounting to the net present value allows the future costs to be directly comparable because they represent the value at one common point in time. For this analysis, all construction is assumed to take place over twelve months in 2019. Operation of each project is assumed to begin in January 2020. All construction costs are in $2014.

Operating and Maintenance (O&M) Costs

The O&M costs represent the marginal cost to operate and maintain each project. The cost of operating and maintaining the new or expanded rail asset is estimated over the 30-year analysis period and then discounted to present value using discount rates of 7% and 3%. These values are an estimate of the cost to operators for hiring new workers as a result of each of the projects, as well as the annual costs to maintain the services and facilities in a state of good repair. The annual O&M costs are assumed to be 5-10% of the capital costs, depending on the project's complexity, and are applied annually starting in 2020 and held constant throughout the analysis period.

Benefit Analysis

The projects fall into two main categories: freight and passenger, which describe the stakeholder group that would experience benefits. The benefits that are quantitatively estimated in this analysis are listed in Table F-2.

Table F-2 Freight and Passenger Benefits

	Freight	Passenger
Residual	x	x
Inventory Savings	x	
Shipper Savings	x	
Train Operating Cost Savings	x	x
Safety Incidents Avoided	x	x
Emissions Avoided	x	x
CO2 Avoided	x	x
Congestion Costs Avoided	x	x
Pavement Costs Avoided	x	x
Willingness to Pay		x
Grade Crossing Benefits	x	x

The benefits were accrued over the 30-year analysis period and discounted to the present value using discount rates of 7% and 3%. The following sections outline the general methodology used to estimate the quantitative projects' benefits. Following the methodologies are brief descriptions and summaries of the quantitative projects and their BCAs.

Residual Value

Some projects include assets that would have value or use that extends beyond the 30-year analysis period. The useful life of the investments was estimated according to BEA guidance for the major components that comprise the option considered.[1] In order to estimate the remaining residual value of these assets at the end of the analysis period, the capital investments were depreciated (straight-line) over the full life of the assets.

Detailed project costs are not available at this point in the planning process; as a result, it was assumed that 70% of the project capital costs are comprised of the physical components of the project that would have a residual value at the end of the 30-year analysis period. The remaining 30% were assumed to be soft costs associated with project management, operations, labor, finances, and/or activities that are not part of the finished product. The first 30 years of depreciation were excluded from the residual estimation; this is the basis of the benefits estimation reported elsewhere. The remaining depreciated value was discounted back at a 7% and 3% rate and summed. Projects that have a useful life of less than 30 years have no residual value.

Inventory Savings

The inventory cost associated with the annual carloads and annual hours of delay was based on the commercial discount rate, or the opportunity cost associated with holding assets in inventory rather than using them for another purpose. The analysis assumed a commercial discount rate of 4.0%. Assuming 8,760 hours in a year (365 days * 24 hours), this yielded an hourly discount rate of 0.00046%. Multiplying the annual number of trains by the time savings per train, the average tons per Class I train in the United States[2], the value of freight shipped[3] per ton, and the hourly commercial discount rate resulted in the total inventory savings for a project.

Shipper Savings

Shipping by rail can offer a cost savings to shippers, because rail can move a greater volume of goods per train and is more fuel efficient than shipping by truck, particularly for large loads or shipments traveling longer distances. Some rail projects would provide shippers in the state with better access to rail service by two Class I carriers, which would provide an opportunity for shippers along these routes to reduce their transportation costs. It is estimated that railroads charge between 10% and 30% less for containerized rail services than trucks in the same shipping lanes.[4] The North Carolina Railroad Company (NCRR) released an economic impact study in 2014[5] that estimated a cost of $0.165 ($2007) per ton-mile by truck. Applying a 20% savings to the truck cost and converting to $2014[6], shippers were estimated to save $0.037 per ton-mile from using rail instead of truck.

Ton-miles were estimated using FAF data for 2015 in North Carolina. Based on this FAF data, North Carolina trucks were calculated to travel 180 miles; this analysis conservatively assumes trucks travel only in one direction. The maximum truckload permitted on highways is 40 tons, so to be conservative it is assumed that the average truck load is 20 tons, to which a factor of 1.3 is applied to decrease the tonnage per truck to account for trucks that cube out before they max out with weight. As a result, each truck to rail diversion is expected to avoid 180 miles per truck carrying 15 tons, the equivalent of 2,700 ton-miles.

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[1] Bureau of Economic Analysis Rates of Depreciation, Table C. - Service Lives, Declining-Balance Rates, and Hulten-Wykoff categories. Accessed at: http://www.bea.gov/scb/account_articles/national/wlth2594/tableC.htm

[2] An average of 3,458 tons per train from 2012 was used in the analysis. See page 2 of 3, https://www.aar.org/StatisticsAndPublications/Documents/AAR-Stats-2013-07-09.pdf

[3] $1,058 per ton by truck and rail from FAF for NC shipments

[4] Schoonmaker, Keith, "UP produced record revenue and operating income in 2013, and we expect the trend to continue," July 1, 2014, http://analysisreport.morningstar.com/stock/research?t=UNP&region=USA&culture=en-US&productcode=MLE

[5] RTI International, Measuring the North Carolina Railroad Company's Impact on North Carolina, 2014, http://www.ncrr.com/wp/wp-content/uploads/2011/11/1030-am_RTI.pdf

[6] Converted to $2014 using GDP deflator

The ton-miles diverted for each project was multiplied by the $0.037 savings per ton-mile for using rail instead of truck to estimate the total shipper savings.

Train Operating Cost Savings

Operating savings result from the train operators (primarily CSXT or Norfolk Southern [NS] for freight rail in North Carolina, and Amtrak for passenger rail[7]) more efficiently using their network and by avoiding delays. Rail infrastructure projects can improve travel times so trains get operating savings based on the hours of delays avoided. To value the hourly savings, the total freight operating expenses and the total train hours in road service were obtained from the CSXT and NS 2013 R-1s.[8] Dividing the expenses by the hours in road service results in an average operating expense per train hour for CSXT and NS.[9] Multiplying the daily number of trains by 280[10], the hours saved per train, and average hourly operating expense yielded the total operating savings for the project.

Safety Incidents Avoided

Improvements to the rail system in North Carolina would provide an opportunity for shippers along these routes to divert current or future truck shipments to rail—thereby reducing truck VMT. In addition, passenger service and facility improvements attract riders who would otherwise drive, thereby reducing auto VMT. This avoided VMT reduces the likelihood of crashes and associated deaths, injuries, and property damage on the state's roadways and throughout the US. The crash rates shown in Table F-3 were applied to the VMT avoided to determine the number of fatalities, injuries, and crashes avoided for each project.

Table F-3 Accidents Rates per 100,000,000 VMT, 2011

Accident Type	Rate
Fatalities	1.1305
Injured persons	79.5663
Crashes	189.1273

Source: 2012 BTS Motor Vehicle Safety Data, Table 2-17

These estimated accidents avoided by type were then converted to the Maximum Abbreviated Injury Score (MAIS) accident scale in order to apply US DOT Guidance on the value of avoiding an accident. The conversion is based on the National Highway Traffic Safety Administration KABCO-AIS Conversion Table (July 2011)[11] for Injury (severity unknown) and No Injury accidents. Applying accident rates to the truck and auto VMT avoided and converting to MAIS accident type resulted in estimates of annual fatalities and MAIS injuries avoided.

The total annual value for accident severity was based on US DOT Guidance[12] estimates for the economic value of avoiding an accident. The economic values applied in this analysis are summarized in Table F-4 below.

7 The near-term projects did not estimate train operating savings for passenger services.

8 US Surface Transportation Board, http://www.stb.dot.gov/stb/industry/econ_reports.html

9 $664 for CSXT, $753 for NS

10 Annualization factor

11 USDOT, TIGER 2014 Benefit-Cost Analysis Resource Guide, April 18, 2014, http://www.dot.gov/sites/dot.gov/files/docs/TIGER%20BCA%20Resource%20Guide%202014.pdf

12 USDOT, Guidance on Treatment of the Economic Value of a Statistical Life (VSL) in USDOT Analyses, 2014, http://www.dot.gov/sites/dot.gov/files/docs/VSL_Guidance_2014.pdf

Table F-4 Value of Accidents Avoided, 2013 ($2014M)

Value of Accidents Avoided	$2013M	$2014M
Value of Statistical Life, 2013	$ 9.200	$ 9.338
MAIS 5 Critical (0.593) Fraction of VSL	$ 5.456	$ 5.537
MAIS 4 Severe (0.266) Fraction of VSL	$ 2.447	$ 2.484
MAIS 3 Serious (0.105) Fraction of VSL	$ 0.966	$ 0.980
MAIS 2 Moderate (0.047) Fraction of VSL	$ 0.432	$ 0.439
MAIS 1 Minor (0.003) Fraction of VSL	$ 0.028	$ 0.028
No Injury, 2010	$ 0.004	$ 0.004

Note: $2013 were escalated to $2014 using GDP Price Deflator
Source: USDOT, Guidance on Treatment of the Economic Value of a Statistical Life, 2014

Applying the value of accidents avoided in Table F-4 to the projections of crash reductions by injury type yielded the annual safety benefits associated with the diversion of VMT to rail for each project. Similar to the shipper savings, the VMT avoided estimates that these benefits are based on is conservative, because it assumed that the truck trips are one-way truck trips of 180 miles on average. The auto VMT avoided for each project was estimated using annual new riders[13] and Amtrak trip data for riders boarding and alighting in North Carolina, resulting in an average of 251 miles per trip.[14]

Emissions and CO2 Avoided

Projects that result in diverting trucks or autos to rail also reduce emissions in the state and the US. Truck emission rate outputs for long-haul truck travel, based on the Federal Motor Carrier Safety Administration's (FMCSA) *Hours of Service (HOS) Environmental Assessment*[15] for carbon monoxide (CO), nitrogen oxide (NOx), volatile organic compounds (VOCs), particulate matter (PM), sulfur dioxide (SO2) and carbon dioxide (CO2), were applied to the annual truck VMT avoided to estimate the pollutant emissions avoided. Table F-5 depicts the FMCSA truck emission rates applied.

Table F-5 Long-Haul Truck Travel Emissions Factors (g/VMT)

Year	CO	NOX	PM2.5	PM10	SO2	VOC	CO2
2020	0.31	1.31	0.05	0.05	0.0053	0.06	750.92

Source: FMSCA, Hours of Service (HOS) Environmental Assessment, Appendix A: Analysis of Air Quality Impacts, 2011

Auto emission rate outputs for carbon monoxide (CO), nitrogen oxide (NOx), volatile organic compounds (VOCs), particulate matter (PM), and carbon dioxide (CO2), were applied to the annual auto VMT avoided to estimate the pollutant emissions avoided. Table F-6 depicts the MOVES 2010a and FTA rates for 20-year horizon estimates applied in the analysis.

Table F-6 Auto Emissions Factors (g/VMT)

For 20-Year Horizon Estimates				
Grams per VMT				
CO	NOx	VOC	PM2.5	C02
10.26	0.20	0.21	0.010	397

Source: MOVES 2010a, FTA[16]

[13] Daily new riders were multiplied by 365 days to estimate annual new riders.

[14] Assuming each rider would have driven alone.

[15] FMCSA, Hours of Service (HOS) Environmental Assessment, Appendix A: Analysis of Air Quality Impacts, 2011, http://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/2011_HOS_Final_Rule_EA_Appendices.pdf

[16] CO2 (Greenhouse Gas) emissions factors for current year from FTA New Starts and Small Starts Evaluation and Rating Process Final Policy Guidance, August 2013, http://www.fta.dot.gov/documents/NS-SS_Final_PolicyGuidance_August_2013.pdf

The emission rates in grams per mile were multiplied by the appropriate conversion factor to calculate short tons per mile for each pollutant type, except CO2 which is in metric tons per mile. The tons of emissions avoided per VMT, were then multiplied by the annual VMT avoided for each project. The resulting tons were multiplied by the economic value of the emissions damage cost from National Highway Safety Administration (NHTSA) guidance[17] as shown in Table F-7. The value of carbon dioxide varies annually from $47.70 ($2014) per metric ton in 2020 to $78.15 ($2014) per metric ton in 2049.

Table F-7 Value of Emissions ($2014)

Value of Emissions	$2013	$2014	Unit
Carbon Monoxide	$0	$0	$/short ton
Volatile Organic Compounds	$1,813	$1,840	$/short ton
Nitrogen Oxides	$7,147	$7,254	$/short ton
Particulate Matter	$326,935	$331,829	$/short ton
Sulfur Dioxide	$42,240	$42,872	$/short ton
Carbon Dioxide18	varies (SCC)	varies (SCC)	$/metric ton

Note: $2013 were escalated to $2014 using GDP Price Deflator
Source: NHTSA, Corporate Average Fuel Economy for MY2017-MY2025 Passenger Cars and Light Trucks, August 2012

Similar to the shipper savings, the VMT avoided estimates that these benefits are based on is conservative, because it assumed that the truck trips are one-way truck trips of 180 miles on average. The auto VMT avoided for each project was estimated using annual new riders[19] and Amtrak trip data for riders boarding and alighting in North Carolina, resulting in an average of 251 miles per trip.[20]

Congestion Costs Avoided

The State Rail Plan projects reduce truck and auto VMT by diverting truck shipments and auto trips to rail. The reduced truck and auto VMT contributes to reduced highway congestion. This reduction in truck and auto VMT benefits the remaining drivers and reduces the marginal cost of congestion on these other vehicles. The marginal cost of truck congestion varies based on whether the Interstate routes used are urban or rural. Because detailed information on trip origins and destinations is not known, it was assumed that half of truck trips are urban and half are rural.

The Federal Highway Administration (FHWA) Cost Allocation Study, 2000 Addendum estimated the marginal congestion costs per VMT to be $0.326 ($2000) or $0.432 ($2014) for a 60kip 4-axle U.S. truck on urban Interstates and $0.033 ($2000) or $0.043 ($2014) for rural Interstates.[21] Averaging the $2014 values resulted in a marginal congestion cost of $0.238 ($2014) per mile. Auto congestion costs per VMT come from the Environmental Protection Agency and National Highway Traffic Safety Administration standard from 2012[22] at $0.056 ($2010) or $0.60[23] ($2014). Multiplying these marginal congestion costs by the annual reduction in truck and auto VMT yielded the congestion cost savings for each project.

Again, the VMT avoided estimates that these benefits are based on is conservative, because it assumed that the truck trips are one-way truck trips of 180 miles on average. The auto VMT avoided for each project was estimated

[17] NHTSA, Corporate Average Fuel Economy for MY2017-MY2025 Passenger Cars and Light Trucks (August 2012), http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/FRIA_2017-2025.pdf

[18] Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (May 2013; revised November 2013), page 18, Table A1 "Annual SCC Values: 2010-2050 ($2007/metric ton CO2)" as reported in the USDOT TIGER 2014 BCA Resource Guide

[19] Daily new riders were multiplied by 365 days to estimate annual new riders.

[20] Assuming each rider would have driven alone.

[21] $2000 were escalated to $2014 using GDP Deflators.

[22] EPA and NHTSA, 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, Table II-19 NHTSA Economic Values for Estimating Benefits, October 15, 2012, https://www.federalregister.gov/articles/2012/10/15/2012-21972/2017-and-later-model-year-light-duty-vehicle-greenhouse-gas-emissions-and-corporate-average-fuel#t-176

[23] $2010 were escalated to $2014 using GDP Deflators.

using annual new riders[24] and Amtrak trip data for riders boarding and alighting in North Carolina, resulting in an average of 251 miles per trip.[25]

Pavement Costs Avoided

The statewide rail improvement projects reduce truck and auto VMT by diverting truck shipments and auto trips to rail. The VMT avoided reduces the marginal cost of maintaining the pavement. The marginal cost of pavement for truck and auto travel depends on whether the Interstate routes that would have been used are urban or rural. Because detailed information on trip origins and destinations is not known, it was assumed that half of the trips are urban and half are rural.

The FHWA Cost Allocation Study, 2000 Addendum estimated the marginal pavement costs per VMT for trucks to be $0.181 ($2000) or $0.215 ($2014) for a 60kip 4-axle US truck on urban Interstates and $0.056 ($2000) or $0.067 ($2014) for rural Interstates.[26] The marginal pavement costs per VMT for autos on rural Interstates was $0.00 ($2000), and for urban Interstates $0.10 ($2000) or $0.119 ($2014).[27] Averaging the rates results in $0.141 ($2014) for truck and $0.059 ($2014) for auto VMT avoided. Applying these marginal pavement costs to the annual reduction in VMT yielded the pavement savings for each project.

Again, the VMT avoided estimates that these benefits are based on is conservative, because it assumes that the truck trips are one-way truck trips of 180 miles on average. The auto VMT avoided for each project was estimated using annual new riders[28] and Amtrak trip data for riders boarding and alighting in North Carolina, resulting in an average of 251 miles per trip.[29]

Willingness to Pay

A willingness to pay (WTP) methodology monetizes the value that people place on amenities, typically through survey data. Using literature, it was found that passengers were willing to pay for the amenity of internet access on transit.[30] The maximum WTP per trip for an average rider was found to be $4.44 ($2008) or $4.84 ($2014).[31] To be conservative, it is assumed that riders would be willing to pay 10% of the maximum, or $0.48 per trip ($2014). The more conservative WTP amount helps ensure that the analysis only captures the amenity value associated with the access to Wi-Fi. Ridership was estimated by totaling the annual boardings and alightings at stations along the *Piedmont* service line[32], and dived by two to account for the stations serving both the *Piedmont* and *Carolinian* services. Assuming half of the riders use each service is conservative without more information on the ridership of each line individually. Ridership was assumed to remain constant throughout the analysis period. Multiplying the annual number of riders by the $0.48 per trip resulted in the total willingness to pay for Wi-Fi on trains.

Grade Crossing Benefits

Highway-rail grade crossings generate negative community impacts through two primary highway-rail interactions: accidents and highway delays while crossings are blocked by trains. Highway delays at grade crossings increase travel times, vehicle operating costs, and emissions while vehicles idle at blocked grade crossings. These interactions are a safety concern for the community as well as a drain on its economic competitiveness as productivity and access are negatively impacted.

The proposed near-term grade crossing improvements, listed in Table F-8, would grade-separate or otherwise improve safety at existing grade crossings, thereby reducing the potential for vehicle, pedestrian, and train conflicts and wait times at crossings. There are five grade separation projects affecting a total

24 Daily new riders were multiplied by 365 days to estimate annual new riders.

25 Assuming each rider would have driven alone.

26 $2000 were escalated to $2014 using GDP Deflators.

27 $2000 were escalated to $2014 using GDP Deflators.

28 Daily new riders were multiplied by 365 days to estimate annual new riders.

29 Assuming each rider would have driven alone.

30 Banerjee, Ipsita and Adib Kanafani, “The Value of Wireless Internet Connection on Trains: Implications for Mode-Choice Models”, UC Berkeley, http://www.uctc.net/research/papers/877.pdf

31 $2008 were escalated to $2014 using GDP Deflators.

32 As reported by Amtrak in 2013 to include the following stations: Burlington, Charlotte, Cary, Durham, Greensboro, High Point, Kannapolis, Raleigh, and Salisbury

of 8[33] crossings, and there is one grade crossing improvement affecting three crossings (Front Street).

Table F-8 State Rail Plan Near-term Grade Crossing Improvement Projects

County	Description	Crossing IDs
Mecklenburg	Extend Clanton Road to provide a grade separated crossing of the NS Mainline between West and Wilkinson Blvds. Close the at-grade crossing of Old Dowd Rd at the NS Mainline in Charlotte	716178E 716184H
Wake	Construct grade separation at Walker Street in Cary, NC.	734755X 630665J 734756E 630664C
New Hanover	Grade separation at Port of Wilmington container yard gate	629463P
New Hanover	Grade separation at Port of Wilmington north gate	629463P[34]
New Hanover	Front Street Lead railroad signalization and gates	628706L 628707T 902751J
Wake	Construct grade separation at Harrison Avenue crossing (734755X) in Cary, NC.	734755X 630665J

Source: Rail Plan Projects 2014 Sep 18 2014 Following NCDOT Comments

[33] The Harrison Avenue project affects two of the same crossings that are estimated in the Walker Street Project.

[34] 629463P is the grade crossing ID for the Port of Wilmington Container Yard project that is used as a proxy for the missing crossings for the Port of Wilmington North Gate project.

Projects

The analysis was conducted at the project level, with the benefits for each project calculated individually. The benefits were estimated by using FRA's GradeDec.NET model.[35] Estimated construction costs are given in undiscounted $2014.

Clanton Road

The Extension of Clanton Road project calculated the benefits associated with extending Clanton Road over the NS Mainline with a grade separated crossing and closing Donald Ross Road and Old Dowd Road crossings. The project is estimated to cost $14.42 million.

Walker Street

The Walker Street Grade Separation project would extend Walker Street in Cary by constructing a grade separation that would attract a portion of traffic away from four nearby at-grade crossings: two along Academy Road (11% diverted) and two along Harrison Avenue (58% diverted).[36] However, there would be no improvements made to these existing four crossings. The project is estimated to cost $31.823 million.

To calculate a benefit from the reduced Average Annual Daily Traffic (AADT), GradeDec requires the assumption of an improvement. Therefore, the baseline was run under the assumption that no grade separation exists at Walker Street. Under this scenario, a given level of AADT was assumed. The build scenario was run under the assumption that a grade separation is constructed at Walker Street. This means that a proportion of the traffic from the four existing grade crossings along Academy Road and Harrison Avenue would be diverted to the grade separation on Walker Street and this reduction in AADT would yield benefits. The net results are positive safety benefits due to the reduced traffic interactions at the four grade crossings as well as positive travel time savings, vehicle operating cost savings, and environmental benefits due to a lower number of vehicles waiting at the grade crossings.

Harrison Avenue

The Harrison Avenue project is an alternate project to the Walker Street project described previously. The Harrison Avenue project would grade separate two crossings on Harrison Avenue, resulting in a reduction in safety incidents, travel time savings, vehicle operating costs, and emissions savings. The project is estimated to cost $14.52 million.

Port of Wilmington Container Yard

The grade separation at the Port of Wilmington Container Yard project reflects the benefits from creating a grade separation at the existing at-grade crossing at the Container Yard entrance. The project is estimated to cost between $15 and $25 million. For the purposes of this analysis, $15 million was used.

Port of Wilmington North Gate

The build scenario for the Grade Separation at the Port of Wilmington North Gate project would provide one grade separation for the three existing at-grade crossings. Because the information for the existing three grade crossings is not present in the GradeDec.NET platform, the Container Yard crossing was used as a proxy. The AADT, truck percentage, number of trains, and minimum and maximum speeds are known for the North Gate; therefore, these data replaced the data used for the Container Yard analysis. The project is estimated to cost between $15 and $25 million. For the purposes of this analysis, $15 million was used.

Front Street

The improvements in the build scenario for the Front Street Lead Railroad project are the implementation of gates at three crossings from the baseline scenario of passive crossings. The capital cost of the project is estimated to be $900,000.

Analysis Assumptions

The grade crossing analysis requires a number of assumptions regarding train and vehicle traffic. The assumptions used in the GradeDec.NET tool are outlined

[35] http://gradedec.fra.dot.gov/

[36] Town of Cary Walker Street Extension Categorical Exclusion, 2010, http://www.townofcary.org/Assets/Engineering+Department/Categorical+Exclusion+Environmental+Doc.pdf

in Tables F-9 and F-10. These values vary by grade crossing; assumptions that were constant across projects are listed below. By 2020, all grade crossing projects are assumed to be completed and rail fully operational. Other assumptions that were consistent across the projects included:

- Minimum crossing block time: 120 seconds
- Train cars for passenger: 6
- Train cars for freight: 50
- Train cars for switch: 15
- Average length of freight rail car: 50 feet
- AADT growth: 0%
- Rail growth: 0%
- Annualization factor: 280

Table F-9 Grade Crossing Assumptions: AADT and Daily Trains

Project	Crossing ID	AADT[37]	Truck Percentage	Daily Passenger Trains	Daily Through Trains	Daily Switch Trains
Extension of Clanton Road	716178E	4944	1	2	41	8
	716184H	3938	2	2	28	4
Grade Separation at Walker Street	734755X	15964/6673	4	6	12	2
	630665J	17795/7438	4	2	4	4
	734756E	9854/8777	3	6	12	2
	630664C	9854/8777	3	2	4	4
Grade Separation at the Port of Wilmington Container Yard	629463P	6804	90	0	0	6
Grade Separation at Port of Wilmington North Gate	629463P[38]	4532[39]	90	0	4	100
Front Street	628706L	434	4	0	2	2
	628707T	19513[40]	3	0	2	2
	902751J	19513[41]	0	0	2	2
Harrison Avenue	734755X	15964	4	6	12	2
	630665J	17795	4	2	4	4

Source: AECOM, NCDOT

[37] Two AADTs for Walker Street existing crossings denote the before/after resulting from diversions to the Walker Street grade separation

[38] 629463P is the grade crossing ID for the Port of Wilmington Container Yard project that is used as a proxy for the missing crossings for the Port of Wilmington North Gate project.

[39] Port of Wilmington North South Gate Corridor Project TIGER V Discretionary Grant Application, May 31, 2013

[40] Ibid.

[41] Ibid.

Table F-10 Grade Crossing Assumptions: Speeds, Tracks, and Lanes

Project	Crossing ID	Max/Avg Speed	Number of Tracks	Number of Lanes
Extension of Clanton Road	716178E	50/37.5	4	2
	716184H	60/37.5	2	2
Grade Separation at Walker Street	734755X	40/25	1	4
	630665J	45/45	1	4
	734756E	40/25	2	3
	630664C	45/45	1	3
Grade Separation at the Port of Wilmington Container Yard	629463P	5/5	1	4
Grade Separation at Port of Wilmington North Gate	629463P[42]	5/5	2	2
Front Street	628706L	10/10	1	2
	628707T	10/10	1	2
	902751J	10/10	1	2
Harrison Avenue	734755X	40/25	1	4
	630665J	45/45	1	4

Source: AECOM, NCDOT

[42] 629463P is the grade crossing ID for the Port of Wilmington Container Yard project that is used as a proxy for the missing crossings for the Port of Wilmington North Gate project.

Grade Crossing Benefits

The community benefits associated with separating existing grade crossings, reducing AADT at existing crossings, and upgrading existing grade crossing devices include:

- Safety
- Travel time savings
- Vehicle operating cost savings
- Vehicle emissions reductions
- Residual

The benefits were estimated by using FRA's GradeDec.NET[43] model. The use of GradeDec.NET estimates the net safety, travel time, vehicle operating cost, and emissions savings associated with proposed improvements to corridor grade crossings (i.e. improvement of device, grade separation, and closing). The GradeDec.NET methodology is described below.

Safety Benefits

The exposure of vehicles associated with grade crossings results in a greater likelihood of safety incidents as trains travel through the crossings. However, constructing a grade separation to prohibit traffic from crossing the at-grade rail alignment prevents injury through normal operations and proper use of the grade crossing improvement. The safety analysis calculates the benefits of reduced vehicle-rail accidents due to the grade separation or crossing improvement compared to the likelihood for highway-rail accidents at the existing at-grade crossings.

GradeDec.NET was updated to account for the time-of-day correlation factors between rail and highway traffic, which are used to predict the number accidents by severity that would occur at the crossings. The safety analysis methodology for grade crossings predicts the number of accidents each year based on the number of daily trains, AADT, time-of-day exposure correlation factor, number of tracks, and number of highway lanes crossing the tracks.[44]

The predicted accidents are then used to estimate the number of accidents by severity (fatal, injury, and property damage only) that would occur. The estimated accidents by severity are based on the maximum speed; Accident Prediction and Severity (APS) model factors for fatal accidents and casualty accidents for grade crossings with gates and lights; number of through, passenger, and/or switch trains; and number of tracks. The number of accidents is multiplied by the monetary value of the respective type of injury. The monetary values of accidents avoided applied in the analysis are shown in Table F-11.

Table F-11 Value of Accidents Avoided

	$2014M	
Value of Statistical Life, 2013	$	9.338
Injury (Average of all injury types)	$	1.894
No Injury	$	0.004

Source: USDOT, Guidance on Treatment of the Economic

Safety improvements are realized for all six projects and are comparatively shown in Table F-12, discounted over the analysis period at a 7% rate.

43 http://gradedec.fra.dot.gov/

44 Time delay at a crossing is based on a Day Flat traffic distribution for both vehicles and trains for Clanton Road, Walker Street, Harrison Avenue, and Front Street projects. The Day Flat traffic distribution is the hourly percent of total daily traffic, which equals 6.67% from 6AM to 6PM, and 1.67% from 6PM to 6AM. Time delay at a crossing is based on the operating hours (8AM to 4.30PM) of the Port of Wilmington for the Grade Separation at the Port of Wilmington Container Yard and Grade Separation at the Port of Wilmington North Gate projects.

Table F-12 Safety Benefits from Improvements

	$2014M over 30 years; Discounted at 7%
Clanton Road Grade Separation	$1.18
Walker Street Grade Separation	$0.09
Harrison Avenue Grade Separation	$0.99
Wilmington Container Yard Grade Separation	$0.06
Wilmington Port North Gate Grade Separation	$0.16
Front Street Crossing Improvement	$0.49

Source: AECOM analysis using FRA's GradeDec.NET

The net safety benefits were calculated by summing the safety benefits gained through improvements to grade crossings and the benefits associated with the baselines, as applicable.

Travel Time Savings

The travel time savings associated with the elimination of highway queuing at existing grade crossings due to grade separation construction as calculated by GradeDec.NET are based on:

- Trains per day
- Train arrival times
  - Trains were uniformly distributed throughout the day for Clanton Road, Walker Street, Harrison Avenue, and Front Street projects
  - Trains were uniformly distributed for a 9-hour period to represent the operating hours of the Port of Wilmington for the Grade Separation at the Port of Wilmington Container Yard and the Grade Separation at the Port of Wilmington North Gate
- Train length
- Average speeds at crossings
- AADT distributed by time of day and segment (auto, truck, and bus)
  - AADT was uniformly distributed throughout the day for Clanton Road, Walker Street, Harrison Avenue, and Front Street projects
  - AADT was uniformly distributed for a 9-hour period to represent the operating hours of the Port of Wilmington for the Grade Separation at the Port of Wilmington Container Yard and the Grade Separation at the Port of Wilmington North Gate
- Number of highway lanes at crossings
- Highway traffic volumes
- Vehicle dispersal rates per lane when closure ends

The highway delays associated with grade crossings result in increased travel times for highway drivers and their passengers as they wait for trains to travel through grade crossings; constructing grade separations would eliminate these waiting times.

The first step in the travel time analysis calculated the average delay each highway vehicle endures. This was accomplished by multiplying the probability that a highway vehicle would be blocked by a grade crossing and the minutes per delay. This value was further multiplied by the number of highway vehicles that arrive at the blocked gate to derive the total vehicle hours of delay. This total value was distributed by the percentage of trucks assumed for each project. Additionally, the number of people traveling in the vehicle was factored into the value of the travel time delay, because passengers also would be negatively impacted by the delay. The average auto occupancy used in the analysis was 1.4.[45] All auto trip delays, therefore, were multiplied by the 1.4 average auto occupancy factors to account for all passengers in the vehicle. The analysis assumed an annualization factor of 280, which accounts for reduced levels of traffic on non-weekdays. The time of day distributions per crossing are displayed in Table F-13 below.

[45] National Household Travel Survey

Table F-13 Time of Day Distribution per Crossing, Trains and Autos

	TOD Distribution
Clanton Road Grade Separation	Day Flat
Walker Street Grade Separation	Day Flat
Harrison Avenue Grade Separation	Day Flat
Wilmington Container Yard Grade Separation	Port DOT
Wilmington Port North Gate Grade Separation	Port DOT
Front Street Crossing Improvement	Day Flat

Source: AECOM

The trip purpose is important to the monetization of the impacts because people value their time differently for different types of trips. USDOT[46] recommends that business travel be valued at 100% of the hourly wage, while personal or leisure travel (including commute time) be valued at 50% of the hourly wage. The average hourly wage for auto and truck drivers was based on USDOT guidance.[47] The North Carolina average wage is $11.06.[48] The average hourly wage for truck drivers was based on USDOT Guidance, $26.17.[49] The national hourly rate was used for truck drivers because truck trips made locally could be made by any truck driver in the US, not just those drivers who reside in North Carolina. The Front Street project would not observe any travel time savings as wait times would not be reduced due to improvements from a passive crossing to one with gates. The total travel time savings associated with the crossing improvements are displayed in Table F-14 below.

Table F-14 Travel Time Savings of Grade Crossing Improvements

	$2014M over 30 years; Discounted at 7%
Clanton Road Grade Separation	$1.15
Walker Street Grade Separation	$0.89
Harrison Avenue Grade Separation	$1.91
Wilmington Container Yard Grade Separation	$0.97
Wilmington Port North Gate Grade Separation	$29.53
Front Street Crossing Improvement	N/A

Source: AECOM analysis using FRA's GradeDec.NET

Vehicle Operating Cost Savings

The highway delays associated with grade crossings result in greater vehicle operating costs associated with the increased idling times at grade crossings while vehicles wait for trains to travel through the crossings. Vehicle operating cost savings are created from the reduction in delay in waiting time, which leads to a decrease in fuel and oil consumption. GradeDec.NET calculated vehicle consumption of fuel and oil for both autos and trucks, as the time delay for each vehicle is multiplied by the consumption rate while waiting at a crossing.[50] The

[46] USDOT Office of the Secretary of Transportation, Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis, http://www.dot.gov/sites/dot.dev/files/docs/USDOT%20VOT%20Guidance_0.pdf

[47] Truck driver wage based on USDOT Guidance, http://www.dot.gov/sites/dot.gov/files/docs/USDOT%20VOT%20Guidance%202014.pdf

[48] Bureau of Economic Analysis, State Economic Profiles, 2013. These values were inflated by the GDP Deflator from the Office of the Secretary of the Treasury. to $2014 for the purpose of this analysis

[49] 2012 wages were inflated by the GDP Deflator from the Office of the Secretary of the Treasury to $2014 for the purpose of this analysis

[50] Time delay at a crossing is based on a Day Flat traffic distribution for both vehicles and trains for Clanton Road, Walker Street, Harrison Avenue, and Front Street projects. The Day Flat traffic distribution is the hourly percent of total daily traffic, which equals 6.67% from 6AM to 6PM, and 1.67% from 6PM to 6AM. Time delay at a crossing is based on a the operating hours (8AM to 4.30PM) of the Port of Wilmington for the Grade Separation at the Port of Wilmington Container Yard and Grade Separation at the Port of Wilmington North Gate projects.

reduction in consumption from the construction of a grade separation was multiplied by their respective costs to derive the vehicle operating cost savings. The gasoline and diesel prices per gallon were assumed to be $3.55 ($2014) and $3.96 ($2014), respectively, based on the Department of Energy's fuel prices.[51] The price of motor oil per quart was assumed to be $4.00 ($2014) based on the price of motor oil available for sale. The Front Street project would not observe any vehicle operating cost savings as wait times would not be reduced due to improvements from a passive crossing to one with gates. The vehicle operating cost savings of the crossing improvements are shown in Table F-15 below.

Table F-15 Vehicle Operating Cost Savings of Grade Crossing Improvements

	$2014M over 30 years; Discounted at 7%
Clanton Road Grade Separation	$0.15
Walker Street Grade Separation	$0.12
Harrison Avenue Grade Separation	$0.26
Wilmington Container Yard Grade Separation	$0.18
Wilmington Port North Gate Grade Separation	$5.69
Front Street Crossing Improvement	N/A

Source: AECOM analysis using FRA's GradeDec.NET

Highway Emissions Benefits

The highway delays associated with grade crossings result in greater vehicle emissions due to increased idling times at grade crossings while vehicles wait for trains to travel through the crossings. Therefore, there would be a reduction in emissions with grade separations. GradeDec.NET uses the monetized values of emissions of hydrocarbons, nitrogen oxides, and carbon monoxide to calculate the economic value of emissions reduced from keeping vehicles from waiting idly at grade crossings. The costs of hydrocarbon, nitrogen oxides, and carbon dioxide applied in the analysis were $2,040 per ton, $7,254 per ton, and $0 per ton respectively.[52]

The emissions rate by vehicle type was multiplied by the time spent by each vehicle type at the grade crossing. The difference in emissions from time spent at the grade crossing and the emissions from utilizing the grade separation was multiplied by the dollar value per emission type, resulting in the highway emissions benefit. The Front Street project would not observe any emissions benefits as wait times would not be reduced due to improvements from a passive crossing to one with gates. The emissions benefits per project discounted at the 7% rate are shown in Table F-16.

Table F-16 Emissions Benefits of Grade Crossing Improvements

	$2014M over 30 years; Discounted at 7%
Clanton Road Grade Separation	$0.01
Walker Street Grade Separation	$0.005
Harrison Avenue Grade Separation	$0.01
Wilmington Container Yard Grade Separation	$0.01
Wilmington Port North Gate Grade Separation	$0.20
Front Street Crossing Improvement	N/A

Source: AECOM analysis using FRA's GradeDec.NET

[51] Department of Energy, http://tonto.eia.doe.gov/oog/info/gdu/gasdiesel.asp

[52] NHTSA, Corporate Average Fuel Economy for MY2017-MY2025 Passenger Cars and Light Trucks, August 2012. $2013 were escalated to $2014 using GDP Price Deflator.

Residual Value

The residual value is the value of the asset remaining at the end of the analysis period. It is based on the straight-line depreciation of the asset over its useful life. The useful life of a grade separation was assumed to be 54 years[53] while the analysis period spans 30 years. Detailed project costs are not available at this point in the planning process; as a result, it was assumed that 70% of the project capital costs are comprised of the physical components of the project that would have a residual value at the end of the 30-year analysis period. The remaining 30% were assumed to be soft costs associated with project management, operations, labor, finances, and/or activities that are not part of the finished product. The first 30 years of depreciation were excluded from the residual estimation; this is the basis of the benefits estimation reported elsewhere. The remaining depreciated value was discounted back at a 7% and 3% rate and summed.

The residual was not calculated for the Front Street project because a grade separation, which represents a new asset, is not being constructed; rather the current grade crossing is instead undergoing safety improvements that would need to be refurbished by the end of the analysis period. Table F-17 shows the residuals for each project where applicable.

Table F-17 Residual Value of Grade Crossing Improvements

	$2014M over 30 years; Discounted at 7%
Clanton Road Grade Separation	$0.40
Walker Street Grade Separation	$0.87
Harrison Avenue Grade Separation	$0.40
Wilmington Container Yard Grade Separation	$0.41
Wilmington Port North Gate Grade Separation	$0.41
Front Street Crossing Improvement	NA

Source: AECOM

Grade Crossing Benefits Summary

Table F-18 below shows the GradeDec.NET model analysis results for the BCAs of the crossing improvements over the 30 year analysis period. The total benefits as described above are compared to their similarly discounted capital costs; it is assumed that no net new operating costs would be incurred for the grade crossing improvement projects. For this analysis, all construction is assumed to take place over twelve months in 2019. Operation of each project is assumed to begin in January 2020.

Table F-18 BCA Results for Grade Crossing Improvement Projects

	Benefit Cost Analysis Ratio; Discounted at 7%
Clanton Road Grade Separation	0.28
Walker Street Grade Separation	0.09
Harrison Avenue Grade Separation	0.34
Wilmington Container Yard Grade Separation	0.15
Wilmington Port North Gate Grade Separation	3.37
Front Street Crossing Improvement	0.76

Source: AECOM analysis using FRA's GradeDec.NET

53 Bureau of Economic Analysis Table C - Rates of Depreciation, http://www.bea.gov/scb/account_articles/national/wlth2594/tableC.htm

As shown in Table F-18, only the Wilmington Port North Gate Grade Separation project results in a BCA ratio greater than 1.0, indicating that the project has more benefits than costs under current analysis assumptions. The Wilmington Container Yard Grade Separation Project currently does not return enough benefits to deem the project worthwhile; however, should the Port deepen and attract larger ships, and/or if an intermodal facility were located on the Port, the analysis should be revisited to adjust the assumptions to more adequately reflect these conditions. At such a time, that project would likely be warranted.

Proposed Near-Term Projects Benefits Analysis

Eight State Rail Plan projects were quantitatively analyzed in the near-term outside of the GradeDec.NET platform. The descriptions of the projects and their analysis assumptions are described here. Summary tables of the benefit cost analysis results are shown in the next section.

Add Wi-Fi to Piedmont Trains

The project involves installing wireless internet accessibility on 20 of the *Piedmont* service trains and is estimated to cost $600,000. Annual operating and maintenance costs were assumed to be 5% of the capital costs, or $30,000. The project assigned a Willingness to Pay benefit to the 394,667 annual *Piedmont* service riders over the 30-year analysis period. The discounted total over 30 years resulted in a BCA ratio of 2.44 at a 7% discount rate.

Table F-19 BCA Results for Wi-Fi Project

	Total NPV ($2014M) over 30 years	
	Discounted at 7%	Discounted at 3%
Costs		
Capital Costs	$ 0.43	$ 0.52
Operating & Maintenance Costs	$ 0.27	$ 0.51
Total Costs	***$ 0.69***	***$ 1.02***
Benefits		
WTP	$ 1.69	$ 3.23
Total Benefits	***$ 1.69***	***$ 3.23***
Benefit Cost Ratio	**2.44**	**3.15**

Source: AECOM analysis

Greensboro Roundhouse Property

The project plans to convert the NS "Roundhouse" property adjacent to the Greensboro, NC Intermodal Facility into a parking lot for container storage to better accommodate growing container volumes in the region. The paved parking lot would be approximately 4 acres, and the project cost includes a security fence, pole mounted lighting, and a new asphalt entrance into the parking area. The parking expansion would increase the volume throughput by 50%. It is expected to cost $1.695 million and annual O&M costs were estimated to be $84,750 per year. The project would divert 41 trucks per day by the end of the 30-year analysis period, resulting in shipper savings and the benefits associated with VMT avoided: emissions, congestion, pavement, and safety costs avoided. The discounted total benefits over the analysis period are compared to their discounted capital costs in the table below. As shown, the project is projected to have significantly more benefits than costs.

Table F-20 BCA Results for Greensboro Roundhouse Property

	Total NPV ($2014M) over 30 years	
	Discounted at 7%	Discounted at 3%
Costs		
Capital Costs	$ 1.21	$ 1.46
Operating & Maintenance Costs	$ 0.75	$ 1.43
Total Costs	***$ 1.96***	***$ 2.90***
Benefits		
Shipper Savings	$ 8.35	$ 16.39
Safety Incidents Avoided	$ 3.85	$ 7.55
Emissions Avoided	$ 0.72	$ 1.41
CO2 Avoided*	$ 1.37	$ 1.37
Congestion Costs Avoided	$ 3.60	$ 7.06
Pavement Costs Avoided	$ 2.13	$ 4.19
Total Benefits	***$ 20.02***	***$ 37.96***
Benefit Cost Ratio	**10.22**	**13.11**

*Discounted at 3%
Source: AECOM analysis

Charlotte Thoroughbred Bulk Terminal Facility

The project would establish a new Thoroughbred Bulk Terminal (TBT) facility in Charlotte at the old Charlotte Intermodal facility, once the area has been vacated. There is an existing market opportunity to handle ethanol shipments at the proposed facility, which is estimated to cost $976,000. Annual O&M costs were assumed to be 10% of the project capital costs, or $97,600. The project benefits were derived off of diverting 4.5 trucks per day throughout the analysis period. The benefits that result from the diversions include shipper savings, and safety, emissions, pavement, and congestion costs avoided. The project has a 1.70 BCA ratio at a 7% discount rate, showing that the project is anticipated to generate benefits in excess of costs.

Table F-21 BCA Results for Charlotte TBT Project

	Total NPV ($2014M) over 30 years	
	Discounted at 7%	Discounted at 3%
Costs		
Capital Costs	$ 0.70	$ 0.84
Operating & Maintenance Costs	$ 0.86	$ 1.65
Total Costs	***$ 1.56***	***$ 2.49***
Benefits		
Shipper Savings	$ 1.11	$ 2.12
Safety Incidents Avoided	$ 0.51	$ 0.98
Emissions Avoided	$ 0.10	$ 0.18
CO2 Avoided*	$ 0.17	$ 0.17
Congestion Costs Avoided	$ 0.48	$ 0.91
Pavement Costs Avoided	$ 0.28	$ 0.54
Total Benefits	***$ 2.65***	***$ 4.91***
Benefit Cost Ratio	**1.70**	**1.97**

*Discounted at 3%
Source: AECOM analysis

Hillsborough Station

The Hillsborough Station project would include constructing a platform, passenger rail station building, site access, utilities, and parking on the Hillsborough-owned site. The station building would be approximately 6,000 square feet. The Hillsborough Station completes the stations planned for the corridor with the average distance between stations of 17 miles. The station is adjacent to a planned 20-acre transit oriented development (TOD). The $8 million station would allow more riders to access passenger rail and reduce vehicle trips in the state. The facility is expected to attract 12 riders per day and ridership was assumed to conservatively grow by 1% per year as a result of the increased connectivity and reliability of the service. The new riders would avoid trips by auto, resulting in reduced VMT and the associated benefits including safety, emissions, congestion, and pavement costs avoided. Annual O&M costs were estimated to be 5% of the capital costs, or $400,000 per year, and because the facility would have a useful life longer than 30 years, the project has a residual value benefit.

In total, the BCA ratio of the project at a 7% discount rate is 0.52, which means that the project is anticipated to have more costs than quantifiable benefits in the analysis period.

Table F-22 BCA Results for Hillsborough Station Project

	Total NPV ($2014M) over 30 years	
	Discounted at 7%	Discounted at 3%
Costs		
Capital Costs	$ 5.70	$ 6.90
Operating & Maintenance Costs	$ 3.54	$ 6.76
Total Costs	***$ 9.24***	***$ 13.66***
Benefits		
Residual	$ 0.22	$ 0.86
Safety Incidents Avoided	$ 2.74	$ 5.37
Emissions Avoided	$ 0.06	$ 0.12
CO2 Avoided*	$ 0.51	$ 0.51
Congestion Costs Avoided	$ 0.65	$ 1.27
Pavement Costs Avoided	$ 0.64	$ 1.26
Total Benefits	***$ 4.82***	***$ 9.38***
Benefit Cost Ratio	**0.52****	**0.69****

*Discounted at 3%
Source: AECOM analysis

**Note: Property premium benefits are excluded in this analysis; the total BCA is anticipated to be higher once the station design is finalized and property premium benefits can be included.

Although the project does not have sufficient quantitative benefits to result in a BCA ratio above 1.0, the project would have other benefits that were not quantified in the above analysis, including a property premium benefit for the properties adjacent to the station as a result of the TOD. Residents and commercial enterprises would be willing to pay a premium for the locations where access is improved relative to the baseline. This premium would be applicable to existing properties. Studies have shown that an increase in property values near transit lines can range from 2% to over 30%.[54] A property premium analysis could be performed once the station design is finalized, and it is expected that the BCA ratio would be greater than 1.0 when the new benefit is included.

Stouts Siding Extension

A 10,000-foot siding extension of the CSXT line in Stouts would create a passing siding in the middle of a 30-mile segment of single track. The siding, which would cost $10.6 million, would result in increased capacity, generating inventory savings, shipper savings, train operating cost savings, and safety, emissions, congestion, and pavement costs avoided. The project would also have a useful life longer than the analysis period, which results in a residual benefit. The new siding is expected to divert 496 trucks per day by the end of the analysis period, resulting in the aforementioned benefits. To be conservative, the truck diversions were interpolated straight-line from 0 in 2019 to 496 by 2049. The eight trains per day (assumed to begin in 2020) save 60 minutes each, resulting in CSXT operating savings. The O&M costs are estimated at 5% of the capital costs, or $530,000 per year. The costs and benefits of the project are displayed in Table F-23 below and show that the projected benefits far outweigh the costs, even with a 7% discount rate.

Table F-23 BCA Results for Stouts Siding Project

	Total NPV ($2014M) over 30 years	
	Discounted at 7%	Discounted at 3%

[54] Capturing Value from Transit (Center for Transit Oriented Development, November 2008) and Robert Cervero and M. Duncan. "Real Estate market Impacts of TOD," 2001.

Costs		
Capital Costs	$ 7.56	$ 9.14
Operating & Maintenance Costs	$ 4.69	$ 8.96
Total Costs	***$ 12.25***	***$ 18.10***

Benefits		
Residual	$ 0.14	$ 0.54
Inventory Savings	$ 0.42	$ 0.85
Shipper Savings	$ 43.79	$ 103.66
Train Operating Cost Savings	$ 13.17	$ 25.17
Safety Incidents Avoided	$ 20.17	$ 47.75
Emissions Avoided	$ 3.77	$ 8.92
CO2 Avoided*	$ 9.33	$ 9.33
Congestion Costs Avoided	$ 18.88	$ 44.69
Pavement Costs Avoided	$ 11.19	$ 26.48
Total Benefits	***$ 120.86***	***$ 267.40***

Benefit Cost Ratio	**9.87**	**14.77**

*Discounted at 3%

Source: AECOM analysis

Upgrade Rail for Freight

The project involves upgrading the rail along US 52 to accommodate freight shipments. The upgrade would result in increased capacity and divert 4.5 trucks to rail daily, which would provide benefits such as shipper savings, reduced safety incidents, emissions, vehicle costs, and congestion. In addition, the project would have residual value because the useful life is longer than the analysis period. The project is estimated to cost $2.1 million, and annual O&M costs are expected to cost $106,300 (5% of capital costs). The project has a 2.69 BCA ratio at a 7% discount rate, showing that the project is anticipated to generate benefits in excess of its costs.

Table F-24 BCA Results for Upgrading Rail for Freight Project

	Total NPV ($2014M) over 30 years	
	Discounted at 7%	Discounted at 3%
Costs		
Capital Costs	$ 1.52	$ 1.83
Operating & Maintenance Costs	$ 0.94	$ 1.80
Total Costs	***$ 2.46***	***$ 3.63***
Benefits		
Residual	$ 0.03	$ 0.11
Shipper Savings	$ 1.11	$ 2.13
Safety Incidents Avoided	$ 0.51	$ 0.98
Emissions Avoided	$ 0.10	$ 0.18
CO2 Avoided*	$ 0.18	$ 0.18
Congestion Costs Avoided	$ 0.48	$ 0.92
Pavement Costs Avoided	$ 0.28	$ 0.54
Total Benefits	***$ 2.69***	***$ 5.04***
Benefit Cost Ratio	**1.10**	**1.39**

*Discounted at 3%

Source: AECOM analysis

4th Frequency

Operating the 4th frequency of the *Piedmont* and *Carolinian* services in North Carolina would result in additional ridership and revenues. The capital investment required for the 4th frequency has already been completed and is excluded from this analysis. The additional frequency would allow more riders to access passenger rail and reduce vehicle trips in the state. Operation of the service is expected to begin in 2020, and as a result the 30-year analysis period for the 4th frequency service is 2020-2049.

The service is expected to attract ridership of 144,000 additional *Piedmont* and *Carolinian* riders per year compared to the 3rd frequency. Ridership is conservatively assumed to be constant throughout the analysis period. The new riders would avoid trips by auto, resulting in reduced VMT and the associated benefits including safety, emissions, congestion, and pavement costs avoided. The average trip length for 4th frequency riders is estimated to be 239 miles,[55] and it is assumed each rider would have driven alone if not for the additional Amtrak service. Annual O&M costs were estimated to be $7.3 million per year[56] and offset by the annual ticket revenue estimated at $4.6 million per year;[57] O&M and revenues were held constant throughout the analysis period. The annual O&M was estimated by taking the difference between the operating costs for the 4th frequency compared to the current O&M of the 3rd frequency, and the revenues consider only the *Piedmont* and *Carolinian* services. While revenues are not a benefit, they help recover some of the O&M costs for the project, and therefore, are included as a cost offset.

In total, the 30-year benefit stream of the project at a 7% discount rate totals $129 million, and when comparing to the O&M costs, the project provides over five times more benefits than costs.

[55] See Table 3-2 for projected daily ridership and revenues of the fourth and fifth frequencies. Average trip length is found from *Piedmont* and *Carolinian* Passenger Miles divided by *Piedmont* and *Carolinian* Ridership.

[56] Operating costs estimated as part of the State Rail Plan

[57] See Table 3-2 for projected daily ridership and revenues of the fourth and fifth frequencies. The difference of ticket revenues for *Piedmont* and *Carolinian* trains from 3 to 4 frequencies totals $4.636 million.

Table F-25 BCA Results for 4th Frequency

	Total NPV ($2014M) over 30 years	
	Discounted at 7%	Discounted at 3%
Costs		
Operating & Maintenance Costs	$ 64.73	$ 123.70
Operating Revenues (Cost Offset)	$ 41.02	$ 78.38
Total Costs	***$ 23.71***	***$ 45.32***
Benefits		
Safety Incidents Avoided	$ 77.18	$ 147.49
Emissions Avoided	$ 1.73	$ 3.30
CO2 Avoided*	$ 13.94	$ 13.94
Congestion Costs Avoided	$ 18.20	$ 34.77
Pavement Costs Avoided	$ 18.06	$ 34.52
Total Benefits	***$ 129.11***	***$ 234.02***
Benefit Cost Ratio	**5.44**	**5.16**

*Discounted at 3%
Source: AECOM analysis

5th Frequency

In addition to the 4th frequency, the 5th frequency of the *Piedmont* and *Carolinian* services in North Carolina would attract additional ridership and revenues. Operating the 5th frequency depends on two projects: extending the lead track in Capital Yard and acquiring one new train set, for a total capital cost of $35.4 million. Service is expected to begin in 2024, and as a result the 30-year analysis period for the 5th frequency service is 2024-2053.

The 5th frequency is expected to attract ridership of 237,400 additional *Piedmont* and *Carolinian* riders per year compared to the 4th frequency. Ridership is conservatively assumed to be constant throughout the analysis period. The new riders would avoid trips by auto, resulting in reduced VMT and the associated benefits including safety, emissions, congestion, and pavement costs avoided. The average trip length for 5th frequency riders is estimated to be 200 miles,[58] and it is assumed each rider would have driven alone if not for the Amtrak service. Annual O&M costs were estimated to be $7.3 million per year[59] and offset by the annual ticket revenue estimated at $7 million per year; [60] O&M and revenues were held constant throughout the analysis period. Because the annual O&M cost for the 5th frequency has not yet been determined, it was assumed to be equal to the O&M cost for the 4th frequency, and the revenues consider only the *Piedmont* and *Carolinian* services. While revenues are not a benefit, they help recover some of the O&M costs for the project, and therefore, are included as a cost offset.

In total, the 30-year benefit stream of the project at a 7% discount rate totals nearly $140 million, and when comparing to the costs, the project provides over six times more benefits than costs.

[58] See Table 3-2 for projected daily ridership and revenues of the fourth and fifth frequencies. Average trip length is found from *Piedmont* and *Carolinian* Passenger Miles divided by *Piedmont* and *Carolinian* Ridership.

[59] Operating costs estimated as part of the State Rail Plan

[60] See Table 3-2 for projected daily ridership and revenues of the fourth and fifth frequencies. The difference of ticket revenues for *Piedmont* and *Carolinian* trains from 4 to 5 frequencies totals $7.045 million.

Table F-26 BCA Results for 5th Frequency

	Total NPV ($2014M) over 30 years	
	Discounted at 7%	Discounted at 3%
Costs		
Capital Costs	$ 19.26	$ 27.13
Operating & Maintenance Costs	$ 49.38	$ 109.91
Operating Revenues (Cost Offset)	$ 47.55	$ 105.83
Total Costs	***$ 21.09***	***$ 31.21***
Benefits		
Safety Incidents Avoided	$ 81.45	$ 181.27
Emissions Avoided	$ 1.82	$ 4.06
CO2 Avoided*	$ 18.29	$ 18.29
Congestion Costs Avoided	$ 19.20	$ 42.74
Pavement Costs Avoided	$ 19.06	$ 42.42
Total Benefits	***$ 139.82***	***$ 288.78***
Benefit Cost Ratio	**6.63**	**9.25**

*Discounted at 3%
Source: AECOM analysis

QUALITATIVE ANALYSIS OF NEAR-TERM PROJECTS

In addition to the typical benefits associated with freight and passenger rail infrastructure improvement projects, there are projects for which no quantifiable benefits were able to be estimated. These projects and their benefits are described below.

Positive Train Control

Positive Train Control (PTC) systems are real-time communication-based systems that are designed to avoid accidents and delays that may be caused by human errors, including train-to-train collisions, established work zone breaches, and derailments caused by speed violations.[61] PTC would allow North Carolina to avoid these incidents by automatically slowing or stopping a train that is about to cause an accident and allow train dispatchers to quickly reroute or schedule trains to avoid unexpected service delays or disruptions. The implementation of PTC on all mainlines used for passenger service or any toxic chemicals is required by December 15, 2015,[62] though most railroads have indicated that they would not be able to meet this deadline until 2017 or later.[63]

The avoidance of these accidents and delays creates numerous safety benefits; however, the Federal Railroad Administration (FRA) does not anticipate that these safety benefits would exceed the costs of the PTC investments.[64] The safety benefits of PTC identified by FRA include:

- Reduced risk for certain types of accidents caused by human or operator error;
- Reduced injuries (in both number and severity) caused by train accidents; and

[61] US Government Accounting Office, *Positive Train Control: Additional Authorities Could Benefit Implementation*, GAO-13-720, August 2013, p.1. Accessed at: http://www.gao.gov/assets/660/656975.pdf

[62] US Congress, Public Law 110-432, Rail Safety Improvement Act of 2008. Accessed at: https://www.fra.dot.gov/eLib/Details/L03588

[63] US GAO, GAO-13-720, p.2.

[64] Ibid, p.27.

- Reduced costs associated with property damage, equipment cleanup, environmental damage, track closures and delays, road closures, emergency response, and evacuations caused by train accidents.

In addition to these safety benefits, it has been suggested that railroads and shippers could experience business benefits due to operational efficiencies offered by PTC. Examples of these additional business benefits include[65]:

- **Line capacity enhancement**: PTC allows trains to operate with closer headways, which allows railroads to run more trains on existing track. In other words, it can help delay or avoid the construction of additional track investments.
- **Improved service reliability**: PTC provides accurate, real-time data on train location and speeds, which allows dispatchers to respond more quickly to service disruptions. It has been estimated that PTC can improve the percentage of shipments arriving on time by 3.5% and can improve travel time variance by 7%.[66] These reliability improvements create shipper benefits in the form of inventory savings and could potentially lower shipping costs if the reliability improvements are great enough to divert shipments from truck to rail.
- **Faster running times**: Studies have shown travel time reductions between 2% and 35%, depending on the commodity/train type and route.[67]
- **More efficient use of cars and locomotives**: PTC allows railroads to issue work orders to train crews in real time, including the delivery or pick up of freight cars, resulting in more efficient use of equipment.
- **Reduction in locomotive failures**: It has been estimated that the availability of real-time locomotive diagnostic information could save 8.3% of total labor compared to locomotives without any diagnostic equipment,[68] by allowing maintenance staff to identify failures and potential failure more quickly. However, most equipment purchased after 1987 has some diagnostic equipment installed.
- **Larger "windows" for track maintenance**: Due to the continued increase in rail traffic, scheduling time for inspections and maintenance has become increasingly difficult. The availability of real-time, accurate data on train locations could increase the productivity of track workers and inspectors by maximizing the time available between trains.
- **Fuel savings**: Access to real-time location data allows train dispatchers to "pace" trains between scheduled stops or points, permitting fuel savings. Railroads have estimated fuel savings in the range of 2.5% due to pacing and more efficient dispatching associated with PTC.[69]

Near-Term Studies

A number of studies are included in the near-term, including feasibility studies for passenger services, track extensions, and service development plans. The near-term studies included in the State Rail Plan are listed in Table F-27 below.

65 Randolph R. Resor, Michael E. Smith, and Pradeep K. Patel, Positive Train Control (PTC): Calculating Benefits and Costs of a New Rail Road Control Technology, prepared for FRA, July 30, 2004. Accessed at: http://www.trforum.org/forum/downloads/2005_PTCBenefits_paper.pdf

66 Ibid, p.10.

67 Resor, Smith, and Patel, p.7.

68 Ibid, p.9.

69 Ibid.

Table F-27 Recommended Studies in the Near-Term

Study Description	Jurisdiction	Possible Benefits
Feasibility of Passenger Service additions between Gastonia and Goldsboro in segment lengths and frequencies based on travel market demands.	NCDOT	Passenger travel time savings, emissions avoided, safety incidents avoided, and travel cost savings
Studies to support extension of Southeast Corridor to Charlotte to Atlanta in cooperation with GADOT and SCDOT	NCDOT	Passenger travel time savings, emissions avoided, safety incidents avoided, and travel cost savings
Service Development Plan to increase access to the corridor between Raleigh and Charlotte, increase farebox recovery and incrementally implement full 8 round-trips	NCDOT	Passenger travel time savings, emissions avoided, safety incidents avoided, travel cost savings, and train operating cost savings
Service Development Plan to incrementally implement the Southeast Corridor from Raleigh to Petersburg in coordination with VA	NCDOT	Passenger travel time savings, emissions avoided, safety incidents avoided, travel cost savings, and train operating cost savings
Service Development Plan to incrementally implement the Southeast Corridor from Petersburg to DC in coordination with VA	NCDOT	Passenger travel time savings, emissions avoided, safety incidents avoided, travel cost savings, and train operating cost savings
Traffic Separation Study along the mainline from the Galyon Depot north towards Rockingham County or Virginia	Greensboro Urban MPO	Passenger and freight benefits including travel time savings, emissions avoided, safety incidents avoided, travel cost savings, train operating cost savings, and shipper savings
Traffic Separation Study along the 'K' Line from the Mainline west towards Forsyth County	Greensboro Urban MPO	Passenger and freight benefits including travel time savings, emissions avoided, safety incidents avoided, travel cost savings, train operating cost savings, and shipper savings
This project is to extend a short rail line from the current termination on US 421 in New Hanover County to the Pender Commerce Industrial Park on the Pender/New Hanover County Line, approximately 1.5 miles	Wilmington Business Development and MPO	Train operating cost savings, shipper savings, emissions avoided, and safety incidents avoided
Hilltop Rd. and Mackey Rd. Study, Greensboro	NCDOT	Grade separation benefits including travel time savings, emissions avoided, safety incidents avoided, and vehicle costs avoided
At-grade rail crossing improvements in Wilmington on CSXT line	WMPO	Grade separation benefits including travel time savings, emissions avoided, safety incidents avoided, and vehicle costs avoided

Study Description	Jurisdiction	Possible Benefits
Study at-grade rail crossing conflicts in Wilmington at WTRY / Port	WMPO	Grade separation benefits including travel time savings, emissions avoided, safety incidents avoided, and vehicle costs avoided
Study Operational Improvements to CSXT Freight and Intermodal Network	Bostic to Hamlet	Train operating cost savings, shipper savings, emissions avoided, and safety incidents avoided
Study rail / highway interactions through Morehead City and determine impact of increased train lengths to traffic compared to shuttling smaller strings and assembling outside of town	NCDOT	Passenger and freight benefits including travel time savings, emissions avoided, safety incidents avoided, travel cost savings, train operating cost savings, and shipper savings
Wilmington Beltline Capacity	NCDOT	Passenger and freight benefits including travel time savings, emissions avoided, safety incidents avoided, travel cost savings, train operating cost savings, and shipper savings
A-Line Projects	NCDOT	Passenger and freight benefits including travel time savings, emissions avoided, safety incidents avoided, travel cost savings, train operating cost savings, and shipper savings

Source: AECOM

The studies would assess and inform the North Carolina Department of Transportation (NCDOT) Rail Division of the future conditions, benefits, costs, and impacts to the general public and shipping communities.

Wood Pellet Projects

According to the NC Maritime Strategy Report,[70] North Carolina boasts a high concentration of the US production of wood products. While its competitiveness has been weakened in recent years, the demand for wood pellets in Europe offers a high potential for growth to the state's timber industry. Expected to grow strongly in the next 10 years, North Carolina is strategically positioned to support the market due to the state's strength in timber production, and there are planned pellet facilities at both of the state's ports. The facility at the Port of Wilmington is expected to handle 1 million tons per year, while the facility at the Port of Morehead City will handle 600,000 tons per year.[71] Ensuring that the state's export facilities have the appropriate infrastructure, which should include covered storage, bulk handling equipment, and rail access from wood growing regions to the ports, is a priority in developing and supporting the wood pellet market potential. Figure F-1 shows the region's growing supply of pellet mills and terminals.

Source: The News & Observer[72]

Figure F-1 Pellet Mills Boom in Eastern North Carolina

[70] AECOM and URS for NCDOT, North Carolina Maritime Strategy Final Report, June 2012, http://www.ncdot.gov/download/business/committees/logistics/maritime/nc_maritime_final_report_2012-06-26.pdf

[71] Siceloff, Bruce, "WoodFuels contract at Morehead City is second pellets deal for NC ports," News & Observer, October 1, 2013, http://www.newsobserver.com/2013/10/01/3245654_woofuels-contract-at-morehead.html?rh=1

[72] Ibid.

Supportive strategic investments in the state's rail infrastructure would allow for higher pricing by producers in the state. This is a result of European buyers requiring that wood pellet exports be moved through a low-carbon-emitting mode, which is primarily rail, in order to meet overall greenhouse gas reduction goals. Pellets that are shipped by low-emission modes for larger portions of the trip are priced higher than comparative pellets shipped by higher-emitting modes. Improvements to the rail network in the western part of the state where producers are located would improve connections to the ports in the east. A risk to the wood pellets market is that it could evaporate, however, if the European Union (EU) initiative is abandoned or redirected to another energy source.

Investments in wood pellet facilities and access infrastructure would result in shipper savings and supply chain benefits. Non-freight users would realize travel time savings as a result of proposed highway network improvements, or from trucks diverting their shipments to rail. The state would further benefit through reduced accidents, emissions, and highway maintenance costs.[73]

Maintenance Projects

Two maintenance projects are included in the near-term prioritization list: bridges on Class I branch lines and short line bridge and infrastructure needs. These projects are necessary to keep the facilities in a state of good repair. The maintenance projects are not defined specifically and therefore do not have measurable quantitative benefits, but they do allow for continued and safe use of bridges and other rail structures. Some types of maintenance projects include:

- Bridge upgrades and repairs
- Rail replacement
- Tie replacement and surfacing
- Management of road crossings
- Siding and spur maintenance
- Yard expansions

[73] AECOM and URS for NCDOT, North Carolina Maritime Strategy Final Report, June 2012, http://www.ncdot.gov/download/business/committees/logistics/maritime/nc_maritime_final_report_2012-06-26.pdf

Maintenance projects can result in benefits of added train capacity or higher speeds, which may generate travel time savings, train operating cost savings, shipper savings, and potentially truck diversions that save trips on the state's highway network. Finally, periodic maintenance also reduces the likelihood of future major repairs or delays replacement, as facilities are kept in a state of good repair.

Expansion of Carolinas ReLoad Facility

The Carolinas ReLoad facility is located in Wadesboro (Anson County). The facility is currently capable of serving 40 rail cars per month based on existing biweekly CSXT service. The existing warehouse is not climate controlled, but has a capacity of 80,000 cubic feet for storage. A track and facility expansion from 3.26 acres to 13.26 acres would quadruple the rail car capacity on site and provide access to a new and expanded warehouse. The new warehouse is proposed to be climate-controlled and store up to 30 million cubic feet of merchandize or bulk materials. The cost of the project, which would allow for expanded capacity and better service to 3rd party motor carriers, is estimated to cost $2.5 million[74] and would provide shipper savings and potentially divert trucks currently traveling on North Carolina's roads to rail, generating emissions, safety, pavement, and congestion benefits for the state.

BENEFITS ANALYSIS OF MID- AND LONG-TERM PROJECTS

The following projects have been proposed for funding beyond the near-term program. The benefits associated with these projects are discussed qualitatively in the sections below, because the required data were not available to do a detailed quantitative analysis.

Proposed Mid-Term Rail Projects

The following projects have been proposed for funding in the 6-10 year program.

[74] Carolinas ReLoad

Mid-Term Studies

A number of studies are included in the mid-term, including feasibility studies for passenger services, grade crossing improvements, pedestrian crossings, a new river crossing, and rail relocation plans. The following studies are proposed for the 6-10 year program.

Table F-28 Recommended Studies in the Mid-Term

Study Description	Jurisdiction	Possible Benefits
Feasibility of Passenger Service Charlotte to DC via Greensboro and Lynchburg.	NCDOT	Passenger travel time savings, emissions avoided, safety incidents avoided, and travel cost savings
Feasibility of Returning Service to SA line, Norlina to VA line	NCDOT	Passenger travel time savings, emissions avoided, safety incidents avoided, and travel cost savings
Connector Bus Service / One Ticket	State Rail Plan	Passenger travel time savings, emissions avoided, safety incidents avoided, travel cost savings, and willingness to pay for an amenity
Install Crossing Signals and Gates on West Dolphin Street	Siler City	Safety incidents avoided
Install Crossing Signals and Gates on West Elk Street	Siler City	Safety incidents avoided
Downtown Pedestrian Crossing on West Raleigh Street	Siler City	Safety incidents avoided
Downtown Pedestrian Crossing on West Second Street	Siler City	Safety incidents avoided
Downtown Pedestrian Crossing on West Third Street	Siler City	Safety incidents avoided
New Cape Fear River Crossing	WMPO	Capacity improvements, more efficient train movements, and state of good repair
Feasibility of Passenger Service Connecting Raleigh to Hampton Roads / Tidewater Area	Raleigh to Hampton Roads	Passenger travel time savings, emissions avoided, safety incidents avoided, and travel cost savings
Relocation of NCRR from Morehead City to Havelock	NCDOT	Increase in rail capacity, train operating cost savings, reduction in auto/rail conflicts, and improvements to safety

Source: AECOM

The studies would assess and inform NCDOT Rail Division on the need for the investments, as well as quantify future conditions, benefits, costs, and impacts to the general public and shipping communities.

New Train Sets

Two new train sets, consisting of seven passenger cars, a cab car, locomotive, and spare parts are estimated to cost $73 million. The equipment would supplement the *Piedmont* route to accommodate higher ridership growth, as well as provide equipment for the proposed 5th frequency. The new trains would reduce operating and maintenance costs, lower the average fleet age, and bring the equipment up to a state of good repair.

Burlington Station Parking Expansion

Expanding the Burlington Station would allow the station to accommodate the increasing need for parking due to ridership growth. The station expansion is estimated to cost $500,000. The station would provide increased accessibility for residents to the state's passenger rail services, which could help reduce VMT on the state's roadways and generate safety, emissions, pavement, and congestion benefits.

Station Parking

These projects would increase station parking capacity at multiple stations including those in Wake, Durham, Guilford, and Rowan counties to accommodate the parking needs due to increased ridership on the *Piedmont*-served stations. Parking structures may be necessary at some stations, and the projects are estimated to cost $80 million. Without the availability of increased parking, the projected growth in passenger rail may not be achieved and could potentially increase the VMT on the state's roadways.

Salisbury Station Expansion

The purchase of the Salisbury station, including expansion and a platform for a second track, is estimated to cost $10 million. The project would accommodate growth in ridership from the increased frequencies of Amtrak services. The project also would address additional parking needs associated with the increase in ridership. The increased ridership that these improvements help accommodate could reduce VMT on the state's roadways and generate safety, emissions, pavement, and congestion benefits.

Kannapolis Station

Increased surface parking at the Kannapolis station would accommodate the increasing demand for parking that is the result of the growth in ridership on Amtrak services. The parking lot expansion is estimated to cost $5 million and also would provide improved dispatch flexibility and track utilization in addition to the potential to remove VMT from the state's roadways.

Lexington Station

The Lexington station project would create a multimodal transportation center within a targeted redevelopment area, the Depot District. The District is adjacent to the historic, vibrant downtown and the project would attract additional ridership to the state's passenger services, induce trips, and remove VMT from the state's roadways.

Harrisburg Station

The Harrisburg station project would expand passenger service to a new town, which improves accessibility to residents. The station would complete the stations planned for the corridor resulting in an average distance between stations of 17 miles. The project also includes track improvements needed to offset delays that are resulting from the addition of the Station stop as required by the Definitive Service Outcome Agreement (DSOA) with NS. The station is estimated to cost $30 million and would help accommodate increased ridership, potentially reducing travel times and reducing VMT on the state's roadways and generating safety, emissions, pavement, and congestion benefits.

Cary Station

The Cary station is proposed to be at a new location, providing better access to the *Carolinian* and *Piedmont* routes. The station could thereby provide travel time savings and travel cost savings to riders, as well as provide safety, emissions, pavement, and congestion benefits by reducing VMT on the state's roadways.

Crossing Signal Upgrades

The project involves upgrading 43 crossing signals for enhanced safety with higher speed trains. The $20 million project would improve crossing safety by optimizing crossing signal timing for faster train speeds and implement new technologies. The improvements would maximize the benefits of speed improvements gained through existing ARRA funded projects. In addition, the upgrades prepare the rail lines for implementation of FRA mandated Positive Train Control and the associated increased maximum speeds. Finally, the crossing upgrades would reduce the probability of delays due to crossing incidents for motorists and pedestrians, thereby reducing emissions and vehicle operating costs associated with these delays.

Upgrading NCRR to 90 MPH

The proposed project would upgrade the NCRRPiedmont corridor tracks to accommodate 90 mph speeds. Current speeds are 79 mph, and the improvements would result in travel time savings for passengers and freight in the corridor. Travel time savings for freight also results in train operating savings, shipper savings, and reduced truck VMT by diverting trucks from highways to rail. The improvements are estimated to cost $30 million.

Wilson Station Canopy Upgrade

The Wilson station canopy upgrade project would provide improved shelter at the station for boarding and alighting passengers. The improvement would be a station amenity valued in a willingness to pay estimate for all station users. The upgrade is estimated to cost $1 million.

Fayetteville Station Canopy Upgrade

The Fayetteville station canopy upgrade project would provide improved shelter at the station for boarding and alighting passengers. The improvement would be a station amenity valued in a willingness to pay estimate for all station users. The upgrade is estimated to cost $1 million.

Selma Station Platform Extension

Extending the platform at Selma station would allow trains to serve the platform more efficiently. This increase in efficiency would reduce delays on the line for trains and passengers. The upgrade is estimated to cost $400,000.

Sanford Station

The Sanford station project would be a new stop on the existing Amtrak *Silver Star* route. The station would provide passenger access to the Amtrak route that already passes through the community. Currently, the nearest stations are 36 miles to the north and 27 miles to the south. An existing historic station could be used, or a new site. The station would provide passengers with mobility benefits including travel cost savings and accessibility to other parts of the state. In addition, the station would help accommodate new riders, reducing VMT on the state's roadways and generating safety, emissions, pavement, and congestion benefits.

Iredell County Grade Separations

The project would provide for grade crossing separations in order to relocate traffic movements from existing substandard crossings within the town. Existing at-grade crossings in and around Mooresville contribute to safety and mobility concerns in the area. Corridor separation and elimination of substandard crossings would be a safety improvement and time savings for the travelling public and provide cost savings for shippers through more efficient train movements. The project is estimated to cost $200,000.

PTI Rail Spur

The project would construct a rail spur at the Piedmont Triad International Airport in Greensboro. The project could provide better access to rail for shippers at the airport, reducing transportation costs for some shipments and potentially attracting business to the airport industrial area. In addition, by allowing for more shipments to be accommodated by rail rather than truck, truck VMT in the state may be reduced, resulting in safety, emissions, pavement, and congestion benefits. The project is estimated to cost $1 million.

Grade Separations in Charlotte

Two grade separation projects in Charlotte are recommended, including a crossing at Old Dowd Road and MLK Boulevard. These crossings would reduce rail and auto conflicts, thereby improving safety and travel times. Trains also would be able to move more efficiently, potentially saving shippers time and money.

Extend Davidson Tracks

The project proposes to extend three forwarding tracks by approximately 1,000 feet each and extend pullback tracks in order to increase capacity. Currently shipments are left in the classification yard due to insufficient track space. A new North End Tower would also replace the existing building at Linwood Yard. The project would increase throughput, estimated at an additional 165 cars per day. The project is expected to cost $4 million, and generate train operating savings and shipper savings due to time saved.

Kimberly Clark Lead

The project would construct a lead track in Lexington that would allow the local train to clear the mainline track during switching operations. The removal of the blockage would result in increased network fluidity for both freight and passenger trains, thereby providing travel time savings, train operator savings, and shipper savings. The track is estimated to cost $2 million.

Pomona Yard

The project plans to extend the Pomona Yard auxiliary track and add power turnouts at a cost of $3 million. The project could result in increased statewide mobility for freight trains, diverting shipments from truck to rail and saving transportation costs for shippers and reducing truck VMT, which would result in safety, emissions, pavement, and congestion benefits.

Campus Ridge Road Grade Separation

The project in Matthews proposes to replace the existing at-grade crossing with a grade separation. The separation would provide safety benefits for autos and trains and reduce vehicle operating costs, travel times, and emissions. It is expected to cost $5.5 million.

Charlotte Intermodal Terminal Expansion

The Phase III Expansion of the Charlotte Intermodal Terminal and supporting rail infrastructure would include construction of new wheeled parking and container stacking areas, construction of four new processing tracks, and installation of three rail-mounted zero-emission wide span cranes for container processing. The improvements would increase capacity at the terminal from 122,000 lifts per year to 246,000 lifts per year. The expansion would provide shipper savings, divert shipments from truck to rail, reduce wear and tear on the state's highways, and encourage economic competitiveness in the region. The project is estimated to cost $49 million.

Grade Separation in Charlotte

A proposed project would grade separate the CSXT SF line and the NS Mainline by relocating the CSXT line into a 3,400 foot long trench below the NS Mainline. As a result, freight conflicts would be reduced, increasing speeds and saving shippers time and money. The project is estimated to cost $257 million.

Grade Separation at Ward Road

The project includes grade separating a crossing in Greensboro at Ward Road and closing another crossing nearby at Maxfield Road. The separation and closure would increase safety and reduce emissions, vehicle operating costs, and travel times for autos. The project is estimated to cost $5.08 million.

Grade Separation at Franklin Boulevard

The project includes grade separating a crossing in Greensboro at Franklin Boulevard and closing another crossing nearby at O'Ferrell Street. The separation and closure would increase safety and reduce emissions, vehicle operating costs, and travel times for vehicles. The project is estimated to cost $10.6 million.

Grade Separation at Wagoner Bend Road

The project includes grade separating a crossing in Greensboro at Wagoner Bend Road and closing another crossing nearby at Buchanan Church Road. The separation and closure would increase safety and reduce emissions, vehicle operating costs, and travel times for vehicles. The project is estimated to cost $7.9 million.

Grade Separation at Harrison Avenue

The project includes grade separating a crossing in Cary at Harrison Avenue. The separation and closure would increase safety and reduce emissions, vehicle operating costs, and travel times for vehicles. The project is estimated to cost $14.5 million.

Automotive Terminal

The construction of a 40 acre facility in Moncure would handle 60 railcars and 2,000 vehicles per day. The facility is expected to serve the Raleigh-Durham, Winston-Salem, and Wilmington markets and cost $13 million. An automotive terminal could provide shipper savings for dealers who would normally ship autos to terminals farther away. As a result, their shipments would experience cost and time savings.

Grade Separation at South West Street

The project includes grade separating a crossing in Raleigh at South West Street and includes the closure of a crossing at nearby West Cabarrus Street. The separation and closure would increase safety and reduce emissions, vehicle operating costs, and travel times for vehicles. The project is estimated to cost $72.6 million.

Grade Separation at Apex Peakway

The project includes grade separating a crossing in Apex at Apex Peakway and South Salem Street and includes the closure of a crossing at nearby Tingen Road. The separation and closure would increase safety and reduce emissions, vehicle operating costs, and travel times for vehicles. The project is estimated to cost $12.1 million.

Sophia Siding

The project involves constructing a new siding at Sophia on the M Line to move cars out of High Point Yard and create room to allow the local train to clear the mainline. The project, estimated to cost $3 million, would provide freight time savings for shippers and potentially passenger travel time savings as well.

Upgrade Oxford-Durham Line

The proposed project would upgrade the Oxford-Durham line in order to serve CertainTeed, a building products manufacturer, with unit trains and the 6-axle locomotives such trains require. The current traffic is supported on a local basis with 4-axle locomotives. As a result of the project, capacity is increased and shippers can save on transportation costs by switching to the upgraded line. The cost of the project is estimated at $7 million.

Andrews to Murphy Reactivation

The reactivation of the NCDOT Rail Division's line between Andrews and Murphy would allow for passenger, freight, or both services between the two towns, located 15 miles apart. As a result, the potential benefits include passenger travel time and cost savings, as well as attracting freight to rail instead of truck. Those diverted shipments would result in safety savings, travel cost savings, and emissions and congestion reductions. The reactivation is estimated to cost $4.2 million.

Relocate Aberdeen Carolina & Western Railway

Relocating the ACWR line in Charlotte would cost approximately $16.5 million. The project would remove conflicts in Charlotte and therefore save shipping time and costs.

Maintenance Projects

Five maintenance projects are recommended in the mid-term, including some ongoing maintenance from the near-term. The projects include:

- Preserving threatened rail lines, at a cost of $12 million
- Maintenance of bridges and structures on NCDOT-owned corridors, at a cost of $12 million
- Maintenance of bridges on Class I branch lines
- Short line bridge and infrastructure needs, at a cost of $174 million
- Maintenance of NCDOT-owned rail corridors

Maintenance projects can result in benefits of added train capacity or higher speeds, which results in travel time savings, operating cost savings, shipper savings, and potentially truck diversions that save trips on the state's highway network. Finally, periodic maintenance also reduces the likelihood of major repairs down the road, as facilities are kept in a state of good repair.

Naco Road

The project in Greensboro would provide passenger and freight safety benefits at a cost of $600,000.

US 421/CSXT Crossing Improvements

Grade crossing improvements in Wilmington at the intersection of US 421 and the CSXT line would improve safety for autos and trains. The project is located south of I-140 and the Dan Cameron Bridge. It is estimated to cost $400,000.

Capital Yard Extensions

The Capital Yard extension in Wake County would eliminate conflicts with passenger and freight trains and to improve train reliability. The growing freight traffic in the adjoining CSXT yard and passenger trains would be able to move more freely with these track improvements. The lead tracks would be extended to both the north and south to reduce conflicts, and yard track would be added as well. The project is estimated to cost $5 million.

Charlotte Gateway Station

The Charlotte Gateway Station, a large infrastructure and real estate venture, estimated to cost $200 million, would provide passenger rail access to larger numbers of riders by interconnecting modes in Uptown Charlotte. The station would be a multimodal hub for local and express bus services, commuter rail, streetcar, and intercity Amtrak services. Increases in ridership would reduce emissions, safety incidents, travel costs, and travel times for riders. It would also provide enhanced access to employment in the city. In addition, the real estate market would benefit from an increase in property values adjacent to the site due to the higher level of accessibility there.

A-Line Projects

The A-Line projects, estimated to cost approximately $500 million, would provide spot improvements along CSXT's A Line that would improve Amtrak's *Carolinian* service and on-time performance. With the improvement to on-time performance comes greater service reliability, which is attractive to passengers and could result in increases in ridership. In June 2014, 257 minutes of delay were experienced on the A-Line by *Carolinian* passengers between Selma and Rocky Mount. Such delays deteriorate not only ridership, but also result in extra shipping and inventory costs for companies whose goods are delayed. These spot improvements would have wide-reaching benefits by attracting riders from their cars, resulting in reduced safety incidents, emissions, congestion, and vehicle operating costs. In addition, shippers would save money on transportation costs and inventory.

Aycock Bridge Replacement

An existing grade separation in Greensboro needs to be replaced where the Norfolk Southern line crosses over Aycock Street. The $10 million project would reconstruct the bridge and to accommodate widening Aycock Street to allow for better auto, pedestrian, and vehicle traffic flows at the road-level, and would provide a wider bridge to accommodate additional rails for proposed additional and/or high speed services in the future. It would also bring the bridge up to current design standards and provide adequate vertical clearances. The increased capacity could attract shipments from trucks to rail, resulting in shipper savings and reduced truck VMT. For vehicles, additional travel lanes on a major thoroughfare that experiences congestion and delays would increase capacity, reduce travel times and congestion, as well as improve safety for better visibility between autos, pedestrians, and cyclists.

Proposed Long-Term Rail Projects

The following projects have been proposed for funding in the 10-20 year program.

Long-Term Studies

A number of studies are included in the long-term, including feasibility studies for passenger and freight services, a multimodal terminal, rail spur, and construction of a rail line. The following studies are proposed for the 10-20 year program.

Table F-29 Recommended Studies in the Long-Term

Study Description	Jurisdiction	Possible Benefits
Feasibility of SA line from Norlina to Roanoke Rapids for potential future freight and passenger connections to Norfolk.	Warren and Halifax counties	Passenger travel time savings, emissions avoided, safety incidents avoided, travel cost savings, and potentially shipper savings and truck diversions to rail
Feasibility of Passenger Rail to Greenville	Pitt County	Passenger travel time savings, emissions avoided, safety incidents avoided, and travel cost savings
Multimodal Terminal in Wilmington	New Hanover County	Passenger travel time savings, emissions avoided, safety incidents avoided, and travel cost savings
Rail Spur from Blue Clay Road to Wilmington Airport	New Hanover County	Freight savings may divert trucks to rail, reducing truck VMT, safety incidents, emissions, pavement maintenance, and congestion
Feasibility of passenger service connecting Raleigh to Morehead City	Wake, Johnston, Wayne, Lenoir, Jones, Craven, and Carteret counties	Passenger travel time savings, emissions avoided, safety incidents avoided, travel cost savings
Construction of railroad line running along the Western side of I-77 from the Iredell County line to connect with the Yadkin Valley Railroad in Surry County	Yadkin, Surry, Iredell counties	Enhance economic development and increase rail shipments, thereby reducing truck VMT, safety incidents, emissions, pavement maintenance, and congestion

Source: AECOM

Charlotte South End Track Improvements

As part of the Charlotte Gateway Station project, the South-End track improvements would provide track for passenger turning trains to return north, and also increase capacity for meets and overtakes. The project would improve on-time performance and result in passenger travel time savings and train operating savings. Finally, safety would also be improved for passengers.

Charlotte Maintenance Facility

Phases IB and II of the Charlotte Maintenance Facility would provide service and maintenance of passenger equipment for three important routes: *Piedmont*, *Carolinian*, and the Southeast High Speed Rail (SEHSR). These rail services provide accessibility for passengers along the East Coast, and remove autos from the road. Benefits of reducing auto VMT include savings for vehicle operating costs, congestion, pavement, emissions, and safety incidents avoided. In addition, the facility would provide more efficient maintenance of the equipment, thereby saving operating and maintenance time and costs for operators. The project is estimated to cost $80 million.

Triple Track Junker to Graham

Triple-tracking the segment between Junker and Graham in Charlotte would provide increased capacity for freight along a heavily-used segment. The capacity would allow for the planned passenger trains to pass freight trains, thereby improving safety and on-time performance for passenger trains. Benefits to passengers would include travel time savings and reliability, and train operator savings and potentially freight shipper savings could be realized. In addition, the capacity increase could result in more trains moving faster, thereby saving travel times for shipments. The cost of the project is estimated at $21 million.

Charlotte North-End Passenger Bypass

The project would provide two tracks dedicated to passenger service at a cost of $53 million. The new tracks would provide a bypass for passenger trains and improve efficiencies for all rail movements that result from the new track configuration. Faster trains result in passenger travel time savings, train operating cost savings, and shipper savings. The capacity increase allows for more growth in the passenger services in the future for higher frequencies and speeds.

NCRR Mainline Sidings

Adding two sidings to the NCRR mainline would provide space for local freight trains to pull off and reduce conflicts with passenger trains on the mainline. The conflicts currently result in delays for both passengers and shipments, negatively impacting shippers and train operators as well as causing travel time losses for passengers. The specific locations of the sidings are yet to be determined, but the total project cost is expected to be $7 million.

Kannapolis Station Platforms

The Kannapolis Station project would construct a new platform for the second track and extend the existing platform. The improvements would provide passenger access to the second track and reliability. The investment maximizes the operational efficiency of the American Recovery and Reinvestment Act of 2009 (ARRA)-funded Reid to North Kannapolis double-track project. The platform projects would allow trains to save travel times and associated operating costs, and passengers would be able to board and alight faster. The project is estimated to cost $5.5 million and could help accommodate increased ridership, potentially reducing VMT on the state's roadways and generating safety, emissions, pavement, and congestion benefits.

Rogers Lake Grade Separation

A grade separation at Rogers Lake Road crossing in Kannapolis would reduce conflicts between trains and autos, resulting in safety incidents avoided, travel time and vehicle operating cost savings, and reduced emissions.

Salisbury Station

The Salisbury Station platform construction and station purchase project would provide access to additional track capacity that would result in improved reliability for passenger arrivals and departures. Train operator savings would result from time saved due to more efficient passenger boardings and alightings, as well as improved dispatch flexibility and increased track utilization. The project is estimated to cost $9 million.

Salisbury North Side Grade Separation

The project would construct a grade separation in the area of 12th Street and Bringle Ferry Road in Salisbury. The elimination of the crossing hazard would reduce the safety incidents for autos and pedestrians. Emissions, travel delays at the crossing, and vehicle operating costs would also be reduced. The project is estimated to cost $21 million.

Long Ferry Road Grade Separation

The project would construct a grade separation in the area of Long Ferry Road in Spencer. The elimination of the crossing hazard would result in safety incidents avoided, travel time and vehicle operating cost savings, and reduced emissions. The project is estimated to cost $17 million.

Liberty Drive Grade Separation

The project would construct a grade separation in the Liberty Drive and Turner Street area in Thomasville. The elimination of the crossing hazard would reduce the likelihood of safety incidents and provide travel time savings, vehicle operating cost savings, and reduced emissions.. The project is estimated to cost $6 million.

Scientific Street Grade Separation

The project would construct a grade separation in the area of Scientific Street in Jamestown. The elimination of the crossing hazard would result in safety incidents avoided, travel time and vehicle operating cost savings, and reduced emissions. The project is estimated to cost $4 million.

Oakdale Grade Separation

The project would construct a grade separation in the area of Oakdale Avenue in Jamestown. The elimination of the crossing hazard would reduce the likelihood of safety incidents for autos and pedestrians and provide travel time savings, vehicle operating cost savings, and reduced emissions. The project is estimated to cost $7 million.

Deep River Bridge Realignment

The Deep River Bridge Realignment project would increase speeds on the bridge from 65 mph up to the design speed of 79 mph. In addition, the bridge would allow for a future upgrade to accommodate train speeds of 90 mph. The new bridge would improve speeds, travel times, and reliability for passengers and potentially reduce train operating costs by saving travel time. The project is estimated to cost $14 million.

Double Track Siding in Greensboro

The project would finish the double-track of a siding between Greensboro and McLeansville. The new siding would provide schedule reliability and reduce travel times. The project would complete a 9-mile double track section from Greensboro to McLeansville and provide capacity for the future 6th frequency of passenger trains. Safety would be improved at multiple grade crossings, reducing the likelihood of incidents. The siding provides for improved speeds, thereby reducing travel times, and increases capacity by allowing for improved track utilization. The project is estimated to cost $82 million.

Double Track in Gibsonville

The project would double track a segment in Gibsonville, which would improve speeds and reliability. The project would complete a 15-mile double track segment from Greensboro to Elon. It would allow for design speeds of 79 mph and provide for future upgrades to 90 mph. The project would result in travel time savings for passengers and freight, resulting in shipper savings and train operating cost savings due to the capacity increase and track upgrades. The project would cost $51 million.

Double Track in Mebane

The project would double-track from the Haw River to the Mebane Siding, including the replacement of the Haw River Bridge and the NC 49 Bridge. The new siding and bridges would reduce travel times for passenger trains. Existing speeds in the area are 45-50 mph, and the project would increase the design speed to 79 mph and allow for future upgrades to 90 mph. The project would also increase capacity and is estimated to cost $94 million.

Mattress Factory Grade Separation

The project would construct a grade separation in the area of Mattress Factory Road in Mebane. The elimination of the crossing hazard would reduce the likelihood of safety incidents for autos and trains, and allow the siding to be fully utilized without delaying highway traffic. Emissions, vehicle delays, and vehicle operating costs would also be reduced. The project is estimated to cost $13 million.

Extend Mebane Siding

The project proposes to extend the Mebane siding from Isom to Efland and provide a grade separation at Buckhorn Road, as well as curve realignment. The speeds would be increased to 79 mph and allow for future upgrades to 90 mph. The improved track geometry increases freight capacity and speeds, resulting in shipper savings and operating cost reductions for trains. The bridge replacement would result in reduced maintenance costs in the future as well. The project is estimated to cost $28 million.

Efland Curve Realignment and Bridge

The project would realign four curves to the east of Efland and potentially replace the US 70/I-85 connector bridge. The improved segment would increase design speeds to 79 mph and allow for future upgrades to 90 mph trains. The improvements would increase capacity, resulting in shipper savings and travel time savings. The cost of the project is $14 million.

Hillsborough Curve Realignment and Bridge

The project would realign four curves to the west of Hillsborough and potentially replace the bridge over the Eno River. The improved segment would increase design speeds to 79 mph and allow for future upgrades to 90 mph trains. The improvements would increase capacity, resulting in shipper savings and travel time savings. The cost of the project is $19 million.

University Station Mainline Realignment

The $41 million project would realign the mainline in Orange and Durham counties for passenger services, creating a new 3-mile route. The new route would extend the Funston siding to remove bottlenecks and make the existing track a 5-mile passing siding. The new facility would have improved safety through longer sight distances and correct the substandard clearance by replacing bridges. The facility would be upgraded to accommodate the design speed of 79 mph with possible future upgrades to 90 mph. Other benefits of the project include reduced track maintenance costs, increased capacity, and shipper savings.

Double Track Fulston to Durham

The $53 million project would double track a segment of the line in Durham and improve five bridges. The project would result in reduced travel times by improving the rail to a design speed of 79 mph and allowing for future upgrades to 90 mph. Freight capacity would also be improved, providing shipper savings, reducing inventory costs, and diverting trucks from the highways.

Durham Station Platform

The new platform at Durham Station would provide capacity through a center-island platform that would increase efficiency and reliability for arriving and departing trains. The increased reliability would result in travel time savings and potentially increased ridership on the service, thereby diverting auto VMT and reducing safety incidents, emissions, vehicle operating costs, and congestion. The project is estimated to cost $10 million.

Durham Siding Extension

Constructing an extension on the East Durham Siding would include a number of grade separations and closures. Three crossings would be closed at Ellis Road, Glover Road, and Wrenn Road. The project would result in freight capacity increases and truck diversions, resulting in decreased VMT on the region's highways. The VMT avoided also would reduce congestion, pavement, vehicle operating costs, safety incidents, and emissions.

Double Track Alexander Drive

The project would double track the segment between Alexander Drive and Clegg, including a bridge over I-40. The project would upgrade rail to accommodate 79 mph design speeds and allow for future upgrades to 90 mph. Freight capacity would also be improved, providing shipper savings, reducing inventory costs, and diverting trucks from the highways. The project is estimated to cost $20 million.

Double Track and Cary Station Platform

The project proposes to double track from west of Harrison Avenue to Fetner, as well as constructing a center island platform at the station. The platform would provide access to the second track, thereby improving reliability and maximizing the operational efficiency of the station expansion project. The increased efficiency and reliability would save travel time for users and increase ridership, potentially diverting autos from the roads and reducing emissions, safety incidents, vehicle operating costs, and congestion. The project is estimated to cost $15.6 million.

Full Implementation of the Southeast Corridor

The project would implement the Southeast Corridor planning, including right of way acquisition, surveying, design, construction, station area improvements, and rolling stock purchases. The project would provide expanded passenger mobility and accessibility to the state, potentially providing time savings to passengers and diverting autos from the roads and reducing emissions, safety incidents, vehicle operating costs, and congestion.

Replacement Equipment for Carolinian Train Set

The project proposes replacing rolling stock for the *Carolinian* service. This would reduce the age of the rolling stock, leading to improved long-term reliability and reduced maintenance costs in the future. In addition, an upgraded riding environment could result in increased ridership, which would reduce VMT on the state's highways and thereby reduce safety incidents, emissions, congestion, and vehicle operating costs.

Triple Track at Linwood Yard or North of Salisbury Station

The project would triple track the segment of rail near Linwood Yard or North of Salisbury Station. The project would lead to improvements in passenger rail capacity, and thus to reduced automobile traffic and fewer emissions, safety incidents, congestion, and vehicle operating costs.

Capital Yard Phase II – New Maintenance Building

This project in Wake County would construct a new maintenance building, which would support service and maintenance of passenger equipment for 8-9 train sets. The facility would reduce O&M costs and maintain equipment at a state of good repair. The project is estimated to cost $13 million.

Southeast North Carolina Passenger Service (SENC) – Wilmington to Raleigh via Goldsboro

This project would expand passenger rail service from Wilmington to Raleigh via Goldsboro. This expansion of service would benefit Wake, Johnston, Wayne, Duplin, Pender, and New Hanover counties, broadening the transportation options and improving mobility for residents. These service improvements could potentially provide time savings to passengers and divert autos from the roads, thereby reducing emissions, safety incidents, vehicle operating costs, and congestion. This project is estimated to cost $90 million.

Southeast North Carolina Passenger Service (SENC) – Wilmington to Raleigh via Pembroke, Fayetteville and Selma

This project would expand passenger rail service from Wilmington to Raleigh via Pembroke, Fayetteville, and Selma. This expansion would include station improvements and would benefit Wake, Johnston, Harnett, Cumberland, Robeson, Columbus, Brunswick, and New Hanover counties, broadening the transportation options and improving mobility for residents. These service improvements could potentially provide time savings to passengers and divert autos from the roads, thereby reducing emissions, safety incidents, vehicle operating costs, and congestion. This project is estimated to cost $160 million.

New Passenger Service between Salisbury and Asheville

This project would establish passenger rail service between Salisbury and Asheville, and would include station improvements. This expansion would benefit McDowell, Catawba, and Iredell counties, specifically the cities of Salisbury, Statesville, Hickory, Conover, Valdese, Morganton, Marion, Old Fort, Black Mountain, and Asheville. It would broaden transportation options and improve mobility for residents in the region who currently do not have access by rail to the rest of the state. These service improvements could potentially provide time savings to passengers and divert autos from the roads, thereby reducing emissions, safety incidents, vehicle operating costs, and congestion.

Passenger Rail Service in Guilford and Forsyth Counties

This project would establish a passenger rail service between Winston-Salem, Kernersville, Piedmont Triad International Airport, and Greensboro, and would be accompanied by line improvements and multi-modal public transportation facilities in Greensboro, Kernersville, Winston-Salem, and by the airport. This project would broaden the transportation options and improve mobility for residents of Guilford and Forsyth counties and potentially provide travel cost savings to important destinations like the airport. These service improvements could potentially provide time savings to passengers and divert autos from the roads, thereby reducing emissions, safety incidents, vehicle operating costs, and congestion.

Grade Separation in Kannapolis

This project would construct a grade separation at or near 22nd Street, in coordination with two at-grade crossing closures, to increase the safety of rail and highway traffic in Kannapolis. The project would result in increased efficiency for trains and autos, reducing emissions, safety incidents, vehicle delays, and vehicle operating costs.

Grade Separation in Durham

This project would construct a grade separation at Ellis Road in Durham. The project would result in increased efficiency for trains and autos, reducing emissions, safety incidents, vehicle delays, and vehicle operating costs.

Relocate NCRR in Craven and Jones Counties

This project would relocate a section of the NCRR in Craven and Jones counties in the same corridor planned for the New Bern bypass for US 70. This project would move the mainline of NCRR out of the downtown streets of New Bern and allows for higher speeds and safer train operations on this section of the route as freight moves to the state port at Morehead City. This project would improve railroad safety and allow freight to move faster, resulting in shipper savings and train operating savings.

Wallace to Castle Hayne Rail Corridor Restoration

This project would restore the Wallace to Castle Hayne Rail Corridor from just north of Wilmington to Wallace. The restoration would provide improved freight rail connectivity in the region, potentially serving more shippers and increasing volumes through the Port of Wilmington. The line would also provide redundancy for military installations in the region. This project is expected to cost $118.25 million.

Connect CSXT Rail Spur at GTP

This project would construct a rail spur from the Global TransPark to the CSXT line parallel to NC 11. This new spur would provide enhanced rail connectivity to shippers at the Global TransPark, potentially removing trucks from the region's roads and increasing the efficiency of moving goods between GTP and locations served by CSXT, including the Ports of Norfolk and Wilmington.

Preservation of Threatened Rail Lines

This project would maintain and preserve 40 miles of threatened rail lines in the state. The maintenance would ensure these rail lines are kept in a state of good repair, thereby avoiding future overhaul costs when and if the lines are again utilized.

Maintenance of Rail Bridges and Structures on NCDOT-owned Rail Corridors

This project would provide for maintenance of 20 miles of rail bridges and structures on NCDOT-owned rail corridors, improving the condition of rail infrastructure in the state. The maintenance would ensure these structures are kept in a state of good repair, thereby avoiding future overhaul costs.

Bridges on Class I Branch Lines

This project would provide for maintenance of bridges on Class I branch lines, improving the condition of rail infrastructure in the state. The maintenance would ensure these structures are kept in a state of good repair, thereby avoiding future overhaul costs.

Short Line Bridge and Infrastructure Needs

This project would provide for maintenance of short line bridges and other infrastructure. The maintenance would ensure these structures are kept in a state of good repair, thereby avoiding future overhaul costs.

Appendix G
Economic Impacts of Rail in North Carolina

INTRODUCTION

The freight and passenger rail networks contribute approximately $1.85 billion in direct economic impacts per year for North Carolina. The impacts are calculated based on the additional economic costs that would result if rail were no longer an option for freight or passengers in the state. For freight, this means that all rail freight would be diverted to trucks, resulting in additional shipping costs (rail is cheaper than truck), pavement costs (i.e. wear and tear on the roads), and congestion costs (travel time impacts for other vehicles from the increased number of trucks on the road). For passenger rail, Amtrak service would no longer be available in North Carolina, resulting in the loss of direct Amtrak jobs, purchases of goods and services, and tourist spending in the state (for those passengers who only take the trip to North Carolina with rail), as well as pavement and congestion savings from increased auto vehicle miles traveled (VMT). Table G-1 summarizes the annual direct economic impacts associated with freight and passenger rail in North Carolina.

Table G-1 Annual Direct Economic Impacts for Freight and Passenger Rail in North Carolina ($2014M)

	Freight (2011)	Passenger (2014/2012)[1]
VMT Avoided within NC Due to Use of Rail	679.8 million	72.5 million
User Cost Savings (Shipper)	$ 1,496.13	$ -
Amtrak Direct Wages and Purchases	$ -	$ 89.00
Tourist Direct Spending[2]	$ -	$ 2.30
Pavement Savings	$ 95.72	$ 4.30
Congestion Savings	$ 161.53	$ 4.34
Total	**$ 1,753.38**	**$ 99.94**

[1]Amtrak Direct Wages and Purchases and Tourist Direct Spending are FY2014, while Pavement and Congestion Savings are based on FY2012 data
[2]Tourist Direct Spending represents the spending of those tourists traveling to North Carolina by rail who would not have come to the state or spent those dollars in the state without Amtrak (based on Amtrak survey data).
Source: AECOM analysis of Waybill, Amtrak, and SEHSR data

The direct economic impacts of freight rail are estimated using a methodology similar to that applied by the North Carolina Railroad Company (NCRR) in a 2014 study[1] that estimated its impacts to the North Carolina economy, with a few important differences. The primary difference is that the NCRR estimate only reflects the impacts for NCRR, while the impacts shown in Table G-1 are for the entire state. In addition, the statewide estimate of shipper savings utilizes more conservative assumptions on cost savings than those applied in the NCRR report. The NCRR report estimates a cost savings of 58% per ton-mile for

[1] RTI International, Measuring the North Carolina Railroad Company's Impact on North Carolina, 2014, http://www.ncrr.com/wp/wp-content/uploads/2011/11/1030-am_RTI.pdf

shipping intermodal freight via rail rather than truck and an overall cost savings of 78% per ton-mile for rail freight compared to truck. The shipper savings shown in Table G-1 assumes a 20% savings for rail shipped via rail instead of truck, based on discussions with railroads and analyst findings that railroads charge between 10% and 30% less for rail services than trucks in the same shipping lanes.[2] In addition, the statewide estimates include pavement savings (reduced wear and tear on the state's roadways resulting in O&M savings for the state) and congestion savings (time savings experienced by other roadways users) in the direct impacts.

In addition to the direct economic impacts, broader social impacts generate approximately $310 million in emissions and safety impacts. The additional emissions and safety impacts are generated as a result of the truck and auto VMT avoided in North Carolina due to the use of freight and passenger rail in the state. These emissions and safety impacts are monetized using recommended economic values or proxies associated with avoiding these negative externalities. These broader social impacts are different from the direct impacts shown in Table G-1 because they do not translate into spendable dollars in the North Carolina economy. Table G-2 summarizes the annual broader social impacts avoided due to the use of freight and passenger rail in North Carolina.

Table G-2 Annual Broader Social Impacts for Freight and Passenger Rail in North Carolina ($2014M)

	Freight (2011)	Passenger (2012)
Auto and Truck Emissions	$ 118.09	$ 2.37
Auto and Truck Safety	$ 172.58	$ 18.39
Total	**$ 290.67**	**$ 20.76**

Source: AECOM Analysis

[2] Schoonmaker, Keith, "UP produced record revenue and operating income in 2013, and we expect the trend to continue," July 1, 2014, http://analysisreport.morningstar.com/stock/research?t=UNP&region=USA&culture=en-US&productcode=MLE

The broader social impacts of rail were estimated using a methodology based on truck and auto VMT avoided within North Carolina due to the presence of rail. This methodology is different from that applied for the social impact estimates produced in the NCRR report, which relied on estimates of average external cost savings per ton-mile.[3] The methodology based on VMT avoided was applied for the statewide impacts so that comparable savings for both passenger and freight rail could be obtained, based on estimates of the number of vehicles removed from North Carolina's roadways and the miles they travel within North Carolina.

METHODOLOGY

This section describes the data and assumptions used to develop the direct economic and broader social impacts associated with freight and passenger rail in North Carolina.

Direct Economic Impacts

The direct economic impacts that result from the state's rail network for passengers and freight include user cost savings, Amtrak wages and procurement spending within the state, Amtrak tourist spending for those passengers who would only come to North Carolina by rail, pavement savings, and congestion savings. The freight impacts are based on the 2011 Surface Transportation Board's Carload Waybill Sample Data for rail shipments destined to, originating in, or traveling through North Carolina. While, the passenger impacts are based on 2012 Amtrak ridership, revenue, and passenger mile data, Amtrak's 2014 Draft Economic Contribution Brochure, and Southeast High Speed Rail Corridor (SEHSR) survey data sponsored by NCDOT.

User Cost Savings - Freight

Shipping goods by rail can offer a cost savings to shippers, because rail can move a greater volume of goods per train and is more fuel efficient than shipping by truck, particularly for large loads or shipments traveling longer distances. As a result, shipping goods by rail in North Carolina saves shippers

[3] RTI International, Measuring the North Carolina Railroad Company's Impact on North Carolina, 2014, http://www.ncrr.com/wp/wp-content/uploads/2011/11/1030-am_RTI.pdf

money in general when compared to shipping by truck. It is estimated that railroads charge between 10% and 30% less for rail services than trucks in the same shipping lanes.[4] The NCRR released an economic impact study in 2014[5] that estimated a shipping cost of $0.165 ($2007) per ton-mile by truck. Applying a 20% savings to that cost, shippers are estimated to save $0.033 ($2007) or $0.037 ($2014)[6] per ton-mile by using rail instead of truck.

Ton-miles are estimated using 2011 Waybill data for goods shipped to or from North Carolina. The 2011 rail ton-miles (40.7 billion) were multiplied by the shipping cost savings per ton-mile ($0.037) to estimate the total shipper savings for North Carolina in 2011.

User Cost Savings – Passenger

An analysis was performed to confirm that passenger rail does not generate an overall travel cost savings for its passengers. This was determined by looking at Amtrak ridership and revenue data, and SEHSR alternate mode of travel survey results for passengers traveling within, to, or from North Carolina. The survey data provided the number of one-way trips for riders within North Carolina that would have traveled by auto or air if rail were not an option. In addition, the survey data provided VMT[7] and the average rail fare for those who would have traveled by auto.

To calculate the user costs saved by rail for auto users, the number of riders[8] was multiplied by the average rail cost of a ticket ($93.84)[9] to give the total cost of the rail trip. The cost of the automobile trips avoided was calculated by multiplying the VMT by the average auto operating cost per mile, $0.323 ($2013) or $0.328 ($2014).[10] The average auto operating cost per mile includes the variable costs of gas, maintenance, tires, and half of depreciation[11]. Subtracting the vehicle costs avoided from the cost of the rail trips yields a negative net travel cost for autos (-$39 million).

To find the user cost savings for Amtrak riders who would have traveled by air, the number of riders was multiplied by an assumed airfare of $300 per trip, and netted against the cost of those same riders taking Amtrak for $107.38[12] per trip. The resulting savings for those passengers totals $40 million. Summing the cost of travel for auto users diverted to rail (-$39 million) and the savings for air users diverted to rail ($40 million) results in approximately no travel cost savings due to passenger rail in the state.

Amtrak Wages and Purchases - Passenger

The impact of Amtrak wages and purchases in the state came from the Draft Amtrak National Contributions Report (2014) which showed that direct procurement spending in North Carolina totaled $76.9 million ($2014) and direct Amtrak wages to North Carolina residents were $12.1 million ($2014). In total, $89 million ($2014) in spending and wages would be lost in the state without Amtrak service.

Tourist Spending - Passenger

Using the same Draft Amtrak National Contributions Report (2014), direct tourist spending resulted in $2.3 million in 2014. The tourist spending value reported pivots off of information collected from an Amtrak survey that asks respondents whether they would have made the trip by another mode or not made the trip at all if Amtrak were not available. As a result, this spending represents those tourists traveling to North Carolina by rail who would not have come to the state or spent those dollars in the state without Amtrak.

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[4] Schoonmaker, Keith, "UP produced record revenue and operating income in 2013, and we expect the trend to continue," July 1, 2014, http://analysisreport.morningstar.com/stock/research?t=UNP&region=USA&culture=en-US&productcode=MLE

[5] RTI International, Measuring the North Carolina Railroad Company's Impact on North Carolina, 2014, http://www.ncrr.com/wp/wp-content/uploads/2011/11/1030-am_RTI.pdf

[6] $2007 are inflated to $2014 using the GDP Price Index Deflator.

[7] Passenger miles traveled were converted to VMT by dividing by vehicle occupancy (1.4) from the National Household Travel Survey

[8] 669,251 one-way trips in 2012

[9] Amtrak, assuming no parking expenses

[10] $2013 are inflated to $2014 using the GDP Price Index Deflator.

[11] AAA Your Driving Costs 2013, http://newsroom.aaa.com/wp-content/uploads/2013/04/YourDrivingCosts2013.pdf

[12] Amtrak, assuming no parking expenses

Pavement Savings – Freight

Because of the state's rail network there are fewer trucks on the roads causing wear and tear to the pavement. As such, the presence of rail service for freight reduces the marginal cost of maintaining that pavement. The marginal cost of pavement for truck travel depends on whether the Interstate routes that would have been used are urban or rural. Because detailed information on trip origins and destinations is not known, it is assumed that half of truck trips are urban and half are rural.

To calculate the VMT avoided by trucks in the state, the total rail tons for freight to, from, or traveling through North Carolina are estimated to total 93 million from 2011 Waybill data. Assuming that each truck carries 20 tons, and increasing by a factor of 1.3 to account for empties and those trucks that would reach the maximum volume before reaching maximum weight, 6.1 million trucks are needed at a minimum to haul the 93 million tons. Assuming most truck trips would be traveling along three main corridors: the Crescent Corridor roughly from Greensboro to Charlotte or from the Ports to Charlotte or Raleigh, and using a weighted average of the originating, destination, and through volumes, the average distance the tons travel is estimated to be 112 miles on North Carolina roads. Multiplying the 6.1 million trucks by the average distance yields the total VMT avoided by trucks (approximately 680 million miles).

The FHWA Cost Allocation Study, 2000 Addendum estimates the marginal pavement costs per VMT to be $0.181 ($2000) or $0.215 ($2014) for a 60kip 4-axle U.S. truck on urban Interstates and $0.056 ($2000) or $0.067 ($2014) for rural Interstates.[13] Averaging the rates results in $0.141 cents ($2014) per truck VMT avoided. Applying these marginal pavement costs to the reduction in VMT yields the pavement savings.

Pavement Savings – Passenger

The reduction in auto VMT associated with the state's passenger rail service reduces the wear and tear on the pavement for roadways, and as such, reduces the marginal cost of maintaining the pavement. The marginal cost of pavement for auto travel depends on whether the Interstate routes that would have been used are urban or rural. Because detailed information on trip origins and destinations is not known, it is assumed that half of auto trips are urban and half are rural.

To calculate the auto VMT avoided in the state, the total passenger miles for passengers traveling to, from, or through North Carolina who would have traveled by auto if rail were not available are estimated to total 101 million, based on 2012 Amtrak data and SEHSR survey data. Assuming an average auto occupancy of 1.4,[14] this translates into approximately 72 million VMT avoided in 2012.

The FHWA Cost Allocation Study, 2000 Addendum estimates the marginal pavement costs per VMT for autos on rural interstates was $0.00 ($2000), and for urban interstates $0.10 ($2000) or $0.119 ($2014). Averaging the rates results in $0.059 ($2014) per auto VMT avoided. Applying these marginal pavement costs to the reduction in auto VMT (as described in previous sections) yields the pavement savings that result from the state's passenger rail network.

Congestion Savings – Freight

The truck VMT avoided contributes to reduced highway congestion in the state. This reduction in truck VMT benefits the remaining users on the state's roadways and reduces the marginal cost of congestion on these other vehicles. The marginal cost of truck congestion varies based on whether the Interstate routes used are urban or rural. Because detailed information on trip origins and destinations is not known, it is assumed that half of truck trips would be urban and half rural.

The Federal Highway Administration (FHWA) Cost Allocation Study, 2000 Addendum estimates the marginal congestion costs per VMT to be $0.326 ($2000) or $0.432 ($2014) for a 60kip 4-axle U.S. truck on urban Interstates and $0.033 ($2000) or $0.043 ($2014) for rural Interstates.[15] Averaging the $2014 values results in a marginal congestion cost of $0.238 per VMT. These marginal

[13] $2000 were escalated to $2014 using GDP Deflators.

[14] Passenger miles traveled were converted to VMT by dividing by vehicle occupancy (1.4) from the National Household Travel Survey

[15] $2000 were escalated to $2014 using GDP Deflators.

congestion costs multiplied by the reduction in truck VMT (as described in previous sections) yields the congestion cost savings of rail in the state.

Congestion Savings – Passenger

The availability of passenger rail service results in reduced auto VMT and contributes to reduced highway congestion in the state. This reduction in auto VMT benefits the remaining users on the state's roadways and reduces the marginal cost of congestion on these other vehicles. Auto congestion costs per VMT come from the Environmental Protection Agency and National Highway Traffic Safety Administration standard from 2012[16] at $0.056 ($2010) or $0.60 ($2014).[17] These marginal congestion costs multiplied by the reduction in auto VMT, as estimated previously, yields the congestion cost savings.

Broader Social Impacts

The broader social impacts that result from the state's rail network for passengers and freight include safety incidents avoided and reduced emissions. Both benefits result from removing vehicles and their associated VMT from the state's roads. The methodology of estimating the impacts of each benefit is the same for passenger and freight, so they are discussed together.

Emissions Benefits – Passenger and Freight

The state's rail network allows trucks and autos to be diverted from highways to rail, and the diverted truck and auto VMT reduces emissions in the state. Truck emission rate outputs for long-haul truck travel, based on the Federal Motor Carrier Safety Administration's (FMCSA) *Hours of Service (HOS) Environmental Assessment*[18] for carbon monoxide (CO), nitrogen oxide (NOx), volatile organic compounds (VOCs), particulate matter (PM), sulfur dioxide (SO2) and carbon dioxide (CO2), are applied to the truck VMT avoided to estimate the pollutant emissions avoided. Table G-3 depicts the FMCSA truck emission rates applied for 2012.

Table G-3 Long-Haul Truck Travel Emissions Factors (g/VMT)

Year	CO	NOX	PM2.5	PM10	SO2	VOC	CO2
2012	0.83	3.48	0.16	0.16	0.0057	0.15	752.44

Source: FMSCA, Hours of Service (HOS) Environmental Assessment, Appendix A: Analysis of Air Quality Impacts, 2011

Auto emission rate outputs for carbon monoxide (CO), nitrogen oxide (NOx), volatile organic compounds (VOCs), particulate matter (PM), and carbon dioxide (CO2), are applied to the auto VMT avoided to estimate the pollutant emissions avoided. Table G-4 depicts the MOVES 2010a and FTA rates for current year estimates applied in the analysis.

Table G-4 Auto Emissions Factors (g/VMT)

For Current Year Estimates				
Grams per VMT				
CO	NOx	VOC	PM2.5	C02
16.77	0.91	0.60	0.010	532

Source: MOVES 2010a, FTA[19]

The emission rates in grams per mile are multiplied by the appropriate conversion factor to calculate short tons per mile for each pollutant type except CO2 which is in metric tons per mile. The tons of emissions avoided per VMT are then multiplied by the VMT avoided. The resulting tons are multiplied by

[16] EPA and NHTSA, 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, Table II-19 NHTSA Economic Values for Estimating Benefits, October 15, 2012, https://www.federalregister.gov/articles/2012/10/15/2012-21972/2017-and-later-model-year-light-duty-vehicle-greenhouse-gas-emissions-and-corporate-average-fuel#t-176

[17] $2012 were escalated to $2014 using GDP Deflators.

[18] FMCSA, Hours of Service (HOS) Environmental Assessment, Appendix A: Analysis of Air Quality Impacts, 2011, http://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/2011_HOS_Final_Rule_EA_Appendices.pdf

[19] CO2 (Greenhouse Gas) emissions factors for current year from FTA New Starts and Small Starts Evaluation and Rating Process Final Policy Guidance, August 2013, http://www.fta.dot.gov/documents/NS-SS_Final_PolicyGuidance_August_2013.pdf

the economic value of the emissions damage cost from National Highway Safety Administration (NHTSA) guidance[20] and the TIGER 2014 Resource Guide[21] as shown in Table G-5.

Table G-5 Value of Emissions ($2014)

Value of Emissions	$2013	$2014	Unit
Carbon Monoxide	$0	$0	$/short ton
Volatile Organic Compounds	$1,813	$1,840	$/short ton
Nitrogen Oxides	$7,147	$7,254	$/short ton
Particulate Matter	$326,935	$331,829	$/short ton
Sulfur Dioxide	$42,240	$42,872	$/short ton
Carbon Dioxide22	$38	$38.57	$/metric ton

Note: $2013 were escalated to $2014 using GDP Price Deflator
Source: NHTSA, TIGER BCA Resource Guide

Safety Benefits – Passenger and Freight

Another benefit to the state that results from the rail network removing trucks and autos from the roads is a reduction in safety incidents. The VMT avoided by trucks and autos reduces the likelihood of crashes and associated deaths, injuries, and property damage. The crash rates shown in Table G-6 were applied to the VMT avoided to determine the number of fatalities, injuries, and crashes avoided.

Table G-6 Accidents Rates per 100,000,000 VMT, 2011

Accident Type	Rate
Fatalities	1.1305
Injured persons	79.5663
Crashes	189.1273

Source: 2012 BTS Motor Vehicle Safety Data, Table 2-17

These estimated accidents avoided by type are then converted to the Maximum Abbreviated Injury Score (MAIS) accident scale in order to apply US DOT Guidance on the value of avoiding an accident. The conversion is based on the National Highway Traffic Safety Administration KABCO-AIS Conversion Table (July 2011)[23] for Injury (severity unknown) and No Injury accidents. Applying accident rates to the auto and truck VMT avoided and converting to MAIS accident type results in estimates of fatalities and MAIS injuries avoided.

The total value for accident severity is based on US DOT Guidance[24] estimates for the economic value of avoiding an accident. The economic values applied in this analysis are summarized in Table G-7 below.

[20] NHTSA, Corporate Average Fuel Economy for MY2017-MY2025 Passenger Cars and Light Trucks (August 2012), http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/FRIA_2017-2025.pdf

[21] Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (May 2013; revised November 2013), page 18, Table A1 "Annual SCC Values: 2010-2050 ($2007/metric ton CO2)" as reported in the USDOT TIGER 2014 BCA Resource Guide. The 2012 value was used in this analysis and escalated to $2014.

[22] Ibid.

[23] USDOT, TIGER 2014 Benefit-Cost Analysis Resource Guide, April 18, 2014, http://www.dot.gov/sites/dot.gov/files/docs/TIGER%20BCA%20Resource%20Guide%202014.pd f

[24] USDOT, Guidance on Treatment of the Economic Value of a Statistical Life (VSL) in USDOT Analyses, 2014, http://www.dot.gov/sites/dot.gov/files/docs/VSL_Guidance_2014.pdf

Table G-7 Value of Accidents Avoided, 2013 ($2014 M)

Value of Accidents Avoided	$2013M	$2014M
Value of Statistical Life, 2013	$ 9.200	$ 9.338
MAIS 5 Critical (0.593) Fraction of VSL	$ 5.456	$ 5.537
MAIS 4 Severe (0.266) Fraction of VSL	$ 2.447	$ 2.484
MAIS 3 Serious (0.105) Fraction of VSL	$ 0.966	$ 0.980
MAIS 2 Moderate (0.047) Fraction of VSL	$ 0.432	$ 0.439
MAIS 1 Minor (0.003) Fraction of VSL	$ 0.028	$ 0.028
No Injury, 2010	$ 0.004	$ 0.004

Note: $2013 were escalated to $2014 using GDP Price Deflator
Source: USDOT, Guidance on Treatment of the Economic Value of a Statistical Life, 2014

Applying the value of accidents avoided in Table G-7 to the projections of crash reductions by injury type yields the safety benefits associated with the diversion of trucks and autos to rail.

Appendix H
Rail Plan Technical Advisory Group Members

Representative	Agency
Todd McIntyre	Federal Rail Administration – Transportation Industry Analyst
Jim Kessler	North Carolina Railroad Company – Vice President, Engineering
Marc Hoecker	Norfolk Southern – Director, Strategic Planning
Marco Turra	CSX Transportation – Director, Passenger Services Strategy
Jay McArthur	Amtrak – Senior Principal Officer
Carl Hollowell	Railway Association of North Carolina - President
Josh Levy	NC Department of Commerce
Rob Hosford	NC Department of Agriculture – Assistant Director, Foreign Direct Investment
Bryce Ball	NC General Assembly – Legislative Liaison
Susan Pullium	NC Department of Transportation – Director, Strategic Planning
Rudy Lupton	NC Department of Transportation – Director, Statewide Logistics
Allan Paul	NC Department of Transportation Rail Division – Deputy Director & Manager of Operations/Facilities
Jason Orthner	NC Department of Transportation Rail Division – Manager of Design & Construction
Jahmal Pullen	NC Department of Transportation Rail Division – Manager of Engineering Coordination & Safety
Marc Hamel	NC Department of Transportation Rail Division – Rail Project Development Manager
Charles Edwards	NC Center for Global Logistics