The Economic Benefits of High-Performance Rail in the Southeast

Technical Report | March 2021

SOUTHEAST CORRIDOR

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Acronyms

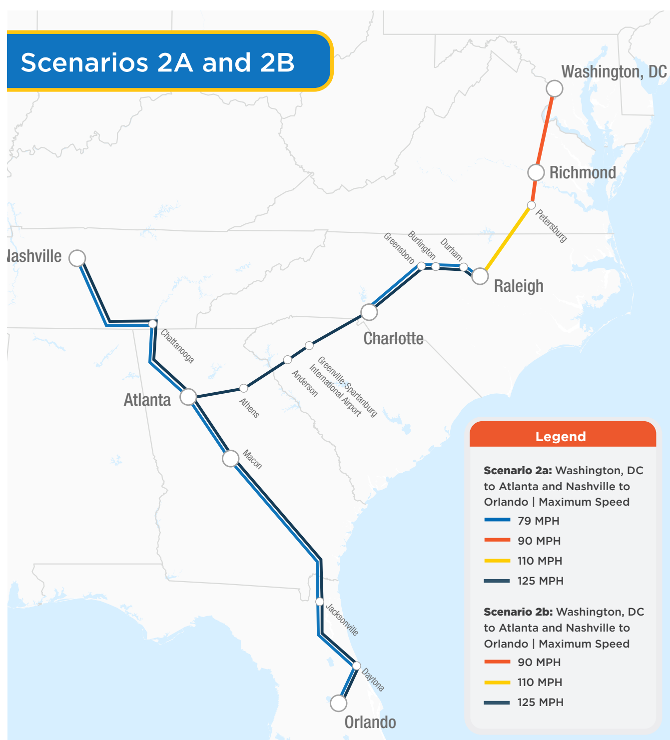
APTA	American Public Transportation Association
BCA	Benefit-cost analysis
BTS	Bureau of Transportation Statistics
CBSA	Core-based statistical area
CPI	Consumer price index
DC2RVA	Washington DC to Richmond High-Speed Rail
DRPT	Virginia Department of Rail and Public Transportation
EIS	Environmental impact statement
FAR	Floor area ratio
FEIS	Final environmental impact statement
FDOT	Florida Department of Transportation
FRA	Federal Railroad Administration
GSP	Greenville–Spartanburg International Airport
HJIA	Hartsfield–Jackson Atlanta International Airport
HSGT	Atlanta to Chattanooga High-Speed Ground Transportation
HSIPR	High-Speed Intercity Passenger Rail Program
HSR	High-speed rail
MPH	Miles per hour
NCDOT	North Carolina Department of Transportation
NEPA	National Environmental Policy Act
NHTSA	National Highway Traffic Safety Administration
NPV	Net present value
NOX	Nitrogen oxides
PM2.5	Particulate matter 2.5
PV	Present value
R2R	Raleigh to Richmond High-Speed Rail
ROD	Record of Decision
SDP	Service development plan
SEC	Southeast Rail Commission
SEHSR	Southeast High-Speed Rail
TDOT	Tennessee Department of Transportation
TSA	Transportation Security Administration
USDOT	United States Department of Transportation
VOC	Volatile organic compounds
VRE	Virginia Railway Express

Executive Summary

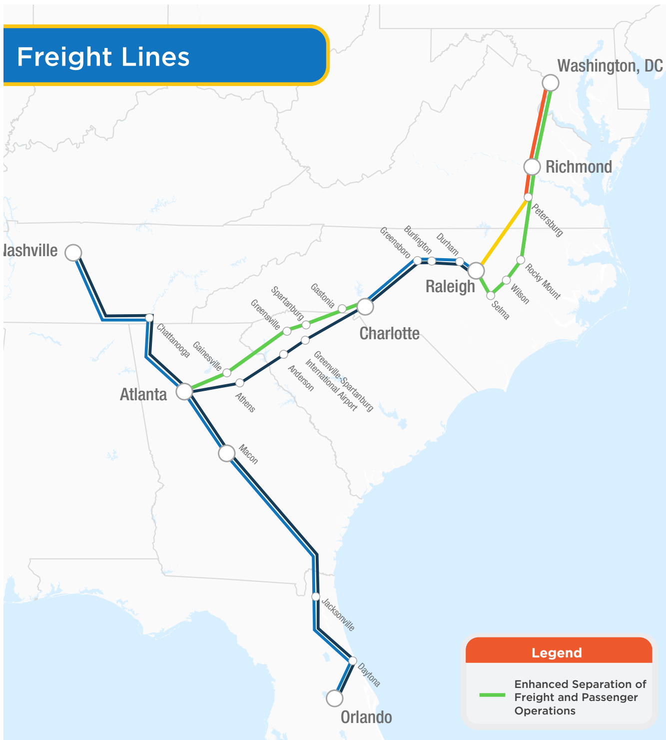
This study documents the key economic benefits of developing high-performance rail service on the Southeast Corridor. New and improved rail infrastructure will help transport goods, reduce highway congestion, improve safety, reduce emissions, and expand connectivity for passengers and freight throughout the Southeast. Improvements in rail capacity through Washington, DC, also will enhance connectivity between the Southeast and major urban centers along the Northeast Corridor.

The economic benefits considered in this study include the number of direct and indirect jobs supported, job market accessibility, increased mobility, improved safety, change in real estate values, and reduced vehicle emissions.

Stakeholders from each state represented in the Southeast Corridor Commission and the region's operating railroads provided input on the development of four scenarios for comparison of benefits. These scenarios focused on the development of the "backbone" of the Southeast Corridor and the opportunities for high-performance rail connections to major metropolitan areas. The recently completed *Southeast Regional Rail Planning Study* provides a long-term vision for passenger rail and defines the backbone of the Southeast network from Washington, DC, to Atlanta, GA, and south to Orlando, FL. The economic impacts of the backbone are then based on the detailed planning work done by the southeastern states over the past 10 years to define corridor alignments and service characteristics for near-term implementation.
In addition to the backbone of the network, the economic impacts of the Nashville, TN, to Atlanta, GA, corridor also are considered in the second scenario because the robust service definition of this corridor presents the potential for strong economic benefits.



Based on input from the freight railroads in the Southeast, expected benefits of improved freight movement were limited to only those corridors that are adding enough capacity as part of high-performance rail development, either through new track or passenger rail right-of-way, to significantly reduce the conflict between passenger and freight trains. These segments are shown below.



The methodologies for calculating economic benefits in this study were based on multiple peer regional rail studies, including the methods for determining employment and economic output increases. In addition, U.S. Department of Transportation (USDOT) guidance for benefits calculations for the purposes of discretionary grant applications was used for the categorization and monetization of social benefits—such as the value of accidents and vehicle emissions avoided by increasing use of rail.

Benefits were considered from 2025 through 2055 to allow time for high-performance rail operations to be implemented in all geographies covered by the scenarios.

To be realistic and conservative, the benefits calculated in the study are phased over time as each segment of the system is at a different stage of planning. This limits the time for accrual of benefits for the segments that are built further into the future; however, determining benefits beyond 2055 was deemed to be too uncertain for inclusion in this study.

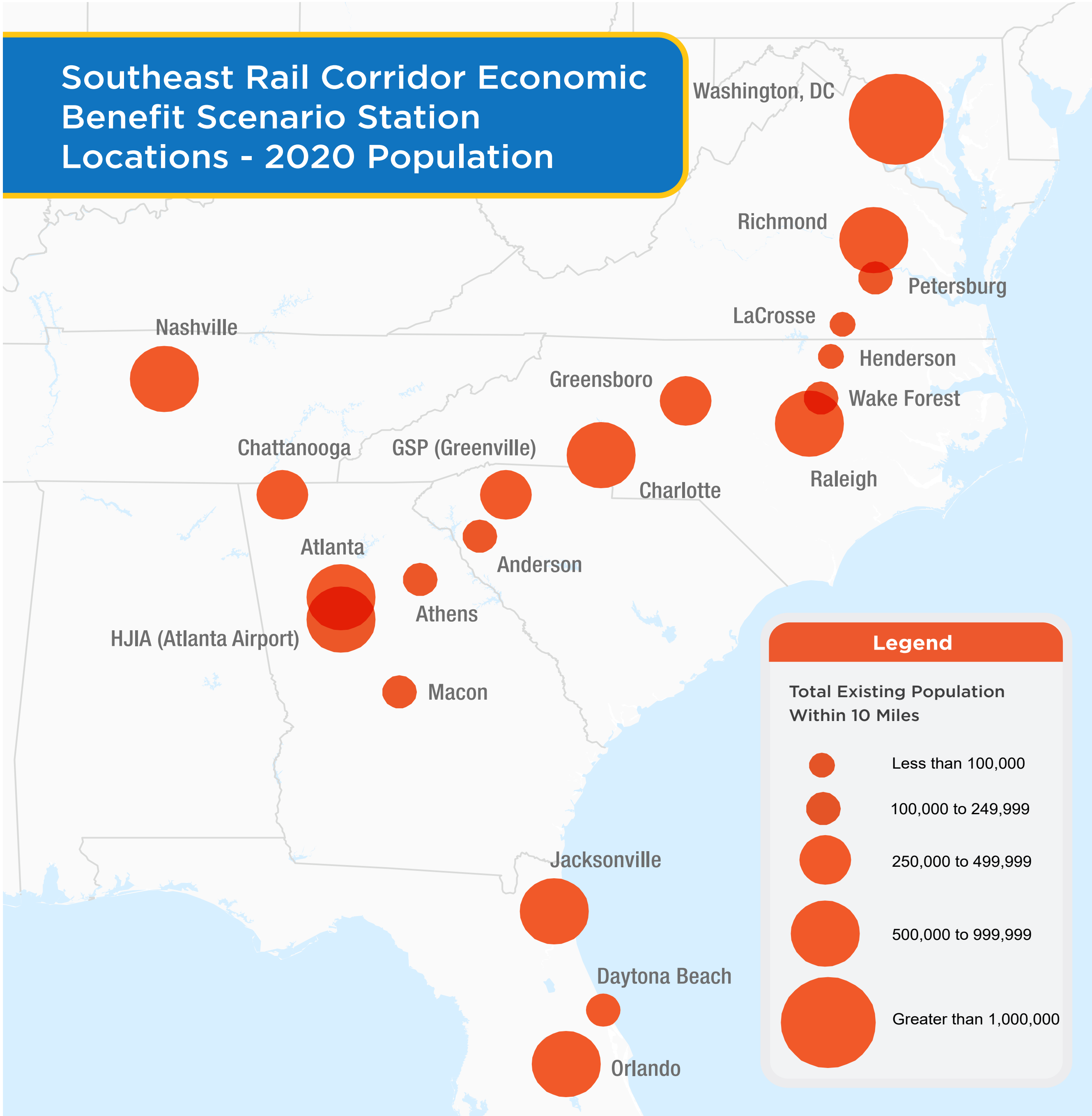
In addition, some economic benefits were monetized as part of this study, including agglomeration benefits and productivity benefits provided by improved rail connections.

The present value (PV) of benefits for each scenario are provided below in millions of 2020 dollars. When compared to the present value of capital costs, these benefits are 2.2 to 2.5 times higher than the upfront investment costs.

In addition to the monetized benefits in the table below, the development of the Southeast Corridor scenarios outlined in this study will:

- Provide for between 7 and 9 million passenger rail trips per year
- Create between approximately 41,000 to 95,000 new jobs in the region during construction
- Sustain between approximately 28,000 and 45,000 new jobs in the region due to station area developments
- Provide access to high-performance rail connections for between 5 and 9 million residents
- Connect 3 to 6 million jobs to high-performance rail stations

Benefit	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Travel Time Savings	$1,093	$1,103	$1,103	$1,101
Safety	$1,245	$1,260	$1,284	$1,336
Emissions	$46	$46	$47	$49
Economic Output	$22,639	$22,639	$30,831	$35,934
Property Value	$2,088	$2,088	$3,256	$3,255
Improved Freight	$153	$153	$153	$153
Total Benefits	**$27,264**	**$27,290**	**$36,675**	**$41,829**


Southeast Rail Corridor Economic Benefit Scenario Station Locations - 2020 Population
Washington, DC
Richmond
Petersburg
LaCrosse
Henderson
Wake Forest
Raleigh
Greensboro
Charlotte
Nashville
Chattanooga
GSP (Greenville)
Anderson
Atlanta
Athens
HJIA (Atlanta Airport)
Macon
Jacksonville
Daytona Beach
Orlando
Legend
Total Existing Population Within 10 Miles
Less than 100,000
100,000 to 249,999
250,000 to 499,999
500,000 to 999,999
Greater than 1,000,000

1.0 Background and Scenarios

This study documents the key economic benefits of developing high-performance rail service on the Southeast Corridor by considering impacts to the existing freight and passenger rail network. High-performance rail is defined for this study as a rail network with variable maximum speeds up to 125 miles per hour (mph) and improved infrastructure that facilitates fewer delays by reducing interference between passenger and freight trains. The economic benefits in this study include the number of direct and indirect jobs supported, change in real estate values, job market accessibility, increased mobility, improved safety, and reduced emissions.

To determine the economic benefits to the Southeast region, four conceptual scenarios representing different improvements to the rail network were developed. These scenarios were derived from corridor studies that define rail service within the state. These scenarios are described in more detail in **Section 1.2** and include both different locations of development and different maximum speeds on the network.

To ensure a balanced perspective on the benefits of passenger rail development, the study team interviewed stakeholders from each state represented in the Southeast Corridor Commission and the region's operating railroads. The list of stakeholders interviewed for the study is included in **Appendix A**. A key finding of those interviews limited the expected benefits of improved freight movement to only those corridors that are making significant capacity improvements that will enable reduced train interference as part of high-performance rail development, based on the input of freight railroads.

1.1 Southeast Corridor

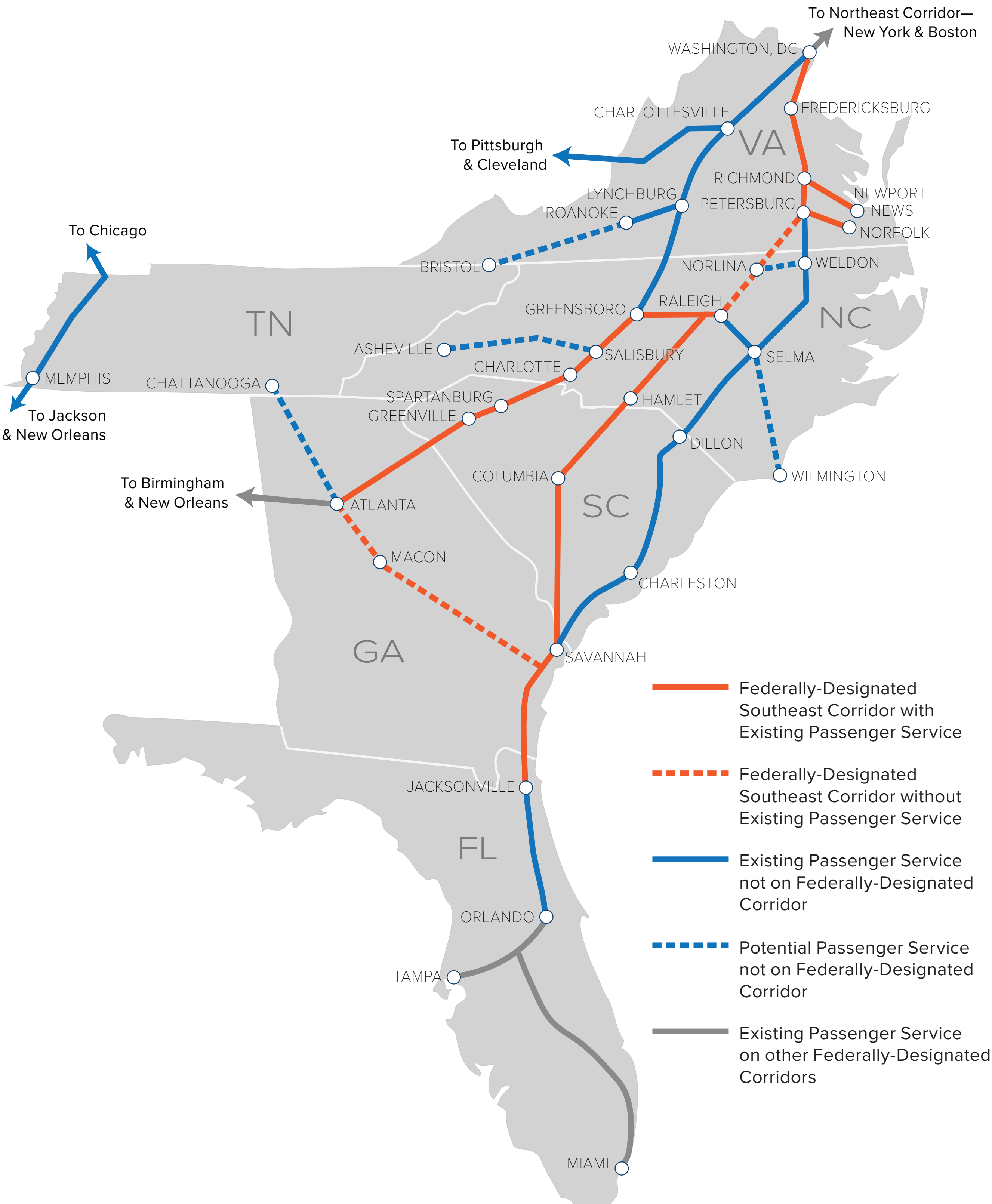
In 1992, USDOT named the Southeast Corridor as one of the first five federally designated high-performing rail corridors in the country. The corridor is a network of passenger and freight rail that runs from Washington, DC, to Jacksonville, FL, encompassing the District of Columbia, Virginia, North Carolina, South Carolina, Tennessee, Georgia, and Florida. **Figure 1** illustrates the federally designated corridor with and without existing passenger service in orange, and adjacent corridors or segments in blue.

Development of high-performance passenger rail in the Southeast provides a unique opportunity to address growing issues such as:

- Highway congestion
- Air pollution
- Limited transportation options
- Aging infrastructure

Credit: Adam Schultz

Figure 1: Southeast Corridor



These challenges will increase as the southeastern region of the United States is projected to see significant growth in population and jobs over the coming decades. During the same time period, freight rail volumes are expected to increase by more than 40 percent. **Figure 2** shows the expected population growth in core-based statistical areas (CBSA) across the Southeast in the coming years.[1] The growth around urban centers will increase travel demand and stress existing passenger and freight transportation infrastructure without new investment.

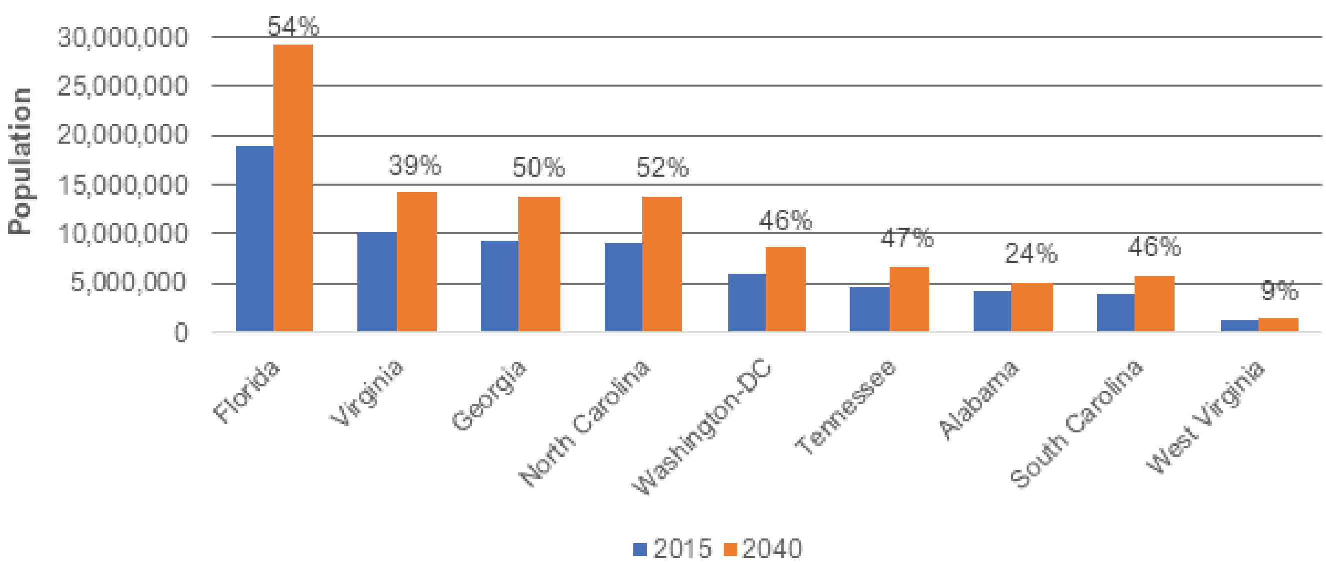
New and improved rail infrastructure will help transport goods, reduce highway congestion, improve safety, reduce emissions, and expand connectivity for passengers and freight throughout the Southeast. Improvements in rail capacity through Washington, DC, also will enhance connectivity between the Southeast and major urban centers along the Northeast Corridor.

1.2 Scenario Development

Developing high-performance rail corridors across the entire Southeast region would certainly offer broad economic benefits. However, for the purpose of this study, development scenarios focused on the backbone of the network and the associated or parallel primary freight rail corridors. These scenarios were designed to capture the largest and most certain economic impacts through 2055.

The scenarios defined for this study also include segments with existing planning studies, as described in the following sections, which provide the parameters for determining economic benefits.

Figure 2: CBSA Population Growth within Southeast Regional Rail Planning Study Area States (2015-2040)



Source: *The Southeast Regional Rail Planning Study*, 2020.

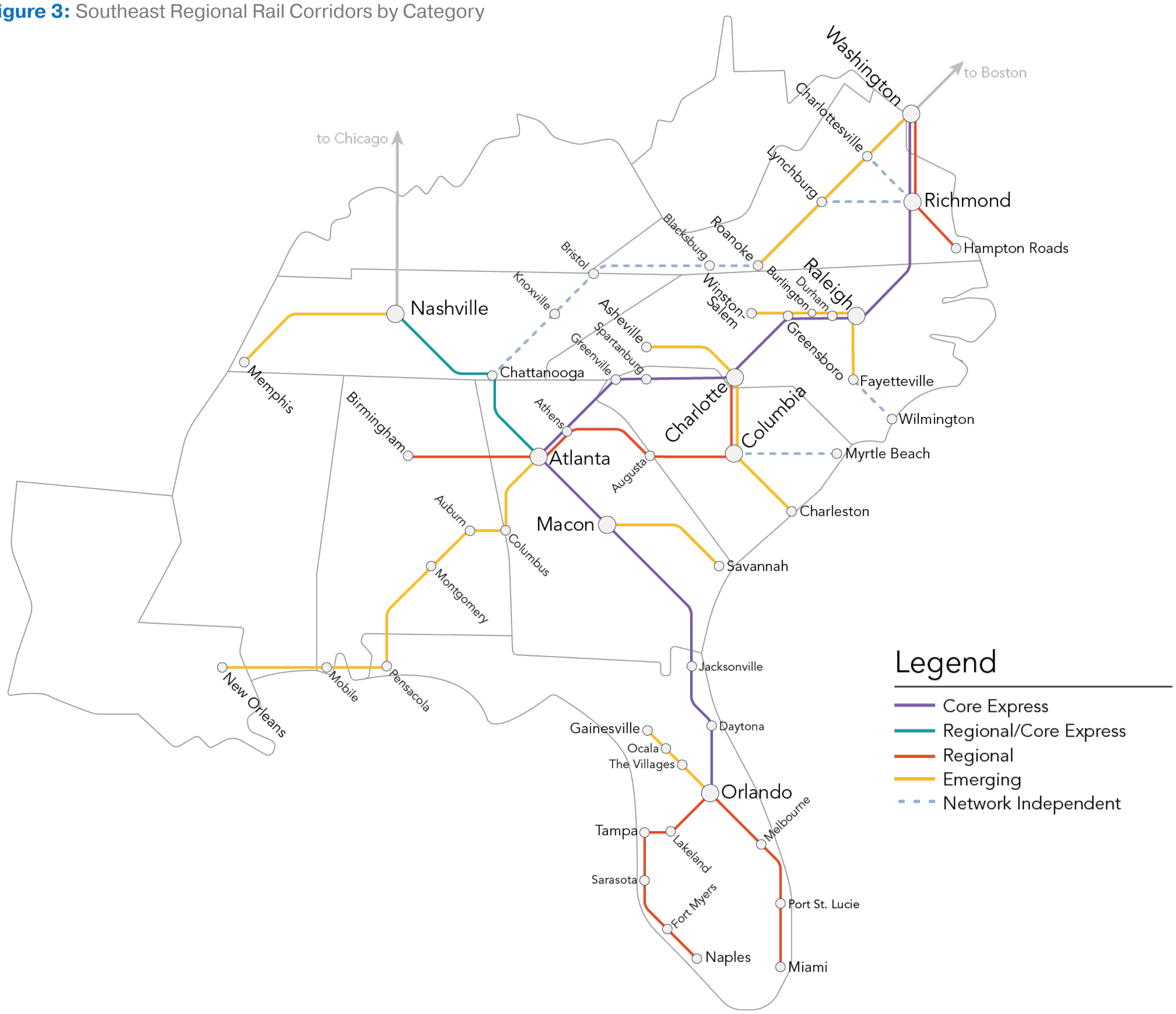
1 A CBSA is an area that consists of one or more counties anchored by an urban center with a population of at least 10,000 people plus adjacent counties that are connected to the urban center via commuting, essentially combining metropolitan and micropolitan statistical areas.

Focus on Backbone

The six southeastern states; Washington, DC; and the Federal Railroad Administration (FRA) worked cooperatively to develop a long-term vision for passenger rail service in the Southeast. The study process and outcomes are documented in *Southeast Regional Rail Planning Study*. The study relied on a high-level, conceputal planning tool, CONNECT, developed by FRA, to evaluate the performance of network configurations and service characteristics. The user can select from three classisficiations of corridor types, shown in **Figure 3** defined by the service charactertics of a corridor based on speed, frequency, and the level of separated right-of-way from freight services.

Core Express corridors can have top speeds of more than 125 mph and support more-frequent services as they connect major metropolitan centers. These characteristics of Core Express corridors yield the largest economic benefits to the region and allow for future connectivity with Regional and Emerging corridors. *The Southeast Regional Rail Planning Study* identifies Washington, DC, to Atlanta, GA; Atlanta, GA, to Orlando, FL; and Nashville, TN, to Atlanta, GA, as corridors that have the potential to support Core Express service. As part of the long-term vision, the *Southeast Regional Rail Planning Study* called for these corridors to operate at 125 mph or higher; however, this *Economic Benefits Study* analyzed the potential economic benefits based on detailed and nearer-term planning and environmental studies developed by the states.

Figure 3: Southeast Regional Rail Corridors by Category



The defining characteristics of each type of corridor are summarized in the table below.

Table 1: Southeast Regional Rail Corridor Categories

Corridor Type	Potential Top Speeds (mph)	Service Characteristics	Primary Markets
Core Express	More than 125	• Frequent service • Dedicated tracks, except in terminal areas	Major metropolitan centers
Regional	90–125	• Frequent service • Dedicated and shared tracks	Mid-sized urban areas
Emerging	Up to 90	• Shared tracks	Mid-sized and smaller urban areas
Network Independent	Have minimal ridership and effect on network performance		

Source: Draft Southeast Regional Rail Planning Study (adapted from FRA, High-Speed Rail in America, High-Speed Rail Strategic Plan, April 2009)

The Regional and Emerging corridors will provide comparatively lower economic benefits compared to Core Express corridors based on their characteristics. In addition, the benefits of improving rail on these corridors will largely be dependent on the connectivity to major economic centers provided initially by the Core Express improvements. While the other corridor types also will generate economic benefits, their benefits will not be fully realized without the connections provided by the backbone linkages resulting from the Core Express improvements.

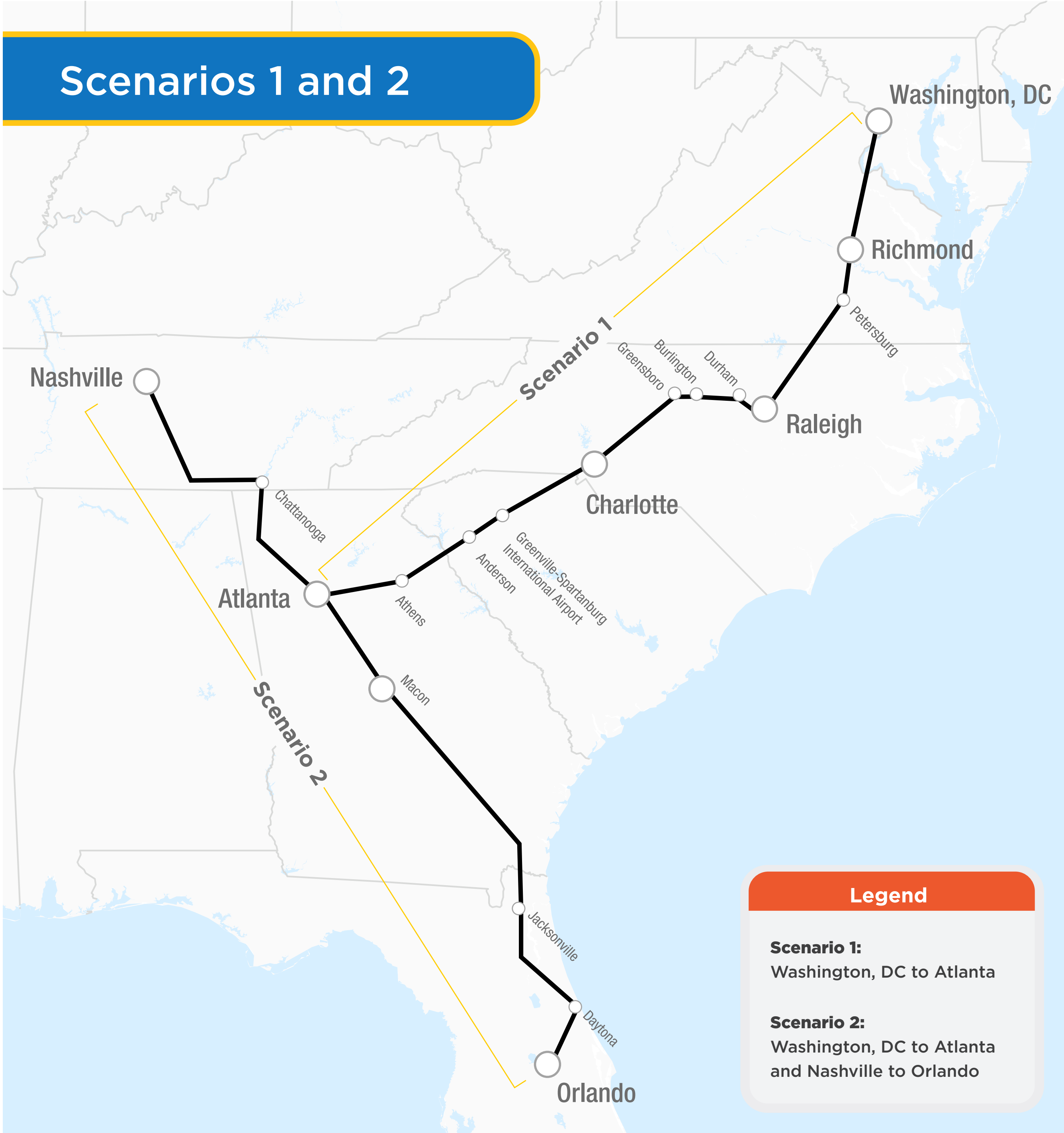
The Core Express corridors proposed for evaluation are:

- **Scenario 1: Washington, DC, to Atlanta** – a major trunk line for passenger and freight traffic along the East Coast
- **Scenario 2: Washington, DC, to Atlanta and Nashville to Orlando** – additional east/west and southern connectivity from expanding the trunk line

Due to the high population density of the metropolitan areas connected by the Core Express corridors, the ridership on these routes will be higher than other areas of the Southeast Network. In addition, these corridors connect major freight hubs, which provides the opportunity for economic benefits through separating freight and passenger traffic and decreasing train interference and delays to both services.

Credit: Adam Schultz

Figure 4: Locations for Scenarios 1 and 2



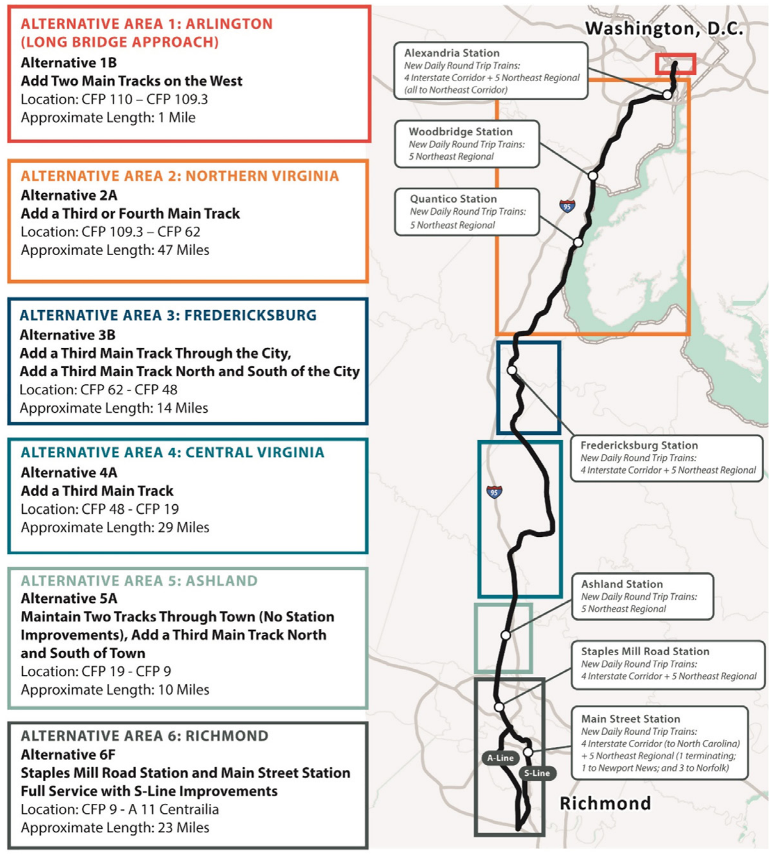
Build from Existing Plans

Given that many of the corridors were funded during the past decade through the High-Speed Intercity Passenger Rail Program (HSIPR) to develop incremental plans for high-speed and high-performance rail service, some sections of the corridor have already gone through project-level environmental processes pursuant to the National Environmental Policy Act (NEPA) and have selected Preferred Alternative alignments with speeds and infrastructure needs defined. Where these processes are complete, there is a federal Record of Decision (ROD) from FRA published for the preferred improvement plan.

These studies were leveraged to provide guidance on the proposed speeds for sections of the corridor and the extent of dedicated tracks for passenger services. The following corridors have completed Tier 2 environmental impact statements (EIS) with an FRA ROD.

- **DC to Richmond Southeast High-Speed Rail (DC2RVA):** This 123-mile corridor would increase passenger train speeds to 90 mph and operate between Washington Union Station and Main Street Station in Richmond, VA, every one to two hours in each direction during the day and early evening hours. Construction of the corridor improvements is anticipated to occur incrementally during a 20-year planning horizon from 2025 to 2045, and the full benefits of DC2RVA corridor service will be dependent on completion of other projects outside of the corridor, including the Long Bridge Project, the Southeast High-Speed Rail (SEHSR) Richmond to Raleigh project, and the SEHSR Richmond to Hampton Roads project.[2]
- **SEHSR Richmond, VA, to Raleigh, NC (R2R):** This 162-mile corridor would provide a new 110-mph connection between Main Street Station in Richmond, VA and Raleigh Union Station in North Carolina, a portion of which would use a currently inactive section of the CSX S-Line. New stations would be constructed at Henderson, NC and La Crosse, VA. The new connection would host four daily higher-speed round trips between Richmond and Raleigh. Three of these daily trips are anticipated to be a result of high-speed train service connecting Charlotte, NC, to New York, NY, via Richmond, VA, and Washington, DC. The fourth connects Raleigh, NC, to New York, NY, via Richmond, VA, and Washington, DC. As such, the full benefits of R2R corridor service will be dependent on the completion of other projects outside of the R2R corridor, including DC2RVA.

Figure 5: DC2RVA Preferred Alternative



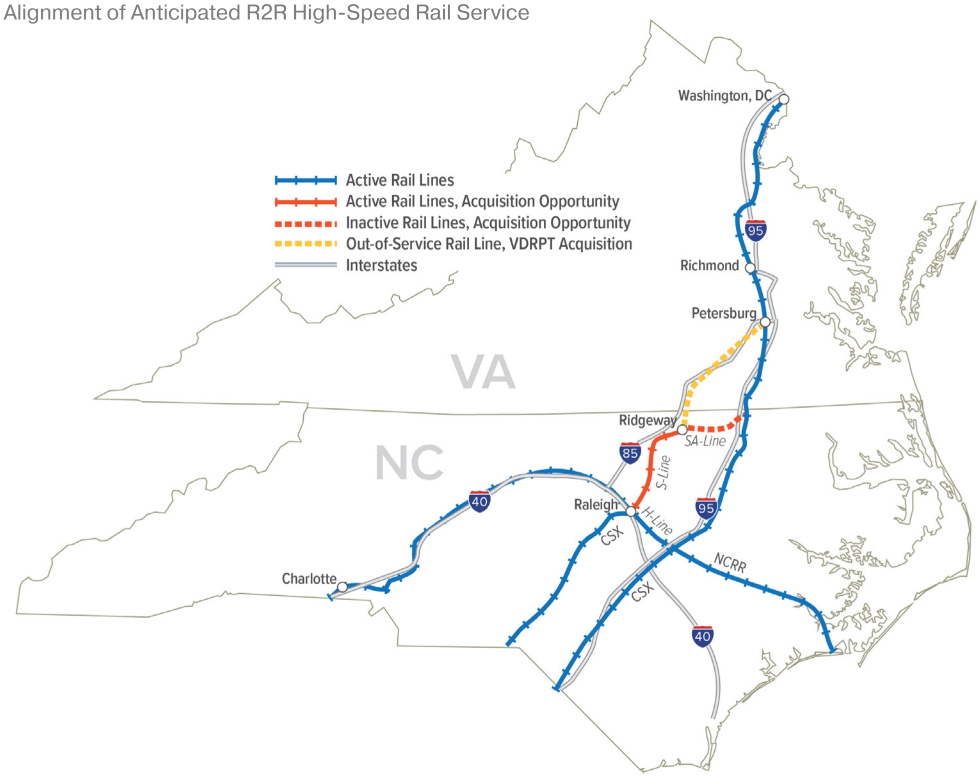
- **Long Bridge Project:** The existing Long Bridge, which spans the Potomac River and connects the rail corridor to Washington, DC, would be expanded with a new two-track bridge and tie into planned four-track interlockings on both sides of the river. This expansion will allow for an increase in the number of trains, including those associated with DC2RVA as well as commuter and freight services, to increase from 76 trains today to 192 trains once completed.

2 High-speed rail between Richmond and Hampton Roads has been studied as part of a Tier I EIS. However, analysis from this study has not been included, as the corridor between Richmond and Hampton Roads is not classified as a Core Express segment in the Draft Southeast Regional Rail Plan.

The service development plans (SDP) for these corridors also provide information on the expected future ridership and benefits of the preferred alternative.

- **DC2RVA:** The Corridor Service Development Plan for DC2RVA anticipates 2.5 million annual riders in the corridor at the beginning of service in 2025, growing to 3.2 million annual riders by 2045. This growth in ridership would divert current roadway users from Interstate 95 (I-95) to a high-speed rail (HSR) option, increasing travel speeds on both the rail and roadway corridors. Reduced highway travel also will result in improved reliability and saving associated with fuel costs, accidents, and emissions. Initial efforts to implement improvements in the DC2RVA corridor, as well as the Long Bridge project, are being carried out through the Transforming Rail in Virginia initiative. Under this program, the Commonwealth will acquire approximately half of the CSX-owned railroad right-of-way between Washington, DC, and Richmond, VA; rights to use the tracks between Richmond, VA, and Petersburg, VA, for passenger rail; all the CSX-owned right-of-way between Petersburg, VA, and Ridgeway, NC (S-Line, see **Figure 6**); and all the CSX-owned right-of-way between Doswell, VA, and Clifton Forge, VA (Buckingham Branch Railroad). Other elements of the initiative include building 37 miles of track in the I-95 corridor (including a new, two-track Long Bridge built for passenger rail use), and adding double the Amtrak state-supported service and Virginia Railway Express (VRE) Fredericksburg Line service during the next decade, depending on track construction phasing.
- **SEHSR R2R:** The Incremental Service Development Plan for R2R service anticipates 3 million annual riders in the corridor with a modeled beginning of 110 mph service in 2025 between Charlotte, NC, and New York, NY, growing to 4 million annual riders by 2045. This growth in ridership, up more than 100 percent from the 2 million annual riders in 2015, would increase travel speeds for existing rail users, which also provides a reliable, high-speed option for current air, highway, and bus passengers. Improved property values and economic development plans near new and existing rail stations could provide additional benefits to expected transportation savings benefits but also could increase local street congestion in some areas.

Figure 6: Alignment of Anticipated R2R High-Speed Rail Service



The **Atlanta to Charlotte Passenger Rail Corridor Investment Plan EIS** has recently moved into the final stages of its Tier 1 EIS. While there is no ROD published at this time, the Preferred Alternative alignment identified during the development of the Tier 1 EIS is included in the scenarios based on the current plans. This plan would develop an approximately 280-mile corridor connecting Hartsfield-Jackson Atlanta International Airport in Georgia and the proposed Charlotte Gateway Station in North Carolina. Three alternative alignments were advanced for further evaluation in the Tier 1 Draft EIS, with a range of options for shared and dedicated passenger tracks, fuel technologies, and speeds from 79 mph to 220 mph. The Final Tier 1 EIS currently under development identifies the Greenfield alignment as the Preferred Alternative, with passenger rail segregated from freight track for the majority of the distance between Charlotte and Atlanta. While a rail technology has not yet been selected, potential impacts were identified for a range of speeds in the Greenfield alignment. This economic benefits study relies on impacts from the 125-mph diesel electric technology alternative, which will result in a more conservative estimate of benefits than if the 220-mph electrified alterative is identified as the Preferred Alternative in future studies. A subsequent Tier 2 EIS is needed to further identify design parameters and specific environmental impacts.

The **2015 Florida Department of Transportation (FDOT) Rail System Plan**, which was updated in 2018, also includes development plans for the rail network south of Jacksonville. The development of the major Florida corridors is currently being carried out by Brightline in partnership with FDOT. In 2014, passenger rail easement rights were acquired for an extension north to Jacksonville for services from Orlando, which would provide a connection to tourist destinations in Daytona Beach and St. Augustine. However, the partnership does not currently have plans to develop the corridor between Jacksonville and Orlando. Brightline's current efforts in Florida are focused on operations in corridors linking Orlando to Miami and Tampa.

The **2019 Tennessee Department of Transportation (TDOT) Statewide Rail Plan** includes long-term plans for HSR in several corridors, including the Jacksonville-Atlanta-Chattanooga-Nashville corridor. The plan identifies the Atlanta-Chattanooga corridor NEPA analysis (part of which is described under the Tier 1 ROD in the following section) as the primary vehicle for continued study of the corridor. No additional details on selected corridor alignments, speeds, or train technologies in the Southeast Corridor are provided in this plan, so any specifics of rail in Tennessee has been limited to information available under existing plans in the Atlanta-Chattanooga corridor.

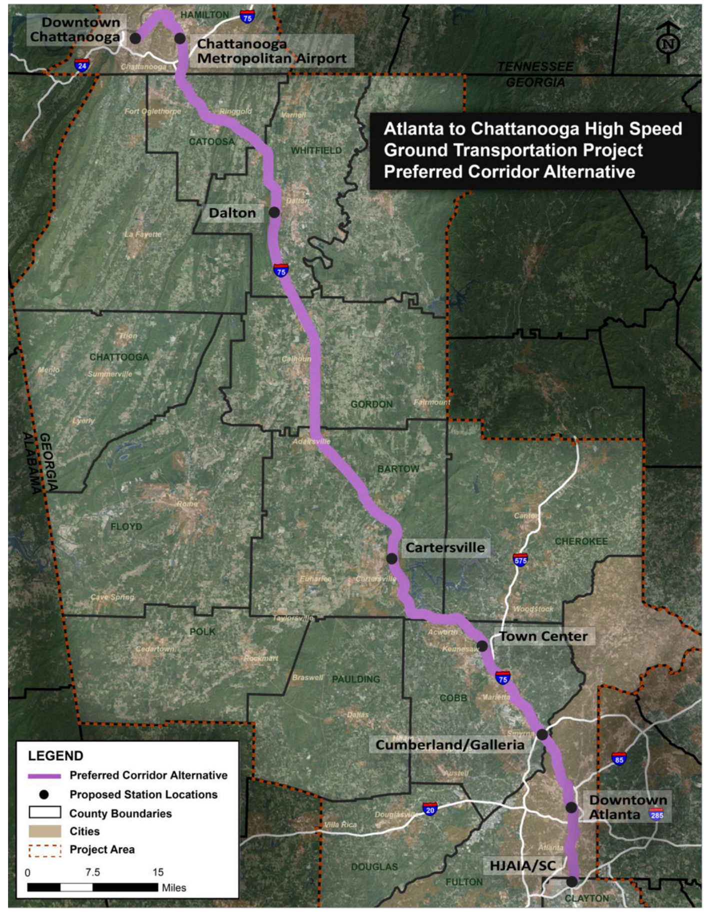
Define Uncertainty

While the existing plans define the Preferred Alternatives for a large portion of the scenario geography, there remains uncertainty regarding the service characteristics of parts of the network. For example, the connection from Nashville to Atlanta does not have a defined service speed or degree of track separation from a ROD. The locations where speed, frequency of service, and track separation are currently undefined in a ROD or SDP include:

Corridors with Available Plans, but Specific Alternative is Not Fully Defined:

- **Atlanta-Chattanooga High-Speed Ground Transportation (HSGT) Tier 1 ROD:** This 128-mile corridor would connect Hartsfield-Jackson Atlanta International Airport in Georgia and Downtown Chattanooga in Tennessee. While speeds, technologies, and alignment configuration will not be determined until the Tier 2 NEPA process, the Tier 1 ROD identified the preferred corridor alternative as one that follows existing Interstate 75 right-of-way in Georgia and CSX right-of way in Tennessee. The corridor would serve proposed stations in Hartsfield-Jackson Atlanta International Airport, downtown Atlanta, Cumberland, Town Center, Cartersville, and Dalton in Georgia and Chattanooga Metropolitan Airport and downtown Chattanooga in Tennessee.
- **GDOT High-Speed Rail Planning Services Report:** This planning effort from 2012 evaluated the feasibility of HSR service in corridors connecting Atlanta, GA, to Jacksonville, FL; Nashville, TN; and Birmingham, AL. The study identified potential alignments for both shared track with freight rail and dedicated passenger rail as well as a spectrum of technologies and travel speed for each corridor. Planning-level costs and ridership estimates were developed for each alternative, as were proposed potential station locations.
- **Corridors without Available Plans for High-Performance Rail:**
  - Jacksonville to Orlando
  - Raleigh to Charlotte

Figure 7: Atlanta-Chattanooga HGST Tier 1 Preferred Alternative Alignment



Study Scenarios

To focus the analysis on backbone services with more certainty regarding the alignment, speeds, and services, the first scenario extends from Washington, DC, to Atlanta. Under Scenario 1, the two sections with Tier 2 EIS- and ROD-defined alignments and maximum speeds, DC2RVA and R2R, were held constant to reflect current plans. In addition, the Preferred Alternative for Atlanta to Charlotte, the Greenfield alignment, were included in the baseline scenario. This leaves only the segment between Raleigh and Charlotte with variable speeds. The analysis considered the current maximum authorized speed of 79 mph and conceptual core express speed identified in the Southeast Regional Rail Plan. However, there are no current NEPA efforts to study a corridor that would separate freight and passenger traffic, so the degree of freight separation was not varied in the scenario.

As shown in **Figure 8**, the remainder of the corridor between Raleigh and Atlanta was varied to illustrate the economic impact of different maximum speeds and different alignments in terms of the amount of separation from existing freight lines. This approach allowed the team to quantify the economic impacts of improved services (in terms of passenger and freight time savings) with some uncertainty regarding the ultimate state of the network.

The second proposed scenario increases the geographic footprint of the corridor improvements to include connections to Nashville and Orlando.

Figure 9 illustrates this scenario, which takes a similar approach to uncertainty in the ultimate alignment and speeds of the Core Express sections of the Southeast Regional Rail Network. The two sections with the Tier 2 EIS and ROD and the Preferred Alternative for Atlanta to Charlotte were again held constant to those plans. The other sections of the corridor varied in terms of maximum speeds and alignment to illustrate the uncertainty in economic outcomes.

Scenario 1: Washington, DC, to Atlanta	
Scenario 1A	**Scenario 1B**
• Planned speeds and infrastructure outlined in the DC2RVA and R2R RODs and Preferred Alternative from Atlanta to Charlotte • Lower maximum speeds (79 mph) along all other segments	• Planned speeds and infrastructure outlined in the DC2RVA and R2R RODs and Preferred Alternative from Atlanta to Charlotte • Higher maximum speeds (125 mph) along all other segments

Scenario 2: Washington DC to Atlanta & Nashville to Orlando	
Scenario 2A	**Scenario 2B**
• Planned speeds and infrastructure outlined in the DC2RVA and R2R RODs and Preferred Alternative from Atlanta to Charlotte • Lower maximum speeds (79 mph) along all other segments	• Planned speeds and infrastructure outlined in the DC2RVA and R2R RODs and Preferred Alternative from Atlanta to Charlotte Higher maximum speeds (125 mph) along all other segments

Figure 8: Illustration Scenario 1A and 1B Locations and Speeds

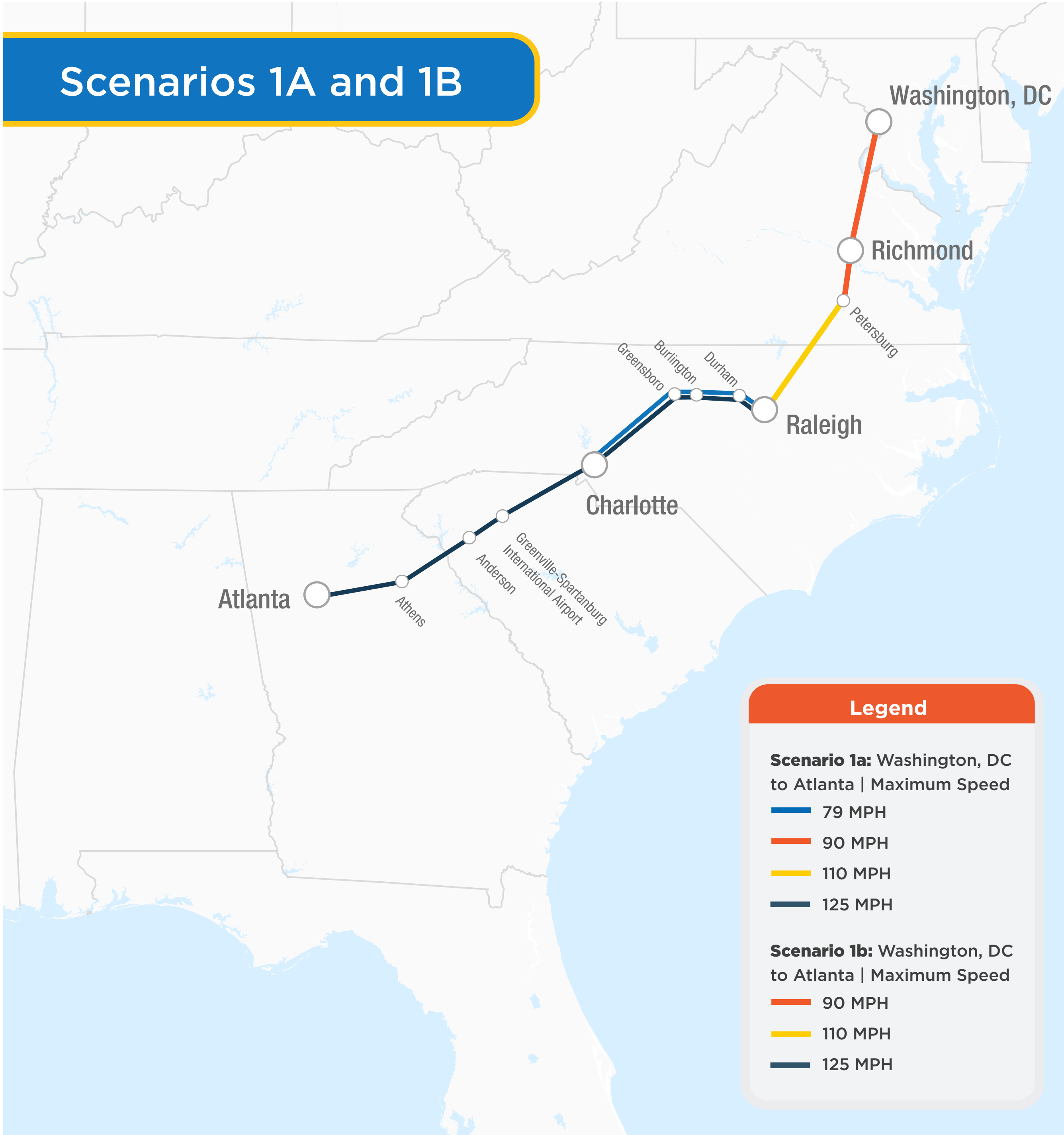
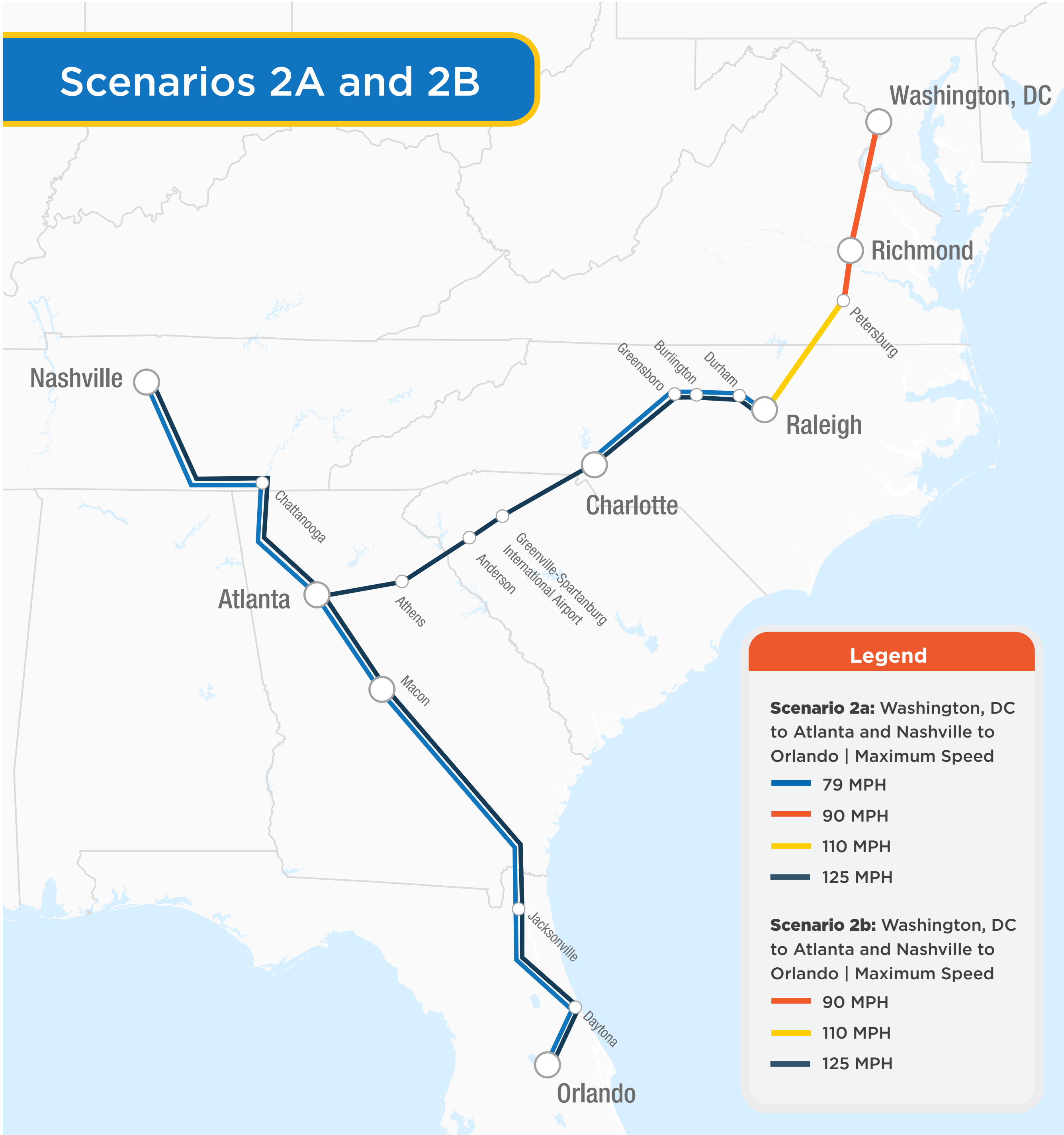


Figure 9: Illustration of Scenario 2A and 2B Locations and Speeds



For Scenario 1 from Raleigh to Charlotte, there are no plans to separate freight and passenger traffic on the segments connecting Atlanta to Nashville or Atlanta to Orlando. Therefore, variability in freight separation impacts were not considered for Scenario 2.

2.0 Peer Review Research

Economic studies performed for other regional high-speed rail corridors throughout the country provided important context for developing the economic benefits of the Southeast Corridor. Completed independently from environmental documentation and planning, these peer studies applied a range of assumptions and analytical methodologies to uncertain corridor conditions to determine the potential economic impacts to their respective regions. Learning from these case studies allowed the study team to apply best practices in defining a range of economic benefits based on available data and highlight areas where data limitations require an alternative approach for determining benefits.

The three economic impact studies that were reviewed for methodologies and economic performance metrics included:

- *Midwest High-Speed Rail Association, The Economic Impacts of High-Speed Rail: Transforming the Midwest (2011)*[3]
- *Virgin Trains USA Economic Impact Analysis (2019)*[4] *– Victorville, CA, to Las Vegas, NV*
- *Texas Central's High-Speed Rail Corridor and Related Private Development: Houston to Dallas/Fort Worth, Texas (2015)*[5]

These three studies took different approaches to estimating the economic benefits of their respective study areas, but several metrics were common across the studies:

- Employment
- Income
- Total economic output

Ridership and travel time savings were included in the benefits for the Midwest and California to Nevada studies. While these measures are benefits in terms of improved mobility, they also provide the basis for social benefits derived from rail's efficiency as a mode—including reduced vehicle emissions and accidents per passenger mile. Only the Midwest region calculated some of these social benefits as part of their analysis.

Increased tax revenue was included in two of the peer studies in terms of regional impacts of rail development. However, tax revenue is not considered an economic benefit as it represents a transfer payment between entities in the economy. Therefore, it is not included as a metric for the Southeast Corridor. **Table 2** provides a comparison of tools and metrics used by each case study.

These benefits were determined using detailed input-output economic models, though the three studies used different models as their primary analysis tool. An input-output model is a quantitative economic model based on the interdependencies between different sectors of a national or regional economy. An input-output model for all seven jurisdictions in the Southeast Corridor does not currently exist for this purpose, though individual states have utilized different input-output models in the past for transportation planning purposes.

3 https://www.hsrail.org/sites/default/files/studies/MHSRA_2011_Economic_Study_Brochure.pdf
4 https://catc.ca.gov/-/media/ctc-media/documents/tab-13-4-21-analysis-a11y.pdf
5 https://www.texascentral.com/wp-content/uploads/2016/04/Economic-Impact-Study-Executive-Summary.pdf

Table 2: Comparison of Peer Case Study Economic Analyses

	Midwest Region	Virgin Trains USA (CA to NV)	Texas Central
Primary Model	TREDIS	IMPLAN	RIMS II
Focus	Operational Benefits	Construction and Operational Benefits	Land Acquisition, Construction, and Operational Benefits
Metrics			
Ridership	✓	✓	
Travel Time Savings	✓	✓	
Employment	✓	✓	✓
Income	✓	✓	✓
Economic Output	✓	✓	✓
Tax Revenue (Transfer Payment)		✓	✓
Additional Metrics	Daily Train Trips, Train Revenue, Value Added, New Visitors, Improved Labor Market Access, Air Quality, Safety		

The results of the peer case studies also were reviewed considering USDOT guidance[6] on calculating economic benefits for transportation improvements. The resulting list of economic benefits for consideration are:

- Increased rail ridership
- Travel time savings
- Increased employment and income
- Increased economic output and improved freight movement
- Enhanced property values
- Improved air quality and reduced emissions
- Improved safety outcomes
- Improved labor market access

It is important to note that ridership benefits underpin many of the other measures, and therefore are not monetized to avoid double counting in the aggregation of benefits. In addition, labor market access is related to the span and coverage of the Southeast Corridor in connecting communities to job opportunities. This benefit also is not monetized, as methodologies for calculating agglomeration benefits or similar measures are beyond the scope of this study.

Credit: Adam Schultz

6 USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2020.

3.0 Methodology

Given the context of the Southeast Corridor, which is in various stages of planning and development, the process for calculating economic benefits relied on best-available data and a sketch planning approach. Where data was not available in the Southeast Corridor plans described in **Section 1** or could not be provided by stakeholders from a previous benefit-cost analysis (BCA), parameters were derived from peer HSR studies. Realistic and conservative assumptions also were utilized where necessary, relying on the peer studies, federal guidance, and other industry information (detailed below).

Table 3 shows the relationship between source material and the parameters used to calculate economic benefits.

Table 4 aligns the economic benefits with the parameters used to calculate or monetize them.

Table 3: Primary Source Material

Data Source	Ridership	Travel Time (Rail)	Travel Time (Other Modes)	Modal Diversion	Capital Cost	Station Locations	Freight Delays
DC2RVA Tier 2 FEIS/BCA for CRISI grant application	•	•		•	•	•	•
R2R BCA for CRISI grant application	•			•	•	•	•
Atlanta to Charlotte: Passenger Rail Corridor Investment Plan Tier 1 EIS Alternatives Considered report	•	•	•	•	•	•	
GDOT High Speed Rail Planning Services Report: Atlanta-Chattanooga-Nashville-Louisville	•	•			•	•	
Atlanta-Chattanooga High-Speed Ground Transportation Tier 1 EIS	•	•				•	
GDOT High Speed Rail Planning Services Report: Atlanta-Macon-Jacksonville	•	•			•	•	
CONNECT model (benchmarking only)	•	•		•			
Original data collection			•				

Table 4: Underlying Parameters for Economic Benefits

Economic Benefit	Ridership	Travel Time (Rail)	Travel Time (Other Modes)	Modal Diversion	Capital Cost	Station Locations	Freight Delays
Safety: Reduced Accidents	•			•			
Air Quality: Reduced Vehicle Emissions	•			•			
Travel Time Savings: Value of Time Saved	•	•	•	•			
Employment: Direct, Indirect, Induced Jobs Created					•		
Economic Output: Increased Income Expenditures					•		
Increased Property Values						•	
Freight Improvements: Reduced Delays/Improved Resiliency							•
Population/Jobs Accessibility						•	

3.1 Timeframe of Analysis

The economic benefits of rail infrastructure improvements happen in two stages—during construction as jobs are created and related incomes are spent, and during operations as users and surrounding areas accrue the benefits of the improved system. USDOT guidance for calculating benefits of investments in long-lived infrastructure, such as railroads, is to accrue benefits over 30 years of operation. The timeframe for this analysis starts in 2025 and runs through 2055. It is more conservative than the guidance from USDOT as it includes five years of construction at the outset, with operations only lasting a maximum of 25 years.

In addition, not all infrastructure in the scenarios will be open for operation in 2030, so many segments accrue operating benefits for fewer years. Again, this is a conservative approach as predicting benefits beyond 2055 was deemed to be too uncertain.

Phased Construction

Rather than assume that each of the scenarios would be built in their entirety in a simultaneous fashion, the analysis was based on a phased construction of each segment. The phasing in of corridor improvements means that economic benefits will accrue over a different number of years for each area, which is more realistic than assuming that all infrastructure improvements are available at once.

For estimating purposes, construction of each segment requires five years each. Construction for the first phase starts in 2025 and ends in 2034, covering all the segments in Scenarios 1A and 1B. Construction for Scenarios 2A and 2B goes through 2049.

The assumed years for opening operations in each segment were derived from existing planning and environmental analysis documentation and confirmed through discussions with Southeast Corridor Technical Committee members as estimates only.

Table 5: Assumed Operational Years by Segment

Segment	Assumed Operational Year	Scenario 1A/1B	Scenario 2A/2B
Washington DC to Richmond	2030	✓	✓
Richmond to Raleigh	2030	✓	✓
Raleigh to Charlotte	2030	✓	✓
Charlotte to Atlanta	2035	✓	✓
Atlanta to Jacksonville	2040		✓
Jacksonville to Orlando	2045		✓
Atlanta to Chattanooga	2045		✓
Chattanooga to Nashville	2050		✓

3.2 Ridership and Modal Diversion

Ridership and mode shift projections are available in all the plans noted in **Section 1** as part of scenario development; however, two of the segments included in this study do not have planning studies for reference. In addition, many of the plans use different ridership models with a different reach across the regional network and different levels of connection with the Northeast Corridor through Washington, DC. The level of ridership and mode shift in these plans was therefore benchmarked against scenario forecasts provided by the FRA Railroad CONceptual NEtwork Connections Tool (CONNECT) tool, used in development of the *Southeast Regional Rail Planning Study*.

CONNECT is a high-level tool based on generalized data and ridership demand methodologies. CONNECT is only capable of producing order-of-magnitude outputs, and detailed studies must be completed to generate performance results that are appropriate for decision-making purposes, such as BCA inputs.

Challenges with determining ridership across the Southeast Network for the purposes of calculating economic benefits illustrates the need for a more detailed, consistent, networkwide ridership model that can be used for multiple Southeast Corridor studies related to development of the network and future BCA reports.

In this study, CONNECT ridership was used to help estimate the percentage of passengers transferring between corridors to represent networkwide ridership without counting passengers traveling between corridors twice. The travel patterns from CONNECT provided a networkwide benchmark for pre-existing corridor-level ridership numbers, which were then used as the basis for economic benefits calculations.

The service scenarios provided for this economic benefits study do not align with those used in the Southeast Regional Rail Planning Study, as the parameters in the precedent corridor plans differ slightly in terms of train frequencies and maximum speeds. The ridership and mode shifts here are unique to this study in matching up the service plans for each segment of the corridor with a plan and filling in the gaps based on the scenario parameters defined in **Section 1**.

More information on how the scenarios were translated into the CONNECT model is provided in **Appendix B**.

The CONNECT model produces a range of ridership forecasts—high, medium, and low. The medium forecasts were used for benchmarking levels of ridership and mode shift by segment. The model estimates ridership in disaggregate for individual CBSA origin-destination pairs. To compile ridership estimates for each segment for comparison, each CBSA pair with at least one end point was aggregated.

Additionally, the CONNECT model assumes service to the Northeast Corridor based on a Regional (90 to 125 mph) service type. CBSA pairs with ends in both the Northeast Corridor and one of the Southeast Corridor segments are included as both the DC2RVA and R2R ridership models also included connections to the Northeast Corridor.

Results of Benchmarking

Overall, the combined ridership and mode shift numbers from the individual studies were much higher than the CONNECT model results. This was due in part to the inclusion of impacts of ridership on adjoining sections being accounted for in multiple studies. For instance, as described above, the R2R ridership model had overlapping ridership impacts with the ridership impacts estimated within the DC2RVA model for connections to the Northeast Corridor. Therefore, the CONNECT model was used to determine which ridership impacts would be double-counted by the combination of study-based ridership estimates. The ridership estimates used in this study were adjusted down from earlier studies to eliminate this redundancy.

The CONNECT model results used a horizon year of 2045, so benchmarking of ridership estimates was performed on estimated 2045 ridership for all segments. These results were then scaled between

2030 and 2045, using ridership growth rates from the DC2RVA and R2R ridership models to estimate ridership growth in each segment. Ridership estimates beyond 2045 were held at a constant for each segment until 2055. This is a conservative assumption of no further ridership growth within a segment past 2045.

Once segment-level ridership and growth were determined, the phases described above were applied to "open" the segment in the correct year. The opening of new segments creates the steps in the ridership estimates seen in **Figure 10**. The step up for Scenarios 2A and 2B in 2050 is due to the estimated opening of the Chattanooga to Nashville segment.

3.3 Accrual and Inflation Adjustments

Project costs and benefits are all stated in 2020 dollars. When necessary, historical cost data from precedent studies have been adjusted to 2020 dollars using the Consumer Price Index (CPI).

3.4 Discounting

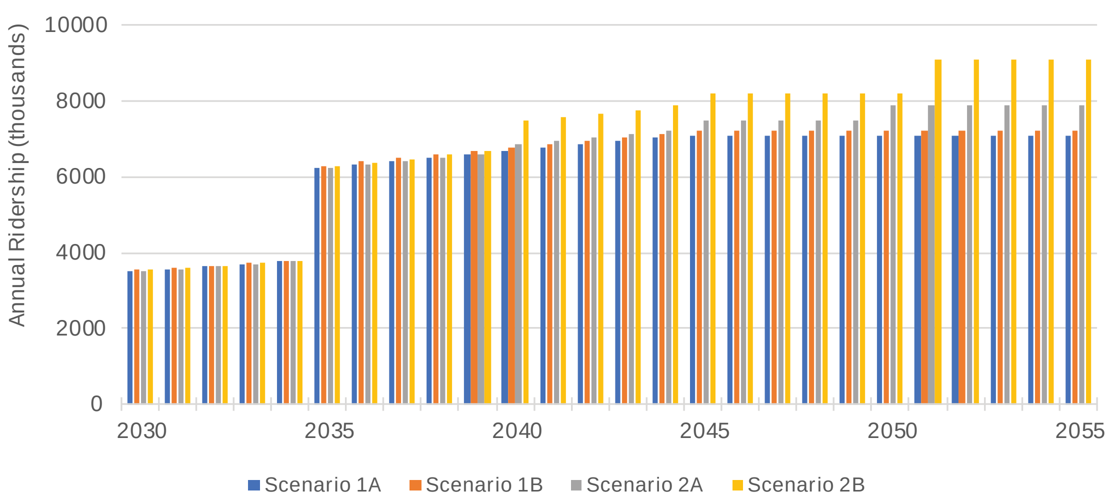
As benefits accrue over time and starting at different points depending on the phasing noted above, discounting is used to aggregate benefits into the same present value (PV) terms. Benefits were all adjusted using a 7 percent discount rate to account for the time value of money. Each benefit stream was separately discounted for each year in the analysis period so that future benefits are expressed in the same PV terms.

Time Value of Money

This is the broadly accepted concept that money you have today is worth more than receiving an equal sum in the future. This is because it can be invested today if you have it on hand. The time value of money is the reason why interest is paid or earned as any amount of money is worth more the sooner it is received due to its potential earning capacity once you have it. Time value of money is also sometimes referred to as PV or present discounted value.

PVs are expressed as the current value of a future sum of money or cash flow given a stated rate of return. Future cash flows are discounted at the discount rate. The higher the discount rate, the lower the present value of the future cash flow.

Figure 10: Annual Ridership Estimates 2030–2055 (in thousands)



4.0 Scenario Economic Benefits

For the purpose of brevity, annual benefits for the 2055 horizon year are reported here, which represents the full or maximum buildout of each scenario. Full buildout benefits were used to compare scenarios, rather than average annual benefits, to make clear the benefits of each scenario once all segments are operating at maximum capacity.

This section presents aggregate benefits for each scenario to allow for comparison between the differing speeds and locations.

The economic benefits for individual segments are represented independently in **Appendix C**.

4.1 Increased Rail Ridership

Methodology

Annual rail ridership is calculated using the phasing plan and methodology described in the previous section. The ridership here is from 2055, though no growth in ridership is projected on individual segments past 2045.

In some cases, CBSA-to-CBSA pairs overlap more than one corridor segment. For example, the Baltimore, MD, to Greensboro, NC, CBSA pair intersects the Washington, DC, to Richmond, VA; Richmond, VA, to Raleigh, NC; and Raleigh, NC, to Charlotte, NC, corridor segments. The pair's ridership estimate is included in each segment's individual sum, but only counted once in the systemwide ridership. Thus, the sum of the individual corridor segments does not equal the systemwide sum.

Ridership estimates, and derivative economic benefit calculations, for the Atlanta to Orlando segment in Scenarios 2A and 2B are understated in this analysis. There are no plans for HSR on this corridor to reference and the CONNECT model does not predict ridership south of Jacksonville. Therefore, the only source of ridership available for this segment is from the CONNECT model but stopping in Jacksonville (as noted in the table below).

Results

Table 6 shows the results of the ridership estimates. Year 2055 annual ridership ranges from approximately 7.1 million passengers in Scenario 1A to more than 9.1 million passengers in Scenario 2B.

Table 6: Ridership (2055)

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Washington, DC to Richmond	4,369,000	4,413,000	4,398,000	4,468,000
Richmond to Raleigh	3,969,000	4,017,000	4,007,000	4,094,000
Raleigh to Charlotte	3,686,000	3,750,000	3,759,000	3,911,000
Charlotte to Atlanta	2,742,000	2,800,000	2,951,000	3,336,000
Atlanta to Nashville			584,000	1,156,000
Atlanta to Orlando (Jacksonville)			223,000	839,000
Total	**7,104,000**	**7,195,000**	**7,903,000**	**9,113,000**

4.2 Travel Time Savings

Methodology

Travel time savings is expressed in two different ways. First, individual travel time savings are estimated for each mode and segment. Second, those savings are extrapolated across ridership estimates to calculate aggregate savings.

Travel Time Savings by Mode

Modal travel time savings is calculated by subtracting the travel time for competing modes, including auto, bus, rail, and air from the corresponding high-performance rail travel time for each corridor segment, as expressed in the following formula:

Travel Time Savings^{m} (minutes) =
High-Performance Rail Travel Time – Travel Time^{m}

Where m is the mode (bus, auto, air, or rail).

This analysis leveraged outputs from the CONNECT model to refine the estimate of HSR travel time. It should be noted that limited travel time data was available for the Jacksonville to Orlando CBSA pair, either from local sources or through a benchmark from the CONNECT model. As such, high-performance rail travel time for this segment was estimated through extrapolation using the route distance between Jacksonville and Orlando.

The Google Maps routing feature was used to estimate travel time for competing modes. Auto travel times assume travel from city center to city center on a weekday morning at 7:00 a.m. ET. All other modes are based on the fastest available private carrier from station to station as close to 7:00 a.m. ET as possible. **Table 7** provides more detail on how segment- and mode-specific travel times were estimated for bus, rail, and air travel.

Table 7: Modal Travel Time Estimation Methodology

Segment	Bus	Rail	Air [7]
Washington, DC, to Richmond	Megabus 8:00 a.m. departure from Union Station to Main Street Station.	Amtrak Northeast Regional 7:20 a.m. departure from Union Station to Main Street Station.	United Airlines 10:30 a.m. departure from IAD to RIC (earliest available non-stop flight).
Richmond to Raleigh	Greyhound 12:55 p.m. departure from Richmond Bus Station to Raleigh.	Amtrak Silver Star 5:17 p.m. departure from Staples Mill Road Station to Raleigh Union Station.	American Airlines 6:02 p.m. departure from RIC to RDU with a stop in CLT.
Raleigh to Charlotte	NA	Amtrak Piedmont 10:00 a.m. departure from Raleigh Union Station to Charlotte Station.	American Airlines 6:12 p.m. departure from RDU to CLT.
Charlotte to Atlanta	Megabus 4:00 p.m. departure from Whitton Street Station to MARTA Station.	Amtrak Crescent 2:45 a.m. departure from Charlotte Station to Atlanta Peachtree Station.	Delta Airlines 6:35 p.m. departure from CLT to ATL.
Atlanta to Nashville	Megabus 11:30 a.m. departure from MARTA Station to TA Truck Stop.	NA	Southwest Airlines 8:00 a.m. departure from ATL to BNA.
Atlanta to Orlando	Redcoach 11:45 p.m. departure from MARTA Station to Orlando Redcoach.	NA	JetBlue Airlines 11:00 a.m. departure from ATL to MCO.

7 In addition to the scheduled travel time, an extra hour was added to air travel to account for check-in and security wait times, which is less than the two-hour early arrival recommended by the Transportation Security Administration (TSA).

Aggregate Travel Time Savings

In addition to total trips, the previous planning studies estimate how many of those trips are diverted from other modes (auto, bus, and air), including diversions from existing rail trips. The CONNECT model was used to benchmark the rates of diversion, though the model does not estimate rail trips diverted. The percentage of existing rail trips diverted was used directly from original studies.

The number of diverted trips for each mode is multiplied by the corresponding average travel time savings to estimate aggregate travel time savings as expressed in the following formula:

*Aggregate Travel Time Savings^m (minutes) = Diverted Passenger Miles^m * Travel Time Savings^m*

Where m is the mode (bus, auto, air, or rail).

Year 2055 annual modal trip diversion estimates are shown in **Table 8**. Segment-level summaries of trip diversion are included in **Appendix C**.

Year 2055 annual aggregate travel time savings, the product of modal travel time savings and total annual modal trips diverted, is shown in **Table 9**. In some cases, the annual aggregate air travel time savings is a negative number; this is because air travel is faster than high-performance rail for that particular segment. Segment-level aggregate travel time savings is included in **Appendix C**.

Economic Value of Time

The economic value of time benefit is based on the premise that travelers' time savings accrued by taking a faster mode allows them to be more productive and provide additional economic value. The value of time for each mode was calculated using the recommended hourly values of time savings from USDOT[8] for business and personal travel.

Table 8: Annual Modal Trip Diversion (2055)

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Auto Trips Diverted	3,417,000	3,417,000	3,828,000	4,210,000
Bus Trips Diverted	366,000	366,000	481,000	664,000
Rail Trips Diverted	128,000	129,000	129,000	132,000
Air Trips Diverted	2,796,000	2,840,000	3,028,000	3,559,000

Table 9: Annual Aggregate Travel Time Savings (2055) in minutes

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Auto	381,556,000	385,914,000	436,753,000	492,594,000
Bus	27,412,000	27,868,000	40,571,000	64,560,000
Rail	11,678,000	11,777,000	11,777,000	12,032,000
Air	298,424,000	301,134,000	279,197,000	229,510,000
Total All Modes	**719,070,000**	**726,693,000**	**768,298,000**	**798,696,000**

8 USDOT, Benefit Cost Analysis Guidance for Discretionary Grant Programs, Office of the Secretary, U.S. Department of Transportation, January 2020

The individual business and personal travel rates were combined into a single, weighted average hourly rate using percentages derived from the BCA performed for the Raleigh to Richmond Corridor[9] and inflated from 2018 to 2020 dollars using a 2 percent annual inflation rate. Finally, the hourly rates for auto, bus, and air were adjusted by 50 percent to account for USDOT's "rule of one-half" consumer surplus approach for estimating travel time savings to new rail users.[10] The economic value of time per hour and per mode calculations are summarized in **Table 10**.

Results

Table 11 shows the annual economic value of time benefit for the year 2055, which is the product of the annual aggregate travel time savings and economic value of time rate calculations described in the methodology. The total economic benefit is comparable across all scenarios, ranging from $196.6 to $201.6 million annually.

In many cases, the economic value of time benefit from diverted air travel is a negative number. This is because air travel is theoretically faster than high-performance rail in many travel markets associated with Southeast Corridor segments, including Raleigh to Charlotte, Charlotte to Atlanta, Atlanta to Nashville, and Atlanta to Orlando (Jacksonville). Corridor segments with higher levels of high-performance rail ridership and diverted air trips have a greater negative economic benefit, which is why Scenarios 2A and 2B have a total annual economic value of time benefit comparable to or less than Scenarios 1A and 1B. Segment-level calculations of the economic value of time are included in **Appendix C**.

Table 10: Economic Value of Time Hourly Rate Calculations

Mode	Business Trips	Personal Trips	2018 Weighted Average	2020 Weighted Average
Air Travel	$67.30 Weight: 14%	$40.40 Weight: 86%	$44.17	$45.93
Auto/Bus	$27.10 Weight: 9%	Local: $15.20 Weight: 18% Long-Distance: $21.30 Weight: 73%	$20.72	$21.55
Rail	$67.30 Weight: 14%	$40.40 Weight: 86%	$44.17	$45.93

Table 11: Annual Economic Value of Time in 2055 (in thousands of 2020 dollars)

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Auto	$68,521	$69,304	$78,434	$88,462
Bus	$4,923	$5,005	$7,286	$11,594
Rail	$8,940	$9,015	$9,015	$9,210
Air	$114,222	$115,259	$106,863	$87,845
Total All Modes	**$196,605**	**$198,583**	**$201,598**	**$197,111**

9 North Carolina DOT, Southeast Corridor Acquisition Project, Raleigh to Richmond Corridor CRISI Grant Application, Benefit Cost Analysis, June 2020

10 USDOT, Benefit Cost Analysis Guidance for Discretionary Grant Programs, Office of the Secretary, U.S. Department of Transportation, January 2020

4.3 Employment

Methodology

Employment benefits associated with the Southeast Corridor are calculated in two different ways. First are employment benefits, both direct and indirect, attributed to construction of high-performance rail. Second are employment benefits generated by access to high-performance rail stations. It should be noted that no proven methodology was identified to estimate the potential employment benefits related to freight and logistics operations that could be generated through corridor separation. As such, the findings in this section should be considered conservative.

Construction-Related Employment Benefits

Construction-related employment benefits are calculated as a function of each segments' capital cost using a multiplier, as expressed in the following formula:

Employment (job years) =
*Capital Cost * Job Years per Million Spent*

Capital cost estimates are taken from the respective precedent corridor studies described in **Table 3** and the scenario technologies described in **Appendix B**. When necessary, cost estimates are inflated or deflated to 2020 dollars to normalize costs for aggregation.

Table 12 identifies the capital cost associated with each segment and scenario, which range from just over $20 billion for Scenarios 1A and 1B, which exclude the segments from Atlanta to Nashville and Atlanta to Orlando, to approximately $41 to $54 billion for Scenarios 2A and 2B, respectively. The increase in cost for Scenario 2B is attributed to faster high-performance rail technology associated with the Atlanta to Nashville and Atlanta to Orlando segments. Richmond to Raleigh segment capital costs are not included in any scenario because those improvements are currently underway.

The factor for jobs per millions of dollars spent on construction is derived from the *California High-Speed Rail Study*, which used IMPLAN to model the economic impacts of high-performance rail investment. Employment is expressed in terms of three separate types:

- Direct employment: construction and professional services for the rail system
- Indirect employment: employment for supply chains that impact the construction of the rail system
- Induced employment: employment created by the spending of income of direct and indirect employees

Table 12: Capital Cost (in millions 2020 Dollars)

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Long Bridge Project	$1,646	$1,646	$1,646	$1,646
Washington, DC, to Richmond	$5,042	$5,042	$5,042	$5,042
Richmond to Raleigh	$2,453	$2,453	$2,453	$2,453
Raleigh to Charlotte[11]	NA	NA	NA	NA
Charlotte to Atlanta	$11,477	$11,477	$11,477	$11,477
Atlanta to Nashville[12]			$10,747	$15,510
Atlanta to Orlando[13]			$10,176	$17,892
Total	**$20,617**	**$20,617**	**$41,541**	**$54,019**

11 Capital improvements for the Raleigh to Charlotte segment are underway and not included in the estimation of economic benefits.
12 Costs include an additional $420 million above the EIS capital costs due to the addition of a new downtown Atlanta station.
13 Capital cost from Atlanta to Jacksonville, extrapolated using the route distance between Jacksonville and Orlando.

Employment is reported in terms of job years for direct, indirect, and induced employment as shown in **Table 13**.

Table 13. Employment Multiplier Derivation [14]

Type	Employment (Job Years)	CA HSR Capital Cost (Millions of 2018 Dollars)	Employment (Job Years) per Million Dollars Spent
Direct	4,150	$815	5.09
Indirect	2,250		2.76
Induced	2,850		3.50

A "job year" is defined as one year of employment. Total job years calculated for each corridor segment were divided by five, the average number of years of construction, to estimate average annual employment created during construction.

Station-Area Employment Benefits

Station-area employment is a function of several factors, including:

- Station location
- Amount of vacant land and redevelopment
- Land use mix (residential vs. non-residential)
- Floor area ratio (FAR) and employment occupancy assumptions

Stations associated with each corridor segment are listed in **Table 14**.

For a half-mile radius around each station location, an inventory of existing land use and employment was collected using Urban Footprint, a cloud-based tool for city planning that includes a robust database of relevant information, including property data, demographic data, and employment data. A sample station area from Urban Footprint is shown in **Figure 11**. Station area employment was calculated for new development and redevelopment using the assumptions in **Table 15**.

Table 15: Station-Area Employment Calculation Assumptions

Land Use Mix		Floor Area Ratio	Occupancy Rate (Employees per Thousand Square Feet)
Residential	Non-Residential		
50%	50%	0.25 to 3.00	2.0

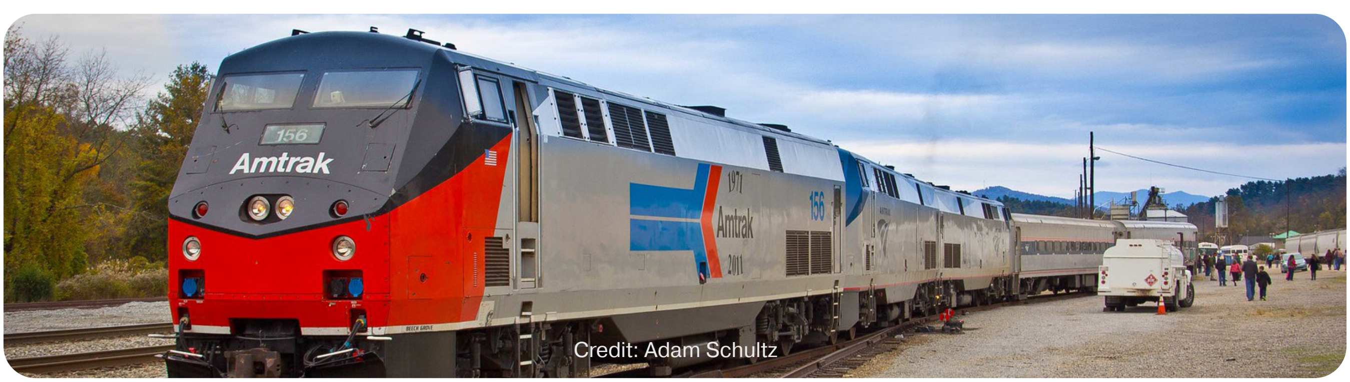
For new development in station areas, the following formula was used:

*Employment = Vacant Land Area * % Non-Residential * FAR * Employees per Thousand Square Feet*

For redevelopment, the following formula was used:

*Employment = (Non-residential Land Area * % Non-Residential * FAR * Employees per Thousand Square Feet) – Existing Non-residential Square Feet*

Assumptions about FAR are based on existing station-area context. For example, if a station is located in a small urban area with an existing FAR of less than 0.25, the assumed FAR is on the lower end of the range, while stations located in large urban areas with high existing FARs are on the higher end of the range. Total new non-residential square feet for each scenario is identified **Table 16**.



Credit: Adam Schultz

14 Derived from IMPLAN modeling and construction cost estimates from California High-Speed Rail Study (Technical Support Document 2017-18).

Table 14: Station Locations

Station	Segment						Existing/ New	Source
	Washington, DC , to Richmond	Richmond to Raleigh	Raleigh to Charlotte	Charlotte to Atlanta	Atlanta to Nashville	Atlanta to Orlando		
Washington, DC	•						Existing	DC2RVA DEIS
Richmond	•	•					Existing	R2R BCA for CRISI grant application
Petersburg (Ettrick)		•					Existing	R2R BCA for CRISI grant application
La Crosse (VA)		•					New	R2R BCA for CRISI grant application
Henderson		•					New	R2R BCA for CRISI grant application
Wake Forest		•					New	R2R BCA for CRISI grant application
Raleigh		•	•				Existing	NCDOT
Greensboro			•				Existing	NCDOT
Charlotte			•	•			New	NCDOT
Greenville–Spartanburg International (GSP) Airport				•			New	Atlanta-Charlotte Tier 1 EIS
Anderson				•			New	Atlanta-Charlotte Tier 1 EIS
Athens				•			New	Atlanta-Charlotte Tier 1 EIS
Atlanta				•	•	•	New (Downtown)	Atlanta-Charlotte Tier 1 EIS
Hartsfield–Jackson Atlanta International Airport (HJIA)				•	•	•	New (Airport)	Atlanta-Chattanooga-Nashville-Louisville HSR Planning Report
Chattanooga					•		New	Atlanta-Chattanooga-Nashville-Louisville HSR Planning Report
Nashville					•		New	Atlanta-Chattanooga-Nashville-Louisville HSR Planning Report
Macon						•	New	Atlanta-Macon-Jacksonville HSR Planning Report
Jacksonville						•	New	Atlanta-Macon-Jacksonville HSR Planning Report
Daytona Beach						•	Existing (Amtrak, DeLand)	Planning assumption
Orlando						•	Existing (Brightline, Airport)	Planning assumption

Many of the benefits in this study are based on the location of stations above, including increased employment and property values. If additional stations are built or stations are located in higher-density areas, such as moving away from the low-density airport locations in Orlando and Greensville-Spartanburg, the benefits associated with high-performance rail will increase.

Figure 11: Example Map of Land Use Within A Half-Mile Radius of the Charlotte Station

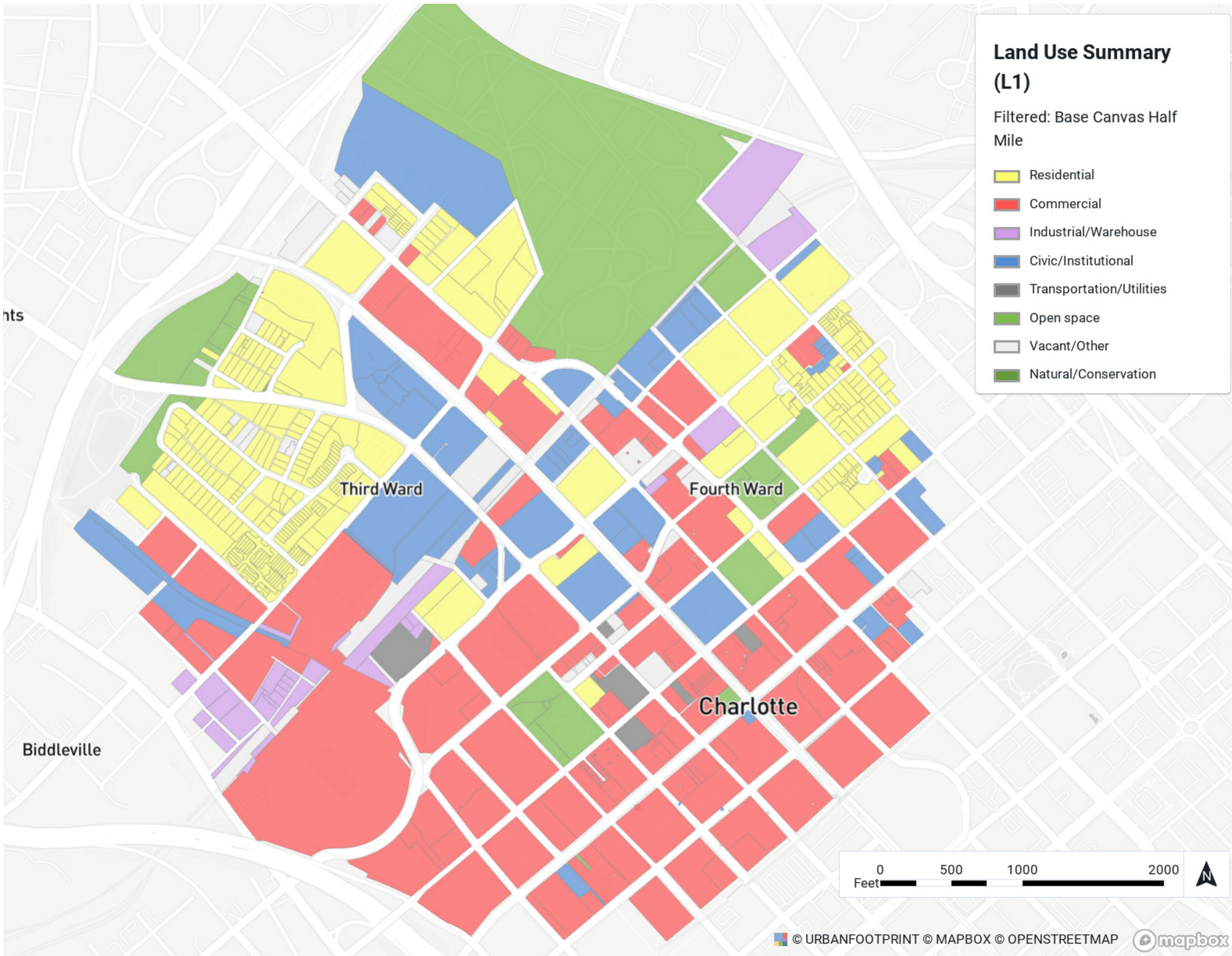


Table 16: New Non-Residential Square Feet in Station Areas

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Washington, DC, to Richmond	6,978,000	6,978,000	6,978,000	6,978,000
Richmond to Raleigh	9,512,000	9,512,000	9,512,000	9,512,000
Raleigh to Charlotte	4,918,000	4,918,000	4,918,000	4,918,000
Charlotte to Atlanta	37,669,500	37,669,500	37,669,500	37,669,500
Atlanta to Nashville			28,915,000	28,915,000
Atlanta to Orlando			25,417,000	25,417,000
Total	**38,458,000**	**38,458,000**	**71,196,000**	**71,196,000**

Although accessibility enhancements associated with high-performance rail will induce new jobs to locate around stations, in many cases, station-area employment also will include existing employment that has relocated to be near a station. For that reason, new regional base employment is calculated as a check against station-area employment calculations.

To calculate new regional base employment, a multiplier was applied to the existing regional employment. The multiplier of 0.74 percent was derived from the Midwest Network HSR Study, which used the TREDIS model for employment relationships. Existing regional base employment was estimated by using Urban Footprint to collect employment data for a 10-mile radius around each station area. A sample 10-mile radius map is shown in **Figure 12**. The existing regional base employment is shown in **Table 17**.

Results

Construction-related employment benefits, in terms of average annual job years, are shown **Table 18**. Annual employment ranges from 40,000 jobs for Scenarios 1A and 1B to more than 74,000 and 94,000 jobs for Scenarios 2A and 2B, respectively. As noted previously, capital improvements for the Raleigh to Charlotte segment are underway and not included in the estimation of economic benefits. Segment-level construction-level employment benefits are included in **Appendix C**.

The calculation assumes an average construction duration of five years. Thus, these employment benefits will accrue for five years. Each segment's benefit will begin accrual approximately five years prior to the operation year listed in **Table 5**.

Table 17: Existing Regional Base Employment (2020)

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Washington, DC, to Richmond	1,605,900	1,605,900	1,605,900	1,605,900
Richmond to Raleigh	1,002,500	1,002,500	1,002,500	1,002,500
Raleigh to Charlotte	1,271,700	1,271,700	1,271,700	1,271,700
Charlotte to Atlanta	2,037,100	2,037,100	2,037,100	2,037,100
Atlanta to Nashville			1,791,900	1,791,900
Atlanta to Orlando			2,028,600	2,028,600
Total	**3,729,000**	**3,729,000**	**6,020,000**	**6,020,000**

Table 18: Construction-Related Employment Benefits (Average Annual Jobs During Construction)

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Direct Employment	18,220	18,220	33,420	42,480
Indirect Employment	9,900	9,900	18,140	23,060
Induced Employment	12,540	12,540	22,980	29,220
Total Employment	**40,660**	**40,660**	**74,540**	**94,760**

Figure 12: Example Map Showing Total Employment Within a 10-Mile Radius of the Charlotte Station

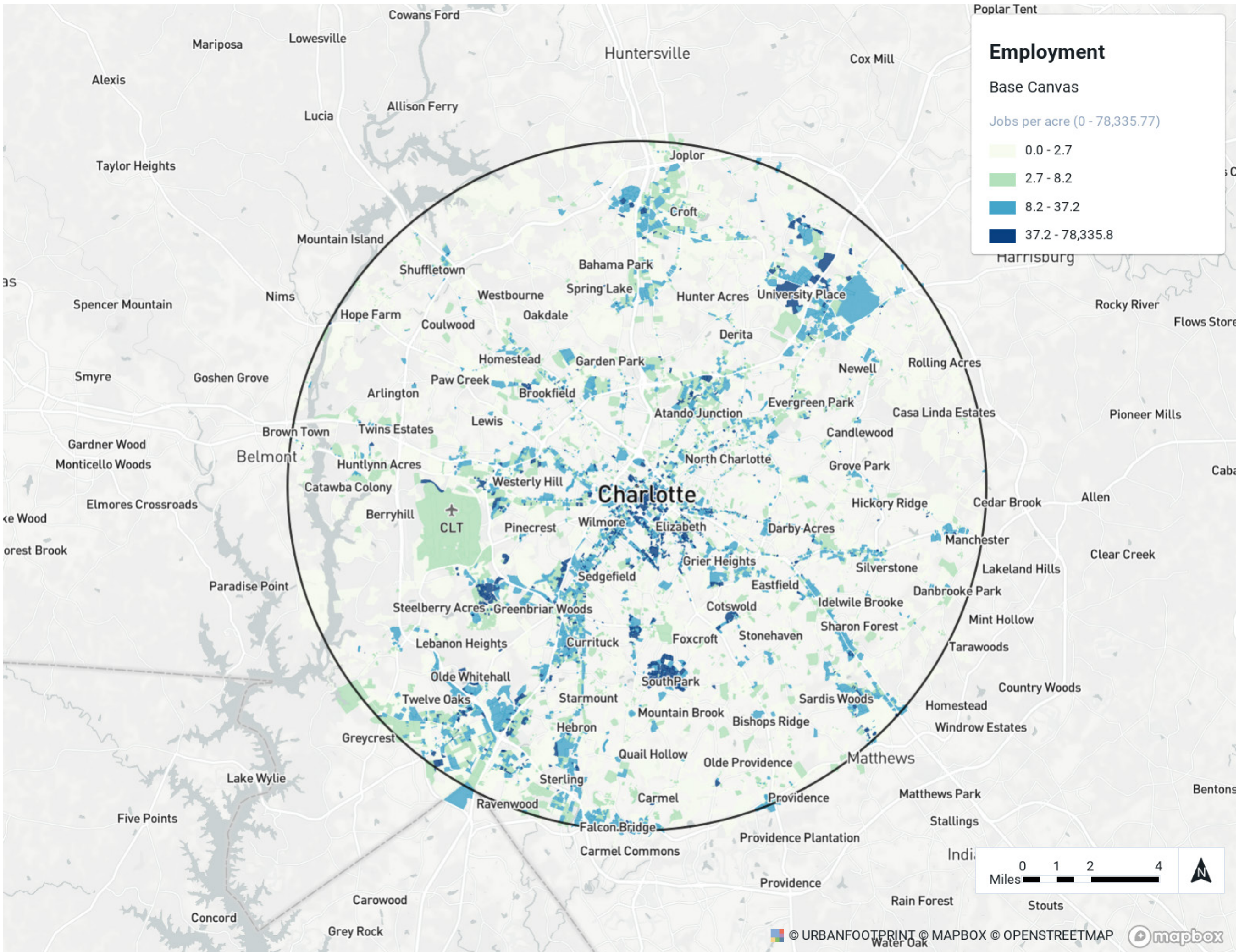


Table 19 identifies new station-area employment and new regional base employment for each scenario. New station-area employment ranges from more than 77,000 jobs for Scenarios 1A and 1B to over 142,000 jobs for Scenarios 2A and 2B. New regional base employment ranges from almost 28,000 jobs for Scenarios 1A and 1B to almost 45,000 jobs for Scenarios 2A and 2B.

These results suggest that less than one-third of new station-area jobs are induced by high-performance rail and the remainder are existing jobs that have relocated to the station areas.

4.4 Economic Output

Methodology

Economic output in the case of high-performance rail investment is calculated in terms of increased spending power and expenditures flowing through the supply chain and employees related to the investments. Similar to construction-related employment benefits, economic output benefits are calculated as a function of each segments' capital cost using a multiplier, as expressed in the following formula:

*Employment Output (Dollars) = Capital Cost * Economic Output per Million Spent*

Capital cost estimates were previously described in **Table 12** and its associated narrative.

The economic output per millions of dollars spent multiplier is derived from the *California High-Speed Rail Study*, which used IMPLAN to model the economic impacts of high-performance rail investment. The derivation of direct, indirect, and induced economic output multipliers is shown in **Table 20**.

The resulting multiplier is reported in 2018 dollars, which was inflated to 2020 dollars using the CPI.

Results

Table 21 shows the economic output benefits associated with each scenario. Total economic output ranges from just over $42 million for Scenarios 1A and 1B to to more than $77 and $98 million for Scenarios 2A and 2B, respectively. As noted previously, capital improvements for the Raleigh to Charlotte segment are underway and not included in the estimation of economic benefits. Segment-level economic output benefits are included in **Appendix C**.

Table 19: New Station Area and Regional Base Employment

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
New Station-Area Jobs	76,900	76,900	142,400	142,400
New Regional Base Jobs	27,600	27,600	44,500	44,500

Table 20: Economic Output Multipliers

Type	Economic Output (Millions)	CA HSR Capital Cost (Millions of 2018 Dollars)	Economic Output per Million Dollars Spent
Direct	$810	$815	$0.994
Indirect	$415		$0.509
Induced	$455		$0.558

Table 21: Economic Output Benefits (in millions of 2020 Dollars)

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Direct Output	$20,300	$20,300	$37,300	$47,400
Indirect Output	$10,400	$10,400	$19,200	$24,300
Induced Output	$11,500	$11,500	$21,000	$26,700
Total Output	**$42,200**	**$42,200**	**$77,500**	**$98,400**

4.5 Property Value Increase

Methodology

The introduction or enhancement of rail passenger service has a positive impact on property values surrounding rail stations. Multiple studies have shown a statistically significant relationship between proximity to passenger rail stations and property value increase.[15] This is a benefit that accrues to both property owners (increased property value) and government agencies (increase in property and/or sales tax revenue).

Property value increase benefits are calculated for residential and non-residential properties, both pre-existing and new, built as a result of proximity to a new rail station. The methodology builds on the process described for calculated station-area employment increase and is based on the same station locations identified in **Table 14**.

Commercial Property Values

A recent US study showed that commercial property values within a half-mile radius of transit stations increased from 5 to 42 percent from 2012 to 2016 as major cities expanded transit services.[16] Analysis completed for the Raleigh to Richmond BCA found that non-residential property within a half-mile of the recently completed Raleigh Union Station increased at a rate 5.78 percent higher than the county.

The Richmond to Raleigh BCA made a conservative assumption that existing commercial properties adjacent to new high-performance rail stations would experience a one-time 5 percent net increase in property values and existing commercial properties adjacent to existing stations enhanced by new high-performance rail service would experience a 2.5 percent net increase. Both assumptions have been used for the economic benefit calculations for this study.

To estimate property values, property assessor market value data curated by Urban Footprint was collected for commercial properties within a half-mile of each planned station. **Figure 13** provides an example of the property value data collected from Urban Footprint within a half-mile of the proposed downtown Charlotte station.

In addition to existing properties, the calculation of benefits assumes that new development will occur in station areas as a result of high-performance rail service, both on vacant parcels and in the form of redevelopment intensification. New development and redevelopment, in terms of non-residential square footage, was calculated based on assumptions about FAR and land-use mix (residential vs. non-residential using the process described in the station-area employment section and assumptions in **Table 15**).

Value associated with new commercial properties is calculated using the following formula:

*New Commercial Property Value = New NRSF * (Existing Commercial Property Value ÷ Existing NRSF)*

Increase in value attributed to new commercial properties accrues at a rate of 10 percent per year for 10 years, beginning in the first year of operation according to the assumed operational years identified in **Table 5**. Station area commercial property data is shown in **Table 22**. Blank cells in the table are attributed to two factors—lack of data (La Crosse and Henderson) or lack of available land (airport locations).

Residential Property Values

Two recent US studies have shown that residential property values increased within a half-mile of transit by a range of either 4 to 24 percent or 3 to 40 percent due to increased accessibility and livability benefits.[17] The Raleigh to Richmond BCA conservatively interpreted these values for its analysis, assuming a one-time appreciation in existing residential property values of 10 percent for newly established stations and a heavily discounted rate of 2.5 percent for established stations.

15 http://www3.drcog.org/documents/archive/The_effect_of_Rail_Transit_on_Property_Values_Summary_of_Studies1.pdf; https://trid.trb.org/view/504776; https://papers.tinbergen.nl/04023.pdf; and TCRP Synthesis 128, Practices for Evaluating the Economic Impacts and Benefits of Transit

16 The Real Estate Mantra – Locate Near Public Transportation, October 2019, APTA and National Association of Realtors

17 The Real Estate Mantra –Locate Near Public Transportation, October 2019, APTA and National Association of Realtors; and http://www.rtd-fastracks.com/media/uploads/nm/impacts_of_rail_transif_on_property_values.pdf

Figure 13: Example Property Value Within a Half-Mile Radius of the Charlotte Station

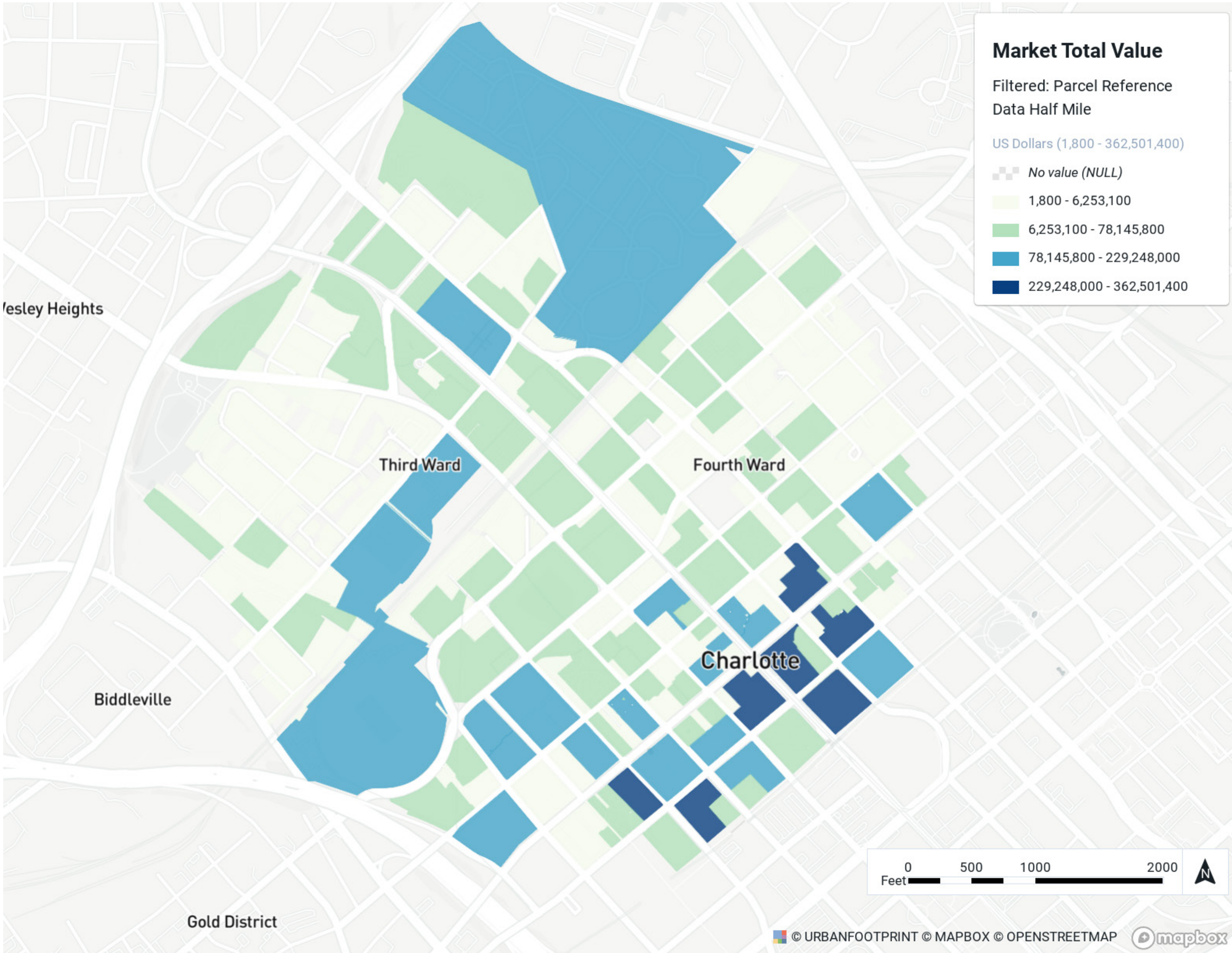


Table 22: Station Area Commercial Property Data

Station	Existing NRSF	Existing Commercial Property Value (Thousands of Dollars)	New NRSF
Washington, DC, to Richmond	**52,450,000**	**$3,339,512**	**6,978,000**
Richmond	22,422,000	$2,817,752	5,685,500
Washington	30,028,000	$521,760	1,292,500
Richmond to Raleigh	**32,228,250**	**$4,239,569**	**9,512,000**
Richmond	22,422,000	$2,817,752	5,685,500
Petersburg (Ettrick)	44,000	$55,586	503,500
La Crosse (VA)	67,000		794,000
Wake Forest	360,250	$49,489	745,500
Henderson	2,960,000		0
Raleigh	6,375,000	$1,316,741	1,783,500
Raleigh to Charlotte	**35,872,000**	**$7,463,469**	**4,918,000**
Raleigh	6,375,000	$1,316,741	1,783,500
Greensboro	6,534,000	$724,718	1,428,000
Charlotte	22,963,000	$5,422,010	1,706,500
Charlotte to Atlanta	**39,123,950**	**$9,045,628**	**37,669,500**
Charlotte	22,963,000	$5,422,010	1,706,500
GSP Airport			0
Anderson	9,900	$494	10,694,500
Athens	9,800	$630	9,072,500
Atlanta	14,364,000	$3,466,417	11,623,000
HJIA	1,777,250	$156,076	4,573,000
Atlanta to Nashville	**30,356,250**	**$7,976,017**	**28,915,000**
Atlanta	14,364,000	$3,466,417	11,623,000
HJIA	1,777,250	$156,077	4,573,000
Chattanooga	1,547,000	$221,523	6,368,000
Nashville	12,668,000	$4,132,000	6,351,000
Atlanta to Orlando	**27,926,150**	**$8,365,578**	**25,417,000**
Atlanta	14,364,000	$3,466,417	11,623,000
HJIA	1,777,250	$156,077	4,573,000
Macon	4,170,000	$192,342	3,384,000
Jacksonville	5,980,000	$397,370	2,473,500
Daytona Beach	204,900	$6,256	3,363,500
Orlando	1,430,000	$4,147,116	0
Total	**118,900,000**	**$23,367,401**	**71,196,000**

To estimate property values, property assessor market value data curated by Urban Footprint was collected for residential properties within a half-mile of each station.

Similar to the calculation of commercial property value benefits, the calculation of residential property value benefits assumes that new development and redevelopment will occur in station areas as a result of high-performance rail service. Development and redevelopment, in terms of new dwelling units, was calculated based on assumptions about net density and land-use mix (residential vs. non-residential) as shown in **Table 23**.

Table 23: Station Area Residential Development Assumptions

Land Use Mix		Density
Residential	Non-Residential	
50%	50%	16 to 64 units per acre

Value associated with new commercial properties is calculated using the following formula:

*New Residential Property Value = New Units * (Existing Residential Property Value ÷ Existing Units)*

Increase in value attributed to new commercial properties accrues at a rate of 10 percent per year for 10 years, beginning in the first year of operation according to the assumed operational years identified in **Table 5**. Station area commercial property data is shown in **Table 24**.

Results

The results of the calculation of station area property value increase benefits, both in terms of the one-time benefit attributed to existing properties and the average annual benefit attributed to new properties, are shown in **Table 25**.

As expected, station areas located in large urban areas, such as Atlanta, Charlotte, Nashville, Raleigh, Richmond, and Washington, DC, have greater property values and development potential than stations located in smaller areas, and thus contribute more significantly to the total benefit. Several stations, like GSP Airport and Orlando, are located on or near airport property, and thus do not capture private property value.

Table 26 shows the results of property value increase benefit calculation by scenario. Benefits range from a one-time increase of $637.5 million and average annual increase of $58.6 million for Scenarios 1A and 1B, which exclude the Atlanta to Nashville and Atlanta to Orlando segments, to a one-time increase of $1,385.9 million and average annual increase of $128.1 million for Scenarios 2A and 2B. The sum of the individual segments exceeds the systemwide sum because segments include overlapping stations.

Table 24: Station Area Residential Property Data

Segment	Existing Units	Existing Residential Property Value (Thousands of Dollars)	New Units
Washington, DC, to Richmond	**4,600**	**$2,068,428**	**2,080**
Richmond	2,300	$638,889	1,480
Washington	2,300	$1,429,539	600
Richmond to Raleigh	**8,500**	**$1,457,445**	**5,280**
Richmond	2,300	$638,889	1,080
Petersburg (Ettrick)	1,100	$152,295	240
La Crosse (VA)	400	$42,000	1,170
Wake Forest	880	$179,872	1,120
Total	**24,000**	**$4,956,106**	**46,000**

Table 24: Station Area Residential Property Data

Segment	Existing Units	Existing Residential Property Value (Thousands of Dollars)	New Units
Henderson	1,670	$125,3334	190
Raleigh	2,150	$319,055	1,480
Raleigh to Charlotte	**9,360**	**$1,276,586**	**660**
Raleigh	2,150	$319,055	1,480
Greensboro	1,710	$148,448	1,510
Charlotte	5,500	$809,083	870
Charlotte to Atlanta	**8,921**	**$1,029,437**	**3,860**
Charlotte	5,500	$809,083	870
GSP Airport			0
Anderson	150	$16,713	5,200
Athens	260	$10,844	4,490
Atlanta	2,600	$176,484	8,530
HJIA	410	$16,313	4,460
Atlanta to Nashville	**6,410**	**$1,657,960**	**22,800**
Atlanta	2,600	$176,484	8,530
HJIA	410	$16,313	4,460
Chattanooga	1,100	$205,404	4,700
Nashville	2,300	$1,259,759	5,110
Atlanta to Orlando	**3,740**	**$333,641**	**17,940**
Atlanta	2,600	$176,484	8,530
HJIA	410	$16,313	4,460
Macon	330	$2,781	1,620
Jacksonville	350	$131,473	1,660
Daytona Beach	50	$6,590	1,670
Orlando	0	$0	0
Total	**24,000**	**$4,956,106**	**46,000**

Table 25: Property Value Increase Benefits by Station (in thousands of 2020 Dollars)

Segment	Residential		Commercial		Total		Beginning Accrual Year
	Existing Properties	New Properties (Annual Average for 10 Years)	Existing Properties	New Properties (Annual Average for 10 Years)	Existing Properties	New Properties (Annual Average for 10 Years)	
Washington, DC, to Richmond	**$51,710**	**$2,168**	**$83,488**	**$7,370**	**$135,198**	**$9,538**	
Richmond	$15,972	$2,168	$70,444	$7,145	$86,416	$9,313	2030
Washington	$35,738	$0	$13,044	$225	$48,782	$225	2030
Richmond to Raleigh	**$62,475**	**$3,260**	**$107,227**	**$18,214**	**$169,702**	**$21,473**	
Richmond	$15,972	$2,168	$70,444	$7,145	$86,416	$9,313	2030
Petersburg (Ettrick)	$3,807	$55	$1,390	$6,361	$5,197	$6,416	2030
La Crosse (VA)	$4,200	$179	$0	$0	$4,200	$179	2030
Wake Forest	$17,987	$449	$2,474	$1,024	$20,461	$1,473	2030
Henderson	$12,533	$143	$0	$0	$12,533	$143	2030
Raleigh	$7,976	$266	$32,919	$3,684	$40,895	$3,950	2030
Raleigh to Charlotte	**$92,595**	**$726**	**$322,138**	**$9,297**	**$414,733**	**$10,023**	
Raleigh	$7,976	$266	$32,919	$3,684	$40,895	$3,950	2030
Greensboro	$3,711	$357	$18,118	$1,584	$21,829	$1,941	2030
Charlotte	$80,908	$103	$271,101	$4,029	$352,009	$4,132	2030
Charlotte to Atlanta	**$102,942**	**$12,125**	**$452,283**	**$47,264**	**$555,225**	**$59,389**	
Charlotte	$80,908	$103	$271,101	$4,029	$352,009	$4,132	2030
GSP Airport	$0	$0	$0	$0	$0	$0	2035
Anderson	$1,671	$5,772	$25	$5,336	$1,696	$11,108	2035
Athens	$1,084	$1,802	$32	$5,832	$1,116	$7,634	2035
Atlanta	$17,648	$3,624	$173,321	$28,049	$190,969	$31,674	2035
HJIA	$1,631	$824	$7,804	$4,016	$9,435	$4,840	2035
Atlanta to Nashville	**$165,795**	**$12,562**	**$398,801**	**$61,900**	**$564,596**	**$74,462**	
Atlanta	$17,648	$3,624	$173,321	$28,049	$190,969	$31,674	2035
HJIA	$1,631	$824	$7,804	$4,016	$9,435	$4,840	2035
Chattanooga	$20,540	$935	$11,076	$9,119	$31,616	$10,054	2045
Nashville	$125,976	$7,179	$206,600	$20,715	$332,576	$27,894	2050
Total	**$347,103**	**$26,900**	**$1,038,824**	**$101,239**	**$1,385,927**	**$128,138**	

Table 25: Property Value Increase Benefits by Station (in thousands of 2020 Dollars)

Segment	Residential		Commercial		Total		Beginning Accrual Year
	Existing Properties	New Properties (Annual Average for 10 Years)	Existing Properties	New Properties (Annual Average for 10 Years)	Existing Properties	New Properties (Annual Average for 10 Years)	
Atlanta to Orlando	**$32,869**	**$7,492**	**$418,123**	**$36,297**	**$450,992**	**$43,789**	
Atlanta	$21,155	$571	$20,180	$1,178	$41,335	$1,748	2035
HJIA	$1,631	$824	$7,804	$4,016	$9,435	$4,840	2035
Macon	$278	$34	$9,617	$1,561	$9,895	$1,594	2040
Jacksonville	$13,147	$1,730	$19,869	$1,644	$33,016	$3,373	2040
Daytona Beach	$165	$1,280	$156	$1,027	$321	$2,307	2045
Orlando	$0	$0	$207,356	$0	$207,356	$0	2045
Total	**$347,103**	**$26,900**	**$1,038,824**	**$101,239**	**$1,385,927**	**$128,138**	

Table 26: Property Value Increase Benefit by Scenario (in millions of 2020 Dollars)

Segment	Scenarios 1A and 1B		Scenarios 2A and 2B	
	Existing Properties	New Properties (Annual Average for 10 Years)	Existing Properties	New Properties (Annual Average for 10 Years)
Washington, DC to Richmond	$135.2	$9.5	$135.2	$9.5
Richmond to Raleigh	$169.7	$21.5	$169.7	$21.5
Raleigh to Charlotte	$414.7	$10.0	$414.7	$10.0
Charlotte to Atlanta	$555.2	$59.4	$555.2	$59.4
Atlanta to Nashville	$0.0	$0.0	$564.6	$74.5
Atlanta to Orlando	$0.0	$0.0	$451.0	$43.8
Total	**$637.5**	**$58.6**	**$1,385.9**	**$128.1**

4.6 Safety

Methodology

The primary safety benefit of the Southeast Corridor is derived from moving passengers from highway automobile and bus trips to rail trips. The accident rates on both of those modes surpass rail, making rail the safer alternative.

Safety benefits quantify the reduction in crashes associated with a shift to HSR from automobile and bus travel, based on the premise that HSR has a significantly lower crash history than those modes. The methodology estimates total crashes avoided based on modal shift and incident rates, then assigns an economic value to the avoided crashes based on the following formula:

$$Safety\ Benefit\ (Dollars) = Avoided\ Crashes^{im} * Economic\ Value^{im}$$

Where i is the incident type (fatality, injury, or property damage) and m is the mode.

Safety benefits are calculated for automobile and bus modes only. Statistics for air travel indicate that, for predictable flights, the change in accident costs would not be statistically significant. Therefore, there is no calculation of avoided air travel accidents in this analysis.

Table 27: Incident Rates

Type	Fatality	Injury	Property Damage Only (PDO)
Auto	0.82	86.00	141.00
Bus	0.28	72.00	NA

Total Crashes Avoided

Total crashes avoided is a function of diverted vehicle miles by mode and incident rates by mode. To estimate diverted vehicle miles, passenger trip modal diversion data for each CBSA pair was multiplied by the corresponding route length. Passenger miles were converted to vehicle miles using average occupancy rates of 1.67 and 21.18 for auto and bus, respectively, based on USDOT guidance.[18]

Finally, total crashes avoided are calculated by applying estimated diverted vehicle miles to incident rates. Incident rates, shown in **Table 27**, are based on historical crash data for 2017 provided by the National Highway Traffic Safety Administration (NHTSA)[19] for automobiles and from the Bureau of Transportation Statistics (BTS) for buses.[20] Total annual crashes avoided for the 2055 horizon year are shown for each scenario in **Table 28**. Segment-level data is included in **Appendix C**.

Credit: Adam Schultz

Table 28: Annual Crashes Avoided (2055)

Segment	Scenario 1A		Scenario 1B		Scenario 2A		Scenario 2B	
	Auto	Bus	Auto	Bus	Auto	Bus	Auto	Bus
Fatality	6.38	0.01	6.46	0.01	7.08	0.01	7.80	0.02
Injury	669.28	2.54	677.85	2.60	742.04	3.29	818.41	4.77
Property Damage Only	1097.32	NA	1111.36	NA	1,217	NA	1,341.81	NA

18 USDOT, Benefit Cost Analysis Guidance for Discretionary Grant Programs, Office of the Secretary, U.S. Department of Transportation, January 2020
19 https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812805 (fatalities and injuries)
20 https://www.bts.gov/content/bus-profile

Economic Value of Safety Improvements

To monetize the value of a crash avoided, the 2018 values from the USDOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs were inflated to 2020 dollars. According to this guidance, fatalities have a total economic monetary value of $11.1 million per crash, injuries are valued at $261,000 per crash, and property damage only has a resulting value of $4,580 per crash.

Results

Table 29 shows the annual safety benefit in 2055, which is the product of crashes avoided and the economic value of those crashes, for each scenario. Total benefits range from just over $250 million for Scenarios 1A and 1B to almost $280 million and more than $300 million for Scenarios 2A and 2B, respectively.

More than 95 percent of the identified safety benefits are derived from avoided automobile crashes, which is a function of both the number of automobile passenger miles diverted to high-performance rail as well as higher incident rates. The higher safety benefit for Scenarios 2A and 2A can be largely attributed to a greater amount of automobile passenger miles diverted.

The safety benefits quantified above are a conservative estimate for the Southeast Corridor, as many of the segments included also will be closing and separating roadway crossings. Any additional benefits associated with separating rail and road traffic are not captured here due to the level of information available.

4.7 Emissions Reduction

Methodology

Like safety benefits, high-performance rail accrues emissions benefits attributed to diversion from automobile, bus, and air travel, which are generally less efficient and rely heavily on fossil fuel-burning technology. The formula for calculating benefits for diverted automobile and bus travel is expressed as:

$$\text{Emissions Benefit (Dollars)} = \text{Diverted Vehicle Miles}^{m} * \text{Emissions Factor}^{em} * \text{Economic Value}^{em}$$

Where m is the mode, and e is the emissions type.

The formula for calculating benefits for diverted air travel is expressed as:

$$\text{Emissions Benefit (Dollars)} = \text{Diverted Passenger Miles}^{m} * \text{Emissions Factor}^{em} * \text{Economic Value}^{em}$$

Passenger miles is generally a better predictor of air travel emissions than vehicle miles because it tracks more closely with vehicle size.

Table 29: Annual Safety Benefit in 2055 (in thousands of 2020 Dollars)

Segment	Scenario 1A		Scenario 1B		Scenario 2A		Scenario 2B	
	Auto	Bus	Auto	Bus	Auto	Bus	Auto	Bus
Fatalities	$70,593	$109	$71,496	$112	$78,267	$142	$86,322	$205
Injuries	$174,683	$664	$176,918	$679	$193,673	$859	$213,605	$1,246
Property Damage Only	$5,026	NA	$5,090	NA	$5,572	NA	$6,146	NA
Total	**$251,075**		**$254,295**		**$278,513**		**$307,524**	

Diverted Vehicle Miles

The same methodology is used to estimate diverted automobile and bus vehicle miles as the methodology used for calculating the safety benefit. Namely, passenger trip modal diversion data for each CBSA pair is multiplied by the corresponding route length to determine vehicle miles shifted, which is converted to passenger miles using average vehicle occupancy rates. Diverted auto and bus vehicle miles and air passenger miles in year 2055 are shown in **Table 30**.

Emissions Factors

Diverted vehicle and passenger miles are converted to volume of emissions using factors. The following vehicle emissions are included in the calculation:

- Carbon dioxide
- Volatile organic compounds (VOC) (auto and bus only)
- Nitrous oxide (NOX)
- Particulate matter 2.5 (PM2.5) (auto and bus only)
- Sulfur dioxide (auto and bus only)

Vehicle emissions factors and sources are shown in **Table 31**. The calculated reduction in emissions was converted from grams to metric tons using a denominator of 1 million (1 million grams equals 1 metric ton) and then to short tons using a factor of 1.1015.

Table 30: Annual Diverted Vehicle and Passenger Miles (2055)

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Diverted Auto Vehicle Miles	778,238,000	788,196,000	862,841,000	951,642,000
Diverted Bus Vehicle Miles	3,534,000	3,613,000	4,569,000	6,631,000
Diverted Air Passenger Miles	1,167,176,000	1,192,263,000	1,248,613,000	1,480,776,000

Table 31: Vehicle Emissions Factors

Mode	Emissions Factor	Units	Source
Highway	404	Grams of Carbon Dioxide per Mile	Based on EPA's Greenhouse Gas Emissions from a Typical Passenger Vehicle (EPA-420-F-18-008) for gasoline
	0.169	Grams of VOC per Mile	Based on exhaust and emissions factors for gasoline-powered cars in 2020 from Argonne National Laboratory's Updated Emission Factors of Air Pollutants from Vehicle Operations in GREET Using Moves (2013)
	0.1198	Grams of NOX per Mile	
	0.0186	Grams of PM2.5 per Mile	
	0.0042	Grams of Sulfur Dioxide per Mile	
Air	0.225	Kilograms of Carbon Dioxide per passenger mile	Based on EPA's Emission Factors for Greenhouse Gas Inventories
	0.0072	Grams of NOX per passenger mile	
Bus	1454.2857	Grams of Carbon Dioxide per Mile	Based on EPA's Greenhouse Gas Emissions from a Typical Passenger Vehicle (EPA-420-F-18-008) for diesel fuel
	0.095	Grams of VOC per Mile	Based on exhaust and emissions for diesel-powered intercity buses in 2020 from Argonne National Laboratory's Updated Emission Factors of Air Pollutants from Vehicle Operations in GREET Using Moves (2013)
	1.423	Grams of NOX per Mile	
	0.084	Grams of PM2.5 per Mile	
	0.0119	Grams of Sulfur Dioxide per Mile	

Economic Value of Reduced Emissions

The reduction in emissions, which is the product of diverted vehicle and passenger miles and emissions factors, is monetized using rates provided in USDOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs. Monetization rates are shown in **Table 32**.

Results

Annual average emissions reduction benefits in year 2055 are shown in **Table 33**. Range is from $9.3 million Scenario 1A to $11.6 million Scenario 2B.

4.8 Improved Freight Performance

Freight performance can be improved either by decreasing interference between passenger services and freight on congested rail corridors or by providing a new alternate route for freight travel to use in case of events that shut down existing rail lines, such as floods or tropical storms. Improved freight performance was demonstrated in previously prepared BCA analyses of two segments, Washington, DC, to Richmond and Richmond to Raleigh. Interviews with operating railroads confirmed that the benefits to freight movements are limited to those segments planning to add enough passenger rail capacity, either through new track or passenger rail right-of-way, to enable fewer train conflicts. The segments with capacity improvements that will reduce passenger and freight train interference are shown in **Figure 15**.

In other segments, the existing planning and environmental studies did not indicate that the planned passenger services would remove a significant amount of existing passenger services from freight corridors and had limited ability to provide resiliency benefits to freight services. While the Greenfield alignment between Atlanta and Charlotte will separate passenger services from freight, there is only one passenger train per day in normal service conditions. The EIS for this segment did not mention or quantify any improvements in freight movement from providing a new alignment for passenger rail. This is likely because the Greenfield alignment still shares track with freight when approaching the Charlotte and Atlanta terminals, so interference could still happen in those locations.

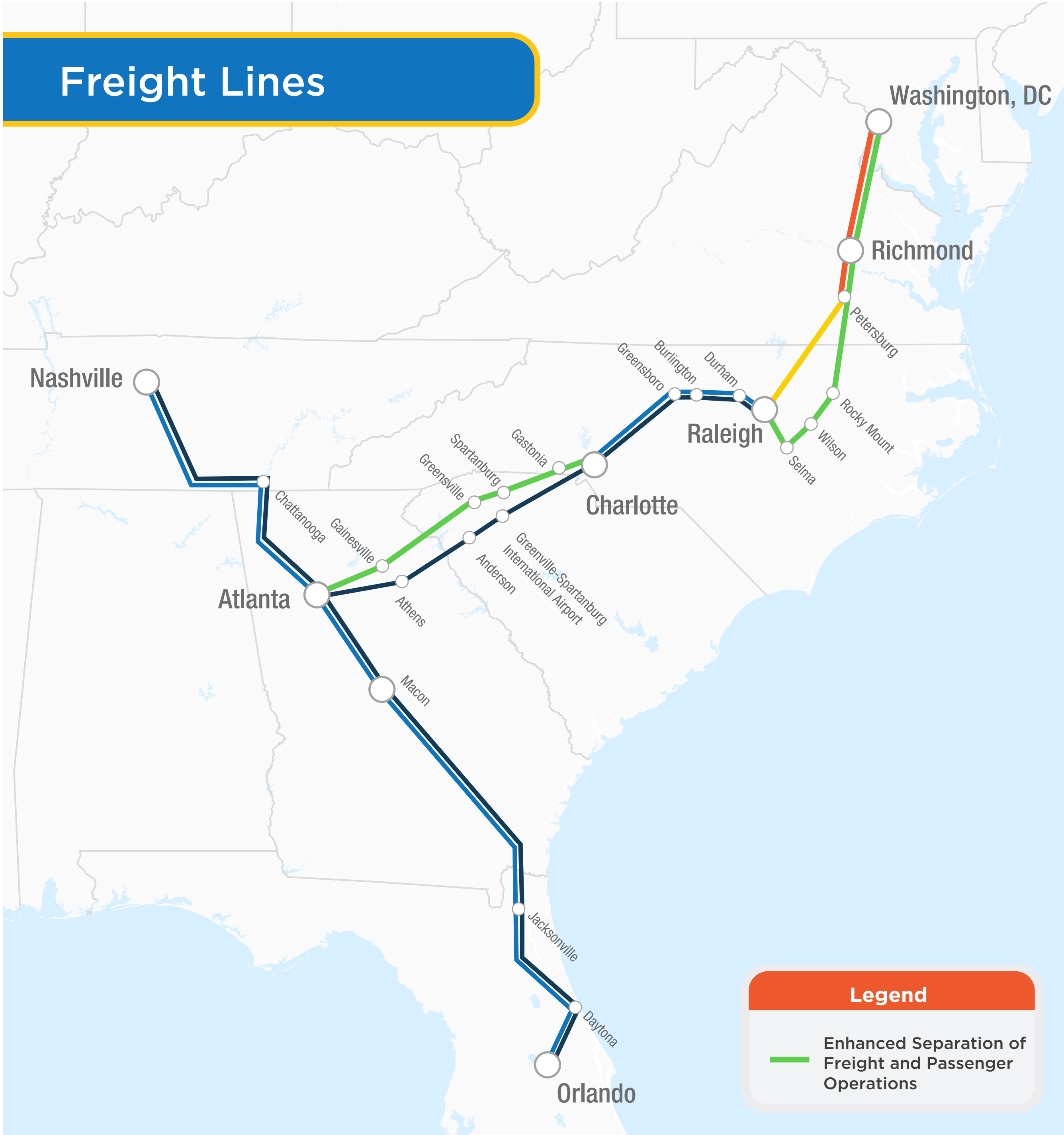
Table 32: Emissions Reduction Monetization Rates

Emission Type	Units	2020 Dollars
Carbon Dioxide to 2034	metric ton	$1.04
Carbon Dioxide starting in 2035	metric ton	$2.08
VOCs	short ton	$2,184
NOX	short ton	$8,944
PM2.5	short ton	$402,792
Sulfur Dioxide	short ton	$52,104

Table 33: Annual Emissions Reduction Benefit in 2055 (in thousands of 2020 Dollars)

Emission	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Carbon Dioxide	$1,211	$1,231	$1,323	$1,513
VOX	$317	$322	$352	$389
NOX	$1,052	$1,066	$1,172	$1,322
PM2.5	$6,559	$6,644	$7,296	$8,106
Sulfur Dioxide	$190	$193	$211	$234
Total	**$9,329**	**$9,456**	**$10,354**	**$11,564**

Figure 15: Illustration of Corridor Improvements Segregating Passenger and Freight Traffic



The only freight rail impacts mentioned in the EIS are decreased track and right-of-way maintenance on the freight alignment, which are not considered economic benefits. Therefore, the removal of that passenger train would not create quantifiable economic benefits in terms of freight movement at this time.

Since the Washington, DC, to Richmond and Richmond to Raleigh segments are the only portions with an identified improved freight performance benefit and the operating speeds for these segments are the same for all four scenarios, the estimated benefit is expected to be the same for each scenario.

For the Richmond to Raleigh segment, re-establishing a direct rail connection along the S-Line would provide rail network redundancy parallel to the CSX A-Line, as shown in **Figure 6**, which is the primary north-south route along the Eastern Seaboard. Flood events associated with major hurricanes have frequently impacted freight traffic on the A-Line until repairs have been made. At times, the A-Line route has been closed, and traffic rerouted. These closures and weather impacts result in freight delay costs to shippers, impacting shipper inventory, dock handling, consignee scheduling, and duration of delivery windows. Restoration of the S-Line connection would provide CSX with an alternative route to move freight when the A-Line is out of service or being maintained following impacts from major hurricanes. The estimated frequency and durations of potential major storms was used to estimate the resiliency benefits of having a redundant rail line further inland, as applied to the opportunity costs of freight delays to shippers. The R2R Consolidated Rail Infrastructure and Safety Improvements (CRISI) grant application estimated these resiliency benefits to freight operations would be approximately $11.71 million annually in avoided delays.

Between Washington, DC, and Richmond (including the Long Bridge Project), the proposed improvements would segregate passenger service from existing and projected future freight rail operations and reduce freight delays. Service development plans for DC2RVA measured freight delay as the average hours and minutes of delay per train, per 100 elapsed train-miles. This metric compared the actual elapsed time a train takes to cover its route, compared to the elapsed time the train would have taken to cover its route had it encountered no unplanned delays en route. Delays en route include events such as waits for trains to pass, clear track ahead, signal clearance, and speed restrictions or reductions. The freight delay minutes per 100 train-miles is 40.0 for the Baseline, 20.0 for Build in 2025 and in 2045. Projected freight train delays were converted to opportunity costs by an estimate of 3,562 tons of freight per train and a delay cost of $0.61 per hour per ton. Avoiding this cost would produce a benefit to freight users of $314.19 million across the 2030 to 2055 timeframe or an average of $12.08 million annually (in 2020 dollars).

Starting in 2030, the beginning of operations assumed for both segments, each scenario can anticipate a combined $23.80 million annually (in 2020 dollars) in improved freight performance benefits, for a total of $618.71 million in benefits through 2055.

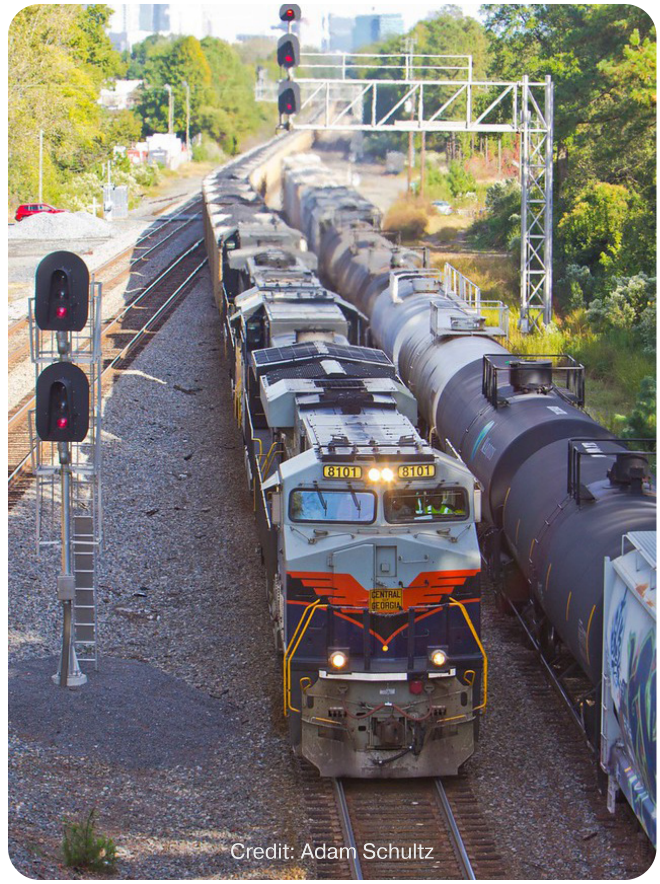
There is a possible disbenefit to freight movements of increased passenger rail traffic on shared corridors within the defined scenarios—which could occur between Nashville and Chattanooga and between Atlanta and Orlando.[21] However, planning efforts have yet to define the preferred alignment for these segments, so any potential increase in train interference cannot be determined at this time.

21 The defined alignment between Chattanooga and Atlanta is separate from CSX-owned right-of-way.

4.9 Access to Passenger Rail

Existing residents and jobs will benefit from improved access to rail, in part through the benefits described previously. Table 34 and Table 35 highlight the number of residents and jobs that would receive the benefits of high-performance rail stations in their communities, from the walkable half-mile station area level to a larger 10-mile market level. This data was collected based on the same assumed station locations and Urban Footprint data used previously for determining property value increases.

Figure 16 and Figure 17 show existing population and employment within 10 miles of each station location, respectively. Population ranges from just under 18,000 people within 10 miles of the La Crosse station to more than 1.8 million people within 10 miles of the Washington, DC, station. Employment ranges from just under 8,000 jobs within 10 miles of the La Crosse station to more than 1.2 million jobs within 10 miles of the Washington, DC, station.



Credit: Adam Schultz

Table 34: Number of Residents with Access to Rail

Number of Residents	Scenarios 1A and 1B	Scenarios 2A and 2B
Within Half-Mile	42,000	50,000
Within 1 Mile	149,000	188,000
Within 5 Miles	2,130,000	3,224,000
Within 10 Miles	5,805,000	9,223,000

Table 35: Number of Jobs with Access to Rail

Number of Jobs	Scenarios 1A and 1B	Scenarios 2A and 2B
Within Half-Mile	226,000	341,000
Within 1 Mile	422,000	709,000
Within 5 Miles	1,930,000	2,966,000
Within 10 Miles	3,729,000	6,020,000

Figure 16: Existing Population Within 10 Miles of Stations

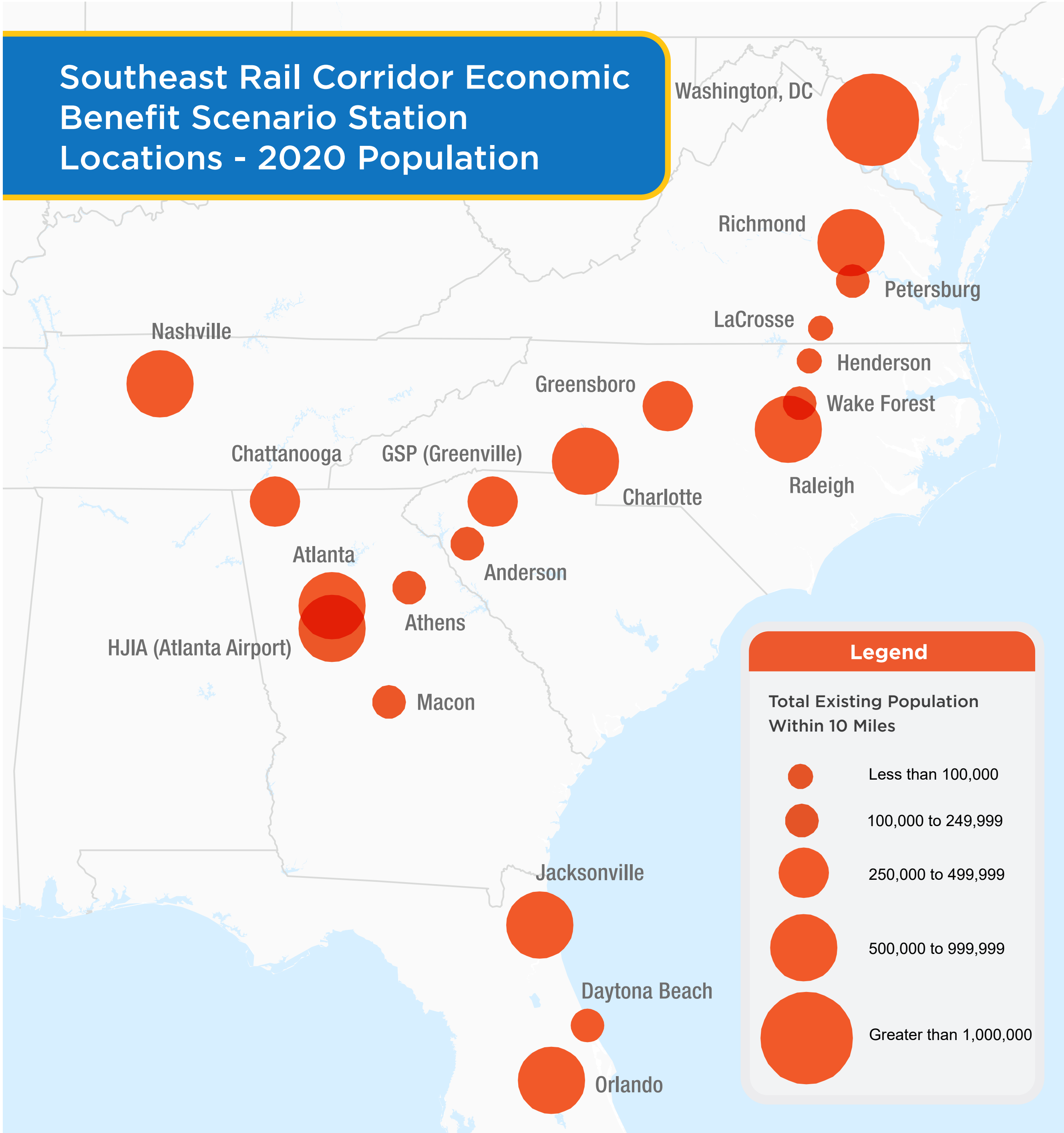
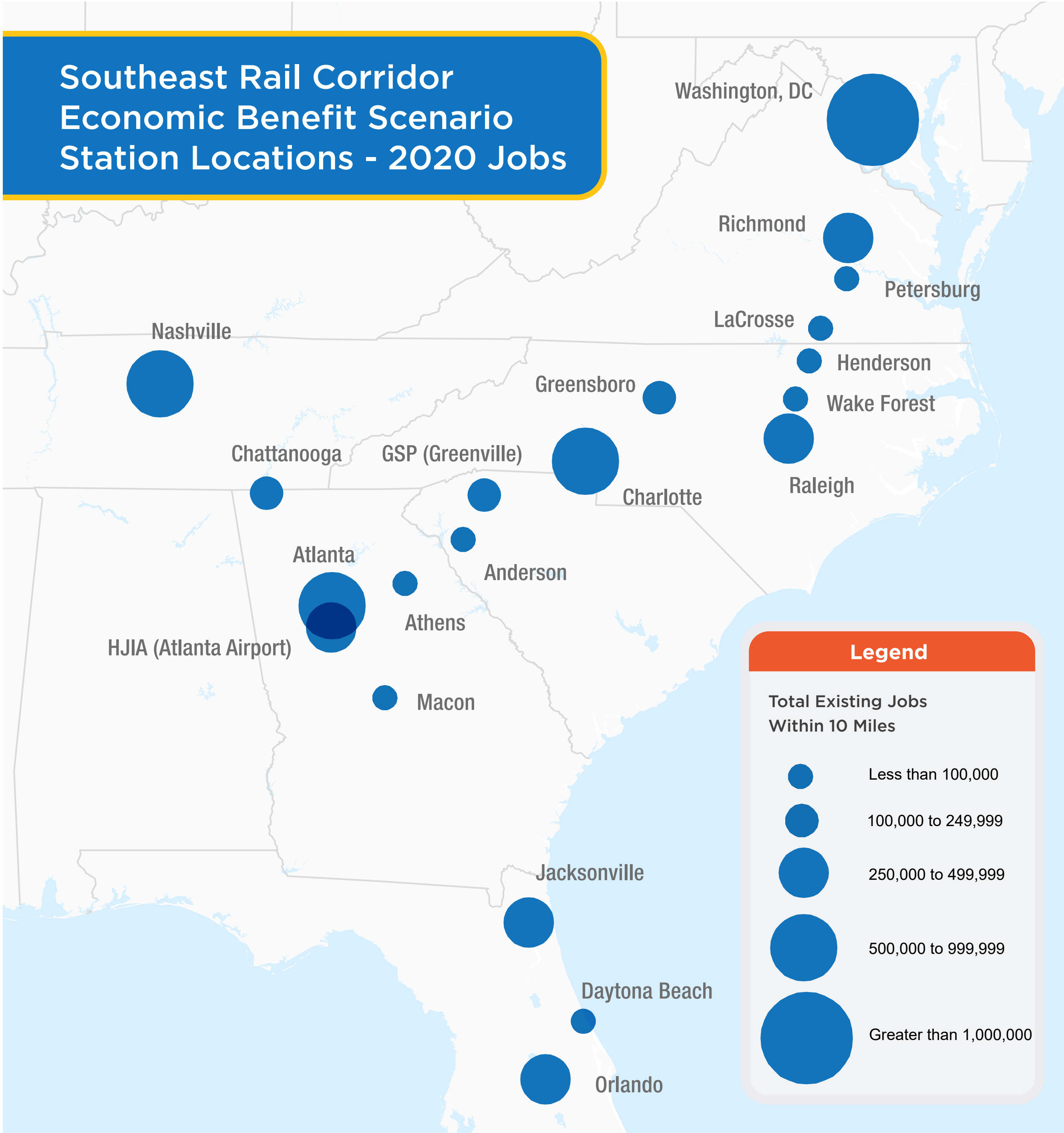


Figure 17: Existing Employment Within 10 Miles of Stations



5.0 Summary of Economic Benefits

The construction of high-performance rail in the Southeast will result in billions of dollars of benefits, regardless if the primary construction and operations focus is on the backbone corridor or if efforts are extended to a network reaching as far as Nashville, TN, and Orlando, FL.

While the benefits presented in this analysis have been calculated in 2020 dollars, the assumed phasing of construction and operations, as confirmed by the Southeast Corridor Technical Committee, allow those benefits to be accrued over time. **Figure 18** shows the flow of those annual benefits in 2020 dollars, prior to discounting. The large benefits for all scenarios from 2025 through 2034 are due to the investments in construction of improvements, which deliver the employment, income, and initial property value increases.

To aggregate the benefits occurring in different years they must be discounted to present values. **Table 36** provides the present value of the calculated benefits for each scenario. Using this method, the total economic value of benefits from implementing high-performance in the Southeast would be between $27.29 million and $41.83 billion.

These estimates rely on conservative assumptions that do not include other potential benefits, such as increased productive time for drivers diverting from auto or bus to rail trips, decreased

Figure 18: Total Annual Benefits of Each Scenario in 2020 Dollars

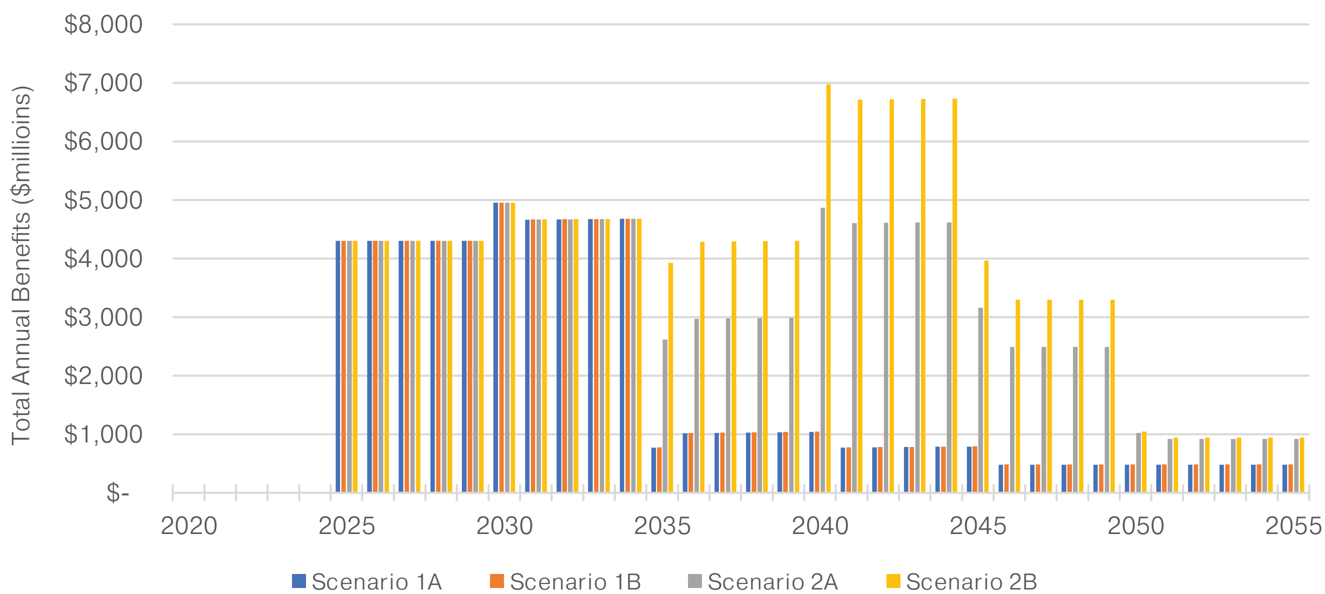


Table 36: Total Estimated Monetized Value of Benefits, 2025–2055 (PV in $ millions)

Benefit	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Travel Time Savings	$1,093	$1,103	$1,103	$1,101
Safety	$1,245	$1,260	$1,284	$1,336
Emissions	$46	$46	$47	$49
Economic Output	$22,639	$22,639	$30,831	$35,934
Property Value	$2,088	$2,088	$3,256	$3,255
Improved Freight	$153	$153	$153	$153
Total Benefits	**$27,264**	**$27,290**	**$36,675**	**$41,829**

maintenance costs associated with state of good repair improvements, or agglomeration benefits resulting from improved travel accessibility. Where there was uncertainty in underlying values or future design decisions, a conservative approach was used. Future studies of individual segment projects may identify even greater levels of economic benefits as planning and development in the Southeast Corridor progresses.

This study does not provide a BCA for each scenario, as operating and maintenance costs are not included in the analysis of benefits. Detailed service plans are required to determine those costs; however, for the purposes of accurate comparison, **Table 37** places the capital costs for each scenario in present value terms. The economic benefits calculated in this study, using conservative assumptions, are more than twice the capital investment costs in all scenarios. The ratio of economic benefits to capital costs range from 2.2 to 2.5.

In addition to the monetized benefits above, the development of the Southeast Corridor scenarios outlined in this study will:

- **Provide for between 7 and 9 million passenger rail trips per year**
- **Create between 41,000 to 54,000 new jobs in the region during construction**
- **Sustain between 28,000 and 45,000 new jobs in the region due to station area developments**
- **Provide access to high-performance rail connections for between 5 and 9 million residents**
- **Connect 3 to 6 million jobs to high-performance rail stations**

Table 37: Total Capital Costs, 2025–2055 (PV in $ millions)

Cost	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Total Capital Costs	$10,838	$10,838	$15,697	$18,723

Appendix A: Stakeholder Interviews

Jurisdiction interviews

- District DOT: Jeffrey Bennet
- Virginia Department of Rail and Public Transportation: Emily Stock
- North Carolina DOT: Jason Orthner, Eddie McFalls, James Bridges
- South Carolina DOT: Doug Frate, Diane Lackey
- Tennessee DOT: Daniel Pallme, Amy Kosanovic
- Georgia DOT: Kaycee Mertz, Ashley Finch
- Florida DOT: Fred Wise, Laura Miller

Private partner interviews

- Brightline (formerly Virgin Trains): Ali Soule, Michael Lefevre
- CSX: John Dillard, Will Roseborough
- Amtrak: Joe McHugh

Appendix B: CONNECT Model Runs

The CONNECT model is a sketch planning tool used to develop high-level estimates of rail ridership between CBSAs for trips diverted from intercity automobile, bus, and air travel as well as induced trips. As a sketch planning tool, the CONNECT model relies on high-level assumptions and may not reflect ridership estimates associated with the more-detailed service planning that will be conducted throughout the development of the Southeast Rail Network.

The parameters provided here are not associated with the Draft Southeast Regional Rail Plan, as the planning assumptions for the scenarios vary from that plan. The phasing of segment operations within this economic benefits study, for instance, identifies near-term improvements that would accrue ridership-related benefits, whereas the Draft Southeast Regional Rail Plan assumes ridership impacts result from the completion of all long-term improvements.

The ridership model assumes three different service types and average speeds:

- Emerging: 50 mph
- Regional: 90 mph
- Core Express: 186 mph

Two separate model runs for Scenarios 1A/2A and 1B/2B were performed using different combinations of service types within the CONNECT model to most accurately replicate the assumed technology associated with each scenario. The relationship between scenarios and CONNECT model service types is described in **Table 38**.

The CONNECT model also assumes different levels of service (all-stop regular and limited-stop express) in each segment. The total number of daily trips for each scenario is summarized in **Table 39**.[22]

Table 38: Scenarios and CONNECT Model Service Types

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Washington, DC, to Richmond	Regional	Regional	Regional	Regional
Richmond to Raleigh	Regional	Regional	Regional	Regional
Raleigh to Charlotte	Regional	Regional	Regional	Regional
Charlotte to Atlanta	Regional	Regional	Regional	Regional
Atlanta to Nashville	NA	Emerging	NA	Regional
Atlanta to Orlando	NA	Emerging	NA	Regional

Table 39: Level of Service Assumptions

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Boston, MA, to Washington, DC	12 regular 12 express	12 regular 12 express	12 regular 12 express	12 regular 12 express
Washington, DC, to Richmond	16 regular 4 express	16 regular 4 express	16 regular	16 regular
Richmond to Raleigh	16 regular 4 express	16 regular 4 express	16 regular	16 regular
Raleigh to Charlotte	16 regular 4 express	16 regular 4 express	16 regular	16 regular
Charlotte to Atlanta	16 regular 4 express	16 regular 4 express	16 regular	16 regular
Atlanta to Nashville		8 regular		16 regular
Atlanta to Orlando		6 regular		12 regular

22 The Boston, MA, to Washington, DC, corridor segment is not part of the economic benefit calculation, but variation in level of service has implications for ridership in study area segments. Riders connecting from the Southeast to the Northeast Corridor were included as part of the model outputs.

Appendix C: Benefits by Rail Segment

Table 40: Annual Modal Trip Diversion (2055) by Segment

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Auto Trips Diverted				
Washington, DC, to Richmond	2,111,000	2,133,000	2,137,000	2,184,000
Richmond to Raleigh	1,727,000	1,747,000	1,761,000	1,812,000
Raleigh to Charlotte	1,805,000	1,826,000	1,862,000	1,934,000
Charlotte to Atlanta	1,363,000	1,380,000	1,478,000	1,600,000
Atlanta to Nashville			286,000	508,000
Atlanta to Orlando (Jacksonville)[22]			133,000	285,000
Auto Total	**3,417,000**	**3,417,000**	**3,828,000**	**4,210,000**
Bus Trips Diverted				
Washington, DC, to Richmond	84,000	84,000	84,000	84,000
Richmond to Raleigh	84,000	84,000	84,000	84,000
Raleigh to Charlotte	66,000	66,000	66,000	66,000
Charlotte to Atlanta	217,000	223,000	217,000	223,000
Atlanta to Nashville			89,000	200,000
Atlanta to Orlando (Jacksonville)			26,000	91,000
Bus Total	**366,000**	**366,000**	**481,000**	**664,000**
Rail Trips Diverted				
Washington, DC, to Richmond	20,000	20,000	20,000	20,000
Richmond to Raleigh	91,000	92,000	92,000	94,000
Raleigh to Charlotte	17,000	17,000	17,000	18,000
Charlotte to Atlanta	NA	NA	NA	NA
Atlanta to Nashville			NA	NA
Atlanta to Orlando (Jacksonville)			NA	NA
Rail Total	**128,000**	**129,000**	**129,000**	**132,000**
Air Trips Diverted				
Washington, DC, to Richmond	1,860,000	1,879,000	1,861,000	1,881,000
Richmond to Raleigh	1,893,000	1,919,000	1,895,000	1,925,000
Raleigh to Charlotte	1,581,000	1,621,000	1,591,000	1,661,000
Charlotte to Atlanta	1,001,000	1,032,000	1,077,000	1,301,000
Atlanta to Nashville[22]			179,000	366,000
Atlanta to Orlando (Jacksonville)[23]			53,000	390,000
Air Total	**2,796,000**	**2,840,000**	**3,028,000**	**3,559,000**

Note: NA indicates that service does not exist currently for that mode or that studies of that segment did not indicate any trip diversion for that mode, while indicating trip diversion did exist for other modes.

23 The model estimates ridership between Atlanta and Jacksonville but does not extend to Orlando.

Table 41: Annual Aggregate Travel Time Savings (2055) in Minutes by Segment

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Auto				
Washington, DC, to Richmond	109,772,000	110,916,000	111,124,000	113,568,000
Richmond to Raleigh	117,436,000	118,796,000	119,748,000	123,216,000
Raleigh to Charlotte	84,835,000	85,822,000	87,514,000	90,898,000
Charlotte to Atlanta	69,513,000	70,380,000	75,378,000	81,600,000
Atlanta to Nashville			24,024,000	42,672,000
Atlanta to Orlando (Jacksonville)[24]			18,965,000	40,640,000
Auto Total	**381,556,000**	**385,914,000**	**436,753,000**	**492,594,000**
Bus				
Washington, DC, to Richmond	4,368,000	4,368,000	4,368,000	4,368,000
Richmond to Raleigh	6,552,000	6,552,000	6,552,000	6,552,000
Raleigh to Charlotte	NA	NA	0	0
Charlotte to Atlanta	16,492,000	16,948,000	16,492,000	16,948,000
Atlanta to Nashville			7,476,000	16,800,000
Atlanta to Orlando (Jacksonville)			5,683,000	19,892,000
Bus Total	**27,412,000**	**27,868,000**	**40,571,000**	**64,560,000**
Rail				
Washington, DC, to Richmond	1,700,000	1,700,000	1,700,000	1,700,000
Richmond to Raleigh	9,009,000	9,108,000	9,108,000	9,306,000
Raleigh to Charlotte	969,000	969,000	969,000	1,026,000
Charlotte to Atlanta[25]	NA	NA	0	0
Atlanta to Nashville[26]			0	0
Atlanta to Orlando (Jacksonville)[26]			0	0
Rail Total	**11,678,000**	**11,777,000**	**11,777,000**	**12,032,000**
Air				
Washington, DC, to Richmond	59,520,000	60,128,000	59,552,000	60,192,000
Richmond to Raleigh	310,452,000	314,716,000	310,780,000	315,700,000
Raleigh to Charlotte	-9,486,000	-9,726,000	-9,546,000	-9,966,000
Charlotte to Atlanta	-62,062,000	-63,984,000	-66,774,000	-80,662,000
Atlanta to Nashville[23]			-10,024,000	-20,496,000
Atlanta to Orlando (Jacksonville)[23]			-4,791,000	-35,258,000
Air Total	**298,424,000**	**301,134,000**	**279,197,000**	**229,510,000**

24 The model estimates ridership between Atlanta and Jacksonville but does not extend to Orlando.
25 Rail service is not currently available between Charlotte and Atlanta, Atlanta and Nashville, and Atlanta and Orlando.
26 The model estimates ridership between Atlanta and Jacksonville but does not extend to Orlando.

Table 41: Annual Aggregate Travel Time Savings (2055) in Minutes by Segment

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Total All Modes				
Washington, DC, to Richmond	175,360,000	177,112,000	5,778,448,000	5,905,536,000
Richmond to Raleigh	443,449,000	449,172,000	8,142,864,000	8,378,688,000
Raleigh to Charlotte	76,318,000	77,065,000	4,113,158,000	4,272,206,000
Charlotte to Atlanta	23,943,000	23,344,000	3,844,278,000	4,161,600,000
Atlanta to Nashville			2,018,016,000	3,584,448,000
Atlanta to Orlando (Jacksonville)			2,704,321,000	5,795,076,000
Grand Total	**719,070,000**	**726,693,000**	**768,298,000**	**798,696,000**

Note: NA indicates that service does not exist currently for that mode or that studies of that segment did not indicate any trip diversion for that mode, while indicating trip diversion did exist for other modes.

Table 42: Annual Economic Value of Time Savings by Segment (2055) in thousands of 2020 Dollars

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Auto				
Washington, DC, to Richmond	$19,713	$19,919	$19,956	$20,395
Richmond to Raleigh	$21,090	$21,334	$21,505	$22,128
Raleigh to Charlotte	$15,235	$15,412	$15,716	$16,324
Charlotte to Atlanta	$12,483	$12,639	$13,537	$14,654
Atlanta to Nashville			$4,314	$7,663
Atlanta to Orlando (Jacksonville)[25]			$3,406	$7,298
Auto Total	**$68,521**	**$69,304**	**$78,434**	**$88,462**
Bus				
Washington, DC, to Richmond	$784	$784	$784	$784
Richmond to Raleigh	$1,177	$1,177	$1,177	$1,177
Raleigh to Charlotte	NA	NA	NA	NA
Charlotte to Atlanta	$2,962	$3,044	$2,962	$3,044
Atlanta to Nashville			$1,343	$3,017
Atlanta to Orlando (Jacksonville)			$1,021	$3,572
Bus Total	**$4,923**	**$5,005**	**$7,286**	**$11,594**
Rail				
Washington, DC, to Richmond	$1,301	$1,301	$1,301	$1,301
Richmond to Raleigh	$6,896	$6,972	$6,972	$7,124
Raleigh to Charlotte	$742	$742	$742	$785
Charlotte to Atlanta	NA	NA	NA	NA
Atlanta to Nashville			NA	NA
Atlanta to Orlando (Jacksonville)			NA	NA
Rail Total	**$8,940**	**$9,015**	**$9,015**	**$9,210**
Air				
Washington, DC, to Richmond	$22,781	$23,014	$22,794	$23,038
Richmond to Raleigh	$118,826	$120,458	$118,951	$120,834
Raleigh to Charlotte	-$3,631	-$3,723	-$3,654	-$3,814
Charlotte to Atlanta	-$23,754	-$24,490	-$25,558	-$30,873
Atlanta to Nashville			-$3,837	-$7,845
Atlanta to Orlando (Jacksonville)			-$1,834	-$13,495
Air Total	**$114,222**	**$115,259**	**$106,863**	**$87,845**

Table 42: Annual Economic Value of Time Savings by Segment (2055) in thousands of 2020 Dollars

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Total All Modes				
Washington, DC, to Richmond	$44,579	$45,018	$44,835	$45,518
Richmond to Raleigh	$147,989	$149,941	$148,605	$151,263
Raleigh to Charlotte	$12,346	$12,431	$12,804	$13,295
Charlotte to Atlanta	-$8,309	-$8,807	-$9,059	-$13,175
Atlanta to Nashville			$1,820	$2,835
Atlanta to Orlando (Jacksonville)			$2,593	-$2,625
Grand Total	**$196,605**	**$198,583**	**$201,598**	**$197,111**

Note: NA indicates that service does not exist currently for that mode or that studies of that segment did not indicate any trip diversion for that mode, while indicating trip diversion did exist for other modes.

Table 43: Construction-Related Employment Benefits (Average Annual Jobs During Construction) by Segment

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Direct Employment				
Washington, DC, to Richmond	6,800	6,800	6,800	6,800
Richmond to Raleigh	2,500	2,500	2,500	2,500
Raleigh to Charlotte	NA	NA	NA	NA
Charlotte to Atlanta	8,920	8,920	8,920	8,920
Atlanta to Nashville			7,800	11,260
Atlanta to Orlando (Jacksonville)			7,400	13,000
Direct Total	**18,220**	**18,200**	**33,420**	**42,480**
Indirect Employment				
Washington, DC, to Richmond	3,700	3,700	3,700	3,700
Richmond to Raleigh	1,360	1,360	1,360	1,360
Raleigh to Charlotte	NA	NA	NA	NA
Charlotte to Atlanta	4,840	4,840	4,840	4,840
Atlanta to Nashville			4,240	6,120
Atlanta to Orlando (Jacksonville)			4,000	7,040
Indirect Total	**9,900**	**9,900**	**18,140**	**23,060**
Induced Employment				
Washington, DC, to Richmond	4,680	4,680	4,680	4,680
Richmond to Raleigh	1,720	1,720	1,720	1,720
Raleigh to Charlotte	NA	NA	NA	NA
Charlotte to Atlanta	6,140	6,140	6,140	6,140
Atlanta to Nashville			5,360	7,740
Atlanta to Orlando (Jacksonville)			5,080	8,940
Induced Total	**12,320**	**12,320**	**22,320**	**28,560**
Total Employment				
Washington, DC, to Richmond	15,180	15,180	15,180	15,180
Richmond to Raleigh	5,580	5,580	5,580	5,580
Raleigh to Charlotte	NA	NA	NA	NA
Charlotte to Atlanta	19,900	19,900	19,900	19,900
Atlanta to Nashville			17,400	25,120
Atlanta to Orlando (Jacksonville)			16,480	28,980
Grand Total	**$40,660**	**$40,660**	**$74,540**	**$94,760**

Table 44: New Station-Area and Regional Base Employment by Segment

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
New Station Area Jobs				
Washington, DC, to Richmond	14,000	14,000	14,000	14,000
Richmond to Raleigh	19,000	19,000	19,000	19,000
Raleigh to Charlotte	9,800	9,800	9,800	9,800
Charlotte to Atlanta	75,300	73,300	75,300	75,300
Atlanta to Nashville			57,800	57,800
Atlanta to Orlando (Jacksonville)			50,800	50,800
Station Area Total	**76,900**	**76,900**	**142,400**	**142,400**
New Regional Base Jobs				
Washington, DC, to Richmond	11,900	11,900	11,900	11,900
Richmond to Raleigh	7,400	7,400	7,400	7,400
Raleigh to Charlotte	9,400	9,400	9,400	9,400
Charlotte to Atlanta	15,100	15,100	15,100	15,100
Atlanta to Nashville			13,300	13,300
Atlanta to Orlando (Jacksonville)			15,000	15,000
New Regional Total	**27,600**	**27,600**	**44,500**	**44,500**

Table 45: Economic Output Benefits (in millions of 2020 Dollars)

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Direct Economic Output				
Washington, DC, to Richmond	$7,600	$7,600	$7,600	$7,600
Richmond to Raleigh	$2,800	$2,800	$2,800	$2,800
Raleigh to Charlotte	NA	NA	NA	NA
Charlotte to Atlanta	$9,900	$9,900	$9,900	$9,900
Atlanta to Nashville			$8,800	$12,600
Atlanta to Orlando (Jacksonville)			$8,200	$14,500
Total	**$20,300**	**$20,300**	**$37,300**	**$47,400**
Indirect Economic Output				
Washington, DC, to Richmond	$3,900	$3,900	$3,900	$3,900
Richmond to Raleigh	$1,400	$1,400	$1,400	$1,400
Raleigh to Charlotte	NA	NA	NA	NA
Charlotte to Atlanta	$4,900	$5,100	$5,100	$5,100
Atlanta to Nashville			$4,500	$6,400
Atlanta to Orlando (Jacksonville)			$4,300	$7,500
Indirect Total	**$10,400**	**$10,400**	**$19,200**	**$24,300**
Induced Economic Output				
Washington, DC, to Richmond	$4,300	$4,300	$4,300	$4,300
Richmond to Raleigh	$1,600	$1,600	$1,600	$1,600
Raleigh to Charlotte	NA	NA	NA	NA
Charlotte to Atlanta	$5,300	$5,600	$5,600	$5,600
Atlanta to Nashville			$4,900	$7,100
Atlanta to Orlando (Jacksonville)			$4,600	$8,100
Induced Total	**$11,500**	**$11,500**	**$21,000**	**$26,700**
Total Economic Output				
Washington, DC, to Richmond	$15,700	$15,700	$15,700	$15,700
Richmond to Raleigh	$5,800	$5,800	$5,800	$5,800
Raleigh to Charlotte	NA	NA	NA	NA
Charlotte to Atlanta	$20,600	$20,600	$20,600	$20,600
Atlanta to Nashville			$18,200	$26,100
Atlanta to Orlando (Jacksonville)			$17,100	$30,200
Grand Total	**$42,200**	**$42,200**	**$77,500**	**$98,400**

Table 46: Annual Average Diverted Vehicle and Passenger Miles (2055) by Segment

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Diverted Auto Vehicle Miles				
Washington, DC, to Richmond	595,720,000	602,844,000	610,385,000	631,409,000
Richmond to Raleigh	569,347,000	576,569,000	587,723,000	612,587,000
Raleigh to Charlotte	544,474,000	552,184,000	571,803,000	605,000,000
Charlotte to Atlanta	375,995,000	382,191,000	418,107,000	464,318,000
Atlanta to Nashville			57,459,000	106,505,000
Atlanta to Orlando (Jacksonville)			29,317,000	67,667,000
Auto Total	**778,238,000**	**788,196,000**	**862,841,000**	**951,642,000**
Diverted Bus Vehicle Miles				
Washington, DC, to Richmond	1,066,000	1,068,000	1,066,000	1,068,000
Richmond to Raleigh	1,066,000	1,068,000	1,066,000	1,068,000
Raleigh to Charlotte	548,000	549,000	548,000	549,000
Charlotte to Atlanta	1,919,000	1,996,000	1,919,000	1,996,000
Atlanta to Nashville			617,000	1,605,000
Atlanta to Orlando (Jacksonville)			419,000	1,413,000
Bus Total	**3,534,000**	**3,613,000**	**4,569,000**	**6,631,000**
Diverted Air Passenger Miles				
Washington, DC, to Richmond	815,460,000	827,268,088	816,066,000	828,450,844
Richmond to Raleigh	856,565,000	872,127,761	857,682,000	877,144,335
Raleigh to Charlotte	767,931,000	791,386,528	774,179,000	816,623,206
Charlotte to Atlanta	459,073,000	478,076,976	496,507,000	621,265,058
Atlanta to Nashville			61,999,000	157,104,155
Atlanta to Orlando (Jacksonville)			19,237,000	151,764,580
Air Total	**1,167,176,000**	**1,192,263,000**	**1,248,613,000**	**1,480,775,968**

Table 47: Annual Crashes Avoided (2055) by Segment

Segment	Scenario 1A		Scenario 1B		Scenario 2A		Scenario 2B	
	Auto	Bus	Auto	Bus	Auto	Bus	Auto	Bus
Fatalities								
Washington, DC, to Richmond	4.88	0.00	4.94	0.00	5.01	0.00	5.18	0.00
Richmond to Raleigh	4.67	0.00	4.73	0.00	4.82	0.00	5.02	0.00
Raleigh to Charlotte	4.46	0.00	4.53	0.00	4.69	0.00	4.96	0.00
Charlotte to Atlanta	3.08	0.01	3.13	0.01	3.43	0.01	3.81	0.01
Atlanta to Nashville					0.47	0.00	0.87	0.00
Atlanta to Orlando (Jacksonville)					0.24	0.00	0.55	0.00
Fatalities Total	**6.38**	**0.01**	**6.46**	**0.01**	**7.08**	**0.01**	**7.80**	**0.02**
Injuries								
Washington, DC, to Richmond	512.32	0.77	518.45	0.77	524.93	0.77	543.01	0.77
Richmond to Raleigh	489.64	0.77	495.85	0.77	505.44	0.77	526.82	0.77
Raleigh to Charlotte	468.25	0.39	474.88	0.40	491.75	0.39	520.30	0.40
Charlotte to Atlanta	323.36	1.38	328.68	1.44	359.57	1.38	399.31	1.44
Atlanta to Nashville					49.42	0.44	91.59	1.16
Atlanta to Orlando (Jacksonville)					25.21	0.30	58.19	1.02
Injuries Total	**669.28**	**2.54**	**677.85**	**2.60**	**742.04**	**3.29**	**818.41**	**4.77**
Property Damage Only								
Washington, DC, to Richmond	839.96	NA	850.01	NA	861	NA	890.29	NA
Richmond to Raleigh	802.78	NA	812.96	NA	829	NA	863.75	NA
Raleigh to Charlotte	767.71	NA	778.58	NA	806	NA	853.05	NA
Charlotte to Atlanta	530.15	NA	538.89	NA	590	NA	654.69	NA
Atlanta to Nashville					81	NA	150.17	NA
Atlanta to Orlando (Jacksonville)					41	NA	95.41	NA
PDO Total	**1097.32**		**1111.36**		**1,217**		**1,341.81**	

Table 48: Average Annual Safety Benefit (2055) in thousands of 2020 Dollars by Segment

Segment	Scenario 1A		Scenario 1B		Scenario 2A		Scenario 2B	
	Auto	Bus	Auto	Bus	Auto	Bus	Auto	Bus
Fatalities								
Washington, DC, to Richmond	$54,037	$33	$54,683	$33	$55,367	$33	$57,274	$33
Richmond to Raleigh	$51,645	$33	$52,300	$33	$53,311	$33	$55,567	$33
Raleigh to Charlotte	$49,388	$17	$50,088	$17	$51,867	$17	$54,879	$17
Charlotte to Atlanta	$34,106	$59	$34,668	$62	$37,926	$59	$42,118	$62
Atlanta to Nashville					$5,212	$19	$9,661	$50
Atlanta to Orlando (Jacksonville)					$2,659	$13	$6,138	$44
Total	**$70,593**	**$109**	**$71,496**	**$112**	**$78,267**	**$142**	**$86,322**	**$205**
Injuries								
Washington, DC, to Richmond	$133,715	$200	$135,314	$201	$137,007	$200	$141,726	$201
Richmond to Raleigh	$127,796	$200	$129,417	$201	$131,920	$200	$137,501	$201
Raleigh to Charlotte	$122,213	$103	$123,943	$103	$128,347	$103	$135,798	$103
Charlotte to Atlanta	$84,396	$361	$85,787	$375	$93,848	$361	$104,221	$375
Atlanta to Nashville					$12,897	$116	$23,906	$302
Atlanta to Orlando (Jacksonville)					$6,581	$79	$15,189	$266
Total	**$174,683**	**$664**	**$176,918**	**$679**	**$193,673**	**$859**	**$213,605**	**$1,246**
Property Damage Only*								
Washington, DC, to Richmond	$3,847		$3,893		$3,942		$4,078	
Richmond to Raleigh	$3,677		$3,723		$3,795		$3,956	
Raleigh to Charlotte	$3,516		$3,566		$3,693		$3,907	
Charlotte to Atlanta	$2,428		$2,468		$2,700		$2,998	
Atlanta to Nashville					$371		$688	
Atlanta to Orlando (Jacksonville)					$189		$437	
Total	**$5,026**		**$5,090**		**$5,572**		**$6,146**	
Total (All Safety Benefits for Auto and Bus)								
Washington, DC, to Richmond	$191,832		$194,124		$196,549		$203,312	
Richmond to Raleigh	$183,351		$185,674		$189,259		$197,258	
Raleigh to Charlotte	$175,237		$177,717		$184,027		$194,704	
Charlotte to Atlanta	$121,350		$123,360		$134,894		$149,774	
Atlanta to Nashville			$18,615		$34,607			
Atlanta to Orlando (Jacksonville)			$9,521		$22,074			
Total	**$251,075**		**$254,295**		**$278,513**		**$307,524**	

*Note: Property Damage Only values do not apply to avoided bus accidents according to USDOT guidance.

Table 49: Year 2025 Annual Average Emissions Reduction Benefit (in thousands of 2020 Dollars) by Segment

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Carbon Dioxide				
Washington, DC, to Richmond	$885	$897	$898	$922
Richmond to Raleigh	$882	$896	$898	$929
Raleigh to Charlotte	$819	$836	$844	$892
Charlotte to Atlanta	$537	$551	$589	$687
Atlanta to Nashville			$79	$168
Atlanta to Orlando			$35	$132
CO2 Total	**$1,211**	**$1,231**	**$1,323**	**$1,513**
VOX				
Washington, DC, to Richmond	$243	$246	$249	$257
Richmond to Raleigh	$232	$235	$239	$249
Raleigh to Charlotte	$222	$225	$233	$246
Charlotte to Atlanta	$153	$156	$171	$189
Atlanta to Nashville			$24	$44
Atlanta to Orlando (Jacksonville)			$12	$28
VOX Total	**$317**	**$322**	**$352**	**$389**
NOX				
Washington, DC, to Richmond	$776	$786	$794	$820
Richmond to Raleigh	$748	$758	$770	$801
Raleigh to Charlotte	$698	$708	$730	$773
Charlotte to Atlanta	$504	$513	$556	$621
Atlanta to Nashville			$81	$159
Atlanta to Orlando (Jacksonville)			$42	$111
NOX Total	**$1,052**	**$1,066**	**$1,172**	**$1,322**
PM2.5				
Washington, DC, to Richmond	$4,959	$5,018	$5,081	$5,254
Richmond to Raleigh	$4,742	$4,801	$4,893	$5,099
Raleigh to Charlotte	$4,497	$4,560	$4,722	$4,996
Charlotte to Atlanta	$3,177	$3,231	$3,524	$3,909
Atlanta to Nashville			$498	$939
Atlanta to Orlando (Jacksonville)			$258	$612
PM2.5 Total	**$6,559**	**$6,644**	**$7,296**	**$8,106**

Table 49: Year 2025 Annual Average Emissions Reduction Benefit (in thousands of 2020 Dollars) by Segment

Segment	Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Sulfur Dioxide				
Washington, DC, to Richmond	$144	$146	$148	$153
Richmond to Raleigh	$138	$140	$143	$149
Raleigh to Charlotte	$131	$133	$138	$146
Charlotte to Atlanta	$92	$94	$102	$113
Atlanta to Nashville	$0	$0	$14	$27
Atlanta to Orlando (Jacksonville)	$0	$0	$7	$17
SOX Total	$190	$193	$211	$234
Total				
Washington, DC, to Richmond	$7,007	$7,093	$7,170	$7,406
Richmond to Raleigh	$6,742	$6,830	$6,943	$7,227
Raleigh to Charlotte	$6,367	$6,462	$6,667	$7,053
Charlotte to Atlanta	$4,463	$4,545	$4,942	$5,519
Atlanta to Nashville	$0	$0	$696	$1,337
Atlanta to Orlando (Jacksonville)	$0	$0	$354	$900
Grand Total	**$9,329**	**$9,456**	**$10,354**	**$11,564**