ATLANTA-BIRMINGHAM EXECUTIVE SUMMARY

BACKGROUND AND PURPOSE

The purpose of this High Speed Rail Planning Study is to evaluate the feasibility of high-speed rail for three corridors in the southeastern United States. The corridors are as follows:

- Atlanta, GA to Birmingham, AL;
- Atlanta, GA to Macon, GA to Jacksonville, FL; and
- Atlanta, GA to Chattanooga, TN to Nashville, TN to Louisville, KY.

The feasibility of implementing and operating high-speed and intercity passenger rail was examined within each corridor for Emerging High-Speed Rail (90-110 mph) and Express High-Speed Rail (180-220 mph) in all three corridors; and Maglev (220+ mph) in the Atlanta-Chattanooga-Nashville-Louisville corridor.

A representative route was elected for each corridor for both Emerging High-Speed Rail (Shared Use) with speeds up to 90-110 mph, and Express High-Speed Rail (Dedicated Use) with speeds up to 150-220 mph. Additionally, Maglev technology was included in the Atlanta-Chattanooga-Nashville-Louisville Corridor. It should be noted that the representative routes are not preferred or recommended alternatives, but are presented as an example of an alternative to develop reasonable estimates for each corridors' high-speed rail performance. Each representative route may have a variety of specific alignments that will be analyzed through the NEPA process, should the route be selected for future analysis.

Emerging High-Speed Rail generally involves utilizing an existing rail corridor owned and operated by a freight railroad. This type of service is also commonly called "Shared Use". Diesel-electric Tilt Train Technology is proposed for Shared Use corridors due to curvature and topography on these routes and typically achieves top speeds of 90-110 mph.

Express High-Speed Rail achieves top speeds from 180 to 220 mph on completely grade-separated, electrified, dedicated track (with the possible exception of some shared right-of-way in terminal areas). Express High-Speed Rail intends to relieve air and highway capacity constraints. In this report, Express High-Speed Rail is referred to as "Dedicated Use".

Magnetic Levitation, abbreviated as Maglev, was only considered along the Atlanta-Chattanooga-Nashville-Louisville corridor, per special permission from the Federal Railroad Administration (FRA). Maglev is an advanced train technology in which magnetic force lifts, propels, and guides a vehicle over a Guideway. Maglev permits cruising speeds between 250 and 300 mph. This alternative also involves establishing a new passenger rail corridor, designated solely to high-speed passenger rail service.

Purpose and Objective

The overall purpose of this study is to determine the relative feasibility of each corridor with regards to capital costs, funding and financing opportunities, operation and maintenance costs, ridership and revenue, operating ratios and benefit-cost analysis. Each corridor is studied independently of one another, and the feasibility of each corridor is dependent upon the potential benefits anticipated from investment in transportation between the major cities and along each of the corridors.

Corridor Description and History

The Atlanta-Birmingham corridor extends from the Hartsfield-Jackson Atlanta International Airport (H-JAIA) to the proposed downtown Atlanta Multi Modal Passenger Terminal (MMPT) and onto downtown Birmingham, AL. This particular rail corridor was included in the 1997 *High-Speed Ground Transportation for America* report and is one of the 11 federally-designated high-speed rail corridors.

Georgia Department of Transportation (GDOT), in partnership with the Regional Planning Commission of Greater Birmingham (RPCGB) analyzed this route segment as a part of this feasibility study as a connection between the Gulf Coast High-Speed Rail Corridor (New Orleans-Birmingham-Atlanta) and the Southeast High-Speed Rail Corridor (Atlanta-Charlotte-Raleigh-Washington D.C.).

There are two major multi-modal projects underway in Atlanta and Birmingham that support the potential need for high-speed rail service between the two cities. In Atlanta, the Atlanta MMPT is proposed to be located in downtown Atlanta. In Birmingham, the Birmingham-Jefferson County Transit Authority (BJCTA) is designing a new multi-modal center adjacent to the existing Amtrak station that will accommodate rail, bus, and taxi services.

Representative Route Development

One of the first steps for this feasibility study was to identify representative corridor routes for each study corridor. Once the representative routes were established, capital costs, forecast ridership, revenues, operating costs, operating ratio, benefit-cost ratio and other comparative factors were calculated.

A high-level screening analysis was applied to the Atlanta-Birmingham corridor to identify a representative route for each technology for further evaluation. Representative routes were identified for: 1) 90-110 mph Emerging High-Speed Rail (Shared Use) on a shared-use freight corridor; and 2) 180-220 mph Express High-Speed Rail (Dedicated Use) on a dedicated, fully grade-separated corridor. The screening and analysis methodology employed to identify a representative route for each operating technology consisted of four steps:

1. Identify the initial universe of route alternatives for each operating technology based on identifying those routes which provide basic connectivity for each of the major city pairs;
2. Screen the initial universe of route alternatives using both quantitative and qualitative factors to identify a representative route for each technology. Representative routes were chosen primarily based on the following quantitative and qualitative factors to deliver the highest level of service with the least public and environmental cost:
    - Route alternative geometry and travel time,
    - Route alternative freight traffic density (for Shared Use routes),
    - Stakeholder knowledge and input on route alternative issues and opportunities, and
    - Intermodal connectivity through potential stations.

    These routes contain several alignment alternatives that would be further analyzed through the NEPA process, should the corridors pass the feasibility threshold;
3. Further refine representative route alignments based upon a more detailed analysis including: service goals including travel time, station location and accessibility, operating feasibility, engineering feasibility, and cost factors; and
4. Evaluate each representative route in terms of its feasibility with regard to capital costs, forecast ridership, revenues, operating costs, operating ratio, benefit-cost ratio and other comparative factors.

CORRIDOR EVALUATION

The Atlanta-Birmingham Corridor is the shortest of the three study corridors and connects Atlanta, GA and Birmingham, AL. Representative routes for 90-110 mph Shared Use and 180-220 mph Dedicated Use corridor operations were identified based on a technical and stakeholder review of the corridor. The selected routes are shown in Figure 1 on page ES-4, along with alternatives that were reviewed.

The Shared Use route follows the NS and Amtrak Crescent corridor, with potential stations at H-JAIA, Atlanta MMPT, Douglasville, GA, Anniston, AL and downtown Birmingham. The Dedicated Use route follows, primarily, the I-20 interstate corridor and transitions to freight route (utilizing freight right-of-way, but on separate tracks) entering and exiting Atlanta and Birmingham. The Dedicated Use route uses the same stations as Shared Use, with the exception of moving the Anniston station southward 3.2 miles in order to intersect with the Dedicated Use route.

OPERATING PLAN

Operating plans and schedules were developed for the Shared Use and Dedicated use routes. The Atlanta-Birmingham Corridor Shared Use route will have an average speed of 64 mph and will take approximately 2 hours and 46 minutes to travel the corridor, 20 minutes slower than average auto travel time using the Interstate highway. Although diesel-electric equipment technology can provide top speeds of 110 mph, curves and station stops reduce average speeds. The Dedicated Use 180-220 mph route will have an average speed of 117 mph and will take 1 hour and 18 minutes to travel the 151 mile corridor, a 1 hour and 8 minute travel time savings over auto travel. The frequencies were established to create a balance between ridership and operating and maintenance costs.

Table 1: Atlanta-Birmingham Operating Plans

	Shared Use	Dedicated Use
Rail Distance (miles)	176.0	150.7
Travel Time (hr : min)	2:46	1:18
Average Speed (mph)	64	117
Frequency (round trips per day)	6	10
Estimated Auto Time (hr : min)	2:26	2:26
Travel Time – Auto Time	+0:20	-1:08

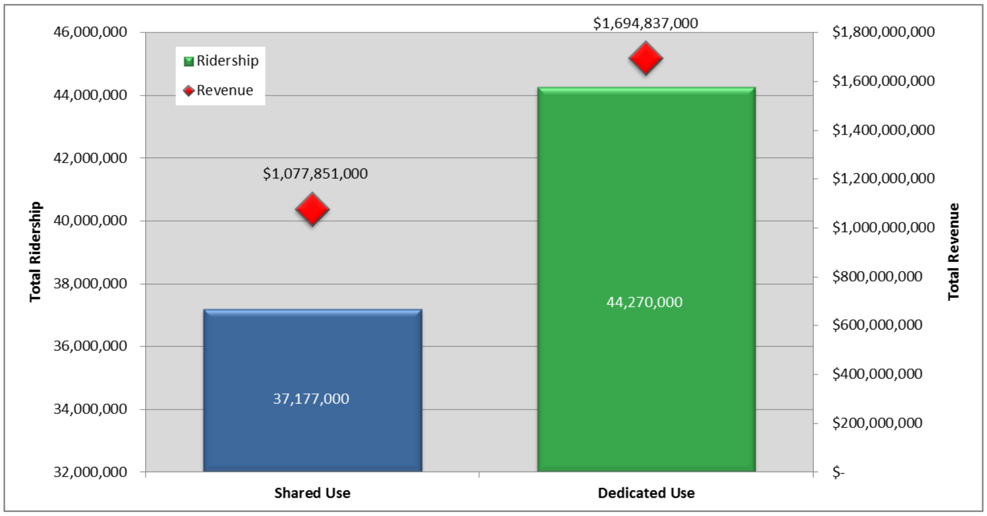
Ridership and Revenue

The study developed the annual ridership and revenue forecasts for both the Shared Use and Dedicated Use routes. The ridership and revenue analysis demonstrated that lower fare structures produce higher ridership levels, but generate lower revenues. Therefore, in order to optimize and balance ridership, revenue, and overall transportation system benefits (consumer surplus) study concluded that the $0.28/mile fare structure for Shared Use and $0.40/mile for Dedicated Use resulted in the optimum balance. Table 4 and Figure 1 illustrate ridership and revenue for years 2021, 2030 and 2040 as well as total ridership and revenue (2021-2040) for the two representative routes. The table and graph show that an increase in level of service and higher travel speeds associated with the 220 mph Dedicated Use corridor service results in an increase in both ridership and revenue for the corridor. The graph also indicates that while ridership may not increase substantially between Shared Use and Dedicated Use technologies, the higher fare used results in a significant increase in the overall revenue.

Table 2: Atlanta-Birmingham Total Ridership and Revenue (2021-2040 in 2010$)

	Shared Use		Dedicated Use	
	Ridership	Revenue	Ridership	Revenue
2021	1,613,000	$46,054,000	1,946,000	$72,791,000
2030	1,847,000	$53,480,000	2,199,000	$84,113,000
2040	2,087,000	$61,731,000	2,481,000	$96,693,000
Total	**37,177,000**	**$1,077,851,000**	**44,270,000**	**$1,694,837,000**

Figure 1: Atlanta-Birmingham Total Ridership and Revenue (2021-2040 in 2010$)



CAPITAL COSTS

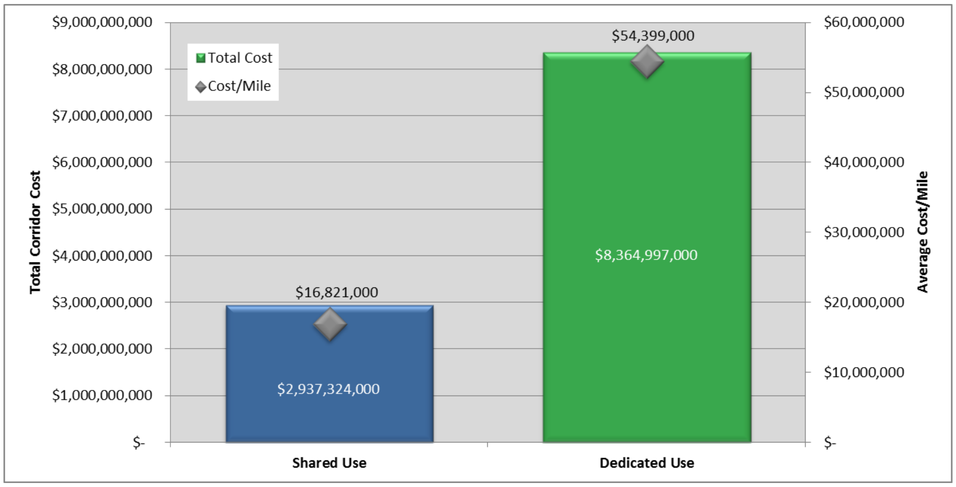
The Atlanta-Birmingham Corridor has the least expensive capital costs of the three corridors. This is primarily due to the short length of the corridor, but may also be partially attributed to the topography and geometry of the track along the corridor.

Table 5 and Figure 2 outline the total capital costs and costs per mile for Shared Use and Dedicated Use routes. The high Dedicated Use costs are mostly associated with the electrification of the track, comprising about 25 percent of the total capital cost and a significant portion of the operations and maintenance costs as well.

Table 3: Atlanta-Birmingham Total Capital Costs (2010$)

	Shared Use	Dedicated Use
Total Cost	$2,937,324,000	$8,364,997,000
Cost per Mile	$16,821,000	$54,399,000

Figure 2: Atlanta-Birmingham Total Capital Costs (2010$)



OPERATING AND MAINTENANCE COSTS

Table 6 shows a breakdown of variable and fixed costing categories used to calculate total operating and maintenance costs. Table 7 illustrates the operating and maintenance costs for 2021, 2030 and 2040 as well as total costs (2021-2040). Total Shared Use operating and maintenance costs equate to approximately $930.3 million compared to the Dedicated Use estimate of $1.7 billion for the same time period.

Table 4: Fixed and Variable Operating and Maintenance Categories

Variable Costs
Train Crew
On-Board Services
Equipment Maintenance
Fuel or Energy
Insurance
Call Center
Credit Car + Travel Agency Commissions
Fixed Costs
Stations
Track and Electrification Maintenance
Administration and Management

Table 5: Atlanta-Birmingham Total Operating and Maintenance Costs (2021-2040 in $ millions and 2010$)

	Shared Use			Dedicated Use		
	Variable	Fixed	Total	Variable	Fixed	Total
2021	$20.9	$22.5	$43.4	$35.0	$44.4	$79.4
2030	$21.8	$22.5	$44.3	$36.6	$44.4	$81.0
2040	$22.7	$22.5	$45.2	$38.1	$44.4	$82.5
Total	**$457.8**	**$472.5**	**$930.3**	**$767.9**	**$932.4**	**$1,700**

CORRIDOR EVALUATION

High-speed rail service in the Atlanta-Birmingham Corridor was evaluated by using both operating ratios and benefit-cost analyses. The study evaluated three scenarios, Conservative, Intermediate and Optimistic, to show the impact of a range of ridership, revenue, capital and operating cost estimates typically encountered in a feasibility-level analysis. Unadjusted base forecasts for ridership, revenue, capital and operating costs were used for the Conservative scenario. Base ridership and revenue estimates were increased for Dedicated Use corridors to establish the Intermediate and Optimistic scenarios.[1] Operating costs were adjusted by the appropriate ridership drivers. Capital cost estimates were adjusted downward in the Intermediate and Optimistic scenarios for all technologies.

<u>*Operating Ratio*</u>

Both the 90-110 mph Shared use and 180-220 mph Dedicated Use representative routes performed well under each of the three sensitivity scenarios, all operating above a 1.0 ratio as outlined in Table 8. It is notable that significant operating revenue surpluses are shown for both technologies during the first year of operation in 2021 using even the most conservative ridership and revenue forecasts. The revenue surpluses then steadily increase over the 20-year planning period to 2040. This provides a strong incentive for potential private sector investors and operators.

---

[1] Ridership adjustments for Intermediate and Optimistic Scenarios were only made for Dedicated Use corridor 180-220 mph electrified, steel-wheel and Maglev technologies (Maglev in Atlanta-Louisville corridor only) based on a peer review of regional and national high-speed rail corridor studies. No scenario ridership adjustment was made for Shared Use corridor diesel-electric technology results based on a peer review of other shared-use corridor studies.

Table 6: Atlanta-Birmingham Operating Ratios (2021-2050)

	Conservative	Intermediate	Optimistic
Shared Use[2]			
2021	1.15	1.15	1.15
2030	1.32	1.32	1.32
2040	1.49	1.49	1.49
Dedicated Use			
2021	1.10	1.72	1.87
2030	1.25	1.86	2.00
2040	1.41	2.00	2.12

Benefit-Cost

Similar to operating ratios, the study evaluated the benefit-cost ratio for the two representative routes and all three sensitivity scenarios. The results in Table 9 show that the Shared Use route alternative does not demonstrate a benefit-cost ratio over 1.0 for any of the sensitivity scenarios and Dedicated Use route alternative produces a benefit-cost ratio above 1.0 for the Optimistic scenario.

Table 7: Atlanta-Birmingham Benefit-Cost Ratios (2021-2050)

	Conservative	Intermediate	Optimistic
Shared Use	0.80	0.88	0.95
Dedicated Use	0.48	0.92	1.13

KEY FINDINGS

The Shared Use and Dedicated Use alternatives perform well under the operating ratio analysis, resulting in ratios well above 1.0 for all three scenarios. This indicates strong operations with lower associated risks to owners and operators. Positive operating ratios indicate an ability to pay down debt services and bonds, and can lead to reduced reliability on public investment subsidies. Additionally, operating surpluses on an annual basis may finance a “rail maintenance fund”, requiring less investment in future years for capital maintenance costs. Positive operating ratios will likely spark private sector investment interest in the corridor, providing additional funding opportunities.

[2] Shared Use operating ratios did not vary between the three sensitivity levels because the same “Conservative Scenario” base case ridership and revenue forecasts were used for each of the scenarios. No scenario ridership adjustment was made for Shared Use corridor diesel-electric technology results based on a peer review of other shared-use corridor studies.

The Dedicated Use route using 180-220 mph electrified, steel-wheel technology shows a benefit-cost ratio of 1.13 for the Optimistic scenario. None of the Shared Use route scenarios show a benefit-cost ratio greater than 1.0.

It should be noted that this feasibility study includes very high-level data and estimates. A more detailed corridor analysis with more definitive study boundaries, travel demand models, and cost estimates, could yield a better benefit-cost evaluation, narrowing the range of estimates.

Taking into account both the operating ratios and benefit-cost ratio and benefit-cost analysis, the study recommends that the results of this analysis be used to set priorities for future state planning and corridor development activities In particular, this study finds that high speed rail service is feasible in the Atlanta-Birmingham Corridor.

HYBRID HIGH PERFORMANCE SCENARIO

One of the results from the Shared Use and Dedicated Use analyses was the introduction of a "hybrid" alternative to offset a portion of the initial capital costs (compared to the Dedicated Use) while improving the travel speeds (compared to the Shared Use), thus positively impacting the operating ratio and benefit-cost analysis. While some analyses were completed for the Hybrid High Performance scenario, there was insufficient data available for a full analysis to be completed. Therefore, more performance and financial details regarding the Hybrid High Performance scenario will need to be explored through the NEPA process. This feasibility study intends to introduce the concept of the Hybrid High Performance scenario and provide a high-level feasibility estimates based on the results found during the Shared Use and Dedicated Use analyses. These estimates include:

- Operational estimates;
- Ridership and revenue;
- Capital Costs; and
- Operating and Maintenance Costs.

From these estimates, the study calculates the high-level operating ratio and Benefit-Cost ratio to compare against the previously identified Shared Use and Dedicated Use ratios to determine if the Hybrid High Performance scenario should be included in a future NEPA analysis.

The study developed a Hybrid High Performance scenario that provides a level of service between Shared Use and Dedicated Use, utilizing fully grade-separated track geometry with no shared-use freight operations. However, rather than electrified high-speed technology, the Hybrid High Performance scenario would implement Diesel-Electric Tilt Technology initially, and when ridership and revenue increase in later operating years, it can be upgraded to a fully-electrified system, obtaining travel speeds of 220 mph or more.

One of the main benefits of the Hybrid High Performance scenario includes significantly lower capital costs compared to the 180-220 mph electrified technology assumed for the Dedicated Use route. However, the Hybrid High Performance scenario still has the potential to reach speeds of up to 130 mph. The study estimated that the Hybrid High Performance scenario would only take approximately 22 minutes longer than the electrified train on the Dedicated Use route. The 130 mph Hybrid High Performance scenario is approximately 1 hour, 16 minutes faster than auto travel by interstate from Atlanta to Birmingham (Table 10).

Table 8: Atlanta-Birmingham Hybrid High Performance Operations

Segment	Shared Use	Dedicated Use	Hybrid High Performance
Rail Distance (miles)	176.0	150.7	150.7
Travel Time (hr : min)	2:46	1:18	1:40
Average Speed (mph)	64	117	90
Frequency (round trips/day)	6	10	10
Estimated Auto Time (hr : min)	2:56	2:56	2:56
Travel Time – Auto Time	+0:10	-1:38	-1:16

<u>*Ridership and Revenue*</u>

The study estimated based on the decrease in average speed and increase in corridor travel time, the revenue for the Hybrid High Performance scenario would decrease 7.3 percent from the Dedicated Use forecasts (refer to Appendix G). Table 11 shows the estimated ridership and revenue for the Hybrid High Performance scenario for 2021, 2030, and 2040 as well as a total ridership and revenue (2021-2040) as compared to Dedicated Use forecasts.

Table 9: Atlanta-Birmingham Hybrid High Performance Ridership and Revenue (2021-2040 in 2010$)

	Hybrid High Performance		Dedicated Use	
	Ridership	Revenue	Ridership	Revenue
2021	1,805,000	$67,484,000	1,946,000	$72,791,000
2030	2,039,000	$77,981,000	2,199,000	$84,113,000
2040	2,300,000	$89,644,000	2,481,000	$96,693,000
Total	**41,043,000**	**$1,571,284,000**	**44,270,000**	**$1,684,837,000**

<u>*Costs*</u>

As previously mentioned, the capital costs, operating costs, and maintenance costs for the Hybrid High Performance scenario will be significantly less than the Dedicated Use route due to the elimination of the track electrification. This also results in decreased in vehicle cost since diesel vehicles are also less expensive than fully electrified vehicles.

Table 12 outlines the Hybrid High Performance scenario capital cost estimates compared to the Dedicated Use technology. Capital costs for the 130 mph Hybrid High Performance scenario are almost two-thirds (2/3) of those for the 180-220 mph electrified steel-wheel technology.

Table 10: Atlanta-Birmingham Hybrid High Performance Rail Capital Costs (2010$)

	Hybrid High Performance	Dedicated Use
Total Cost	$5,487,672,000	$8,322,897,000
Cost per Mile	$35,688,000	$54,399,000

Operating and maintenance costs for the Hybrid High Performance scenario will also be reduced from the Dedicated Use estimates due to less required track inspection and maintenance because heavy freight trains will not be sharing the track. Table 13 illustrates the estimates the Hybrid High Performance scenario operating and maintenance costs for 2021, 2030 and 2040 as well as total operating and maintenance costs (2021-2040) compared to the Dedicated Use route.

Table 11: Atlanta-Birmingham Hybrid High Performance Scenario Operating and Maintenance Costs (2021-2040 in $ millions and 2010$)

	Hybrid High Performance Rail			Dedicated Use		
	Variable	Fixed	Total	Variable	Fixed	Total
2021	$34.4	$31.8	$66.2	$35.0	$44.4	$79.4
2030	$35.8	$31.8	$67.6	$36.6	$44.4	$81.0
2040	$37.2	$31.8	$69.0	$38.1	$44.4	$82.2
Total	**$751.8**	**$667.8**	**$1,420**	**$767.9**	**$932.4**	**$1,700**

Feasibility Evaluation

Similar to the Shared Use and Dedicated Use routes, the study developed an operating ratio and benefit-cost ratio for the Hybrid Performance alternative. Table 14 and Table 15 illustrate the results of these analyses for the three sensitivity scenarios: Conservative, Intermediate and Optimistic as compared to the Dedicated Use route.

Table 12: Atlanta-Birmingham Hybrid High Performance Scenario Operating Ratio

	Conservative	Intermediate	Optimistic
Hybrid High Performance			
2021	1.18	1.85	2.02
2030	1.34	2.00	2.14
2040	1.51	2.13	2.26

	Conservative	Intermediate	Optimistic
Dedicated Use			
2021	1.10	1.72	1.87
2030	1.25	1.86	2.00
2040	1.41	2.00	2.12

Table 13: Atlanta-Birmingham Hybrid High Performance Scenario Benefit-Cost Ratio (2021-2050)

	Conservative	Intermediate	Optimistic
Hybrid High Performance	0.72	1.28	1.62
Dedicated Use	0.48	0.92	1.13

Initial investigation into the Hybrid High Performance scenario indicates that an incremental approach to high-speed rail may provide significant advantages in the Atlanta-Birmingham Corridor both in terms of reducing initial capital cost requirement and increasing benefit-cost ratios.

The study used high-level estimates for revenue and costs associated with the Hybrid High Performance scenario. Therefore, a more detailed analysis of this alternative is needed to make definitive conclusions regarding the feasibility of the Hybrid High Performance scenario. The study recommends that the Hybrid High Performance scenario be included in the next phase of the passenger rail planning analysis as a viable technology alternative for passenger rail within the Atlanta-Birmingham Corridor.

Final Conclusions

High-speed rail service in the Atlanta-Birmingham Corridor presents an opportunity to provide needed transportation solutions and promotes economic development. While high-speed rail is not the only transportation solution, this study gives evidence that passenger high-speed rail will provide added mobility and transportation choices to consumers. High-speed rail can provide more efficient and cost-effective means to consumers, providing added connectivity to major cities such as Atlanta and Birmingham through commercial centers and national/international destinations.

This study illustrates that although the initial investment in high-speed rail is significant, the mobility and economic opportunities offered by this new mode are also significant. Based on the analysis findings, this study determines that high-speed rail is feasible in the Atlanta-Birmingham Corridor. It is further recommended that a Tier 1 NEPA Document and Service Development Plan be pursued for high-speed rail service within the corridor.

ATLANTA-MACON-JACKSONVILLE EXECUTIVE SUMMARY

BACKGROUND AND PURPOSE

The purpose of this High Speed Rail Planning Study is to evaluate the feasibility of high-speed rail for three corridors in the southeastern United States. The corridors are as follows:

- Atlanta, GA to Birmingham, AL;
- Atlanta, GA to Macon, GA to Jacksonville, FL; and
- Atlanta, GA to Chattanooga, TN to Nashville, TN to Louisville, KY.

The feasibility of implementing and operating high-speed and intercity passenger rail was examined within each corridor for Emerging High-Speed Rail (90-110 mph) and Express High-Speed Rail (180-220 mph) in all three corridors; and Maglev (220+ mph) in the Atlanta-Chattanooga-Nashville-Louisville corridor.

A representative route was elected for each corridor for both Emerging High-Speed Rail (Shared Use) with speeds up to 90-110 mph, and Express High-Speed Rail (Dedicated Use) with speeds up to 150-220 mph. Additionally, Maglev technology was included in the Atlanta-Chattanooga-Nashville-Louisville Corridor. It should be noted that the representative routes are not preferred or recommended alternatives, but are presented as an example of an alternative to develop reasonable estimates for each corridors' high-speed rail performance. Each representative route may have a variety of specific alignments that will be analyzed through the NEPA process, should the route be selected for future analysis.

Emerging High-Speed Rail generally involves utilizing an existing rail corridor owned and operated by a freight railroad. This type of service is also commonly called "Shared Use". Diesel-electric Tilt Train Technology is proposed for Shared Use corridors due to curvature and topography on these routes and typically achieves top speeds of 90-110 mph.

Express High-Speed Rail achieves top speeds from 180 to 220 mph on completely grade-separated, electrified, dedicated track (with the possible exception of some shared right-of-way in terminal areas). Express High-Speed Rail intends to relieve air and highway capacity constraints. In this report, Express High-Speed Rail is referred to as "Dedicated Use".

Magnetic Levitation, abbreviated as Maglev, was only considered along the Atlanta-Chattanooga-Nashville-Louisville corridor, per special permission from the Federal Railroad Administration (FRA). Maglev is an advanced train technology in which magnetic force lifts, propels, and guides a vehicle over a Guideway. Maglev permits cruising speeds between 250 and 300 mph. This alternative also involves establishing a new passenger rail corridor, designated solely to high-speed passenger rail service.

Purpose and Objective

The overall purpose of this study is to determine the relative feasibility of each corridor with regards to capital costs, funding and financing opportunities, operation and maintenance costs, ridership and revenue, operating ratios and benefit-cost analysis. Each corridor is studied independently of one another, and the feasibility of each corridor is dependent upon the potential benefits anticipated from investment in transportation between the major cities and along each of the corridors.

Corridor Description and History

The Atlanta-Macon-Jacksonville corridor extends from the proposed downtown Atlanta Multi Modal Passenger Terminal (MMPT) to Hartsfield-Jackson Atlanta International Airport (H-JAIA) to Macon, GA, Savannah, GA and downtown Jacksonville, FL. The Atlanta-Macon-Jacksonville Corridor is a variation of the federally designated high-speed rail corridor. The original corridor travels from Atlanta, Macon, Jesup, Georgia and Jacksonville, Florida. This route was included in the route alternative analysis; however, the route including Savannah, GA was chosen based on the increase in ridership and revenue associated with the higher population. The Savannah metropolitan statistical area (MSA) is the fourth largest travel market in the state of Georgia, and the Savannah to Jacksonville Corridor is also part of the federally-designated Southeast High Speed Rail Corridor (SEHSR).

There are two multi-modal projects underway in Atlanta and Jacksonville that support the potential need for high-speed rail service between the two cities. In Atlanta, the Atlanta MMPT is proposed in downtown Atlanta. Jacksonville, FL is also proposing a new multi-modal terminal for downtown Jacksonville that will accommodate both intercity rail and local transit and ground transportation alternatives.

Representative Route Development

One of the first steps for this feasibility study was to identify representative corridor routes for each study corridor. Once the representative routes were established, capital costs, forecast ridership, revenues, operating costs, operating ratio, benefit-cost ratio and other comparative factors were calculated.

A high-level screening analysis was applied to the Atlanta-Macon-Jacksonville Corridor to identify a representative route for each technology for further evaluation. Representative routes were identified for: 1) 90-110 mph Emerging High-Speed Rail (Shared Use) on a shared-use freight corridor; and 2) 180-220 mph Express High-Speed Rail (Dedicated Use) on a dedicated, fully grade-separated corridor. The screening and analysis methodology employed to identify a representative route for each operating technology consisted of four steps:

1. Identify the initial universe of route alternatives for each operating technology based on identifying those routes which provide basic connectivity for each of the major city pairs;
2. Screen the initial universe of route alternatives using both quantitative and qualitative factors to identify a representative route for each technology. Representative routes were chosen primarily based on the following quantitative and qualitative factors to deliver the highest level of service with the least public and environmental cost:
   - Route alternative geometry and travel time,
   - Route alternative freight traffic density (for Shared Use routes),
   - Stakeholder knowledge and input on route alternative issues and opportunities, and
   - Intermodal connectivity through potential stations.

   These routes contain several alignment alternatives that would be further analyzed through the NEPA process, should the corridors pass the feasibility threshold;
3. Further refine representative route alignments based upon a more detailed analysis including: service goals including travel time, station location and accessibility, operating feasibility, engineering feasibility, and cost factors; and
4. Evaluate each representative route in terms of its feasibility with regard to capital costs, forecast ridership, revenues, operating costs, operating ratio, benefit-cost ratio and other comparative factors.

CORRIDOR EVALUATION

The Atlanta-Macon-Jacksonville Corridor connects Atlanta, Macon and Savannah, Georgia with Jacksonville, Florida. Representative routes for 110 mph Shared Use and 180-220 Dedicated Use corridor operations were identified based on a technical analysis and stakeholder review of the corridor.

Shared Use Route Representative Route: 110 mph, Diesel-Electric Technology:

- NS S-Line from Atlanta, Georgia to Macon, Georgia;
- Georgia Central Railroad from Macon, Georgia to Savannah, Georgia;
- Partially abandoned CSXT S-Line from Savannah, Georgia to Callahan, Florida; and
- CSXT A-Line from Callahan, Florida to Jacksonville, Florida.

The Shared Use route proposes a total of seven potential stations including Atlanta MMPT, H-JAIA, Griffin, Macon, Savannah, Brunswick, and Jacksonville.

__Dedicated Use Representative Route: 180-220 mph, Electrified Steel-Wheel Technology:__

The proposed Dedicated Use route generally follows Interstate 75 (I-75) and the NS Griffin "S-Line" from Atlanta to Macon, and Interstate 16 (I-16) from Macon to Savannah. There is one primary opportunity for a Dedicated Use route between Savannah and Jacksonville following the partially abandoned CSXT S-Line. There are two routing options, then, entering the Jacksonville metropolitan area. The first option is to continue following the CSXT S-Line from Savannah through Brunswick into Jacksonville providing access to the Jacksonville International Airport, but bypassing the existing Jacksonville Amtrak station. The second option provides a transition from the CSXT S-Line to the CSXT A-Line just north of the city. This option would access the Amtrak station, but bypass the Jacksonville International Airport.

Operating Plan

Operating plans and schedules were developed for the Shared Use and Dedicated use routes. The Atlanta-Macon-Jacksonville Corridor Shared Use route will have an average speed of 77 mph and will take approximately 5 hours and 19 minutes to travel the corridor, 6 minutes faster than auto travel time using the Interstate highway. Although diesel-electric equipment technology can provide top speeds of 110 mph, curves and station stops reduce average speeds. The Dedicated Use 180-220 mph route will have an average speed of 131 mph and will take 2 hour and 49 minutes to travel the 368 mile corridor – a 2 hour and 35 minute travel time savings over auto travel. The frequencies were established to create a balance between ridership and operating and maintenance costs.

Table 1: Atlanta-Macon-Jacksonville Operating Plans

	Shared Use	Dedicated Use
Rail Distance (miles)	408.6	368.1
Travel Time (hr : min)	5:18	2:49
Average Speed (mph)	77	131
Frequency (round trips per day)	8	14
Estimated Auto Time (hr : min)	5:24	5:24
Travel Time – Auto Time	-0:06	-2:35

Ridership and Revenue

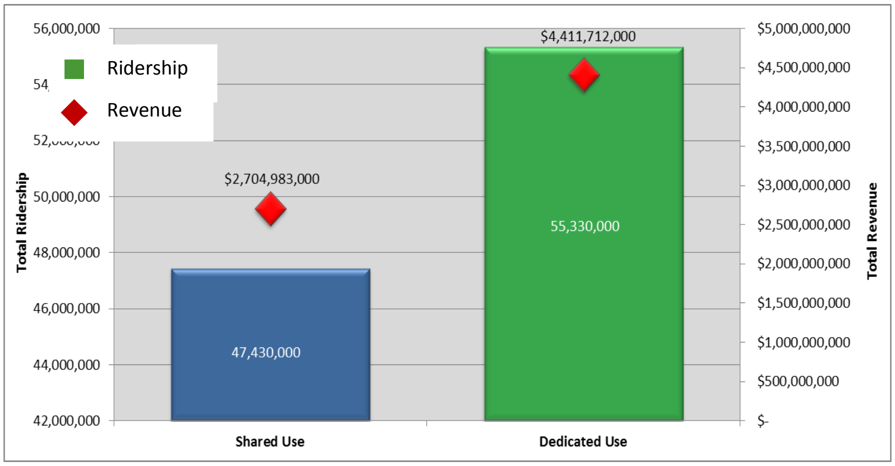
The study developed the annual ridership and revenue forecasts for both the Shared Use and Dedicated Use routes. The ridership and revenue analysis demonstrated that lower fare structures produce higher ridership levels, but generate lower revenues. Therefore, in order to optimize and balance ridership, revenue, and overall transportation system benefits (consumer surplus) study concluded that a $0.28/mile fare structure for Shared Use and $0.40/mile for Dedicated Use resulted in optimum balance. Table 2 and Figure 1 illustrate ridership and revenue for years

2021, 2030 and 2040 as well as total ridership and revenue (2021-2040) for the two representative routes. The table and graph show that an increase in level of service and higher travel speeds associated with the 220 mph Dedicated Use corridor service results in an increase in both ridership and revenue for the corridor. The graph also indicates that while ridership may not increase substantially between Shared Use and Dedicated Use technologies, the higher fare used results in a significant increase in the overall revenue.

Table 2: Atlanta-Macon-Jacksonville Total Ridership and Revenue (2021-2040 in 2010$)

	Shared Use		Dedicated Use	
	Ridership	Revenue	Ridership	Revenue
2021	2,011,000	$109,776,000	2,355,000	$181,193,000
2030	2,353,000	$133,908,000	2,745,000	$218,512,000
2040	2,732,000	$160,723,000	3,178,000	$259,978,000
Total	**47,430,000**	**$2,704,983,000**	**55,330,000**	**$4,411,712,000**

Figure 1: Atlanta-Macon-Jacksonville Total Ridership and Revenue (2021-2040 in 2010$)



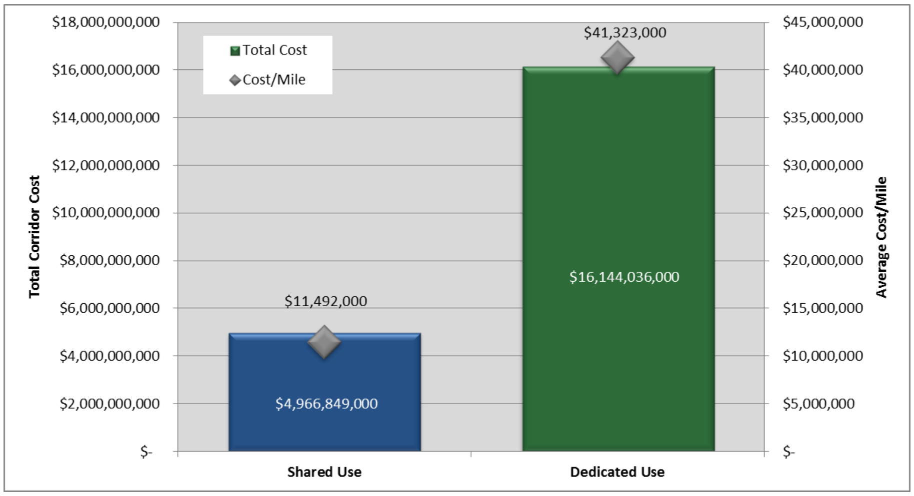
CAPITAL COSTS

The Atlanta-Macon-Jacksonville Corridor reflected the lowest cost per mile of the three study corridors. This is due to the flat terrain and relatively straight geometry of both the Shared Use and Dedicated routes. Table 3 and Figure 2 outline the total capital costs and costs per mile for Shared Use and Dedicated Use routes. The high Dedicated Use costs are mostly associated with the electrification of the track, comprising about 25 percent of the total capital cost and a significant portion of the operations and maintenance costs as well.

Table 3: Atlanta-Macon-Jacksonville Total Capital Costs (2010$)

	Shared Use	Dedicated Use
Total Cost	$4,966,849,000	$16,144,036,000
Cost per Mile	$11,492,000	$41,323,000

Figure 2: Atlanta-Macon-Jacksonville Total Capital Costs (2010$)



Operating and Maintenance Costs

Table 4 shows a breakdown of variable and fixed costing categories used to calculated total operating maintenance costs. Table 5 illustrates the operating and maintenance costs for 2021, 2030 and 2040 as well as total costs (2021-2040). Total Shared Use operating and maintenance costs equate to approximately $2.1 billion compared to the Dedicated Use estimate of $4.1 billion for the same time period.

Table 4: Fixed and Variable Operating and Maintenance Categories

Variable Costs
Train Crew
On-Board Services
Equipment Maintenance
Fuel or Energy
Insurance
Call Center
Credit Car + Travel Agency Commissions
Fixed Costs
Stations
Track and Electrification Maintenance
Administration and Management

Table 5: Atlanta-Macon-Jacksonville Total Operating and Maintenance Costs (2021-2040 in $ millions and 2010$)

	Shared Use			Dedicated Use		
	Variable	Fixed	Total	Variable	Fixed	Total
2021	$60.1	$35.6	$95.7	$109.1	$80.9	$190.1
2030	$62.8	$35.6	$98.5	$113.9	$80.9	$194.8
2040	$65.6	$35.6	$101.2	$118.7	$80.9	$199.6
Total	**$1,320**	**$747.6**	**$2,067**	**$2,392**	**$1,699**	**$4,090**

CORRIDOR EVALUATION

High-speed rail service in the Atlanta-Macon-Jacksonville Corridor was evaluated by using both operating ratios and benefit-cost analyses. The study evaluated three scenarios, Conservative, Intermediate and Optimistic, to show the impact of a range of ridership, revenue, capital and operating cost estimates typically encountered in a feasibility-level study. Unadjusted base forecasts for ridership, revenue, capital and operating costs were used for the Conservative scenario. Base ridership and revenue estimates were increased for Dedicated Use corridors to establish the Intermediate and Optimistic scenarios.[3] Operating costs were adjusted by the appropriate ridership drivers. Capital cost estimates were adjusted downward in the Intermediate and Optimistic scenarios for all technologies

Operating Ratio

Both the 90-110 mph Shared Use and 180-220 mph Dedicated Use representative routes performed well under each of the three sensitivity scenarios, all operating above a 1.0 ratio as outlined in Table 6. It is notable that significant operating revenue surpluses are shown for both technologies during the first year of operation in 2021 using even the most conservative ridership and revenue forecast. The revenue surpluses then steadily increase over the 20-year planning period to 2040. This provides a strong incentive for potential private sector investors and operators.

---

[3] Ridership adjustments for Intermediate and Optimistic Scenarios were only made for Dedicated Use corridor 180-220 mph electrified, steel-wheel and Maglev technologies (Maglev in Atlanta-Louisville corridor only) based on a peer review of regional and national high speed rail corridor studies. No scenario ridership adjustment was made for Shared Use corridor diesel-electric technology results based on a peer review of other shared-use corridor studies.

Table 6: Atlanta-Macon-Jacksonville Operating Ratios (2021-2050)

	Conservative	Intermediate	Optimistic
Shared Use[4]			
2021	1.25	1.25	1.25
2030	1.48	1.48	1.48
2040	1.73	1.73	1.73
Dedicated Use			
2021	1.14	1.83	2.04
2030	1.35	2.00	2.17
2040	1.56	2.15	2.29

Benefit-Cost

Similar to operating ratios, the study evaluated the benefit-cost ratio for the two representative routes and all three sensitivity scenarios. The results in Table 7 show that the Shared Use route alternative has benefit-cost ratio of 1.0 or more for both the Intermediate and Optimistic scenarios and the Dedicated Use route alternative has a benefit-cost ratio greater than 1.0 for the Optimistic scenario.

Table 7: Atlanta-Macon-Jacksonville Benefit-Cost Ratios (2021-2050)

	Conservative	Intermediate	Optimistic
Shared Use	0.92	1.00	1.07
Dedicated Use	0.49	0.93	1.12

KEY FINDINGS

The Shared Use and Dedicated Use alternatives perform well under the operating ratio analysis, resulting in ratios well above 1.0 for all three scenarios. This indicates strong operations with lower associated risks to owners and operators. Positive operating ratios indicate an ability to pay down debt services and bonds, and can lead to reduced reliability on public investment subsidies. Additionally, operating surpluses on an annual basis may finance a "rail maintenance fund", requiring less investment in future years for capital maintenance costs. Positive operating ratios will likely spark private sector investment interest in the corridor, providing additional funding opportunities.

[4] Shared Use operating ratios did not vary between the three sensitivity levels because the same "Conservative Scenario" base case ridership and revenue forecasts were used for each of the scenarios. No scenario ridership adjustment was made for Shared Use corridor diesel-electric technology results based on a peer review of other shared-use corridor studies.

The benefit-cost results show ratios greater than 1.0 for both Shared Use and Dedicated Use for the Optimistic scenario and well as for the Shared Use Conservative scenario.

It should be noted that this feasibility study includes very high-level data and estimates. A more detailed corridor analysis with more definitive study boundaries, travel demand models, and cost estimates, could yield a better benefit-cost evaluation narrowing the range of estimates.

Taking into account the both operating ratios and benefit-cost ratios, the study recommends that the results of this analysis be used to set priorities for future state planning and corridor development activities. In particular, this study finds that high speed rail service is feasible in the Atlanta-Macon-Jacksonville Corridor.

The study developed an additional “Hybrid” High Performance scenario, discussed in detail below that further supports the above conclusions. This alternative has the potential to reduce initial capital costs and positively impact the benefit-cost analysis while maintaining the ability to achieve higher speeds along the corridor.

HYBRID HIGH PERFORMANCE SCENARIO

One of the results from the Shared Use and Dedicated Use analyses was the introduction of a “hybrid” alternative to offset a portion of the initial capital costs (compared to the Dedicated Use) while improving the travel speeds (compared to the Shared Use), thus positively impacting the operating ratio and benefit-cost analysis. While some analyses were completed for the Hybrid High Performance scenario, there was insufficient data available for a full analysis to be completed. Therefore, more performance and financial details regarding the Hybrid High Performance scenario will need to be explored through the NEPA process. This feasibility study intends to introduce the concept of the Hybrid High Performance scenario and provide a high-level feasibility estimates based on the results found during the Shared Use and Dedicated Use analyses. These estimates include:

- Operational estimates;
- Ridership and revenue;
- Capital Costs; and
- Operating and Maintenance Costs.

From these estimates, the study calculates the high-level operating ratio and Benefit-Cost ratio to compare against the previously identified Shared Use and Dedicated Use ratios to determine if the Hybrid High Performance scenario should be included in a future NEPA analysis.

The study developed a Hybrid High Performance scenario that provides a level of service between Shared Use and Dedicated Use, utilizing fully grade-separated track geometry with no shared-use freight operations. However, rather than electrified high-speed technology, the Hybrid High Performance scenario would implement diesel-electric tilt technology initially, and when ridership and revenue increase in later operating years, it can be upgraded to a fully-electrified system, obtaining travel speeds of 220 mph or more.

One of the main benefits of the Hybrid High Performance scenario include significantly lower capital costs compared to the 180-220 mph electrified technology assumed for the Dedicated Use route. However, the Hybrid High Performance scenario, which utilizes diesel-electric tilt train technology, still has the potential to reach speeds of up to 130 mph. The study estimated that the Hybrid High Performance scenario would take approximately 1 hour, 7 minutes longer than the electrified train on the Dedicated Use route. The Hybrid High Performance is approximately 1 hour, 29 minutes faster than auto travel by interstate from Atlanta to Jacksonville (Table 8).

Table 8: Atlanta-Macon-Jacksonville High Performance Operations

Segment	Shared Use	Dedicated Use	Hybrid High Performance
Rail Distance (miles)	408.6	368.1	368.1
Travel Time (hr : min)	5:18	2:49	3:55
Average Speed (mph)	77	131	94
Frequency (round trips/day)	8	14	14
Estimated Auto Time (hr : min)	5:24	5:24	5:24
Travel Time – Auto Time	-0:06	-2:35	-1:29

Ridership and Revenue

The study estimated based on the decrease in average speed and increase in corridor travel time, the revenue for the Hybrid High Performance scenario would decrease 19.21 percent from the Dedicated Use forecasts (refer to Appendix G). Table 9 shows the estimated ridership and revenue for the Hybrid High Performance scenario for 2021, 2030, and 2040 as well as a total ridership and revenue (2021-2040) as compared to Dedicated Use forecasts.

Table 9: Atlanta-Macon-Jacksonville High Performance Ridership and Revenue (2010$)

	Hybrid High Performance		Dedicated Use	
	Ridership	Revenue	Ridership	Revenue
2021	2,061,000	146,386,000	2,355,000	$181,193,000
2030	2,402,000	176,536,000	2,745,000	$218,512,000
2040	2,781,000	210,036,000	3,178,000	$259,978,000
Total	**48,414,000**	**$3,564,222,000**	**55,330,000**	**$4,411,712,000**

Costs

As previously mentioned, the capital costs, operating costs, and maintenance costs for the Hybrid High Performance scenario will be significantly less than the Dedicated Use route due to the elimination of the track electrification. This also results in decreased in vehicle cost since diesel vehicles are also less expensive than fully electrified vehicles.

Table 10 outlines the Hybrid High Performance scenario capital cost estimates compared to the Dedicated Use technology. Capital costs for the 130 mph Hybrid technology alternative are almost half of those for the 180-220 mph electrified steel-wheel technology.;=

Table 10: Atlanta-Macon-Jacksonville High Performance Scenario Capital Costs (2010$)

	Hybrid High Performance	Dedicated Use
Total Cost	$8,904,394,000	$16,144,036,000
Cost per Mile	$22,792,000	$41,323,000

Operating and maintenance costs for the Hybrid High Performance scenario will also be reduced from the Dedicated Use estimates due to less required track inspection and maintenance because heavy freight trains will not be sharing the track. Table 11 illustrates the estimates the Hybrid High Performance scenario operating and maintenance costs for 2021, 2030 and 2040 as well as total operating and maintenance costs (2021-2040) compared to the Dedicated Use route.

Table 11: Atlanta-Macon-Jacksonville Hybrid High Performance Scenario Operating and Maintenance Costs (2021-2040 in $ millions and 2010$)

	Hybrid High Performance Rail			Dedicated Use		
	Variable	Fixed	Total	Variable	Fixed	Total
2021	$114.6	$50.2	$164.7	$109.1	$80.9	$190.1
2030	$118.4	$50.2	$168.6	$113.9	$80.9	$194.8
2040	$122.3	$50.2	$172.4	$118.7	$80.9	$199.6
Total	**$2,487**	**$1,054**	**$3,541**	**$2,392**	**$1,699**	**$4,090**

Feasibility Evaluation

Similar to the Shared Use and Dedicated Use routes, the study developed an operating ratio and benefit-cost ratio for the Hybrid Performance alternative. Table 12 and Table 13 illustrate the results of these analyses for the three sensitivity scenarios: Conservative, Intermediate and Optimistic as compared to the Dedicated Use and Maglev routes.

Table 12: Atlanta-Macon-Jacksonville Hybrid High Performance Scenario Operating Ratio

	Conservative	Intermediate	Optimistic
Hybrid High Performance			
2021	1.03	1.66	1.86
2030	1.21	1.95	2.17
2040	1.41	2.18	2.39
Dedicated Use			
2021	1.14	1.83	2.04
2030	1.35	2.00	2.17
2040	1.56	2.15	2.29

Table 13: Atlanta-Macon-Jacksonville Hybrid High Performance Scenario Benefit-Cost Ratio (2021-2050)

	Conservative	Intermediate	Optimistic
Hybrid High Performance	0.63	1.21	1.48
Dedicated Use	0.49	0.93	1.12

Initial investigation into the Hybrid High Performance scenario indicates that an incremental approach to high-speed rail may provide significant advantages in the Atlanta-Macon-Jacksonville Corridor both in terms of reducing initial capital cost requirements and increasing the benefit-cost ratios.

The study used high-level estimations for revenue and costs associated with the Hybrid High Performance scenario. Therefore, a more detailed analysis of this alternative is needed to make definitive conclusions regarding the feasibility of the Hybrid High Performance scenario. The study recommends that the Hybrid High Performance scenario be included in the next phase of the passenger rail planning analysis as a viable technology alternative for passenger rail within the Atlanta-Macon-Jacksonville Corridor.

FINAL CONCLUSIONS

High-speed rail service in the Atlanta-Macon-Jacksonville Corridor presents an opportunity to provide needed transportation solutions and promote economic development. While high-speed rail is not the only transportation solution, this study gives evidence that passenger high-speed rail will provide added mobility and transportation choices to consumers. High-speed rail can provide more efficient and cost-effective means to consumers, providing added connectivity to major cities such as Atlanta and Birmingham through commercial centers and national / international destinations.

This study illustrates that although the initial investment in high-speed rail is significant, the mobility and economic opportunities offered by this new more are significant. Based on the analysis findings, this study determines that high-speed rail is feasible in the Atlanta-Macon-Jacksonville Corridor. It is further recommended that a Tier 1 NEPA Document and Service Development Plan be pursued for high-speed rail service within the corridor. This analysis should continue to address a range of technology alternatives including the Hybrid High Performance implementation approach.

ATLANTA-CHATTANOOGA-NASHVILLE-LOUISVILLE EXECUTIVE SUMMARY

BACKGROUND AND PURPOSE

The purpose of this High Speed Rail Planning Study is to evaluate the feasibility of high-speed rail for three corridors in the southeastern United States. The corridors are as follows:

- Atlanta, GA to Birmingham, AL;
- Atlanta, GA to Macon, GA to Jacksonville, FL; and
- Atlanta, GA to Chattanooga, TN to Nashville, TN to Louisville, KY.

The feasibility of implementing and operating high-speed and intercity passenger rail was examined within each corridor for Emerging High-Speed Rail (90-110 mph) and Express High-Speed Rail (180-220 mph) in all three corridors; and Maglev (220+ mph) in the Atlanta-Chattanooga-Nashville-Louisville corridor.

A representative route was elected for each corridor for both Emerging High-Speed Rail (Shared Use) with speeds up to 90-110 mph, and Express High-Speed Rail (Dedicated Use) with speeds up to 150-220 mph. Additionally, Maglev technology was included in the Atlanta-Chattanooga-Nashville-Louisville Corridor. It should be noted that the representative routes are not preferred or recommended alternatives, but are presented as an example of an alternative to develop reasonable estimates for each corridors' high-speed rail performance. Each representative route may have a variety of specific alignments that will be analyzed through the NEPA process, should the route be selected for future analysis.

Emerging High-Speed Rail generally involves utilizing an existing rail corridor owned and operated by a freight railroad. This type of service is also commonly called "Shared Use". Diesel-electric Tilt Train Technology is proposed for Shared Use corridors due to curvature and topography on these routes and typically achieves top speeds of 90-110 mph.

Express High-Speed Rail achieves top speeds from 180 to 220 mph on completely grade-separated, electrified, dedicated track (with the possible exception of some shared right-of-way in terminal areas). Express High-Speed Rail intends to relieve air and highway capacity constraints. In this report, Express High-Speed Rail is referred to as "Dedicated Use".

Magnetic Levitation, abbreviated as Maglev, was only considered along the Atlanta-Chattanooga-Nashville-Louisville corridor, per special permission from the Federal Railroad Administration (FRA). Maglev is an advanced train technology in which magnetic force lift, propel, and guide a vehicle over a Guideway. Maglev permits cruising speeds between 250 and 300 mph. This alternative also involves establishing a new passenger rail corridor, designated solely to high-speed passenger rail service.

PURPOSE AND OBJECTIVE

The overall purpose of this study is to determine the relative feasibility of each corridor with regards to capital costs, funding and financing opportunities, operation and maintenance costs, ridership and revenue, operating ratios and benefit-cost analysis. Each corridor is studied independently of one another, and the feasibility of each corridor is dependent upon the potential benefits anticipated from investment in transportation between the major cities and along each of the corridors.

CORRIDOR DESCRIPTION AND HISTORY

The Atlanta-Chattanooga-Nashville-Louisville corridor extends between the Hartsfield-Jackson Atlanta International Airport (H-JAIA) and Downtown Louisville, KY. As documented in the Georgia State Rail Plan, the Atlanta-Chattanooga Corridor has been a subject of study for over 10 years and was part of the GDOT 1997 Intercity Rail Plan. The Atlanta Regional Commission (ARC) analyzed the corridor from 1999 to 2003. Currently, the State of Georgia is preparing a Tier I EIS considering 180 mph high-speed rail and Maglev within the corridor. The State of Tennessee prepared a State Rail Plan in 2003, and the Kentucky Transportation Cabinet (KYTC) State Rail Plan was completed in 2002. Both the Tennessee and Kentucky State Rail Plans explored options and the opportunity for high-speed service. These plans link Chattanooga, Nashville, and Louisville, KY.

REPRESENTATIVE ROUTE DEVELOPMENT

One of the first steps for this feasibility study was to identify representative corridor routes for each study corridor. Once the representative routes were established, capital costs, forecast ridership, revenues, operating costs, operating ratio, benefit-cost ratio and other comparative factors were calculated.

A high-level screening analysis was applied to the Atlanta-Chattanooga-Nashville-Louisville Corridor to identify a representative route for each technology for further evaluation. Representative routes were identified for: 1) 90-110 mph Emerging High-Speed Rail (Shared Use) on a shared-use freight corridor; 2) 180-220 mph Express High-Speed Rail (Dedicated Use) on a dedicated, fully grade-separated corridor; and 3) 220+ mph Maglev on a dedicated, fully grade-separated corridor. The screening and analysis methodology employed to identify a representative route for each operating technology consisted of four steps:

1. Identify the initial universe of route alternatives for each operating technology based on identifying those routes which provide basic connectivity for each of the major city pairs;

2. Screen the initial universe of route alternatives using both quantitative and qualitative factors to identify a representative route for each technology. Representative routes were chosen primarily based on the following quantitative and qualitative factors to deliver the highest level of service with the least public and environmental cost:
    - Route alternative geometry and travel time,
    - Route alternative freight traffic density (for Shared Use routes),
    - Stakeholder knowledge and input on route alternative issues and opportunities, and
    - Intermodal connectivity through potential stations.

   These routes contain several alignment alternatives that would be further analyzed through the NEPA process, should the corridors pass the feasibility threshold;
3. Further refine representative route alignments based upon a more detailed analysis including: service goals including travel time, station location and accessibility, operating feasibility, engineering feasibility, and cost factors; and
4. Evaluate each representative route in terms of its feasibility with regard to capital costs, forecast ridership, revenues, operating costs, operating ratio, benefit-cost ratio and other comparative factors.

CORRIDOR EVALUATION

The representative routes were identified based on a technical and stakeholder review of the corridor.

The Shared Use route follows the CSXT route, with potential stations at Hartsfield-Jackson International Airport (H-JAIA), Atlanta Multi-Modal Passenger Terminal (MMPT), Cumberland/Galleria, Marietta, Cartersville, Dalton, Lovell Airport Field, Downtown Chattanooga, Murfreesboro, Nashville International Airport, Downtown Nashville, Bowling Green, Elizabethtown, Louisville International Airport, and Downtown Louisville. The Dedicated Use route uses the same stations as Shared Use, with the exception of the Marietta station due to station location and route proximity.

The Dedicated Use/Maglev route follows I-75 from Atlanta to Chattanooga, I-24 from Chattanooga to Nashville, and I-65 from Nashville to Louisville. The Atlanta to Chattanooga segment is the same as that used in the Tier I EIS. Both the Shared Use and Dedicated Use routes use viaduct structures entering and exiting Atlanta, Chattanooga, Nashville, and Louisville.

OPERATING PLAN

Operating plans and schedules were developed for the Shared Use, Dedicated Use, and Maglev corridors. The Atlanta-Chattanooga-Nashville-Louisville Corridor Shared Use route will have an average speed of 72 mph and will take approximately

6 hours and 55 minutes to travel the corridor, 1 minute slower than auto travel time using the Interstate highway. The Dedicated Use route will have an average speed of 122 mph and will take 3 hours and 32 minutes to travel the 428-mile corridor, substantially quicker than driving. The Maglev operation will have an average speed of 143 mph and will take 3 hours and 2 minutes, 30 minutes quicker than Dedicated Use and almost 4 hours quicker than automobile travel. The frequencies were established to create a balance between ridership and operating and maintenance costs

.

Table 1: Atlanta-Chattanooga-Nashville-Louisville Operating Plans

		Shared Use	Dedicated Use	Maglev
Rail Distance (miles)		489.8	428.2	428.2
Travel Time (hr : min)		6:55	3:32	3:02
Average Speed (mph)		72	122	143
Frequency (round trips per day)	Atlanta-Chattanooga	16	28	28
	Chattanooga-Nashville	10	20	20
	Nashville-Louisville	5	12	12
Estimated Auto Time (hr : min)		6:54	6:54	6:54
Travel Time – Auto Time		+0:01	-3:22	-3:52

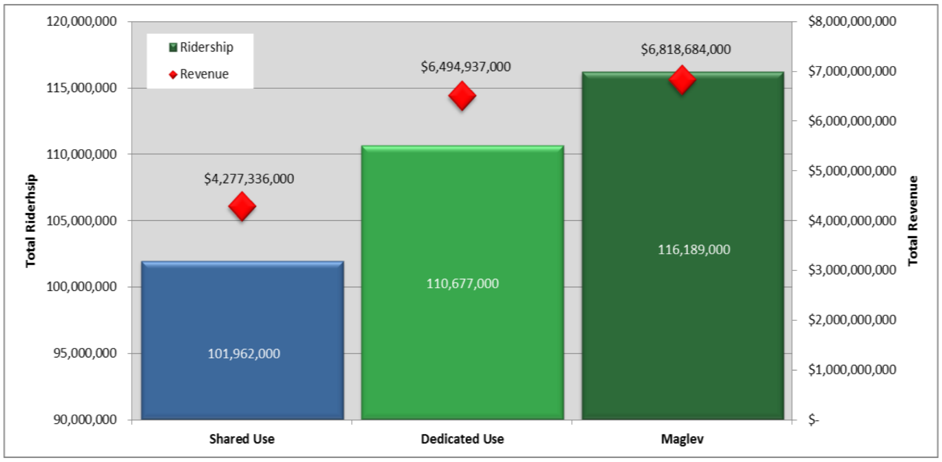
RIDERSHIP AND REVENUE

The study determined the annual ridership and revenue for the Shared Use and Dedicated Use/Maglev routes. The ridership and revenue analysis suggested that lower fare structures produce higher ridership levels, but generate lower revenues. Therefore, in order to optimize and balance ridership and revenue and overall transportation system benefits (consumer surplus) study concluded that the $0.28/mile fare structure for Shared Use and $0.40/mile for Dedicated Use / Maglev resulted in the optimum balance. Table 2 and Figure 1 illustrate ridership and revenue for years 2021, 2030 and 2040 as well as total ridership and revenue (2021-2040) for the two representative routes. The table and graph show that an increase in level of service and higher travel speeds results in an increase in both ridership and revenue for the corridor. The graph also indicates that while ridership may not increase substantially between Shared Use and Dedicated Use/Maglev technologies, the higher fare used results in a significant increase in the overall revenue.

Table 2: Atlanta-Chattanooga-Nashville-Louisville Total Ridership and Revenue (2021-2040 in 2010$)

	Shared Use		Dedicated Use		Maglev	
	Ridership	Revenue	Ridership	Revenue	Ridership	Revenue
2021	4,380,000	$175,529,000	4,715,000	$267,084,000	4,949,000	$284,385,000
2030	5,060,000	$211,849,000	5,491,000	$321,712,000	5,764,000	$337,733,000
2040	5,816,000	$252,205,000	6,353,000	$382,410,000	6,669,000	$401,454,000
Total	**101,962,000**	**$4,277,336,000**	**110,677,000**	**$6,494,937,000**	**116,189,000**	**$6,818,384,000**

Figure 1: Atlanta-Chattanooga-Nashville-Louisville Total Ridership and Revenue (2021-2040 in 2010$)



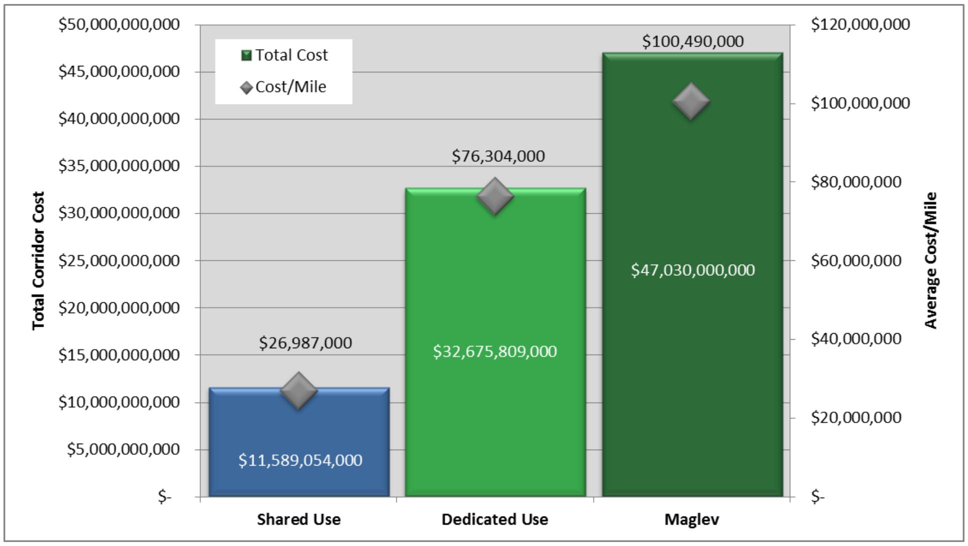
Capital Costs

The Atlanta-Chattanooga-Nashville-Louisville Corridor capital costs considered the mountainous terrain and geometry of the track and corridor. Table 3 and Figure 2 outline the total capital costs and costs per mile for Shared Use and Dedicated Use/Maglev routes. The high Dedicated Use and Maglev costs are mostly tied to the electrification of the track, comprising about 25 percent of the total capital cost and a significant portion of operating and maintenance costs as well.

Table 3: Atlanta-Chattanooga-Nashville-Louisville Total Capital Costs (2010$)

	Shared Use	Dedicated Use	Maglev
Total Cost	$11,589,054,366	$32,675,809,000	$43,030,000,000
Cost per Mile	$26,978,000	$76,304,000	$100,490,000

Figure 2: Atlanta-Chattanooga-Nashville-Louisville Total Capital Costs (2010$)



OPERATING AND MAINTENANCE COSTS

Table 4 shows a breakdown of variable and fixed costing categories used to calculate total operating and maintenance costs. Table 5 illustrates the operating and maintenance costs for 2021, 2030 and 2040 as well as total costs (2021-2040). Shared Use operating and maintenance costs equate to approximately $2.8 billion compared to the Dedicated Use estimate of $5.8 billion and Maglev estimate of $4.5 billion for the same time period.

Table 4: Fixed and Variable Operating and Maintenance Categories

Variable Costs
Train Crew
On-Board Services
Equipment Maintenance
Fuel or Energy
Insurance
Call Center
Credit Car + Travel Agency Commissions
Fixed Costs
Stations
Track and Electrification Maintenance
Administration and Management

Table 5: Atlanta-Chattanooga-Nashville-Louisville Total Operating and Maintenance Costs (2021-2040 in $ millions and 2010$)

	Shared Use			Dedicated Use			Maglev		
	Variable	Fixed	Total	Variable	Fixed	Total	Variable	Fixed	Total
2021	$88.0	$40.6	$128.6	$168.8	$101.6	$270.4	$95.1	$97.4	$192.4
2030	$91.8	$40.6	$132.4	$175.3	$101.6	$276.9	$113.8	$98.0	$211.8
2040	$96.0	$40.6	$136.6	$182.4	$101.6	$284.0	$134.7	$98.8	$233.5
Total	**$1,928**	**$852.6**	**$2,780**	**$3,681**	**$2,134**	**$5,814**	**$2,391**	**$2,059**	**$4,449**

CORRIDOR EVALUATION

High-speed rail service in the Atlanta-Chattanooga-Nashville-Louisville Corridor was evaluated by using both operating ratios and benefit-cost analyses. The study evaluated three scenarios, Conservative, Intermediate and Optimistic, to show the impact of a range of ridership, revenue, capital and operating cost estimates typically encountered in feasibility-level analysis. Unadjusted base forecasts for ridership, revenue, capital and operating costs were used for the Conservative scenario. Base ridership and revenue estimates were increased for Dedicated Use corridors to establish the Intermediate and Optimistic scenarios.[5]

Operating Ratio

The 90-110 mph Shared Use, 180-220 mph Dedicated Use and 220+ mph Maglev representative routes performed well under each of the three sensitivity scenarios, all operating above a 1.0 ratio as outlined in Table 6. It is notable that significant operating revenue surpluses are shown for all three technologies during the first year of operation in 2021 using even the most conservative ridership and revenue forecasts. The revenue surpluses then steadily increase over the 20-year planning period to 2040. This provides a strong incentive for potential private sector investors and operators.

[5] Ridership adjustments for Intermediate and Optimistic Scenarios were only made for Dedicated Use corridor 180-220 mph electrified, steel-wheel and Maglev technologies based on a peer review of regional and national high speed rail corridor studies. No scenario ridership adjustment was made for Shared Use corridor diesel-electric technology results based on a peer review of other shared-use corridor studies.

Table 6: Atlanta-Louisville Operating Ratios (2021-2040)

	Conservative	Intermediate	Optimistic
Shared Use[6]			
2021	1.49	1.49	1.49
2030	1.74	1.74	1.74
2040	2.01	2.01	2.01
Dedicated Use			
2021	1.21	1.95	2.16
2030	1.39	2.23	2.45
2040	1.62	2.40	2.58
Maglev			
2021	1.75	2.23	2.35
2030	1.91	2.38	2.49
2040	2.06	2.51	2.61

Benefit-Cost

Similar to operating ratios, the study evaluated the benefit-cost ratio for the three representative routes and all three sensitivity scenarios. The results in Table 7 show that the Shared Use does not demonstrate a benefit-cost ratio over 1.0 for any of the sensitivity scenarios; Dedicated Use shows a benefit-cost ratio near 1.0 for the Optimistic scenario; Maglev does not demonstrate a benefit-cost ratio over 1.0 for any of the sensitivity scenarios.

Table 7: Atlanta-Louisville Benefit-Cost Ratios (2021-2050)

	Conservative	Intermediate	Optimistic
Shared Use	0.71	0.78	0.85
Dedicated Use	0.40	0.78	0.96
Maglev	0.34	0.65	0.80

KEY FINDINGS

The Shared Use, Dedicated Use and Maglev alternatives perform well under the operating ratio analysis, resulting in ratios well above 1.0 for all three scenarios. This indicates strong operations with lower associated risks to owners and

[6] Shared Use operating ratios did not vary between the three sensitivity levels because the same "Conservative Scenario" base case ridership and revenue forecasts were used for each of the scenarios. No scenario ridership adjustment was made for Shared Use corridor diesel-electric technology results based on a peer review of other shared-use corridor studies.

operators. Positive operating ratios indicate an ability to pay down debt services and bonds, and can lead to reduced reliability on public investment subsidies. Additionally, operating surpluses on an annual basis may finance a "rail maintenance fund", requiring less investment in future years for capital maintenance costs. Positive operating ratios will likely spark private sector investment interest in the corridor, providing additional funding opportunities.

The benefit-cost results are not greater than one for any of the representative routes. It should be noted that this feasibility study includes very high-level data and estimates. A more detailed corridor analysis with more definitive study boundaries, travel demand models, and cost estimates, could yield a better benefit-cost evaluation narrowing the range of estimates.

Taking into account the operating ratios and benefit-cost ratios, the study recommends that the results of this analysis be used to set priorities for future state planning and corridor development activities. In particular, this study finds that high speed rail service is feasible in the Atlanta-Chattanooga-Nashville-Louisville Corridor.

The study developed an additional "Hybrid" High Performance scenario, discussed in detail below that further supports the above conclusions. This alternative has the potential to reduce initial capital costs and positively impact the benefit-cost analysis while maintaining the ability to achieve higher speeds along the corridor.

HYBRID HIGH PERFORMANCE SCENARIO

One of the results from the Shared Use and Dedicated Use analyses was the introduction of a "hybrid" alternative to offset a portion of the initial capital costs (compared to the Dedicated Use) while improving the travel speeds (compared to the Shared Use), thus positively impacting the operating ratio and benefit-cost analysis. While some analyses were completed for the Hybrid High Performance scenario, there was insufficient data available for a full analysis to be completed. Therefore, more performance and financial details regarding the Hybrid High Performance scenario will need to be explored through the NEPA process. This feasibility study intends to introduce the concept of the Hybrid High Performance scenario and provide a high-level feasibility estimates based on the results found during the Shared Use and Dedicated Use analyses. These estimates include:

- Operational estimates;
- Ridership and revenue;
- Capital Costs; and
- Operating and Maintenance Costs.

From these estimates, the study calculates the high-level operating ratio and Benefit-Cost ratio to compare against the previously identified Shared Use and

Dedicated Use ratios to determine if the Hybrid High Performance scenario should be included in a future NEPA analysis.

The study developed a Hybrid High Performance scenario that provides a level of service between Shared Use and Dedicated Use, utilizing fully grade-separated track geometry with no shared-use freight operations. However, rather than electrified high-speed technology, the Hybrid High Performance scenario would implement Diesel-Electric Tilt Technology initially, and when ridership and revenue increase in later operating years, it can be upgraded to a fully-electrified system, obtaining travel speeds of 220 mph or more.

One of the main benefits of the Hybrid High Performance scenario includes significantly lower capital costs compared to the 180-220 mph electrified technology assumed for the Dedicated Use route. However, the Hybrid High Performance scenario still has the potential to reach speeds of up to 130 mph. The study estimated that the Hybrid High Performance scenario would only take approximately 1 hour, 29 minutes longer than the electrified train on the Dedicated Use route. The 130 mph Hybrid High Performance scenario is approximately 1 hour, 52 minutes faster than auto travel by interstate from Atlanta to Louisville (Table 8).

Table 8: Atlanta-Chattanooga-Nashville-Louisville Hybrid High Performance Operations

		Hybrid High Performance	Dedicated Use	Maglev
Rail Distance (miles)		428.2	428.2	428.2
Travel Time (hr : min)		5:02	3:32	3:02
Average Speed (mph)		85 mph	122	143
Frequency (round trips per day)	Atlanta-Chattanooga	16	28	28
	Chattanooga-Nashville	10	20	20
	Nashville-Louisville	5	12	12
Estimated Auto Time (hr : min)		6:54	6:54	6:54
Travel Time – Auto Time		-1:52	-3:22	-3:52

Ridership and Revenue

The study estimated based on the decrease in average speed and increase in corridor travel time, the revenue for the Hybrid High Performance scenario ridership and revenue would decrease 16.04 percent from the Dedicated Use forecasts (refer to Appendix G). Table 9 shows the estimated ridership and revenue for the Hybrid High Performance scenario for 2021, 2030, and 2040 as well as a total ridership and revenue (2021-2040) as compared to Dedicated Use forecasts.

Table 9: Atlanta-Chattanooga-Nashville-Louisville Hybrid High Performance Ridership and Revenue (2021-2040 in 2010$)

	Hybrid High Performance		Dedicated Use		Maglev	
	Ridership	Revenue	Ridership	Revenue	Ridership	Revenue
2021	4,126,000	$224,244,000	4,715,000	$267,084,000	4,949,000	$283,385,000
2030	4,804,000	$270,109,000	5,491,000	$321,712,000	5,764,000	$337,733,000
2040	5,559,000	$321,071,000	6,353,000	$382,410,000	6,669,000	$401,454,000
Total	**92,925,000**	**$5,453,149,000**	**110,677,000**	**$6,494,937,000**	**116,189,000**	**$6,818,384,000**

Costs

As previously mentioned, the capital costs for the Hybrid High Performance scenario will be significantly less than the Dedicated Use route due to the elimination of the track electrification. This also results in decreased in vehicle cost since diesel vehicles are also less expensive than fully electrified vehicles.

Table 10 outlines the Hybrid High Performance scenario capital cost estimates compared to the Dedicated Use/Maglev routes. Capital costs for the 130 mph Hybrid High Performance scenario are half of those for the 180-220 mph electrified steel-wheel technology and nearly one-third (1/3) of Maglev.

Table 10: Atlanta-Chattanooga-Nashville-Louisville Hybrid High Performance Capital Costs (2010$)

	Hybrid High Performance	Dedicated Use	Maglev
Total Cost	$16,428,173,000	$32,675,809,000	$43,030,000,000
Cost per Mile	$38,366,000	$76,304,000	$100,490,000

Operating and maintenance costs for the Hybrid High Performance scenario will also be reduced from the Dedicated Use estimates due to less required track inspection and maintenance because heavy freight trains will not be sharing the track. Table 11 illustrates the estimates the Hybrid High Performance scenario operating and maintenance costs for 2020, 2030 and 2040 as well as total operating and maintenance costs (2020-2040) compared to the Dedicated Use and Maglev routes.

Table 11: Atlanta-Chattanooga-Nashville-Louisville Hybrid High Performance Scenario Operating and Maintenance Costs (2021-2040 in $ millions and 2010$)

	Hybrid High Performance			Dedicated Use			Maglev		
	Variable	Fixed	Total	Variable	Fixed	Total	Variable	Fixed	Total
2021	$183.8	$69.3	$253.1	$168.8	$101.6	$270.4	$95.1	$97.4	$192.4
2030	$189.2	$69.3	$258.5	$175.3	$101.6	$276.9	$113.8	$98.0	$211.8
2040	$195.2	$69.3	264.5	$182.4	$101.6	$284.0	$134.7	$98.8	$233.5
Total	**$3,973**	**$1,455**	**$5,429**	**$3,681**	**$2,134**	**$5,814**	**$2,391**	**$2,059**	**$4,449**

Feasibility Evaluation

Similar to the Shared Use, Dedicated Use, and Maglev routes, the study conducted an operating ratio and benefit-cost ratio for the Hybrid Performance alternative. Table 12 and Table 13 illustrate the results of these analyses for the three sensitivity scenarios: Conservative, Intermediate and Optimistic as compared to the Dedicated Use and Maglev routes.

Table 12: Atlanta-Chattanooga-Nashville-Louisville Hybrid High Performance Scenario Operating Ratios (2021-2040)

	Conservative	Intermediate	Optimistic
Hybrid High Performance			
2021	1.03	1.66	1.86
2030	1.21	1.93	2.16
2040	1.41	2.22	2.46
Dedicated Use			
2021	1.21	1.96	2.16
2030	1.39	2.23	2.45
2040	1.62	2.40	2.58
Maglev			
2021	1.75	2.23	2.35
2030	1.91	2.38	2.49
2040	2.06	2.51	2.61

Table 13: Atlanta-Chattanooga-Nashville-Louisville Hybrid High Performance Scenario Benefit-Cost Ratio (2021-2050)

	Conservative	Intermediate	Optimistic
Hybrid High Performance	0.59	1.16	1.43
Dedicated Use	0.40	0.78	0.96
Maglev	0.34	0.65	0.80

Initial investigation into the Hybrid High Performance scenario indicates that an incremental approach to high-speed rail may provide significant advantages in the Atlanta-Chattanooga-Nashville-Louisville Corridor both in terms of reducing initial capital cost requirement and increasing benefit-cost ratios.

The study used high-level estimations for revenue and costs associated with the Hybrid High Performance scenario. Therefore, a more detailed analysis of this alternative is needed to make definitive conclusions regarding the feasibility of the Hybrid High Performance scenario. The study recommends that the Hybrid High Performance scenario be included in the next phase of the passenger rail planning analysis as a viable technology alternative for passenger rail within the Atlanta-Chattanooga-Nashville-Louisville Corridor.

FINAL OBSERVATIONS

High-speed rail service in the Atlanta-Chattanooga-Nashville-Louisville Corridor presents an opportunity to provide needed transportation solutions and promote economic development. While high-speed rail is not the only transportation solution, this study gives evidence that passenger high-speed rail will provide added mobility and transportation choices to consumers. High-speed rail can provide more efficient and cost-effective means to consumers, providing added connectivity to major cities such as Atlanta, Chattanooga, Nashville and Louisville through commercial centers and national/international destinations.

This study illustrates that although the initial investment in high-speed rail is significant, the mobility and economic opportunities offered by this new mode are also significant. Based on the analysis findings, this study determines that high-speed rail is feasible in the Atlanta-Chattanooga-Nashville-Louisville Corridor. It is further recommended that a Tier 1 NEPA Document and Service Development Plan be pursued for high-speed rail service within the corridor, while also noting the findings outlined in the current Tier 1 EIS documentation for the Atlanta-Chattanooga Corridor. This analysis should continue to address a range of technology alternatives including the Hybrid High Performance implementation approach.