CHAPTER 6 COMPARISONS OF ALTERNATIVES

6.0 Introduction

This chapter presents the potential comparative benefits and impacts of the alternatives examined in the Tier I Draft Environmental Impact Statement (EIS). The purpose of this chapter is to summarize the salient facts related to each alternative so that the benefits, costs and environmental impacts can be evaluated against the goals and objectives of the project as identified in Chapter 1, Purpose and Need. The summary will facilitate the decision-making process by highlighting the prominent facts and trade-offs of each alternative. This summary will also aid in selecting an alternative for further evaluation and in communicating the issues to the public and elected officials.

This chapter is divided into five sections. The first section briefly describes the methodology and approach to the evaluation of the alternatives by defining terms, summarizing objectives and identifying trade-offs. The second section reviews the purpose and need statement and presents the measures of effectiveness to be applied to each objective. The third section addresses effectiveness and other measures of project feasibility through comparative analysis of the Build alternatives against the Status Quo and No Action alternatives. The fourth section provides a comparative evaluation of the Build alternatives in terms of financial feasibility. The fifth section discusses the preferred alternative decision-making process.

6.1 Methodology

The approach to the evaluation of alternatives developed for the Richmond/Hampton Roads Passenger Rail Project addresses both local goals and objectives and the need for compatibility with the SEHSR project. This chapter draws from the regulatory guidance and technical data provided in the previous chapters of this Tier I Draft EIS in order to develop the findings presented in this chapter. Each alternative was rated on its ability to meet the project's goals and objectives as stated in Chapter 1, Purpose and Need. A detailed description of each alternative is provided in Chapter 2, Alternatives Considered.

Both quantitative and qualitative criteria are used to evaluate each alternative's ability to meet the project goals. The evaluation is based on the findings of this Tier I Draft EIS as described in Chapter 3 of this document. Table 6-1 shows the qualitative rating system used to evaluate how well the alternatives meet the project goals and objectives.

Table 6-1: Rating Symbols

Symbol	Rating
++	Strongly supports goal or objective
+	Supports goal or objective
O	No impacts relative to goal or objective
-	Does not support goal or objective due to minor negative impacts
- -	Does not support goal or objective due to severe impacts

6.2 Summary of Project Goals and Objectives

The project goals and objectives were developed based on the transportation needs described in Chapter 1. Table 6-2 Project Goals and Objectives lists the goals and objectives used for this comparison of alternatives.

Table 6-2: Project Goals and Objectives

Goals		Objectives
1	Regional Linkage	Improve trip reliability
		Reduce trip time
		Compatibility with Southeast High-Speed Rail
		Compatibility with Northeast Corridor
2	Limit Growth of Highway Congestion	Total rail passengers
		ADT volumes
		Congestion relief
3	Safety	Grade crossing protection
		Right-of-way
		Hurricane evacuation
4	Cost Effectiveness	Maximize system value by balancing costs and benefits
		Cost per passenger
5	Minimize Environmental Impacts	Meet air quality standards
		Avoid, minimize and mitigate impacts to: • Wetlands • Floodplains • Wildlife habitats
		Minimize operating noise
		Avoid, minimize and mitigate impacts to: • Sensitive land uses • Historic properties • Open spaces

6.3 Comparison of Alternatives

All of the project's alternatives are compared in this section, including the Status Quo alternative, the No Action alternative, and the three Build alternatives, 1, 2a, and 2b. As described in Chapter 2, the Status Quo Alternative would not provide any additional passenger rail service along the Peninsula/CSXT route or any passenger service on the Southside/NS route. The No Action alternative would provide one additional round-trip (a total of three round-trip trains) to the existing Amtrak passenger rail service that operates on the Peninsula/CSXT route. The additional trip would operate at conventional speed. Each of the Build alternatives would share a common right-of-way between Washington, DC and Richmond. Alternatives 1 and 2a would have trains operating south to Petersburg where the line would diverge east to Norfolk using the Southside/NS route. Alternatives 1, 2a and 2b would have trains operating on the Peninsula/CSXT route.

The differences between Alternatives 1 and 2a are the maximum authorized speed (MAS) options and the number of trains operating on either the Peninsula/CSXT route or Southside/NS route. Alternative 1 would have three daily round-trip trains operating at 79 mph MAS on the Peninsula/CSXT route while six daily round-trip trains would operate on the Southside/NS route at the higher speed. Alternative 2a would invert the operating plan so that six daily round-trip trains would operate at higher speeds along the Peninsula/CSXT route while three daily round-trip trains would operate at 79 mph MAS on the Southside/NS route.

Each of the three Build alternatives is also compared under 90 mph and 110 mph MAS options. The actual operating speed of trains under these options would vary depending on operating conditions.

The general effectiveness of the alternatives under consideration is measured in terms of their ability to achieve the stated goals and objectives of the project. These measures address the goal categories of regional mobility and linkages, highway congestion, safety, cost-effectiveness and environmental impacts. This section summarizes the results of the evaluation of the alternatives under study.

6.3.1 Regional Linkage

The regional linkage goal is intended to improve transportation choices and mobility in the corridor to provide a more balanced transportation system when combined with planned and programmed rail and highway improvements. Four objectives for this goal were identified, (although the last two are discussed together in this section):

- Increase frequency of passenger rail service.
- Improve trip reliability.
- Reduce trip time.
- Integrate compatible passenger rail services with the proposed Southeast High-Speed Rail (SEHSR) project.
- Integrate compatible passenger rail services with the Northeast Corridor (NEC).

Under the Status Quo and No Action alternatives, there would be little change in mobility options. The existing transportation system would continue to be congested and travelers would still be dependent on highway and air travel for long distance trips.

The implementation of one of the Build alternatives (1, 2a, or 2b) would alter travel behavior by providing more frequent train service from the Hampton Roads region to Richmond and other parts of the country served by Amtrak. Alternatives 1 and 2a would provide direct access to the Southside of the James River and serve more communities with direct passenger rail service. Passenger service is provided to both the Peninsula and Southside in these alternatives with a total of nine round-trip trains. Alternative 2b would serve only the Peninsula and would provide nine round-trip trains daily instead of the planned three and current two round-trip trains under the Status Quo and No Action alternatives.

The measures used to evaluate how each of the alternatives improves mobility and regional linkages and the results of the analysis are summarized in the following paragraphs.

6.3.1.1 Improve Trip Reliability

The ability of passenger rail service to maintain reliable and dependable on-time performance is impaired when passenger trains must share the right-of-way with mixed passenger and freight rail traffic and compete for congested track space.

The Status Quo alternative provides no capacity improvements. The No Action alternative proposes only minor capacity improvements on the Peninsula/CSXT route. The Build alternatives propose major capacity improvements along the routes that would be served by each alternative.

A measure of reliability is the percentage of trains operating on-time. When coupled with the major improvements being made in the SEHSR corridor, noticeable improvements to on-time performance should be achieved and have been accounted for in the ridership forecasts produced for this Tier I Draft EIS. Table 6-3 illustrates existing and forecasted on-time performance. As shown in the table, higher speed service would yield 90 percent on-time performance along the Peninsula/CSXT route in Alternatives 2a and 2b, and along the Southside/NS route in Alternative 1. Conventional speed service on the Peninsula/CSXT route in Alternative 1 and along the Southside/NS route in Alternative 2a would yield 72 percent on-time performance. The average on-time performance of the alternatives was determined by combining the performance percentages along both routes. Alternatives 1 and 2a would each yield an average on-time performance rate of 84 percent, which would be greater than the 70 and 72 percent rates expected by the Status Quo and No Action Alternatives, respectively. The higher speed trains on the Peninsula/CSXT route in Alternative 2b would yield a 90 percent average on-time performance rate, which is the highest on-time performance rate of any of the alternatives considered.

Table 6-3: Forecasted On-Time Performance (by Alternative and MAS)

On-time Performance % (Year 2025)	Status Quo 79 mph MAS	No Action 79 mph MAS	Alternative 1		Alternative 2a		Alternative 2b	
			90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS
Peninsula/CSXT route	70%	72%	72%*	72%*	90%	90%	90%	90%
Southside/NS route	No train	No train	90%	90%	72%*	72%*	No train	No train
Total Average On-time performance	70%	72%	84%	84%	84%	84%	90%	90%

* Conventional speed trains with a maximum authorized speed (MAS) of 79 mph.

Amtrak short-distance trains currently operate at approximately 69.7 percent on-time[51]. The major causes of Amtrak delays are host railroad freight train interference or slow orders. Future increases in freight volumes, particularly along the Southside/NS route in connection with NS's Heartland Corridor project, have the potential to adversely impact passenger train operations and on-time performance rates along that route in Alternatives 1 and 2a. More trains occupying tracks on the route can potentially affect train travel speeds and block train movements. Major investments proposed in the Build alternatives would include implementing strategies, such as sidings and operational controls, to enable trains to operate safely and reduce interference. These types of strategies are commonly applied along combined passenger and freight train routes and should alleviate many of the conflicts associated with mixed-traffic operations. The track improvements will mitigate slow orders, especially on the Peninsula/CSXT route. Alternative 2b, with nine daily higher speed round-trip trains operating on the Peninsula/CSXT route, has the best average on-time performance.

6.3.1.2 Reduce Trip Time

The impact on travel time between origins and destinations in the Richmond/Hampton Roads study area was evaluated using several representative trips from within the study area to Charlotte, New York, Richmond and Washington, DC. A more detailed discussion on travel time can be found in Chapter 3.1 Transportation Impacts. The table below examines travel time savings between Newport News and Richmond on the Peninsula/CSXT route and between Norfolk and Richmond on the Southside/NS route.

The comparisons are between automobile and rail trips at the varying maximum authorized speeds for the Build alternatives. Selected rail origins include terminal stations on each route in the corridor. The terminal stations on the Peninsula/CSXT route include either the existing Newport News Amtrak Station for Alternative 1 or the proposed Downtown Newport News Station for Alternatives 2a or 2b. The terminal station on the Southside/NS route is the proposed Downtown Norfolk station. Table 6-4 illustrates travel times throughout the corridor.

Table 6-4: Travel Times by Alternative, Route and MAS in hours and minutes (x:xx)

Travel Time (Year 2025)	Status Quo 79 mph MAS	No Action 79 mph MAS	Alternative 1		Alternative 2a		Alternative 2b	
			90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS
Newport News/Richmond Automobile	2:02	2:02	2:02	2:02	2:02	2:02	2:02	2:02
Newport News/Richmond Peninsula/CSXT Rail	1:25	1:10	1:10*	1:10*	1:03	0:57	1:03	0:57
Travel time savings	0:37	0:52	0:52	0:52	0:59	1:05	0:59	1:05
Norfolk/Richmond Automobile	2:28	2:28	2:28	2:28	2:28	2:28	2:28	2:28
Norfolk/Richmond Southside/NS Rail	No train	No train	1:35	1:27	1:38*	1:38*	No train	No train
Travel time savings	No train	No train	0:53	1:01	0:50	0:50	No train	No train

* Conventional speed trains with a maximum authorized speed (MAS) of 79 mph.

[51] Amtrak, *Monthly Performance Report*, Washington, DC; April, 2008.

On average, due to increasing congestion on the highway network between Hampton Roads and Richmond, an investment in passenger trains will yield travel time savings ranging between 37 minutes and 65 minutes (1:05) when compared to driving a car, depending on the route selected and maximum authorized speed (MAS) option. The most time saved (1:05) is through Alternative 2b, which is the 110 mph MAS option operating on the Peninsula/CSXT route.

6.3.1.3 Compatibility with Southeast High-Speed Rail and Northeast Corridor

The Richmond/Hampton Roads Passenger Rail Project is considered to be an extension of the SEHSR corridor under federal legislation that designates U.S. high-speed rail corridors. Although this project has independent utility from the SEHSR project (which is still in the final stages of the study process), it was assumed that the SEHSR project would be in full operation prior to completion of this project. Therefore, the operational plan developed for this Tier I Draft EIS reasonably includes the operation of the SEHSR service between Washington, DC and Charlotte, NC. Passengers from Hampton Roads wishing to travel south on SEHSR trains can transfer either at Richmond Main Street Station or Petersburg depending on which alternative is selected. Passengers traveling to Washington, DC would not have to transfer as the Hampton Roads trains are through-routed to Union Station in Washington, DC. Travelers going north to Baltimore, Philadelphia, New York and Boston would transfer at Union Station for trips on the Northeast Corridor (NEC). Table 6-5 illustrates the evaluation of compatibility with SEHSR and NEC services.

Table 6-5: Qualitative Assessment of Compatibility with SEHSR and NEC (by Alternative and MAS)

Compatibility with SEHSR and NEC	Status Quo 79 mph MAS	No Action 79 mph MAS	Alternative 1		Alternative 2a		Alternative 2b	
			90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS
Peninsula/CSXT route	O	O	+*	+*	++	++	++	++
Southside/NS route	No train	No train	++	++	+*	+*	No train	No train
Overall rating	O	O	++	++	++	++	++	++

++ Strongly supports project goal or objective
+ Supports project goal or objective
O No impacts relative to project goal or objective.
- Does not support project goal or objective due to minor negative impacts.
- - Does not support project goal or objective due to severe impacts.
* Conventional speed trains with a maximum authorized speed (MAS) of 79 mph.

All of the alternatives support the SEHSR and NEC services. The potential higher speed and greater frequencies of Alternatives 1, 2a and 2b support the SEHSR and NEC services more than the conventional speed and lower frequency services in the Status Quo and No Action alternatives.

6.3.2 Highway Congestion

Regional and corridor impacts on congestion are measured through changes in vehicle miles traveled (VMT) and average daily traffic (ADT) volumes. The Status Quo alternative and the No Action alternative highway network are the baseline for all evaluations of the impacts of the Build alternatives. ADT volumes were identified using the Virginia Department of Transportation (VDOT) Average Daily Traffic Volumes publication for 2004. According to the license plate survey conducted as part of the Tier I Draft EIS, the average vehicle occupancy along SR-460 and I-64 was 1.75 across all trip purposes. Based on this information, it would require 1,750 train passengers to remove 1,000 cars from the congested highway network.

The investment in passenger rail service between Richmond and Hampton Roads will decrease rail travel times, improve on-time performance of trains and provide a viable alternative to the automobile for travel in the corridor. The travel time savings between automobile and rail trips is substantial. Increased frequency of service will make passenger rail service more convenient. With increases in population and employment throughout the region, travel on the local highways will become more burdensome, making travel by train more attractive. Consequently, ridership should grow substantially over the Status Quo and No Action alternatives. Table 6-6 again illustrates the projected ridership levels with the Status Quo, No Action and Build alternatives assuming that the SEHSR service is operating.

Table 6-6: Estimated Range of Probable Passenger Rail Ridership (by Alternative, Route and MAS in the Year 2025)

Category	Status Quo 79 mph MAS	No Action 79 mph MAS	Alternative 1		Alternative 2a		Alternative 2b	
			90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS
Peninsula/CSXT high	262,300	464,800	223,400*	222,300*	914,600	968,400	1,101,100	1,147,000
Peninsula/CSXT low	245,500	425,700	212,500*	211,200*	732,200	768,000	897,800	937,000
Southside/NS high	No train	No train	886,700	939,900	209,700*	193,000*	No train	No train
Southside/NS low	No train	No train	727,100	773,000	192,500*	187,000*	No train	No train
Total High	262,300	464,800	1,110,100	1,162,200	1,124,300	1,161,400	1,101,100	1,147,000
Total Low	245,500	425,700	939,600	984,200	924,700	955,000	897,800	937,000
Difference from 79 mph MAS Status Quo Alternative								
High		202,500	847,800	899,900	862,000	899,100	838,800	884,700
Low		180,200	694,100	738,700	679,200	709,500	652,300	691,500
Difference from 79 mph MAS No Action Alternative								
High			645,300	697,400	659,500	696,600	636,300	682,200
Low			513,900	558,500	499,000	529,300	472,100	511,300

* Conventional speed trains with 79 mph maximum authorized speed (MAS).
Source: *Travel Demand Methodology and Results,* as revised March 2008.

The forecast results reflect changes in service frequencies, improved connections, population, and employment growth over the planning time horizon, improved on-time performance (OTP), and highly competitive rail travel times when compared to highway travel times. The substantial increase in ridership forecast for the No Action alternative when compared to the Status Quo alternative reflects the addition of one train between Richmond and Newport News and improved service resulting from proposed SEHSR service. SEHSR trains would serve the Richmond Main Street Station, providing faster, more frequent service to the major markets in the Northeast and Southeast, including Washington, DC, New York, Boston, Raleigh, and Charlotte.

Amtrak provided actual 2007 ridership and revenue data for all direct service to/from Hampton Roads and for trips between Hampton Roads and North Carolina (which require a transfer in Richmond). In 2007, approximately 160,000 rail passengers traveled to/from the Hampton Roads stations of Williamsburg and Newport News; this includes direct trips to other locations in Virginia, destinations in the Northeast Corridor, and transfers to destinations in North Carolina. At existing levels of passenger rail service, approximately 91,418 automobile trips are removed from Virginia's highways annually, or approximately 250 car trips per day primarily along I-64.

The alternatives with the highest total ridership are Alternatives 1 and 2a, which have trains operating at varying speeds serving both the Peninsula/CSXT and Southside/NS routes. The optimistic forecast for Alternative 1 has the highest ridership forecast of 1,162,000 annual riders. This would take 664,000 automobile trips off the highway network annually and is equal to approximately 1,820 automobile trips daily.

According to the VDOT *Average Daily Traffic Volumes 2004* publication, I-64 carried approximately 126,000 vehicles per day across the Hampton/Newport News city limit in 2004. This volume is expected to increase to approximately 140,000 vehicles per day by 2025. Passenger rail will divert 1.3 percent of total ADT in 2025, which is an amount larger than the expected ADT annual growth rate of 0.5 percent. Table 6-7 shows the effects of the alternatives on highway congestion qualitatively. More quantitative analysis regarding traffic congestion, mode share and other localized transportation impacts would be conducted as part of subsequent analysis during the Tier II studies.

Table 6-7: Qualitative Assessment of Effects on Highway Congestion by Alternative, Route and MAS

Limit Highway Congestion	Status Quo 79 mph* MAS	No Action 79 mph* MAS	Alternative 1		Alternative 2a		Alternative 2b	
			90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS
Peninsula/CSXT route	-	-	O*	O*	+	+	+	+
Southside/NS route	No train	No train	+	+	O*	O*	No train	No train
Overall rating	-	-	+	+	+	+	+	+

++ Strongly supports project goal or objective
+ Supports project goal or objective
O No impacts relative to project goal or objective.
- Does not support project goal or objective due to minor negative impacts.
- - Does not support project goal or objective due to severe impacts.
* Conventional speed trains with 79 mph maximum authorized speed (MAS).

Expanded and higher speed passenger rail will not dramatically impact highway congestion. The increased cost of automobile usage due to the higher prices of fuel has already begun to lower automobile travel throughout the country. The existence of more frequent and reliable passenger rail service provides people with an alternative to continued use of highway travel. Consequently, the Build alternatives with higher speeds and improved frequency of service provide greater travel benefits than the Status Quo or No Action alternatives.

Mode choice was not evaluated as part of this Tier I Draft EIS. More detailed mode share analysis would be conducted as part of subsequent analysis.

6.3.3 Safety

Both the existing, conventional speed passenger rail and freight rail operations (up to 79 mph, maximum authorized speed (MAS) along the Peninsula/CSXT route and the Southside/NS route cross highways at-grade. Current safety measures at public crossings include flashers, flashers and gates, and crossbucks. Private crossings are currently not protected. The total numbers of private and public grade crossings inventoried are listed in Table 6-8.

Table 6-8: Total Number of Grade Crossings by Route

Total Number of Grade Crossings by Route	Number of Public Crossings	Number of Private Crossings	Total Crossings
Peninsula/CSXT route	22	28	50
Southside/NS route	46	28	74
Total	68	56	124

As described in Section 3.3 of this Tier I Draft EIS, the FRA regulations prescribe safety measures for roadway at-grade crossings that are based on rail MAS. The regulations range from protecting at-grade crossings with some combination of flashers, gates and/or crossbucks as indicated for conventional speeds, to the consolidation and closure of at-grade crossings and the provision of barriers and grade separation for higher speed operations.

For existing speeds up to 79 mph, safety measures at public and private crossings are as described above for the existing condition. Thus, for the Status Quo and No Action alternatives, the number of at-grade crossings along the Peninsula/CSXT route and Southside/NS route would likely remain the same.

For speeds up to 90 mph MAS, consolidation and closure of some crossings would be considered along the Southside/NS route in Alternatives 1 and 2a. Approximately 17 percent of the public crossings and approximately 42 percent of private crossings potentially would be grade separated or closed on the Southside/NS route. DRPT estimates that none of the existing at-grade crossings potentially would be closed on the Peninsula/CSXT route.

For speeds up to 110 mph, consolidation and closure of some crossings would be considered along the Peninsula/CSXT route and the Southside/NS route in Alternatives 1 and 2a. DRPT estimates that approximately 40 percent of the public crossings and approximately 25 percent of private crossings potentially would be closed on the Peninsula/CSXT route. In addition, approximately 45 percent of the public crossings and approximately 71 percent of private crossings potentially would be grade separated or closed on the Southside/NS route.

Table 6-9 summarizes the potential number of at-grade crossings that may remain after implementing each alternative and MAS. This data indicates that the highest potential number of grade crossing closures would occur by implementing the Southside/NS route component of Alternative 1, particularly at 110 mph MAS. Grade crossing closures along the Peninsula/CSXT route would likely occur only with the 110 mph MAS in Alternatives 2a or 2b route

Table 6-9: Number of Grade Crossings by Alternative, Route and MAS

Total Grade Crossings (public and private)	Status Quo 79 mph MAS	No Action 79 mph MAS	Alternative 1		Alternative 2a		Alternative 2b	
			90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS
Peninsula/CSXT route	50	50	50*	50*	50	28	50	28
Southside/NS route[1]	74**	74**	54	33	74*	74*	74**	74**
Total	124	124	104	83	124	102	124	102

[1] For purposes of comparison, no distinction between freight and passenger trains was made.
* Conventional speed trains with 79 mph maximum authorized speed (MAS).
** No passenger service.

In all alternatives, the safety needs of each at-grade crossing location would be considered. Crossings that would remain open would be provided with safety features in accord with the FRA and FHWA regulations. Specifically, remaining at-grade crossings may be protected by new or improved devices such as four-quadrant gates, barriers that have longer gate arms, median barriers and warning lights and bells activated by approaching trains. These measures have been implemented in numerous states to treat the different types of grade crossings across a specific route.

The elimination of grade crossings to achieve higher speed passenger rail service may require mitigation measures to avoid potential negative impacts on localized traffic congestion and emergency response time as well as access and egress to businesses and residences. Decisions as to closure and appropriate protective measures at grade crossings would be made with input from the community along each selected route during subsequent analysis.

6.3.4 Cost Effectiveness

Cost effectiveness describes the extent to which an alternative is projected to achieve expected results at a lower cost when compared with other alternatives. An assessment of cost effectiveness evaluates the benefits arising from the activities of the project to determine if these benefits could be produced at a lower cost when compared to other alternatives. In this Tier I Draft EIS assessment, cost effectiveness was measured by examining ridership as a measure of benefit. Annualized capital costs and annual operating and maintenance costs are summed and then divided by annualized ridership.

6.3.4.1 Maximize System Value

The benefits associated with an investment in higher speed passenger rail projects include direct and indirect benefits to users of the passenger rail services, to non-users and to the general public. Direct benefits to users of the passenger rail service flow from travel time savings and can be directly measured by the value of their time saved. This benefit also can be measured by fare revenue because it is a direct measure of the value that passengers assign to the service. Thus, the terms revenue and benefit are considered equivalent in this assessment.

Table 6-10 shows the approximate revenue that would be potentially generated by each alternative. High and low revenue estimates correlate to the modeled high and low travel demand estimates. Revenue is shown for each route in the table and then totals reflecting the combination of routes are provided at the bottom of the table for each alternative and MAS.

The revenue data in the table indicates that each of the Build alternatives would generate substantially more revenue than either the Status Quo alternative or the No Action alternative and, consequently, higher levels of direct and commensurate indirect benefits. Alternative 1 at the 110 mph MAS option would provide the highest level of revenue and benefit of all of the Build alternatives. Alternatives 2a and 2b would provide slightly less benefit and revenue compared to Alternative 1.

Table 6-10: Revenue Generated by Alternative, Route and MAS

Revenue Range by Route and Total (Millions 2008 $)	Status Quo 79 mph MAS	No Action 79 mph MAS	Alternative 1		Alternative 2a		Alternative 2b	
			90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS
Peninsula/CSXT route high	$15.95	$28.07	$11.31*	$11.23*	$59.27	$62.17	$68.01	$70.51
Peninsula/CSXT route low	$14.49	$24.95	$10.52*	$10.41*	$46.60	$48.55	$54.02	$56.08
Southside/NS route high	No train	No train	$57.81	$60.89	$9.89*	$9.05*	No train	No train
Southside/NS route low	No train	No train	$45.98	$48.57	$8.84*	$8.59*	No train	No train
Total High	$15.95	$28.07	$69.12	$72.12	$69.16	$71.23	$68.01	$70.51
Total Low	$14.49	$24.95	$56.50	$58.98	$55.44	$57.14	$54.02	$56.08

* Conventional speed trains with 79 mph maximum authorized speed (MAS).

6.3.4.2 Cost Efficiency (Fare Recovery)

Cost efficiency describes the extent to which an alternative has economically converted the minimum amount of resources/inputs (such as fare box revenue) into achieving the maximum possible outputs and outcomes. In other words, how much will it cost to operate the service and will the cost of the passenger rail service be covered by passenger fares? Cost efficiency can be measured by examining whether or not an alternative covers its operating costs by fare box revenue either as an operating ratio or by total surplus or deficit. Table 6-11 shows the fare box revenue, operating and maintenance (O&M) costs and surplus or deficit, which would require a subsidy. The revenue ranges between high and low depending on the optimistic or conservative ridership and revenue forecasts outlined in Chapters 3.1 and Chapter 4 respectively.

Table 6-11: Fare Recovery (Operating Surplus or Deficit)

Category	Status Quo 79 mph MAS	No Action 79 mph MAS	Alternative 1		Alternative 2a		Alternative 2b	
			90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS
Revenue Forecast Range and O&M Costs by Alternative (Millions 2008 $)								
Revenue High	$15.95	$28.07	$69.12	$72.12	$69.16	$71.23	$68.01	$70.51
Revenue Low	$14.49	$24.95	$56.50	$58.98	$55.44	$57.14	$54.02	$56.08
Total O&M Costs	$16.9	$21.3	$80.0	$81.4	$77.9	$79.4	$71.7	$72.4
Operating Surplus (Deficits) by Route and Total (Millions 2008 $)								
Peninsula/CSXT route high	($0.95)	$6.77	($9.99)*	($10.07)*	$5.87	$7.27	($3.69)	($1.89)
Peninsula/CSXT route low	($2.41)	$3.65	($10.78)*	($10.89)*	($6.80)	($6.35)	($17.68)	($16.32)
Southside/NS route high	No train	No train	($0.89)	$0.79	($14.61)*	($15.45)*	No train	No train
Southside/NS route low	No train	No train	($12.72)	($11.53)	($15.66)*	($15.91)*	No train	No train
Total Surplus (Deficit) High	($0.95)	$6.77	($10.88)	($9.28)	($8.74)	($8.17)	($3.69)	($1.89)
Total Surplus (Deficit) Low	($2.41)	$3.65	($23.50)	($22.42)	($22.46)	($22.26)	($17.68)	($16.32)

* Conventional speed trains with 79 mph maximum authorized speed (MAS).

Revenue exceeds operating costs for the No Action alternative (surplus) under all travel demand assumptions, which includes three round-trip conventional speed (79 mph MAS) trains and connections to SEHSR and NEC trains. Operating costs exceed revenue (deficit) for all Build Alternatives except for the three round-trip 90-110 mph MAS trains operating on the Peninsula/CSXT route in Alternative 2a. Alternative 2a generates an operating surplus despite higher speed service operating on the Southside/NS route for the optimistic travel demand forecast, which is depicted as the high revenue value. The higher speed 110 mph MAS train operating on the Southside/NS route in Alternative 2a is the only Southside/NS service that generates a small annual surplus. All other Southside/NS trains generate deficits ranging from a low of $0.89 million to $15.91 million annually.

Another useful criterion used to assess cost effectiveness is an index that measures the cost per passenger attracted to passenger rail. This approach allows the comparison of the alternatives based on data such as estimated capital, operating and maintenance costs and forecasts of passenger boardings.

The cost effectiveness index (CEI) is calculated as the annualized change in capital costs plus the change in annual operating and maintenance costs, divided by the annual number of passenger boardings. Table 6-12 presents the CEI for the Build alternatives when compared to both the Status Quo and No Action alternatives.

Table 6-12: Cost Effectiveness by Alternative, Route and MAS

Cost Effective Index	Status Quo 79 mph MAS	No Action 79 mph MAS	Alternative 1		Alternative 2a		Alternative 2b	
			90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS
Capital costs (Millions 2008 $)	0	0	$475.4	$543.0	$742.3	$844.2	$330.0	$431.9
Annualized capital costs	0	0	37.7	43.1	58.9	66.9	26.2	34.2
Annual O&M costs	$16.9	$21.3	$80.0	$81.4	$77.9	$79.4	$71.7	$72.4
Total annualized cost	$16.9	$21.3	$117.7	$124.5	$136.8	$148.3	$97.9	$106.6
Total High ridership	262,300	464,800	1,110,100	1,162,200	1,124,300	1,161,400	1,101,100	1,147,000
Total Low ridership	245,500	425,700	939,600	984,200	924,700	955,000	897,800	937,000
Cost per rider High rider estimate	$64.43	$45.83	$106.03	$107.09	$121.64	$126.01	$88.88	$92.98
Cost per rider Low rider estimate	$68.84	$50.04	$125.27	$126.46	$147.90	$153.24	$109.01	$113.82

When compared to the Status Quo and No Action alternatives, all of the Build alternatives cost more per rider, reflecting the higher level of infrastructure investment and annual operating costs. Alternative 2b at the 90 mph MAS option has the lowest average cost per rider than any of the other Build alternatives.

6.3.5 Environmental Impacts

One of the project's goals is to protect the existing environment and minimize adverse impacts of constructing new infrastructure. A wide range of environmental impacts was examined with the expressed objective of preserving and protecting the natural and built environment within the study area. The impact analyses have the focused on land-use, employment, displacements, visual quality, aesthetic character, air quality, noise and vibration, ecosystems, water resources, farmland, energy, historic and cultural resources, traffic, parking and contamination. Chapter 3 of this Tier I Draft EIS provides greater detail on each of these topics. For the purpose of alternatives evaluation, several resource impact categories have been grouped together to facilitate comparisons of resource categories with similar impact characteristics.

The evaluation of environmental impacts was intended to identify and isolate the impacts associated with each alternative to assist in selecting an alternative for further evaluation. Where impacts were identified, potential mitigation strategies were discussed. Many of the mitigation strategies will require further definition and refinement during preliminary engineering and the subsequent analysis phase of project development if a Build alternative is selected.

The following paragraphs present the summary of environmental impacts by category for each of the alternatives. More detailed comparisons based on the analysis presented in Chapter 3 are found in Table 6-13 at the end of this section.

6.3.5.1 Air Quality

Ridership projections for this Tier I Draft EIS have not determined how many passengers would be diverted from other modes, especially automobiles. Forecasted trip diversions would be calculated during subsequent analysis and would be used as part of a more detailed air quality analysis. Consequently, the approach taken for this document does not provide the depth of a typical air quality analysis for a site-specific EIS. Rather than using MOBILE (standard software program used to model air quality) and travel demand models, an estimate of probable air quality impact was made by evaluating changes in ridership to determine air quality impacts. Consequently, a qualitative comparison among alternatives was employed to determine the probable impacts on air quality by examining the SEHSR project Tier I EIS and other high-speed rail EIS documents.

In order to determine the potential effects on air quality, the estimated probable annual ridership for 2025 was used to ascertain which alternative would likely result in higher diversion of automobile trips to rail. The higher the ridership, the more diversion is likely and therefore more beneficial impacts on air quality can be expected. Table 6-13 summarizes the findings of this assessment for each alternative and MAS. Whereas the Status Quo and No Action alternatives would have no measurable benefit on regional emissions, each of the Build alternatives would attract ridership from automobiles, thereby benefiting air quality through reduced emissions. Thus, each of the Build alternatives would respond to the project goal of reducing air quality impacts. Alternatives 2a and 2b would perform at a slightly higher level due to increased service along the Peninsula/CSXT route. However, overall performance among the Build alternatives would be similar.

Table 6-13: Qualitative Air Quality Evaluation by Alternative, Route and MAS

Probable Air Quality Impacts	Status Quo 79 mph MAS	No Action 79 mph MAS	Alternative 1		Alternative 2a		Alternative 2b	
			90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS
Peninsula/CSXT route	O	O	O*	O*	+	+	+	+
Southside/NS route	No train	No train	+	+	+*	+*	No train	No train
Overall rating	O	O	+	+	+	+	+	+

++ Strongly supports project goal or objective
\+ Supports project goal or objective
O No impacts relative to project goal or objective.
\- Does not support project goal or objective due to minor negative impacts.
\- - Does not support project goal or objective due to severe impacts.
* Conventional speed trains with a maximum authorized speed (MAS) of 79 mph.

Overall, based on the air quality analysis conducted for other high-speed rail projects, this project would likely be categorized as "exempt" under the general conformity regulations because no net increases in VOC or NOx emissions are likely to be projected in the ozone nonattainment or maintenance areas that exceed the rates set forth in Virginia's general conformity regulations.

The Status Quo and No Action alternatives would not have any negative impacts to ambient air quality related to construction activities. Alternative 2b would have fewer short-term negative impacts to ambient air quality related to construction activities than Alternatives 1 and 2a, since construction would only take place on the Peninsula/CSXT route. Construction in nonattainment areas would be limited and would occur over a minimum of a three-year period. Pollutant emissions associated with construction would not exceed the annual threshold rates set forth in the general conformity regulations.

6.3.5.2 Wetlands, Floodplains, Wildlife Habitats

Impacts to wetlands, floodplains and wildlife habitats can occur from physical impacts or through indirect impacts of a proposed action. Direct impacts to these resources, mostly related to right-of-way acquisition, can occur with dredge and fill of wetland areas, encroachment of the floodplain or loss of wildlife habitat due to new facilities or acquisition of right-of-way. Indirect impacts to these resources can occur during construction activities or result from actions that would alter the existing conditions adjacent to these resources, such as an increase in impervious ground surfaces that could result in higher run-off volumes.

Table 6-14 summarizes the potential impacts to wetlands, floodplains and wildlife habitats by alternative and MAS. Wetlands, floodplains and wildlife habitats were identified along both the Peninsula/CSXT route and the Southside/NS route. Impacts to these resources would be avoided under the Status Quo and No Action alternatives. Greater potential to impact wetlands, floodplains and wildlife habitats would occur with Alternatives 1 and 2a due to the track and other facility improvements along both the Peninsula/CSXT and Southside/NS routes. Alternative 2b would have less of an impact to these resources since impacts would only occur along the Peninsula/CSXT route. More precise impact analysis would be undertaken in subsequent analysis once an alternative is selected.

Table 6-14: Qualitative Assessment of Potential Impacts to Wetlands, Floodplains and Wildlife Habitats by Alternative, Route and MAS

Probable Wetland, Floodplain and Wildlife Habitat Impacts	Status Quo 79 mph MAS	No Action 79 mph MAS	Alternative 1		Alternative 2a		Alternative 2b	
			90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS
Peninsula/CSXT route	O	O	O*	O*	-	-	-	-
Southside/NS route	No train	No train	- -	- -	- -	- -	No train	No train
Overall Rating	O	O	- -	- -	- -*	- -*	-	-

++ Strongly supports project goal or objective
\+ Supports project goal or objective
O No impacts relative to project goal or objective.
\- Does not support project goal or objective due to minor negative impacts.
\- - Does not support project goal or objective due to severe impacts.
* Conventional speed trains with 79 mph maximum authorized speed (MAS).

6.3.5.3 Noise and Vibration

During a Tier I Draft EIS when details of the Build alternatives are not fully developed, a screening assessment is conducted to estimate the potential for noise and vibration impacts. The screening assessment gives a conservative estimate of the potential impacts of noise and vibration, and helps define the areas along the routes where future impacts are most likely. More detailed assessments would be conducted during subsequent analysis.

Noise Level Impacts - Noise levels associated with the Richmond/Hampton Roads Passenger Rail Project for any of the Build alternatives are expected to be slightly higher than those projected for the Status Quo and No Action alternatives throughout most of the project area due to route characteristics and operating speeds. Table 6-15 highlights the qualitative rating of potential noise impacts by alternative, route and MAS. The overall potential noise impacts of Alternatives 1 and 2a would be similar to one another. Alternatives 1 and 2a would reactivate abandoned Virginian Railway right-of-way near Kilby. Providing service along these track segments would result in noise associated with rail service for the first time in many years. Noise impacts associated with Alternatives 1 and 2a also would be slightly higher than Alternative 2b due to this issue. Alternative 2b would have the least potential noise impacts compared to Alternatives 1 and 2a, since no improvements would be made along the Southside/NS route.

Table 6-15: Qualitative Assessment of Potential Noise Impacts by Alternative, Route and MAS

Probable Noise Impacts	Status Quo 79 mph MAS*	No Action 79 mph MAS*	Alternative 1		Alternative 2a		Alternative 2b	
			90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS
Peninsula/CSXT route	O	O	O*	O*	-	-	-	-
Southside/NS route	No train	No train	- -	- -	- -	- -	No train	No train
Overall Rating	O	O	- -	- -	- -*	- -*	-	-

++ Strongly supports project goal or objective
\+ Supports project goal or objective
O No impacts relative to project goal or objective.
\- Does not support project goal or objective due to minor negative impacts.
\- - Does not support project goal or objective due to severe impacts.
* Conventional speed trains with a maximum authorized speed (MAS) of 79 mph.

Increased rail service may also result in the potential for more frequent sounding of locomotive horns at grade crossings for safety reasons. This issue can be mitigated by grade separations, where warranted, and by establishing “quiet zones” through appropriate crossing treatments.

Vibration Impacts - In addition to the higher speed train noise, potential vibration impacts from Richmond/Hampton Roads Passenger Rail operations would be evaluated in greater detail in subsequent analysis. Ground-borne vibration is a small but rapidly fluctuating motion transmitted through the ground. Ground-borne vibration diminishes over distance. Some soil types transmit vibration quite efficiently while others do not.

In areas where projected operating speeds are greater than either the Status Quo or No Action alternative speeds, projected vibration levels are expected to be slightly higher than either the Status Quo or No Action alternative. Chapter 3.5 provides an inventory of the land area affected by each Build alternative, and Table 6-16 illustrates the qualitative evaluation of the vibration impacts on that land area.

Table 6-16: Qualitative Assessment of Potential Vibration Impacts by Alternative, Route and MAS

Probable Vibration Impacts	Status Quo 79 mph MAS*	No Action 79 mph MAS*	Alternative 1		Alternative 2a		Alternative 2b	
			90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS	90 mph MAS	110 mph MAS
Peninsula/CSXT route	O	O	O*	O*	- -	- -	- -	- -
Southside/NS route	No train	No train	- -	- -	-	-	No train	No train
Overall Rating	O	O	- -	- -	- -*	- -*	- -	- -

++ Strongly supports project goal or objective
\+ Supports project goal or objective
O No impacts relative to project goal or objective.
\- Does not support project goal or objective due to minor negative impacts.
\- - Does not support project goal or objective due to severe impacts.
* Conventional speed trains with a maximum authorized speed (MAS) of 79 mph.

6.3.5.4 Sensitive Land Uses, Historic Properties and Open Spaces

Impacts to sensitive land uses, historic properties and open spaces can occur from a direct impact to the resource, such as land acquisition for needed right-of-way or facilities, or indirectly due to proximity effects such as noise or vibration. Although there would be no direct impact to sensitive land uses, historic properties or open spaces related to the Status Quo or No Action alternatives, these alternatives would not be consistent with area land use plans and cannot be rated as neutral. Specifically, the Status Quo and No Action alternatives would not meet specified goals and objectives in local plans related to transportation, regional connectivity and economic growth.

Under Alternatives 1 and 2a, minimal negative proximity effects would occur to parklands and historic properties/resources. Alternatives 1 and 2a would be generally consistent with area land use plans, with the exception of the area between Kilby and Bower's Hill on the Southside/NS route, where an abandoned railroad would be restored to service and substantial construction would occur. Alternative 2b also has the potential to have proximity effects to parklands and historic properties/resources. However, impacts related to Alternative 2b would be less than Alternatives 1 and 2a, given the involvement of both rail routes under Alternatives 1 and 2a and only the Peninsula/CSXT route in Alternative 2b. Alternative 2b would be consistent with area land use plans along the Peninsula/CSXT route. The higher frequency of service under the Build alternatives could generate more economic development than the Status Quo or No Action alternatives, thereby responding at a potentially high level to project goals and objectives.

Other sensitive land uses within the project study area include agricultural lands and designated agricultural/forestal protection districts (Section 3.10 of this Tier I Draft EIS). Agricultural land is more prominent along the Southside/NS route. However, several designated agricultural/forestal districts are located on the Peninsula/CSXT route. Consequently, Alternative 2b would have a greater potential to impact designated agricultural/forestal districts than the Status Quo and No Action alternatives based on the higher frequency of service and improvements needed to support such service. Alternatives 1 and 2a would potentially have a greater impact to agricultural lands given the need for additional right-of-way in the vicinity of Kilby. Table 6-17 provides a qualitative assessment of potential impacts to sensitive land uses, historic properties and open spaces.

Table 6-17: Qualitative Assessment of Potential Impacts to Sensitive Land Uses, Historic Properties and Open Spaces (by Alternative and MAS)

Sensitive Land Uses, Historic Properties and Open Space Impacts	Status Quo 79 mph	No Action 79 mph	Alternative 1		Alternative 2a		Alternative 2b	
			90 mph	110 mph	90 mph	110 mph	90 mph	110 mph
Peninsula/CSXT route	-	-	O*	O*	+	+	++	++
Southside/NS route	No train	No train	+	+	+*	+*	No train	No train
Overall Rating	-	-	+	+	+	+	++	++

++ Strongly supports project goal or objective
+ Supports project goal or objective
O No impacts relative to project goal or objective.
- Does not support project goal or objective due to minor negative impacts.
- - Does not support project goal or objective due to severe impacts.
* Conventional speed trains with 79 mph maximum authorized speed (MAS).

6.3.5.5 Environmental Assessment by Alternative

A side by side comparison of all environmental resources that comprise each resource grouping was evaluated for each alternative in this Tier I Draft EIS and is provided in Table 6-18.

Table 6-18: Environmental Impact Assessment by Alternative

Environmental Factor	**Status Quo**	**No Action**	**Alternative 1 Peninsula Conventional/Southside Higher Speed**	**Alternative 2a Peninsula Higher Speed/Southside Conventional**	**Alternative 2b Peninsula Higher Speed only**
5. Minimize Environmental Impacts					
Air quality standards met	**O**	**O**	**+**	**+**	**+**
Air Quality	NA	Marginal improvement on regional air quality than Status Quo, but largely negligible.	Greater effect on regional air quality than Status Quo or No Action, but marginal overall impact. Short-term negative impacts to ambient air quality related to construction activities	Greater effect on regional air quality than Status Quo or No Action, but marginal overall impact. Short-term negative impacts to ambient air quality related to construction activities. Most construction impacts will occur at any speed option.	Greater effect on regional air quality than Status Quo or No Action, but marginal overall impact. Short-term negative impacts to ambient air quality related to construction activities. Fewer impacts than Alternatives 1 and 2a.
Energy use	**O**	**O**	**- -**	**- -**	**-**
Energy Usage (% greater than Status Quo)	NA	50%	417%	367%	333%
Minimize operating noise and vibration	**O**	**O**	**- -**	**- -**	**-**
Noise	No impact	No impact	Impacts likely due to increased train frequencies and train warning horns.	Impacts likely due to increased train frequencies and train warning horns.	Impacts likely due to increased train frequencies and train warning horns.
Vibration	No impact	No impact	Impacts likely due to increased train frequencies.	Impacts likely due to increased train frequencies.	Impacts likely due to increased train frequencies.

Environmental Factor	Status Quo	No Action	Alternative 1 Peninsula Conventional/Southside Higher Speed	Alternative 2a Peninsula Higher Speed/Southside Conventional	Alternative 2b Peninsula Higher Speed only
Avoid, minimize and mitigate impacts to: • Wetlands • Floodplains • Critical habitats					
	O	**O**	**- -**	**- -**	**-**
Surface Waters	No impact	No impact	Greater potential to impact surface waters during construction activities and in areas where additional right-of-way may be needed (due to improvements along both routes).	Greater potential to impact surface waters during construction activities and in areas where additional right –of-way may be needed (due to improvements along both routes).	Potential to impact surface waters during construction activities and in areas where additional right-of-way may be needed.
Floodplains	No impact	No impact	Greater potential to encroach or impact floodplains where additional right-of-way may be required (due to improvements along both routes).	Greater potential to encroach or impact floodplains where additional right-of-way may be required (due to improvements along both routes).	Potential to encroach or impact floodplains where additional right –of-way may be required.
Wetlands	No impact	No impact	Greater potential for impacts in areas where additional right-of-way may be required (due to improvements along both routes).	Greater potential for impacts in areas where additional right-of-way may be required (due to improvements along both routes).	Potential for impact in areas where additional right-of-way may be required.
Water Quality	No impact	No impact	Greater potential for increased run-off with new impervious ground surfaces (due to improvements along both routes).	Greater potential for increased run-off with new impervious ground surfaces (due to improvements along both routes).	Potential for increased run-off with new impervious ground surfaces.
Coastal Zone	No impact	No impact	Study area within Virginia's Coastal Zone with potential to impact coastal resources.	Study area within Virginia's Coastal Zone with potential to impact coastal resources.	Study area within Virginia's Coastal Zone with potential to impact coastal resources.
Protected Species	No impact	No impact	Potential for impacts near Williamsburg Amtrak Station and proposed Bower's Hill Station.	Potential for impacts near Williamsburg Amtrak Station and proposed Bower's Hill Station.	Potential for impacts near Williamsburg Amtrak Station.

Environmental Factor	Status Quo	No Action	Alternative 1 Peninsula Conventional/Southside Higher Speed	Alternative 2a Peninsula Higher Speed/Southside Conventional	Alternative 2b Peninsula Higher Speed only
Habitats	No impact	No impact	Elko Conservation Easement adjacent to Peninsula/CSXT route.	Elko Conservation Easement adjacent to Peninsula/CSXT route.	Elko Conservation Easement adjacent to Peninsula/CSXT Route.
Avoid, minimize and mitigate impacts to: • Sensitive land uses • Historic properties • Open spaces					
	- -	- -	+	+	++
Land Use	No impact	No impact	Generally consistent with policies, actions and goals of area land use plans with the exception of the area between Kilby and Bower's Hill on the Southside. Potential land use conversions may occur where additional right-of-way is needed.	Generally consistent with policies, actions and goals of area land use plans with the exception of the area between Kilby and Bower's Hill on the Southside; consistent with City of Williamsburg's goal of improved high-speed rail service. Potential land use conversions may occur where additional right-of-way is needed.	Consistent with policies, actions and goals of area land use plans; consistent with City of Williamsburg goal of improved high speed rail service. Potential land use conversions may occur where additional right-of-way is needed.
Community Facilities	No impact	No impact	Potential grade crossing closures could impact community cohesion. Noise and vibration may affect facilities adjacent to tracks.	Potential grade crossing closures could impact community cohesion. Noise and vibration may affect facilities adjacent to tracks.	Potential grade crossing closures could impact community cohesion (to a lesser extent than Alternative 1 or 2a). Noise and vibration may affect facilities adjacent to tracks.

Environmental Factor	Status Quo	No Action	Alternative 1 Peninsula Conventional/Southside Higher Speed	Alternative 2a Peninsula Higher Speed/Southside Conventional	Alternative 2b Peninsula Higher Speed only
Environmental Justice Communities	No disproportionate adverse impacts expected, although would not benefit from improved mobility.	No disproportionate adverse impacts expected, and would benefit somewhat from improved mobility.	No disproportionate adverse impacts expected, and would benefit from improved mobility.	No disproportionate adverse impacts expected, and would benefit from improved mobility.	No disproportionate adverse impacts expected, and would benefit from improved mobility.
Parklands	No impact	No impact	Minimal proximity effects expected due to increased train frequencies (both the Peninsula and Southside).	Minimal proximity effects expected due to increased train frequencies (both the Peninsula and Southside).	Minimal impacts expected related to increased train frequencies (Peninsula only).
Agricultural Lands	No impact	No impact	Potential for impact in vicinity of Kilby.	Potential for impact in vicinity of Kilby.	Several agricultural and forestal districts located along Peninsula/CSXT route.
Cultural Resources	No impact	No impact	Potential proximity effects on known resources. Effects potentially greater due to inclusion of both routes.	Potential proximity effects on known resources. Effects potentially greater due to inclusion of both routes.	Potential proximity effects on known resources. Effects potentially less due to inclusion of only the Peninsula route.
Aesthetics/Visual Character	No impact	No impact	Alterations in aesthetic/visual character expected near proposed Bower's Hill and downtown Norfolk stations.	Alterations in aesthetic/visual character expected near proposed downtown Newport News, Bower's Hill and downtown Norfolk stations.	Alterations in aesthetic/visual character expected near proposed downtown Newport News station.
Utilities	No impact	No impact	Potential to disrupt services and may require utility lines to be relocated in areas where right-of-way is needed. Greater impact due to infrastructure improvements needed to Southside.	Potential to disrupt services and may require utility lines to be relocated in areas where right–of-way is needed. Greater impact due to infrastructure improvements needed to Southside.	Potential to disrupt services and may require utility lines to be relocated in areas where right-of-way is needed.

Environmental Factor	Status Quo	No Action	Alternative 1 Peninsula Conventional/Southside Higher Speed	Alternative 2a Peninsula Higher Speed/Southside Conventional	Alternative 2b Peninsula Higher Speed only
Contaminated Sites/Hazardous Materials	No impact	No impact	Potential to encounter contaminated sites along both routes.	Potential to encounter contaminated sites along both routes.	Potential to encounter contaminated sites along the Peninsula route only.
Section 4(f)/6(f)	No impact	No impact	Section 4(f)/6(f) resources identified for both routes. Greater potential for proximity effects due to larger number of resources.	Section 4(f)/6(f) resources identified for both routes. Greater potential for proximity effects due to larger number of resources.	Section 4(f)/6(f) resources identified along route.

++ Strongly supports project goal or objective
+ Supports project goal or objective
O No impacts relative to project goal or objective.
- Does not support project goal or objective due to minor negative impacts.
- - Does not support project goal or objective due to severe impacts.

6.4 Comparative Evaluation of Alternatives

The purpose of the trade-offs analysis is to frame the decision to select an alternative by highlighting advantages and disadvantages of choosing one alternative over another. This analysis is designed from the broader perspective to determine the key trade-offs of costs and benefits that must be considered in choosing a course of action. As in the preceding examinations, the content and approach to the trade-offs analysis is based on the project's goals and objectives and the relative merits of the alternatives considered. The major task is to reduce the vast amount of information and data developed during the technical evaluation to those essential differences between the alternatives that may permit decision-makers to discern the advantages of choosing one alternative and speed option over the others.

6.4.1 Comparison of the Build Alternatives 1, 2a and 2b

The Richmond/Hampton Roads Passenger Rail Project is considered to be an extension of the SEHSR project. The total number of trains operating between Hampton Roads and Richmond is derived from an capacity analysis conducted as part of the Tier I EIS for the SEHSR project. The total number of round-trip trains that can be added to the line segment between Washington, DC and Richmond in the forecast year of 2025 with SEHSR trains also operating in the corridor is nine, which limits the Richmond/Hampton Roads Passenger Rail Project to a combination of no more than nine total round-trip trains for any alternative. The ridership projected for all of the alternatives is consistent with the travel patterns associated with the SEHSR project.

Each of the Build alternatives shares a common right-of-way between Washington, DC and Richmond. Alternatives 1 and 2a have trains operating along the Southside/NS route south to Petersburg where the line diverges east to Norfolk utilizing the Norfolk Southern mainline. Alternatives 1, 2a and 2b have trains operating on the Peninsula/CSXT route utilizing the CSX mainline. Each of these routes serves slightly different market areas and has different impacts on the environment. The differences in length of route and market area translate into differences in costs, ridership, cost effectiveness and environmental consequences.

The differences between Alternatives 1 and 2a are the maximum authorized speed (MAS) options and the number of trains operating on either the Peninsula/CSXT route or Southside/NS route. Alternative 1 has three daily round-trip trains operating at 79 mph MAS on the Peninsula/CSXT route while six daily round-trip trains operate on the Southside/NS route at the higher speed options. Alternative 2a inverts the operating plan so that six daily round-trip trains operate at higher speeds on the Peninsula/CSXT route while three daily round-trip trains operate at 79 mph MAS on the Southside/NS route.

Alternatives 1 and 2a carry the most people at any speed since more stations are served, making it more convenient for people living on the Southside of the James River to access a station. Passenger volumes range from a low of 924,700 for the 90 mph MAS in Alternative 2a to a high of 1,161,400 in Alternative 1 for the 110 mph MAS. Alternative 2b ridership forecasts range between a low forecast of 897,800 for the 90 mph MAS to high forecast of 1,147,000 for the 110 mph MAS.

Alternative 1 produces the highest annual system ridership and produces the highest level of revenue generation of any of the alternatives considered and evaluated.

Alternatives 1 and 2a are also the most expensive to build due to the new infrastructure required to route passenger trains from Richmond to the NS mainline east of Petersburg along the Southside/NS route. In addition, more passing tracks are required and a completely new parallel route into Downtown Norfolk is proposed to eliminate conflicts with freight trains operating on the Southside/NS route and to alleviate capacity constraints in Norfolk.

The 110 mph MAS option is the least cost effective option when compared to the 90 mph MAS option. The capital cost for Alternative 1 is $475.4 million for the 90 mph and $543 million for the 110 mph MAS respectively. The capital cost for Alternative 2a is $742.3 million for the 90 mph MAS and $844.2 for the 110mph MAS. The capital cost for Alternative 2b is $330 million and $431.9 million for the 90 mph and 110 mph MAS respectively.

The 110 mph MAS options are the mostly costly to construct and operate. Under Alternative 1 it would cost an additional $47.6 million in capital costs to raise the MAS from 90 mph to 110 mph on the Southside/NS route. As a result, only eight minutes in scheduled travel time savings are achieved for each train. In Alternatives 2a and 2b it costs an additional $101.9 million in infrastructure costs to save six minutes of scheduled travel time for each train operating on the Peninsula/CSXT route.

The increase in ridership on the Southside/NS route achieved by the eight-minute time savings in the 110 MAS translates into approximately 53,200 additional annual riders on six daily round-trip trains. This is an increase of 5.9 percent over the 90 mph MAS. The increase in ridership for the higher speed options for Alternative 2a and 2b on the Peninsula/CSXT route achieved by the six-minute time savings for six daily round-trip trains is 53,800 additional riders annually, which is an increase of 5.8 percent over the 90 mph MAS.

The increased annual cost per passenger over current operating costs to achieve these scheduled time savings per train is $894 per passenger each year for Alternative 1 and $1,894 per passenger each year for Alternatives 2a and 2b. Alternative 2b is the least costly alternative to operate at any speed range. This is a function of route miles, train miles and passenger miles, which account for the bulk of the operating cost factors. Consequently, Alternative 2b also has the highest fare box recovery ratio despite having lower average revenue than the other two Build alternatives. This results in Alternative 2b having a lower operating subsidy per passenger than Alternatives 1 and 2a.

Although Alternatives 1 and 2a attract the most ridership, they are not as cost effective as Alternative 2b, which requires the least amount of capital infrastructure investment. Consequently, Alternative 2b is the most cost effective alternative with a cost per passenger ranging between $88.88 and $92.98 for the 90 mph and 110 mph MAS options at the high ridership forecast and $109.01 and $113.82 at the low ridership forecast. Alternative 1 has a cost per passenger index of $106.03 and $107.09 for the 90 mph and 110 mph MAS options at the high ridership forecast and $125.27 and $126.46 at the low ridership forecasts. Alternative 2a has a cost per passenger index of $121.64 and $126.01 for the 90 mph and 110 mph MAS options at the high ridership forecast and $147.90 and $153.24 at the low ridership forecasts.

Additionally, Alternative 2b eliminates most of the negative noise, vibration, historic and cultural resource, traffic, parking, and community and construction impacts associated with Alternatives 1 and 2a which require passenger train operations in mixed-freight traffic on two different routes.

6.4.2 Comparison of the Build Alternatives to the Status Quo and No Action Alternatives

The Status Quo and No Action alternatives are both lower cost options than any of the Build alternatives, but they do not adequately address the long term transportation problems in the Richmond/Hampton Roads study area. Table 6-19 presents the summary findings of the technical evaluation for all five alternatives including the MAS options for the Build alternatives.

The following paragraphs highlight the salient differences between the Build alternatives and the comparisons to the Status Quo and No Action alternatives:

- The Status Quo and No Action alternatives do not support the goal of improving regional linkages. Both the Status Quo and No Action alternatives would fail to provide either increased service area coverage or service frequencies.
- The Status Quo and No Action alternatives do not support the goal of limiting growth of highway congestion. Both alternatives continue to support existing transportation patterns and behaviors by limiting travel choices and would not therefore provide a meaningful alternative to continued driving.
- The Status Quo and No Action alternatives do not support the goal of protecting air quality in nonattainment areas. Both alternatives would not attract sufficient ridership to significantly reduce regional vehicular emissions compared to the existing condition.

Table 6-19: Comparative Analysis of Alternatives

Richmond/Hampton Roads Passenger Rail Project
Virginia Department of Rail and Public Transportation

Comparative Analysis of Alternatives

Planning Year 2025
Assuming Southeast High-speed Rail Project
7-Jul-08

Evaluation Criteria	79 MPH Status Quo	79 MPH No Action	90 MPH Option Alt 1	90 MPH Option Alt 2a	90 MPH Option Alt 2b	110 MPH Alt 1	110 MPH Alt 2a	110 MPH Alt 2b
System Features (Assumes SEHSR Project)								
Route Miles (Hampton Roads to Richmond)								
Peninsula/CSXT Route	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9
Southside/NS Route	0.0	0.0	101.0	101.0	0.0	101.0	101.0	0.0
Total Route Miles	73.9	73.9	174.9	174.9	73.9	174.9	174.9	73.9
Frequency of Service - Daily Roundtrips								
Peninsula/CSXT Route	2	3	3	6	9	3	6	9
Southside/NS Route	0	0	6	3	0	6	3	0
Total Daily Roundtrips	2	3	9	9	9	9	9	9
Average Annual Ridership (2025)								
Peninsula/CSXT Route								
High estimate	262,300	464,800	223,400	914,600	1,101,100	222,300	968,400	1,147,000
Low estimate	245,500	425,700	212,500	732,200	897,800	211,200	768,000	937,000
Southside/NS Route								
High estimate	0	0	886,700	209,700	0	939,900	193,000	0
Low estimate	0	0	727,100	192,500	0	773,000	187,000	0
Total High estimate	262,300	464,800	1,110,100	1,124,300	1,101,100	1,162,200	1,161,400	1,147,000
Total Low estimate	245,500	425,700	939,600	924,700	897,800	984,200	955,000	937,000
Difference from Status Quo - high estimate		202,500	847,800	862,000	838,800	899,900	899,100	884,700
Difference from Status Quo - low estimate		180,200	694,100	679,200	652,300	738,700	709,500	691,500
Difference from No Action - high estimate			645,300	659,500	636,300	697,400	696,600	682,200
Difference from No Action - low estimate			513,900	499,000	472,100	558,500	529,300	511,300
Capital Costs (2008$)								
Peninsula/CSXT Route Subtotal	$0	$0	$0	$330,000,000	$330,000,000	$0	$431,900,000	$431,900,000
Richmond - Petersburg	$0	$0	$148,900,000	$148,900,000	$0	$148,900,000	$148,900,000	$0
Petersburg - Norfolk	$0	$0	$326,500,000	$263,400,000	$0	$394,100,000	$263,400,000	$0
Southside/NS Subtotal	$0	$0	$475,400,000	$412,300,000	$0	$543,000,000	$412,300,000	$0
Total Capital Costs (2008$)	$0	$0	$475,400,000	$742,300,000	$330,000,000	$543,000,000	$844,200,000	$431,900,000
Annualized Capital Costs								
Annualized Capital Costs (Peninsula/CSXT)	$0	$0	$0	$26,169,000	$26,169,000	$0	$34,249,670	$34,249,670
Annualized Capital Costs (Southside/NS)	$0	$0	$37,699,220	$32,695,390	$0	$43,059,900	$32,695,390	$0
Total Annualized Capital Costs (Approximated)	$0	$0	$37,699,220	$58,864,390	$26,169,000	$43,059,900	$66,945,060	$34,249,670
Operating & Maintenance (O&M) Costs (2008$)								
Peninsula/CSXT Route	$16,900,000	$21,300,000	$21,300,000	$53,400,000	$71,700,000	$21,300,000	$54,900,000	$72,400,000
Southside/NS Route	$0	$0	$58,700,000	$24,500,000	$0	$60,100,000	$24,500,000	$0
Annual Operating and Maintenance Costs (2008$)	$16,900,000	$21,300,000	$80,000,000	$77,900,000	$71,700,000	$81,400,000	$79,400,000	$72,400,000
Change in Annual O&M Costs from Status Quo		$4,400,000	$63,100,000	$61,000,000	$54,800,000	$64,500,000	$62,500,000	$55,500,000
Change in Annual O&M Costs from No Action			$58,700,000	$56,600,000	$50,400,000	$60,100,000	$58,100,000	$51,100,000
Average Annual Revenue (2025)								
Peninsula/CSXT Route								
High estimate	$15,950,000	$28,070,000	$11,310,000	$59,270,000	$68,010,000	$11,230,000	$62,170,000	$70,510,000
Low estimate	$14,490,000	$24,950,000	$10,520,000	$46,600,000	$54,020,000	$10,410,000	$48,550,000	$56,080,000
Southside/NS Route								
High estimate	$0	$0	$57,810,000	$9,890,000	$0	$60,890,000	$9,050,000	$0
Low estimate	$0	$0	$45,980,000	$8,840,000	$0	$48,570,000	$8,590,000	$0
Total High estimate	$15,950,000	$28,070,000	$69,120,000	$69,160,000	$68,010,000	$72,120,000	$71,220,000	$70,510,000
Total Low estimate	$14,490,000	$24,950,000	$56,500,000	$55,440,000	$54,020,000	$58,980,000	$57,140,000	$56,080,000
Difference from Status Quo - high estimate		$12,120,000	$53,170,000	$53,210,000	$52,060,000	$56,170,000	$55,270,000	$54,560,000
Difference from Status Quo - low estimate		$10,460,000	$42,010,000	$40,950,000	$39,530,000	$44,490,000	$42,650,000	$41,590,000
Difference from No Action - high estimate			$41,050,000	$41,090,000	$39,940,000	$44,050,000	$43,150,000	$42,440,000
Difference from No Action - low estimate			$31,550,000	$30,490,000	$29,070,000	$34,030,000	$32,190,000	$31,130,000
Operating Ratio (percent O&M costs covered by revenue)								
Peninsula/CSXT Route								
Operating ratio - high revenue estimate	94.4%	131.8%	53.1%	111.0%	94.9%	52.7%	113.2%	97.4%
Operating ratio - low revenue estimate	85.7%	117.1%	49.4%	87.3%	75.3%	48.9%	88.4%	77.5%
Southside/NS Route								
Operating ratio - high revenue estimate	n/a	n/a	98.5%	40.4%	n/a	101.3%	36.9%	n/a
Operating ratio - low revenue estimate	n/a	n/a	78.3%	36.1%	n/a	80.8%	35.1%	n/a
Operating ratio - high revenue estimate	94.4%	131.8%	86.4%	88.8%	94.9%	88.6%	89.7%	97.4%
Operating ratio - low revenue estimate	85.7%	117.1%	70.6%	71.2%	75.3%	72.5%	72.0%	77.5%
Cost Effectiveness (Annualized Cost per Rider)								
Annualized Costs Peninsula/CSXT	$16,900,000	$21,300,000	$21,300,000	$79,569,000	$97,869,000	$21,300,000	$89,149,670	$106,649,670
Annualized Costs Southside/NS	$0	$0	$96,399,220	$57,195,390	$0	$103,159,900	$57,195,390	$0
Total Annualized Costs	$16,900,000	$21,300,000	$117,699,220	$136,764,390	$97,869,000	$124,459,900	$146,345,060	$106,649,670
Peninsula/CSXT Route								
Annualized Cost per rider - high ridership estimate	$64.43	$45.83	$95.34	$87.00	$88.88	$95.82	$92.06	$92.98
Annualized Cost per rider - low ridership estimate	$68.84	$50.04	$100.24	$108.67	$109.01	$100.85	$116.08	$113.82
Southside/NS Route								
Annualized Cost per rider - high ridership estimate	n/a	n/a	$108.72	$272.75	n/a	$109.76	$296.35	n/a
Annualized Cost per rider - low ridership estimate	n/a	n/a	$132.58	$297.12	n/a	$133.45	$305.86	n/a
Annualized Cost per rider - high ridership estimate	$64.43	$45.83	$106.03	$121.64	$88.88	$107.09	$126.01	$92.98
Annualized Cost per rider - low ridership estimate	$68.84	$50.04	$125.27	$147.90	$109.01	$126.46	$153.24	$113.82
Subsidy / Surplus per Rider								
Peninsula/CSXT Route								
(Subsidy) Surplus per rider - high revenue estimate	($3.62)	$14.57	($44.72)	$6.42	($3.35)	($45.30)	$7.51	($1.65)
(Subsidy) Surplus per rider - low estimate	($9.82)	$8.57	($50.73)	($9.29)	($19.69)	($51.56)	($8.27)	($17.42)
Southside/NS Route								
(Subsidy) Surplus per rider - high revenue estimate	n/a	n/a	(1.00)	(69.67)	n/a	0.84	(80.05)	n/a
(Subsidy) Surplus per rider - low estimate	n/a	n/a	(17.49)	(81.35)	n/a	(14.92)	(85.08)	n/a
(Subsidy) Surplus per rider - high revenue estimate	($3.62)	$14.57	($9.80)	($7.77)	($3.35)	($7.98)	($7.04)	($1.65)
(Subsidy) Surplus per rider - low estimate	($9.82)	$8.57	($25.01)	($24.29)	($19.69)	($22.78)	($23.31)	($17.42)
Financial Capacity								
Total Capital Costs (2008$)			$475,400,000	$742,300,000	$330,000,000	$543,000,000	$844,200,000	$431,900,000
Federal Share at 80% of Build Alternative*			380,320,000	593,840,000	264,000,000	434,400,000	675,360,000	345,520,000
Non-federal share			95,080,000	148,460,000	66,000,000	108,600,000	168,840,000	86,380,000
Non-federal share as percent of total cost			20.0%	20.0%	20.0%	20.0%	20.0%	20.0%

- The Status Quo and No Action alternatives are neutral with regard to impacts on the natural environment, such as wildlife habitat and water resources.
- The Status Quo and No Action alternatives have the lowest annualized cost and the best cost effectiveness index of any of the alternatives examined when compared to the build alternatives. The Status Quo alternative has the lowest annual cost of operation. The No Action alternative has the highest farebox recovery ratio and actually shows a slight operating surplus per rider compared to any of the other alternatives evaluated. All of the Build alternatives add substantial deficits to the hypothetical operating budget, which the Commonwealth of Virginia will have to cover with subsidy.
- The Status Quo and No Action alternatives have no capital cost shortfalls because there is no major investment other than what is already planned and programmed. All of the Build alternatives exceed the DRPT long-range capital budget for the project and would require federal participation. Currently, the federal grant program for state supported trains is not funded at a level that could provide 80 percent of the funding required.
- The Build alternatives with higher speed options are the more costly to construct and operate. Under Alternative 1, it would cost an additional $475.4 million to construct the 90 mph MAS option and $543 million to construct the 110 mph MAS option when compared to the Status Quo and No Action alternatives. The most expensive alternative in capital costs is Alternative 2a, which costs $742.3 million for the 90 mph MAS and $844.2 million for the 110 mph MAS. The least costly Alternative in capital costs is Alternative 2b, which costs $330 million for the 90 mph MAS and $431.9 million for the 110 mph MAS.
- The costly higher speed, more frequent service achieved by the Build alternatives would result in travel time savings for rail passengers when compared to the Status Quo and No Action alternatives. Substantially higher ridership would result along the Southside/NS route in Alternative 1 and the Peninsula/CSXT route in Alternatives 2a and 2b. For example, the increase in ridership in Alternative 1 would attract approximately 513,900 to 697,400 additional annual riders (120 to 150 percent) on six daily round-trip trains compared to the No Action alternative and approximately 694,100 to 899,900 additional riders (283 to 343 percent) compared to the Status Quo alternative.
- The increased annual operating cost per passenger over current conditions to achieve these marginal time savings per train ranges between $60.20 per passenger each year for the 90 mph MAS and $76.42 per passenger each year for the 110 mph MAS for Alternative 1. The increased annual operating cost per passenger for Alternative 2a ranges between $75.82 for the 90 mph MAS and $103.21 for the 110 mph MAS respectively. The least costly alternative in terms of annual operating cost per passenger over current conditions is Alternative 2b. Under the 90 mph MAS the increased annual operating cost per passenger ranges between $43.06 for the optimistic ridership forecast at the 90 mph MAS and $63.79 for the conservative estimate of the 110 mph MAS option.
- All the Build alternatives have potential impacts on visual quality, noise, vibration, traffic, and community cohesion when compared to the Status Quo and No Action alternatives. Alternatives 1 and 2a have more adverse impacts than Alternative 2b, which is limited to the Peninsula/CSXT route.
- The construction of the third track and Petersburg connection on the Southside/NS route for Alternatives 1 and 2a would likely result in business disruption for the freight railroads involved, particularly Norfolk Southern, since passenger trains do not currently operate over this route. Re-constructing the former C&O double-track Peninsula/CSXT route would be beneficial to CSXT since it would create additional capacity along a route that currently includes both passenger and freight rail traffic.
- The substantial improvements to railroad infrastructure would likely result in noticeable improvements to on-time performance and have been accounted for in the ridership forecasts produced for this Tier I Draft EIS.
- Travel time savings for rail passengers when compared to highway driving are substantial. All Build alternatives save travel time for rail passengers when compared to the existing Status Quo and No Action alternatives.

- The 110 mph MAS alternatives could result in the highest number of at-grade crossing closures, thereby resulting in the highest potential for roadway traffic and circulation effects. Alternatives 1 and 2a at 90 mph MAS could result in fewer at-grade crossing closures. The Status Quo and No Action alternatives could result in no closures. In all alternatives, the safety needs of each at-grade crossing location would be considered in accordance with FRA regulations. The elimination of grade crossings to achieve higher speed passenger rail service may require mitigation measures to avoid potential negative impacts on localized traffic congestion and emergency response time as well as access and egress to businesses and residences. Decisions as to closure and appropriate protective measures at crossings would be made with input from the community along each selected route during subsequent analysis.
- The higher speed and greater frequencies of Alternatives 1, 2a and 2b support the SEHSR and Northeast Corridor services more than the conventional speed Status Quo and No Action alternatives by providing complementary service strategies and higher frequencies of trains to make the rail network more convenient for existing and potential passengers.
- All of the Build alternatives have a beneficial impact on air quality when compared to the Status Quo and No Action alternatives.
- All of the Build alternatives have a beneficial impact on potential economic development by providing better regional linkages and more frequent passenger rail service than the Status Quo and No Action alternatives.

6.5 Preferred Alternative

After public review of and comment on the Tier I Draft EIS, DRPT will review and consider the public comments. The selection of a locally preferred alternative will be made by the Commonwealth Transportation Board (CTB) at the conclusion of the Tier I Draft EIS process. DRPT will recommend an alternative to the CTB for consideration and make a recommendation to FRA based on all of the information contained within the Tier I Draft EIS and the public comments. Once the CTB selects and approves an alternative, it will be identified in the Final EIS. FRA will then issue a Record of Decision (ROD) naming the selected alternative.

This Page Intentionally Left Blank