Cost-Effectiveness Analysis Supplementary Documentation
FASTLANE Discretionary Grant Program

North Florida Freight Rail Enhancement Program - Phase II

Florida Department of Transportation, Jacksonville, FL

December 14, 2016

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Cost Effectiveness Analysis Supplementary Documentation

1. Executive Summary

The Cost-Effectiveness Analysis conducted for this grant application compares the costs associated with the proposed investment to the benefits of the project. To the extent possible, benefits have been monetized. Where not possible to assign a dollar value to a benefit, efforts have been made to quantify it. A qualitative discussion is also provided when a benefit is anticipated to be generated but is not easily monetized or quantified.

The North Florida Freight Rail Enhancement Program Phase II improves freight rail system operations at the CSXT Beaver Street Interchange and throughout the Jacksonville Terminal. The proposed project includes: constructing a new parallel 7,000 foot long bypass/storage track; installing new turnouts and crossovers with power switches for more efficient and safer operations throughout the Jacksonville Terminal and CSXT Moncrief Yard; and upgrading the existing FEC signal system with Centralized Traffic Control (CTC) for approximately 5.35 miles between Bowden Yard and the FEC St John's River Railway Bridge to provide more efficient train signaling for the routing trains into and out of the Jacksonville Terminal.

A table summarizing the changes expected from the project, and the associated benefits, is provided below. Monetized and non-monetized benefits are provided.

Table ES-1: Merit Criteria and Cost-Effectiveness - Summary of Infrastructure Improvements and Associated Benefits

Current Status or Baseline & Problems to be Addressed	Changes to Baseline / Alternatives	Type of Impacts	Population Affected by Impacts	Economic Benefit	Summary of Results Discounted at 7%
Bottleneck creating constraint for freight movement by rail	Improving the rail line in order to increase efficiency and therefore relieve capacity constraint increasing capacity	Mobility		Congestion and Maintenance Cost Reduction	$33,451,365
		Safety		Injury and Fatality Accident Reduction	$22,528,518
		Community and Environmental		Emission and Noise Reduction	$4,315,656

In addition to benefits that can be monetized and quantified, a number of qualitative benefits are also likely to be generated by this improvement. Such benefits include reducing response times of emergency vehicles due to realignment of rail and decongestion of highways, reduced inventory and shipping costs as well as a reduction in recurring delays across the Beaver Interchange.

The period of analysis used in the monetization of benefits and costs corresponds to 23 years, including 3 years of planning and construction and 20 years of operation.

A summary of the relevant data and calculations used to derive the monetized benefits and costs of the project are shown in Table ES-2 (in dollars of 2015). Based on the analysis presented in the rest of this document, the project is expected to generate $60.3 million in discounted benefits and $32 million in discounted costs, using a 7 percent real discount rate. Therefore, the project is expected to generate a Net Present Value of $28.3 million and a Benefit/Cost Ratio of 1.88.

Table ES-2: Summary of Pertinent Data, Quantifiable Benefits and Costs

Calendar Year	Project Year	Total Benefits	Mobility	Safety	Community And Environmental	Total Costs
2017	1	$0	$0	$0	$0	$11,408,911
2018	2	$0	$0	$0	$0	$10,662,534
2019	3	$0	$0	$0	$0	$9,964,985
2020	4	$4,653,468	$2,645,702	$1,795,346	$212,421	$0
2021	5	$4,390,890	$2,508,557	$1,700,713	$181,621	$0
2022	6	$4,172,823	$2,378,520	$1,611,068	$183,235	$0
2023	7	$3,967,452	$2,255,259	$1,526,148	$186,045	$0
2024	8	$3,780,947	$2,138,415	$1,445,704	$196,828	$0
2025	9	$3,597,396	$2,027,648	$1,369,501	$200,247	$0
2026	10	$3,431,844	$1,922,626	$1,297,314	$211,904	$0
2027	11	$3,268,144	$1,823,058	$1,228,932	$216,154	$0
2028	12	$3,112,726	$1,728,672	$1,164,155	$219,899	$0
2029	13	$2,962,337	$1,639,192	$1,102,792	$220,352	$0
2030	14	$2,822,362	$1,554,363	$1,044,663	$223,336	$0
2031	15	$2,693,482	$1,473,952	$989,599	$229,931	$0
2032	16	$2,568,503	$1,397,735	$937,437	$233,331	$0

Calendar Year	Project Year	Total Benefits	Mobility	Safety	Community And Environmental	Total Costs
2033	17	$2,448,804	$1,325,475	$888,024	$235,304	$0
2034	18	$2,329,226	$1,256,952	$841,216	$231,058	$0
2035	19	$2,220,770	$1,191,994	$796,876	$231,901	$0
2036	20	$2,117,194	$1,130,404	$754,872	$231,918	$0
2037	21	$2,012,866	$1,072,008	$715,083	$225,776	$0
2038	22	$1,918,206	$1,016,653	$677,390	$224,163	$0
2039	23	$1,826,097	$964,181	$641,685	$220,231	$0
Total		**$60,295,539**	**$79,877,285**	**$33,451,365**	**$53,607,718**	**$32,036,430**

In addition to the monetized benefits presented in Table ES-2, the project would generate other benefits that are difficult to monetize, but can be quantified using units that are not dollar values. These are detailed below.

Economic Outcome

- An economic benefit identified as part of the project, but not monetized in the BCA, relates to shipping costs and efficiency. Businesses that switch shipment of their freight from truck to rail are expected to move freight more cheaply, faster and more efficiently resulting in reduced shipping and inventory costs.

Mobility Outcome

- Currently, there are recurring delays on the Beaver Interchange bottleneck. Improved infrastructure will allow more efficient movement along the rail, decreasing current delays.

Safety Outcome

- There are 24,000 annual urgent ambulance visits to the downtown Jacksonville medical campus. Many of these are delayed due to the frequent stops and slow movement of trains through the downtown area blocking the road. Because of the improved flow of rail, wait times for ambulances are expected to decrease, potentially increasing the likelihood of patient survival as they seek emergency medical care.

2. Introduction

This document provides detailed technical information on the economic analyses conducted in support of the Grant Application for the North Florida Freight Rail Enhancement Program – Phase II.

Section 3, Methodological Framework, introduces the conceptual framework used in the Cost-Effectiveness Analysis. To the extent possible, and as recommended in the Notice of Funding Opportunity (NOFO), monetized benefits and costs are estimated through a Benefit-Cost Analysis (BCA), which is described in this section. Section 4, Project Overview, provides an overview of the project, including a brief description of existing conditions and proposed alternatives; a summary of cost estimates and schedule; and a description of the types of effects that the North Florida Freight Rail Enhancement Program is expected to generate. Monetized, quantified, and qualitative effects are highlighted. Section 5, General Assumptions, discusses the general assumptions used in the estimation of project costs and benefits, while estimates of travel demand and traffic growth can be found in Section 6, Demand Projections. Specific data elements and assumptions pertaining to the merit criteria are presented in Section 7, Benefits Measurement, Data and Assumptions, along with associated benefit estimates. Estimates of the project's Net Present Value (NPV), its Benefit/Cost ratio (BCR) and other project evaluation metrics are introduced in Section 8, Summary of Findings and BCA Outcomes. Next, Section 9, BCA Sensitivity Analysis, provides the outcomes of the sensitivity analysis. Additional data tables are provided in Section 10, Supplementary Data Tables, including annual estimates of benefits and costs, as well as intermediate values to assist DOT in its review of the application.

3. Methodological Framework

The Cost-Effectiveness Analysis conducted for this project includes the monetized benefits and costs measured through Benefit-Cost Analysis (BCA), as well as the quantitative and qualitative merits of the project. BCA is a conceptual framework that quantifies in monetary terms as many of the costs and benefits of a project as possible. Benefits are broadly defined. They represent the extent to which people impacted by the project are made better-off, as measured by their own willingness-to-pay. In other words, central to BCA is the idea that people are best able to judge what is "good" for them, what improves their well-being or welfare.

BCA also adopts the view that a net increase in welfare (as measured by the summation of individual welfare changes) is a good thing, even if some groups within society are made worse-off. A project or proposal would be rated positively if the benefits to some are large enough to compensate the losses of others.

Finally, BCA is typically a forward-looking exercise, seeking to anticipate the welfare impacts of a project or proposal over its entire life-cycle. Future welfare changes are weighted against today's changes through discounting, which is meant to reflect society's general preference for the present, as well as broader inter-generational concerns.

The specific methodology developed for this application was developed using the above BCA principles and is consistent with the FASTLANE guidelines. In particular, the methodology involves:

- Establishing existing and future conditions under the build and no-build scenarios;
- Assessing benefits with respect to each of the four merit criteria identified in the FASTLANE BCA guidance;
- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement;
- Using DOT guidance for the valuation of travel time savings, safety benefits and reductions in air emissions, while relying on industry best practice for the valuation of other effects;
- Discounting future benefits and costs with the real discount rates recommended by the DOT (7 percent, and 3 percent for sensitivity analysis); and
- Conducting a sensitivity analysis to assess the impacts of changes in key estimating assumptions.

4. Project Overview

The North Florida Freight Rail Enhancement Program Phase II improves freight rail system operations at the CSXT Beaver Street Interchange and throughout the Jacksonville Terminal. The proposed project includes: constructing a new parallel 7,000 foot long bypass/storage track; installing new turnouts and crossovers with power switches for more efficient and safer operations throughout the Jacksonville Terminal and CSXT Moncrief Yard; and upgrading the existing Florida East Coast Railway (FEC) signal system with Centralized Traffic Control (CTC) for approximately 5.35 miles between Bowden Yard and the FEC St John's River Railway Bridge to provide more efficient train signaling for the routing trains into and out of the Jacksonville Terminal.

Base Case and Alternatives

For the purpose of this analysis, the build scenario (i.e., alternative) assumes completion of the rail line improvements and full operation of the rail line at the Beaver Interchange. This will be compared to the no-build scenario, or base case, in order to measure the incremental benefits of the facility. The build scenario includes a 7,000 foot long bypass/storage track, installing new turnouts and crossovers and upgrading the existing FEC signal system with Centralized Traffic Control. No other alternatives are under consideration.

Types of Impacts and Affected Population

The North Florida Freight Rail Enhancement Program will address known deficiencies by providing a more efficient rail network for existing and future freight rail users. The new turnouts and crossovers, as well replacement of antiquated rail switches and connective track, will improve capacity, safety and environmental sustainability in the region.

Project Cost and Schedule[1]

The project costs in the table below include capital costs (turnouts, crossovers, power switches, etc.). These expenditures are necessary in order to improve and enhance the Beaver Interchange. The project capital costs will be spent over 3 years in 2017, 2018 and 2019. The benefits will start accruing the following year in 2020 and are analyzed over a 20-year period until 2039.

Table 1: Project Cost Summary Table, Discounted at 7%

Cost Type	Cost in 2015 Dollars
Capital Cost	$32,036,430
TOTAL	**$32,036,430**

Disruptions Due to Construction

The North Florida Freight Rail Enhancement Program project may have short-term construction impacts on rail traffic but are expected to create minimal delays. No disruptions to traffic are included in the BCA.

FASTLANE Merit Criteria

The main benefit categories associated with the project are mapped into the four merit criteria set forth by the DOT in the tables below.

[1] All cost estimates in this section are in millions of dollars of 2015, discounted to 2016 using a 7 percent real discount rate.

Table 2: Expected Effects on Merit Outcomes and Benefit Categories

Merit Criteria	Benefit or Impact Categories	Description	Monetized	Quantified	Qualitative
Economic	Inventory Cost Savings	Faster delivery times for mode switchers as well as remaining highway truck users due to less congestion will lead to inventory cost savings			Yes
Mobility	Reduced Pavement Costs	Decrease in cost of maintaining and repairing pavement and infrastructure due to use of new materials in the build scenario	Yes		
	Reduced Congestion Costs	Decrease in the amount of freight truck traffic on the highways will lead to less congestion for remaining highway users	Yes		
	Efficiency at Grade Crossings	Improvements will reduce wait times for vehicular traffic at crossings	Yes		
Safety	Accident Cost Reduction	Reduction in injuries and fatalities due to infrastructure improvements in the build scenario	Yes		
	Less Ambulance Waiting Time	Reduction in the amount of time ambulances have to wait at train crossings during emergency response			Yes
Community and Environmental	Emission Cost Reduction	Reduction in vehicle pollutants and green house gases due to reductions in vehicle miles traveled (VMT) from decreased truck traffic in the build scenario	Yes		
	Noise Cost Reduction	Reduction in noise pollution from a decrease in VMT of truck traffic in the build scenario	Yes		

5. General Assumptions

The BCA measures benefits against costs throughout a period of analysis beginning at the start of construction and including 20 years of operations.

The monetized benefits and costs are estimated in 2015 dollars with future dollars discounted in compliance with FASTLANE requirements using a 7 percent real rate, and sensitivity testing at 3 percent.

The methodology makes several important assumptions and seeks to avoid overestimation of benefits and underestimation of costs. Specifically:

- Input prices are expressed in 2015 dollars;
- The period of analysis begins in 2017 and ends in 2039. It includes project development and construction years (2017-2019) and 20 years of operations (2020-2039);
- A constant 7 percent real discount rate is assumed throughout the period of analysis. A 3 percent real discount rate is used for sensitivity analysis;
- Opening year demand is an input to the BCA and is assumed to be fully realized in Year 1 (no ramp-up); and
- Unless specified otherwise, the results shown in this document correspond to the effects of the build alternative defined in section 4.

6. Demand Projections

The success of a freight project is dependent on its ability to attract new and other modal (diverted) freight due to the new interchange improvements. This analysis assumes that shippers are independent and rational decision makers who will only divert if the new facility lowers their general cost to ship. Costs to ship goods depend on many factors, including the type of good, distance to location, and length of drayage. All these factors are considered in the analysis.

Methodology

Diversion estimates were developed utilizing a capacity-based approach. Specifically, rail capacity data were provided by Jacksonville Transportation Authority (JTA). Diversion estimates and forecasts are based on the FHWA Freight Analysis Framework (FAF3) database. Only truck traffic with either the origin or destination directly feeding into the Beaver Interchange is included in the diversion analysis. The decision process included working with CSX Intermodal Office to flag commodity groups that are more than 50 percent likely to travel via rail over truck. Key diversion assumptions are located in the section below.

Assumptions

Raw data provided by the FAF database is reported in tons from each origin and destination point. An assumption is made on the average payload of trucks to convert the data into volume of trucks.

Table 3: Assumption of Average Truck Payload

Variable Name	Unit	Value	Source
Payload	Tons	15	HDR Subject Matter Expert

The data from the FAF database is filtered further by eliminating those freight units traveling at shorter distances. Freight traveling short lengths would not divert to rail because it would be less economically viable when taking into account drayage. HDR assumed a threshold distance based on prior rail experience.

Table 4: Assumption of Minimum Threshold for Truck Trip Length

Variable Name	Unit	Value	Source
Minimum Threshold - Trip Length	Miles	500	HDR Subject Matter Expert

From this data, an assumption must be made on the proportion of trucks whose general shipper costs would be lower if they divert to rail. In previous similar regional analysis, a diversion rate of 10 percent was provided by subject matter experts.

Table 5: Assumption on Diversion Rate for Truck Freight

Variable Name	Unit	Value	Source
Diversion Rate	%	10	Subject Matter Expert

In order to estimate certain benefits such as pavement maintenance and accident reduction, the vehicle miles traveled (VMT) must be estimated for those diverted trucks in the no-build scenario. Miles traveled are provided in the FAF database but some assumptions must be made as they relate to drayage and any additional miles added from rail.

Table 6: Assumptions on Drayage and Added Trip Miles

Variable Name	Unit	Value	Source
Drayage	Miles	100	HDR Subject Matter Expert
Rail Miles – Truck Miles Factor	-	1.15	

It is expected that traffic will grow over the analysis period. This was accomplished using truck traffic growth forecasts from the University of Florida's Bureau of Economic and Business Research (BEBR).

Table 7: Assumptions on Truck Traffic Growth Rates

Variable Name	Unit	Value	Source
Growth Rate	Percentage	1.365%	University of Florida's Bureau of Economic and Business Research (BEBR)

The demand uses the capacity of the new rail line as a constraint from demand. Capacity for the line will increase as an additional rail line will be added to increase efficiencies but not infinitely.

Table 8: Assumptions on Rail Capacity

Variable Name	Unit	Value	Source
Additional Capacity	Additional Trains per Day	1	HDR Subject Matter Expert
Rail Cars per Train	Rail Cars per Train	200	

The rail grade crossing data used to estimate the benefits to the crossing users are sourced fro the FRA Grade Crossing Database. The data shown in Table 9 is from the latest year of record for each crossing and traffic counts were increased in accordance with the city of Jacksonville population growth trends.

Table 9: Rail Grade Crossing Data

Location	Average Train Speed	Traffic Count (AADT)	Year	Source
Reba St	32.5 mph	3300	1988	FRA Grade Crossing Database
Emerson St	32.5 mph	20684	1988	
St. Augustine Rd	22.5 mph	9660	1988	
Atlantic Blvd	22.5 mph	12000	1988	
Hendricks Ave	22.5 mph	15723	1988	
Nira St	22.5 mph	3020	1988	
Gary St	17.5 mph	1640	1988	
San Marco Ave	15 mph	10400	1988	
Prudential	15 mph	10137	1988	
McQuade St	22.5 mph	5567	2008	

Demand Projections

The resulting projections for diversion are presented in the table below at 10-year intervals. Projections by year are provided in Table 21.

Table 10: Demand Projections

Demand	In Project Opening Year	2028	2038	Total
Trucks Diverted	20,419	23,058	26,393	465,705

7. Benefits Measurement, Data and Assumptions

This section describes the measurement approach used for each benefit or impact category identified in Table 2 and provides an overview of the associated methodology, assumptions, and estimates.

Merit Criteria

MOBILITY OUTCOMES

The mobility outcomes resulting from this project's implementation include a decrease in pavement maintenance costs and reduced congestion costs due to diversion of truck cargo off of the roadways and on to rail. Efficiency at grade crossings for vehicular traffic on the roadways is also monetized as a mobility benefit in the congestion category.

Methodology

Pavement maintenance costs as well as reduced congestion costs are calculated using vehicle miles traveled (VMT) as well as pavement cost per VMT and congestion cost per VMT values included in the FASTLANE BCA Resource Guide (November 2016). Grade crossing congestion is calculated by estimating an average delay at the grade crossings in the project area for each and assuming the rail line improvements will provide an improved efficiency in the reduction of automobile wait time.

Assumptions

The assumptions used in the estimation of mobility benefits are summarized in the table below.

Table 11: Assumptions used in the Estimation of Mobility Benefits

Variable Name	Unit	Value	Source
Pavement maintenance cost	Cents per VMT	10.5	FASTLANE BCA Resource Guide, November 2016, US DOT. HDR has inflated values from 2014 Dollars to 2015 Dollars using Consumer Price Index.
Congestion Costs	Cents per VMT	12.1	FASTLANE BCA Resource Guide, November 2016, US DOT. HDR has inflated values from 2014 Dollars to 2015 Dollars using Consumer Price Index.
Southbank Grade Crossing Average Delay	Minutes	3.67	FDOT Observations
Northbank Grade Crossing Average Delay	Minutes	3	FDOT Observations
Efficiency improvement in Grade Crossing Wait Time	%	10	HDR Subject Matter Expert

Benefit Estimates

The results for mobility benefits are shown below in Table 12. The pavement maintenance cost savings for the opening year is $1.47 million while the opening year benefits to congestion are calculated at $1.69 million. Over the 20-year analysis period, pavement costs are reduced by a total of $33.6 million or $15.1 million when discounted at 7%. Congestion costs are reduced by $38.6 million over the analysis period undiscounted and $17.3 million discounted at 7%. Grade crossing efficiency is also included in the reduced congestion costs.

Table 12: Estimates of Mobility Benefits, Millions of 2015 Dollars

Variable	In Project Opening Year	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Reduced Pavement Costs	$1.47	$33.6	$15.1
Reduced Congestion Costs	$1.69	$38.6	$17.3

SAFETY OUTCOMES

The safety outcome associated with the North Florida Freight Rail project reflects a reduction in the number of injury- and fatality-causing accidents due to a decrease in the number of trucks on the highway.

Methodology

The number of accidents resulting in injuries or fatalities was determined through the use of injury and fatality rates per VMT. A decrease in VMT leads to a reduction in accidents, as well as injuries and fatalities. Injury and fatality rates per VMT for the increase in rail miles were taken into account as well to provide a net benefit.

Assumptions

The assumptions used in the estimation of safety benefits are summarized in Table 13.

Table 13: Assumptions used in the Estimation of Safety Benefits

Variable Name	Unit	Value	Source
Truck traffic injury rate	Injuries per million VMT	.265	Federal Railroad Administration (FRA)
Truck traffic fatality rate	Fatalities per million VMT	.014	FRA
Rail injury rate	Injuries per million VMT	6.537	FRA
Rail fatality rate	Fatalities per million VMT	1.355	FRA
Cost per Injury Growth Factor	Percentage	1.00%	Guidance on Treatment of the Economic Value of a Statistical Life, 2015, US DOT

Benefit Estimates

The table below shows the monetized safety benefits in the opening year of 2019 as well as over the project lifecycle. In the opening year, accident costs will be reduced by $417,131 with fatality costs decreasing by $1.94 million. Over the analysis period, we expect injury costs to be reduced by $9.5 million while fatality costs decrease $44.2 million over that same time period. Discounted at 7%, this reduction is $3.99 million and $18.5 million respectively.

Table 14: Estimates of Safety Benefits, Millions of 2015 Dollars

Variable	In Project Opening Year	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Reduced Injury Accident Costs	$0.42	$9.5	$3.99
Reduced Fatality Accident Costs	$1.94	$44.2	$18.5

COMMUNITY AND ENVIRONMENTAL

The North Florida Freight Rail Enhancement Program will contribute to the environmental sustainability category by reducing vehicle emissions and noise pollution.

Methodology

Vehicle emission cost savings were calculated by using vehicle emission rates per VMT derived through the Motor Vehicle Emissions Simulator (MOVES). These values are then monetized using dollar values consistent with those found in NHTSA's Final Regulatory Impact Analysis of the CAFÉ for MY2012-MY2016 Passenger Cars and Light Trucks and in the FASTLANE BCA Resource Guide (November 2016).

Noise pollution cost reduction is calculated using VMT reduction and cost per VMT, consistent with the FASTLANE BCA Resource Guide (November 2016).

Assumptions

The assumptions used in the estimation of community and environmental benefits are summarized in the table below.

Table 15: Assumptions used in the Estimation of Community and Environmental Benefits

Variable Name	Unit	Value	Source
Volatile Organic Compounds (VOC)	$ per short ton	$2,032	FASTLANE BCA Resource Guide, November 2016, US DOT
Nitrogen Oxides (NOx)	$ per short ton	$8,010	
Fine Particulate Matter (PM)	$ per short ton	$366,414	
Sulfur Dioxide (SO2)	$ per short ton	$42,341	
Carbon (CO2)	$ per short ton	$43	
Noise	$ per VMT	$.022	

Benefit Estimates

Emission costs are reduced by $4.67 million over the analysis period, with a slight increase of $36,248 in the opening year. Discounted 7% emission cost savings are $1.30 million over the analysis period. Emissions reductions due to less idling at grade crossings are included in the overall emissions cost reduction. Noise reduction cost savings are $7.17 million over the analysis period, $3.01 million when discounted 7%. $300,000 is saved in noise costs during the opening year.

Table 16: Estimates of Community and Environmental Benefits, Millions of 2015 Dollars

Variable	In Project Opening Year	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Emissions Cost Reduction	-$0.036	$4.67	$1.30
Noise Cost Reduction	$0.314	$7.17	$3.01

8. Summary of Findings and BCA Outcomes

The tables below summarize the BCA findings. Annual costs and benefits are computed over the lifecycle of the project (20 years). As stated earlier, construction is expected to be completed by 2019. Benefits accrue during the full operation of the project.

Table 17: Overall Results of the Benefit Cost Analysis, Millions of 2015 Dollars*

Project Evaluation Metric	7% Discount Rate	3% Discount Rate
Total Discounted Benefits	$60.30	$97.15
Total Discounted Costs	$32.04	$34.53
Net Present Value	$28.26	$62.62
Benefit / Cost Ratio	1.88	2.81
Internal Rate of Return (%)	15%	
Payback Period (years)	8	

** Unless Specified Otherwise*

Considering all monetized benefits and costs, the estimated internal rate of return of the project is 15 percent. With a 7 percent real discount rate, the investment would generate a Benefit/Cost ratio of approximately 1.88.

With a 3 percent real discount rate, the Net Present Value of the project would increase to $62.6 million, for a Benefit/Cost ratio of 2.81.

Table 18 presents monetized benefit estimates by merit criteria in the build alternative. Benefits associated with mobility account for 55% of the benefits, while safety benefits make up nearly 37% of the benefits for a total of 93% between the two categories.

Table 18: Benefit Estimates by Merit Criteria for the Full Build Alternative

Merit Criteria	Benefit Categories	7% Discount Rate	3% Discount Rate
Mobility	Maintenance Cost Reduction	$14.5	$23.2
	Congestion Reduction	$19.0	$30.4
Safety	Injury Cost Reduction	$4.0	$6.4
	Fatality Cost Reduction	$18.5	$29.7
Community and Environmental	Emission Cost Reduction	$1.3	$2.7
	Noise Cost Reduction	$3.0	$4.8
Total Benefit Estimates		$60.3	$97.2

Note: * Excluding the short-term employment impacts of the project

9. BCA Sensitivity Analysis

The BCA outcomes presented in the previous sections rely on a large number of assumptions and long-term projections, all of which are subject to considerable uncertainty.

The primary purpose of the sensitivity analysis is to help identify the variables and model parameters whose variations have the greatest impact on the BCA outcomes: the “critical variables.”

The sensitivity analysis can also be used to:

- Evaluate the impact of changes in individual critical variables – how much the final results would vary with reasonable departures from the “preferred” or most likely value for the variable; and
- Assess the robustness of the BCA and evaluate, in particular, whether the conclusions reached under the “preferred” set of input values are significantly altered by reasonable departures from those values.

The outcomes of the quantitative analysis for the North Florida Freight Rail Enhancement Program using a 7 percent discount rate are summarized in the table below. The table provides the percentage changes in project NPV associated with variations in variables or parameters (listed in row), as indicated in the column headers.

Table 19: Assessment of BCA Sensitivity, Summary

Parameters	Change in Parameter Value	New NPV	Change in NPV	New B/C Ratio
Value of Statistical Life	Lower Bound of Range Recommended by US DOT ($5.4 million)	$20,149,913	-28.7%	1.63
	Upper Bound of Range Recommended by US DOT ($13.6 million)	$35,982,583	27.3%	2.12
Capital Cost Estimate	25% Reduction	$36,268,216	28.3%	2.51
Efficiency Factor at Grade Crossings	Eliminate the Efficiency Improvement	$25,488,847	-9.8%	1.80
Efficiency Factor at Grade Crossings	Increase the Efficiency Improvement to 25%	$31,289,416	10.7%	1.98

10. Supplementary Data Tables

This section breaks down all benefits associated with the four merit criteria (Economic, Mobility, Safety, Community & Environmental) in annual form for the North Florida Freight Rail Enhancement Program. Supplementary data tables are also provided for some specific benefit categories. For example, tables providing estimates of annual emission reductions (in tons) are provided under Environmental Sustainability.

Table 20 - Annual Monetized Estimates of Total Project Benefits and Costs

Calendar Year	Project Year	Total Benefits ($2015)	Total Costs ($2015)	Undiscounted Net Benefits ($2015)	Discounted Net Benefits at 7%	Discounted Net Benefits at 3%
2017	1	$0	$11,408,911	-$12,207,535	-$11,408,911	-$11,851,976
2018	2	$0	$10,662,534	-$12,207,535	-$10,662,534	-$11,506,773
2019	3	$0	$9,964,985	-$12,207,535	-$9,964,985	-$11,171,624
2020	4	$6,099,748	$0	$6,099,748	$4,653,468	$5,419,547
2021	5	$6,158,450	$0	$6,158,450	$4,390,890	$5,312,333
2022	6	$6,262,282	$0	$6,262,282	$4,172,823	$5,244,563
2023	7	$6,370,861	$0	$6,370,861	$3,967,452	$5,180,093
2024	8	$6,613,666	$0	$6,496,371	$3,780,947	$5,128,295
2025	9	$6,613,666	$0	$6,613,666	$3,597,396	$5,068,824
2026	10	$6,750,957	$0	$6,750,957	$3,431,844	$5,023,346
2027	11	$6,878,960	$0	$6,878,960	$3,268,144	$4,969,507
2028	12	$7,010,456	$0	$7,010,456	$3,112,726	$4,916,993
2029	13	$7,138,772	$0	$7,138,772	$2,962,337	$4,861,157
2030	14	$7,277,556	$0	$7,277,556	$2,822,362	$4,811,322
2031	15	$7,431,402	$0	$7,431,402	$2,693,482	$4,769,934
2032	16	$7,582,642	$0	$7,582,642	$2,568,503	$4,725,252
2033	17	$7,735,318	$0	$7,735,318	$2,448,804	$4,679,995
2034	18	$7,872,627	$0	$7,872,627	$2,329,226	$4,624,339
2035	19	$8,031,477	$0	$8,031,477	$2,220,770	$4,580,239
2036	20	$8,192,875	$0	$8,192,875	$2,117,194	$4,536,196
2037	21	$8,334,399	$0	$8,334,399	$2,012,866	$4,480,150
2038	22	$8,498,421	$0	$8,498,421	$1,918,206	$4,435,262
2039	23	$8,656,667	$0	$8,656,667	$1,826,097	$4,386,262
Total		**$145,511,203**	**$32,036,430**	**$108,771,303**	**$28,259,109**	**$62,623,237**

Table 21 - Annual Demand Projections

Year	Project Year	Total Truck VMT No Build	Total Truck VMT Build	Total Trucks Diverted in the Build Scenario
2020	1	142,076,351	127,875,707	13,981
2021	2	144,008,590	129,614,816	14,171
2022	3	145,967,107	131,377,578	14,364
2023	4	147,952,259	133,164,313	14,559
2024	5	149,964,410	134,975,348	14,757
2025	6	152,003,926	136,811,012	14,958
2026	7	154,071,179	138,671,642	15,162
2027	8	156,166,547	140,557,577	15,368
2028	9	158,290,412	142,469,160	15,577
2029	10	160,443,162	144,406,740	15,789
2030	11	162,625,189	146,370,672	16,003
2031	12	164,836,892	148,361,313	16,221
2032	13	167,078,673	150,379,027	16,442
2033	14	169,350,943	152,424,182	16,665
2034	15	171,654,116	154,497,150	16,892
2035	16	173,988,612	156,598,312	17,122
2036	17	176,354,857	158,728,049	17,354
2037	18	178,753,283	160,886,750	17,590
2038	19	181,184,328	163,074,810	17,830
2039	20	183,648,435	165,292,627	18,072
Total		**3,240,419,273**	**2,916,536,785**	**318,878**

Table 22: Mobility - Annual Benefit Estimates

Calendar Year	Project Year	Total Benefits	Discounted Benefits at 7%	Discounted Benefits at 3%
2020	1	$3,467,975	$2,645,702	$3,081,251
2021	2	$3,518,380	$2,508,557	$3,034,986
2022	3	$3,569,518	$2,378,520	$2,989,415
2023	4	$3,621,453	$2,255,259	$2,944,573
2024	5	$3,674,195	$2,138,415	$2,900,443
2025	6	$3,727,748	$2,027,648	$2,857,009
2026	7	$3,782,097	$1,922,626	$2,814,235
2027	8	$3,837,268	$1,823,058	$2,772,124
2028	9	$3,893,301	$1,728,672	$2,730,683
2029	10	$3,950,200	$1,639,192	$2,689,894
2030	11	$4,007,978	$1,554,363	$2,649,745
2031	12	$4,066,680	$1,473,952	$2,610,247
2032	13	$4,126,342	$1,397,735	$2,571,400
2033	14	$4,186,931	$1,325,475	$2,533,162
2034	15	$4,248,412	$1,256,952	$2,495,494
2035	16	$4,310,878	$1,191,994	$2,458,434
2036	17	$4,374,307	$1,130,404	$2,421,948
2037	18	$4,438,714	$1,072,008	$2,386,028
2038	19	$4,504,180	$1,016,653	$2,350,698
2039	20	$4,570,728	$964,181	$2,315,950
Total		**$79,877,285**	**$33,451,365**	**$53,607,718**

Table 23: Safety - Annual Benefit Estimates

Calendar Year	Project Year	Total Benefits 2015 Dollars	Discounted Benefits at 7%	Discounted Benefits at 3%
2019	1	$2,353,332	$1,795,346	$2,090,905
2020	2	$2,385,338	$1,700,713	$2,057,613
2021	3	$2,417,778	$1,611,068	$2,024,851
2022	4	$2,450,660	$1,526,148	$1,992,611
2023	5	$2,483,989	$1,445,704	$1,960,884
2024	6	$2,517,771	$1,369,501	$1,929,662
2025	7	$2,552,013	$1,297,314	$1,898,937
2026	8	$2,586,720	$1,228,932	$1,868,702
2027	9	$2,621,900	$1,164,155	$1,838,948
2028	10	$2,657,558	$1,102,792	$1,809,667
2029	11	$2,693,700	$1,044,663	$1,780,853
2030	12	$2,730,335	$989,599	$1,752,498
2031	13	$2,767,467	$937,437	$1,724,594
2032	14	$2,805,105	$888,024	$1,697,135
2033	15	$2,843,254	$841,216	$1,670,112
2034	16	$2,881,922	$796,876	$1,643,520
2035	17	$2,921,117	$754,872	$1,617,351
2036	18	$2,960,844	$715,083	$1,591,599
2037	19	$3,001,111	$677,390	$1,566,257
2038	20	$3,041,926	$641,685	$1,541,319
Total		**$53,673,841**	**$22,528,518**	**$36,058,020**

Table 24: Community and Environmental - Annual Benefit Estimates

Calendar Year	Project Year	Total Benefits 2015 Dollars	Discounted Benefits at 7%	Discounted Benefits at 3%
2019	1	$278,440	$212,421	$247,390
2020	2	$254,732	$181,621	$219,734
2021	3	$274,986	$183,235	$230,297
2022	4	$298,748	$186,045	$242,909
2023	5	$338,187	$196,828	$266,968
2024	6	$368,146	$200,247	$282,154
2025	7	$416,847	$211,904	$310,174
2026	8	$454,972	$216,154	$328,681
2027	9	$495,255	$219,899	$347,362
2028	10	$531,015	$220,352	$361,595
2029	11	$575,878	$223,336	$380,723
2030	12	$634,387	$229,931	$407,189
2031	13	$688,833	$233,331	$429,258
2032	14	$743,283	$235,304	$449,698
2033	15	$780,962	$231,058	$458,733
2034	16	$838,677	$231,901	$478,286
2035	17	$897,451	$231,918	$496,897
2036	18	$934,840	$225,776	$502,523
2037	19	$993,130	$224,163	$518,307
2038	20	$1,044,013	$220,231	$528,993
Total		**$11,842,783**	**$4,315,656**	**$7,487,871**