Broward County's Port Everglades Intermodal Freight Connector Project

Benefit-Cost Analysis Documentation

Overview

The technical documentation below describes the Benefit-Cost Analysis completed in support of Broward County's Port Everglades Intermodal Freight Connector Project. The documentation is organized around the worksheets provided in the attached MS Excel spreadsheet.

Monetized Values and Factors

The "Monetized Values and Factors" tab contains many of the main factors used in the overall analysis. The majority of these, particularly those related to safety, economic competitiveness, and environmental protection came directly from the *Benefit Cost Analysis Guidance for Discretionary Grant Programs* provided in June 2018 by the U.S. Department of Transportation. These factors include: the value of a statistical life, value of injuries, value of property damage only crashes, value of time by user type, truck operating costs, and the value of emissions for four emission types. In addition, these factors were supplemented by the following values:

- Pavement Damage as defined by the *Pricing Freight Transport to Account for External Costs, Congressional Budget Office Working Paper 2015-03* for measuring the impacts on the State of Good Repair.

- Rail Operating Costs based on *Total Annual Spending 2015 Data* from the Association of American Railroads (AAR) for measuring the impacts on Economic Competitiveness.

- Truck Fuel Consumption based on the *2016 Vehicle Technologies Market Report* from the Oak Ridge National Laboratory and the U.S. Department of Energy for measuring impacts on Environmental Protection.

- Rail Fuel Consumption based on *Total Annual Spending 2015 Data* from the Association of American Railroads.

Inflation Adjustment

The "InflationAdjustment" tab contains factors used to adjust dollars from one year to the next. Because not all measures are given in same year values, particularly for multi- year projects with benefits accruing over multiple decades, it is necessary to adjust the values to a consistent year to ensure a fair comparison. These factors were provided from the *Benefit Cost Analysis Guidance for Discretionary Grant Programs.*

Emissions – Truck

Truck emissions were determined based off the California Life-Cycle Benefit-Cost Analysis Model (Version 6.0) from Caltrans. This model provides emissions factors for 2011 and 2031 for varying rates of speed for six emissions types: CO, CO_2, NOx, PM_{10}, SOx, and VOC. Given the available values are only for 2016 and 2036, the interim years were estimated based on an average annual rate of change.

This range did not provide values for the entire life of the project. For environmental impacts beyond 2036, values for each emissions type were held constant at the 2036 value. This is a conservative estimate for CO, NOx, and VOC as each of these had a negative rate of change, suggesting that impacts in later years are less than those in earlier years for the same mileage. CO_2, PM_{10}, and SOx had a rate of change of effectively zero so these values are relatively unchanged over time.

Because emission rates are impacted by the truck speed, values for each average speed were applied to the average speeds calculated for the individual markets with and without the project. More details on the calculation of speed are found in the "Without Market Assumptions" sheet.

It should be noted that the U.S. DOT does not currently provide recommended unit values for CO_2.

Emissions – Rail

Rail emission rates were not provided through the BUILD guidance and with the privatized nature of railroads, these rates are more difficult to find. However, the U.S. Environmental Protection Agency (EPA) developed a *Logistics Company Partner 2.0.16 Tool: Technical Documentation 2017 Data Year – United States Version* which does contain some of these emission rates. Values were found for CO_2, NOx, and $PM_{2.5}$. A note here is that $PM_{2.5}$ is not the same as PM_{10}. $PM_{2.5}$ is more associated with fuel burning, industrial combustion processes, and vehicle emissions. PM_{10}, on the other hand, includes these same things but also other contributions such as road dust and construction activities and includes particulates of larger sizes (10 µm vs 2.5 µm). In this case, the particulate matter for railroads is less encompassing but the $PM_{2.5}$ value is used in lieu of better available data. With the railroad share of traffic being several orders of magnitude less than the truck share, this has a minimal impact on the benefits.

In addition to the discrepancies in particulate matter, values were not found for VOCs or SOx for railroads. However, these too have little impact on the overall benefits of the project. Including these two emission types would reduce the overall benefits slightly but these have the smallest impact of the five emission types included as part of this analysis. Based on guidance from *Benefit Cost Analysis Guidance for Discretionary Grant Programs*, VOCs have the lowest monetized value per metric ton (compare $1,905/short ton versus $343,442/short ton for particulate matter). SOx, for its part, is the least emitted type of the five based on available truck values. As mentioned, excluding these values does exclude some positive benefits associated with a decrease in rail mileage with the completion of this project however the change in rail usage is significantly smaller than shifts in truck usage and has minimal impact on the final benefit-cost ratio.

Crash Rates

The "Crash Rates" sheet supplements the information given by the BCA Guidance. These values allow for a calculation of the rate of accident occurrence to determine the quantity of fatalities, injuries, and property damage only crashes. The quantity is then used with the monetized values provided by the BCA Guidance to determine the cost to human life of truck and rail travel.

The truck travel values were determined by the latest *Large Truck and Bus Crash Facts 2015* provided by the Federal Motor Carrier Safety Administration (FMCSA) in April 2017. As incident rates were reported for both single-unit trucks and combination trucks, an average incident rate was computed based on the vehicle miles traveled (VMT) share of these modes. The VMT values are the latest available from the Federal Highway Administration's (FHWA) *Freight Facts and Figures 2017.*

Rail crash rates were determined from the Bureau of Transportation Statistics' *Railroad System Safety and Property Damage Data*, with 2016 representing the most current year of data. These crash rates were used to determine fatalities and injuries per train mile. Property damage only accident rates were not used here as the railroads report total property damage which can then be divided by the total train miles to determine the average property damage per train mile.

Project Costs

The "Project Costs" sheet details at a high level overall project costs. Note that the total costs here include more than what is being asked for as part of this grant. Additional project costs were based on previously funded and/or completed projects. Specifically, these relate to environmental mitigation. These projects have not been included in the grant request amount as they are funded through state and local efforts and have moved forward as precursor components. Annual future operating and maintenance costs were also included here in the amount of 0.5 percent of the total construction cost.

Other Factors

The "Other Factors" sheet encompasses the other factors which are utilized in order to calculate the benefits. Namely, this focuses on the conversion of TEUs to trucks and trains, the weight of a truck or railcar, and the mode split, distance, travel time, and travel speeds to serve each market with and without the project.

The conversion of TEUs to trucks was assumed to be a 2:1 ratio due to current industry practice to predominately use FEU (forty equivalent units), which is equivalent to 2 TEUs for intermodal shipments. The conversion of TEUs to railcars was assumed to be a 3:1 ratio to account for some double-stacking of containers on the railcars. Lastly, it was assumed that there are 151 railcars per train coming out of Port Everglades. This is based on the fact that the Intermodal Container Transfer Facility (ICTF) operated at Port Everglades is capable of processing 8,000' trains. With an average railcar length assumed to be 53', this then works out to 151 railcars per train.

The average weight of a truck was based on the maximum allowable loaded weight in the state of Florida, 80,000 pounds. A discount of 5 percent was applied to this to account for some trucks being lightly loaded. This is often not the case as shippers aim to make the best utilization of a truck trip and may even at times go over the legal weight if they do not believe they will be caught. This is a conservative estimate as a higher assumed truck tonnage would result in higher benefit in the final calculation. The average loaded railcar was assumed to be 58.8 tons based on current statistics from the Class I railroads.

The three main markets expected to be served by this project are South Florida, Central Florida, and the Southeastern United States. Of these, the only one anticipated to be served by rail with this project is the Southeastern United States. Based on the Port Everglades Master/Vision Plan, the anticipated rail share of this project is 12.4 percent. The remaining 87.6 percent of cargo is anticipated to be trucked to these markets based on the following market shares:

- South Florida – 70%
- Central Florida – 25%
- Southeastern United States – 5%

To determine the mode split of cargo without this project being completed the Freight Analysis Framework (FAF) version 4.4 developed by the Federal Highway Administration (FHWA) was utilized. This data source shows existing commodity flows by mode for imports and exports and the origin or final destination for these goods. The mode splits used, based on input from FAF, are shown in Table 1.

Table 1 Mode Split by Market Without the Project

	South Florida	Central Florida	Southeastern US
Truck	85%	70%	70%
Rail	15%	30%	30%

For the average truck distance and average travel speed with this project, Google and Google Maps were utilized to determine the distance and travel time between Port Everglades and the target markets by truck. These two values were then used to determine the travel speed between locations. Note that travel times have been increased 10 percent over the suggested Google time based on estimates by FHWA that trucks travel is 10 percent slower than passenger cars.

As only one market is served by rail with this project, these factors were only computed for the Southeastern United States. Due to the lack of readily available data, the train distance between Port Everglades and the Southeastern United States was assumed to be the same as the truck distance. Based on reports from the Class I railroads in the JOC, the average intermodal train was assumed to move at 31 miles per hour. Using the rail transit distance and average speed, the average rail travel time was calculated.

For the without project travel distances, speed, and time, refer to the "Without Project Port Usage" sheet explanation.

Without Project Port Usage

The benefits for this project were determined based on the differences between the scenario of this project being built and the scenario where this project is not built. In order to determine this, an important piece of information is what other ports can handle this cargo in the event that Port Everglades is not able to. To develop this information, FAF 4.4 was once again utilized. This was supplemented with information on investments being made at other ports competing for the larger post-Panamax ships that this project will attract. The following locations were determined to be the main competitors for this market:

- Jacksonville, Florida (Jaxport)
- Los Angeles/Long Beach, California (Port of Los Angeles/Long Beach)
- Miami, Florida (PortMiami)
- New York City, New York/New Jersey (Port of New York and New Jersey)
- Savannah, Georgia (Port of Savannah)
- Hampton Roads, Virginia (Port of Virginia)

Similar to the method used for the with project scenario, Google and Google Maps were then utilized to determine the distance and travel time between these port locations and the target markets by truck. These two values were then used to determine the travel speed between locations. Note that travel times have been increased 10 percent over the suggested Google time based on estimates by FHWA that trucks travel is 10 percent slower than passenger cars.

As rail transit distances are not readily available, the determined truck distance between the ports and markets were used. The exception to this is the Port of Los Angeles/Long Beach, which was increased to account for a transfer in Kansas City, Missouri based on current rail patterns. Based on reports from the Class I railroads in the JOC, the average intermodal train was assumed to move at 31 miles per hour. Using the rail transit distance and average speed, the average rail travel time was calculated.

For each of the target markets, South Florida, Central Florida, and the Southeastern United States, the market share was split among the determined competitor ports to simulate where the cargo will be processed if the project was not built. This was done for both rail and truck movements.

Using these market shares, average trip distances, average travel time, and average speed were determined for each market by both rail and truck.

Trip Calculation

The prior discussion of the worksheets within this workbook focused on the factors used as inputs into the calculation process. The remaining discussion focuses on the actual calculations used to determine the benefits. The first necessary step is to determine how many truck and rail trips will be generated by this project based on the estimated throughput. This is the primary factor impacting the remaining calculations.

Estimated throughput was provided by Port Everglades and assumed to reach a maximum of 730,000 TEUs per year. However, this volume is not anticipated to be achieved within the first year. A 10-year ramp up for cargo volumes was applied to this estimate with an assumed design life of 30 years. Multiplying this volume by the determined mode split in the "Other Factors" sheet calculates how many TEUs are moved by truck and rail with or without the project completion.

From here, the number of trips by mode was determined based on the average number of TEUs per movement per mode. For trucks, this involves dividing the truck TEUs by the TEU/truck ratio. For rail, this entailed dividing the rail TEUs by the TEU/railcar ratio and the railcar/train ratio to determine the total number of trains per year. The results of this are seen in Table 2. As a reality check, the maximum truck trips of 319,740 per year equates to roughly 1,230 truck trips per day assuming a five day work week, 52 weeks per year. The maximum train volumes of 200 per year equates to just under one train per day. This is realistic given the current operating conditions at Port Everglades and the supporting infrastructure that has been enhanced over the past few years. Further details on the split of these trips by market is shown in the MS Excel workbook. This additional calculation is based on the market share determined in the "Other Factors" sheet and is necessary due to the differing distances vehicles must travel to serve these markets.

Table 2 Change in Trips by Mode With and Without the Project

	With Project	Without Project	**Net Change**	**Annual Average**
Truck Trips	7,831,440	7,080,301	**822,301**	**27,410**
Rail Trips	4,896	8,214	**(3,318)**	**(111)**

As Table 2 details, with the completion of this project, there are more total truck trips over the life of the project but a lesser use in rail. While there is in a net increase in the number of truck trips produced by this project, on average, the trucks are traveling shorter distances to reach their destination. As such, there will still be a reduction in truck miles traveled, resulting in overall positive benefits.

VMT Ton-Mile Driver Time

The truck trips previously computed were then utilized to determine vehicle miles traveled (VMT), ton-miles, and the travel time by mode for users.

Vehicles miles traveled were calculated by multiplying the number of trips by mode and by market by the average modal distances determined for that mode/market as part of the "Other Factors" sheet. This was done for each of the three key markets for each mode, with and without the project. The changes in truck travel distances for the South Florida and Central Florida markets, at 82 miles and 96 miles respectively, result in an overall reduction in vehicle miles traveled by truck of nearly 1.5 billion over the life of this project. On average, this is about 48 million miles per year. For rail, there is a decrease in miles traveled due to this project of about 9.9 million miles per year. This is approximately 331,103 fewer rail miles per year. The overall summary of vehicles miles traveled by mode with and without project is summarized in Table 3.

Table 3 Change in Vehicle Miles Traveled by Mode With and Without the Project

	With Project	Without Project	**Net Change**	**Annual Average**
Truck VMT (in millions)	912	2,364	**(1,452)**	**(48)**
Rail VMT (in thousands)	3,158	13,091	**(9,933)**	**(331)**

The next step was to determine the ton-miles associated with each mode. This was done by taking the total VMT by each mode and multiplying it by the average loaded truck weight for truck calculations and the average loaded railcar weight for rail calculations. These factors can be found in the "Other Factors" sheet. As with the other calculations in the change between the with and without project scenarios, truck ton-miles show a positive impact with a total reduction of over 55 billion ton-miles over the life of the project, or about 1.8 billion ton-miles per year on average. Rail can be expected to experience an overall decrease in ton-miles as well with the implementation of this project in the amount of nearly 88 billion ton-miles over the 30-year life of the project, or about 3 billion ton-miles per year. The results of this calculation are summarized in Table 4.

Table 4 Change in Ton-Miles by Mode With and Without the Project

	With Project	Without Project	**Net Change**	**Annual Average**
Truck Ton-Miles (in millions)	34,670	89,847	**(55,177)**	**(1,839)**
Rail Ton-Miles (in millions)	28,029	116,190	**(88,161)**	**(2,939)**

The change in travel time is a factor of the total trips traveled. As each market has a different average travel time by mode with and without the project, this was determined on a per market basis. For instance, the total driver time associated with truck trips to South Florida with this project was calculated by multiplying the truck trips for South Florida with the project in "Trip Calculation" sheet by the average truck travel time for South Florida with the project found in the "Other Factors" sheet. This was done for each market by mode with and without the project completion. A summary of these calculations is shown in Table 5. In total, this project is projected to result in a net savings of over 6.9 million truck driver hours, and a decrease in locomotive engineer travel time of 302,422 hours. While this is a reduction in truck driver hours of over 231,000 hours per year on average, it would not impact the ability of truck drivers to find work due to the significant truck driver shortage in the U.S. Rather, this provides drivers an opportunity to make more turns per day within their allowable hours of service in a local market.

Table 5 Change in Travel Time by Mode With and Without Project Construction

	With Project	Without Project	**Net Change**	**Annual Average**
Truck Driver Travel Time (hours in thousands)	14,176	21,109	**(6,933)**	**(231)**
Locomotive Engineer Travel Time (hours in thousands)	102	422	**(320)**	**(11)**

State of Good Repair

The State of Good Repair benefits are determined based on the anticipated pavement damage caused with and without this project. As each truck travels, it causes a certain amount of wear on the roadway. The heavier the truck is, the more damage it may cause. While each truck may only cause a negligible amount of damage itself, the overall impact of thousands of trucks can add up to significant wear and tear.

Based on this, the overall impacts on pavement damage are based on the total ton-miles calculated previously. The value of pavement damage is computed by multiplying this ton-mileage by the pavement factors included in the "Monetized Values and Factors" sheet. The summary of these calculations is shown in Table 6. With the completion of this project, there will still be wear and tear on the roadways as the cargo is delivered. However, since there is an average reduction in ton-miles, the damage is not as significant. With this project, total pavement damage is estimated at $310 million (2014$). Without it, pavement damage will be nearly $828 million (2014$). This resulting net change (pavement damage avoided) of over half a billion dollars is equivalent to roughly $18 million (2017$) per year on average.

Table 6 Pavement Damage Caused With and Without the Project

	Pavement Damage (Avoided)	Annual Average
With Project (2014$, in millions)	$310	$10.3
Without Project (2014$, in millions)	$828	$27.6
Net Change (2014$, in millions)	($517)	$17.2
Net Change (2017$, in millions)	**($539)**	**($18.0)**

Economic Competitiveness

Economic Competitiveness is based on two factors: Vehicle Operating Costs and the Value of User Time.

Truck operating costs are calculated by multiplying the vehicle miles traveled previously computed by the "Truck Operating Costs" factors found in the "Monetized Values and Factors" sheet. Similarly, rail operating costs are calculated by multiplying the "Rail Operating Costs" factor found in this same sheet by the rail ton-mileage previously computed. The value of operating costs are summarized in Table 7. The net change between the with and without the project scenarios is approximately $2.3 billion, or $75 million per year. Based on the final analysis, this is the greatest factor impacting the total benefits associated with this project.

Table 7 Operating Costs With and Without the Project

	Operating Costs	Annual Average
With Project (2017$, in millions)	$1,124	$37.5
Without Project (2017$, in millions)	$3,382	$112.7
Net Change (2017$, in millions)	**($2,259)**	**($75.3)**

The cost of travel time associated with this project is based on the change in user travel time previously computed in the "VMT Ton-Mile Driver Time" sheet. The truck driver time (in hours) was multiplied by the hourly value of travel time for truck drivers provided in the BCA 2018 Guidance found in the "Monetized Values and Factors" sheet. Similarly, the rail user time was multiplied by the hourly value of travel time for a locomotive engineer. The total cost associated with user travel time with this project is estimated at $410 million compared to $623 million without this project. The net impact is a total benefit of $213 million in travel time cost savings, or about $7.1 million per year. The results from this calculation are shown in Table 8.

Table 8 Travel Time Cost With and Without the Project

	Driver Travel Time Costs	Annual Average
With Project (2017$), in millions)	$410	$13.7
Without Project (2017$, in millions)	$623	$20.8
Net Change (2016$, in millions)	**($213)**	**($7.1)**

The total Economic Competitiveness benefits are the summation of benefits from operating costs and travel time costs (Tables 7 and 8). Table 9 shows this summation. The construction of the Intermodal Fright Connector project will result in a positive benefit of almost $2.5 billion over the life of the project, or about $82 million per year.

Table 9 Total Economic Competitiveness With and Without the Project

	Economic Competitiveness	Annual Average
With Project (2017$, in millions)	$1,534	$51.1
Without Project (2017$, in millions)	$4,005	$133.5
Net Change (2017$, in millions)	**($2,471)**	**($82.4)**

Environmental Protection

The impact on Environmental Protection consists of four emission types: Nitrogen Oxides (NOx), Particulate Matter (PM), Sulfur Dioxide (SOx), and Volatile Organic Compounds (VOCs). The change in diesel consumption is also calculated here for illustrative purposes, but is not included in the overall benefits as fuel costs are a portion of vehicle operating costs included as part of the Economic Competitiveness benefits. The change in Carbon Dioxide (CO_2) is also included as it was previously calculated for prior analyses. However, Executive Order 13783 rescinded the determined monetized value for this emission type. To this end, CO_2 is presented as the net change in metric tons, but is not monetized nor included as part of the final Benefit-Cost Ratio.

Diesel consumption is based on ton-mileage previously calculated and the number of ton-miles used per gallon. Ton-mileage by mode was divided by the ton-miles/gallon factor included in the "Monetized Values and Factors" sheet. The net benefits of this project include a decrease in fuel consumption by over 545 million gallons over the life of the project.

The remaining Environmental Protection benefits for the four emission types (and CO_2) were calculated the same way for each. For truck emissions, this goes back to the discussion of the "Emissions – Truck" sheet. The emission rates for each type vary by both year and by speed so the calculations were done on a market basis with and without the project. In short, the calculation is the vehicle miles traveled multiplied by the emission rate found in the "Emissions – Truck" sheet based on the interpolated values for the specific speed determined for that market found in the "Other Factors" sheet. For instance, for South Florida, the average speed with the project was determined to be 54 miles per hour (mph). Therefore, the VMT associated with South Florida with this project construction was multiplied by the emissions rates for trucks traveling at 54 mph. Doing this for each market and each emissions type with and without the project results in the final protection benefits shown in Table 10. Note this table also includes rail emissions for CO_2, NOx, and PM but not SOx and VOCs as previously discussed in the "Emissions – Rail" sheet. Rail emissions are computed on a per ton-mile basis. Therefore the rail factors found in "Emissions – Rail" are multiplied by the computed ton-mileage found in "VMT Ton-Mile Driver Time" to determine the environmental benefits associated with rail movements. Based on the decrease in miles traveled for this project, emissions of each type are found to decrease.

Table 10 Environmental Protection (Pollution and Fuel Saved) With and Without the Project

	With Project	Without Project	**Net Change**
Diesel Consumption (million gallons)	285	830	**(545)**
Carbon Dioxide (CO_2) (metric tons)	1,293,803	3,984,527	**(2,690,724)**
Nitrogen Oxides (NOx) (metric tons)	12,212	50,130	**(37,918)**
Particulate Matter (PM) (metric tons)	340	1,401	**(1,062)**
Sulfur Dioxide (SOx) (metric tons)	7	15	**(8)**
Volatile Organic Compounds (VOCs) (metric tons)	18	40	**(22)**

These calculated metric tonnages were then multiplied by the Value of Emissions provided by *Benefit Cost Analysis Guidance for Discretionary Grant Programs,* which can be found in the "Monetized Values and Factors" sheet. Table 11 shows the total value of emissions in non-discounted dollars with the exception of CO_2.

Table 11 Value of Environmental Protection Benefits With and Without the Project

	With Project	Without Project	**Net Change**
NOx (2017$, in thousands)	$100,991	$414,578	**($313,586)**
PM (2017$, in thousands)	$128,477	$530,170	**($401,697)**
SOx (2017$, in thousands)	$336	$745	**($410)**
VOCs (2017$, in thousands)	$37	$84	**($47)**

Safety

Impacts to Safety include the value associated with fatalities, injuries, and property damage only incidents.

The loss of life is a factor of the vehicle miles traveled previously determined. The VMT is multiplied by the fatality rate per truck-mile (for trucks) and per train-mile (for rail) found in the "Crash Rates" sheet. With project implementation, it is estimated that there will be 14 fatalities over the 30-year life of this project associated with the delivery of goods. However, without the project, as the vehicle miles traveled is significantly higher, fatalities are estimated at 36. The implementation of the Intermodal Freight Connector project is forecasted to result in a reduction of 22 fatalities in total, or almost 1 per year. The value of this impact is determined by multiplying the number of fatalities by the value of a statistical life, which results in a savings of over $215 million.

Table 12 Loss of Life (Fatalities Avoidance) With and Without the Project

	Fatalities	Average Annual
Fatalities With Project	14	0.5
Fatalities Without Project	36	1.2
Net Change in Fatalities	**(22)**	**(0.7)**
Value of Net Change in Safety (2017$, in thousands)	**($215,465)**	**($7,182)**

Injuries are calculated in the same manner as fatalities, but instead of using the fatalities per mile factor found in the "Crash Rates" sheet, the injuries per mile factor is used. The construction of this project will result in 625 fewer injuries related to the transportation of goods over the life of the project, or about 21 per year. A summary of these benefits is shown in Table 13. To calculate the value of this impact, the net change in injuries was multiplied by the value associated with a "Moderate" injury crash as provided by the BCA Resource Guide. This is a conservative estimate versus using a more severe crash type as the higher values associated with more severe crashes would increase the overall net benefits associated with safety for this project.

Table 13 Injuries With and Without the Project

	Injuries	Average Annual
Injuries With Project	390	13.0
Injuries Without Project	1,015	33.8
Net Change in Injuries	**(625)**	**(20.8)**
Value of Net Change (2017$, in millions)	**($282)**	**($9.4)**

The property damage due to truck crashes was also calculated similar to the fatality and injury rates. The truck miles traveled was multiplied by the Property Damage Only Crashes per Truck VMT factor found in the "Crash Rates" sheet. The net change in incidents is approximately 1,772 fewer property damage only incidents total, or about 59 per year. This total was then multiplied by the per vehicle value for property damage only crashes. The value of this change is at nearly $7.7 million as shown in Table 14. This is a conservative estimate as it assumes only one vehicle per crash. Assuming more than one vehicle per crash would increase the overall benefits associated with this project.

Table 14 Property Damage Due to *Truck* Crashes With and Without the Project

	Property Damage	Average Annual
Incidents With Project	1,114	37.1
Incidents Without Project	2,886	96.2
Net Change in Incidents	**(1,772)**	**59.1)**
Value of Net Change (2017$, in thousands)	**($7,669)**	**($256)**

The value factor for property damage due to rail crashes is based on rail mileage and computes the value directly, rather than calculating an interim step of how many rail crashes are caused each year with or without this project. As this is a different methodology from the property damage only crashes associated with trucks, these calculations are shown separately in Table15. The actual calculation involves taking the rail mileage previously calculated and multiplying it by the Property Damage/Train Mile found in the "Crash Rates" sheet. The property damage to rail associated with this project implementation is estimated at a total of $1.1 million. Without this project, the value of damage is estimated at around $6 million for a total net change of $4.4 million.

Table 15 Property Damage Due to *Rail* Crashes With and Without the Project

	Property Damage	Average Annual
Value of Incidents With Project (2017$, in thousands)	$1,443	$48.1
Value of Incidents Without Project (2017$ in thousands)	$5,983	$199.4
Value of Net Change (2017$, in thousands)	**($4,439)**	**($151.3)**

The combined safety benefits due to the project implementation are projected to amount to $510 million.

Other Benefits Not Included in Final Benefit-Cost Ratio Estimate

This analysis worked to ensure that all related costs and benefits associated with the Intermodal Freight Connector Project were captured. However, there are benefits that cannot be quantified due to limitations in data and existing methodologies. In particular, these benefits include trade imbalances and value of passenger time savings.

Trade imbalances encompass truck traffic and rail traffic. Truck and rail traffic follow similar patterns here. Due to a large consuming population in South Florida, there is a severe imbalance in the number of goods entering the region versus the number of goods leaving the region. An often quoted statistic by the rail industry is that for every four trains that come loaded south, only one train is loaded north, resulting in three trains of empty containers. Similar statistics are found in the trucking industry. This imbalance results in significantly higher commodity prices for South Floridians as the transport rates for goods coming south typically account for the fact that the return trip north will not be profitable. The benefits associated with a better balance in this movement for both consumers and the trucking industry are not captured here.

Value of passenger time savings are related to three factors: fewer vehicles on the roadway, reduction in crashes, and reduction in at-grade highway/rail crossing delays. Passenger vehicles will benefit from the reduced truck VMT determined here as it will free up capacity on the roadways that these trucks previously traversed. Passenger cars, and freight traffic for that matter, will also benefit from a reduction in crashes as delays associated with said incidents will no longer exist if the crash never occurs. *The Economic and Societal Impact of Motor Vehicle Crashes, 2010* by the National Highway Traffic Safety Administration estimated that motor vehicle crashes in 2010 accounted for economic losses of $242 billion, not including quality of life valuations. Any reduction in crashes will thereby reduce the economic losses. Lastly, the reduction in train miles traveled will reduce delays at at-grade crossings as the trains will no longer be blocking the crossings as they make their way to their final destination, thus saving the driving community time. While benefits affiliated with these components would be positive for the Intermodal Freight Connector Project, they are not captured in the final summary of benefits.

Summary of Benefits

The "Summary of Benefits" sheet summarizes the total benefits associated with this project by type of benefit. The total non-discounted benefits (excluding any impacts of carbon emissions) is estimated at over $4.2 billion over the total 30-year project life. As shown in Table 16, the largest impacts of this comes from Economic Competitiveness, specifically the changes in vehicle operating costs. The second greatest impact is from Environmental Protection, which is based on reductions in emissions. These benefits were discounted at the seven real discount rate for the derivation of the Benefit-Cost Ratio and the Net Present Value as discussed below.

Table 16 Summary of Net Change in Benefits

	Net Impacts
State of Good Repair (2017$, in millions)	$539
Economic Competitiveness (2017$, in millions)	$2,471
Sustainability (2017$, in millions)	$716
Safety (2017$, in millions)	$510
Total, Non-Discounted (2017$, in millions)	$4,236
Total, Discounted at 7% (2017$, in millions)	$1,152

Summary of Costs

Project costs were previously shown in more detail for various stages of construction in the "Project Costs" sheet. The "Summary of Costs" shows, at a higher level, spending per year and those expenditures discounted at seven and three percent. Table 17 summarizes this information.

Table 17 Summary of Projects Costs (2017$)

	Before Discounting	Discounted at 7%
2014	$2,578,749	$3,380,214
2015	$29,144,269	$35,702,982
2016	$1,664,094	$1,905,221
2017	$14,850,520	$15,890,057
2018	$65,853,659	$65,853,659
2019	$120,845,729	$112,939,934
2020	$124,476,703	$108,722,773
2021	$103,966,414	$84,867,563
2022	$74,530,685	$56,859,103
2023	$34,654,191	$24,707,959
2024-2051	$2,834,480	(varies)
Total	**$651,930,459**	**$535,357,901**

Benefit-Cost Analysis – Summary Results

The baseline BCA metrics were determined by comparing the discounted benefits and discounted costs at using a seven percent real discount rate. As shown in Table 18, the total monetized benefits of the proposed IFCP are projected at close to $1.2 billion (in present discounted value terms) while the total costs of the project (including capital expenses and incremental operating and maintenance costs) are forecast at $535 million. This results in a benefit-cost ratio of 2.2, and a net present value (NPV) of $616.8 million. The corresponding internal rate of return (IRR) of the project is projected at 12.9 percent.

Table 18 Benefit-Cost Analysis – Summary Metrics

	Discounted at 7%
Total Benefits (2017$, in millions)	$1,152
Total Costs (2017$, in millions)	$535
Benefit Cost Ratio	**2.2**
Net Present Value (2017$, in millions)	**$617**
Internal Rate of Return	**12.9%**

Scenario Testing

One concern raised when evaluating the need for a project costing over half a billion dollars is how accurate the assumptions made are. While most forecasts in general may not be perfectly accurate, they represent the best understanding of the data and conditions available at the time. With the flexibility of the spreadsheet analysis developed here, it is possible to easily test various scenarios of differing conditions. Of the assumptions made for this BCR analysis, four were separately tested to understand their impact on the final results:

- Three Percent Real Discount Rate
- "Without Project" Port Usage Estimates
- TEU Throughput Estimate
- Carbon Dioxide Pricing

Without Project Port Usage Estimates

The ports handling the cargo destined for the three markets included here (South Florida, Central Florida, and Southeastern US) in the event that the Intermodal Freight Connector Project is not completed were determined using FAF 4.4 data as detailed for the "Without Project Port Usage" sheet. This analysis showed a strong usage of East Coast ports serving the three markets by truck, with no amount moving from Los Angeles/Long Beach by truck to any market. Given the dominance of the West Coast port complex, it is unlikely the volume of trucks moving to one of the defined three market areas is zero.

In fact, this outcome is different from prior versions of FAF based on an analysis of FAF 4.2, 4.3, and 4.4. Key changes which impact the outcome of the BCR are as follows:

- Between versions 4.2 and 4.3 significant amounts of "Truck" traffic were reclassified as "Multiple Modes & Mail". This resulted in no commodity moved classified as moving by truck only from the West Coast.
- Between versions 4.3 and 4.4 significant amounts of "Truck" traffic were added from ports serving their local markets (i.e. additional truck traffic destined for South Florida coming through South Florida ports). This increase resulted in an inherently larger percentage of truck traffic being affiliated with South Florida ports even though the traffic volume from

other ports did not decrease.

The sensitivity of this information was tested based on the following assumptions:

- Some amount of traffic will be trucked from Los Angeles, in particular high value, time sensitive goods. Security and urgency of this cargo will always result in some volume of truck traffic from the West Coast. To account for this, each market was assigned a 5 percent truck share for Los Angeles/Long Beach in the "Without Port Project Usage" sheet. This 5 percent was then taken away from the more local markets (PortMiami for the South Florida and Central Florida markets and Savannah for the Southeastern U.S. market).

- Ports in Southeast Florida have not seen significant growth over the last five year, in particular as they compare with the Port of Savannah. Based on local knowledge and port throughput volumes, it seems unlikely that Savannah only has 5 percent of the truck traffic for the South Florida market and 10 percent for the Central Florida market. For this reason, the share of truck traffic for the Port of Savannah was increased by 5 percent for both of these markets while at the same time reducing PortMiami's share by 5 percent. Further support for this is presented in Tables 19 and 20.

Table 19 shows how loaded container volumes at Port Everglades, PortMiami, the Port of Palm Beach, Jaxport, and the Port of Savannah have changed over the course of the last five years. Average growth at the three Southeast Florida ports has been about 6 percent while growth at Jaxport and Savannah has been 7 percent and 13 percent, respectively. This illustrates that the Southeast Florida ports have grown at a slower rate than other ports that have been determined to serve the markets examined here. In addition, Table 19 shows that the Port of Savannah transports more loaded containers than both the Southeast Florida ports and Jaxport combined. This demonstrates how much broader of a market Savannah serves at present.

Table 19 Seaport Loaded TEUs, 2012-2016

	Port Everglades	Port Miami	Port of Palm Beach	Southeast Florida	Jaxport	Port of Savannah
2012	638,546	735,893	119,078	1,493,517	715,887	2,289,094
2013	698,673	709,504	144,023	1,552,200	752,402	2,349,151
2014	748,501	682,386	156,366	1,587,253	800,630	2,605,288
2015	716,182	765,980	140,863	1,623,025	755,452	2,824,529
2016	741,628	778,817	136,363	1,656,808	798,078	2,889,993
5 Year Average	708,706	734,516	139,339	1,582,561	764,490	2,591,611
Change 2012-2016	11%	0%	17%	6%	7%	13%

Source: U.S. Army Corps of Engineers Waterborne Commerce Statistics Center.

Hand in hand with port volume numbers is the population changes in these markets. Table 20 shows that the Southeast Florida region has grown about 5 percent over this same time period. This rate means that the port has only grown slightly faster than the population and thus only gained a small market share to serve the local market. Therefore, it is unlikely that the shifts characterized in the most recent FAF update have occurred over the last few years and more likely that Savannah contributes a larger share of the truck traffic than the data currently suggests.

Table 20 South Florida Population Change, 2012-2016

	2012	2016	Net Change	Percent Change
Miami	2,551,290	2,700,794	149,504	6%
Broward	1,771,099	1,854,513	83,414	5%
Palm Beach	1,335,415	1,391,741	56,326	4%
Total	5,657,804	5,947,048	289,244	5%

Source: Bureau of Economic and Business Research.

The resulting assumptions of the port share of traffic to be modified in the "Without Project Port Usage" sheet is summarized in Table 21.

Table 21 Resulting Port Share of Traffic for Scenario

	South Florida	Central Florida	Southeastern U.S.
Port Miami	75%	35%	0%
Savannah	10%	15%	80%
Los Angeles/Long Beach	5%	5%	5%

TEU Throughput Estimate

The TEU throughput increase determined for this project was calculated based on extensive research and analysis on the part of Port Everglades and its stakeholders. From this analysis, it was determined that the Intermodal Freight Connector Project would result in 730,000 additional TEUs being transported through the Port each year. In addition, it was determined that 12.4 percent of this cargo would be transported to the Southeastern United States by rail. The remaining cargo would be trucked with 70 percent going to the South Florida market, 25 percent going to the Central Florida market, and 5 percent going to the Southeastern United States.

Feedback from FHWA on prior FASTLANE grant submittals questioned the large increase in TEU throughput. While Port Everglades is confident in the analysis of this future cargo throughput, the BCR spreadsheet was manipulated to determine the impacts of halving this estimate. For the TEU Throughput Estimate scenario, TEUs were reduced from 730,000 TEUs per year to 365,000 TEUs per year.

Carbon Dioxide Pricing

The impacts of the reduction in Carbon Dioxide associated with the Intermodal Freight Connector Project were previously presented in the Sustainability discussion. However, these impacts were solely documented as a reduction in tonnage emitted, with no monetary value assigned. Monetary benefits were not calculated as values previously utilized for TIGER and FASTLANE grants were rescinded by Executive Order 13783. With that in mind, this project is estimated to reduce Carbon Dioxide emissions by 2.7 million metric tons over its life. Assigning even a small value to this tonnage would result in significant monetary benefits.

In order to estimate what this monetary value would be, the rescinded values - as per the 2016 TIGER Resource Guide - were utilized. While not ideal, they represent the best attempt at assigning values to this emission type.

Benefit-Cost Ratio Comparison for Scenario Testing

The BCR results for each of the alternative scenarios are presented in Table 22. As expected, lowering the discount rate, changes in the Without Project Port Usage, and inclusion of Carbon Dioxide Pricing each result in an increase in the BCR while reducing the TEU Throughput Estimate result in a lower BCR.

Under the three percent real discount rate, the project's economic feasibility increases, with the BCR rising to 4.2.

For the without Project Port Usage scenario, the BCR increases to 3.6. This increase is the result in only a small change in assumptions of cargo locations, which are reasonably expected despite what may be currently reported in commodity flow databases.

For the TEU Throughput Estimate scenario, the BCR was reduced by roughly half, in line with the reduction in expected cargo throughput by half. The resulting BCR (at 1.1) is still above 1.0. This signifies that even if throughput estimates are vastly overestimated, while unlikely, the project will still generate positive net benefits.

Lastly, for the Carbon Dioxide Pricing scenario, with the CO_2 pricing based on the 2016 BCA Guidance, the BCR would increase 2.4. While, at present, there were no domestic values for Carbon Dioxide readily available, assuming any value related to this emission type will increase the benefits associated with the project.

Table 22 Benefit-Cost Ratio - Scenario Results

Baseline BCR (7% Discount Rate)	2.2
Without Project Port Usage	3.6
TEU Throughput Estimate	1.1
With Carbon Dioxide Pricing	2.4
3% Discount Rate	4.2