I-75 EXPRESS BUS SERVICE

Application for

Transportation Investment Generating Economic Recovery (TIGER)

Discretionary Grant Program

Benefit-Cost Analysis

I-75 Express Bus Capital Purchase/Regional Park-n-Ride Lot

Table of Contents

Executive Summary

Cambridge Systematics (CS) conducted the benefit-cost analysis in support of the TIGER IV application for the I-75 Express Bus Capital Purchase/Regional Park-n-Ride Lot project in Broward and Miami-Dade counties in South Florida. The project includes the purchase of six hybrid electric buses, the construction of a park-n-ride lot and three bus shelters on Griffin Road in the vicinity of I-75 in Broward County, and the implementation of transit signal priority and signage and branding to provide express bus transit service on I-75 and State Road 826 (SR-826). Please refer to the attached Excel spreadsheet for calculations and assumptions, which are detailed in comment boxes throughout the spreadsheet (see "Read First" tab).

Project Description

The proposed Griffin Road park-n-ride will serve as an intermodal transfer point between the I-595 express buses connecting west Broward County residents to the South Florida Education Center (SFEC) in Davie and to downtown Fort Lauderdale to the east, and a new premier transit bus service, the I-75 Express, connecting commuters in west Broward County with Miami-Dade Transit's Palmetto Metrorail Station to the south. Broward County commuters will have access to the Miami International Airport (MIA), to the multimodal connections at the Miami Intermodal Center (MIC)[1], and to downtown Miami and the surrounding activity centers accessible by the rest of the Miami-Dade Transit (MDT) Metrorail system via a transfer at the Palmetto Metrorail Station.

The I-75 Express buses will also provide reverse commute service to residents of western Miami-Dade County giving them access to employment opportunities in western Broward County including the Weston Park of Commerce in the city of Weston, and the Sawgrass International Corporate Park, South Florida's largest office park, and the Sawgrass Mills Mall, the second largest mall in Florida, in the city of Sunrise. It will also provide reverse commuters with a connection to the express buses traveling east on I-595 allowing Miami-Dade commuters to transfer at the proposed Griffin Road park-n-ride to the I-595 buses to access the South Florida Education Center (SFEC) in Davie and downtown Fort Lauderdale, two major destinations in Broward County.

The proposed project will provide a direct express transit link between west Broward County and west Miami-Dade County that currently does not exist. It will also enhance the intermodal transit connections at the proposed Griffin Road park-n-ride providing a connection point between the I-595 Express buses traveling east and the proposed I-75 Express buses traveling south. Finally, it will create a modal shift from single-occupancy vehicle travel to transit that will produce several long-term outcomes with respect to the five selection criteria specified in the Federal guidance as summarized in Table 1.

[1] The Miami Intermodal Center (MIC) is a multimodal transportation hub, currently in construction and scheduled to be completed by 2013, next and with direct access to the Miami International Airport (MIA), linking intercity, commuter, and heavy rail, intercity and local bus, and automobile traffic under one roof.

Table 1. Primary Selection Criteria – Types of Long-Term Outcomes/Societal Benefits

Long-Term Outcome	Societal Benefits	Description
Livability	Accessibility to Transit	Commuters in addition to economically disadvantaged populations, non-drivers, senior citizens, and persons with disability will have accessibility to a non-single-occupancy mode of transportation, currently not available between western Broward County and western Miami-Dade County.
	Mobility Options/ Intermodal Connectivity	Enhanced existing mobility options and increased points of intermodal connectivity linking two park-n-ride lots in Broward County with the Metrorail system in Miami-Dade County via a stop at the Palmetto Metrorail Station, and providing riders a connection to the I-595 express buses at the Griffin Road Park-n-Ride.
	Job Commuting Options	Improved job commuting options between residential and commercial areas and employment centers in Broward and Miami-Dade Counties.
Economic Competitiveness	Vehicle Operating Cost Savings	Reductions in monetary operating costs to drivers switching from driving, a higher-cost travel mode, to transit, a lower-cost transportation mode.
Safety	Accident Reduction	Reductions in the risk of fatalities and injuries due to reductions in automobile use resulting from drivers switching to transit, a safer travel mode.
Sustainability	Emissions Reductions	Reductions in pollutants and greenhouse gases due to auto use reductions resulting from drivers switching to transit, a less-polluting mode.
State of Good Repair	Bus Maintenance Savings	Reductions in transmission and brake maintenance due to hybrid-electric buses technology when compared with standard diesel bus technology.

Project Economic Benefits

Economic benefits included in the BCA and evaluated quantitatively in terms of the TIGER IV criteria are vehicle operating costs savings (Economic Competitiveness), reduction in the risk of accidents (Safety), and reduction in emissions (Sustainability), as summarized in Table 2. Livability and State of Good Repair benefits, also part of the TIGER IV evaluation criteria, were not quantified for the benefit-cost analysis but are discussed elsewhere in the application.

Table 2. Project Matrix – Summary of Economic Impacts, Benefits and Results

Current Status & Problem to be Addressed	Change to Baseline	Type of Impacts	Population Affected by Impacts	Economic Benefits	Summary of Results	Page # in BCA
Lack of mobility options to single-occupancy vehicle travel between west Broward County and Miami-Dade County on the I-75 corridor during peak hours to access major employment centers in both counties.	New park-n-ride lot on Griffin Road providing connection to the I-595 express buses and the proposed new express/ premium bus service on I-75 corridor between Broward County and Miami-Dade County to provide increased access to major employment centers in both counties.	Reductions in monetary users operating costs, risk of fatalities and injuries, and pollutants and greenhouse gases from drivers switching to transit, a lower-cost, safer, and less polluting mode.	Number of single-occupant vehicle travelers shifting to transit during peak hours to travel between west Broward County and Miami-Dade County.	Economic Competitiveness: Reduced vehicle operating costs ($0.60 per mile). Safety: Reduced risk of accidents (0.6 fatalities avoided and 52.3 injuries avoided). Sustainability: Reduced amount of emissions/ pollution (27,120 metric tons).	Total Benefit (3% discount rate) = **$63.7M** Economic Competitiveness: Savings in vehicle operating costs = **$37.7M** Safety: Reduced accident costs = **$25.3M** Sustainability: Reduced cost of emissions/ pollution = **$632K**	pp. 7-19 p. 12 p. 13 p. 15

Project Costs

Project capital costs include the design and construction of the Griffin Road Park-n-Ride lot including three bus shelters, the purchase of six 60-foot hybrid electric buses, the equipment and installation/implementation costs of transit signal priority and signage and branding to provide express bus transit service on I-75 and State Road 826 (SR-826). Project operational expenses include the operations and maintenance costs of the I-75 Express bus service, including replacing of the buses at 12 years of age, as well as the maintenance of the new park-n-ride lot. Total project costs discounted to 2012 at 3% real discount rate are $34.4 million and at 7% are $25.9 million in 2011 dollars.

Project Benefit-Cost Ratio and Net Present Value

The main results of the analysis are shown in Table 3. The I-75 Express Bus Capital Purchase /Regional Park-n-Ride Lot project has a benefit-cost ratio of 2.28 at a real discount rate of 3% and 1.84 at a real discount rate of 7%. The Net Present Value (NPV) of the project is $29.3 million at 3% and $14.1 million at 7%. "Real" discount rates are inflation free.[2] Table 3 summarizes the results of the benefit-cost analysis (BCA) and validates the long-term economic benefits associated with this investment.

[2] Real discount rates reflect the opportunity costs of money net of the rate of inflation.

Table 3. Benefit-Cost Ratio and Net Present Value ($2011)

Discount Rates	3%	7%
Project Benefits	**Discounted Present Value (2012)**	
Economic Competitiveness Benefits	$37,730,270	$23,573,867
Safety Benefits	$25,332,753	$15,827,900
Sustainability Benefits	$631,710	$593,747
Discounted Present Value of All Benefits	**$63,694,733**	**$39,995,514**
Project Costs	**Discounted Present Value (2012)**	
Discounted Present Value of All Costs	**$34,419,215**	**$25,923,018**
Benefit-Cost Ratio	**1.85**	**1.54**
Net Present Value	**$29,275,518**	**$14,072,496**

Source: Cambridge Systematics, Inc.

Benefit-Cost Analysis

As prescribed by the U.S. DOT, benefits and costs should be shown in each year for the useful life of the project, at least 20 years, and both should be discounted to the year 2012 applying two different inflation–free discount rates to both the project costs and benefits (3% and 7%). These real discount rates reflect the opportunity cost of money net of the rate of inflation. To calculate the benefit-cost ratio, the present value of benefits and the present value of costs are calculated. The Present Value of Benefits (PV_B) is the sum of the discounted present value of all benefits:

$$PV_B = \sum_{i=0}^{n} \mathrm{B_i} / (1+r)^i$$

where:

B_i = the benefit of the project in year i.

r = the discount rate (e.g.,.03 for 3%)

n = the number of years for which benefits are analyzed.

The Present Value of Costs (PV_C) equals the sum of the discounted present value of all costs:

$$PV_C = \sum_{i=0}^{n} \mathrm{C_i} / (1+r)^i$$

where:

C_i = the cost of the project in year i

r = the real discount rate (e.g.,.03 for 3%)

n = the number of years for which costs are analyzed.

Projects benefits and costs are estimated for each year after work on the project is begun and for a period of at least 20 years in the future and shown in 2011 dollars.

The Benefit-Cost ratio (B/C) is defined as the ratio of the Present Value of Benefits and the Present Value of Costs: B/C = PV_B / PV_C. The Net Present Value (NPV) is the difference between the Present Value of Benefits the Present Value of Costs: NPV = PV_B – PV_C.

Project Economic Benefits

The modal shift from auto travel to transit forms the basis for the estimation of the economic benefits produced by the construction of the Griffin Road park-and-ride lot and the implementation of the I-75 Express bus service during peak hours only. Therefore, the first step in the analysis was to estimate the affected population that will be impacted by the project investments. This population is defined as the estimated ridership for the I-75 Express bus service once the project is operational in mid-2015. It is assumed that the potential transit market represents the number of vehicle person trips who will switch to the new I-75 Express bus service.

Affected Population (Transit Ridership Estimate)

The commuter travel market is considered to be primarily from the Bank Atlantic Center park-and-ride in the vicinity of the Sawgrass Mills Mall and the proposed park-and-ride lot in the vicinity of Griffin Road in Broward County to the Palmetto Metrorail Station in west Miami-Dade County and its surrounding areas. Commuters traveling from the east on the I-595 express buses to the Bank Atlantic Center or Griffin Road park-n-ride lot could also continue south making a connection to the I-75 express buses to access activity centers in west Miami-Dade and nearby the Metrorail system with a transfer at the Palmetto Metrorail Station.

The project will also provide a transit reverse commute option to residents from Miami-Dade who work in Broward County, particularly to the Cleveland Clinic in Weston and the corporate parks in Weston Road and International Drive in Sunrise, but also to the South Florida Education Center and downtown Fort Lauderdale, via a connection to the I-595 express buses traveling east from the Bank Atlantic Center or Griffin Road park-n-ride lots.

The proposed I-75 Express bus service characteristics are summarized in Table 4. Based on this proposed level of service the transit ridership for the I-75 Express bus service was estimated.

Table 4. Proposed I-75 Express Bus Service Characteristics and Level of Service

Proposed I-75 Express Bus Service	
Start of Operations	July 1, 2015
Number of Seats per Bus	64 seats
Number of Allowable Standees	26 standees
Maximum Passenger Load per Bus	90
Daily Number of Trips	14 trips (peak hours only) 7 trips in AM (5:30 – 8:00 am) 7 trips in PM (3:30 – 7:00pm)
Headway	30 minutes
Total Route Miles	54
Average Passenger Miles per Trip[3]	22
Premium Transit Fare per Trip[4]	$2.35 (one-way) including transfers

Source: Florida Department of Transportation (FDOT) and Cambridge Systematics, Inc.

Commute/Peak Travel Demand

To estimate the commuter travel demand for the new I-75 Express bus service, the ridership of the 95 Express bus service traveling from the Miramar Town Center (southwest Broward County) to the Jackson Memorial area hospitals and downtown Miami in Miami-Dade County

[3] Average of the distance between the Bank Atlantic Center Park-n-Ride Lot and the Palmetto Metrorail station (26 miles) and the distance between the Griffin Road Park-n-Ride Lot and the Palmetto Metrorail station (18 miles).

[4] Assumed to be the same premium fare per trip charged in 2011 for the 95 Express bus services to Miami. For this analysis, it is assumed the premium fare includes a free transfer to Metrorail, the Doral Trolley, or Metrobus.

was evaluated (as discussed in the Building Upon Proven Success section of the application). The ridership trend of the Miramar 95 Express bus, which started service on January 2011 and in its first year of service its ridership has grown exponentially, was used as the base model to estimate the expected travel demand from central Broward to Miami-Dade County for the I-75 Express bus given the similarity between the transit services (i.e. express commuter buses to Miami), but particularly the markets.

The Miramar 95 Express bus and the proposed I-75 Express bus both serve an untapped commute transit market between residential areas of Broward County and major employment centers in Miami-Dade County that previously did not have access to transit as a mobility option between the counties. However, the Miramar 95 Express provides a one-seat ride to employment centers in Miami to residents living in southwest Broward while the I-75 Express bus route will provide a two-seat ride to residents in Broward County going to destinations in west Miami-Dade County (Medley and Doral areas) and to others part of Miami-Dade County via the Metrorail system (i.e. making a transfer at the Palmetto Metrorail station). Given a transfer will be required for the I-75 Express bus service, it was assumed the I-75 Express bus service will achieve slightly lower levels of ridership in its first year of operations than the Miramar 95 Express route has achieved. A 25 percent transfer penalty is assumed. In other words, it is assumed the I-75 Express transit ridership will be 25 percent less than the Miramar 95 Express route estimated ridership to Miami due to the required transfer.

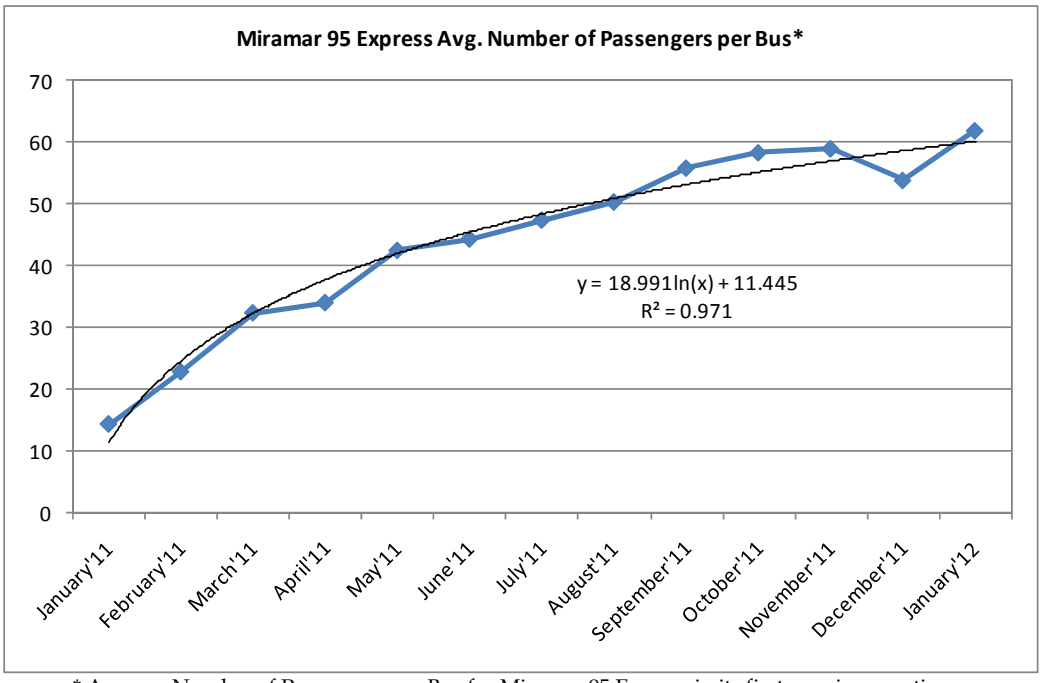
The following methodology was used to estimate the commuter travel market on the I-75 express buses.

- A regression analysis based on the natural log regression[5] of the average number of passengers per trip of the Miramar 95 Express bus service in its first year in operations was conducted to use as the baseline to estimate the average weekday ridership expected for the commuter market of the I-75 Express bus service ("TransitTripsEst" tab, chart on cell A36 and Figure 1). Regression results indicate that in its first six months in service, the Miramar 95 Express bus service, used as the baseline for the I-75 Express bus, is estimated to carry an average of 45 passengers per bus per trip.
- Applying a 0.75 transfer penalty or 25 percent ridership reduction, it was assumed the I-75 Express bus service in its peak/commute direction would grow to carry 34 passengers per bus in 2015 during its first six months in service, assuming the service starts on July 1, 2015, and grow to about 87 passengers per bus in twenty years. ("TransitTripsEst" tab, row 20 and Table 5). This estimated average daily number of passengers per trip was assumed to be the commuter transit market for each of the 14 daily trips proposed for the I-75 Express bus service.
- Finally, the estimated average weekday ridership was calculated as the average daily number of passengers per trip times the 14 daily trips assumed ("TransitTripsEst" tab, row

[5] Regression equation: Average Number of Passengers per Trip = 18.991 ln(x) + 11.445 where x is the number of months the bus has been in service.

21). To obtain the total annual ridership for the I-75 Express bus service, a 254 expansion daily to annual factor[6] was used ("TransitTripsEst" tab, row 22).

Figure 1: Regression Analysis to Estimate I-75 Transit Demand based on Miramar 95Express Ridership



* Average Number of Passengers per Bus for Miramar 95 Express in its first year in operations.
Source: Broward County Transit Monthly Ridership Reports and Cambridge Systematics, Inc.

Reverse Commute/Non-Peak Travel Demand

The Miramar 95 Express bus service, currently, does not provide a reverse commute market to serve as a model for the estimation of a reverse commute market for the I-75 Express buses. Data readily available at the time of this analysis of express commuter bus routes from the Charlotte Area Transit System (CATS) in North Carolina and the Chicago Transit Authority (CTA) in Illinois was reviewed to obtain a baseline to estimate the reverse commute market. Given CATS, and not the CTA, is considered a peer of the Broward County Transit system (BCT)[7], data from CATS' Route 53x Northlake Express, Route 77x North Mecklenburg Express, and Route 54x University Research Park Express was analyzed to identify the split between commute and reverse commute market in an express bus given the similitude of these routes with the proposed I-75 Express bus service (refer to maps on "CATS" tab).

These three routes provide express bus service during peak hours along major expressways (I-77 and I-85) between the central business district and the northern parts of the city of Charlotte

[6] The daily to annual factor assumes the bus will be in service 254 days a year = 52 weeks * 5 days a week - 6 national holidays.

[7] Broward County Transit Development Plan 2009- 2018, Executive Summary, Page 6. http://www.broward.org/BCT/Documents/TDP2009ExuctiveSummary.pdf

connecting major shopping and employment destinations. They provide commute (to/from Charlotte CBD) and reverse commute service (to/from shopping and employment centers) as is being proposed for the I-75 Express buses. As a result, their ridership data from February 2012 was analyzed to identify the split in the total ridership between the commuter and reverse commute market. Data indicates that on average, 80 percent of the total AM peak ridership for these three express bus routes accounts for the commute travel market while 20 percent accounts for the reverse commute market ("CATS" tab, row 74). In other words, 25 percent (20/80) of the commute market represents the reverse commute market. Therefore, the I-75 Express bus reverse commute market (from Miami-Dade to Broward County) was assumed to be 25 percent of the commute market ("TransitTripsEst" tab, row 29).

Total Transit Travel Demand

The sum of the total estimated commute market ridership and the estimated reverse commute market ridership results in the total transit demand estimated for the I-75 Express bus service ("TransitTripsEst" tab, row 37). After the estimated total transit ridership was estimated, the average transit passenger miles traveled per year were calculated assuming an average trip distance of 22 miles[8] times the total ridership ("TransitTripsEst" tab, row 39). The annual average transit vehicle miles is the product of the total route miles per trip (54 miles) times the daily number of trips per day (14) times the daily to annual expansion factor (254), for a total of 192,024 route miles traveled every year[9] ("TransitTripsEst" tab, row 41).

In conclusion, the group of transportation users who would benefit from the project is the estimated riders of the new I-75 Express bus. These new transit users are assumed to drive alone if the project is not implemented (no-build scenario), thus representing the modal shift from auto travel to transit that forms the basis for the quantification of the benefits. This is justified due to the lack of transit options currently available between the travel markets in Broward and Miami-Dade along the I-75 corridor. To estimate then the number of vehicle trips saved once the project is operational, the estimated total transit ridership was divided by the regional average automobile occupancy[10] ("TransitTripsEst" tab, row 43). This takes into consideration transit users who could have shifted from driving alone or carpooling. Results of the transit trips estimation are summarized in Table 5.

[8] Average of the distance between the Bank Atlantic Center Park-n-Ride Lot and the Palmetto Metrorail station (26 miles) and the distance between the Griffin Road Park-n-Ride Lot and the Palmetto Metrorail station (18 miles).

[9] It is assumed in this analysis the level of service of the I-75 Express bus service will not be adjusted (i.e. frequencies increased and therefore, higher ridership growth) throughout the life of the project to be conservative.

[10] Regional average automobile occupancy of 1.33 was assumed as indicated by the federally approved regional travel demand model, SERPM65 – Southeast Regional Planning Model.

Table 5. Transit Ridership with Project (Build Scenario)

I-75 Express Transit Market	2015	2035
Average Number of Passengers Commute Trips	34	87
Average Number of Passengers Reverse Commute Trips	9	22
Average Number of Passengers per Round-Trip[11]	43	109
Average Weekday Ridership	597	1,522
Total I-75 Express Transit Market	**2015 - 2035**	
Total Annual Transit Ridership	**6,845,106**	
Vehicle Trips Saved from Modal Shift to Transit	5,146,697	
Vehicle Miles Saved from Modal Shift to Transit	113,227,323	

Source: Cambridge Systematics, Inc.

The following sections describe the benefits included in the Benefit-Cost Analysis and evaluated quantitatively in terms of the TIGER IV criteria based on the auto trips and vehicle miles saved by the project due to the modal shift from auto trips to transit, as described earlier in Table 1:

- **Economic Competitiveness** - Vehicle operating costs savings,
- **Safety** - Reduction in the risk of accidents, and
- **Sustainability** - Reduction in emissions.

Economic Competitiveness Benefits

Economic competitiveness benefits for the I-75 Express bus service result from modal diversion from auto trips to transit. Per federal guidelines published in the NOFA, economic competitiveness refers to the ability of the project to "measurably contribute over the long term to growth in productivity of the American economy". In this case, the number of transportation users shifting from driving (a higher-cost transportation mode) to transit (a lower-cost transportation mode) reduce their operating costs by saving the expenses associated with owning, operating, and maintaining a vehicle. Transit fares are considered as equivalent components of cost for the I-75 Express users. As a result, the net savings in vehicle operating costs for transit users (i.e. vehicle operating costs less the transit fares costs) were calculated and quantified for this analysis.

To obtain the monetized value for the vehicle operating costs savings, the annual data on driving costs per-mile published by the American Automobile Association (AAA) was used as instructed by the TIGER IV guidance posted online. The AAA report indicates the composite average cost per mile of driving an average of 15,000 miles a year is 58.5 cents in 2010 dollars.[12] That cost was inflated to 2011 dollars using the CPI factor, for an average cost per mile of $60.15 cents. The cost components of the vehicle operating costs reported by the AAA include fuel, maintenance and repairs, tire wear, insurance, license, registration and taxes, vehicle depreciation, and finance. Given the operating costs are per mile and the average distance

[11] Includes commute trip and reverse commute trip.
[12] http://www.aaaexchange.com/Assets/Files/201145734460.DrivingCosts2011.pdf

traveled per trip is 22 miles, the total cost of operating a vehicle per trip totals $13.27. Transit fare per trip is assumed to be $2.35, therefore every vehicle trip that shifts to transit saves $10.92 per trip. Multiplying those savings per trip by the number of vehicle trips estimated to have shifted to transit ("EconCompBen" tab, row 6) results in the total average operating costs saved by former drivers ("EconCompBen" tab, row 13).

Table 6 provides a summary of the total value of economic competitiveness benefits due to the reduction of operating costs to transportation users switching from driving, a higher-cost travel mode, to transit, a lower-cost transportation mode. The dollar value of economic competitiveness benefits were discounted at both 3% and 7% as prescribed in the TIGER IV federal guidelines for a discounted present value of $37.3 million at 3% and $23.6 million at 7%.

Table 6. Economic Competitiveness Benefits – Vehicle Operating Costs Savings ($2011)

Summary of Economic Competitiveness Benefits	2015 - 2035
Total Number of Vehicle Trips Saved with Project	5,146,697
Average Vehicle Costs Savings per Trip	$10.92
Total Value $ of Economic Competitiveness Benefits (undiscounted)	$56,208,439
Discounted Present Value (2012) of Vehicle Operating Costs Savings	
Discounted Present Value (3%)	$37,730,270
Discounted Present Value (7%)	$23,573,867

Source: Cambridge Systematics, Inc.

Safety Benefits

Safety benefits are a function of the reduction in highway usage from the auto users switching to the I-75 Express bus service, estimated earlier. The project will improve safety because of the modal diversion from a less safe mode of travel, driving, to a safer mode of travel, public transportation. Accident costs, like other variable costs, is dependent on the reduction of vehicle-miles. To calculate the reduction in the risk of accidents and fatalities, the fatalities and injuries rate per billion vehicle-miles for passenger cars, and the fatalities and injuries rate per billion passenger-miles for transit motor bus were obtained from the National Transportation Statistics, Research and Innovative Technology Administration, Bureau of Transportation Statistics, Tables 1-35, 1-40, 2-21, and 2-33.[13] These rates per mile are summarized in Table 7 below.

[13] http://www.bts.gov/publications/national_transportation_statistics/html/table_01_35.html
http://www.bts.gov/publications/national_transportation_statistics/html/table_01_40.html
http://www.bts.gov/publications/national_transportation_statistics/html/table_02_33.html
http://www.bts.gov/publications/national_transportation_statistics/html/table_02_21.html

Table 7. Safety Data per Mode, Fatality and Injuries Rate (2008)

2008 Safety Data per Mode	Passenger Car	Transit Motor Bus
Total Fatalities	14,587	63
Total Injuries	1,304,000	5,805
Vehicle Miles (millions)	1,578,948	2,272
Passenger Miles (millions)	3,199,116	21,198
Fatalities Rate per Billion Vehicle-Miles	9.24	-
Fatalities Rate per Billion Passenger-Miles	-	2.97
Injuries Rate per Billion Vehicle Miles	825.87	-
Injuries Rate per Billion Passenger-Miles	-	273.85

Source: U.S. Department of Transportation, National Transportation Statistics, Research and Innovative Technology Administration, Bureau of Transportation Statistics, Tables 1-35, 1-40, 2-21, and 2-33.

Using the most recent data on fatalities and injuries rates per miles nationwide for passenger car occupant and transit bus, the reduction in accidents for passenger cars and the number of accidents for transit motor bus were calculated. The product of the vehicle miles saved from the modal shift to transit and the fatalities and injuries rate for passenger cars per vehicle miles result in the number of fatalities and injuries for passenger cars reduced by the project ("SafetyBen" tab, rows 18 and 20). The number of fatalities and injuries from the new transit bus service was calculated multiplying the total number of passenger miles by the fatalities and injuries rate for transit motor buses ("SafetyBen" tab, rows 26 and 28). The difference between these two results is the net reduction in the risk of fatalities and injuries from the modal shift from driving to transit ("SafetyBen" tab, rows 30 and 32). These were then multiplied by the unit value of statistical life and serious injuries summarized below in Table 8, to obtain the total value of safety benefits summarized in Table 9 ("SafetyBen" tab, rows 34, 36 and 38).

Table 8. Value of Statistical Life and Injuries ($2011)

Maximum Abbreviated Injury Scale (MAIS)	Severity	Fraction of Value of Statistical Life (VSL)	Unit Value ($2011)
MAIS 1	Minor	0.003	$18,600
MAIS 2	Moderate	0.047	$291,400
MAIS 3	Serious *	0.105	$651,000
MAIS 4	Severe	0.266	$1,649,200
MAIS 5	Critical	0.593	$3,676,600
MAIS 6	Fatality/Unsurvivable	1	$6,200,000

Note: * Serious Severity assumed for Non-Fatal Accidents.
Source: Treatment of the Economic Value of a Statistical Life in Departmental Analysis (2008 revised guidance and 2011 update). http://www.dot.gov/tiger/docs/tiger-12_bca-resourceGuide.pdf, Page 2.

Table 9 provides a summary of the total value of safety benefits due to the reduction of vehicle travel from transportation users switching from driving to transit, a safer travel mode. The total value of safety benefits was discounted at both 3% and 7% as prescribed in the TIGER IV federal guidelines for a discounted present value of $25.3 million at 3% and $15.8 million at 7%.

Table 9. Safety Benefits – Reduction in Fatalities and Injuries (2015-2035)

Summary of Safety Benefits	Passenger Car	Transit Bus
Changes in Fatalities with Project	-1.046	0.448
Change in Injuries with Project	-93.511	41.239
Net Reduction in Fatalities	-0.598	
Net Reduction in Injuries	-52.271	
Total Value $2011 of Reduction in Fatalities (undiscounted)	$3,710,610	
Total Value $2011 of Reduction in Injuries (undiscounted)	$34,028,705	
Total Annual Value of Safety Benefits (undiscounted)	$37,739,315	
Discounted Present Value (2012) of Safety Benefits		
Discounted Present Value (3%)	$25,332,753	
Discounted Present Value (7%)	$15,827,900	

Source: Cambridge Systematics, Inc.

Environmental Sustainability Benefits

Emission benefits were estimated based on the reduction of vehicle miles traveled with the project due to the modal shift from driving to transit. Five types of emissions were measured in this analysis: volatile organic compounds (VOC), nitrous oxide (NOx), carbon dioxide (CO_2), sulfur dioxide (SO_2), and particular matter ($PM_{2.5}$). The EPA Motor Vehicle Emission Simulator (MOVES)[14] run for the entire U.S. using all default inputs for passenger cars and transit buses in an urban restricted access roadway produced the consumption values for these pollutants in grams per mile for the year 2015 and year 2035 taking into account future regulations and trends ("Emission Rates" tab and Table 10). Values for intervening years (2016–2034) were linearly interpolated.

Table 10. Emission Rates for Passenger Cars and Transit Buses in Urban Restricted Access Roadway (2015 and 2035)

Emission Rates (grams*/mile)	Passenger Cars		Transit Buses	
	2015	2035	2015	2035
Carbon dioxide (CO2)	325.801	269.65	1556.731	1556.69
Volatile Organic Compounds (VOCs)	0.0698	0.03729	0.50950	0.04958
Nitrogen oxides (NOx)	0.2701266	0.094452	7.69963	1.29913
Sulfur dioxide (SOx)	0.011729	0.003856	0.011729	0.010857
Particulate matter (PM)	0.010859	0.009256	0.403028	0.037809

* 1 gram = 0.000001 metric ton

Source: MOVES output run by Cambridge Systematics, 2011.

The passenger cars emission rates were applied to the number of vehicle miles traveled saved due to the modal shift from driving to transit to obtain the amount of emissions saved ("SustainBen"tabs, rows 22-28). The transit buses emission rates were applied to the total number of average transit vehicle miles traveled by the express buses to obtain the amount of emissions produced by the express bus service ("SustainBen"tab, rows 43-49). Given MOVES currently does not model hybrid electric transit buses, which have lower emissions than the

[14] http://www.epa.gov/otaq/models/moves/index.htm

traditional diesel bus vehicle type included in MOVES, the transit bus emissions used in this analysis are higher than the I-75 Express bus emissions expected with the use of hybrid-electric buses. The difference between the passenger car emissions saved and the transit bus emissions produced in metric tons was calculated, separating the non-CO_2 pollutants of the CO_2 pollutants, in order to apply the value of emission reductions appropriately ("SustainBen"tab, rows 53-59). For each pollutant type, the dollar value of emission reductions was derived by multiplying the net annual reduction in metric tons of emissions by the appropriate monetization rate ("SustainBen" tab, row 81) as indicated in the federal guidance document using the monetized values for the vehicles manufactured for Model Year (MY) 2012-2016[15] and shown in Table 11.

Table 11. Value of Emissions (MY 2012-2016)

Type	$ / metric ton ($2007)	$ / metric ton ($2011)*
Carbon dioxide (CO2)	varies	varies
Volatile Organic Compounds (VOCs)	$1,280	$1,384
Nitrogen oxides (NOx)	$5,217	$5,643
Sulfur dioxide (SOx)	$30,516	$33,006
Particulate matter (PM)	$285,469	$308,758

* 2007$ values have been inflated to $2011 using a CPI factor.
Source Source: http://www.dot.gov/tiger/docs/tiger-12_bca-resourceGuide.pdf, Page 5.

The value of carbon dioxide varies per year and based on federal TIGER IV guidance, the "social cost of carbon at 3% discount" by year is used to convert CO_2 reductions to dollar values[16] ("SCC 3% tab). The total emission values were discounted at both 3% and 7%; for a discounted present value of $631,710 at 3% and $593,747 at 7%[17]. Table 12 summarizes the sustainability benefits throughout the project's lifecycle.

Table 12. Emissions Reduction Benefits (2015 – 2035)

Summary of Emission Benefits	$2011
Total Value $ of Non-CO_2 Emission Benefits (undiscounted)	$104,109
Total Value $ of CO_2 Emission Benefits (undiscounted)	$887,595
Total Value of Emission Benefits (Non-CO_2 + CO_2) (undiscounted)	$991,703
Discounted Present Value (2012) of Emissions Benefits	
Discounted Present Value (3%)	$631,710
Discounted Present Value (7%)	$593,747

Source: Cambridge Systematics, Inc.

Project Costs

The Florida Department of Transportation (FDOT) provided cost estimates in 2011 dollars for the capital and operational expenses associated with the project. Project capital costs include

[15] http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/CAFE_2012-2016_FRIA_04012010.pdf
[16] http://www.epa.gov/oms/climate/regulations/scc-tsd.pdf, Table A1: Annual SCC Values 2010 – 2050 (in 2007 dollars). Values were inflated to 2011 dollars using a CPI factor.
[17] Per federal guidance, CO_2 benefits were discounted at 3% and combined with non-CO_2 benefits discounted at 7%.

design and construction of the Griffin Road park-n-ride lot, the construction of three bus shelters, the purchase of six 60-foot hybrid electric buses, and the equipment and installation/implementation costs of transit signal priority and signage and branding to provide express bus transit service on I-75 and State Road 826 (SR-826) ("Costs" tab, row 12). Project operational expenses include the operations and maintenance costs of the I-75 Express bus service as well as the maintenance of the new park-n-ride lot on Griffin Road. It was assumed the estimated life of a bus is 12 years; therefore, the cost of replacing the buses when they reach 12 years of age (which will occur once during the 21 years of operational expenses considered herin) is also included in the total costs of the project ("Costs" tab, row 19).

Design costs of the Griffin Road park-n- ride lot are estimated for a 12-month period beginning in June 2012 ("Costs" tab, row 5). Construction costs are estimated for a 18-month period from December 2013 to June 2015 and include mobilization and maintenance of traffic (MOT) estimated costs, a 20 percent contingency applied by FDOT, as well as landscaping estimated costs ("Costs" tab, row 6). Design costs are estimated to be 15 percent of the total construction costs less mobilization, MOT and contingency. The Transit Signal Priority (TSP) and Signage and Branding equipment and installation are estimated to last about 12 months starting in December 2013 ("Costs" tab, row 8 and 9). The delivery of the six hybrid-electric buses is expected to begin in June 2014 and last 12 months, assuming one bus is delivered every other month ("Costs" tab, row 10). The construction of three bus shelters, two for the park-n-ride lot and one for the kiss-n-ride, including their installation are estimated to be completed in six months, starting in January 2014 ("Costs" tab, row 7). The project scheduled is summarized in Table 13.

Table 13: Project Schedule

Activity	Start	End
Design Griffin Road / I-75 Park-n-Ride Lot	June 2012	June 2013
Construction Griffin Road / I-75 Park-n-Ride Lot	December 2013	June 2015
Transit Signal Priority / Signage and Branding Installation	December 2013	December 2014
Three (3) Bus Shelters Installation	January 2014	June 2014
Delivery of Six (6) Hybrid-Electric Buses	June 2014	June 2015

Source: Florida Department of Transportation, 2012.

FDOT also provided estimated annual operating and maintenance costs for the six buses of the I-75 Express bus service at $960,000 per year beginning in July 1, 2015 when the express bus service is expected to start revenue service ("Costs" tab, row 15). The estimated park-n-ride lot maintenance was estimated to start also in July 2015 as well and was estimated based on maintenance cost per parking space obtained from the most recent update of the FDOT State Park & Ride Lot Program Planning Manual.[18] The proposed Griffin Road park-n-ride lot includes 522[19] parking spaces which are estimated to cost $112 a year per space in $2011 to maintain, for a total of $58,265 a year[20] ("Costs" tab, row 16) The life of a transit bus is about 12

[18] http://www.nctr.usf.edu/pdf/Park%20and%20Ride%20Lot%20Manual.pdf

[19] 474 regular parking spaces + 26 kiss & ride spaces + 22 plaza spaces.

[20] Park-n-ride maintenance costs per space per year include: routine and periodic upkeep such as patching, striping, painting, drainage clean-out, landscaping; replacement of pavement, traffic control devices, fences, guardrails, etc.

years; therefore, by 2028, all six hybrid-electric buses will be replaced ("Costs" tab, row 17). Total undiscounted capital and operations & maintenance costs for the project in 2011 dollars are summarized in Table 14.

Table 14. Undiscounted Project Costs ($2011)

Project Costs	$2011
Griffin Road / I-75 Park-n-Ride Lot – Design	$927,500
Griffin Road / I-75 Park-n-Ride Lot – Construction*	$8,703,000
Three (3) Bus Shelters	$75,000
Six (6) 60′ Hybrid-Electric Buses	$6,924,000
Signage and Branding Installation at Two (2) Park-n-Ride Lots	$150,000
Transit Signal Priority (TSP)	$200,000
Total Capital Costs	**$16,979,500**
Bus Operating and Maintenance	$19,680,000
Park-n-Ride Lot Maintenance	$1,194,433
Replacement of Buses (every 12 yrs)	$6,924,000
Total Operating and Maintenance Costs (21 years)	**$27,798,433**
Total Project Costs (undiscounted)	**$44,777,933**

* Includes mobilization, MOT, contingency and landscaping applied by FDOT.
Source: Florida Department of Transportation, 2012.

The discounted present value of all costs is shown in Table 15. Costs are discounted to 2012 using the real discount rates of 3% and 7% as prescribed by the TIGER IV federal guidance.

Table 15. Discounted Present Value of Total Project Costs ($2011)

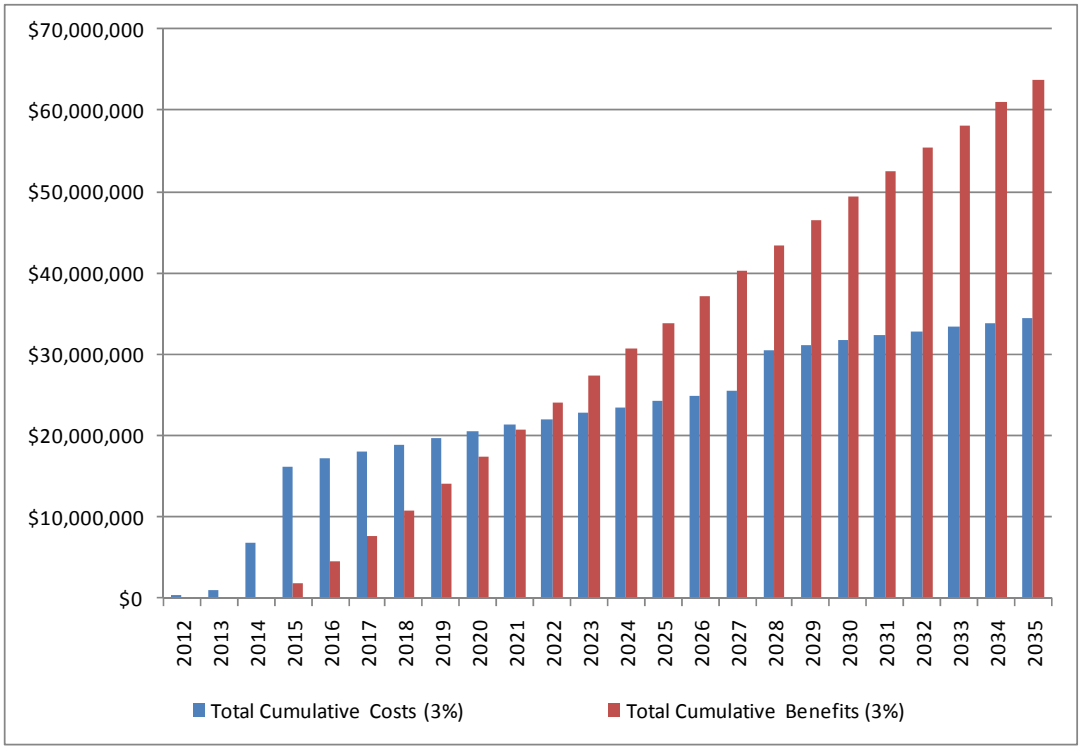
Total Project Costs	Discounted Present Value (2012)	
Discount Rates	**3%**	**7%**
Discounted Present Value of All Costs	$34,419,215	$25,923,018

Source: Cambridge Systematics, Inc.

Benefit-Cost Ratio

Economic Competitiveness, Safety and Sustainability benefits increase in proportion to the increasing number of riders who switch from auto to the express bus service. The cumulative discounted (3%) benefits exceed the cumulative costs of construction and operations by 2022 ("CumBenCosts" tab, rows 10-11), after which net benefits start to accumulate, as shown in Figure 1.

Figure 2: Cumulative Discounted Benefits and Costs ($2011)



At both real discount rates, the lifecycle benefits exceed the lifecycle costs of the project. The benefit-cost ratio at a discount rate of 3% is 1.85 and with a discount rate of 7% the B-C ratio is 1.54. As summarized in Table 16, the long-term outcomes or benefits of this project exceed the project's costs on a net present value basis, validating the long-term economic benefits associated with the investment of the I-75 Express Bus Capital Purchase and Regional Park-n-Ride Lot included in this TIGER IV grant application.

Table 16. Summary of Benefit-Cost Analysis ($2011)

Discount Rates	3%	7%
Project Benefits	**Discounted Present Value (2012)**	
Economic Competitiveness Benefits	$37,730,270	$23,573,867
Safety Benefits	$25,332,753	$15,827,900
Sustainability Benefits	$631,710	$593,747
Discounted Present Value of All Benefits	**$63,694,733**	**$39,995,514**
Project Costs	**Discounted Present Value (2012)**	
Discounted Present Value of All Costs	**$34,419,215**	**$25,923,018**
Benefit-Cost Ratio	**1.85**	**1.54**
Net Present Value	**$29,275,518**	**$14,072,496**

Source: Cambridge Systematics, Inc.