Economic Impacts of Florida's Transportation Investments

A Macroeconomic Analysis

September 2009

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Florida Department of Transportation
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Executive Summary

The Florida Department of Transportation (FDOT) has estimated the economic impacts of its Work Program for fiscal years (FYs) 2008/2009 through 2012/2013. The analysis covers almost all of Work Program spending, including highway, rail, seaport and transit modes. The primary results are shown in Table ES.1. Economic benefits of the Work Program consist of:

- **Personal user benefits**, which arise from personal travel via highways or transit, including commuting, recreational and social trips; and
- **Increased personal income**, which stems from business travel including person trips for business purposes and freight trips via truck, rail and water.

With adjustments for the present value of future benefits, total benefits will be $139 billion. Costs reflect the Work Program budget in 2008 dollars[1]. The ratio of total benefits to costs is 4.92, meaning, on average, every dollar invested in the Work Program will yield about $4.92 in user benefits and additional productivity for the Florida economy between now and FY 2038.

Table ES.1 Benefits and Costs of the FDOT Work Program*
(Billions of 2008 Dollars, 2009-2038)

Present Value of Personal Travel User Benefits	$ 79.7
Present Value of Increased Personal Income	$ 59.5
Total Economic Benefits	$139.2
Present Value of Work Program Budget (Costs)	$ 28.3
Estimated Benefit-Cost Ratio	4.92

* July 1, 2008 Adopted Work Program

Other notable results of the study are:

- In parallel with increasing personal income and gross state product for Florida, the Work Program will create up to 62,000 jobs. About 40,000 of these jobs will be created in the first five years of the Work Program as transportation improvements are completed.
- For the medium term – the next five years – the Work Program will increase gross state product by over $11 billion in increased productivity. This is above and beyond the short term stimulus effect of capital spending, which is not accounted for in this analysis.

[1] Calculation of a benefit-cost ratio requires discounting all benefits and costs to the present day. Both costs and benefits were discounted to 2008 dollars to reflect the time value of money.

- The study shows significant payoff from rail, seaport and transit improvements. Work Program investments will further increase capacity and service in these modes over the next five years.

Study results were compared with results from prior analyses from 2003 and 2006. All three studies apply a similar methodology, but some changes in the results are caused by changes in underlying data, changes in a few computational procedures, and additions to the analysis including a new analysis of benefits to transit riders. The overall benefit-cost ratio declined from about 5.6 in the 2006 study to 4.9 in the current analysis. The main reasons for a decline in the benefit-cost ratio are:

1. Substantial cost escalation in highway and other transportation construction from 2004 to 2007. In this period, national highway construction costs increased by 42 percent, compared to an increase of 10 percent in the Consumer Price Index. Such significant transportation project cost increases mean fewer projects can be undertaken for any given budget amount. Completing fewer transportation projects directly translates into lower total benefits.
2. An increase in auto and truck operating costs, largely stemming from the increased cost of fuel – increased costs for fuel and other vehicle operating costs decreased the amount of benefits from Work Program highway improvements.
3. Relatively limited growth in general inflation and real wages – the value of travel time savings has not changed significantly from prior analyses, in contrast to the rapid increase in costs.

With higher costs for highway construction and less growth of benefits for auto and truck travel, the benefit-cost ratio for this Work Program is lower, but it still shows the Work Program is a very positive investment in Florida's economic future.

The results of this study do not apply to short term stimulus effects of transportation construction. It is important to realize that virtually all Work Program expenditures produce two streams of benefits – short term and long term – and this report is focused on measuring long term benefits relative to costs. This is discussed further in Chapter 1, Section 6.

Future updates to this report are anticipated to expand the analysis to include aviation investments; further refine the methodologies used for evaluating highway, rail, seaport and transit investments; and address the short term impacts of construction spending, among other enhancements to the modeling system.

In conclusion, Work Program investments in Florida's transportation system yield significant benefits to both business and personal travel, and the long term benefits are documented in this report. The current national economic recession has further reinforced the importance of transportation investment in supporting a globally competitive economy.

1.0 Background

The purpose of this study is to analyze the long term economic impacts of the Florida Department of Transportation (FDOT) Work Program. For purposes of this report, the terms economic impacts and macroeconomic impacts are synonymous. Similarly, this report includes economic growth as a major benefit of transportation investment. Therefore, analysis of benefits and costs and of economic impacts is merged into a single set of quantitative estimates. This chapter provides a general introduction and describes the Florida legislative mandate which this study fulfills. It reviews the Department's five-year Work Program analyzed here. It also summarizes previous study results from 2003 and 2006. Lastly, there is a brief discussion of how this study relates to economic short term stimulus proposals and policies.

1.1 Introduction

Transportation is the backbone of the Florida economy and a functioning transportation system is a key factor behind economic growth. Here are some examples of characteristic movements enabled by Florida's transportation system:

- workers to their jobs
- raw materials and supplies to construction sites and manufacturers,
- farm products to markets
- visitors to tourist destinations
- consumers to retail establishments.

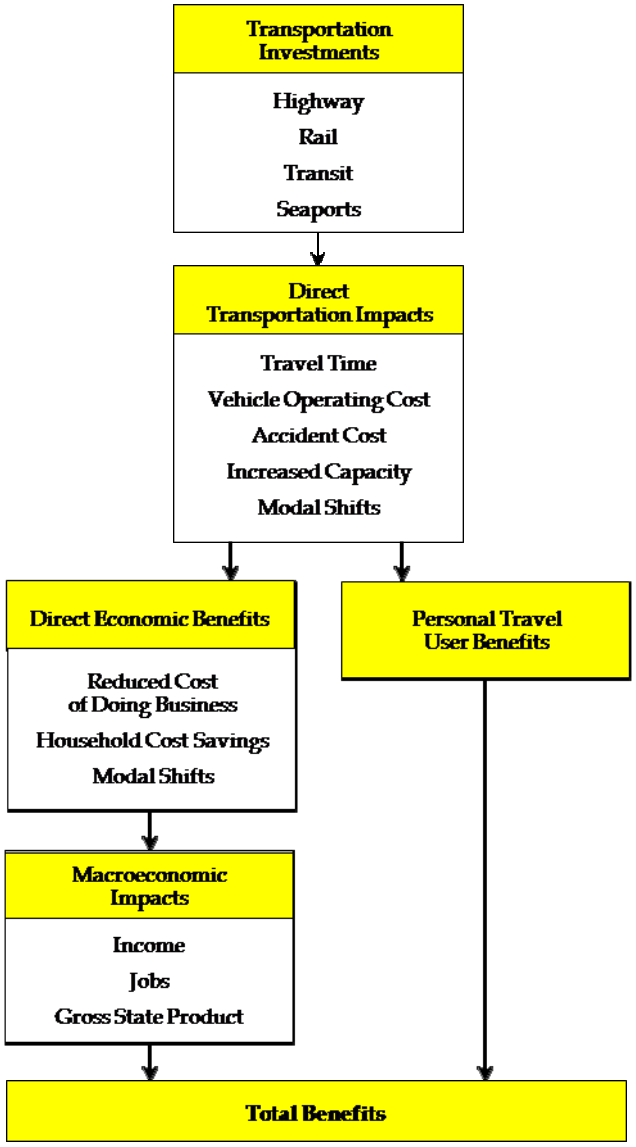
The web of supply lines and transportation routes is complex and depends on well maintained infrastructure. The state's economic health and its ability to remain competitive in the globalized economy depend on the efficient transport of people and goods.

The five-year Work Program, which covers fiscal years 2008/2009 through 2012/2013, accounts for $37.1 billion in transportation investments. One of the main purposes of the Work Program is to enhance the transportation system's efficiency. This macroeconomic analysis establishes the link between Work Program investments in highways, seaports, transit and rail over the next five years, and economic growth in Florida over the following 25 years.

Economic impacts include increases in employment, business output, value-added (as measured by gross state product) and personal income. In addition, this study measures the return on investment of FDOT's Work Program by conducting a benefit-cost analysis to compare the magnitude of benefits and costs over time. In order to make sound projections for these economic performance measures, direct user benefits experienced by travelers and freight carriers were determined first. The benefits to businesses function as inputs to the regional economic model used in this study. The economic model estimates the long run benefits. The conceptual methodology of the macroeconomic analysis framework is illustrated in Figure 1.1.

A more detailed discussion of the specific methodologies for each modal analysis will be provided in Chapters Three and Four.

Figure 1.1 Macroeconomic Analysis Framework



Florida's multimodal network of roads and highways, commercial and general aviation airports, the spaceport, seaports and waterways, passenger and freight rail corridors and terminals and public transit services has evolved as a result of continuous investment. The improvement and expansion of this system depends on public and private expenditures on new and improved infrastructure, technology and services. These investments have direct benefits, including travel time savings for commuters and reduced shipping costs for manufacturers,

distributors and retailers as well as reduced vehicle operating and accident costs and broader economic impacts. These transportation benefits lead to long term macroeconomic impacts such as higher employment, greater gross state product (GSP), more personal income, more new enterprises and beneficial impacts for the national and world economies.

1.2 Response to Legislative Mandate

The catalyst for this study is a Florida legislative requirement, passed in 2000, to analyze the macroeconomic implications of transportation investments and to provide an understanding about how transportation impacts the state's competitive position. A more thorough listing of the relevant legislative mandate(s) can be found in Sections 334.046(4)(b), shown in Appendix A, and in Section 339.137(2)(b), both from Florida Statutes. In addition, the 2025 Florida Transportation Plan (FTP) includes a stronger economy through enhanced mobility for people and freight as one of five long-range goals.

This study is required so "the state has a clear understanding of the economic consequences of transportation investments…." The agreed method for reaching this goal is to "develop a macroeconomic analysis of the linkages between transportation investment and economic performance."

In response to this legislative mandate, FDOT has developed a macroeconomic analysis methodology to evaluate the long-term economic benefits of FDOT's Work Program. These benefits are based on an understanding of how transportation investments save time, reduce costs and enhance economic competitiveness and opportunities. Consistent with economic theory, an improved transportation system makes Florida more attractive to productive assets, primarily skilled workers, successful businesses and investment. These assets enable the state to produce more at competitive prices. As the state's economy becomes more productive, Floridians' incomes, opportunities and lifestyles will improve over the long run.

The legislation specifically requires the analysis to assess the following:

1. **The state's economic performance relative to the competition.** Investments in transportation can improve travel time, reduce vehicle-operating costs, and lessen economic costs associated with accidents. The macroeconomic approach developed by FDOT directly analyzes the impact of Work Program investments on travel conditions in the state on a mode-by-mode basis. The model quantifies the benefit of Work Program investments reducing transportation costs, and then translates those benefits into cost savings for the state's businesses. For example, investments in highway infrastructure will lessen congestion and travel time delay, which subsequently will reduce the time and cost spent throughout a company's supply chain.

The reduced cost of doing business in Florida allows businesses to be more competitive and increase market share in national or global markets. Specific business benefits are increased output (sales), hiring additional workers and ultimately increasing the personal income of Florida's residents. These benefits spread from the direct users of the transportation infrastructure to the broader Florida economy.

2. **The business environment as viewed from the perspective of companies evaluating the state as a place to do business.** The Regional Economic Models, Inc. (REMI) economic simulation model, used in the macroeconomic analysis, accounts for the expansion and attraction of firms due to a reduced cost of doing business from transportation investments. In other words, by providing efficiencies in the transportation system, the state reduces business costs and becomes more attractive to employers and companies.

REMI estimates economic expansions, as well as an influx of workers who would move to the state to take advantage of new employment opportunities and the improved business environment. Over a 25-year period, the improved business environment would help create a significant number of new long term jobs. Other research has also documented these beneficial economic impacts. For example, previous work by the Florida Chamber Foundation, the *Transportation Cornerstone* study, provided a detailed evaluation of the business environment and transportation service in Florida. It included many interviews with businesses in Florida to understand their transportation needs, and it recommended policies and investments.

3. **The state's capacity to sustain long-term growth.** The emphasis of this analysis is on long-term economic growth impacts of transportation improvements rather than short term, temporary benefits. Short term impacts are also important, and they are discussed in Section 1.6. However, this report's focus is on the state's ability to attract businesses and sustain long-term growth. Short-term impacts are being evaluated through other analyses.

Over a 25-year period, Work Program investments will reduce the cost of doing business in the state, and are estimated to result in an increase in personal income for Florida residents. The full results of this study can be seen in Chapter 6 of this report. The FDOT Work Program includes a large percentage, but not all, of the total investment being made in the state's transportation system by all levels of government, the private sector and other entities. Analysis of all transportation investments would require the collection and processing of considerably more data and the cooperation of many more agencies, companies and others.

1.3 Florida Department of Transportation Work Program

This macroeconomic analysis assesses the impacts of the transportation investments in the FDOT Work Program. Investments include activities such as upgrades to existing highways (widening, interchange improvements, etc.), new highway or interchange construction, resurfacing/reconstruction, right-of-way purchases, and capital expenditures applicable to transit, rail and seaports. These activities are found in the "Product" category within the 10-year Program and Resource Plan, which includes a summary of Work Program investments over the next five years.

In addition to Product expenditures, the Florida DOT's Program and Resource Plan includes categories for other activities, including Product Support, Operations and Maintenance, and Administration. These support activities are essential and the Product expenditures could not occur without them. Consequently, these three support activities, with expenditures of over $11 billion, were included as part of the cost of delivering the Work Program investments.

Product Investments within the Work Program

Table 1.1 presents the proposed expenditures by Product and other investment categories contained in the 2008/2009 to 2012/2013 Work Program in year-of-expenditure dollars. For consistency with the 2003 and 2006 analyses, these amounts do not include "roll forward" amounts from prior years. As the table shows, over 75 percent of the Work Program Product investments are focused on product categories which are primarily highway related. However, significant investments are also made in a variety of other modes. For example, investments in transit infrastructure and services amount to nearly $2 billion and rail investments comprise $784 million of FDOT's Work Program.

Table 1-1: FDOT Work Program, FY 2009-2013
In Year of Expenditure Dollars

PROGRAM AREAS	08/09*	09/10	10/11	11/12	12/13	TOTAL
I. PRODUCT	5,567.3	4889.4	4870.8	5612.8	4570.7	25510.9
A.SIS/Intrastate Highways	1,708.0	1852.4	1590.3	2298.4	1410.6	8859.6
B. Other Arterials	859.8	623.7	646.6	828.4	727.2	3685.7
C. Right Of Way	655.8	330.9	289.1	296.6	397.5	1970.0
D. Aviation	217.8	184.2	140.7	153.8	150.4	847.0
E. Transit	384.8	317.4	546.1	309.8	325.1	1883.1
F. Rail	173.1	46.1	147.6	288.0	129.1	783.9
G. Intermodal Access	74.2	62.1	32.9	36.1	35.4	240.6
H. Seaports	56.0	49.8	55.1	69.5	37.0	267.5
I. Safety	101.6	107.0	97.6	110.0	108.6	524.7
J. Resurfacing	1,005.5	990.7	1019.6	982.1	980.7	4978.5
K. Bridge	330.7	325.2	305.1	240.1	269.2	1470.2
II. PRODUCT SUPPORT	1,282.6	1162.5	1145.9	1130.8	1202.7	5924.6
III.OPERATIONS & MAINTENANCE	980.1	925.7	930.2	976.3	1014.9	4827.3
IV. ADMINISTRATION	141.9	188.2	173.0	171.9	175.8	850.9
TOTALS	7971.9	7165.8	7119.9	7891.8	6964.2	37113.6

* Fiscal Year 08/09 does not include Roll Forward funds
Source: Florida Department of Transportation 2008 Work Program Summary, 08/09 through 12/13.

A variety of analytic tools were used to assess macroeconomic impacts. Similar to past studies, three of the principle tools were the Highway Economic Requirements System (HERS), the

National Bridge Investment Analysis System (NBIAS) and the Regional Economic Models, Inc. (REMI) economic impact forecasting model. The impacts of rail and transit investments were analyzed using spreadsheet models and appropriately integrated into the HERS and REMI analysis. The economic impacts from seaport investments were estimated separately based on other studies done in Florida and elsewhere and integrated into the results for highways, rail and transit. All tools are described in more detail in Chapters 3, 4 and 5. Tools and data to assess the incremental benefits from new investments in the aviation mode were not available.

Understanding Work Program Expenditures

Work Program expenditures are presented in three ways in this report: year of expenditure dollars, constant dollars and discounted costs. The expenditure concept used depends on the specific analysis. In this report, Work Program expenditures are analyzed using the following concepts:

• Year of Expenditure Dollars. Year of expenditure dollars (sometimes called nominal dollars) reflect the actual Work Program investments expected to occur in future years. Since some degree of inflation is expected to continue, year of expenditure amounts will always be greater than constant amounts to build a particular facility. This is consistent with how FDOT presents investments in its Work Program summary documents, and is reported here for comparison and reference purposes only. Within the context of this analysis, we analyzed Work Program Product investment totaling $25.5 billion in year of expenditure dollars. Work Program Product Support, Operations and Maintenance, and Administration expenditures are $11.6 billion, and the total Work Program entails $37.1 billion in expenditures.

• Constant Dollars. Year of expenditure dollars are adjusted for inflation in order to reflect the extent of expenditures in each future year. These constant dollars (sometimes called real dollars) have been used as inputs into several of the economic models, including HERS and REMI. For the purposes of this study, the final results also are reported in 2008 constant dollars.[2]

• Discounted Costs. In order to provide a consistent basis for a comparison of dollar concepts over time, the value of future Work Program investments and benefits are discounted to reflect a present value at 2008 levels. Essentially, discounting Work Program expenditures accounts for the time value of money. A dollar today is worth more than a dollar next year since it can be invested and earn interest (above inflation). Discounted Work Program expenditures and benefits are utilized in the benefit-cost analysis section of this report. Please see Appendix C, Glossary, for broad definitions of several of these terms.

[2] The HERS and NBIAS models currently are calibrated for 2006 dollars, so their results were converted to 2008 dollars for consistency.

1.4 Florida Results of Previous Macroeconomic Analyses

Previous evaluations of the Work Program showed significant economic benefits from these large scale investments. The results of those analyses are presented below.

2003 Analysis of Work Program

The five-year Work Program evaluated in the 2003 analysis was compiled of total capital expenditures of $26.2 billion (in 2002 dollars). The results of the analysis showed a very strong correlation between the transportation investments and economic benefits. Key findings of the study included:

- Work Program investments in highway, transit and rail over the five-year period were projected to result in an increase of $44 billion in personal income for Florida residents and generate 88,000 new jobs over the next 25 years. Work Program investments also were projected to yield significant direct user benefits to personal travel in terms of reduced travel time, vehicle operating costs and accident costs. Specifically, the direct user benefits for personal travel over the 25-year time frame were estimated to be $74 billion.
- From a benefit-cost perspective, macroeconomic business benefits and personal travel benefits were estimated as $5.50 worth of economic benefits for every $1.00 invested in the transportation Work Program.

2006 Analysis of Work Program

Similar to the previous study, the 2006 analysis showed transportation investments have significant economic benefits for Florida businesses and residents. The 2006 study reached the following conclusions:

- Through the year 2030, the Work Program investments would create an additional 68,000 jobs, $6.7 billion in personal income (in 2006 dollars), $7.5 billion in gross state product and $11.8 billion in increased output for Florida businesses.
- The Work Program investments would generate over $147 billion in user and economic benefits to Florida residents and businesses through the year 2030.
- These benefits, compared to total costs of approximately $26 billion, would produce a benefit-cost ratio of 5.6.

1.5 Comparison of 2003 and 2006 Results

This section compares the updated analysis in 2006 to previous results in 2003. As shown in Table 1.2, the estimated benefit/cost ratios were almost identical: 5.6 in the 2006 analysis, compared to 5.5 in the 2003 report.

It is instructive to consider some of the changes in approach and results between the 2003 and 2006 studies especially in light of the current research presented in this report.

Table 1-2: Comparison of 2003 and 2006 Analysis Results*

	2003	2006
Benefits		
Discounted Value of Disposable Personal Income	50.8	54.2
Discounted Value of Non-business Auto User Benefits	85.3	93.5
Total Discounted Benefits	136.1	147.7
Total Discounted Costs	24.7	26.3
Net Present Value (Benefits minus Costs)	111.4	121.4
Benefit-cost ratio (Discounted benefits divided by discounted costs)	5.5	5.6

* All dollar values shown are in billions of 2006 dollars. The Benefit-cost ratios are pure numbers.

- The inclusion of the seaport economic benefits in 2006 helped to increase the benefit-cost ratio since the seaport program analysis produced a benefit-cost ratio of 6.9. Still, seaport investments accounted for a relatively modest share of total of Product expenditures (1.1 percent).
- Transit ridership projections from the 2003 study underestimated the strong growth in transit ridership during the past few years, thereby underestimating transit-related benefits. The 2006 statistical analysis of transit ridership included more recent years of high ridership and also higher projections of future ridership (corresponding to higher levels of transit investment). Consequently, the benefits of transit investments increased.
- The value of freight rail investments grew substantially from about $5.5 million annually in the 2002 Work Program to approximately $55 million per year in the 2006 Work Program. New methodologies developed by the FDOT Rail Office, in partnership with data collection from the railroads, helped to estimate substantial benefits in terms of truck-to-rail diversion and reduced shipping costs.
- Increases in transportation construction costs generally outpaced overall inflation and growth in the size of the work program, offseting some of the gains in modal benefits.

Although the direct transportation benefits estimated were higher in the 2006 analysis (e.g., present value of non-business benefits are $93.5 billion compared to $74.4 billion), the employment impact results were actually lower. In the final year of the analysis, job impacts were almost 20,000 lower in the 2006 analysis. However, personal income, gross state product and business output were all larger in the second analysis (e.g., gross state product was 22 percent higher). This implies the personal income and wage benefit per employee were greater than previously estimated.

The primary reason for these changes is likely the growth in labor productivity over the timeframe of the analysis and projected for the future. Higher levels of labor productivity means industries can produce higher volumes of goods and services per employee. Higher

levels of labor productivity typically also result in higher average wages but may not require firms to hire as many employees. The account of the 2006 analysis is consistent with overall economic trends of the period – relatively small increases in the number of jobs combined with more substantial increases in compensation per job.[3]

1.6 Relationship With Economic Stimulus Proposals

This study, *Economic Impacts of Florida's Transportation Investments*, does not address the generation of construction jobs or other short term stimulus impacts of transportation spending. It documents the economic benefits of transportation facilities themselves, not short term benefits related to construction. The initial impetus for the study came from statutory language passed in 2000. At that time, and for most of the decade of the 2000s, short term economic growth was satisfactory, and transportation policy, including the Work Program, was focused on generating and maintaining growth over a period of decades.

The economic situation changed substantially in 2008, as the quantitative work of the study was nearing completion. In response to a massive financial crisis and a deepening recession, public policy shifted to using transportation and other public works programs to reduce unemployment in Florida and the U.S. With favorable timing, public works programs can have a noticeable short term impact on the GSP and unemployment rate during recessions.

An analysis performed in 2007 by the U.S. Federal Highway Administration (FHWA) shows that an additional $1 billion spending on highway construction is associated with an additional 9,500 person-year jobs in construction or closely related occupations. There are likely to be an additional 18,500 jobs in supporting industries and from higher consumer spending resulting from increased employment (the multiplier or ripple effect). However, the methods used in this economic impacts study will need to be substantially altered in order to provide further analysis of short term economic stimulus and job creation effects. Thus these short term effects are being addressed through separate analyses, not within the analytic results of this report.

[3] Please refer to Chapter 7 for a discussion of the 2009 study results and how they compare to those of the earlier studies.

2.0 Study Improvements

This year's economic impacts study combines established methods and new techniques to provide more extensive information on the economic effects of the Work Program. The major changes in the analysis from prior versions are as follows:

- **Enhanced Transit Analysis -** The methodology was enhanced by considering user surplus benefits to transit riders. Previous analyses had only considered the effect of transit improvements on highway congestion. The current analysis incorporates the effects on transit consumers themselves. As with highway improvements, improved transit service for commuters enables them to reach their place of work more quickly and reliably. If workers can reach more places of employment by transit, this improves the flexibility of labor markets and ultimately makes Florida a more attractive location for business. Also, as with the highway side, transit improvements tend to provide value to transit users by saving them time.

  In response to dramatic fluctuations in gasoline prices, as well as other forces, Florida transit ridership has increased significantly in this decade. Further expansions in transit service are planned, and there is potential for increased funding in this area, especially from combined federal, state and local sources.

- **Change in Base Case Assumption –** The REMI model includes a baseline economic and demographic forecast that implicitly includes transportation conditions similar to current conditions. Thus the baseline includes the Work Program. In previous Work Program analyses, it had been assumed that the Work Program was not in the REMI baseline economic forecast and was modeled as a positive impact to the Florida economy, resulting in higher gross state product and employment than the default projections of economic growth. Upon discussion within the project team and with a few outside experts, there was a consensus that the REMI default values include infrastructure investments to maintain the transportation network. Consequently, we assume the essence of the Work Program is incorporated into the REMI Regional Baseline Forecast. Therefore, the absence of the Work Program results in a reduction in the growth anticipated in the REMI baseline forecast.

- **Sensitivity to Alternative Assumptions** - An additional objective of the study was to understand the range of potential impacts given different policy assumptions. The results of this study will enable FDOT to evaluate a variety of scenarios in the future. Given the state's economic and fiscal conditions, there is significant uncertainty about future work program levels and construction cost inflation. The study conducted sensitivity analyses to help document how overall benefits would change under

different assumptions for each of these factors. This study produced a database of these results, which provides FDOT information to analyze potential changes in benefits without repeating the comprehensive analysis.

The rate of cost escalation has a marked effect on the number and size of projects that can be constructed for a given budget. Beginning in 2004 and continuing into early 2008, the State of Florida saw that highway construction costs increased at a rate much higher than that of general inflation. Some of this cost escalation was driven by increases in the cost of materials such as steel and concrete; shortages of qualified engineers and other skilled workers also contributed to the higher costs. Because large capital projects in other modes are rarer, and because they are not always funded by FDOT, it is harder to tell how much the cost escalation applied to other transportation modes.

With the onset of a recession, the trend reversed abruptly in 2008. At least in some parts of the state, highway construction costs actually decreased substantially. Declining costs, or deflation, continued in early 2009. While general price deflation is a serious threat to the economies of the United States and Florida, construction cost deflation for highways, and potentially for capacity projects in other modes, provide FDOT with an opportunity to complete more projects. Therefore, the study investigated a wide range of possible cost escalation rates during the five years of the Work Program.

In addition to the overall benefit-cost ratio, a large number of other projections and outcomes are included in the analytic results. The HERS analysis generates delay projections for Florida's State Highway System. Specifically, hours of delay experienced by auto commuters, by individuals traveling on business, and by trucks have the greatest economic impacts. The Work Program will reduce those categories of delay. Total annual reductions in delay can be estimated for different budget levels. Additionally, the economic benefits of the Work Program express themselves in terms of increased gross state product, personal income and employment. REMI software enables the projection of these economic statistics for every fiscal year from 2009 to 2038, the end of the study period.

During the conduct of this study, two issues were identified that need additional analysis in future updates. They are:

- There is not enough information available to reasonably estimate the impact of incremental investments in the Aviation Work Program on economic measures for this analysis. Fortunately, the FDOT Aviation Office is performing the Florida Statewide Aviation Economic Impact Study, which is expected to be complete in spring 2010. The Aviation Economic Impact Study includes an estimate of the current economic impact of the entire aviation system, going beyond the effects of the FDOT Work Program. Upon completion of the aviation study, there will be an opportunity to further research and identify economic impacts of the Aviation Work Program.

- One of the key benefits of the FDOT Work Program is an improvement in state highways for safety purposes. Observed decreases in total fatalities of the last few years are highly encouraging. On the other hand, capacity improvements may increase traffic volumes and contribute to higher numbers of accidents on certain facilities. HERS software performs limited safety analysis and estimates reduced traffic accidents and reductions in societal costs brought on by improved safety. However, the project team ascertained this analysis does not include all the needed issues and outcomes for safety analysis. Therefore, safety analysis was reduced in scope for this study.

3.0 Methodology: Highway Analysis

3.1 Introduction

Chapter 3 describes the overall methodology and the specific approach chosen to analyze the economic impacts of highway investments. Chapter 4 outlines the technical methodologies applied to all other modes. Later chapters provide analytic results including benefit-cost ratios for the Work Program.

3.2 Overview of Analytical Methodology

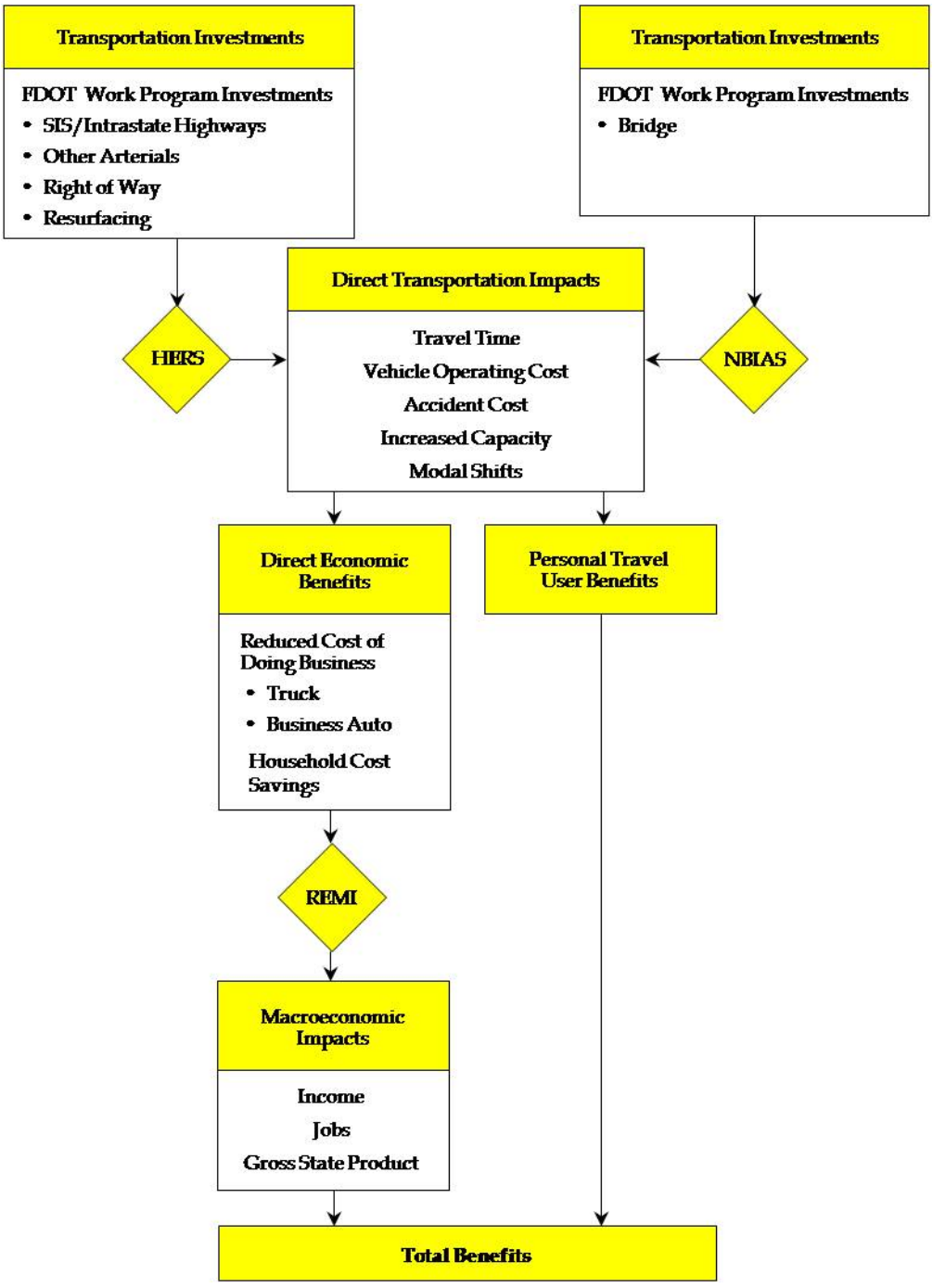
The general analytical framework is shown in Figure 3.1. As shown, investments in highways have a direct impact on auto and truck travel time, vehicle operating cost and accident costs. These cost savings represent direct economic benefits to both personal travel and business-related travel including freight. For the business-related portion of these benefits, the resulting reduction in the cost of doing business leads to macroeconomic benefits measured by increases in personal income for Florida residents, employment and gross state product.

Several software tools to operationalize the algorithm are shown in Figure 3.1. The key tools are two models developed and maintained by the Federal Highway Administration: the Highway Economics Requirements System – State Version (HERS-ST) and the National Bridge Investment Analysis System (NBIAS). A brief description of these tools as well as the selected methodology is provided here.

HERS-ST The Highway Economic Requirements System-State Version (HERS-ST) estimates the highway user benefits from investment programs affecting either highway system performance or usage. The model has been used in a number of states, and at the national level, to estimate the direct economic benefits of highway investments. FHWA uses HERS, in conjunction with NBIAS to prepare its biennial report on the conditions and performance of U.S. highways, bridges and transit. The U.S. Government Accountability Office (GAO) has evaluated the models in HERS and found it an appropriate tool to estimate highway program investments at both the federal and state level.

- **Travel Time Savings.** Travel time savings reflect the dollar value of the reduction in vehicle-hours of travel associated with improved highway conditions. Travel time savings result from reduced congestion due to increased highway capacity or reduced vehicle miles of travel (i.e., from diversion to transit and rail), improved roadway geometry and improved pavement condition. The model assigns different values of time for personal auto, business auto and truck trips. Reduced inventory holding costs and the time savings from reductions in non-recurring incident delay are also captured.

Figure 3.1 Highway Analysis Approach



- **Vehicle Operating Cost Changes.** Vehicle operating costs include fuel, tires, lubricants and maintenance. These costs are affected both by travel time and the general wear and tear on vehicles from substandard pavement conditions.

- **Safety Effects.** Investment can reduce the crash rate on a highway system by reducing congestion and improving roadway geometry. Conversely, improving highway conditions could increase the number of crashes by inducing more total travel on the highway network or increase crash severity if speeds increase significantly. HERS estimates the impacts of capacity investments on the overall crash rate by type of crash (fatality, injury and property damage only), calculates the total number of crashes by category based on vehicle miles traveled and assigns a monetary value to these changes in crashes. HERS does not currently estimate the safety benefit of non-capacity safety investments, such as adding guardrails or geometric improvements; see discussion in Chapter 8.

NBIAS The National Bridge Investment Analysis System (NBIAS) simulates conditions of highway bridges, predicting direct transportation benefits resulting from performing preservation and/or functional improvement work on existing bridges. As in the case of HERS-ST, the model has been used to project bridge investment needs in several states, and FHWA uses the system for its bridge investment modeling.

Please see Appendix B-1, HERS and NBIAS Analysis Steps, for further details concerning the conduct of the analysis for highways and bridges.

4.0 Methodology: Other Modes

The previous chapter discussed the methodology applied to analyze the highway portion of the Work Program. Significant investments are also made in other transportation modes. This chapter covers the methodology used for the estimation of benefits and economic impacts for investments in seaports, transit service and rail systems in order to provide a comprehensive assessment of the total impact of the FDOT Work Program. The aviation mode is not included in this study. Combining user benefits from several modes yields the main inputs to the regional economic model described in the next chapter of this report.

4.1 – Transit/Passenger Rail Analysis

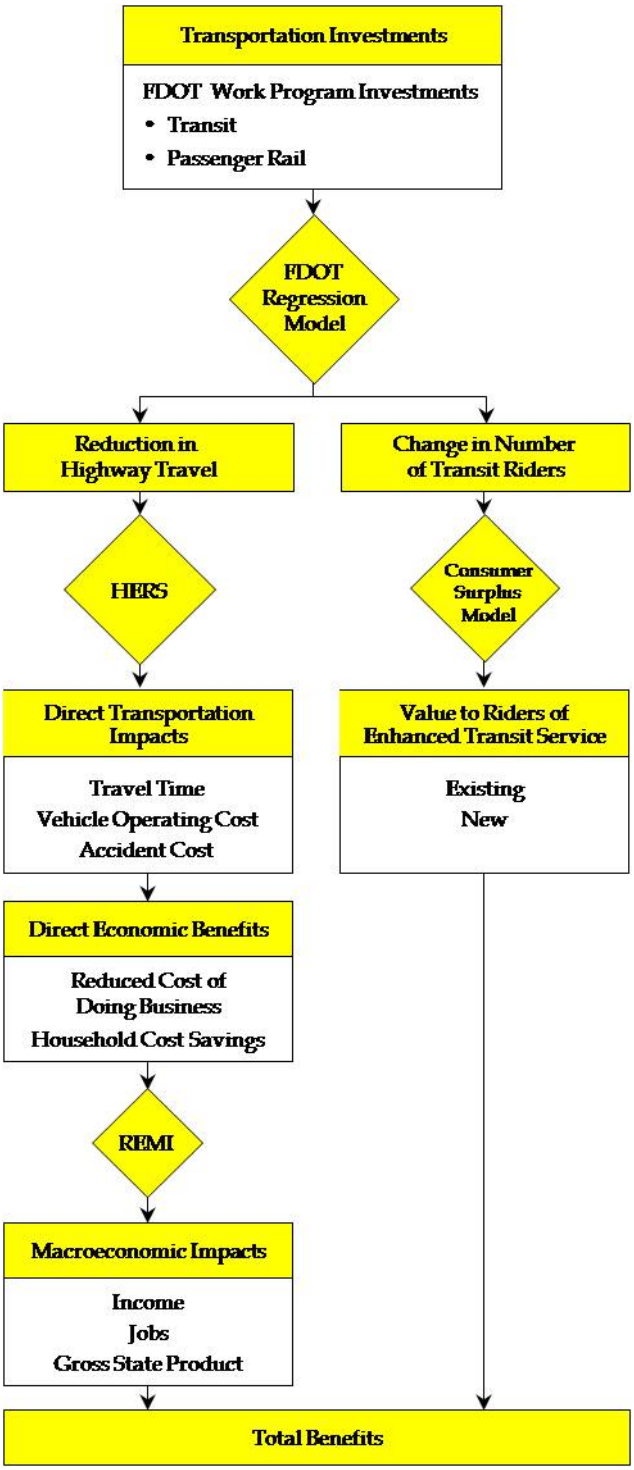
The analysis of the transit work program includes analysis of fixed route bus service and rail transit, which in Florida consists primarily of commuter rail and heavy rail. The macroeconomic impacts of transit have been captured by performing two separate analyses:

1. Travel efficiency benefits are generated by the reduction in highway traffic. Remaining highway users enjoy less congested facilities as a result of a small percentage of automotive trip takers switching to transit. These benefits can be applied to the HERS model, which generates estimates for travel time savings, vehicle operating cost savings and safety cost reductions.

2. Additionally, all transit riders benefit from transit improvements, typically through the reduction of door to door trip time. This is roughly analogous to highway users benefiting from reductions to congestion or from the opening of new road facilities. It is sometimes referred to as increases in consumer surplus. Consumer surplus can be defined as the difference of a person's willingness to pay for a service and the actual price paid.

Please see Appendix B-3, Transit Analyses, for further details concerning the methodology of both analyses.

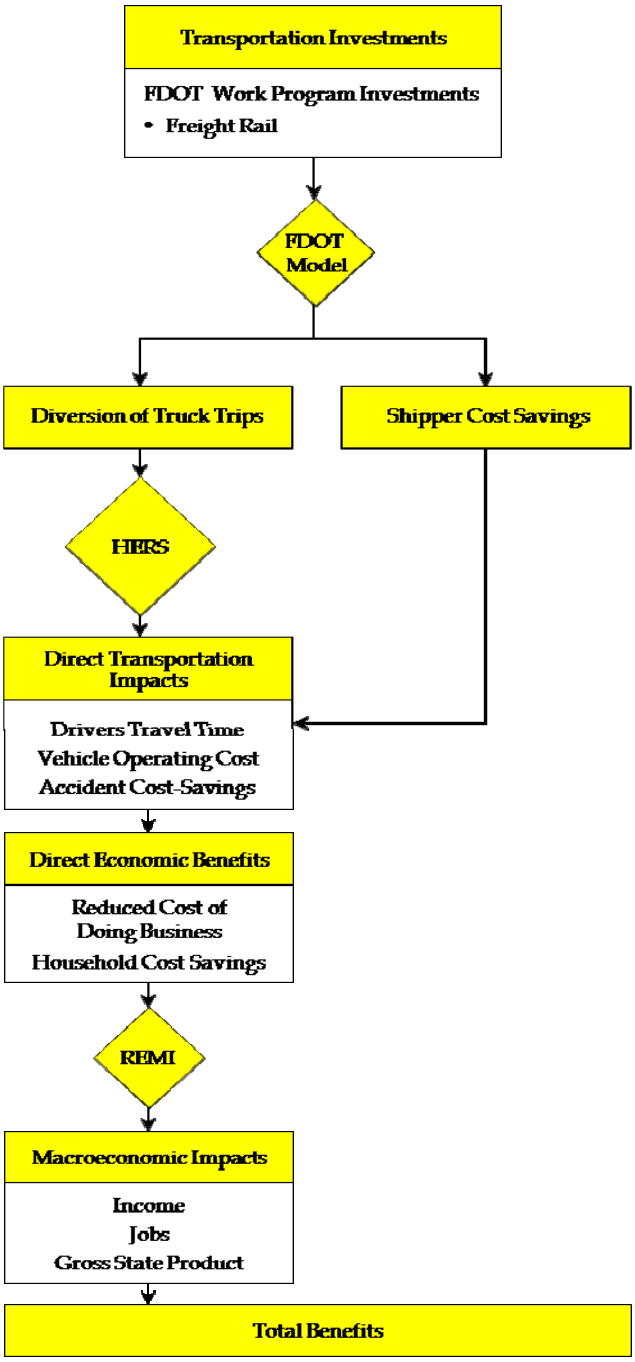
Figure 4.1 Transit/Passenger Rail Analysis Approach



4.2 – Freight Rail Analysis

The benefits stemming from freight rail investments were estimated based on data provided by the FDOT Rail Office. The method is shown diagrammatically in Figure 4.2. The analysis depends on constructing estimates of the number of truck trips that will be diverted to rail and of the savings to shippers that result from freight rail improvements.

Figure 4.2 Freight Rail Analysis Approach



A representative sample of ongoing and future projects was used for the analysis. Most freight rail projects are supported by the FDOT Strategic Intermodal System (SIS) program, with the exception of some minor invetments in shortline railroads and rail-highway crossings. Depending on project specifics, the SIS program pays for various percentages of the project, usually ranging from 50 percent to 100 percent. The sample rail improvement projects including the total estimated cost and the SIS share are shown in Table 4.1.

Table 4.1 – Freight Rail Projects in the Adopted Work Program[4]

Year	Railroad	Project	Total	SIS	Balance
			$	$	$
FY 2008/09	SWFRC	Southwest Florida Rail Corridor ROW	3,000,000	3,000,000	0
FY 2009/10	FEC	Hypoluxo Villa Rica double track	11,000,000	5,500,000	5,500,000
FY 2010/11	SWFRC	Southwest Florida Rail Corridor	863,000	863,000	0
FY 2011/12	FCRR	Amelia River Bridge Rehab	2,267,000	1,700,000	567,000
	FEC	Magnolia North Double track	1,662,000	1,662,000	0
	NS	Westlake Lacy Traffic Control	6,228,000	3,114,000	3,114,000
	FEC	Pineda Causeway Grade Separation	26,160,000	26,160,000	0
		TOTAL	62,408,000	48,061,000	14,347,000

Freight rail improvements generate economic benefits in two ways: by reducing shipping costs and by reducing highway congestion.

1. Cost savings. Rail capacity improvements reduce the cost of shipping by rail, and also enable more shippers to start using rail to move their products instead of trucks. Rail shipments are on average lower cost than their counterparts on the roads especially when the supply lines cover long distances. The sum of these cost savings within Florida makes up one portion of the total economic benefit. The current analysis has followed the approach used for the 2006 macroeconomic Work Program evaluation.

2. Highway travel benefits. Additionally, by removing trucks from highways, the flow of traffic is improved as highway travel is reduced. This in essence leads to travel time savings, vehicle operating cost reductions and a decrease in accidents. Dollar values

[4] Projects associated with the agreement between FDOT and CSX Transportation to consolidate freight shipments on the CSX inland route and create a new integrated logistics center near Winter Haven are not included in this analysis due to the ongoing review of the Development of Regional Impact.

have been assigned to these benefits using HERS unit costs. The portion of the HERS outputs accounted for by business travel were then input into the REMI analysis.

In order to generate the projected economic benefits of the freight rail improvements, the analysis completed in 2006 was leveraged and used to extract the main assumptions and parameters. Based on previous analysis, one dollar spent on rail improvements generates roughly a 0.11 mile reduction in truck travel. Similarly, based on the number of trucks diverted from the roads and trucks loads now carried by rail, cost savings could be estimated.

The project-specific results were then scaled to the size of the current Work Program for freight rail improvements. Based on the Adopted Work Program, $316.3 million are scheduled to be spent on such improvements over the next five years. Additionally, only 50 percent of the cost savings for projects involving the large national railroads (referred to as Class I, including CSX and Norfolk Southern) are assumed to be incurred within the State of Florida. Investments in regional and local rail operations incur all of their benefits within the state.

Rail benefits were estimated for year 2013, and allocated among the first four years of the work program based on the proportion of investments occurring in each year. The highway travel reductions and shipping cost savings as estimated based on the adopted Work Program are shown in Table 4.6 below.

Table 4.2 – Impact of on Truck Miles Traveled and Shipping Costs

	Reduced truck-miles traveled in Florida (millions)	**Shipping cost savings accrued to Florida businesses (million $)**
2009	29.7	$167.3
2010	30.9	$187.7
2011	32.2	$273.2
2012	33.5	$284.7
2013	34.9	$296.5

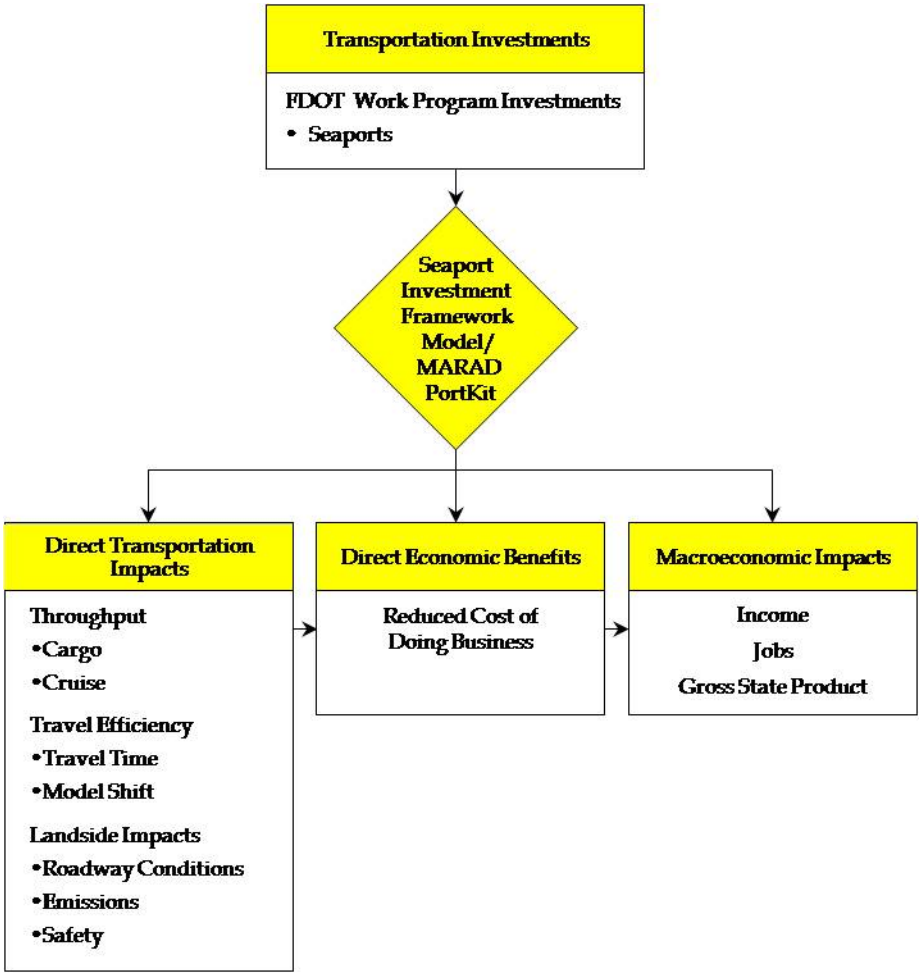
4.3 – Seaport Analysis

The seaport Work Program analysis used the benefit-cost tool developed for FDOT as part of the Seaport Investment Framework. This tool was originally designed to quantify the benefits and costs of a specific improvement project related to economic competitiveness and mobility factors. In order to evaluate the entire seaport Work Program, data from a sample of projects deemed representative of the current Work Program was analyzed. This is consistent with

standard social science theory.[5] The results from these sample projects were then proportionally expanded to represent the entire seaport Work Program budget.

As shown in Figure 4.3, the seaport analysis tool contains structural relationships capturing the economic consequences of investments in different aspects of seaport infrastructure. The seaports supplied the data for this analysis, and the FDOT Seaports Office checked the data for reasonableness compared to prior analyses.

Figure 4-3. Seaport Macroeconomic Analysis Approach



The tool was employed to evaluate throughput impacts for cargo (containers and tonnage) and cruise activity using multipliers from the U.S. Maritime Administration (MARAD) Portkit model, which is used to estimate the economic impact of seaport investments. These multiplier relationships capture the extent of the increase in regional economic activity as a result of an increase in cruise terminal capacity, for example. Similarly, freight-specific benefits are

[5] Babbie, Earl, The Practice of Social Research, 11th ed. Belmont, CA, Wadsworth, 2006.

assumed to directly affect the regional economy depending on the types of goods and commodities targeted. Therefore, the seaport analysis, unlike the highway analysis, was not entered into the REMI model to analyze further economic impacts. Such REMI analysis would have been redundant to the multiplier and regional effects already captured by the model. The seaport model also used an existing analysis to evaluate travel efficiency impacts typically associated with on-port roadway projects.

Along with the benefits obtained from the MARAD Portkit model and the travel efficiency benefits, the seaport tool estimated negative impacts generated by projects in terms of roadway maintenance, railway maintenance, emissions and safety/accidents. These negative impacts were subtracted from the benefits to obtain "net benefits" which in turn were compared to costs.

Please see Appendix B 4 for two detailed examples of how this methodology was applied to specific Florida port projects.

5.0 Methodology: Economic Impacts

The Regional Economic Models, Inc. (REMI) Policy Insight model was used to estimate the indirect and induced economic impacts of the Work Program investments within the state of Florida. The REMI model used in this study is a statewide model, with 70 industry-sector detail; it is the same model used by the Florida Legislature. REMI generates control forecasts and simulates policy changes based on a series of linked socioeconomic variables representing industry output, demand for goods and services, labor supply, wages and prices, and industry market shares.

Key features of the REMI model include: [6]

- **Input-output structure.** At the core of the REMI model is an input-output model which captures inter-industry linkages and multiplier effects.
- **Econometrically estimated relationships**. Econometric and advanced statistical techniques are used to estimate many of the key relationships in REMI, such as costs, market shares and business output
- **Dynamic time series.** The model estimates economic and demographic changes over time, which allows for firms and individuals to respond to changing economic conditions. These mechanisms allow for changes in the demand for labor and the prices of goods over time.
- **Demographic influences.** Includes a detailed cohort component model (age, race and gender) estimating population trends and movements including how the labor force and population respond to changes in employment opportunities.

For this study, the estimates of direct business travel benefits (business auto and truck) generated by the HERS and NBIAS models, and the freight analysis were translated into reductions in the cost of doing business and input into REMI to estimate macroeconomic impacts. The direct user benefits in terms of travel time, operating cost and safety effects were input into REMI as:

1. **Trucking benefits.** Businesses using, owning or operating trucks and trucking services are the major direct beneficiary of these user benefits. These are largely the shippers and receivers of motor freight. Truck user benefits were allocated to industries based on relative industry size and demand for trucking services.

2. **Business auto benefits.** Businesses whose employees drive "on-the-clock" for business purposes, such as sales meetings, also experience a direct benefit from reduced travel times and

[6] For more information see: www.remi.com/

costs. Business auto user benefits were allocated to industries based on each industry's share of total private sector jobs in the economy.

3. **Rail shipping costs.** Businesses relying on shipping and receiving goods by rail experience a direct benefit from improved rail capacity and speed. For example, freight rail investments allow for a greater share of freight to move by rail (compared to highway) and thus result in lower per ton mile shipping costs. Rail shipping cost benefits were allocated to industries based on relative industry size and demand for freight rail services.

It is worth noting economic impacts due to seaport investments, while not captured through the REMI analysis, are included in total economic impacts and the cost-benefit analysis. Seaport investments are estimated using FDOT's Seaport Office benefit-cost analysis tool, which includes the MARAD port kit economic impact model. The MARAD model estimates the same types of economic benefits projected by REMI.

All Work Program Scenarios were modeled in a theoretical analysis to estimate the impacts of the Work Program compared to zero investments by FDOT. The difference between the control forecast and the simulated effects of the Work Program reflects the estimated positive economic benefits of the Work Program.

Transportation Cost Savings

There are three input elements to the REMI model: the freight rail analysis results, HERS highway analysis results (which includes traffic congestion relief benefits of transit) and NBIAS bridge analysis results. Other modal benefits estimated in this study (e.g. seaports impacts and transit user benefits) while not included in the REMI analysis, are included in the benefit cost analysis. The inputs to REMI strictly represent benefits to businesses and do not include any personal travel benefits.[7] The cost savings, in dollars, estimated by the HERS, NBIAS and the freight rail analysis enter REMI as industry cost savings for Florida businesses. As businesses realize lower transportation costs, these savings increase their competitiveness and market share, and therefore output (or sales) are estimated to increase.

Please see Appendix B-2, REMI Analysis, for further details concerning the distribution of transportation benefits among various industries.

[7] Personal auto and transit benefits are included within the Benefit Cost analysis.

6.0 Results and Findings

The overall efficiency of transportation investments can be assessed by comparing the appropriate economic benefits against the economic costs. This Chapter presents the summary of economic benefits and costs, and the benefit-cost ratio, of investments in the FDOT Work Program. Consistent with previous macroeconomic analyses, this approach includes economic impacts related to competitiveness and growth in addition to the direct user benefits. The cost analysis follows a traditional benefit-cost approach by including all of the Work Program's expenditures such as the costs to build, operate and maintain infrastructure, as well as associated administrative and support costs. The following are a description of the components of the costs and benefits included in the Work Program analysis:

Table 6.1: Components of Benefit-Cost Analysis

Benefits	Costs
Change in Personal Income	Capacity Spending
Change in Personal Auto Benefits	Costs for Operations and Maintenance
Change in Transit Rider Benefits (i.e., Consumer Surplus)	Costs for Administration and Support

6.1 Benefits and Costs

The benefits attributable to the FDOT Work Program include the macroeconomic impacts measured by changes in real personal income, which result from improved transportation performance and the impact of these improvements on business productivity and expansion. In other words, investments reduce the cost of doing business for firms in Florida and this increases employment growth, business sales, and personal income. Direct highway and transit user benefits for personal travel are included. Highway user benefits include the travel time savings, vehicle cost reductions and accident cost reductions created by improved travel conditions. Transit consumer surplus benefits are described in Chapter 4 and Appendix B 3.

This approach avoids double-counting because user benefits of a direct business nature are used as inputs to the broader macroeconomic benefits analysis. Excluded from the benefits estimation are short term construction benefits, operational expenditures and any environmental or social benefits. Even though there are likely to be significant short term economic and employment growth as a result of the Work Program, the analysis uses a long-term time horizon, which does not take them into consideration.

Costs included in the analysis include the Work Program itself with investments in highways, transit, seaports and rail between the fiscal years 2008/2009 and 2012/2013. Also added to the

total cost for the analysis are expenditures for investment support, operations and maintenance, and administration. Excluded from the analysis are airport program investments, non-capacity safety program investments and most intermodal access investments. The department is working on methodologies to incorporate these types of investments into future macroeconomic analyses.

6.2 Analytic Assumptions

As a general guideline, the analysis examined a period of 25 years. The final year for which quantitative results were generated was 2038, so 25 years of economic impacts are included for projects completed in 2013. Costs and benefits are expressed in constant 2008 dollars and discounted to present value to enable comparability. The present value of costs and benefits occurring in future years were discounted at a rate of 7 percent, as currently recommended by the U.S. Office of Management and Budget[8] and consistent with the prior studies. Use of the discounted "present value" of future costs and benefits provides a consistent basis for comparing costs and benefits accruing at different times in the future. A cost or benefit is more heavily discounted as it occurs further into the future, so its equivalent present dollar value can be greatly reduced. Discounting reflects the time value of money; a dollar in hand today has greater value than one received in five years, even after adjusting for inflation, because the dollar in hand now can be invested.

In keeping with the convention for transportation infrastructure projects and programs, the primary measure of effectiveness is the benefit-cost ratio. The benefit-cost ratio is defined as the discounted stream of present and future benefits divided by the discounted stream of present and future costs. In some cases, the net present value is used to supplement or replace the benefit-cost ratio. The net present value is defined as the difference between the discounted stream of benefits and the discounted stream of costs (see Appendix C, Glossary). In virtually all cases, these two terms are simply different ways of expressing the same set of mathematical relationships. The information used to calculate the benefit-cost ratio can be used to calculate the net present value.

6.3 Methodology

Estimating Benefits:
One major output of the study is the increase in aggregate personal income for the state of Florida. The other major category is the personal travel benefits for highway and transit users. Personal travel benefits have economic value, but do not directly contribute to cost reductions for businesses. The improvements to infrastructure fundamentally cause both of these benefit types. As explained in Section 1.6, short term economic benefits, such as construction and operational expenditures, are not included in this analysis.

[8] Office of Budget and Management (OMB) Circular No. A-94 Revised: "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs"

User benefits

User benefits are the result of individual time savings from infrastructure improvements resulting in benefits to Florida residents. Also referred to as non-business benefits, they accrue to individuals using the transportation system to commute to work or school, or for recreational and social travel. These include personal auto benefits from highway and bridge improvements, and transit user benefits. Seaport investments are not assumed to generate any user benefits.

Personal auto benefits. The auto personal benefits were calculated within the HERS and NBIAS analysis. The personal time savings are due to improvements to highways and bridges, as well as reduced congestion from increased transit ridership or the diversion of truck trips to other modes. These personal time savings estimates are multiplied by the value of time to determine the aggregate personal auto benefits for Florida residents. In addition, HERS also estimates the personal auto benefits resulting from lower vehicle operating costs and reduced accidents. Both categories are included in the total estimate for personal auto benefits.

Transit consumer surplus. Improvements to transit infrastructure will reduce travel time, which will benefit both existing transit passengers and new transit passengers. As transit investments are made, a portion of those who once relied on auto transportation will now shift to public transit. In addition public transit passengers will benefit, usually by reducing their travel time. Reduced travel time increases the net value, or consumer surplus, of each trip for transit riders.

Benefits to businesses

Benefits to business take the form of increases in Florida's real personal income. Real personal income is a major component of gross state product, which rises as well.

The main benefits for this analysis were the estimates for real personal income generated as a result of the Work Program investments. Real personal income is a true measure of a region's economic well being and is adjusted for inflation to represent purchasing power. The real personal income estimates combine the REMI and MARAD results. The personal income estimates derived in the REMI analysis include the economic impacts of highway, bridge, and freight infrastructure improvements. The results of the 2006 MARAD work program analysis were extrapolated to estimate economic benefits from alternative levels of the Seaport Work Program budget.

Estimating Costs:

The direct planned expenditures of the Work Program represent the costs within this analysis. This analysis only includes costs of highway, bridge, rail, seaport and transit improvements, which account for the overwhelming majority of the Work Program budget. Therefore the costs exclude safety, air, and most Intermodal Program investments. Appropriate costs for Product Support, Operations and Maintenance, and Administration were included within the analysis. These three cost categories were adjusted to match the modal investments within the analysis. Expenses from either major reconstruction projects or operations and maintenance work after 2013 are excluded from the cost computations. Similarly, salvage values at the end of the timeframe were assumed to be negligible. The cost analysis is narrowly focused on the evaluation of the next five years of transportation expenditures.

6.4 Economic Impact Results

The economic impacts below are based on the adopted Florida DOT Work Program as of July 2008. Table 6.2 shows the economic impact benefits for selected years. Personal income effects range from $2.7 billion in 2011 to $6.6 billion in 2031 and represent the benefits to Florida residents due to increased jobs and wages. Gross State Product (GSP) is the most commonly used macroeconomic indicator of value-added economic activity, while business output represents all sales (goods and services) by Florida firms. GSP annual impacts are over $8.9 billion while total business output impacts are $13.8 billion in 2031. The employment impact is a net job effect that would include both new jobs created by greater economic competitiveness as well as jobs retained (that otherwise would be lost without transportation investments). Employment effects are over 30,000 in 2011 and increase to 63,990 jobs annually in 2031. Population effects grow dramatically from 19,680 in 2011 to 117,200 in 2036.

Table 6.2 Summary of Economic Impact Results

	2011	2021	2031	2036
Personal Income*	$2,740	$5,353	$ 6,635	$ 6,331
Gross State Product*	$2,798	$7,059	$ 8,951	$ 8,644
Output*	$4,456	$10,950	$ 13,809	$ 13,257
Employment	30,280	59,130	63,990	56,880
Population	19,680	88,780	117,200	117,200

* All dollar concepts in millions of 2008 dollars

Figure 6.1 displays the total employment impact from 2009 to 2038 due to Work Program investments. The employment impact grows rapidly over the five years of the Work Program (FY 2008/09 to 2012/13) and then expands gradually in line with projected growth in transportation volumes. The employment impact peaks in 2032 at 64,480 jobs as annual difference due to the Work Program. The modest drop-off after 2032 is simply due to assumptions about the useful life of FDOT investments as investments are generally modeled to produce a 20 to 25 year stream of benefits.

Figure 6.1 Total Employment Impact
In Millions of 2008$

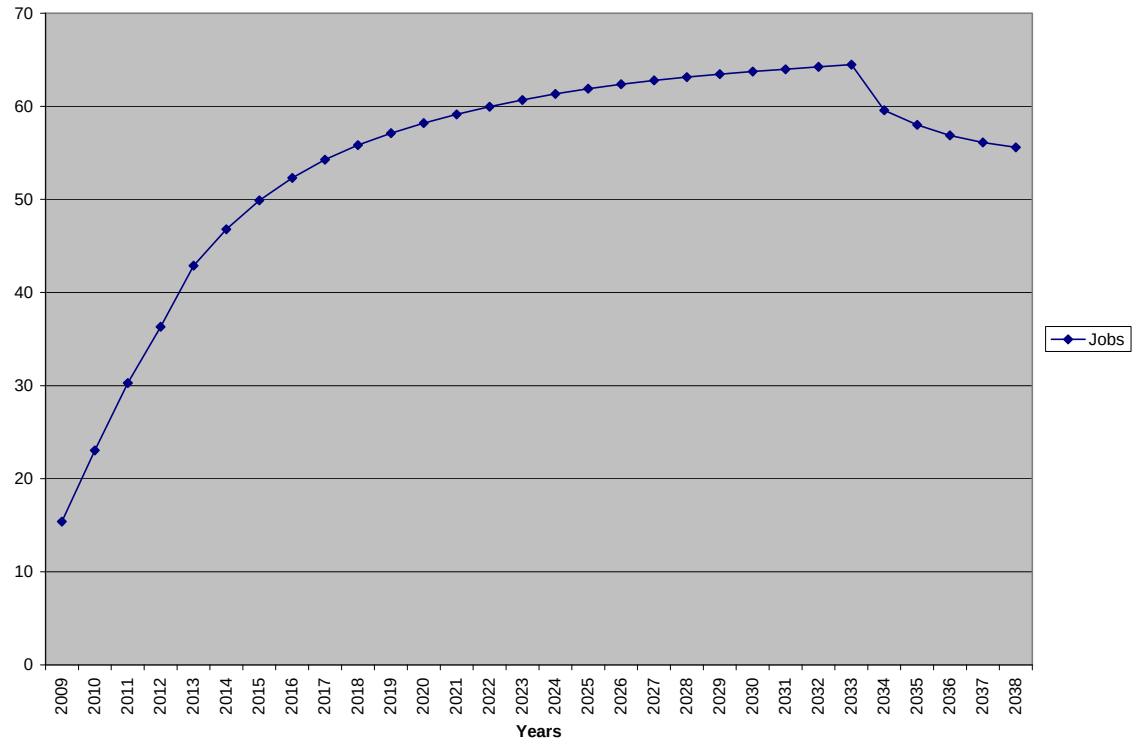


Figure 6.2 displays the time series of impacts for personal income, GSP, and business output from 2008 to 2038 each with a similar pattern as the job trend in Figure 6.1. Business output impacts are consistently larger than GSP since it includes all sales value, including intermediate goods, while GSP only counts value-added by Florida businesses. A major source of difference between GSP and personal income is business profits.

Figure 6.2 Personal Income, GSP, and Output Impacts
In Millions of 2008$

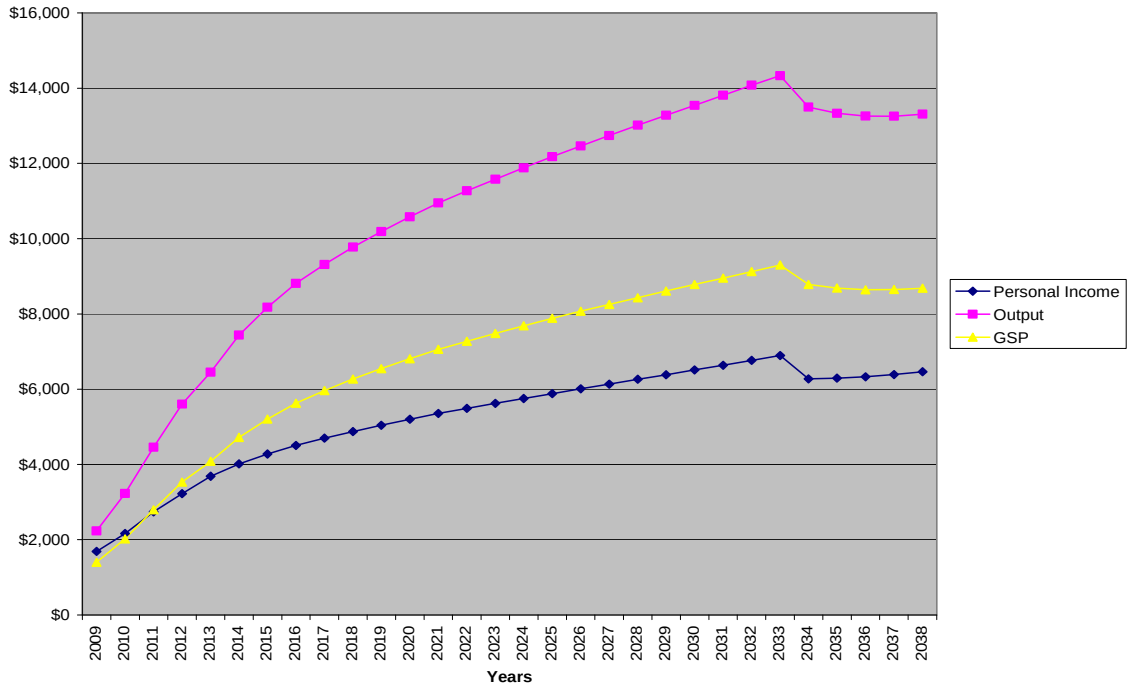


Table 6.3 provides industry-level employment impacts in 2011, 2021, 2031 and 2036. The industries that are projected to benefit the most from the FDOT Work Program include retail and wholesale trade, and services including education, health care, arts, accommodations and food services, and professional and business services. These industries tend to be the well-represented in Florida, and also require transportation services. The employment impacts to transportation and warehousing, and manufacturing (as a share of total job impacts) are estimated to exceed their current share of all jobs in Florida, reflecting the obvious importance of transportation to these industries.

Table 6.3 Employment by Industry Impacts

Employment	**2011**	**2021**	**2031**	**2035**
Forestry, Mining, Utilities	344	827	929	856
Construction	4,284	5,747	4,600	3,088
Manufacturing	1,200	2,430	2,621	2,323
Retail & Wholesale trade	5,388	9,196	8,883	7,378
Transportation Warehousing	1,067	2,082	1,982	1,574
Finance, Real estate	3,514	6,200	6,462	5,592
Info & Profess Services	2,179	4,834	5,577	5,074
Mgmt Admin	2,543	5,531	6,054	5,454
Education and Health	3,081	7,175	9,450	9,371
Arts Accommodation & Services	5,669	10,482	11,410	10,145
Total	**29,269**	**54,504**	**57,968**	**50,854**

6.5 Summary of Results

As shown in Table 6.4, the benefit-cost ratio of the FDOT five-year Work Program is estimated to be 4.92 with a net present value of $111 billion over 25 years. The analysis indicates for every $1 invested into the Work Program, Florida's residents and businesses will receive a benefit of $4.92. The results of this analysis show the benefit of the FDOT Work Program and its effects on the Florida transportation system compared with making no investments and allowing the system to deteriorate.

Table 6.4 Benefit-Cost Summary
Of the FDOT Work Program
(All monetary values reported in billions of 2008 dollars)

BENEFITS	
Present Value of Personal Income Change	$ 59.5
Present Value of Non-Business User Benefits	$ 79.7
Total Discounted Benefits	$139.2
COSTS	
Present Value of Total Costs	$ 28.3
Net Present Value (Benefits Minus Costs)	$110.9
Benefit-Cost Ratio	4.92

In parallel with increasing personal income and gross state product for Florida, the Work Program is projected to create over 64,000 jobs. Most of these are long term jobs; the vast majority is generated by 2015 and continues well into the decade of the 2030s. Although the analysis period ends in 2038, job support and job creation should continue for decades beyond. However, the jobs of the 2040s and 2050s are likely to stem from future FDOT work programs that are not included in this analysis.

7.0 Discussion

7.1 Benefit Cost Ratio

The results of this study show every $1 invested in FDOT's work program will generate $4.92 in user and economic benefits over 30 years. This means FDOT investments in transportation infrastructure and related programs will produce a favorable return for Florida's workers, businesses, consumers and governments. An improved transportation system will improve efficiency, enhance accessibility and lower business costs. In turn, these improvements will improve business competitiveness and contribute to a highly skilled work force. This projected payoff is estimated using a real discount factor of 7 percent per year on future benefits; this means an investment of $1 in 2010 would have to yield $3.87 in 2030 to break even.

The benefit-cost ratio (BCR) of about 4.9 is not as high as the ratios of 5.5 and 5.6, which were estimated by previous analyses completed in 2003 and 2006, respectively. The main reason for the decrease in the estimated benefit-cost ratio is the substantial cost escalation in highway and other transportation construction and right of way. Specifically, during the 2004 to 2007 period, highway construction costs increased by about 42 percent compared to an increase of 10 percent in the Consumer Price Index. Highway construction costs continued to increase in 2007 and into 2008.[9] The increases during 2004 and 2005 were not captured in the 2006 analysis due to lags in data reporting. The increase in costs means the cost of transportation investments rose and thus the FDOT Work Program budget (which increased at a lower rate) can complete fewer projects. Completing fewer transportation projects directly translates into lower total benefits.

A second reason for the decrease was an increase in auto and truck operating costs, largely stemming from the increased cost of gasoline and diesel fuel. In the HERS model, operating costs are a major factor determining the use of highway facilities, as measured by vehicle miles traveled by both cars and trucks. When operating costs increase, vehicles make less use of highways, which reduces the degree of economic benefit generated from these facilities. Thus increasing costs for fuel also contributed to the decreased benefit from the Work Program highway improvements.

The overall rate of inflation has been lower than the rate of inflation for agency costs and operating costs. Put another way, the growth in agency costs and operating costs has outpaced the growth in costs of other goods and services in the economy, including the cost of labor. The

[9] Statistics published by the Federal Reserve Bank of Minneapolis and the United States Bureau of Economic Analysis; please see http://www.minneapolisfed.org/community_education/teacher/calc/hist1913.cfm and http://www.bea.gov/national/nipaweb/TableView.asp?SelectedTable=161&ViewSeries=NO&Java=no&Request3Place=N&3Place=N&FromView=YES&Freq=Year&FirstYear=2004&LastYear=2007&3Place=N&Update=Update&JavaBox=no

overall rate of inflation is used as the basis for calculating the change in the value of time. The value of time increased only modestly between the 2006 and 2008, consistent with the relatively flat level of real wages during the period. Because the value of time is about the same, the monetary benefits of saving an hour of travel time have been relatively constant.

Taking these factors into consideration, construction cost increases have reduced the 'purchasing power' of FDOT's Work Program, while benefits, especially the ones based on travel time savings and vehicle operating costs, have been reduced or grown only slowly. The combination of slower growth in benefits and rapid growth in costs reduces the overall benefit-cost ratio for the work program.

There were also factors which tended to increase the benefit-cost ratio or, in this case, reduce the extent of decrease. These include:

- Inclusion of transit user benefits – augmenting the previous studies, this analysis developed an innovative program-level approach to estimate and include user benefits to existing and new transit riders based on a consumer surplus approach (see Chapter 4 and Appendix B 3);
- Increased funding levels for freight rail and seaports and the associated benefits of these modes (see Chapter 4 and Appendix B 4); and
- As estimated by the REMI model, long term economic growth effects will be slightly greater than previously projected.

7.2 Sensitivity Analyses

FDOT conducted several sensitivity analyses to determine how economic benefits would vary under different assumptions, including the following:

- **Changes in the rate of highway construction cost escalation.** For the initial analysis, the HERS model assumed an average highway construction cost escalation of about 5% per year. As part of the sensitivity analysis, several model runs were based upon different rates of cost escalation. Specifically, the analysis included the possibility that the rate of cost escalation could be higher or lower than the HERS projected rates. In the most extreme case, cost escalation rates were assumed to be 6% per year lower, resulting in construction cost deflation for most of the five year period.

  When the various assumptions were run through HERS and REMI, the results showed that changes in the rate of highway cost escalation could have a major effect on the BCR of the entire Work Program. If costs consistently escalated at a rate of 6% per year ***less*** than assumed by HERS, then the BCR would go up from 4.9 to 5.8. On the other hand, if costs consistently escalated at a rate of 6% per year ***more*** than originally assumed, then the BCR would go down to 4.0. As expected, results for changes in cost escalation of 2% per year, up or down, show smaller changes in the BCR. With cost escalation of 2% per year lower, then the BCR would go up to 5.2 according to the HERS/REMI projections. Please see Appendix

B-5, Cost Escalation, for further exposition and a figure illustrating different cost escalation assumptions.

- **Changes in the size of the work program**. The analysis examined economic benefits from potential Work Programs, which could include reasonably higher or lower budgeted amounts than the adopted 2009-2013 Work Program. The results indicate benefit-cost ratios remain within a range of 4.0 to 5.0 as the budget is varied.

- **Changes in the value of time**. The analysis finds economic benefits and benefit-cost ratios are very sensitive to the value of time assigned to truck and auto travel. The primary simulations used conservative values of time, generally in the lower half of the range supported by available research. If values from the high end of the range were used, or if new research or data such as growth in high-wage jobs supported higher values, then the benefit-cost ratios generated by our analysis would increase considerably. The results indicate benefit-cost ratios range from 4.1 to 7.5 as the value of time is varied.

7.3 Technical Issues

In all quantitative studies like this one, issues arise concerning the availability, comprehensiveness, quality and processing of data. The department possesses extensive data and analysis capabilities on highway passenger travel, but there are significant limitations on data and analytic tools for the other modes, especially seaports, freight rail and aviation. Some of the areas where additional data are likely to be useful in the future include more detail on passenger and freight trips, intermodal connectivity, dollar values of freight shipments, freight transfer costs, measurements of capacity and volume/capacity ratios by mode, and data auditing.

For the highway mode, the analysis of Work Program impacts could be improved if there was greater capability to forecast utilization and trip purposes for improved highways and interchanges. These and other analysis and research issues are addressed in Chapter 8.

7.4 Transportation and the Economic Environment

When the current macroeconomic analysis was initiated in early 2008, Florida's economic growth was slowing from the rapid pace of the 2003 to 2007 period. It was widely believed both the U.S. and Florida economies could resume robust growth during 2008.

However, the economy has entered a major recession. As of the preparation of this report (July 2009), the Florida Revenue Estimating Conference projected the recession would last throughout 2009 and continue into 2010.[10] Although a full recovery is projected for 2011, a serious recession could bring major changes to the structure of the state's economy. Consequently, Federal and State governments are taking action to create jobs quickly.

[10] "Florida Economic Outlook" p.3, http://edr.state.fl.us/conferences/fleconomic/FEEC0810_execsumm.pdf

Additionally, there may be declines in right-of-way and construction costs enabling the State to complete more projects for the available budget.

There is a high degree of uncertainty concerning the future course of the Florida economy, and the department needs to be able to respond quickly to changing conditions, needs and opportunities. Based on economic assumptions and appropriate data, this study provides long range projections, targeted analysis and further understanding of the impact of the FDOT Work Program. This knowledge can contribute to policy development and decision making.

8.0 Ideas for Further Analysis and Research

The 2008 macroeconomic evaluation of the FDOT Work Program is the third iteration of this analysis following the 2000 legislative mandate. The analyses completed over the last five years have helped Florida's decision-makers and a wider group of stakeholders understand the economic impacts generated by transportation investments and improved system performance. The results have consistently shown a dollar spent on transportation in Florida yields significant benefits not only for direct users of the infrastructure but also to the entire state economy. The methodology applied to estimate macroeconomic impacts and the benefit-cost analysis is based on the current state of practice in transportation planning and economics. It enhances understanding and analysis of the Work Program, enabling FDOT to be more effective at serving the residents, visitors and businesses of the state.

While the core analytic methodology applied in this updated study is similar to the original macroeconomic analysis report published in 2003, each subsequent analysis has sought to expand the coverage of modes and apply the latest in research and data trends. For example, this study provides the following enhancements compared to the 2003 study:

- Inclusion of seaport investments and their anticipated benefits, developed in a consistent manner to the 2006 FDOT research report on the economic impacts and return on investment of seaports.
- Updated highway construction cost factors in the HERS and NBIAS models to capture recent and projected cost escalation.
- Enhanced freight rail analysis based on results and performance measures from the FDOT Rail Office's cost-benefit analysis tool.
- Estimates of the user benefits to existing and new transit riders due to public transit investments, measured through a consumer surplus methodology.
- Use of the current version of the REMI model, which incorporates updated historical and forecast economic data, as well as a better understanding of economic geography.
- Enhanced sensitivity testing of the value of time to passenger and freight travel, alternative levels of future Work Program investment and cost escalation factors.

Several areas have been identified for potential further development. The following ideas for enhancement would continue the process of refining the analysis and providing full modal coverage.

1. Additional Improvements to Highway Analysis – The highway analysis could incorporate detailed commodity flow data, which would create a more accurate picture of the freight benefits generated by the highway improvements. The sources for such data need to be defined

but it may be possible to use TRANSEARCH, the statewide freight travel demand model or another data resource as the basis for such analysis.[11]

An additional potential improvement is the allocation of user benefits across different industry categories. At the moment, Transportation Satellite Accounts published jointly by the U.S. Bureau of Economic Analysis and the U.S. Bureau of Transportation Statistics are used for this purpose. But these data are now significantly aged, and it is uncertain when a new version will be released. This may reduce the accuracy of the inputs to the economic model. The adoption of a more current allocation method is desirable, and updated travel surveys could be used for this purpose. Other data may be available depending on which industries are of greatest interest to state policy makers.

In addition to user benefits such as time savings, operating cost reductions and crash cost reductions, reliability benefits may also be included in the analysis. Investments in transportation infrastructure and/or operational improvements expand capacity and allow for the peak congestion period to be flattened or shortened. As a result the buffer time, the time added to the trip in order to be on time, can be reduced as well. The decrease in this time can be picked up as a reliability benefit from the Work Program. The HERS estimate of travel time savings accounts for anticipated reduction in non-recurring delay (e.g. reductions in the number of incidents) but does not include the economic value to people or businesses of having more reliable travel times. This capability may be included in future versions of HERS. FDOT is working to develop reliability data for several of its major highways, which can be used in future versions of this analysis.

Greater attention also could be given to the user and economic benefits of improved or new interchanges. Interchange projects are not directly modeled in HERS, but benefit data could be extracted from other models, such as the Interchange Management Analysis Tool currently being tested by the FDOT Systems Planning Office.

2. Network Modeling of Highway Capacity Investments – The analysis of highway investments is currently accomplished by applying the HERS model and using the annual Work Program expenditures as inputs to the model. User benefits are annualized and used as inputs for the regional economic model. Overall, this analysis approach works well for the macroeconomic evaluation. However, HERS allocates funds based on an internal cost-benefit analysis optimization program. Consequently, it can be difficult to retain the desired structure of the Work Program for new capacity and preservation. Adjustments are required in order to make sure the investments and results are consistent with the structure and composition of the Work Program. Additional work may be needed to streamline this process.

A travel demand model could be used in addition to HERS. This type of model is available either at the state, district or metropolitan level. Highway improvements would be coded so the structure of the Work Program is retained and the results specifically relate to FDOT's pattern of capital expenditures. The adoption of a travel demand model would mean a

[11] The TRANSEARCH database was recently used by FDOT as part of a statewide freight planning study.

significant work effort to code the entire Work Program, but it would give the study greater accuracy and specificity on the facility level. The travel demand model would also facilitate differentiation of the economic impact of commuter trips. Highway preservation investments and bridge improvements would still need to be evaluated, possibly using HERS and NBIAS.

3. Analysis of safety investments. HERS estimates the safety impacts of highway capacity investments – for example, changes in the crash rate likely to results from widening a highway or changing an existing highway to limited access. But HERS and the other tools used in this study do not estimate the benefits of investments made in the Safety element of FDOT's work program, such as adding guardrails or educating users about safety belt usage. Published research can be used to analyze a greater variety of safety programs.

4. Seaport Methodology Improvements – The current analysis includes benefits and costs of seaport projects. The development of a seaport system plan may better define the waterside, portside and groundside projects to be included in the Work Program in coming years. The FDOT Seaport Office is also working on improving and extending its methodology, and it is expected the future iterations of the macroeconomic impacts study will be able to incorporate improved data and forecasts.

5. Freight Rail Methodology Improvements – The current analysis includes shipping costs savings and highway travel benefits associated with freight rail projects. As part of the update of the Florida Rail System Plan, the FDOT Rail Office is updating needs assessment and clarifying the factors used to evaluate rail projects. It is expected the future iterations of the macroeconomic impacts study will be able to incorporate improved data and forecasts.

6. Coverage of Aviation Sector – The macroeconomic studies so far have not included investments in the aviation sector. Aviation investments generate significant and growing benefits and economic impacts for the state. These impacts should ideally be included in the analysis. It is therefore desirable to work closely with the Florida DOT Aviation Office in order to develop the necessary data and analysis methodologies. Successful collaboration with the Seaport Office and Rail Office provide a template for future research into economic impacts of the Aviation Work Program.

7. Additional Research into Transit Consumer Surplus Benefits – The 2008 analysis differed from previous versions by incorporating the consumer surplus benefits created as a result of transit investments. The development of the methodology to credibly estimate these benefits constitutes significant progress, but the unique features and significant ridership growth of the transit mode provide an impetus for further work. The scheduled construction of the SunRail line will provide commuter rail service to Central Florida. Additional research could address issues such as refining estimates of the generalized cost of travel, the duration of transit economic impacts and more customized analyses for bus and rail services. As with the highway model, it would be desirable to differentiate commuter trips from trips for other purposes as part of the economic analysis.

8. **Intermodal Access Transportation Investments –** The economic evaluation largely considers each transportation mode individually. Many investments involving intermodal connectors or terminals could have benefits for multiple modes. For example, expanded capacity on a highway or rail line serving a seaport could enable freight to move into and out of the seaport more efficiently, eliminating delays near the gate. The reduction of this bottleneck could enable the entire seaport to process more cargo each day, effectively expanding the capacity of the seaport. These factors should be considered for inclusion in future analyses of the highway and rail programs, perhaps through a supplemental analysis of intermodal connectors.

9. Incorporation of short term construction impacts – Transportation expenditures do more than create long-term efficiencies. In the short term, investment and expenditures create employment and sales in the construction, engineering and raw materials industries. Such benefits are generally excluded from benefit-cost studies because they tend to be temporary, but a comprehensive analysis should also reflect their short term economic contribution. This is especially timely considering recent requests to determine short term employment effects.

10. Development of an integrated modeling framework – Currently, macroeconomic evaluation of the Work Program uses a variety of analytic tools, i.e. HERS, NBIAS, the MARAD model, freight and transit analyses completed in EXCEL and the regional economic model REMI. These are not directly connected with each other, and manual adjustments and processes are required in order to transfer information between these tools. It is possible to combine and run these individual components via a coordinated interface. The exact information technology configuration would need to be researched. It may be possible to create a Geographic Information Systems (GIS) multimodal tool which would permit more extensive analysis and user-friendly display. This technology would most likely be appropriate if these techniques are to be applied more frequently as part of regional, corridor or project-level analyses, rather than for a program-level analysis once every few years.

Appendices

Appendix A – Florida Statutes

Title XXXVI, Public Transportation
Chapter 334, Transportation Administration

334.046 Department mission, goals, and objectives.--
(1) The prevailing principles to be considered in planning and developing an integrated, balanced statewide transportation system are: preserving the existing transportation infrastructure; enhancing Florida's economic competitiveness; and improving travel choices to ensure mobility.
(2) The mission of the Department of Transportation shall be to provide a safe statewide transportation system that ensures the mobility of people and goods, enhances economic prosperity, and preserves the quality of our environment and communities.
(3) The department shall document in the Florida Transportation Plan, in accordance with s. 339.155 and based upon the prevailing principles of preserving the existing transportation infrastructure, enhancing Florida's economic competitiveness, and improving travel choices to ensure mobility, the goals and objectives that provide statewide policy guidance for accomplishing the department's mission.
(4) At a minimum, the department's goals shall address the following prevailing principles.
(a) *Preservation.*--Protecting the state's transportation infrastructure investment. Preservation includes:
1. Ensuring that 80 percent of the pavement on the State Highway System meets department standards;
2. Ensuring that 90 percent of department-maintained bridges meet department standards; and
3. Ensuring that the department achieves 100 percent of the acceptable maintenance standard on the state highway system.
(b) *Economic competitiveness.*--Ensuring that the state has a clear understanding of the economic consequences of transportation investments, and how such investments affect the state's economic competitiveness. The department must develop a macroeconomic analysis of the linkages between transportation investment and economic performance, as well as a method to quantifiably measure the economic benefits of the district-work-program investments. Such an analysis must analyze:
1. The state's and district's economic performance relative to the competition.
2. The business environment as viewed from the perspective of companies evaluating the state as a place in which to do business.
3. The state's capacity to sustain long-term growth.
(c) *Mobility.*--Ensuring a cost-effective, statewide, interconnected transportation system.

Appendix B – Technical Appendices

This appendix provides quantitative description and examples of several of the analysis tools used to produce quantitative results. These will be of interest to persons who wish to know exactly how the results were achieved. This information will also be useful to persons wishing to replicate this study or to perform similar studies. Some of the terms used here are defined and explained in the Glossary at the end of this report.

Appendix B-1 – HERS and NBIAS Analysis Steps

The basics of HERS and NBIAS are described in Section 3. The following steps were followed in using HERS-ST for the analysis:

- FDOT provided the most recent available Highway Performance Monitoring System data, which represents road conditions as of 2006, for input to HERS-ST. The road conditions contain data on the performance level of a road segment as well as the traffic volume.

- Current costs and model parameters for use with HERS-ST were obtained from the Federal Highway Administration. These model parameters were current as of January 2008. These parameters include estimates of the values of time to be used in the analysis. HERS differentiates the value of time by type of vehicle and also incorporates occupancy factors when determining the combined value of time for a vehicle category. In addition to these values of time, the parameters also included construction cost estimates (i.e. construction unit costs and cost escalation factors) as well as assumptions of the current per mile operating costs for the different types of vehicles, fuel cost estimates and vehicle usage efficiency assumptions. The cost assumptions and value of time parameters were compared to real world data and Florida-specific cost figures, as well as value of time assumptions taken from the literature. It was concluded the HERS default parameters were adequate for the analysis.

- The budget for the analysis was determined as described in Chapter 1. Specifically, the highway capacity portions of the Work Program (i.e., Strategic Intermodal System highways, other arterials and right of way) were combined with the resurfacing components in order to develop the inputs into HERS. These budget numbers were changed from year of expenditure dollars to constant dollars and included as parameters in HERS. Conceptually, the model runs through the network of roads and analyzes it. The model's product is a prioritized list of capacity improvements and resurfacing projects based on the expected transportation benefits. This list of projects is not identical to the final Work Program priorities, which also reflect additional factors, but it is a useful approximation.

- An adjustment was made to a HERS-ST parameter in order to retain the same relationship between investments in resurfacing and reconstructing projects contained in the Work

Program. HERS-ST does not allow for the separate specification of budgets by work type. The parameter that was adjusted was the threshold value for satisfactory pavement condition.

- HERS-ST was run, simulating conditions for five one-year analysis periods under two scenarios: with the proposed highway program funding, and without funding. In the funding case, HERS-ST optimizes the selection of projects based on the estimated benefits. In the no funding case, HERS-ST illustrates the decline of the performance of the infrastructure when no money is spent.

- STOP SPOT Unit user costs (dollars per vehicle mile traveled) were obtained for each year of the analysis for autos and trucks for travel time costs, operating costs and crash costs. The direct transportation benefits of investment were calculated as the difference between the unit costs with and without investment multiplied by predicted vehicle miles traveled. Vehicle miles traveled were assumed to be the same in both scenarios of highway capacity improvements, and the effects of elasticity were assumed to be minimal, consistent with previous macroeconomic analyses.[12]

- The predicted benefits were disaggregated into business and non-business benefits, and into internal versus external trips. This involved applying a set of assumptions identical to those made in previous macroeconomic analyses concerning the fraction of auto and truck trips internal to the state (versus trips beginning or ending in another state), the fraction of auto trips related to business and the fraction of safety benefits associated with property damage.

HERS-ST was also used to analyze benefits to highway users realized from transit investment. For this analysis, HERS-ST was run as described above. However, the predicted future traffic was adjusted based on the transit analysis described in Chapter 4 and Appendix B-3. HERS-ST then predicted the improvements in mobility resulting from reduction in traffic.

The HERS model and Highway Performance Monitoring System data do not include information regarding bridges. The National Bridge Investment Analysis System (NBIAS) is used to capture the benefits of bridge investments. This system contains Florida-specific bridge data and allocates investments from the Work Program to Florida bridges to generate program-level benefits. Similar to the highway analysis, NBIAS benefits are then used as inputs to REMI to generate macroeconomic impacts. The following steps were followed in using NBIAS for the analysis:

- FDOT provided the most recent available National Bridge Inventory data, which represents bridge conditions as of 2006, for input to NBIAS.

- Current costs and model parameters for use with NBIAS were obtained from the Federal Highway Administration. These model parameters were current as of January 2008. All

[12] The transit and rail analyses estimated a change in highway vehicle miles traveled from these modal investments, as discussed in Appendix B-3.

costs were expressed in terms of 2006 dollars and subsequently adjusted to 2008 dollars. The NBIAS parameters include Florida-specific cost adjustments.

- The budget was determined as described in Chapter 1. Specifically, the bridge component of the Work Program was used as the input parameter for NBIAS.

- The system reads National Bridge Inventory data, uses these data to determine functional characteristics and estimates the conditions for the structural elements for each bridge in the inventory. The analysis included almost all bridges on the Florida road system eligible for federal funding.

- NBIAS determines the cost minimizing approach to keep each type of structural element in a state of good repair. The best approach, termed the "optimal preservation policy," is determined for each element and climate zone.

- NBIAS predicts future conditions for a specified budget or a range of budgets.

- For each year of an analysis period, NBIAS determines what work should be performed based on the objective of maximizing user and agency benefits. The system considers preservation actions consistent with the optimal preservation policy. Also, the system considers performing certain types of functional improvements where a bridge fails to meet specified functional specifications. Improvements considered by the system include widening existing lanes and shoulders, raising bridges, strengthening bridges and bridge replacement.

- The system predicts future conditions, including physical conditions, funds spent and benefits obtained from the planned work. User benefits modeled by NBIAS include reduced travel time costs from raising or strengthening bridges, reduced crash costs from widening existing lanes and shoulders and reduced operating costs from improving bridge decks. Replacing a bridge yields all of the benefits achieved by performing needed preservation and functional improvement work.

- NBIAS was run, simulating conditions for five one-year analysis periods with the proposed funding. Similar to the HERS analysis, the NBIAS project list is not identical to the final Work Program priorities, which also reflect additional factors, but it is a close approximation.

- Predicted benefits were obtained by year relative to the alternative of deferring investments. Direct transportation benefits obtained included travel time, operating and safety benefits obtained from preservation, functional improvement and replacement work.

- The predicted benefits were disaggregated into business and non-business benefits, and into internal versus external trips as described above for the HERS-ST analysis.

Appendix B-2 – REMI Projections

The use of REMI models to conduct economic impact analysis was presented in Chapter 5. One critical use of the REMI model is to distribute the transportation benefits to each industry for the forecast years. The following information and methods were used:

Business Auto Industry employment estimates from REMI's baseline forecast were used to determine employment shares by industry. Industries with the most employees received the largest portion of the business auto benefits, while industries with few employees received a smaller portion of the benefits. The table below shows projections for the year 2013. According to the REMI analysis, the top five industries in Florida in terms of employment will be:

Table B.1
Top five industries by jobs
Retail trade
Administrative and support services
Construction
Professional and technical services
Food services and drinking places

Trucking and Freight Rail For the year 2013 and other future years, the total trucking and rail benefits were distributed by industry using the U.S. Bureau of Transportation Statistics' Transportation Satellite Accounts. These accounts estimate the amount of transportation usage by mode by industry. The truck and freight rail dependency factors are multiplied by the business output of each industry to determine the projected total transportation use and thus the share of benefits. Tables B.2 and B.3 below show the potential future top five industries utilizing truck and rail services:

Table B.2
Top Five Truck Dependent Industries
Truck transportation, including couriers and messengers
Nonmetallic mineral product manufacturing
Paper manufacturing
Primary metal manufacturing
Plastics and rubber manufacturing

Table B.3
Top Five Rail Dependent Industries
Rail transportation
Utilities
Transit, including ground passenger transportation
Scenic and sightseeing transportation
Primary metal manufacturing

Appendix B-3 – Transit Analyses

As discussed in Chapter 4, two analyses were performed to estimate the two major economic impacts of the transit work program. The first estimated the relief of highway congestion as a result of transit improvements. The second estimated the travel time savings to transit users.

Transit travel efficiency benefits

While we anticipate increases in transit ridership as a result of the Work Program, our projections show the majority of person-trips will continue to use the highway mode. Similarly, truck trips will continue to be crucial to freight transportation. The travel efficiency benefits of the transit Work Program are best captured by assessing the extent to which increases in transit investment, service and ridership reduce highway congestion in the business travel and freight sectors. Travel times and operating costs for business travel (trucks and business auto) are reduced when the number of trips made on transit rather than automobiles increases.

Regression analyses were conducted to estimate the vehicle miles traveled reductions as a result of the transit investments. Revenue miles in future years are estimated by using projected transit funding based on the Work Program. In a second step, ridership was estimated using projected revenue miles of service. The projected increase in transit ridership is equated to a decrease in the vehicle miles of auto travel (see table B.4).

Based on these regression runs, transit ridership is expected to increase from 276.4 million in fiscal year 2008 to 385.7 million in fiscal year 2014 – leading to an annual reduction of 54.5 million vehicle miles traveled in fiscal year 2014. Reductions in vehicle miles traveled (VMT) are allocated to Florida highway segments based on the current distribution of transit ridership in the state. The portion of these user benefits accruing to businesses are input to the REMI model as cost savings, similar to the highway analysis. The analysis is careful to isolate the impact due to the Work Program, which includes state and limited federal investments for capital and operations, but does not include other local, private or federal expenditures.[13] The Work

[13] Most federal funds for mass transit are distributed directly to local transit agencies rather than through the FDOT Work Program.

Program share of total transit capital investments in recent years has averaged slightly lower than 40 percent.

Table B.4 Transit Investment and Reduction in Vehicle Miles Traveled

Fiscal Year	Investment (Millions, Year of Expenditure Dollars)	Revenue Miles of Service (Millions)	Transit Ridership (Millions)	Estimated Annual Reduction in Highway Travel (Millions of Vehicle-Miles)
2006/07	$279.60		258.44	
2007/08	$410.30		276.37	
2008/09	$384.80	267.60	295.45	64.69
2009/10	$317.40	287.04	311.18	53.33
2010/11	$546.10	320.46	338.23	91.72
2011/12	$309.80	339.42	353.56	52.01
2012/13	$325.10	359.31	369.65	54.56
2013/14	$325.10	379.18	385.74	54.54

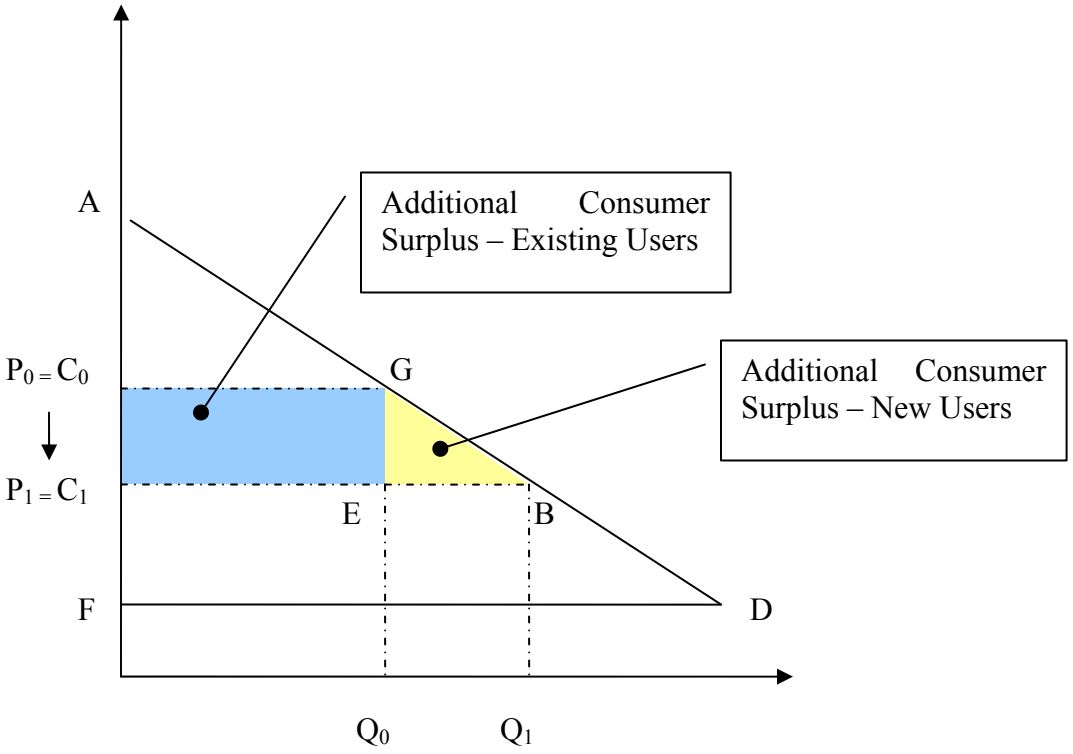
Transit Rider Benefits

The analysis of benefits to transit riders also uses the projected increase in ridership as a starting point. Most of the benefits are enjoyed by existing riders, who substantially outnumber new riders. It was assumed transit investments will not affect fare levels but rather lower the travel time by making transit function more efficiently. In order to estimate the time savings from improved transit service, it was necessary to "work backwards" and estimate the degree of time savings attracting the estimated number of ***new*** riders. Then the benefits of the time savings were applied to existing riders as well as new riders.

As mentioned above, a set of statistical regressions were completed for the purpose of estimating the impacts of the Transit Work Program on transit ridership. Benefits from time savings to transit riders themselves are included for the first time. In economic terms, the benefit from reduced transit travel time is additional consumer surplus. The difference between the estimated consumer surplus in each year is equal to the generated benefit as a result of the annual investment. Figure B.1 shows the graphical representation of the increase in consumer surplus, where:

- P stands for price, and Q stands for Quantity
- Triangle (A C_0 G) is total consumer surplus before the transit investment.
- Triangle (A C_1 B) is total consumer surplus after the transit investment.
- Quadrilateral (C_0 C_1 B G) is the change to consumer surplus as a result of the transit investment.

Figure B.1: Transit Consumer Surplus



The final estimates of consumer surplus also take into consideration the portions of total transit investments by federal and local governments not included in the FDOT Work Program. Benefits have been reduced by 60 percent to account for this effect. The Transit Work Program covers a wide variety of projects and programs. In performing this analysis, emphasis was placed on capital expenditures, including the purchases of buses and train cars. These were assumed to provide consumer surplus for many years. On the other hand, subsidies to transit agencies' operating expenditures, including salaries for drivers and other personnel, were assumed to only provide consumer surplus during the year of expenditure. The estimated consumer surplus benefits are show in Table 4.4 below.

Table B.5 - Transit Investments and Consumer Surplus Estimates
(Millions of current dollars)

Year	Transit Work Program Investment Level	Consumer Surplus
2009	$385	$93
2010	$317	$77
2011	$546	$132
2012	$310	$75
2013	$325	$79

Appendix B-4 – Seaport Examples

The following two examples show how seaport methodology, described in Chapter 4, was applied to specific projects.

Port Everglades Cruise Passenger Project

Port Everglades in Fort Lauderdale, one of Florida's major seaports, handles a high volume of cruise passengers as well as freight. The port proposed to build an on-port roadway improvement with funding from the State of Florida. The improvement will impact internal cruise ship-related passenger and truck trips. It is not expected to have a measurable impact on throughput (i.e., ship calls) but will improve efficiency and reduce travel times.

Port staff provided estimates of current travel time on access routes and potential travel time savings from the project. The project was estimated to improve landside travel time by 25 percent. This savings was applied to multi-day passengers at the relevant terminals to estimate travel time savings (in minutes and hours) and in dollars (using a value for time). To account for the availability of alternate routes, it was assumed this benefit would impact just one fourth of all travelers.

Current travel times for passenger are approximately 30 minutes from home, hotel or airport to the port (or return trip). The project proposes to reduce this time by approximately 25 percent to 22.5 minutes, or 7.5 minute time savings. The port handled approximately 2.2 million passengers in fiscal year 2004, and the benefits would apply to one fourth of the travelers. As shown in Table 4.1, the estimated benefits over the life of the project amount to $4.3 million, with a discounted cost of $952,000 producing a benefit-cost ratio of 4.5.

Table B.6 – Port Everglades Project

Project Name:	Midport Expansion	Roadway
Seaport:	Everglades	
Discounted Benefits		$4,290,415
Discounted Negative Impacts		-
Discounted Net Benefits		$4,290,415
Discounted Costs		$952,357
Benefit-cost ratio (not in dollars)		4.5

Port of Jacksonville Berth For Vehicles

The Port of Jacksonville contracts with the Toyota Corporation to receive many of its vehicles being imported from Asia to the United States. The port requested state funding for the replacement of one of its berths. This project will completely renovate and replace the existing berth for import of Toyotas, which currently handles about 250,000 vehicles per year. If this berth is not replaced, the port would expect to lose this business.

At the time, the port estimated the impact to be the retention of 250,000 vehicles per year and projected growth of 2 percent per year. As shown in Table 4.2, by completing this project the port and the Jacksonville region will generate over $61 million in benefits from port business, employment and contribution to the gross regional product. But the project will generate negative benefits stemming from additional truck traffic in Duval County and other areas of Florida and Georgia. These reduce the value of project benefits by almost $10 million. When the discounted net benefits of almost $52 million are divided by the project cost of $12 million, the benefit-cost ratio is 4.3.

Table B.7 – Port of Jacksonville Project

Project Name:	Toyota Berth
Seaport:	Jacksonville
Discounted Benefits	$ 61,401,458
Discounted Negative Impacts	$ 9,675,846
Discounted Net Benefits	$ 51,725,612
Discounted Costs	$ 12,000,000
Benefit-cost ratio (not in dollars)	4.3

Appendix B-5 – Cost Escalation Sensitivity Analysis

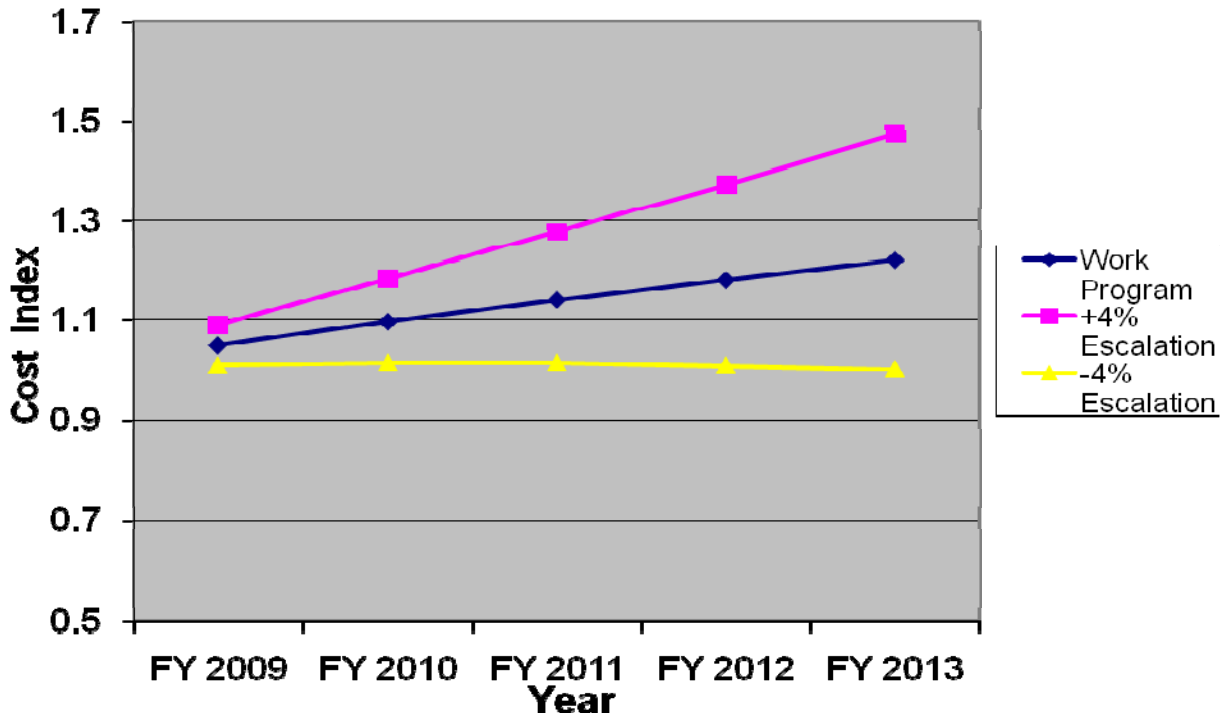
The rationale for the cost escalation analysis is provided in Chapter 2, Goals of This Study, and the basic results are presented in Chapter 7, Section 2, Sensitivity Analyses. Because of the complexity of large highway construction projects (as well as of large projects for other modes), many factors determine the rate of cost escalation. These include engineering complexities, right of way acquisition, material prices (inflation), scope creep, market conditions, or schedule delays.[14] The unpredictability of construction costs was dramatically illustrated in the past two years, when serious highway cost construction inflation was transformed into cost deflation in just a few months. To address potential changes in cost escalation over the course of the Work Program, a sensitivity analysis was performed to determine how varying rates of cost escalation will impact the Work Program benefits.

For the cost escalation sensitivity analysis the overall Work Program budget was held constant while construction costs would increase (or decrease) relative to the default rate of cost escalation. An increase in cost escalation could result in higher project completion costs, and reduce the number of projects that could be completed. The escalation rates represent a percentage-point difference over the baseline Work Program scenario.

Figure B-2 illustrates how a cost index might change for alternate assumptions. The figure shows the effects a plus 4% and a minus 4% percentage point per year difference compared to the baseline Work Program scenario's cost escalation rate. The +4% cost escalation scenario shows that a cost index will surpass the baseline Work Program cost index value by over 20 percentage points by FY 2013. On the other hand, the -4% cost escalation scenario shows that a cost index will reach a level about 18.5 percentage points lower than the baseline Work Program cost index value by FY 2013. Additionally, lowering the cost escalation rate by 4% for each of the 5 years results in cost de-escalation, or deflation. In this scenario, the cost index will be slightly lower in FY 2013 than it was in FY 2008.

[14] NCHRP: "Final Report for NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects During Planning, Programming, and Preconstruction" 2006

Figure B-2: Cost Escalation



The rest of the sensitivity analysis focuses on four alternative cost escalation scenarios plus and minus 2 percentage points per year, and plus and minus 6 percentage points per year. These four alternative assumptions generate a range of possible BCRs from 4.0 to 5.8. The scenarios with a positive cost escalation rate of 2 and 6 percentage points reduced the benefit cost ratio of the Work Program to 4.6 and 4.0 respectively. On the other hand, the scenarios with a negative cost escalation rate of 2 and 6 percentage points increased the benefit cost ratio to 5.2 and 5.8 respectively. Table B.5 shows the benefit cost ratios for each alternative cost escalation scenario.

Table B.8 Alternative Cost Escalation Scenarios
Benefit-Cost Ratios under alternative
Cost Escalation Assumptions

SCENARIO	BCR
6% per year Increased Cost Escalation	4.0
2% per year Increased Cost Escalation	4.6
Work Program Default Cost Escalation	4.9
2% per year Decreased Cost Escalation	5.2
6% per year Decreased Cost Escalation	5.8

Appendix C – Glossary

Benefit-Cost Analysis – A systematic quantitative method of attempting to assess the desirability of government projects or policies.[15] It requires calculating or estimating all significant benefits and all significant costs.

Benefit-Cost Ratio (BCR) - The ratio of the benefits of a project or program to the cost of the project or program, with the present value of benefits (including negative benefits) placed in the numerator of the ratio and the present value of the initial agency investment cost in the denominator. The ratio is usually expressed as a quotient (also known as a pure number, e.g., $2.2 million/$1.1 million = 2.0).[16]

Congestion – Increased delay and inconvenience caused by traffic. Highway congestion results when traffic demand approaches or exceeds the available capacity of the transportation facility or facilities.[17]

Congestion Reduction – Any set of actions that will lower the degree of congestion, and hours of delay, on a highway network, in this case the Florida State Highway System (SHS). The congestion reduction programs analyzed by this study consist primarily of highway and transit improvements. Frequently, highway improvements reduce congestion by increasing capacity or making more efficient use of existing capacity. Transit improvements may reduce congestion by drawing trip takers from automotive vehicles to transit.

Constant or Real Dollar Values – Economic units measured in terms of constant purchasing power. A real value is not affected by general price inflation.[18] In expressing dollar amounts in constant dollars, it is necessary to choose a fixed time as the constant reference for valuing all dollar amounts. In this study, 2008 is usually chosen as the fixed time, so constant dollar values are expressed as "2008 dollars". Please see Chapter 1, Section 3 for an explanation of the use of Constant dollars in this study.

Current or Nominal Dollar Values – Economic units measured in terms of purchasing power of the date in question. A current or nominal value reflects the effects of general process inflation.[19] Also known as Year of Expenditure Dollars.

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[15] Based on Office of Management and Budget (OMB), Circular No. A-94 Revised (Transmittal Memo No. 64), "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," October 1992.
[16] Based on U.S. Department of Transportation Federal Highway Administration (FHWA) Office of Asset Management, *Economic Analysis Primer*, August 2003.
[17] Florida Department of Transportation (FDOT) Office of Policy Planning (OPP), *Transportation Glossary of Terms and Acronyms*, August 2005.
[18] OMB, Circular No. A-94 Revised (Transmittal Memo No. 64), "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," October 1992.
[19] Ibid.

Discount Rate – The interest rate used in calculating the present value of expected yearly benefits and costs.[20] The discount rate is used to reflect the time value of money in economic calculations. The discount rate is applied to Constant Dollars to estimate discounted costs. Please see Chapter 1, Section 3 for further explanation.

Gross State Product (GSP) – The sum of the money values of all final goods and services produced in the state economy and sold on organized markets during a year. It is the state equivalent of gross domestic product (GDP).[21]

Highway Economic Requirements System (HERS) – An engineering/economic analysis (EEA) tool developed for the U.S. Federal Highway Administration (FHWA) that uses engineering standards to identify highway deficiencies, and then applies economic criteria to select the most cost-effective mix of improvements for system-wide implementation. The State Version of HERS (HERS-ST) is used in this analysis.[22]

Inflation, General – The proportionate rate of change in the general price level, as opposed to the proportionate increase in a specific price. General inflation erodes consumer purchasing power. Inflation is usually estimated by a broad-based price index, such as the implicit deflator for the Gross Domestic Product or the Consumer Price Index (CPI).[23] If consumer prices are generally *decreasing*, then the appropriate term is *deflation*. Deflation was not seen in the U.S. during the second half of the twentieth century, but it is possible during recessions.

Inflation, Transportation Construction – Proportionate rate of change in the cost of constructing transportation facilities. Highway construction is a major component of transportation construction, and increases in highway construction costs have been closely tracked by a number of federal and state agencies. However, transportation construction includes rail lines, airports and seaports. Costs are highly influenced by a small number of commodities, particularly steel, concrete, asphalt and other petroleum products. At any given time, the level of transportation construction inflation may be quite different than the level of general inflation.[24]

Maritime Administration (MARAD) – A U.S. Department of Transportation agency dealing with waterborne transportation. It promotes the use of waterborne transportation, integration with other segments of the transportation system, and the viability of the U.S. merchant marine. MARAD has developed a model to estimate the economic impact of seaport investments, and an adapted version of this model is used in this study to evaluate the seaport work program.

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[20] Ibid.
[21] Adapted from Baumol, William J. and Alan S. Blinder, *Economics: Principles and Policy*, Ninth Edition, 2003.
[22] FHWA, *HERS-ST 2.0: Highway Economics Requirements System-State Version Overview*, 2002.
[23] Derived from OMB, Circular No. A-94 Revised (Transmittal Memo No. 64), "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," October 1992, and www.forextips.com/forex-terms-ghijkl.htm.
[24] For more information on this topic please refer to the following URL: http://www.fhwa.dot.gov/programadmin/contracts/price.cfm.

National Bridge Investment Analysis System (NBIAS) – An engineering/economic analysis (EEA) tool developed for the FHWA to predict bridge maintenance, improvement and replacement needs.[25] NBIAS complements HERS and is used here to estimate and analyze the benefits of the bridge component of the Florida DOT Work Program.

Net Present Value (NPV) – The difference between the discounted present value of benefits and the discounted present value of costs.[26] NPV represents the total present value of time series of cash flows. Expressed as a formula,[27]

$$NPV = \sum \frac{R_t}{(1+i)^t}$$

Where, t – the time of the cash flow
i – the discount rate, or appropriate rate of interest
R_t – the net cash flow (total inflow minus total outflow) at time t

In the U.S., R_t is expressed in terms of dollars, and thus NPV is a dollar value. The choice of discount rate, i, will have a dramatic effect on the computed NPV of most projects, especially projects that entail cash flows over a decade or longer. Normally, in such cases a small increase in the discount rate will generate a large decrease in the NPV.[28]

Personal Income – Income received by persons from all sources. It includes income received from participation in production as well as from government and business transfer payments.[29] Note that the economic definition of personal income differs from that used for tax and accounting purposes. In this report, we use the economics definition with special focus on the total increases in personal income, over a period of many years, which result from the transportation investments of the Work Program.

Present Value (PV) – The value of a future payment or stream of payments considering discounting. If an analyst knows the appropriate discount rate, he or she can calculate the PV of any sum of resources or money to be spent or received in the future. The application of the discount rate to future sums to calculate their present value is known as "discounting". Through discounting, different investment alternatives can be objectively compared based on their respective present values, even though each has a different stream of future benefits and costs.[30]

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[25] Cambridge Systematics, *National Bridge Investment Analysis Version 3.3 User Manual*, technical report prepared for the FHWA, May 2007.
[26] OMB, Circular No. A-94 Revised (Transmittal Memo No. 64), "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," October 1992.
[27] Adapted from FHWA Office of Asset Management, *Economic Analysis Primer*, August 2003.
[28] Adapted from http://en.wikipedia.org/wiki/Net_present_value
[29] Bureau of Economic Analysis, *Glossary*, http://bea.gov/glossary/glossary.cfm?letter=P accessed January 2009.
[30] Adapted from FHWA Office of Asset Management, *Economic Analysis Primer*, August 2003.

PV can be calculated for any date, past, present or future, for example "present value as of 1975".

Product – This term is used in two different ways in this report:

1. In the economic terms Gross Domestic Product (GDP) and Gross State Product (GSP) and related uses, "product" includes all goods and services produced by the economy, valued in monetary terms.
2. A category of the Program and Resource Plan (PRP, see below). In this context, "product" refers to expenditures that directly build transportation infrastructure or provide transportation services. In the PRP, "products" include road and bridge construction, the cost of land purchased for rights of way for transportation facilities, transit vehicles and several categories of grants. "Product" is different from "product support," which includes preliminary engineering, operations and maintenance, and/or administration. See also "Productivity" immediately below.

Productivity –Quality or state of being productive.[31] Transportation investments generate long-term increases in GDP as a result of improved efficiency in the movement of people and goods, which increases productivity. This contrasts with the short term effect of employing workers for construction, which stimulates the economy. This effect is referred to as "stimulus". Another definition of productivity refers to labor productivity which can be measured by output per unit of effort.[32] Although very important to the economy, labor productivity, per se, is not a focus of this study.

Program and Resource Plan (PRP) - A 10-year plan that establishes financial and production targets for the Florida Department of Transportation programs, thereby guiding program funding decisions to carry out the goals and objectives of the Florida Transportation Plan (FTP).[33]

Regional Economic Modeling, Inc. (REMI) – A software and consulting company best known for its economic modeling software packages, including Transight and Policy Insight. Sometimes the term REMI is used to describe any of these packages. The economic modeling for this project, including future projection of GSP, was performed using REMI software.

Return on Investment – Also known as the "rate of return," this is the discount rate that sets the net present value of the stream of net benefits equal to zero. There may be multiple values for this rate when the stream of net benefits alternates from negative to positive more than once.[34] Usually expressed in terms of percent per year, as in "a return of 4% per year". Not to be confused with rate of return on U.S. highway trust fund contributions, which is a different concept and is not addressed in this study.

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[31] *Merriam-Webster's Ninth New Collegiate Dictionary*.
[32] http://economics.about.com/od/economicsglossary/g/productivity.htm
[33] FDOT OPP, *Transportation Glossary of Terms and Acronyms*, August 2005.
[34] OMB, Circular No. A-94 Revised (Transmittal Memo No. 64), "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," October 1992.

Stimulus – Also referred to as economic stimulus or fiscal stimulus, this is government spending or reduction in tax collections for the purpose of stimulating an economy and increasing employment in the short term.

Strategic Intermodal System (SIS) - A transportation system comprised of facilities and services of statewide and interregional significance, including appropriate components of all modes. The SIS was designated in Florida Statute in 2003.[35]

User Benefits – In this study, this term refers to benefits to individuals or businesses from improvements to transportation facilities and services. These include direct reductions in transportation costs (see Vehicle Operating Costs below). The most typical user benefit is reduced travel time. Very often, user benefits accrue to individuals in their roles as consumers, and the user benefits do not necessarily directly increase GSP. However, user benefits have real economic value because users would be willing to pay for them (i.e. a shopper stuck in traffic would be willing to pay some amount to eliminate it).

Value of Time – Measure of the economic value an individual places on their personal time. This may also be viewed as one's willingness to pay, on average, to reduce their travel time. The value of time is needed to assign aggregate economic value to reductions in congestion for automobile traffic or improvements in transit service. The values of time used in this study are based on the values used by FHWA when running HERS to develop its biannual Report to Congress: Conditions and Performance of the National's, Highways, Bridges and Transit.

Vehicle Operating Costs (VOC) – Costs of owning and operating vehicles, including fuel, oil, maintenance, tires and other costs. VOC can be affected by a project due to the changes that it causes in highway speeds, traffic congestion, pavement surface, and other conditions that affect vehicle fuel consumption and wear and tear.[36] The sum of these costs, aggregated over the entire state, was estimated using HERS software for this report.

Work Program - The five-year listing of all transportation projects planned for each fiscal year by the Florida Department of Transportation, as adjusted for the legislatively approved budget for the first year of the program.[37]

Year of Expenditure Dollars – see definition for "Current or Nominal Dollar Values". Also, see Chapter 1, Section 3 for an explanation of why and how Year of expenditure dollars are presented in this study.

[35] FDOT OPP, *Transportation Glossary of Terms and Acronyms*, August 2005. http://www.dot.state.fl.us/planning/glossary/glossary.pdf
[36] Adapted from FHWA Office of Asset Management, *Economic Analysis Primer*, August 2003.
[37] FDOT OPP, *Transportation Glossary of Terms and Acronyms*, August 2005.