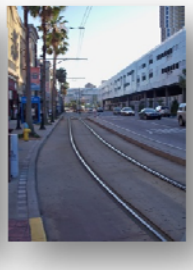

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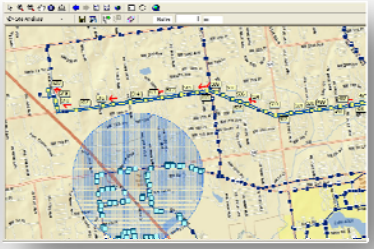
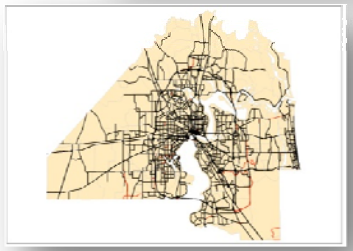
The Florida Guidebook for Model Application in FTA New Starts and Small Starts

Prepared For:
Florida Department of Transportation
Public Transit Office

Final Report

The Florida Guidebook for Model Application in FTA New Starts and Small Starts

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Introduction to the Florida Guidebook for Model Application in FTA New Starts and Small Starts

Levels of congestion in the State of Florida are growing as the dependency of the personal automobile increases. With diminishing financial resources from the State and less surface area to expand existing roadways, transit systems must be developed and extended to promote mobility throughout the metropolitan regions of the State.

A current source of momentum for transit projects throughout the United States is the Federal Transit Administration's (FTA) New Starts Program, a program that provides federal funding for select transit projects. Since New Starts projects often focus on fixed guideway transit, such as Light Rail Transit and Commuter Rail, the Small Starts program was initiated to aid in funding (less than $250 million) projects, including Bus Rapid Transit and other small-scale transit system improvement efforts.

The New Starts and Small Starts programs have a concentrated focus on the methods and input data used to forecast travel demand and analyze subsequent impacts of transit planning. As the schedules and budgets allocated for major transit projects are limited, methods and forecasting tools must be used efficiently and effectively.

The Florida Department of Transportation (FDOT) Central Office is committed to supporting the development and implementation of the best modeling practices for application in a variety of projects throughout the State. The Systems Planning Office and the Public Transit Office play significant roles in the development of two of the major forecasting tools utilized in Florida: the Florida Standard Urban Transportation Model Structure (FSUTMS) and the Transit Boardings Estimation and Simulation Tool (TBEST).

FSUTMS models recently experienced a transition to the Cube/Voyager software, enabling further advancement of the regional planning model framework in Florida. The FSUTMS four-step models allow for both highway and transit forecasting for metropolitan areas. In contrast, TBEST provides transit forecasts that allow users to conduct transit analysis on a stop/station level. TBEST runs on an ArcMap platform and generally has a shorter run time than a FSUTMS model.

FTA New Starts and Small Starts projects may vary in their modeling procedures. Due to the divergence in requirements for each program, a series of guidelines have been derived to determine state-wide recommendations regarding modeling methodologies for projects applying for New Starts or Small Starts program funding.

Various projects within Florida have been in the FTA New Starts pipeline, but no Florida projects have reached funding in Small Starts processes to-date. Therefore, an analysis of Florida New Starts modeling practices, as well as an overview of nationwide Small Starts modeling techniques will be assessed to determine which modeling procedures should be used for preparing FTA grant applications.

The purpose of this Guidebook is to review FTA travel forecasting requirements for New Starts and Small Starts and to make recommendations and provide guidance to local agencies regarding the use of forecasting tools, with an emphasis on the FSUTMS and TBEST models, to meet those requirements. The FTA does not approve models; rather, they approve forecasts generated by models. Knowledge of modeling practices used in FTA funded projects will be analyzed and compared to provide examples for future applications. As each project is individually market driven and unique to local corridors, modeling methodologies will be reviewed for applications in a variety of projects.

A series of studies were completed to obtain information related to New Starts and Small Starts programs, as well as the development and application of forecasting tools for these programs. The study was divided into the following categories, which compose the five (5) sections of this Guidebook:

- *Section 1: Review of Travel Forecast Analysis Requirements for FTA New Starts and Small Starts Projects*- Various documents provided by the FTA regarding acceptable travel forecasting practices were reviewed, including the *2009 Guidance on New Starts Policies and Procedures*, FTA forecasting workshop materials, "Case for the Project" guidelines, and other provided guidance. New Starts and Small Starts reporting instructions and templates were examined to determine the data necessary for review by FTA. This section describes these requirements necessary for FTA submission as applicable to travel forecasting.

- *Section 2: Review of the Applicability of the TBEST Model for New Starts and Small Starts Applications*- Given the effort by both FDOT and individual transit agencies in the development of TBEST, this section investigates expanding the usage of TBEST to include support of FTA New Starts and Small Starts projects within the State of Florida. TBEST model methodologies, input requirements (including supply side data such as speeds, counts, access modes, etc.), calibration and validation techniques, and future forecasting application were reviewed and discussed. Additionally, documentation of the TBEST model methodology including; accessibility calculations, ridership estimation techniques, data output categories, and travel patterns were examined. Data and procedural shortcomings of the TBEST model were identified, and areas of potential improvement are discussed.

- *Section 3: Review of the FSUTMS Model for New Starts and Small Starts Applications*- The FTA analyzes and evaluates forecasts based on the following information: data available for model testing, model testing techniques, quality control of forecasts, analysis and documentation of uncertainties, clear forecast presentation and documentation, and model coordination efforts with the FTA. The FSUTMS model structure was analyzed in accordance with these measures in this evaluation. FSUTMS model methodologies, input requirements (including supply-side data such as speed, counts, access, etc.), calibration and validation techniques, and future forecasting application were reviewed. Documentation of the FSUTMS modeling methodology including; highway and transit networks, ridership estimation techniques, and data output categories were also examined in this evaluation. All

data or procedural shortcomings of the FSUTMS model structure were identified and areas of potential improvement are discussed.

- *Section 4: Review of National Forecast Methodologies for New Starts and Small Starts Projects*- To obtain a greater understanding of travel forecasting practices for New Starts and Small Starts submissions a comprehensive list was compiled for New Starts and Small Starts projects on a national scale. A critical analysis of project work and submissions to FTA was conducted to determine the forecasting practices that are acceptable to the FTA. Modeling methodologies, team practices, and other forecasting techniques relevant to New Starts and Small Starts requirements were reviewed. In addition to the analysis of example modeling practices on national and statewide levels, projects currently in the FTA process and newly developing projects from the State of Florida were researched to develop a knowledge base of the projects that may be approaching FTA New Starts or Small Starts project application phases in the near future.

- *Section 5: Analysis of TBEST and FSUTMS for Use in FTA Applications for New Starts and Small Starts Projects*- Applying the information obtained in the previous sections, the data requirements for FTA New Starts and Small Starts were independently compared with FSUTMS and TBEST model capabilities. Where FSUTMS output currently supports FTA requirements, the methodology to produce the data and also any post-processing necessary to compile the data in FTA required formats were documented as related to FTA programs. This same evaluation was conducted for TBEST in relation to FTA New Starts and Small Starts programs, relating model data and post-processing for potential application of FTA funding programs. This section includes constructive suggestions on using FSUTMS and TBEST models for individual FTA project submissions. It identifies criteria and reporting requirements for each grant program, and recommendations for the appropriate use of both models for each type of FTA application.

SECTION 1: Review of Travel Forecast Analysis Requirements for FTA New Starts and Small Starts Projects

1.1 Introduction to Requirements Analysis

Several transit agencies in the State of Florida will apply to enter into the Federal Transit Administration's (FTA) New Starts and Small Starts (Starts) programs in the next decade. As the first step in developing a set of Starts travel forecasting guidelines for entities throughout the State, the current requirements and forecasting recommendations must be reviewed and analyzed to determine the most effective methodologies and tools.

The FTA's project justification criteria for Starts projects include mobility improvements; environmental benefits; operating efficiencies; cost effectiveness; and transit support land-use policies and future patterns. This project will focus on the mobility improvements criteria and analyze forecasting practices for FTA project submissions.

The Starts templates and supplementary forecast guidelines contain the most critical information for FTA evaluation of mobility improvements. By reviewing the materials that are required for submission, specific areas can be highlighted in the forecast modeling process and the most effective and analytical approaches can be recommended for future application forecasts. Data and information requirements for Starts applications will be reviewed in detail as part of this section.

The FTA requests that travel demand forecasts for New Starts and Small Starts projects illustrate the effects that a build alternative has on its study area and "make the case" for the proposed transit improvements. Forecasts allow for the measurement of user benefits by determining ridership, travel time savings, and transit dependent utilization. The various forecasting tools used for Starts program applications will be reviewed to identify the different travel demand estimation methodologies that are accepted by the FTA, as well as the information and data that these techniques are capable of producing.

Both the New Starts and Small Starts programs will be addressed in relation to the available forecasting tools. Forecast modeling requirements for New Starts and Small Starts will be discussed to determine acceptable forecasting practices for each program. Coordination with the FTA throughout the Starts forecasting process will be discussed as a critical factor in the development of project submissions.

1.1.1 Starts Program Definitions

New Starts projects are the largest scale of projects in the FTA Starts program. New Starts projects must have a cost greater than $250 million and propose a fixed guideway system, such as light rail transit (LRT), commuter rail (CR), bus rapid transit (BRT), streetcars, ferries, or similar systems. New Starts projects must proceed through three (3) major phases: alternatives analysis, preliminary engineering, and final design.

Small Starts projects are smaller-scale projects. The total project cost must be less than $250 million. At least one (1) of three (3) varying specifications must be met in order to be considered for FTA Small Starts funding. A submission must be one of the following:

- A fixed guideway system for at least 50 percent of the proposed project route in peak period service;
- A new fixed guideway project; or
- A corridor-based bus project that has sizable transit stations, a level area for boarding the vehicle, priority in traffic signaled areas, 10-minute peak and 15-minute off-peak headways for over 14 hours of the weekday, and branding on the proposed service.

Very Small Starts projects are Small Starts projects that have a total cost under $50 million. Small Starts projects that qualify for Very Small Starts are bus, rail, or water vehicle projects. In order to be considered for FTA Very Small Starts funding, a submission must either be a corridor-based project that has sizable transit stations; a level area for boarding the vehicle; priority in traffic signaled areas; 10-minute peak and 15-minute off-peak headways for over 14 hours of the weekday; branding on the proposed service and/or over 3,000 existing weekday riders that will benefit from the proposed transit project.

This section provides an in-depth review of the forecasting process for each of the Starts programs. It provides analysis of forecasting evaluation criteria, forecasting tools, proper applications for Starts programs, and examples of acceptable program submissions. Any further detail regarding Starts program definitions can be located on the FTA website at:
www.fta.dot.gov/planning/newstarts.

1.2 Mobility Improvement Evaluation Criteria

Each of the FTA's major justification criteria are divided into subcategories for project evaluation purposes. The FTA's mobility improvement criteria are separated into five (5) major categories as the basis for its evaluation of Starts project travel forecast submissions. These mobility criteria are focused on travel time savings, relative increases in transit trips, and the impact on transit dependent populations within the community. The critical evaluation measures are as follows:

- Number of transit trips;
- User benefit hours per passenger mile;
- Number of transit trips by transit dependents;
- User benefit hours per passenger mile for transit dependent riders; and
- User benefit hours for transit dependents compared to total transit dependents in the region.

The number of transit trips is measured for the validation year using transit surveys and data from supplementary modeling tools to validate and calibrate the model used to forecast the number of transit trips for the forecast year. Projects that generate more riders are considered to be more effective projects.

Travel time savings per passenger mile is measured using the Summit program and regional travel forecasting models. Travel time per passenger mile for the baseline scenario is compared to the travel time per passenger mile for the transit alternative scenarios. The amount of travel time per passenger mile savings is then calculated as the difference between the build and baseline scenarios. Projects with the highest values of benefits divided by passenger miles are regarded more beneficial to the study area.

Populations reliant on transit for mobility are often categorized as the population with zero cars per household. The percentage of transit dependents within the study area is calculated using this data figure. The number of transit trips taken by these transit dependent users is then calculated by the model. Projects that produce higher numbers of transit dependent riders are considered more beneficial to the study area.

User benefits per passenger mile for transit dependents is also calculated by the Summit program and travel forecast models by taking the number of zero car per household riders in the study area and determining the savings in travel expenditure per passenger mile for this percent of the population. Projects that provide the highest amount of benefits to the average transit dependent rider are considered more beneficial to the study area.

Transit dependent user benefit hours in the study area compared to total transit dependents in the region is a proportional measure of benefits for transit dependents in the project impact region in relation to the entire population of transit dependents throughout the greater metropolitan or city region. Projects that impact a greater percentage of transit dependents are regarded more effective because they extend more service to transit dependent areas.

The Summit program and supplementary forecasting tools, such as the Aggregate Rail Ridership Forecast (ARRF) model, the Transit Boardings and Estimation Simulation Tool (TBEST), other forecast models, and off-model methodologies, are used to support transit ridership forecast requirements. The FTA is stringent in reviewing modeling practices utilized by transit agencies to ensure that all figures are reasonably calculated and represent the study area as accurately as possible. FTA modeling recommendations and thoughts on good practice will be analyzed to identify the best techniques to obtain forecast data for Starts project submissions.

1.3 Project Submission Specifications

The FTA requires that both New Starts and Small Starts projects submit the "Travel Forecasts Template" as part of the Starts program application. The "Travel Forecasts Template" includes information relating to transit trips, user benefits, special markets information, and transit dependent trips. The template format divides all information into three categories:

- Trip Purpose-Specific Information;
- Special Market Information; and
- General Information.

A blank copy of the "Travel Forecast Template", along with the other required Starts templates, is provided in **Appendix A** of this document. As required by the FTA, the columns in the Trip Purpose-Specific Information section of the template must be categorized as eight (8) conventional trip purposes defined in the model for reporting purposes and added to the first row of the template. The column headings for the Special Markets section can also define up to eight (8) special markets in the area. Each row is then summed or averaged in the far right column to compute totals for all trip purposes and special markets.

1.3.1 Trip Purpose-Specific Information

The data in the Trip Purpose-Specific Information section is produced by the Summit program. This section is intended to provide user benefit information by trip purpose. This information includes daily transit trips for both the baseline and build alternative, the daily person trips for the build alternative, the daily hours of user benefits, the positive user benefit hours after the alterations in the transit facility, the daily hours or user benefits adjusted by capping (standard cap of 45 weighted minutes per-trip), and the daily hours of user benefits for the transit dependent population.

The Trip Purpose-Specific Information template section also includes a partition for the calculation of quality control measures. This section includes daily new transit trips; daily new transit trips distribution percentages; daily user benefit distribution percentages; daily transit trips distribution percentages for the baseline alternative; percent of user benefits lost to capping; and the percent of user benefits for transit dependents, each by trip purpose. This information allows for the comparison between trips produced by alternative and comparison between user benefits by alternative. Major differences can be easily identified and analyzed for quality control purposes.

1.3.2 Special Market Information

The Special Market Information section of the template applies off-model developed information to determine the amount of trips related to travel markets not considered by local travel demand models. Examples of special markets include sporting arenas, stadiums, convention centers, and theme parks.

Special markets must be individually examined, and attraction data must be obtained in order for trips to be accurately represented. Information required for special markets includes special market trips per event day, special market user benefit hours per event day, special market pass-miles per event day, and the annualization factor (event days per year).

The Special Market Information section also includes a partition for quality control measure evaluation. This section includes the identification of the annual new transit trips for special markets, the annual user benefit hours for special markets, and minutes of user benefits per project trip for special markets. Any major outliers regarding change in transit trips and user benefits between alternatives are highlighted in this partition for quality checking purposes.

1.3.3 General Information

The final section of the "Travel Forecasting Template" is the General Information section, which utilizes data generated by a regional travel forecasting model. General information requested on the template consists of the annualization factor (days per year); daily project trips excluding special markets, daily project trips for transit dependents; daily project pass-miles excluding special markets, daily project pass-miles for transit dependents; person trips by transit dependents; person trips stratified by trip purposes only; employees within a half-mile of the station area; residents within a half-mile of the station; and project length. Each piece of data required in the General Information section of the "Travel Forecasts Template" also evaluates the overall effectiveness of the project for employees, residents and transit dependents within the study area.

General quality control measures for evaluation include minutes of user benefits per daily project trip prior to capping, minutes of user benefits per daily project trip after capping, percent of user benefits that are coverage related, percent of user benefits that are off-model based, percent of project trips that are new transit trips, and project average trip distance as a percentage of project length. Other required figures include the following: daily project trips per station area employee; daily project trips per station areas residents; daily minutes of user benefits per station area employee; and daily minutes of user benefits per station area resident. As with the other quality control partitions in the template, the marginal difference between alternatives is provided to identify any outlying data for quality control. When comparing the baseline to the build scenarios, the difference in coverage-related user benefit hours should be less than ten percent. The percentage of new transit trips in the build alternative should be consistent with experience, typically between 30 to 40 percent. **Table 1.3.1** provides a summary of the data required for each template section, the format in which the data must be presented, and the origin of the data.

Table 1.3.1: Summary of FTA Starts "Travel Forecast Template" Required Data

Info.	Data	Unit	Source
Trip Purpose Specific	Daily Transit Trips (BASE)	# Trips	Summit Table 30*
	Daily Transit Trips (BUILD)	# Trips	Summit Table 40*
	Daily Person Trips (BUILD)	# Trips	Summit Table 20*
	Daily Hrs of User Benefits	Hours	Summit Table 70/60*
	Positive User Benefits Hrs from Coverage Changes	Hours	Summit Table (44+47+48)/60*
	Change in Hrs of User Benefits due to capping	Hours	Summit Capping Impact/60*
	Daily Hrs of User Benefits for Transit Depend.	Hours	Summit Standard Report*
Trip Purpose Specific Quality Control Measures	Daily New Transit Trips	Count	Summit Table 40-30*
	Daily New Transit Trips - Distribution	Percentage	Template: Purpose / Total
	Daily User Benefits - Distribution	Percentage	Template: Purpose / Total
	Daily Transit Trips (BASE) - Distribution	Percentage	Template: Purpose / Total
	User Benefits Lost to Capping	Percentage	Template: Purpose / Total
	User Benefits Accruing to Transit Dependents	Percentage	Template: Purpose / Total
Special Markets	Project Trips Per Event-Day	# Trips	Off-Model Methodology
	User Benefit Hrs Per Event-Day	Hours	Off-Model Methodology
	Pass-Miles Per Event-Day	Miles	Off-Model Methodology
	Annualization Factor	Event Days/Year	Off-Model Methodology
Special Markets Quality Control Measures	Annual New Transit Trips Distribution, Special Markets Only	Percentage	Template: Purpose / Total
	Annual User Benefits Distribution, Special Markets Only	Percentage	Template: Purpose / Total
	User Benefits Per Project Trip, Special Markets Only	Minutes	Template: Purpose / Total
General	Annualization Factor (Must exclude effects of special markets)	Days/Year	Current/Similar Guideway
	Daily Project Trips (Trips of any part of the proposed fixed guideway, excluding Special Markets)	# Trips	Reg. Travel Forecast Model*
	Daily Project Trips, Transit Dependents (Subset of daily project trips made by transit dependents- defined by lowest socioeconomic stratum of the local travel market)	# Trips	Reg. Travel Forecast Model*
	Daily Project Passenger Miles (Passenger-miles on the proposed fixed guideway project, excluding special markets)	Miles	Reg. Travel Forecast Model*
	Daily Project Passenger Miles, Transit Dependents (Subset of daily passenger miles made by transit dependents)	Miles	Reg. Travel Forecast Model*
	Person-Trips by Transit Dependents (Total number of daily trips made by transit dependents)	# Trips	Reg. Travel Forecast Model*
	Person-Trips by All Travelers (Total number of daily trips made across all trip purposes in local travel modes)	# Trips	Reg. Travel Forecast Model*
	Station-Area Employees within 1/2 Mile	# Persons	Reg. Travel Forecast Model*
	Station-Area Residents within 1/2 Mile	# Persons	Reg. Travel Forecast Model*
	Project Length	Miles	Reg. Travel Forecast Model*

General Quality Control Measures (Excluding Special Markets)	User Benefits per daily project trip before capping	Minutes	Reg. Travel Forecast Model*
	User Benefits per daily project trip after capping	Minutes	Reg. Travel Forecast Model*
	Coverage Related User Benefits	Percentage	Quality Control Calculation
	Off-Model User Benefits	Percentage	Quality Control Calculation
	Project Trips - New Transit Trips	Percentage	Quality Control Calculation
	Project Average Trip Distance / Project Length	Percentage	Quality Control Calculation
	Trips Per Station Area Employee	# Trips	Reg. Travel Forecast Model*
	Trips Per Station Area Resident	# Trips	Reg. Travel Forecast Model*
	User Benefits Per Station-Area Employee	Minutes	Reg. Travel Forecast Model*
	User Benefits Per Station-Area Resident	Minutes	Reg. Travel Forecast Model*

* Data typically comes from this source, but other technologies/methodologies may be applied when discussed with the FTA.

1.3.4 Other Necessary Reporting

In addition to the data required for the "Travel Forecasting Template," several other reports are also necessary for submission in the travel forecasting section of the Starts Application. These data requirements include the reporting of changes over time, the reporting of changes between alternatives, and the reporting of applied quality control measures.

1.3.4.1 Reporting of Changes over Time

The reporting of changes over time illustrates how demographics, person trips, travel times, number of transit trips, and the number of transit shares in the study area will change between the validation year, the no-build scenario and the build opening year. All information is summarized by district.

For demographic change reporting, population, employment, and supportive data (such as dwelling units, persons per household, workers per household, parking costs, and other demographic variables) is provided for the validation year, the no-build scenario and the build opening year. Deltas and percent changes are calculated to demonstrate overall change.

Person trips are analyzed by determining the changes and percent changes between the validation and forecast years. Person trips can be further examined by trip purpose. Home-based work trips and other person trips can be used to illustrate the differences in each of the three alternatives. To summarize travel time changes across the alternatives, peak and off-peak averages are taken by district for highway travel time, transit in-vehicle time, and transit total weighted time. These averages are compared by differences between each alternative.

The number of transit trips is the next factor used to summarize changes over time across scenarios. Total transit trips, home-based work transit trips, other transit trips, and project trips by purpose are each compared by difference and percent difference between the scenarios. Finally, transit shares are compared using the change and percent change in home-based work transit shares, other transit shares, and project shares by purpose for each scenario.

1.3.4.2 Reporting of Changes between Alternatives

To determine the changes between the various forecast year alternatives, comparative information is provided for the no-build scenario, the transportation systems management (TSM) scenario, and the build scenario. The no-build scenario is compared to the TSM, and the build scenario is compared to the TSM. Each is compared by the number of transit trips and the amount of user benefits on a district level.

The total transit trips, the transit trips made by transit dependent riders, and the project transit trips are compared by difference and percent difference between the scenarios to determine the change in transit trips. The following factors are analyzed when determining the changes in user benefits hours:

- Total user benefit hours;
- User benefit hours for transit dependents;
- User benefits and share of user benefits for TSM riders when comparing the build scenario with the TSM;
- User benefits and share of user benefits for no-build riders when comparing the TSM with the no-build;
- Negative user benefits and share of negative user benefits for TSM riders when comparing the build scenario with the TSM; and
- Negative user benefits and share of negative user benefits for no-build riders when comparing the TSM with the no-build.

Other tools that can be used to summarize the user benefits across alternatives are stratified tables summarizing transit trips for the build alternative by change in transit price. Frequency distributions can also be calculated to determine build alternative transit trips by change in transit price, user benefits by change in transit price, and trips for all eight (8) access combinations.

1.3.4.3 Quality Control Reporting

Quality control reporting is conducted using two reports. One report focuses on the amount of the user benefits that are directly impacted by the project. The second report is a summary of the user benefits that were caused by a change in in-vehicle transit time.

The project-related user benefits report includes the identification of user benefits based on best paths by transit access mode. The report also includes the identification of user benefits based on best paths by transit access mode, replacing the project in-vehicle time with the in-vehicle time from the baseline scenario. The reporting of these user benefits is produced by the Summit program.

1.3.5 Back Up Data Materials

The FTA does not require back-up data materials to be submitted with Starts applications. The project sponsor has the option to further discuss any outstanding or noticeably contradictive data presented in the quality control measure sections of the template in the project submission.

In instances where the outlying data is not discussed in the initial Starts application, the FTA will contact the sponsoring agency to make further inquiries regarding any data discrepancies. At this point, project sponsors may submit specific responses to FTA questions regarding data in the quality control measures sections.

1.3.6 Case for the Project

Prior to adjustments in 2008 New Starts and Small Starts submission requirements, a "Case for the Project" document was required to provide information to justify the project. It is no longer a mandatory element in the Starts submission process, but it may be provided as a supplementary tool for project analysis. It will not be scored as a portion of the project justification rating.

The "Case for the Project" document is intended to provide a narrative description of the benefits that a project will have on its respective study area. The impacts will be studied in this document, comparing forecast results to current conditions and outlining all influences rendered by the project for review by the FTA.

The "Case for the Project" documentation will be useful in the decision-making process in the Starts program. It will also provide information for project briefings and New Starts and Small Starts Annual Reports.

1.3.7 Supplementary Data Materials

Starts program projects are encouraged to apply alternative forecasting techniques when executed under appropriate circumstances. These forecast methodologies, if conducted correctly, may provide substantial insight to required forecast information.

Programs including the ARRF model, TBEST, "Alternative-Specific Effects for Different Transit Modes," elasticity or pivot-point analysis, and off-model calculation methodologies may be used as additional forecasts if their results are reasonable, relevant and bring additional awareness to the effectiveness of a transit alternative on a study area.

The use of supplementary data materials will be discussed later in this section. The models and tools used to derive these additional forecasts will be included.

1.3.8 Certification of Technical Methods

The final element in travel forecast reporting for Starts programs is the completion of the Certification of Technical Methods. The purpose of the Certification is to ensure that all technical aspects of the project, including forecasting, cost estimation, and financial planning, are reviewed and the quality of data is ensured. The forecast modeling conventions that must be certified consist of the following technical details:

- The forecast year must be either a 20 or 25 year horizon for New Starts projects, while opening year forecasts are the required horizon year for Small Starts projects;
- The forecasts must be a single set of projections that were produced in accordance with the regional travel demand;
- The forecast model input data must be prepared properly;

- The transit and highway network performance between the alternatives must be constant;
- The transit mode-specific constants must be approved by FTA;
- The levels of service in each alternative are defined to forecast ridership using consistent vehicle loading standards;
- Quality assurance reviews must be completed;
- The amount of transit riders using park-and-ride access must not be higher than the number of park-and-ride spaces declared in provided planning documents;
- Opening-year forecasts and outer-year forecast methodologies must be consistent;
- The definition of alternatives as coded in the models must be the same as those described in all planning documents; and
- The annualization factors must be consistent with local standards and the same for each alternative.

Once each of the criteria on the Certification of Technical Methods is checked, it may be completed and signed to ensure model standards were maintained during project development. A blank copy of the Certification of Technical Methods is located in **Appendix B** of this document. The Certification of Technical Methods can also be located on the FTA website under reporting instructions and templates.

1.4 Travel Forecasting Tools

Several forecasting methods can be used for Starts forecast submission. Some methods are required by the FTA and produce specific project data, while other tools can be used in addition to the generally required techniques. It is critical that all methods and models are closely coordinated with the FTA to ensure best practices and techniques. Acceptable forecasting methods include regional travel forecasting models, Summit program testing, tour-based enumerated models, simplified forecast models, and individual calculations of travel forecasts. These individual tools and forecast data techniques will be discussed in this section.

1.4.1 Regional Travel Forecasting Models

Regional travel forecasting models are used to generate highway and transit forecasts for a regional area for a specified build year. Because travel demand forecast models are designed for long-range time periods, they typically forecast twenty to twenty-five years into the future. Some regional travel forecasting models, however, are designed with interim years, for example ten to fifteen years into the future, that may be utilized for transportation studies and alternatives analysis.

In order for a regional travel forecasting model to reasonably forecast future year travel, it must consider all aspects of the metropolitan area that the proposed transit will be servicing. The models should be locally prepared for a logically established regional area. The models must also exhibit a valid understanding of the existing transit base. All travel volumes should be reasonable when compared to current data, and the model must be both calibrated and validated utilizing the most accurate and up-to-date data. Meticulous quality control measures should be applied to the model development process, as well.

One of the primary focuses for regional travel forecasting models in the Starts programs is the ability to "make the case." In order to achieve FTA funding, forecasts must provide a plausible statement of project impact and illustration of the effects on local travel markets. Finally, regional models should function as a quantification of evaluation measures. Through the use of current data and reasonable forecasting methodologies, project impacts and user benefits may be converted to an analytical, numerical value for comparison and evaluation.

The FTA has four (4) major criteria regarding the development of the regional travel forecasting models used for Starts program applications, including:

- Data requirements,
- Model assessment,
- Forecast testing, and
- Documentation.

1.4.1.1 Data Requirements

Highway and transit data used to calibrate the model must be obtained either through a well-designed and conducted survey effort by a local transit or sponsor agency that is documented and reviewed by the FTA or through a legitimate existing data source.

Highway data needed to calibrate and validate the model include traffic counts and speed data. Traffic counts in Florida are typically taken from the Annual Average Daily Traffic (AADT) counts taken by traffic count stations throughout the State. Highway speed must be taken through speed survey efforts either conducted manually by survey personnel or using Geographic Information Systems (GIS) based techniques. Origin-destination and trip length data can be obtained through various types of highway and household surveys, as well.

Transit on-board surveys are most commonly used to obtain transit ridership information for use in model calibration and validation. The most critical data components to obtain during a survey effort include origin-destination information, trip purpose data, access and egress modes (to and from transit), transit path information, and transit rider demographic characteristics. Surveys must be individually designed on a case-by-case basis, as each project and study area will differ in characteristics and require different data and collection procedures. Transit speeds for non-fixed guideway modes in models are typically a function of highway speed; therefore, no actual observed data is required for model calibration or validation. Transit speeds for fixed-guideway modes are often a function of transit technology and station location.

Obtaining accurate observed data is essential for proper model validation and calibration. A detailed discussion of speed and on-board survey guidelines for use in FTA Starts forecasting is located in *Section 3.0*.

1.4.1.2 Model Assessment

Model calibration and validation are critical processes that must be completed prior to model testing to ensure that the model exhibits a sufficient understanding of its travel market characteristics.

Calibration efforts should assess trip generation rates, travel patterns, trip length frequency distribution, transit mode shares, transit ridership, and highway assignment results. If the results do not sufficiently represent observed data, model parameters, such as coefficients and constants, will need to be reviewed for adequacy. The model will then need to be adjusted in order to match the existing travel market behavior. All calibration efforts should be documented, including market assessment, mode choice assessment, and calibration forecast data.

Validation efforts will be conducted to check the reasonableness of the model forecasts with current conditions, as well as the reasonability of the travel forecasts for year 2030. Transit speeds should also be examined closely in the validation process. Transit time deltas can be analyzed to determine reasonability. The model will be validated based on current travel market behavior.

1.4.1.3 Model Testing

The FTA requires that forecast models are tested against ridership pattern data. The emphasis of model development should be on testing efforts rather than estimation efforts, as testing is a more effective indicator of model performance in relation to transit travel markets.

Model testing should focus on the project's key market segments. All errors detected during testing should be noted and corrected. Tests should be completed several times, to observe any impacts that input alterations may have on the model.

Travel patterns can be tested by viewing the expanded survey person trip tables versus the modeled person trip tables with a focus on mode choice. The travel market segments can be analyzed on a district-to-district or zone-to-zone basis by mode share. Data quality can also be checked using roadway skims and travel time variation.

Transit paths can be tested either on an aggregate or disaggregate level. Highway network and transit network input data must be checked initially. On an aggregate level, boardings by mode, route and station derived from expanded survey trip tables are compared to model-generated trip tables containing transit rider volumes, distribution of boardings and alightings, travel times, and access and egress modes. Major divergences between estimated and observed data will be further examined and corrected to generate more reasonable results.

On a disaggregate level, individual interchanges can be evaluated using prediction-success tests. Prediction-success tests are conducted by analyzing built paths at observed interchanges using observed mode combinations. Mode shares, transfer counts, transit waiting times, zone sizes, and station data are examined by interchange to ensure results are consistent with observed data.

When testing regional travel forecasting models, the emphasis should be on the observation of patterns, the reasonability of these patterns in relation to existing market data, and the understanding of why the model is producing any unreasonable data. Once model behavior is fully comprehended, its parameters and inputs may be adjusted to generate more plausible results. Additional discussion of model testing is included in *Section 3.5.2*.

1.4.1.4 Documentation

These forecasting efforts will be comprehensively documented once all calibration, reasonability testing, and model testing is completed. This documentation ensures quality control and assessment for each model used in Starts program forecasting.

The regional travel forecasting models used for the Starts program enable long-term forecasts and estimations for alternatives analysis. The project information generated by these models can be summarized in analytical formats for review by decision makers and can be presented graphically by district, traffic analysis zone, or study area region to convey the impacts of an alternative and provide a simple means for cross-comparison.

1.4.1.5 FSUTMS Guidelines

Starts program submissions typically involve data generated by a regional travel forecasting model. In Florida's case, a Florida Standard Urban Transportation Model Structure (FSUTMS) model was developed. There is currently a variety of regional travel forecasting models in use within the State of Florida. The standard Florida model operated using either a TRANPLAN or CUBE interface and applies a four step method. The four (4) primary steps in the travel forecasting model are as follows: trip generation, trip distribution, mode choice, and assignment. The FSUTMS model structure includes additional steps to aid in the regional travel forecasting modeling process. **Table 1.4.1** summarizes the processes that occur in the Florida standard regional travel forecasting model to generate travel forecasts.

Table 1.4.1: Regional Travel Forecasting Model Process Summary

Model Process	Description
GENERATION	Generates Ps and As Develops matrix for EE Trips Balances Ps and As
NETWORK	Updates speeds/capacities/VFactors/toll characteristics Builds free flow skims
DISTRIBUTION	Uses gravity model Develops person trip table Conducts pre-assignment Develops congested skims for transit
TRANSIT	Builds transit network and paths Compiles transit skims
MODE SPLIT	Uses logit mode choice model Develops vehicle/transit trip table
ASSIGNMENT	Conducts highway assignment Conducts transit assignment Conducts network clean-up
REPORTING	Reports

In 2008, a standard CUBE Voyager Public Transport (PT) transit model was developed for use in FSUTMS models. The transit model was designed in accordance with FTA modeling standards to

ensure that models used throughout the State of Florida would generate uniform and acceptable results. The transit model developed for FSUTMS models includes the following major components: a transit network, access to transit, transit paths and skims, mode choice model, and transit assignment.

The standard PT transit network is composed of transit lines with attributed modes, operators, transit fares, speeds, and wait-curves (curves that relate transit service headways to rider wait-time at individual transit stations or stops). It also establishes various coding techniques that can be used to reasonably capture various aspects of the transit network. Transit lines must be represented as closely as possible to their actual route segments. The mode, operator, and route name are each identified in the transit line attributes. Each line has a specified travel time, individually adjusted to the operating characteristics and highway travel times, in the case of mixed-traffic transit services. A transit line must have at least two (2) and no more than five (5) headways to reflect peak, off-peak, and any other time-of-day service.

Access to transit represents a critical component of transit modeling. There are three (3) types of access used in the FSUTMS models: walk access (within a half mile between the centroid and transit station), park-and-ride (car stops in parking lot), and drop-off (assumed to also be dropped off in parking lot area). These access modes each require the development of connectors to generate trips from the zone to the transit station. Special connector programs are used by the model to generate these connections.

Models in areas that have bus service in the validation year, but do not have fixed guideway service, typically utilize four (4) types of transit paths: walk-to-bus, drive-to-bus, walk-to-project, and drive-to-project. Walk-to-bus and drive-to-bus trips are composed of only local bus service. Walk-to-project and drive-to-project trips are comprised of premium transit modes and possibly local buses, as well. Transit paths are built based on these trip categories between each zone in the model.

FSUTMS models use a nested logit mode choice model, where different mode share alternatives are determined by using subsets of similar modes. Each of the in-vehicle travel times, out-of-vehicle travel times, wait times, parking and transit fare costs, and other mode specific factors are computed for each mode-share alternative in the mode choice model to determine the utility component for each mode choice alterative. The mode choice model produces trip tables that are used to assign transit paths. Each transit trip is assigned to its respective minimum cost path. Transit trips are always assigned in production/attraction format.

1.4.2 Summit Program

The Summit program is a standard application that is used to calculate the user benefits that an alternative has on a study area. User benefits for FTA Starts project evaluation are the differences in travel times for a set number of trips once improvements are made on a specific transit facility or facilities. User benefits are measured in hours of travel time and can be calculated by multiplying person trips by the difference in overall price of travel.

The Summit program was developed by the FTA to provide a consistent and controlled tool to effectively evaluate and rank projects. Summit output is not a required submission component by

the FTA, but it is a helpful tool for user benefit calculation and reporting. Summit is used to measure user benefit hours to evaluate cost effectiveness, providing project data to "make the case" for its proposed transit improvements. Summit has the ability to report analytical information in a uniform format that can be used by decision makers. Including Summit reports in FTA Starts submissions allows for consistency in all Starts program applications, allowing for simple cross-comparison.

Market segments in the Summit program are described by their accessibility to transit stations and stops. There are three categories of market segments: can walk (CW), must drive (MD), and no transit (NT). From this information, the access market to transit is determined. The Summit program produces trip tables that provide summaries of travel between districts. It also creates specified tables that can summarize data, such as persons by trip mode, transit share, impedances, transit paths, transit expenditures, and frequency distributions. **Table 1.4.2** reviews the table groups that are used for Summit analytical reporting in Starts project templates:

Table 1.4.2: Summit Table Grouping

Table Group	Description
1-10	Base Person Trips
11-20	Alternative Person Trips
21-30	Base Transit Trips
31-40	Alternative Transit Trips
41-50	Total User Benefits
51-60	Auto User Benefits
61-70	Transit User Benefits
71-80	Trip Table User Benefits
81-90	Transit User Benefits Per Trip
91-99	Total User Benefits Per Trip

Source: March 2009 FTA Workshop on Travel Forecasting

The standard cap applied to per-trip transit user benefits is around 45 weighted minutes. This cap is applied to CW-CW and MD-MD trips. FTA has the ability to adjust this cap on an individual project basis.

Specific tables can be generated by the Summit program through the use of function operators to calculate desired information. For example, specifications may be set that will add, subtract, multiply, divide, determine true or false, and determine maximum and minimum values between tables.

Maps can also be generated for graphical assessment of mobility improvements. Thematic maps have the ability to illustrate totals or changes in user benefits by-district within the study area. Common themes for Summit maps include population, employment, trip end changes, transit mode share changes, user benefits by trip production or attraction for impacted areas, and percentage of riders that experience a difference in user benefits.

The Summit program is a helpful tool for Starts project forecasting. Because the program reports data uniformly for each sponsor agency, it can eliminate the variability between traditional forecast models to ensure consistency and a quality controlled evaluation of projects.

1.4.3 Supplementary Forecasting Tools

In recent years, the main focus of Starts project evaluation shifted to providing insight on a project-by-project basis to ensure the greatest quality of information for effective decision making. Insight into the project area, travel market, and travel demand constituency is critical to project evaluation and can aid in the establishment of standards for effectual modeling practices. Therefore, the FTA welcomes the use of supplementary forecasting models to provide as much insight as possible for submitted projects.

As there are many methods of determining user benefits and various modeling techniques, it is also recommended that Starts project managers and sponsors contact the FTA Office of Planning and Environment to evaluate all potential methodologies for alternatives analysis prior to further development of the studies.

1.4.3.1 The Aggregate Rail Ridership Forecast Model

The Aggregate Rail Ridership Forecast (ARRF) model was developed by the FTA to convert Census Journey-to-Work data directly into total fixed guideway trips. The ARRF model is intended to both provide quality control of model results and develop order-of-magnitude estimations for regions lacking commuter rail or light rail in the base year. Inputs for the ARRF model include: level of service (for proposed commuter rail systems), year 2000 Census Transportation Planning Package (CTPP) journey-to-work flows, and station location information for the proposed fixed-guideway alternative.

Level of service information is only necessary in commuter rail systems due to the variations in the range of service between weekday and weekend operations. Light rail transit typically offers higher levels of service consistently across light rail systems, and therefore does not require this variable.

CTPP journey-to-work flows and station location information are critical inputs to ARRF model application. The ARRF utilizes calibrated mode shares that correspond with observed travel patterns on existing examples of similar Light Rail and Commuter Rail to the proposed alternative.

The CTPP journey-to-work flows are multiplied by this established trip rate to produce the total unlinked rail trips for the proposed system. Testing is conducted in specific buffers around rail stations and rail stations with park and ride facilities. Typical production capture areas for the ARRF model are park-and-ride access residences, which are characterized by residences within six (6) miles of a rail station, and walk/bike/kiss-and-ride access residences, which are characterized by residences within two (2) miles of a transit station. Typical attraction capture area distances are employment locations within one (1) mile of a rail station.

Each trip type is calculated by multiplying trip rates by CTPP and then multiplying this value by level of service and other necessary adjustments. The rail weekday unlinked trips are then computed by summing the each trip type.

The ARRF model is a commonly utilized tool for FTA Starts program supplementary forecasts. It may provide insight as to the practicality of regional travel model forecasts and can further develop an understanding of the project study area. The ARRF-I model was recently upgraded to the ARRF-II model that now has improved capabilities for CTPP data processing that discounts trips using the same station as a boarding station and alighting station. ARRF-II also combines individual estimates for home-based work walk and drive access and other trip purpose walk and drive access into one normalized model for estimating ridership for all modes.

1.4.3.2 Transit Boardings Estimation and Simulation Tool

The Transit Boardings Estimation and Simulation Tool (TBEST) is strictly a direct demand model. TBEST is operated using a GIS interface. The most current version of the estimation model is TBEST 3.2. It forecasts transit boardings for fixed route bus systems in a mid-term (zero- to ten-year) time span.

Data used for estimations in the TBEST model include trip origin buffer locations, buffer area demographic information, transfer potential, transit impedances (for example, transit fares, in-vehicle travel time, transit wait time, number of transfers, and walk time), and route and stop attributes. TBEST currently uses 2000 Census data as its population information source and year 2007 data for base employment information.

The tool does not split transit trips by mode, and it does not consider changes in the highway network or auto-operating variables in its estimations. The quality of service on transit is also not accounted for in the TBEST model. TBEST provides for the coding of premium transit modes, but it is not calibrated to these modes at this time. The Los Angeles Metro is currently in the process of calibrating their TBEST model. It will contain coefficients for premium transit.

TBEST provides stop-level analysis for four (4) weekday time periods and weekends. The tool uses transit network characteristics like transit fares, route headways, transit vehicle speeds, types of routes (for example, local routes, express routes, circulators, shuttles, etc.), stop accessibility, and relationships between stations to create its boardings estimates.

A unique quality of TBEST is its ability to distinguish between direct transit boardings and transfer boardings. This quality of the model enables it to produce accurate counts of total daily ridership.

TBEST is commonly used for transit service planning, strategic planning, developing Transit Development Plans, and local transit corridor analysis. TBEST also provides the distinctive ability to produce information for small-scale transit project development and develop an understanding of the demographics of transit riders within an area.

Future plans for TBEST include further model refinement, including the adoption of parcel level input data to enhance the accuracy of address-level demographics and provide land-use based trip attractors developed from ITE trip generation rates, creation of special generator methodologies including park-and-ride, custom reporting to measure the impact of local development on transit as it relates to mobility plans, and any other possible enhancements to further convey transit demand on a mid-term scale.

TBEST is owned and developed by the FDOT. Additional enhancements to the model to meet FTA requirements are also a possibility in future TBEST development.

1.4.3.3 Alternative-Specific Effects for Transit Modes

Another supplementary forecast analysis approach that was adopted by the FTA in 2007 is the "Alternative-Specific Effects for Different Transit Modes" analysis. This method is for projects proposing a new mode of transit that will include stations and vehicles with amenities, dynamic arrival information facilities, and exclusive service options.

The Alternative-Specific Effects Approach incorporates additional attributes, including guideway-like characteristics, quality service span, and passenger amenities, each not included in standard regional travel models. Depending on these transit facility characteristics, adjustments and weights can be made to travel time savings to adjust total user benefits. A lump sum credit measured in minutes of travel time savings is given to each passenger trip, as well as a reduction in minutes of in-vehicle travel time.

The maximum amount of travel time savings is 15 minutes for each rider and a 20 percent discount on in-vehicle travel time weight. Projects with fewer of the attributes for consideration have lower maximum user benefit caps. Full user benefit adjustments are given to fixed guideway portions of trips, while there are reductions to the user benefit adjustments for trips that involve both the fixed guideway system and transfers from local buses.

Using the Alternative-Specific approach, a Starts project sponsor will document various transit facility attributes, in terms of transit guideway, service levels, and amenities, for both the baseline and build alternative scenarios compared. The FTA will then review the attributes of each scenario and determine what adjustments in travel time can be made for each alternative based on these characteristics.

FTA recommended model adjustments include alterations to zonal locations of trips ends, access mode (walking versus driving), travel time on the fixed guideway system, and travel time on local buses. Once the project sponsor agency receives FTA's adjustments, they may then incorporate the alterations into the travel forecast model to impact the user benefits per alternative. The result is additional user benefits for build alternatives based on inter-zonal trip estimates.

The intent of the Alternative-Specific approach is to incorporate various aspects of transit that are not accounted for in regional travel forecasting models. It is a supplementary task that will be incorporated into the model upon FTA approval. The objective of the Alternative-Specific approach is not to affect the ridership levels on transit facility alternatives, but to increase the number of variables used to measure individual user benefits of transit alternatives and minimize the use of mode bias constants.

1.4.4 Off-Model Methodologies

While there are several types of travel forecast models available for Starts program forecasting, it is possible that additional techniques and calculations may be helpful in providing a further understanding of user benefits and transit improvements for specific projects. Off-model methods

should be discussed and developed in close coordination with FTA, as they do not have an existing standard methodology and may require extensive review.

Off-model methodologies can most feasibly occur in corridors where there is an existing transit service proposed for upgrade. The use of "elasticity" and "pivot-point" analysis may be considered useful, as the analysis will calculate changes in ridership in accordance with changes in aspects, such as headways, fares, and travel times. Using existing data and existing rates, the demand curve of a transit service will be determined, and thus estimate the impacts that a new facility will have on the current system.

Obtaining existing observed ridership is critical to off-model calculations. Expansion techniques can often be applied for projects on a shorter time-frame. Existing transit data along the corridor must be captured and grown to an estimation forecast year. In order to obtain an accurate number of existing and benefiting riders in the project corridor, the transit agency must:

- Conduct a count of existing riders in the project corridor (The collection effort must be done on an average weekday with no extra service during a time period in which a maximum number of buses are scheduled. Routes must operate on the street segments where the project line will operate or a parallel facility if no route currently exists in the corridor.);
- Estimate the number of existing riders that will benefit from the project (The number of benefiting riders is equal to the sum of (1) riders on-board the buses when they begin travel into the project area and (2) riders who board the buses in the project area. The agency should then average the weekday ridership based on the system's daily ridership and should not include days with extra service.); and
- Submit documentation of the data collection and estimation to FTA (The following information should be summarized by route for the boarding and alighting counts: (1) total passenger boardings, (2) total riders on-board the transit facilities when entering the project study area, and (3) total passenger boardings in the project area, to obtain a statement by the Director of the Agency certifying that the ridership data was properly collected and reviewed.).

Once this ridership information is obtained, historic information and current trends may be used to develop estimates for future years. This data can be used to determine the number of riders benefitting along the corridor.

Off-model methodologies must also be utilized to calculate trips for special-market areas. Special market areas include airports, sporting or entertainment venues, or other markets that are not properly accounted for by the regional travel forecasting model. The number of patrons traveling to and from these special markets each day must be calculated. This can often be measured by the number of passengers per day, venue capacity, or daily attendance records. For sporting or entertainment venues, the number of event days per year must also be documented to determine the frequency of large attractions.

Each of these factors can be utilized to determine average daily productions and attractions for each area, which can be applied to the model by means of zonal attributes or special generator

delineation. As markets may vary and traditional models may not cover individualized aspects on a project-by-project basis, varying techniques can be submitted for review by the FTA. Off-model methodologies are encouraged to impart any additional insight regarding user benefits to transit trips within a corridor. Further examination and discussion of off-model methodologies used for Starts projects will be included in *Section 3.0.*

1.5 Forecasting Techniques for Starts Program Sectors

As each program in the Starts process varies by size, schedule, budget, and mode, forecasting requirements will vary. Each sector will be discussed as its modeling requirements relate to the modeling tools described.

1.5.1 New Starts

Conducting forecasts for New Starts projects typically requires the application of a regional travel forecasting model, as New Starts projects have longer project schedules and therefore require later forecast years. The regional travel forecasting model will be used to fill in the "General Information" section of the "Travel Forecast Template", as well as provide information for any narratives or additional data submitted to the FTA. Off-model forecasting techniques may be applied in the place of regional forecasting models for projects where transit already exists in the proposed corridor, but the FTA should be in close coordination for all off-model forecasting efforts.

New Starts programs require the use of the Summit program for quality control purposes and the standard determination of user benefits for Starts projects. The Summit program reports will be used to complete the "Trip-Purpose Specific Information" section of the "Travel Forecast Template", and any other Summit output or maps can be used in narrative or additional reports.

Supplementary data can also be submitted with New Starts project applications. For example, the ARRF model is commonly submitted for commuter rail and LRT projects as it is an effective communicator of ridership forecasting in specific buffers within the study area for a fixed-guideway project. As the ARRF model requires minimal input data and quick forecasting, it is a highly encouraged method of submitting additional forecasts that can be used for reasonableness assessment of travel demand model forecasts.

It is possible that with further analysis and refinement, TBEST may also be used as a supplementary forecasting tool for projects like BRT systems. No existing projects to date have applied this methodology. "Alternative-Specific Effects for Different Transit Modes" analysis is welcome for use in New Starts applications along with off-model methodology techniques. The use of tools like TBEST and "Alternative Specific Effects" analysis is not required but may provide helpful information for project evaluation.

1.5.2 Small Starts

Small Starts projects require an alternatives analysis, but these studies often involve significantly less alternatives than New Starts projects due to the smaller scale of transit system possibilities. Because Small Starts projects occur on a smaller scale, they only require opening year forecasts.

Similar to New Starts projects, Small Starts projects also most typically involve the use of the "Travel Forecast Template" and therefore may use the regional travel forecasting model and Summit program to fill-in the information requirements. Small Starts projects, however, can also apply simpler forecast techniques using available data pertaining to the supply and demand side of the transit market.

Using a simplified conceptual approach to travel demand modeling, factors like highway congestion, transit levels of service, demographic information, travel patterns, and ridership data can be compared between current and opening year data to determine project impacts. Project riders can be determined by trips that lie within the proposed project corridor. The number of new transit riders can then be determined by calculating the change in riders due to changes in the transit services. Time savings can be computed by adding current and new riders and multiplied by travel time saved. Opening year riders is then a matter of growing current project ridership to the opening year and adding the calculated number of new riders. Opening year time savings can be computed by growing the current time savings to the opening year.

These off-model techniques often involve more data input than a regional travel forecasting model or the Summit program would require. Therefore, these estimations may provide just as accurate information than travel forecasting model-generated output. To be effective, the forecasts must be a consistent and reasonable practice that comprehends the current transit system features and capabilities. Off-model estimations must be conventional and support the transit service proposed, while providing the FTA with all required forecasts and materials. Coordination with the FTA in the forecast development process is critical to project development.

Other supplementary modeling techniques may be applied to Small Starts projects, like the ARRF model and TBEST. Because the ARRF model focuses on commuter rail and LRT, it may not apply to all Small Starts applications. TBEST, as it is a reporting tool for local, express, and BRT may be useful for Small Starts forecasting. TBEST has not been applied in a Small Starts project to date, but may prove to be a highly efficient and effective tool for opening year forecasts, as the model forecasting year is typically close to the current year for service planning purposes. As TBEST is able to isolate the transit network, it can produce a sufficient stop-by-stop analysis, model walk access riders, and distinguish between direct riders and transfer riders. It will generate more insightful, transit market related forecasts for supplementary analysis as a result of these capabilities.

Some Small Starts projects planned for downtown areas or other corridors that are not typically well-captured by traditional travel demand models can also include alternative methods of travel forecasting to better capture ridership information for their study. For example, the use of "elasticity" and "pivot-point" analysis may be considered when there is an existing transit line within the corridor. Variations in analysis techniques should be discussed with FTA technical staff prior to use. Travel impact years should also be considered when working with Small Starts projects, due to shorter time-frames and less environmental impacts for build alternatives in lower cost projects.

1.5.2.1 Very Small Starts

In order to be considered as a Very Small Starts project, a submission must be a corridor-based project that has 3,000 existing weekday riders that will benefit from the proposed transit project. Very Small Starts projects utilize a very simple mobility impact assessment process. No travel forecast modeling or Summit testing is required. As mentioned above, one of the key requirements for a Very Small Starts projects is that it will benefit at least 3,000 existing transit riders in the project corridor on an average weekday. Therefore, rather than forecasting, a project submission will require proof that over 3,000 riders will benefit. Very Small Starts projects use resources like ridership surveys to obtain count data and application of growth rates as described in *Section 1.4.4*.

Although forecasting for Very Small Starts is not required, estimates generated using programs like ARRF and TBEST may be effectual with closer forecast years and simple data inputs. This supplementary data can be used for quality control purposes to confirm that off-model methodology calculations are reasonable estimations.

1.6 Documentation of Uncertainties in Predictions of Ridership

As no forecast can be certain, the FTA established a new application requirement in December 2008, requesting documentation of uncertainties in ridership forecasts. This requirement will go into effect for projects applying for fiscal year 2011 funding. Most regional travel forecasting models forecast to 25 years. Therefore, many of the model inputs, like transit fares, demographics, auto-operating costs, and auto-ownership are highly uncertain. The documentation of uncertainties will assess the reasonableness of the model forecasts by determining what is driving the model and for which factors the model is not properly accounting. Because projects qualifying for Very Small Starts do not require a model to be used for ridership forecasting, the documentation of uncertainties is not required in Very Small Starts project submissions.

Many forecasts rely on transit markets that do not exist in current year forecasts. The intent of the documentation of uncertainties is to discuss ridership forecast reliability depending on travel markets affected and changes in model variables. The documentation of uncertainties will aid in assuring that all modeling methodological information is disclosed to the FTA for review. It is also to ensure that forecasts are insightfully and realistically analyzed, rather than generated and provided as simple figures with no further explanation.

The documentation of uncertainties will incorporate a range of three (3) rider estimates: a low-range estimate, a high-range estimate, and a medium-range "best" estimate. These low to high range estimates will be produced using an incremental sensitivity testing of market identifying data from current year data to forecast data. For example, the low-range estimate will be the alternative with all transit market conditions set to the validation year.

Data regarding the transit markets, like auto-operating cost, demographic information, price of fuel, price of parking, and other similar measures, will be incrementally increased, producing estimations up to the forecast year. Using this methodology, the effect of each variable will be apparent through the changes in ridership forecast in relation to the slight incremental shifts in

each variable. Project sponsors will be accountable for establishing the criteria for these ridership forecast ranges.

From these incremental changes to produce low, high, and best forecasts each potential source of uncertainty can be defined, and the FTA can quantify the reliability of the model. The criteria that the FTA will use to determine the reliability of forecasts will include the following:

- Complete documentation of uncertainties;
- Quality of data collection and model testing efforts;
- Magnitude of forecast to manage identified uncertainties;
- Sponsor history of reaching projected ridership in previous projects; and
- Dependence of the forecast on conditions considerably differing from current conditions.

Because all modeling practices and uncertainties will be clearly defined in the application, the documentation of uncertainties will allow FTA to review applications more efficiently, as they will have a better concept of the context and the reasonability of the forecasts.

The addition of the documentation of uncertainties will allow for all project forecasts to have another set of quality control measures, as well as encourage insightful and honest practices that will aid in the decision-making process for Starts project evaluation.

1.7 FTA Starts Project Submission Examples

In order to obtain a better understanding of FTA acceptable forecasting methods, two (2) examples of previously submitted Starts project applications were researched. Both are Small Starts projects that received funding to enter into project development in recent years. The first project is the Fitchburg Commuter Rail Line Improvements Program that was submitted for FTA funding and received almost $70 million towards project expenses in fiscal years 2009 and 2010. The second project is the East Bay Bus Rapid Transit project that received $15 million in FTA Starts program funding for fiscal year 2011.

The forecasting techniques applied in each of these projects vary greatly from one another, as the scale of the projects and the existing infrastructure differed substantially. Both project methodologies will be discussed and compared as acceptable FTA practices.

1.7.1 Fitchburg Commuter Rail Line Improvements Project

The Fitchburg Commuter Rail Line Improvements Project was developed to improve and extend a 50-mile commuter rail into suburban areas northwest of Boston, MA, starting in Fitchburg and traveling south to North Station. The improvements include an 8.5 mile addition of double track, increase in vehicle speed from 60 to 80 miles per hour, drainage system improvement, four (4) graded crossing improvements, the addition of three (3) high platforms, and increase in midday service by two (2) runs.

The Fitchburg Commuter Rail Line Improvements Project entered into the FTA Small Starts pipeline in 2009 when it received an overall medium-high project rating and $30 million for the fiscal year. The total project cost for improvements to the commuter line was $149.8 million.

Forecasts for the Fitchburg Commuter Rail Line Improvements were conducted using off-model methodologies. It should be noted that the Fitchburg Commuter Rail Line Improvements project is one of the simplest forecast methodologies accepted by the FTA to date. No model was applied in forecast development for this project, but estimation techniques were used to grow existing data. This atypical forecasting methodology for Starts projects required significant correspondence with the FTA due to its simplistic nature.

The estimated 2012 opening year forecast was 11,700, yielding over 7,000 new transit riders. In order to develop this estimate, forecasters used the following information to compute ridership and growth:

- Existing Riders: Current Station On and Off Counts Expanded
- Travel Time Savings (Minutes): Train Time Improvements from Estimations
- Opening Year Riders: Estimated Using an Aggregate Factor
- New Riders: Estimated Using Travel Time Improvements and a Run-Time Elasticity of -0.6
- Person Hours Saved: Opening Year Riders Multiplied by Travel Time Savings
- New Riders Hours Saved: New Riders Multiplied by Travel Time Savings and Run-Tim Elasticity of -0.6

The total time savings calculated for the Fitchburg Commuter Rail Line Improvements was 987 hours per day of operation for 2012. In order to provide a quality check, low and high estimates were derived using varying elasticity rates of -0.4 and -0.8, and the final results appeared reasonable.

As mention previously, the FTA gave the Fitchburg Commuter Rail Line Improvements project a medium-high overall rating. The only suggestion that FTA later gave on the forecasting methodology was the possible inclusion of existing train times. Because the Fitchburg Commuter Rail encountered several delays in its day-to-day operations, information regarding the average length of delays and the causes of delay would be applicable to travel times savings calculation. With this information the proposed improvements may have gained further insight to their impact on the existing program.

1.7.2 East Bay Bus Rapid Transit

The East Bay Bus Rapid Transit is a line proposed from Downtown Berkeley to Downtown Oakland in the San Francisco Bay area in California run by Alameda-Contra Costa (AC) Transit. The $234 million line just misses the $250 million cut-off for New Starts qualification, rendering it a significantly large Small Starts project. The proposed BRT line covers a total of 16.9 miles with 49 stations. The BRT project entered the FTA Starts pipeline when it was awarded $15 million for Project Development in fiscal year 2011 with a “high” overall project rating.

Because the East Bay BRT line is a large Small Starts project, both a regional travel forecasting model and the Summit program were used to forecast project impacts. The regional travel forecasting model used for the project was the Alameda County Congestion Management Agency (ACCMA) Countywide Travel Demand Model, the model used in the project's Draft Environmental Impact Statement (DEIS) that was calibrated and validated for highway and transit in the proposed BRT study area. The model has a base year of 2005 and a mid-term forecast year of 2015 that was used for Small Starts modeling.

The FTA was closely involved in the development of the model for Small Starts forecasting. Several calls, emails and meetings were held in correspondence regarding changes to the model structure to develop a model that would produce the most reasonable forecasts for the specified project area. Issues involving mode choice coefficients, validation efforts, baseline scenario approval, Summit testing, model output review, model development and validation documentation, attribute reclassifications, and user benefit analysis were all discussed to maintain good practice throughout the entire modeling process from late 2007 to late 2008.

Some of the major changes applied to the ACCMA Travel Demand Model were the addition of 90 TAZs, the addition of trips generated by group quarters along the transit corridor, the addition of trips to and from Berkeley City College, the change in parking allocations at the University of California Berkeley, and transit updates to the 2005 system.

The results produced by the model overestimated the number of trips on the BRT line, as it captured trips from parallel transit lines run by AC Transit and Bay Area Rapid Transit (BART). In order to restore these trips to their respective lines, factors were created and applied to adjust the boardings. The factors were determined as follows:

- The percent change between the difference in boardings between the Build and No-Build Scenarios in the DEIS and the final difference in boardings between the Build and No-Build Scenarios in the DEIS, as determined by a factoring method, was applied to the difference in boardings between the No-Build and Build Scenarios using the Small Starts refined model.
- This factored difference in boardings was then added to the Small Starts Baseline boardings, which adjusted the result of the model.

The model forecasted 42,560 daily project trips, which included 6,800 new transit riders. The project has requested $75 million in FTA funding. It will remain in the pipeline as it progresses through the development stages.

1.7.3 Submission Comparison

As the East Bay BRT line was almost $100 million more than the Fitchburg project and proposed an entirely new fixed guideway, its modeling efforts were demonstrated to be significantly more extensive than those of the Fitchburg Commuter Rail Line Improvements. The Fitchburg Commuter Rail Line has existing ridership data on its actual facility; therefore, growing the data was a simple and effective task. The East Bay BRT previously modeled alternatives in its DEIS and had a preexisting model set-up. Validation efforts and model testing were sufficient to produce corridor-specific model results.

Each modeling technique was accepted by the FTA. These example studies prove that forecast modeling is case-specific. Every project will require its own study area analysis and the most effective modeling methodologies should be applied. The Project Description and Travel Forecast Templates for each of these projects is located in **Appendix C**.

1.8 Summary

With a myriad of modeling tools available to planners, the possibilities for FTA Starts programs are far-reaching. Regional travel forecasting models and the Summit program are standardized models that are used in high frequency to illustrate the mobility improvements of a transit project. Other methodologies can also be applied in order to supplement and add further insight to project evaluation. Peer review of all forecasting methods and estimations may also be conducted for further project insight. The key focus that the FTA would like to bring to the model forecast practice is insight for the application of best methods of forecasting practice on a case-by-case basis.

Forecasts should "make the case" for their project, bringing analytical thought to the forecasts and not simply numbers. Forecast methodologies should be well-documented and clearly reported, with a description of any atypical or additional measures taken to produce the most practical forecasts for the study area. Model testing should be completed and documented, and quality control measures to minimize error should also be applied and documented for FTA review. Cross-comparisons with other models and projects may also be conducted by a project sponsor as quality control measures. Coordination with the FTA regarding forecasting practices and methods is highly encouraged.

Project specific forecasting is critical to New Starts and Small Starts project submissions. The application of various forecasting methodologies should be used to make the case for the project. Starts forecasts must be analytical: telling the story and presenting a critical necessity for community transit improvements. The FTA Starts program evaluates on effectiveness, reasonability, and reliability. Forecasts should be made transparent to aid decision-makers by illustrating the dependability of forecasts and the extent of mobility improvements for each project.

SECTION 2: Review of the Applicability of the TBEST Model for New Starts and Small Starts Applications

2.1 TBEST in New Starts and Small Starts

The creation of the Transit Boardings Estimation and Simulation Tool (TBEST) was initiated by the Florida Department of Transportation (FDOT) with the goal of developing a software tool that allows for short- and mid-term planning of local bus services. TBEST estimates transit boardings using stop-level analysis techniques for current to mid-term time frames (0-10 years). The software is specifically designed to determine access to transit mode, determine connectivity within the transit system, account for special generators at stops throughout the network, and account for both residential and employment characteristics in transit areas.

TBEST is used by local transit agencies, as well as local and regional planning agencies, to analyze service improvements and to support the creation of Transit Development Plans (TDPs). As TBEST makes boarding estimation a simplified process and provides a time-efficient and flexible method for transit planning, its incorporation for short- and mid-term transit application has potential.

Currently, the most up-to-date version of TBEST is Version 3.2.1, which is compatible with both ArcGIS Versions 9.3 and 9.3.1. Compatibility with ArcGIS 10 is currently being developed. The estimations program is in continuous development and enhancement by the FDOT to further expand the program's capabilities.

To date, the TBEST program has not been applied for forecasting in any Federal Transit Administration (FTA) Starts project. The TBEST model is prepared and available for use by Florida transit agencies. The model currently has coefficients for only bus mode; therefore, it is not applicable for use in most New Starts projects. As TBEST presents many opportunities for forecast development and quality assessment in Small Starts projects like Bus Rapid Transit (BRT) and other transit improvement projects, the possibility of incorporating the software for future Starts projects in the sense of forecasting, conducting feasibility studies, and sketch-planning is further discussed in this section. The possibility of utilizing TBEST for conducting ridership estimated for Very Small Starts projects is also included.

In this section, the methodologies applied for estimation and simulation, as well as input, output, and validation standards are discussed. The expansion of the TBEST program to provide FTA Starts forecasts is also investigated. Detailed recommendations for the advancement and application of TBEST will be provided in *Section 5.0*.

2.2 Methodology

TBEST is a "direct demand" fixed-route transit model that uses stop, segment, and route network characteristics to estimate stop-level ridership based on walk access to transit, destination accessibility through the transit network, and measurement of competing and complementary effects of multiple transit networks. TBEST applies a methodology that incorporates multiple time

periods of analysis to capture peak, off-peak, and weekend travel. The model also has the ability to differentiate between direct boardings and transfer boardings.

TBEST differs from typical regional travel demand models because it does not contain a highway network, which eliminates the need for a mode split function. Rather, in the TBEST model, a purely transit route network is used, and the transit system operating speeds are manually input into the model for base year development. Therefore, there are no person trip tables for distribution, and highway speeds are not used to calculate local bus speed.

Six major methodological approaches are incorporated into the TBEST model to estimate transit ridership. These six methodologies include:

1. Stop-Level Socioeconomic Data Assignment;
2. Stop Origin-Destination Impedance Matrix;
3. Transit Network Inter-Relationships;
4. Network Accessibility Impacting the Subject Stop;
5. Measuring Accessibility; and
6. Direct and Transfer Boardings Estimation.

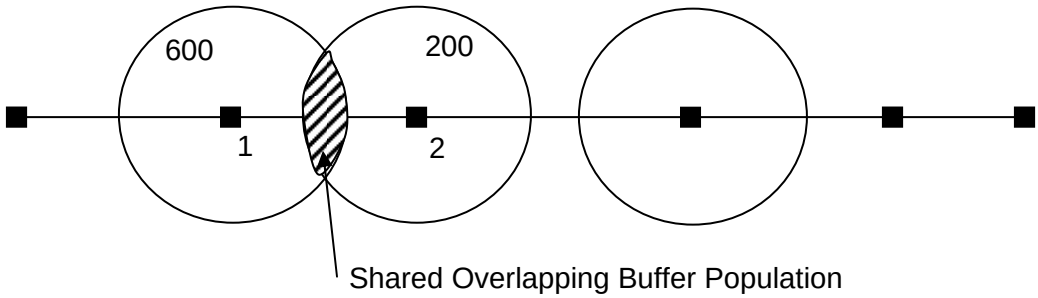
Each of these processes is critical to the TBEST application. These methodologies will be individually discussed in this section.

2.2.1 Stop-Level Socioeconomic Data Assignment

During each model run, TBEST calculates and summarizes the population and employment with walk access to each stop in the system. For TBEST, walk access is defined as areas within one-fourth of a mile of the subject stop.

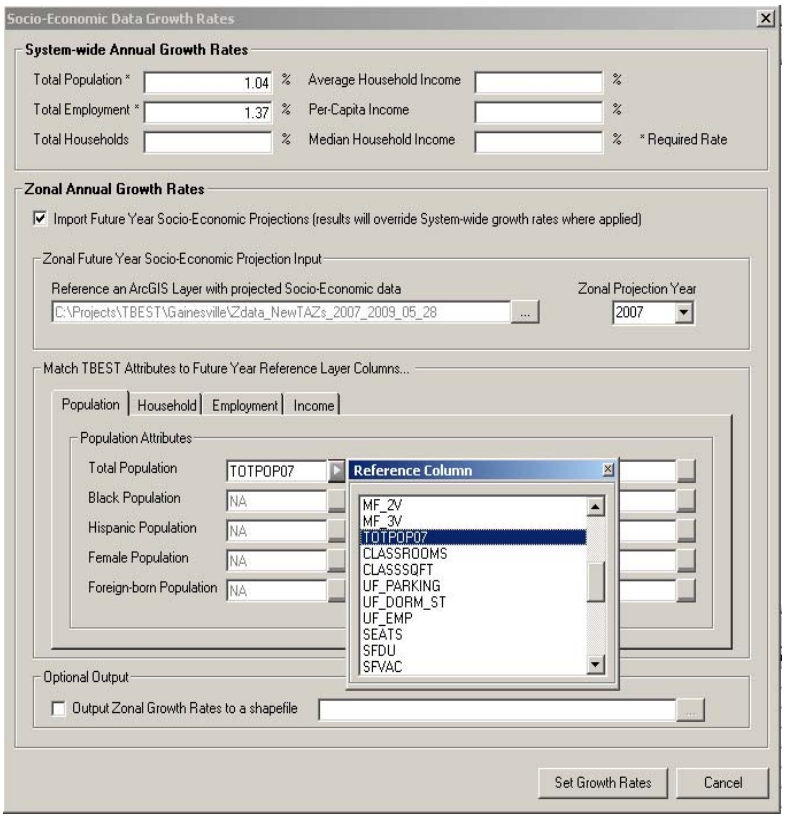
To calculate the walk access market without double counting individuals, households, or employees within the buffer, the TBEST model captures the density of overlapping markets (buffers) from surrounding stops and distributes population and employment based on the calculated overlap. In this way, the market competition at the stop is captured by distributing population and employment within the shared buffer areas. As the model continues with accessibility computations, the socioeconomic variables assigned at the stop-level are utilized to determine potential riders at an origin stop (access) and destination demand at accessible stops (egress). **Figure 2.2.1** illustrates the shared overlapping buffer population.

Figure 2.2.1: Illustration of Overlapping Buffer Area



Within the framework of calculating stop-level socioeconomic data, population, and employment data is incremented or decremented based on user-defined growth rates. The model will accept a no-growth scenario, a scenario where overall population and employment growth is based on a single growth rate, or TBEST will accept zonal data containing population and employment projections for a given year. From the zonal data, TBEST will perform a spatial auto-correlation between the Census block-group geometry utilized within TBEST and traffic analysis zone (TAZ) geometry to correlate the input zonal population and employment to the Census block group-level. From this comparison, growth rates are calculated for corresponding TBEST and TAZ socioeconomic variables at the Census block group-level. **Figure 2.2.2** below illustrates the TBEST interface for socioeconomic growth input.

Figure 2.2.2: TBEST User Interface for Socioeconomic Data Growth Input



For un-validated models, the growth rates are compounded over the duration between the source year of the data and the target base year. For validated models, the growth rates are compounded between the base year and the horizon year. In addition to system-wide growth rates, users can specify localized growth for any stops within the system. These growth-rates would correspond to planned land-use changes such as Development of Regional Impact (DRI's), employment industry changes, and other predicted variations in socioeconomic distributions. The localized growth rates are input using the TBEST user interface and work together with scenario-wide growth rates to accurately reflect the synergy of general growth patterns and growth at the local-level.

2.2.2 Stop Origin-Destination Impedance Matrix

Prior to summarizing the composite network access influencing ridership, the TBEST routing engine calculates a stop origin-destination (OD) impedance matrix for the entire transit system. TBEST determines network connectivity and accessibility at a particular stop by determining all possible destinations through the transit network based on 85 minutes of total impedance and a limit of one transfer. Impedance is measured in time and the components of impedance are listed in **Table 2.2.1**. The components of impedance are also weighted based on industry standard weights adopted from existing literature. Implementation of first weight time is summarized in **Table 2.2.2**.

Table 2.2.1: Components of TBEST Network Impedance

Components	Unit	Determination	Symbol	Weight Value
1. First-Wait Time	Minutes	Reference Table 2.2	FWT	2.0
2. First-Boarding Fare	Dollars	Base cash fare	FBF	1/v
3. In-Vehicle-Time	Minutes	Cumulative scheduled travel time	IVL	1.0
4. Transfer-Wait Time	Minutes	Half of Headway	TWT	2.0
5. Number of Transfers	Number	One	NTF	5.0
6. Transfer Walk Time	Minutes	Average speed at 3 miles per hour	FWT	1.5
7. Transfer-Boarding Fare	Dollars	Base cash fare for transfers	TBF	1/v

Note: v = value of time

Table 2.2.2: Implementation of First-Wait Time

Headway (h)	Weekday FWT	Weekend FWT
<30	h / 2	h / 2
<=60 and >30	h / 3	h / 3
<=90 and >60	20	h / 4
<=120 and >90	20	h / 5
<=150 and >120	20	h / 6
<=180 and >150	20	h / 7
<=210 and >180	20	h / 8

The TBEST model utilizes the OD matrix to summarize the accessible destination stops that impact the ridership at the origin stop. Neighboring stops whose destination stops either compete with or complement the destination stops of the origin stop are discussed in the next section.

2.2.3 Transit Network Inter-Relationships

Each stop within the transit network is affected by the stops around it, regardless of whether the routes servicing these stops include the same or different destinations. Each individual stop, or subject stop, is surrounded by "neighboring" stops. A stop's boardings are directly impacted by the opportunities presented to potential riders by its neighboring stops. The opportunities are measured by calculating the accessibility from each neighboring stop through the transit network. The application of the measured accessibility values is also discussed in this section.

There are three categories of neighboring stops established in the TBEST program, each providing either a single stop or group of stops that will be used to determine the network accessibility impacting the origin stop. The neighboring stops are classified as either N_1, N_2, or N_3 stops. **Table 2.2.3** summarizes each neighboring stop category.

Table 2.2.3: Neighboring Stop Designations

Stop-Level	Includes
N_1	Next sequential stop on the route after the origin stop *Note: N_1 stops are not required to fall within a buffer*
N_2	Closest stop to the origin stop running on the same route in the opposite direction
N_3	Stops on other routes within 990 ft of the origin stop

These neighboring stops are utilized as input to the transit network destination accessibility calculations, which further examine the impact of competition and complementary effects on destinations of routes/stops originating at the stop market area or along the origin route.

2.2.4 Network Accessibility Impacting the Subject Stop

H-Stops are groups of accessible stops that are used to summarize destination accessibility originating from neighboring stops associated with an origin stop. There are five H-Stop categories: H_1, H_2, H_3, H_4, and H_5. **Table 2.2.4** summarizes each of the H-Stop accessibility classifications.

The TBEST model is designed to calculate this information for each individual stop in the network. This information will be used as an input into the measurement of stop accessibility that is discussed in the next section.

Table 2.2.4: Stop Accessibility Designations

H-Stop	Description	Purpose
H_1	Stops that can reach any N_1 stops on other routes located in the origin buffer	Capture riders going to the Subject Stop on other routes
H_2	Stops downstream of the Subject Stop that can be reached by the Subject Stop via the subject route	Capture the opportunity for activity accessible by boarding at the Subject Stop or at an N_1 stop
H_3	Stops upstream of the Subject Stop through the subject route that can be reached via an N_2 stop	Capture the opportunity for activity in the opposite direction of travel at the Subject Stop via the same route as boarding at the Subject Stop
H_4	Stops that can be reached from any N_3 stops	Capture opportunities for activity via other routes
H_5	Stops characterized as H_3 or H_4 that overlap stops in H_2	Captures the H2, H3 and H4 overlap area in order to calculate O_6

2.2.5 Measuring Accessibility

The TBEST model's O-values (Opportunity) summarize the network accessibility computations captured in the H-Stops. When population and employment are discussed in terms of O-values, they function as an accessibility index of those numbers, not actual counts. In other words, the population and employment accessibility output is unit-less. When summarizing O-values, TBEST utilizes a gravity formula which decreases the value of destination population and employment the greater the impedance relative to the subject stop. **Table 2.2.5** provides a summary of the O-values.

Table 2.2.5: O-Value Designations

O-Value	Description	Purpose
O_1	Riders (calculated by the Direct Boardings model) that have access to the subject stop via the transit network (H_1 stops)	Measure of riders with the ability to transfer at the subject stop
O_2	Population and Employment accessible at the subject stop on the same route in the same direction (H_2 stops)	Measure of downstream accessibility
O_3	Population and Employment accessible at the subject stop on the same route in the opposite direction (H_3 stops)	Measure of upstream accessibility
O_4	Population and Employment accessible from stops that can be reached from any N_3 stops (H_4 stops)	Captures opportunities for activity via neighboring stops/routes
O_5	Population and Employment of stops in H_4 stops whose buffers overlap with those of H_2 stops	Provides the total level of destination competition for subject stop
O_6	Population and Employment within the overlapped buffer areas in H_4 stops whose buffers overlap with those of H_2 stops	Subset of the level of destination competition for the subject stop calculated by determining the level of overlap between H_4 and H_2 stops

2.2.6 Direct and Transfer Boardings Estimation

TBEST incorporates separate equations for estimating and distinguishing between direct boardings and transfer boardings at each stop location. At any given transit stop, there may be patrons who will begin their trip at the designated stop and other patrons who are transferring at the designated stop. By distinguishing between direct and transfer boardings, TBEST is able to:

- Account for stop characteristics that contribute to transit linked trip making and transit network characteristics that influence transfer activity levels and locations;
- Account for stop buffer characteristics that contribute to attracting and generating walk access ridership at a stop;
- Provide a quantitative perspective on the extent of trip linking; and
- Provide a framework for analyzing the impacts of transfer points and transfer opportunities on ridership.

Once TBEST has completed the processes of socioeconomic data assignment, OD matrix development, transit interrelationship establishment, and accessibility measurement, it has the variables necessary for the direct and transfer boardings equations.

TBEST independently models these two types of boardings so that linked trips can be estimated in the network. Consequently, the direct boardings equation is applied to all stops in the system, and the transfer boardings equation is applied to only those stops with at least one transfer opportunity. Transfer opportunities are stops on other routes within one-eighth of a mile of the subject stop.

In addition, the transfer boardings equation differs from the direct boardings model in that it utilizes the O_1 accessibility measure. O_1 is calculated as a measure of riders (direct boardings) with the potential to transfer at the subject stop. Therefore, in the model sequence, direct boardings are calculated and then used as input to the transfer boardings equation in the form of O_1 accessibility. **Figure 2.2.3** and **Figure 2.2.4** provide the actual direct and transfer boarding equations utilized in the TBEST model.

Figure 2.2.3: TBEST Direct Boarding Equation

Direct Boarding Equation

$$D_n^s = f\left(B^s, O_{2n}^s, O_{3n}^s, O_{4n}^s, O_{5n}^s, O_{6n}^s, X_n^s\right) \qquad n = 1, \ldots, N$$

s refers to stop on a route in a given direction

n refers to time period

D = direct boardings

B = vector of buffer characteristics (population/employment)

O_i = accessibility measures = characteristics of buffer areas of accessible stops, H_i, i = 2, 3, 4, 5

Figure 2.2.4: TBEST Transfer Boarding Equation

Transfer Boarding Equation

$$T_n^s = g\left(O_{1n}^s, O_{2n}^s, O_{3n}^s, O_{4n,}^s O_{5n}^s, O_{6n}^s, Y_n^s\right) \qquad n = 1,\ldots,N$$

T = transfer boardings

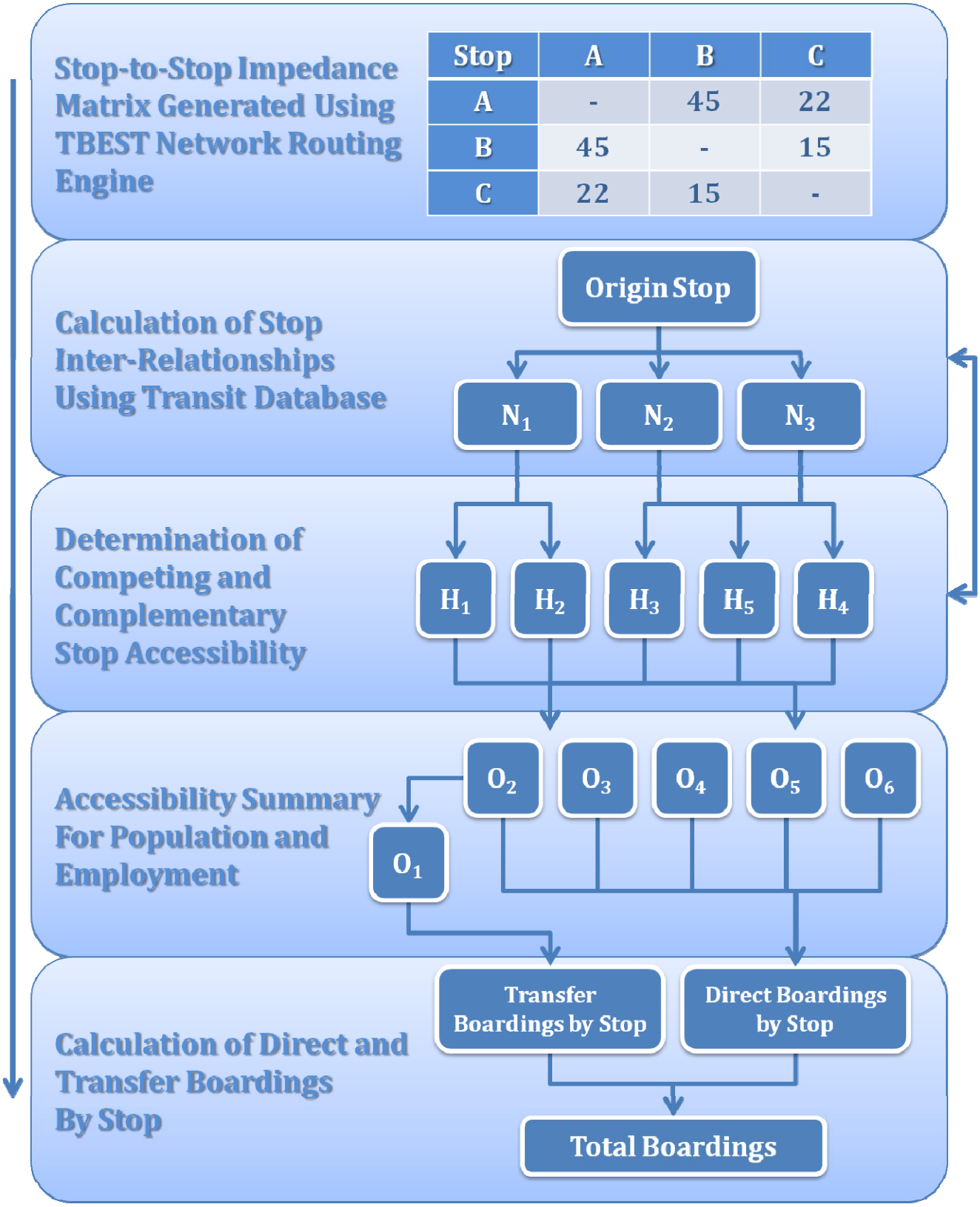
O_1 = accessibility measure = total boardings at all stops, H_1, during period *n* toward stop *s*

Y = vector of other route and stop characteristics

The estimated number of direct boardings is then added to the estimated transfer boardings. This value is equal to the total number of boardings for the subject stop.

Figure 2.2.5 on the next page provides an illustration of the methodologies utilized in TBEST. The technique used in the model allows for the determination of stop-to-stop impedances and calculation of inter-relationships between stops in the transit system, establishes the accessibility between stops, determines the opportunities available for each stop, and calculates the direct and transfer boardings for each stop.

Figure 2.2.5: TBEST Applied Methodology Diagram



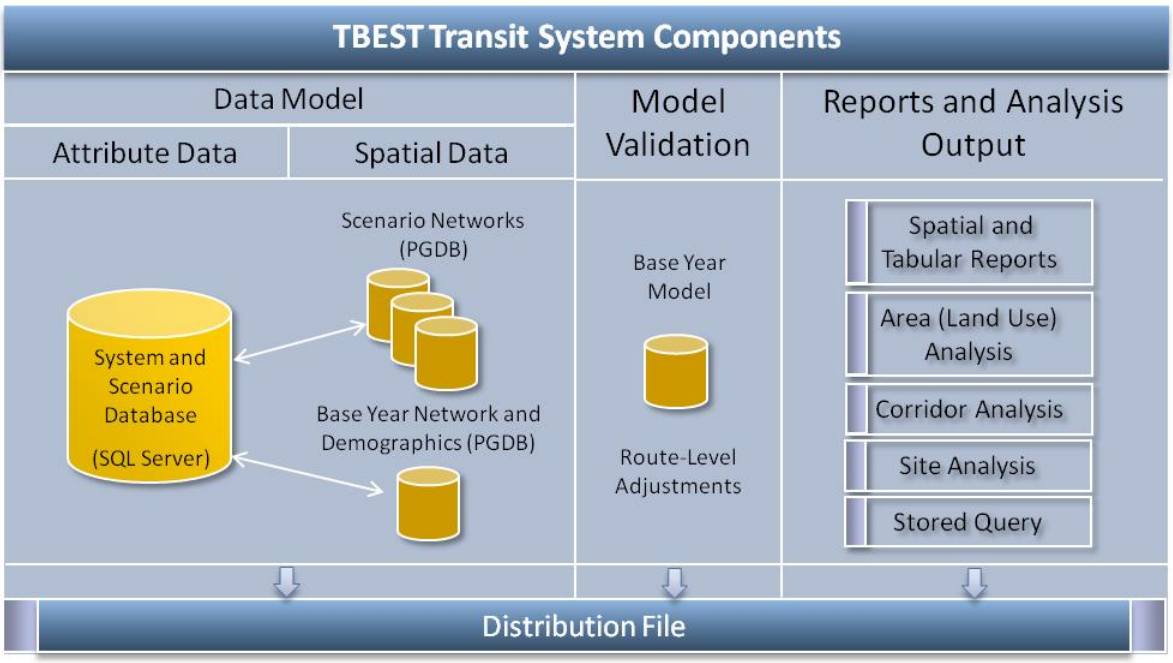
2.3 Model Data Summary

There are several input and output components in the TBEST model structure that are required for the estimation of transit boardings. Each of these factors will be discussed in relation to the TBEST model methodology. The discussion of required input and output will later be expanded in *Section 5.0*, to include the evaluation of the TBEST data and parameters pertaining to New Starts and Small Starts project application.

TBEST manages spatial data pertaining to the transit network, Census geography and address-level InfoUSA data in ESRI personal geodatabase (PGDB) or shapefile format. System, validation and scenario specific attributes are housed in Microsoft SQL Server Express 2005 database format.

Output reports are saved in .csv (comma separated values) format which is compatible with Microsoft Excel. **Figure 2.3.1** illustrates the storage environment for input and output data within the TBEST environment. Notice that all of the TBEST data components can be combined into a single file, called a Distribution File, for ease in transferring, versioning, and backing up model data.

Figure 2.3.1: Storage Environment for Input and Output Data



TBEST stores input and output data by pre-defined time periods for the modeling process. A comprehensive definition of each service time period is shown in **Table 2.3.1**. TBEST output can be summarized by weekday or weekend.

Table 2.3.1: Defined Service Time Ranges

Period Name	Variable Description
Weekday AM Peak period	6:00 – 8:59 AM
Weekday Off-Peak period	9:00 AM – 2:59 PM
Weekday PM Peak period	3:00 – 5:59 PM
Weekday Night period	6:00 PM – 5:59 AM (next day)
Saturday (24 hrs)	12 midnight – 11:59 PM
Sunday (24 hrs)	12 midnight – 11:59 PM

2.3.1 Model Input Data

The TBEST model requires input of socioeconomic data, ridership data, and transit network information. With the data from each of these components, the model will be able to calculate inter-relationships, accessibility, and boardings for the transit system.

2.3.1.1 Socioeconomic Data

Population and demographic data used in the TBEST model are taken from the 2000 Census SF1 and SF3 data tables and then associated with either Census Block- or Block Group-level geometry depending on the variable. Socioeconomic characteristics used in the model, including number of households, income, percent below poverty line, ethnicity shares, gender shares, employment shares, vehicles-per-household shares, and age-range shares, are provided in this package. **Table 2.3.2** lists the socioeconomic variables that are input into the TBEST model.

Table 2.3.2: TBEST Socioeconomic Variables

Variable Name	Variable Description
TOTPOP	Total population
TOTHH	Total households
AVGINC	Average household income
PERINC	Per-capita income
INCMEDIN	Median household income
SHBLACK	Share of Black population
SHHISP	Share of Hispanic population
SHPOPPVTY	Share of population living below poverty line
SHPOP65	Share of population greater than 65 years of age
SHPOP16	Share of population under 16 years of age
SHFEMALE	Share of population that is female
SHWORKER	Share of population that is employed/working
IMMIG	Share of population that is foreign-born
SHAUTOMF	Share of population living in multi-family dwelling unit
SHAUTOS0	Share of population living in zero-vehicle households
SHAUTOS1	Share of population living in one-vehicle households
SHHHCHILD	Share of households with children under 16 years of age

Address-level employment data used in the TBEST model is derived from the 2007 InfoUSA database that was purchased and made available by the State of Florida. The employment data categories provided are aggregated into three main categories: industrial, service, and commercial employment. The categories are the same as to the Florida Standard Urban Transportation Model Structure (FSUTMS) employment data. **Table 2.3.3** lists the SIC codes TBEST uses to aggregate InfoUSA employment data.

Table 2.3.3: TBEST Employment Variables SIC Codes

Employment Group	SIC Codes
Industrial	1, 2, 8, 9, 7, 10, 12, 13, 14, 15, 16, 17, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39
Commercial	50, 51, 52, 53, 54, 55, 56, 57, 58, 59
Service	40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 60, 61, 62, 63, 64, 65, 66, 67, 70, 72, 73, 75, 76, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 91, 92, 93, 94, 95, 96, 97

In addition to address-level employment data, TBEST will accept zonal data aggregated into the same industrial, commercial, and service categories. In some cases, the zonal data was developed by FDOT or Metropolitan Planning Organizations (MPOs) as input into the FSUTMS model. TBEST can use this zonal data as direct input into the model. TBEST will treat this data differently than address-level data in that it will not apply any user specified growth rates to the zonal data. It is assumed that the user will manipulate this data outside of TBEST to have it fit a particular scenario year.

In addition to the current TBEST socio-economic data inputs, TBEST is currently undergoing modifications to accommodate parcel-level demographics and land-use categories. With this new target model structure, the TBEST model will respond to demographics at the address-level as well as trip generation based on ITE trip-generation rates for land use categories. The new model structure is due out in late 2010.

Both population and employment socioeconomic data factors are grown to future year values using various growth rate techniques to allow for future year ridership forecasting. These techniques will be discussed in *Section 2.3.1.3*.

2.3.1.2 Ridership Counts

Ridership counts are needed for the TBEST model validation process. Average daily ridership counts should be compiled for weekday, Saturday, and Sunday for the time frame of the base year scenario. Local agencies can obtain transit ridership count information through Automatic Passenger Count (APC) data, transit ticket sales, and other boarding information. If ridership data is not available for weekday time periods, estimates based on daily totals are used.

Ridership counts are used in the TBEST validation process both at the route-level (or collection of routes) and on a limited basis at the stop-level. Routes can be grouped together for the validation process to match the level of detail in the observed ridership information.

2.3.1.3 Transit Network

The TBEST model requires a coded transit network representing the system route structure, service levels, travel times, fares, transfer stations, and special generators. FDOT has invested in the pre-development of over 20 TBEST networks for use throughout the State of Florida. These networks are available for use by transit agencies, MPOs, and consultants to serve as a starting point for TBEST model development.

The transit network contains individual routes or route patterns coded by direction. When creating a route, the user specifies the route name, directional descriptions, route type, technology, and service span. Once created, the route segments, stops, and their attributes are defined through the TBEST network coding interface. Individual routes are the same as route patterns within the TBEST model. If a particular route deviates during the day, each deviation/pattern must be coded as an individual TBEST route. **Table 2.3.4** summarizes the TBEST route characteristics and the domain of possible values for each variable.

Table 2.3.4: User-Specified Route Parameters

Component	Description	Dialog/Form
Route Type	***Choose between:*** Radial (Routes Begin/End at Central Station) Circulator (Local Service, *ie.* Loop, One-Way) Crosstown (Continuous Service through Central Area) Express (Service with Limited Stops)	Route Properties
Technology	***Choose between:*** Bus Heavy Rail (i*e.* South Florida Tri-Rail, Miami Metrorail,) People Mover (*ie.* Jacksonville Skyway, Miami Metromover) Streetcar (*ie.* Tampa TECO line) BRT (Bus Rapid Transit) (*ie.* South Miami-Dade Busway) Light Rail (*ie.* Portland MAX, Dallas DART) Other	
Route Name	Transit System and Route Specific (*ie.* Route 28, Route AX, etc.)	
Route Description	Transit System and Route Specific (*ie.* Downtown Plaza to Mall)	
Direction Description 1	Transit System and Route Specific (*ie.* inbound, northbound, etc.)	
Direction Description 2	Transit System and Route Specific (*ie.* outbound, southbound, etc.)	
Service Span	Route Span of Service for each TBEST Time Period	Service Span Dialog

The linear path of each route direction is managed by segment. Generally, the extent of segments corresponds with time point locations, but segments can also be coded to closely match highway

corridors and adopt the speed of those corridors. Each segment is coded with the in-vehicle travel time (IVTT) for each TBEST time period and the optional identifiers for the individual segment or corridor. If input by the user, the Corridor ID allows predicted ridership to be summarized per unique Corridor ID in the TBEST reporting module. **Table 2.3.5** summarizes the user-specific segment parameters.

Table 2.3.5: User-Specified Segment Parameters

Component	Description	Dialog/Form
Length	Length of segment in miles as drawn in TBEST	Segments Tab
SegmentID	User specified label (ie. 1, 2, 3, AB, BC, etc.)	
CorridorID	User specified corridor level label	
AM IVTT	Time taken to traverse segment in minutes during the Weekday AM Peak Period	
Off-Peak IVTT	Time taken to traverse segment in minutes during the Weekday Off Peak Period	
PM IVTT	Time taken to traverse segment in minutes during the Weekday PM Peak Period	
Night IVTT	Time taken to traverse segment in minutes during the Weekday Night Peak Period	
Saturday IVTT	Time taken to traverse segment in minutes during the Saturday Service Span	
Sunday IVTT	Time taken to traverse segment in minutes during the Sunday Service Span	

As stated above, TBEST uses schedule-based travel times as model input. Since TBEST was designed for transit ridership estimation over short-term periods (0-10 years), the model intrinsically assumes minimal changes to highway operating speeds.

Unlike the highway and transit networks in the FSUTMS structure, TBEST does not calculate the congested speed for the highway network and utilize these speeds for ridership estimation on the transit network. For TBEST base year development, the IVTT for each route segment originates from the transit operating schedule. For future year scenarios, the IVTT is based solely on user input. Factors that can influence future-year modifications to IVTT could be: 1) changes to operating times within a proposed bus schedule; 2) expected improvements in travel-times based on operational or technology changes; or 3) expected changes based on roadway improvements. For the third option, if users have congested link speeds extracted from a highway model, TBEST provides the ability to enter segment speed and automatically calculate the proposed IVTT for a segment.

For each route, characteristics must also be defined for each individual stop on the line. **Table 2.3.6** provides a description of the inputs required for each transit stop in the network.

Table 2.3.6: User-Specified Stop Characteristics

Component	Description	Dialog/Form
Stop	Stop ID number (ie. 1, 2, 3, etc.)	Stops Tab
Description	Description of stop (ie. Downtown Plaza, 15th Ave. & E St.)	
Time Point	If the stop has a time point on the transit system, route schedule, or timetable, this is the name of the time point	
Arrivals	Number of arrivals at stop in defined time period (calculated automatically if headway input first)	
In-Vehicle Travel Time (IVTT)	Travel time to next stop location in defined time period and route direction	
Headway	Headway in minutes in defined time period (calculated automatically if # of arrivals input first)	
Special Generator	Special generators at stop 1 = university/college 2 = military 3 = shopping mall 4 = event center 5 = park-n-ride lot (# of spaces also may be input) 6 = airport 7 = recreational park	

Stop inventories and route networks that have been coded in ArcGIS, Cube Voyager, or derived from Global Positioning System (GPS) devices are not directly compatible with TBEST. The TBEST model requires that each stop is associated with a segment and that the segment is associated with a transit route. To create this network topology, it is necessary to either code the network using the TBEST network coding environment or develop tools to import a network from existing spatial and/or non spatial data sources. There are currently two transit agencies that have adopted the latter approach. These agencies are able to generate their entire network using output from transit operational software such as Trapeze. In addition, the possibility exists to enable these import tools to be compatible with the Google Transit specification.

Network characteristics regarding fares, inflation rates for growth to the target base year calculation, and inter-route relationships of the transit system are available user input. These system-wide parameters are summarized in **Table 2.3.7**.

Table 2.3.7: User-Specified System-Wide Alternative Parameters

Component	Description	Unit	Dialog/Form
Fare for First Wait Time	First boarding cash fare	$	Network Properties
Transfer Fare	Transfer boarding cash fare	$	
Inflation Rate	Inflation rate between ***Population Source Year*** and ***Target Base Year*** (applied to base fares)	%	
Transfer Stations	Whether stop provides transfer opportunities (timed or untimed transfers)	N/A	
Interlined Routes	Whether one or more routes are interlined (run parallel/concurrently) for portions of route	N/A	

2.3.2 Model Output

The TBEST model structure provides significant flexibility for transit service planning and land use analysis. TBEST tools provide the ability to report ridership at the route-level with performance measures, as well as the segment-level and stop- (point) level. Generating ridership estimations at the stop-level is important for analysis because the TBEST ridership estimations can be aggregated to any level of geography including the corridor-level, site-level, and even regional-level distributions. The TBEST software enables this aggregation and analysis capability by providing tools to modify all of the TBEST variables. This section will discuss the types of data modifications that are possible in TBEST and the tools for viewing the model results.

2.3.2.1 Service Changes

Service planning often needs to assess the patronage impacts for a variety of service changes. These service changes can be assessed in the model structure in several different ways. Users can make modifications to service variables at the network-level (fare structure, transfer stations, interlined routes), route-level (service span), segment-level (IVTT), and stop-level (headway/ arrivals). In addition, the transit route structure can be altered by adding or deleting routes; modifying existing segments; adding additional segments; or adding, deleting and/or moving stops. **Table 2.3.8** summarizes these service change impacts.

Table 2.3.8: Service Change Impact Summary

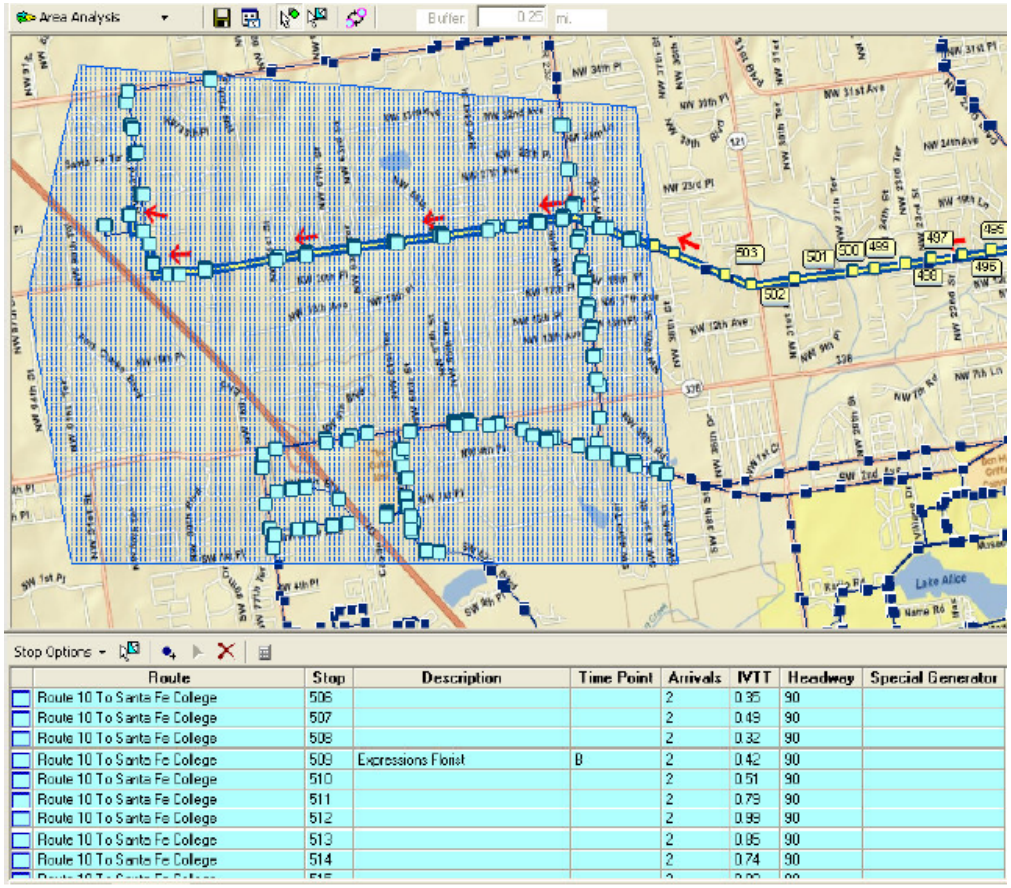
Category	Changes	Realization
Operating Strategies	Headway Adjustment	First wait and transfer wait between un-coordinated routes in impedance through accessibility; number of runs at subject stop and neighboring stops on other routes or direction
	Short Turning	Number of runs; accessible stops through accessibility
	Route Splitting	Reliability; number of transfers and transfer fare in impedance through accessibility
	Through Routing	Number of transfers and transfer fare in impedance through accessibility; forecast transfer volume
Schedule Changes	Running Time Adjustments	In-vehicle time in impedance through accessibility
	Schedule Coordination between Routes	Transfer wait in impedance through accessibility; forecast transfer volume
	Span of Service Adjustments	Number of runs during open-end period; accessible stops though accessibility
Alignment Changes	Extend Routes	Opportunities and accessible stops through accessibility
	Shorten Routes	Opportunities and accessible stops through accessibility
	New Routes	Opportunities and accessible stops through accessibility
System Changes	Service Redistribution	Impedance, opportunities, and accessible stops through accessibility
	Network Structure	Impedance, opportunities, and accessible stops through accessibility
Fare Policy	First-Boarding Fare	Impedance through accessibility
	Transfer Fare	Impedance through accessibility

2.3.2.2 Land Use Analysis

TBEST provides a built-in set of spatial tools to assist the user in editing and summarizing system variables across user-defined areas, corridors, and sites. With these spatial tools, modifications to socioeconomic variables and/or service variables can be performed and analyzed. In addition, the area, corridor, or site analysis geography can be saved within TBEST and utilized across additional scenarios, which allows the user to test variations in the original set of scenario modifications.

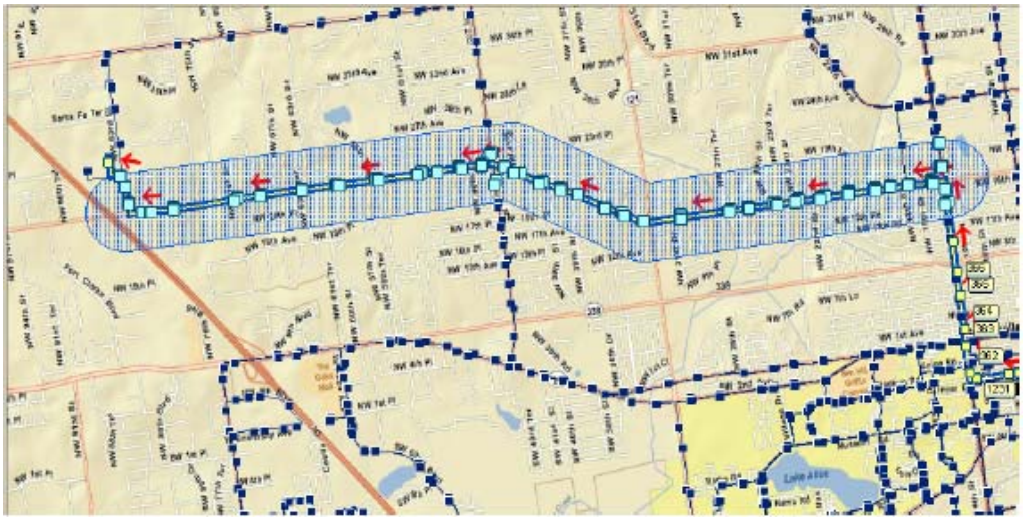
Area analysis in TBEST can be conducted by drawing a polygon that defines the boundary of the area to be analyzed. TBEST will then select all stops that are located within the limits of this user-defined boundary. An illustration of a user-created area analysis is shown in **Figure 2.3.2.**

Figure 2.3.2: User-Specified Area Analysis



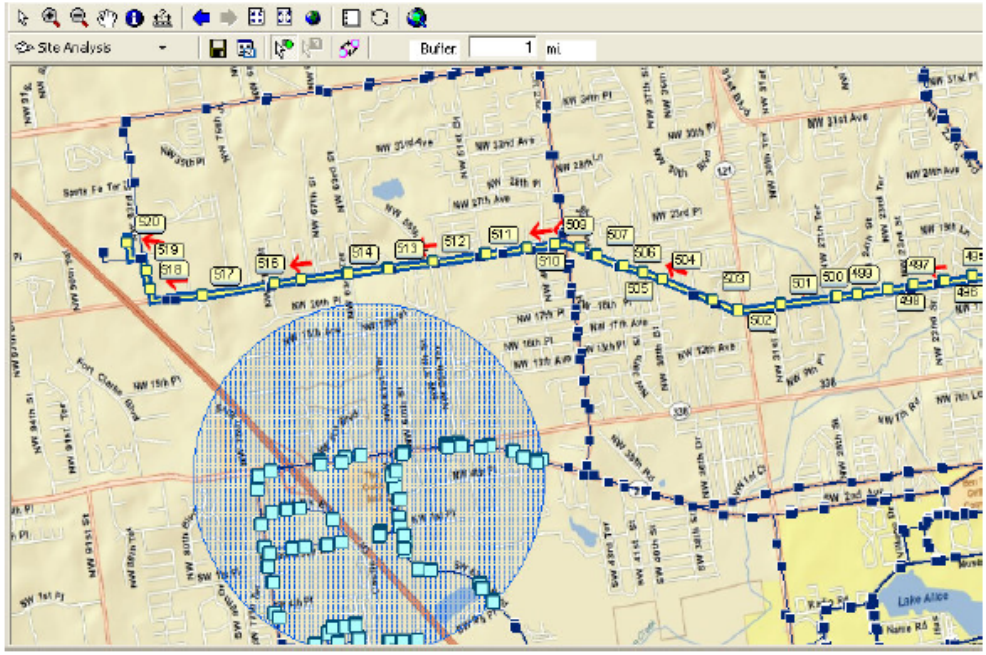
The corridor analysis tool allows the user to select a buffer of a certain distance along a line of multiple points. TBEST will select stops that fall within the buffered corridor. An example of a user-drawn corridor analysis is shown in **Figure 2.3.3** below.

Figure 2.3.3: User-Specified Corridor Analysis



For site analysis, the user may specify a certain radial buffer distance from a specific point on the base map. A depiction of a user-created site analysis buffer and stops is shown in **Figure 2.3.4** below.

Figure 2.3.4: User-Specified Site Analysis

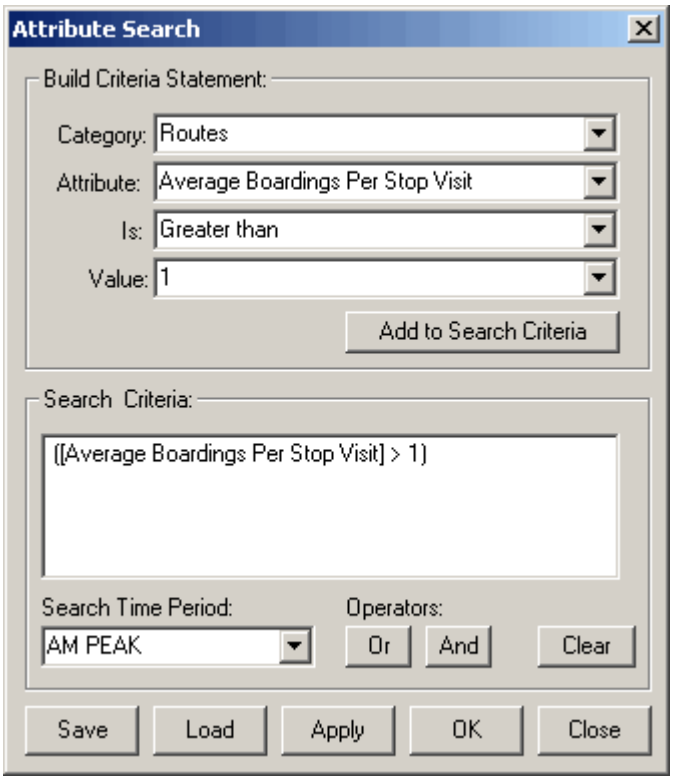


These analysis programs are valuable tools that facilitate the evaluation of ridership impacts in specific areas as a result of transit improvements. A detailed explanation of the three types of analysis functions and processes is included in the *TBEST 3.2 User's Manual* for additional reference.

2.3.2.3 Query Analysis

The TBEST data architecture allows for the ability to interactively query all of the TBEST variables and output. This ability can assist in identifying trends in the data, correlation between variables, and provide a means for reporting these trends and correlations across scenarios. With the TBEST Attribute Search tool, the user can search the attributes of routes, segments, and stops through logical expressions. For example, using the Attribute Search tool, the user can identify trends in the data including low performing routes based on user specified performance metrics. Additionally, the search criteria can be saved within the TBEST environment to generate reports within other scenarios. The ridership and/or performance measures associated with a search can easily be generated in the TBEST Report Builder and then compared across scenarios. A depiction of the Attribute Search tool is provided in **Figure 2.3.5**.

Figure 2.3.5: TBEST Attribute Search Tool



3.3.2.4 Reporting Model Output

Reports are generated in TBEST by the Report Builder. The Report Builder will create stop-, segment-, and route-level reports for all features or selected features. In addition, the Report Builder allows for a Regional Analysis report that will spatially summarize ridership or service based on a user supplied polygon shapefile, such as TAZ zones. The route-level reports offer individual route performance measures that depict the overall performance of routes in the system. For interactive reporting, the Report Builder works together with the Corridor Analysis, Area Analysis, Site Analysis, and Search functions to summarize data for the selected features. The TBEST Report Builder can generate reports based on a selected TBEST time period, as well as aggregated weekday or weekend reports. As TBEST reports are generated, they are saved in .csv format. **Table 2.3.9** provides a summary of output choices that can be selected by the user for reporting.

Table 2.3.9: TBEST Reporting Output Choices

Level	Heading in Report Builder
Stops	Summarize by:
Routes	
Segments	
Regional Analysis	
AM Peak	Time Period:
Off-Peak	
PM Peak	
Night	
Weekday (aggregation of the previous 4 time periods)	
Saturday	
Sunday	
Weekend (aggregation of the previous 2 time periods)	
No Grouping	Routes to Summarize: Group by:
Route Name	
Route Direction	
Route Type	
Route Technology	
Route Validation Collections*	
***Route Validation covered in next section.**	

The user can select the level, time period(s), and grouping desired in a report for service measures or simplified ridership forecasts using stop-level estimation capabilities. If *Performance Measures* is selected when generating output, the service measures listed in **Table 2.3.10** will be calculated and generated by TBEST.

Table 2.3.10: Service Performance Measures Generated for Route-Level Reporting

Measure	Description
Transfer Opportunities	# of transfer boardings TBEST predicts are possible
Direct Boardings	# of initial boardings (non-transfer)
Transfer Boardings	actual # of transfer boardings TBEST forecasts
Total Boardings	sum of transfer and direct boardings forecast
Revenue Service Trips	# of trips made by vehicle during specified time period
Route Miles	# of miles in a single service trip
Revenue Service Miles	# of miles covered in all service trips
Revenue Service Hours	# of hours of travel time elapsed in service time period
Boardings per Service Mile	# of total boardings / revenue service miles
Boardings per Service Hour	# of total boardings / revenue service hours
Boardings per Service Trip	# of total boardings / revenue service trips
Average Boardings per Stop Visit	# of total boardings / # of stops on route

In addition to specified tables and sub-area analysis reports, TBEST is able to provide a Loaded Network output which associates socioeconomic data, ridership model forecasts, route names, and travel time among other features with individual stops and segments by time period. This Loaded Network can be exported for further analysis as a geodatabase compatible with ArcMap and Microsoft Access. This output may be viewed spatially or analyzed analytically to determine transit improvement impacts.

2.4 Model Estimation and Validation

The TBEST model was designed for ease of use and provides flexibility to the user for either estimating model equations to the local context or using a set of software tools to validate a local model using the default model equations. This section will discuss the origin of the TBEST model equations and the software processes for validating the model to the local context.

2.4.1 Model Estimation

The current TBEST direct boardings and transfer boardings models were estimated with data from Tri-Met in Portland, Oregon. Tri-Met installed APCs on approximately 75% of its bus fleet. Along with the APCs, Tri-Met also had on-board Automatic Vehicle Location (AVL) systems on their vehicles, making it a reliable source of stop-level boarding data properly indexed to the route, direction, and the geographical location of the stop. Tri-Met services cover around 575 square miles of the urban portion of the tri-county area (Clackamas County, Multnomah County, and Washington County) in Portland, Oregon with a total population of 1.3 million in year 2000.

The models were estimated as negative binomial regression models to recognize that the dependent variable represents the number of boardings at each stop. In addition, the mean and the variance of the dependent variable are significantly different from one another, thus violating the assumption of the Poisson regression model. In the negative binomial regression model, the expected number of boardings at each stop is estimated using the equation in **Figure 2.4.1**.

Figure 2.4.1: Equation for Number of Boardings at Each Stop

Number of Boardings at Each Stop (Direct and Transfer) =

$$\exp(a0 + b1X1 + b2X2 + b3X3 + \ldots + bkXk)$$

a0 = constant term

bk = model coefficient associated with kth explanatory variable/factor/attribute

Xk = kth explanatory variable/factor/attribute value

By taking the exponential of the linear combination of the variables, it is ensured that the model will always yield positive predictions of boardings at each stop.

Tables 2.4.1 and **2.4.2** summarize the variables and coefficients used for estimating direct and transfer boardings for each time period.

Table 2.4.1: Model Coefficients for Direct Boardings

Variable	AM Peak	Off-Peak	PM Peak	Night	Saturday	Sunday
Constant						
One	-2.16933	-1.35045	-0.49661	-3.91886	-9.10036	-9.52480
Route Types						
RADIAL	0.25930	0.04298				
CROSSTOWN			0.14375			
EXPRESS	0.81960					
Accessibility						
O2 Population						0.00022
O6 Population	0.00005	-0.00019	0.00011		-0.00060	
O2 Employment					0.00004	
O3 Employment	-0.00005					
O6 Employment		0.00009				-0.00037
O3+O4-O6 Employment		-0.00003		-0.00014	-0.00006	-0.00011
Log O2 Population	0.26377	0.24925	0.10479	0.05671		
Service						
Service Span				0.41124	0.60000	0.60000
Log of Service Span					0.60000	0.60000
Population						
Total Population		0.00248				
Black Population	0.00505	0.00401	0.00811	0.00634	0.00479	0.00000
Multi-Family DU			0.00165	0.00040	0.00180	
One Vehicle HH						0.00164
Zero Vehicle HH				0.00536		
Hispanic		0.00402	0.00290	0.00340	0.00180	0.00136
Poverty Level	0.00404					0.00286
Worker	0.00505					
Employment						
Commercial	0.00346	0.00998	0.01154		0.00810	0.00790
Share Service	0.00563	0.00555		0.00569	0.00396	0.00431
Special Generators						
PARK-N-RIDE Spaces	0.00565					
UNIVERSITY				0.73422	0.57605	0.50249

Table 2.4.2: Model Coefficients for Transfer Boardings

Variable	AM Peak	Off-Peak	PM Peak	Night	Saturday	Sunday
Constant						
One	-0.03364	1.06406	0.35655	-0.05096	-0.08727	2.24843
Route Types						
CIRCULATOR			0.56243		0.34813	
CROSSTOWN	0.32769		0.49052	0.52406		0.28869
Accessibility						
O1 Population					0.00040	
O2 Population			0.35655	0.00079		
O6 Population	0.00065	.00125	0.00096	-0.00255		0.00228
O2 Employment						0.00006
O6 Employment	-0.00015	-0.00044	-0.00032	-0.00031	-0.00012	-0.00067
(O3+O4)-O6 Employment				-0.00001	-0.00001	
Log of O1 Boardings	0.08007		0.10066	0.34768		0.00592
Log of O2 Population	0.04584	0.02153	0.02773	0.10007	0.37003	
Service						
Inbound Transfers	0.00488	0.00813	0.01048	0.03633		
Special Generators						
Mall	0.67408	0.71766	0.67045		0.80926	0.88864
College/University		1.21282	1.49320		0.49605	

2.4.2 Model Validation

To allow for transferability of the model across transit properties and service areas without re-estimation, the TBEST software provides an automated validation process which compares TBEST ridership estimates, which are based on the Tri-Met model equations, with observed ridership data to determine validation adjustment factors for an input set of stops, routes or collection of routes. The adjustment factors are then applied in future year scenarios to reflect the local context of the system. The TBEST validation process occurs after the local base year network and socioeconomic data are prepared and initial model runs are evaluated for accurate representation of existing conditions. The validation procedure used in the TBEST model includes four major steps:

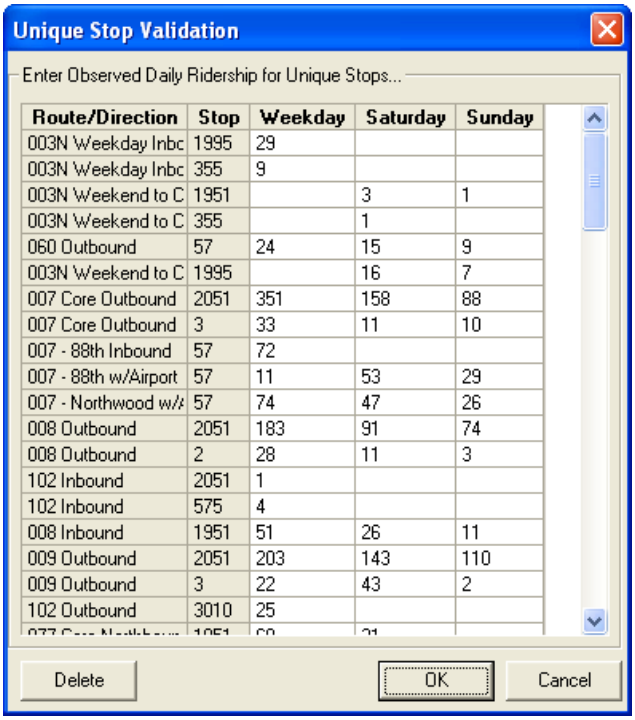
1. Development of Stop-Level Observed Ridership (this step is optional);
2. Definition of Route Collections;
3. Development of Collection-Level Observed Ridership; and
4. Running the Model-Validation Process.

2.4.2.1 Stop-Level Observed Ridership

The development of stop-level observed ridership is an optional feature that allows the user to input known ridership data for specific stops. This method is intended for locations with known ridership data that include stops with unique ridership generating characteristics that may not be

accurately forecasted by TBEST. Stop-level observed ridership can be used for any stops in the network, with a maximum of 100 stops. These stops are not necessarily special generators, but exhibit ridership that cannot be explained by population, employment, or service characteristics. **Figure 2.4.2** depicts the window used for entering stop-level observed daily ridership values.

Figure 2.4.2: Stop-Level Validation Observed Ridership Input



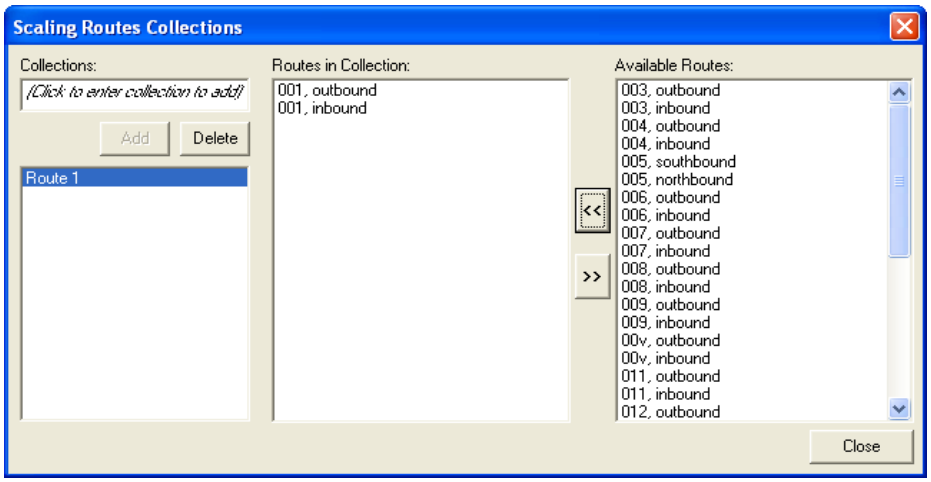
Route/Direction	Stop	Weekday	Saturday	Sunday
003N Weekday Inbc	1995	29		
003N Weekday Inbc	355	9		
003N Weekend to C	1951		3	1
003N Weekend to C	355		1	
060 Outbound	57	24	15	9
003N Weekend to C	1995		16	7
007 Core Outbound	2051	351	158	88
007 Core Outbound	3	33	11	10
007 - 88th Inbound	57	72		
007 - 88th w/Airport	57	11	53	29
007 - Northwood w/	57	74	47	26
008 Outbound	2051	183	91	74
008 Outbound	2	28	11	3
102 Inbound	2051	1		
102 Inbound	575	4		
008 Inbound	1951	51	26	11
009 Outbound	2051	203	143	110
009 Outbound	3	22	43	2
102 Outbound	3010	25		

2.4.2.2 Definition of Route Collections

The TBEST model is designed to accept observed ridership information at the level maintained by a particular agency. TBEST enables this type of validation by grouping routes (by individual direction) into "collections". In practice, this will generally involve grouping the directional lines of a route together to match a single ridership number observed for the entire route. Another typical application of route collections is to group multiple route patterns (belonging to single route) into a single collection to match a single observed route ridership number.

Another less likely scenario is the matching of all routes to a single observed ridership number. For example, if a smaller agency only recorded ridership information at the system-level on a daily basis, the TBEST model can employ a route collection to group all routes in the system in order to match a single observed ridership number. The caveat to this approach is that route collections must contain routes that are the same TBEST route type and technology. If there are multiple route types, those routes must be examined together within another collection. **Figure 2.4.3** provides an illustration of the window used in the collection of routes.

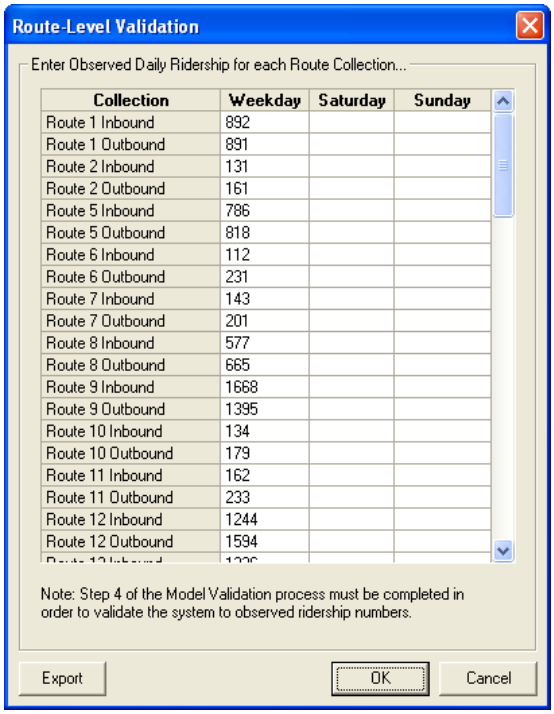
Figure 2.4.3: Route Collection Application



2.4.2.3 Development of Collection-Level Observed Ridership

The ridership counts described in *Section 2.3.1.2* are entered into the system during this step. With the route collections defined, the user simply enters observed ridership at the collection level. Observed daily ridership is entered for a typical weekday, Saturday, and Sunday. **Figure 2.4.4** depicts the application used to enter the ridership counts into the TBEST model.

Figure 2.4.4: Ridership Count Input for Validation



Collection	Weekday	Saturday	Sunday
Route 1 Inbound	892		
Route 1 Outbound	891		
Route 2 Inbound	131		
Route 2 Outbound	161		
Route 5 Inbound	786		
Route 5 Outbound	818		
Route 6 Inbound	112		
Route 6 Outbound	231		
Route 7 Inbound	143		
Route 7 Outbound	201		
Route 8 Inbound	577		
Route 8 Outbound	665		
Route 9 Inbound	1668		
Route 9 Outbound	1395		
Route 10 Inbound	134		
Route 10 Outbound	179		
Route 11 Inbound	162		
Route 11 Outbound	233		
Route 12 Inbound	1244		
Route 12 Outbound	1594		

3.4.2.4 Running the Model-Validation Process

The model validation process initiates a procedure to calculate adjustment factors based on the defined route collections. The process compares the observed ridership entered for the route

collections and the total TBEST predicted ridership for the route collections. The model validation process completes the following steps: 1) creates and stores the route collection adjustment factors; 2) updates the source socioeconomic data using factors in the network to reflect base year conditions; and 3) stores the current scenario as the base year. **Figure 2.4.4** provides an illustration of validation factors for route collections by route.

Once these steps are completed, the collection-level validation factors can be viewed. These values can be evaluated to develop an understanding of how the TBEST model is performing. TBEST provides the option to reject the validation if it needs to be performed again.

Figure 2.4.5: Validation Factors for Route Collections

Route Collection Validation Factors

Collection	Weekday Factor	Saturday Factor	Sunday Factor
Route 1	2.37	7.6	1
Route 2	3.8	12.25	1
Route 3	1.29	2.82	1
Route 4	2.61	7.67	1
Route 5	0.7	1	1
Route 6	1.77	1	1
Route 7	1.14	1	1
Route 8	1.3	4.05	1
Route 9	1.21	1	1
Route 10	0.42	1	1
Route 11	0.09	1	1

Export OK

For future year application of the adjustment factors, routes that are contained in a collection receive the adjustment calculated for the collection. For service enhancements (for example adding a new route), the adjustment factor must either by adopted from an existing similar route or be assigned from outside of the collection if an existing similar route does not exist. **Table 2.4.3** details the application of adjustment factors for service expansion.

Table 2.4.3: Route Adjustment Source for Service Expansion

Case		Route Adjustment Factors Source
Existing route service expansion	Additional Weekday Service	Weekday RAF_r
	Inaugural Weekday Service	Saturday RAF_r or Sunday RAF_r
	Additional Saturday Service	Saturday RAF_r
	Inaugural Saturday Service	Weekday RAF_r or Sunday RAF_r
	Additional Sunday Service	Sunday RAF_r
	Inaugural Sunday Service	Saturday RAF_r or Weekday RAF_r
New route, existing technology and service type	Inaugural Weekday Service	Mean (technology, service type) RAF^t
	Inaugural Saturday Service	
	Inaugural Sunday Service	
New route, existing service type, new technology	Inaugural Weekday Service	Mean (all technologies, existing service type) RAF^t
	Inaugural Saturday Service	
	Inaugural Sunday Service	
New route, existing technology, new service type	Inaugural Weekday Service	Mean (existing technology, all service types) RAF^t
	Inaugural Saturday Service	
	Inaugural Sunday Service	

2.5 Summary

TBEST is a direct-demand, micro-level model designed for short timeframe transit planning. The model contains large amounts of data for each zone that is helpful in determining small-scale forecasts, allowing TBEST to address issues that cannot be measured using a traditional regional planning model. The TBEST model was not designed for FTA-type forecasting, but rather for the purposes of estimating ridership for comparison of transit enhancements and alternatives for TDP planning through the direct calculation of transit ridership, taking sensitivity to walk access, zone sizes, and zonal characteristics into account.

Travel time in the TBEST model is based on transit schedules rather than highway travel time. The model does not generate or rely on trip tables and since only one mode exists, there is not a mode choice procedure in the model. Because it does not include a highway network, the variation in highway speed and thus travel time savings cannot be measured using TBEST. In this sense, TBEST is not ideal for New Starts or Small Starts evaluation, but the application of TBEST as an initial feasibility study tool or supplementary measure of aggregate ridership improvements for Small Starts and Very Small Starts projects is highly feasible. TBEST can analyze these smaller-scale transit improvements with calibrated transit coefficients to provide valuable information. This possibility will be investigated further in *Section 5.0*.

TBEST boarding data includes either direct boardings or transfer boardings. The access to the transit stop is not distinct by mode. In order for further analysis of transit behavior, the determination of access mode may need to be incorporated into the TBEST model structure. This prospect will be analyzed with regard to FTA standards in *Section 5.0*, as well.

Another major factor to consider when thinking in terms of Starts program forecasting, is the ability to compare alternatives and baselines. There is no integrated output designed for comparison techniques for analysis in TBEST currently. Each run is a stand-alone function of the model. Methods of creating a template or an application to generate comparison tables by alternative may also prove to be a valuable component for TBEST application in FTA Small Starts or Very Small Starts projects forecasting. This issue will be further addressed in *Section 5.0*.

The TBEST model has existing transit network structures developed for each county in Florida. It provides a ready-made and easy to use platform for the evaluation of local transit improvements. TBEST does not require licensing, as it is distributed through the FDOT. The model presents many opportunities for application in Starts programs, as it has the capabilities to tell-the-story for local and express bus improvement projects, bus-only lane projects, bus-speed improvement projects, and other BRT projects within a region. The potential for TBEST to be enhanced for inclusion in the FTA Starts process will be discussed in *Section 5.0*.

SECTION 3: Review of the FSUTMS Model for New Starts and Small Starts Applications

3.1 FSUTMS in New Starts and Small Starts

The Florida Department of Transportation (FDOT) Systems Planning Office developed the Florida Standard Urban Transportation Model Structure (FSUTMS) to provide planning agencies within the State of Florida with a travel forecasting tool that primarily supports the formulation of Long-Range Transportation Plans. Given the effort by FDOT, individual Metropolitan Planning Organizations (MPOs) and other government and transit agencies in the development of FSUTMS models, this section will evaluate the capabilities of FSUTMS models for travel forecasting support of Federal Transit Administration (FTA) New Starts and Small Starts projects within the State of Florida.

FSUTMS model methodologies, data requirements, inputs, outputs, and overall performance as they relate to FTA Starts forecasting will be evaluated in this section. Enhancing the functions of FSUTMS to further support FTA Starts forecasting will also be investigated. Any recommendations for additional model enhancements to aid in the development of FTA Starts program forecasts will be discussed in detail in *Section 5.0*.

This section addresses good modeling practices for agencies throughout the State of Florida. It will serve as a guide for future forecasting practices and provide additional recommendations for supplementary data.

3.2 Overview of FSUTMS Models

The standardization of the Florida model structure over the past two decades yielded a consistent framework for structural model development, but due to diverse State and regional issues, models throughout Florida have varying input and output components, as well as parameters and configurations. Each model in the State of Florida has its own unique qualities.

As discussed in *Section 1.0*, FSUTMS was updated to a Cube Voyager interface. The model continues to use a four-step modeling practice. Rather, it uses the following model steps to create travel forecasts: GENERATION, NETWORK, DISTRIBUTION, TRANSIT, MODE SPLIT, and ASSIGNMENT. Each step is summarized in **Table 3.2.1** below.

Table 3.2.1: Summary of FSUTMS Modules

Module	Description
GENERATION	Socioeconomic data is used to generate trip productions and attractions
NETWORK	A full highway network, ready for editing and updating using Cube, is coded using a myriad of variables. This module also allows for highway pathbuilding.
DISTRIBUTION	The Gravity Model is used to distribute trips
TRANSIT	The transit network is prepared, transit access connectors are generated, and transit paths and skims are built. Tier A models (models with no premium transit) build two sets of paths, while Tier B/C models (models with premium transit modes) build four different sets of paths.
MODE SPLIT	The Nested Logit Model is used to split trips by mode.
ASSIGNMENT	The equilibrium highway assignment technique is used to assign highway trips and an all-or-nothing assignment is used for transit trips.

In 2008, a standard transit model was developed and adopted by the FDOT for application in FSUTMS models entitled the FSUTMS Voyager Transit Model (FVTM). The discussion of the TRANSIT, MODE SPLIT, and ASSIGNMENT steps in this document are based on this standardized transit framework. Both downloads for the FVTM and directions for its application can be located at www.fsutmsonline.net.

In this section, data requirements for standard Florida models, as well as input and parameters for each model step, will be discussed as they pertain to FTA Starts project forecasting. An emphasis will be placed on modeling procedures that have a significant impact on forecast results for FTA Starts projects. Observed data items; trip generation data; highway network coding and development; trip distribution data; transit network coding and development; mode choice processes; highway and transit assignment processes; and reporting methods will each be examined. An evaluation of model performance will then be provided based on an evaluation of FTA Starts project modeling requirements.

3.3 Data Requirements

Actual observed data is required to test the reasonableness of model estimates and forecasts. Several data sources, surveys, and counts are conducted regarding socioeconomic, highway, and transit characteristics to obtain data that can be used to validate and test the model.

3.3.1 Travel Characteristics Data

There are various sources for travel characteristic data used in the FSUTMS model structure. The required socioeconomic and travel characteristic data may be either existing data that is acquired from other sources or data gathered from data collection efforts.

3.3.1.1 Existing Data

Socioeconomic data used in models is obtained from MPOs and local governments. These agencies use County Property Appraiser data to count dwelling units and apply factors to dwelling unit data

to estimate populations. Outer year forecast populations are typically checked using medium-range population information from the Florida University Bureau of Economic and Business Research (BEBR).

County Property Appraiser data is also used to obtain square-foot calculations for businesses to determine employment by type. Employment data sources used by local government agencies also include InfoUSA, Woods & Poole, and ES2 State data. Data for school enrollment is typically collected from the County School Board, supplemented with any available sources with information regarding private school enrollment.

Socioeconomic data can be checked against other national sources like the National Household Travel Survey (NHTS) for quality purposes. Relationships across variables can also be checked between base and future years to ensure that the applied growth rates provide reasonable forecasts. Historically estimated growth rates or other case-specific local growth rates are typically applied to socioeconomic data to develop future year socioeconomic forecasts.

Socioeconomic data estimations for New Starts forecasting must be thoroughly reviewed prior to application in model. Analytical reports, maps and graphics may be derived to observe the percent changes in population, dwelling units, employment, and other socioeconomic characteristics within the study area. These changes must be examined to identify outliers and to check for consistency in the magnitude of growth in specific locations. The key factor in socioeconomic data forecasting is thorough reasonability assessment using knowledge of the area, understanding of the market drivers, and relative comparison of the generated values. The 2000 Census Transportation Planning Package (CTPP) is another source for socioeconomic data that can be used to supplement and validate data obtained by the MPO or local government. Information provided by the CTPP data includes residence and employment information. CTPP information also provides journey-to-work flow data that is valuable for validating home-based work trip ends, lengths, and patterns.

The 2010 Census will not include the long form survey. There are currently studies in progress to determine the best possible source of CTPP data will be for future modeling purposes. The Census Bureau's American Community Survey and NHTS may potentially be used depending on sample size.

Parking cost data can be obtained from local government agencies that operate various parking garages and street meters. Parking costs in downtown areas, in employment areas, and in other activity centers in the model must be obtained. This information is then used to create parking cost averages by traffic analysis zone (TAZ) for use in the development of mode splits.

Transit fare data is also required for application in the model to aid in illustrating actual transit ridership. Transit fares are applied by transit mode, and transfer fares are also required between individual modes. Transit fares must be obtained for the base year from the local operating transit agency by mode. As with parking costs, an elasticity analysis may also be completed to check for any significant impacts that changes in transit fare may cause on mode splits.

3.3.1.2 Data Collection

Travel characteristics surveys are conducted to provide a realistic assessment of actual and potential travel patterns. Various different types of travel characteristics surveys can be implemented to obtain a wide range of data including origin and destination locations to establish an understanding of regional travel patterns. Other helpful information, like trip purpose and trip length distribution, can be determined through these surveys, as potential model validation data sources.

Paramount to any survey effort is the ability to foster coordination and communication among the participating agencies, MPOs, FDOT, regional and stakeholder agencies, and the FTA. This coordination begins with survey design and understanding of local and federal needs and requirements. Listed below are typical travel characteristic surveys and the type of data collected. Information on highway counts, highway speed, transit ridership, and transit speed surveys is detailed in the following two subsections.

- *Household Surveys* – These surveys are distributed to obtain information regarding routine household trips. These surveys can be conducted on a large-scale, like the NHTS mentioned above, or they can be conducted on a smaller regional scale to focus on local travel patterns. Household travel surveys require respondents to answer specific questions regarding local travel. Information requested for each trip includes travel mode, trip distance, trip duration, and trip purpose. It is also common to obtain demographic, geographic, and economic data, as well as travel characteristics in these surveys.
- *Seasonal Resident Surveys* – Seasonal residents are an important part of Florida's population and are identified as people that live in Florida more than 30 days a year but less than 6 months a year. Seasonal Residents Surveys are similar to Household Surveys though sometimes it is necessary to identify where seasonal residents reside.
- *Cordon Line Surveys* – Cordon Line Surveys may also be known as Origin-Destination or License Plate Surveys and can be conducted on a regional level. Surveys are sent to households of car owners recorded as crossing the cordon line to request information regarding the trip taken on the selected corridor. Using this method, trip origin-destination information can be recorded, as well as trip length, mode, and purpose.
- *Hotel/Motel Surveys* – There are two parts to hotel/motel surveys. First is to survey hotel and motel owners throughout the region to obtain information regarding the types of hotels within the area. Typical data acquired through these surveys includes the number of rooms; hotel amenities; the capacity of ballrooms or conference rooms; trip purpose for both weekend and weekday visitors; typical length of stay of visitors; and the average hotel occupancy. The second part is to survey hotel/motel guests to analyze their trips including: trip purpose, trip length, trip frequency, mode of transportation, arrival from and departure to, airport connection, and number in their party.

There are additional types of surveys that may be implemented to obtain specific data for the model. More information regarding travel surveys and good practices with regard to travel demand modeling purposes can be located at the Transportation Research Board (TRB) website: http://www.trb.org/Main/Home.aspx.

3.3.2 Highway Count and Speed

Highway traffic counts are obtained using two sources. Florida State traffic count stations collect data at various locations within each county. Also, local traffic counts are collected to obtain local traffic data.

Highway speed data is acquired through the implementation of travel speed surveys. This data is not used as a direct input, but rather as an illustration of ground conditions with which model data can be compared. In most instances, survey vehicles are dispatched to collect data either manually (with surveyors recording traffic times by hand) or electronically (using a GPS device that will record times programmed to automatically collect travel time and distance data).

Speed surveys are conducted on selected corridors, typically project specific, or on selected area type and facility type combinations to ensure that an appropriate sample size of roadways is surveyed. Average speeds on each facility are calculated by dividing the distance of corridor segments by the time it takes to travel the segment while maintaining speed with the flow of surrounding traffic. As speed surveys are conducted to obtain an accurate depiction of current observed travel speeds, the data obtained during these survey efforts is valuable information for model validation.

3.3.3 Transit Ridership and Speed

Transit ridership can be obtained from ridership information collected by local transit agencies. Transit surveys are also a valuable resource to obtain observed ridership counts. Transit surveys are conducted to obtain origin-destination information, trip purpose information, trip length, trip frequency, trip duration, and socioeconomic information.

The results of transit surveys are critical for the validation of transit ridership in the model. Transit surveys must provide a sound illustration of transit usage by origin, destination, and purpose to establish the existing travel market in a region. Since transit calibration is an integral component for developing reasonable transit ridership in the model, great emphasis is placed on obtaining accurate ridership information through the implementation of surveys.

The initial step in designing an effective transit survey is to identify relevant travel markets by observing local travel patterns. A survey technique (for example: on-board survey, mail-in survey, or personal interview survey) and questionnaire must then be developed that will capture the origins, destinations, and traveler characteristics for each of these markets. The questionnaire should be tested and reviewed prior to the actual implementation of the survey. Typical trip characteristics that can be captured through transit surveys are summarized by trip information and traveler information in **Table 3.3.1**.

Table 3.3.1: Trip/Traveler Information

Trip	Traveler
Origin/Destination	Age
Trip Purpose	Gender
Access/Egress Modes	Employment/Income
Boarding/Alighting Stations	Driver's License
Transit Lines Used During Trip	Vehicles per Household
Trip Frequency	Drivers Per Household

A major factor to consider during a survey effort is the sampling plan. Again, the transit markets must be considered, as well as the purpose of the data being collected. The sampling plan will depend on: the number of routes/runs that will be surveyed; the number of riders on each route; the time periods for survey implementation; and other factors specific to the transit system/survey effort in question.

The logistics of the survey will outline the schedule, delegation of responsibilities, survey training, pretest, and collection of auxiliary data (for example, counts of cars at park-and-ride, counts of vehicles at kiss-and-ride point, on-off counts on-board vehicle, etc.) Once these factors are addressed, the survey plan is complete, and the actual data collection can begin.

Whether data collection is conducted via on-board survey, mail-in survey, or personalized interviews, survey techniques should maintain consistency throughout the survey effort. Surveys must follow guidelines established during the survey training, and the schedule should be adhered to, ensuring that the routes are each surveyed to obtain the sample size. Reasons for non-responses should be noted and discussed to prevent survey biases, as well.

When the survey effort is completed, the data is input into a database, analyzed, and expanded. Aggregate expansion should be avoided to eliminate the use of large factors. Disaggregate expansion should be conducted by utilizing several sub-market control counts to provide a set of expansion factors for each individual transit line. Examples of disaggregate control counts include stratification by route, direction, and time period. Disaggregate expansion is an effective way to reduce or eliminate non-response bias, which can be skewed by factors such as trip purpose, socioeconomic characteristics, and trip length.

One method of avoiding non-response bias is the application of multidimensional sample expansion. Factors such as boarding location and alighting location can be used in the expansion. Boarding by access mode, alightings by egress mode, and socioeconomic information can also function as a useful basis for multidimensional expansion to elude non-response survey bias.

Geocoding may be used for post-processing survey data. Geographic Information Systems (GIS) technology can use the origin and destination addresses to geographically identify the observed travel patterns and spatially depict this trip information. Paths that appear to be unusual or illogical can be identified through geocoding as a measure of data quality.

Once a survey or multiple surveys are completed, expanded, and analyzed, the results will provide existing ridership data that will be critical to conducting an effective validation of the travel demand model. The more current data available to the project sponsor, the clearer the understanding of the project travel markets will be. Coordination with FTA on survey efforts and post-processing is very important to ensure that the survey was administered to obtain a reasonable and comprehensive representation of transit travel within the region of study.

The calculation of transit speed and travel time is critical for FTA Starts project forecasting because these are indicators of the resulting user benefits from a transit improvement. In FSUTMS models, transit speeds for facilities in mixed traffic is calculated as a function of highway speeds by time of day. Therefore, it is imperative that highway speeds for each time period are reasonable in comparison with actual highway speed data. Highway speeds are calculated on a link-by-link basis using facility type, area type, and mode. Each transit mode in the model is provided with its own auto-transit speed relationship.

Modes running on a fixed-guideway system require input speeds for transit travel time calculation. For these fixed-guideway systems, speed will be an equation of motion and location. The average speed of the transit vehicle, whether a streetcar, ferry, rapid bus, light rail, commuter rail, or high speed rail, must be calculated for its established route in the regional system. Also, the location and number of stations or stops that the fixed-route vehicle will make must also be taken into account. The FTA stresses applying logic to capture appropriate transit speeds during peak and off-peak traffic time periods.

3.4 Model Processes

Aside from observed data, FSUTMS models require an array of inputs and parameters to produce forecasts. As models throughout the State of Florida vary by input data and parameters, each model is a separate forecasting entity that was regionally developed and specialized to account for local travel conditions. Each of the current FSUTMS/CUBE standard model processes will be evaluated with regard to FTA Starts forecasting, and FTA Starts project forecasting concerns regarding input or parameter specifications will be discussed.

3.4.1 Trip Generation

Trip generation involves the use of socioeconomic data to determine the productions and attractions for each TAZ by trip purpose. Socioeconomic data used in the model includes population; single and multifamily dwelling units; employment by industry; hotel and motel counts and occupancies, and school enrollment data. TAZs have significant socioeconomic data that can be used for land-use forecasting, but currently land-use data in the FSUTMS model is limited. Further incorporation of land-use modeling may be necessary with regard to FTA Starts forecasting as transportation and transit improvements often yield significant impacts on land-use development.

Because TAZs are critical to the determination of trip origins and destinations, they have significant effects on the accuracy of the model. Detailed guidance for TAZ development in FSUTMS models was released in the 2007 in *A Recommended Approach to Delineating Traffic Analysis Zones in*

Florida. The document provides recommendations for the determination of TAZs in consideration of the highway network, centroid connector loadings, geographical features, special generators, socioeconomic characteristics, developments of regional impact (DRIs), transit access, and similar factors. Additional information white paper on TAZ development can be located at www.fsutmsonline.net.

TAZ division for project-specific study areas is also critical with regard to modeling practices for FTA Starts program forecasting. Within a transit alternative corridor, some of the TAZs may be disaggregated so that transit access is distributed appropriately throughout the zonal area and for transit capturing purposes.

Aside from TAZ structure recommendations, other trip generation specifications were established in documentation by FDOT provided in March 2009 for application and development in FSUTMS models. Specifications in this documentation regarding zonal variables include: the addition of income as a variable; the separation of households based-on presence of children; the addition of the number of workers per household as a variable; the elimination of single- and multi-family household categories upon the availability of NHTS survey data; and the additional stratification of employment categories to include manufacturing industrial, other industrial, commercial, service, and total employment.

In this documentation, it is recommended that an auto-ownership model based on variables like income, accessibility, and other relevant data replace the autos-per-household variables in the model. Also, it is recommended that dynamic area-type estimation should be employed by the trip generation process to account for both existing and future area types. Local origin and destination information obtained through survey data should be used to establish the effects of area-type on attractions by trip purpose. If survey data is not available, the area-type variable should not be included in the trip generation process. When available, the resulting area-type would function as a zonal variable in the trip attraction equation. If survey data is not available, the model should have the ability to turn off the area-type variable depending on if the variable is used.

The production model used for trip generation should utilize a household cross-classification methodology, and the attraction model should operate using a “zero-intercept” trip rate approach. In the 2009 documentation, new trip purposes were developed, which were combined with other existing trip purposes to create a set of ten standard trip purposes for FSUTMS models. These ten trip purposes include:

- Home-Based Work;
- Home-Based Shopping;
- Home-Based Social/Recreation;
- Home-Based School;
- Non-Work Airport;
- Home-Based Other;
- Non-Home-Based Work;
- Non-Home-Based Other;

- Commercial Vehicle; and
- Medium/Heavy Trucks.

External trips should also be divided by purpose: external-to-internal, internal-to-external, and external-to-external, based on available survey data, journey-to-work data, and local knowledge. More information regarding the establishment and balancing of these trips can be located in the FDOT *Trip Generation Review and Recommendations* document on the FSUTMS website.

Subarea balancing may be conducted by trip purpose so that attractions and productions are balanced within subareas rather than complete regions. The use of smaller areas for analysis is intended to mitigate the effects of variation in employment estimate sources on the model results. Each of these trip purposes may be provided a different TAZ subset for subarea balancing in the trip generation process.

Trip generation rates used in the model should be examined to ensure that they are accurate representations of travel within the region and have specific behavioral explanations. The trip generation process requires the analysis of special generators within the corridor. Special generators include productions or attractions (like military bases, universities, community colleges, hospitals, and shopping malls) that result in an atypical magnitude of daily trips.

Trip generation models should be refined as detailed as possible prior to the addition of special generators. If special generators are needed to compensate for trip generators, production- and attraction-side survey data should be used to update the standard special generator rates established in FSUTMS documentation. These established rates are outdated; therefore, supplementary survey data is imperative for an accurate representation of trips.

In relation to FTA Starts forecasting, the ridership impact of study area special markets, including entertainment and major event venues, should be analyzed separately from daily model forecasting. It is important that the analysis of special markets is catered to each study area depending on its regional characteristics and all of the various aspects of these special events markets are accounted for. In order for annual trip generating characteristics to be accurate, annualization factors for each identified special market must be addressed depending on the occurrence of events per year. In addition to the specific special markets, all generation rates for travel markets specific to the alternative transit corridor should be thoroughly analyzed. The modeling approach for special markets in FTA forecasting will be further discussed in *Section 5.0*.

3.4.2 Highway Network

Highway free-flow and congested skims generated during the highway network process will be critical to transit forecasts, as highway speeds affect transit bus speeds. Therefore, during model testing, free-flow and congested skims developed during this step in the model will need to be thoroughly reviewed to establish that the highway network is reasonably generating regional traffic. However, highway network coding should utilize the standard modeling practices for FSUTMS and include all roadways within the study area that will yield an impact on the transit alternatives.

3.4.3 Trip Distribution

The trip distribution step utilizes the gravity model to distribute highway trips and calculate congested highway skims. The distribution model should also involve the use of a Fratar model to distribute external-to-external trips.

A review of the FSUTMS trip distribution process released by FDOT in June 2009 recommends that FSUTMS models use a doubly constrained gravity model for Home-Based Work trips and then a singly constrained gravity model, which utilizes fewer iterations, for all other purposes. This methodology is in testing stages and will require examination on a broader range of Florida models prior to establishment as a FSUTMS standard.

As mentioned in *Section 3.4.1*, the FDOT recommends the addition of income as a zonal attribute. Using this variable incorporated by zone into the model, the FDOT also recommends that Home-Based Work trips in models covering large urban areas are stratified by income. This additional process will cause an increase in the overall runtime of the model, but the inclusion of a singly constrained gravity model for all trip purposes aside from Home-Based Work will decrease the original runtime, thus balancing the overall runtime.

Depending on model characteristics, varying areas may require the application of different travel times or skims. In areas where the transit systems are very well-developed, the use of transit skims may suffice for zero-car households. In areas where tolls exist, toll plaza service time should be incorporated. In larger urban areas, the use of congested skims should be used for peak hour traffic, and non-peak traffic should use the free-flow skims. Issues involving peak and off-peak travel will be further discussed with time-of-day modeling in *Section 3.6*.

The congested skims that are generated in the trip distribution phase must be thoroughly checked for accuracy, as transit speed on mixed traffic guideways will develop transit speeds based on these highway speeds. It is critical to test the trip distribution results prior to running the transit processes to obtain reasonable forecast results. The change in congested vehicle travel time will also be important data in the development of the FTA Starts project case.

Model distribution processes are another major factor requiring extensive review prior to application in FTA Starts forecasting, as they may cause issues with mode choice model calibration and high alternative-specific constants later in the model process. In FSUTMS models, the distribution methodology for zero-car household and special markets requires additional attention.

The distribution of zero-car household trips is a critical factor in relation to FTA Starts forecasting, as it is a representation of the distribution of transit dependent populations. Typically, for origin zones where transit service is available, zero-car household trips are distributed using transit skims or highway skims only for zonal interchanges where transit is available. For origin zones where transit is not available, highway network skims are used for the entire row.

Special market distribution is also critical because large attractions often yield significant ridership impacts on transit facilities. Additional data and model comparisons may be required. Further discussion of this issue will be provided in *Section 5.0*.

3.4.4 Transit Network and Path

In 2008, the FVTM was developed for application in FSUTMS models using the Cube Voyager Public Transport (PT) module. This framework was designed in accordance with FTA modeling measures to ensure that models used throughout the State of Florida will generate uniform and reasonable results. The FVTM developed for FSUTMS models has four major components: the transit network, transit paths and skims, mode choice model, and transit assignment. Once the initial framework for the FVTM is established in the FSUTMS model, the parameters and setups may be modified in order to reflect the local conditions of the modeled area. In addition, pathbuilding and mode choice structures may also require changes to more accurately capture area-specific characteristics.

3.4.4.1 Transit Network Coding

The FVTM is composed of transit lines with attributed modes, operators, transit fares, speeds, and wait-curves each designed to satisfy FTA data needs. It also establishes coding techniques that can be used to reasonably capture various aspects of the transit network. Transit lines must be represented as closely as possible to their actual route segments. The mode, operator, and route name are each identified in the transit line attributes. Each line has a specified travel time, individually adjusted to the route. A transit line must have at least two, and no more than five, headways to reflect peak, off-peak, and any other time-of-day service.

Transit modes assigned to each line are designed to distinguish between different transit mode travel times. Each model will have default transit modes, but additional modes can be added, as necessary. Operators must also be designated for each transit line. Single fare systems require a single operator designation, and multiple transit fares require multiple operator delineations. The issue of new modes being introduced in the forecast year will be discussed in *Section 3.4.5*.

Transit fare data, as discussed in *Section 3.3.3*, is used to calculate fares by mode in the FVTM fare structure. There are three fare structures used in FSUTMS models: flat fares, where the fare is not related to the length of the transit trip; free fares, where no fare is given to the transit facility; and zone-based fares, where the fare is based on the number of fare zones traversed.

As mentioned in *Section 3.3.3*, transit speeds are computed on a link-by-link basis. When operating in a mixed-traffic environment, the transit speeds are determined as a function of auto-speed. On a fixed-guideway transit system, the speed is determined through motion calculation.

The wait time allotted to the transit system to account for time elapsed while waiting for transit is usually half the service headway in FSUTMS models. Wait curves can also be assigned to each transit stop or station. Wait curves relate transit service headways to the rider wait time. Up to 255 wait curves can be applied in a FSUTMS model. The minimum wait curve is two minutes, and the maximum wait curve is thirty minutes.

Detailed coding techniques are also incorporated into the FVTM to define the regional transit system as realistically as possible. Transit-only links were created to provide paths for transit facilities that operate on smaller roads that are not coded into the highway network. These links are then solely used for transit purposes.

Station micro-coding is another method suggested by FTA to more accurately accommodate for station characteristics where more than one boarding area exists. More detail is added to reflect all paths used to access transit. In the FVTM, the station micro-coding default walk time to reach the boarding area is one minute, unless the station has very unique spatial characteristics.

Park-and-ride facilities and kiss-and-ride zones are also micro-coded into the transit network in the FVTM. These facilities are characterized by the following attributes that are coded into the transit network: number of parking spaces, cost of parking, maximum highway network distance assigned for auto-access, terminal times, and peak period designation. The park-and-ride and kiss-and-ride areas are coded separately for peak period times.

3.4.4.2 Transit Access

The FVTM also addresses transit access issues that are critical for FTA Starts project evaluation. There are three types of transit access used in the FSUTMS models: walk access (within a half mile between the centroid and transit station), park-and-ride access (car stops in parking lot), and kiss-and-ride access (assumed to also be dropped off in parking lot area). These access modes each require connectors to generate trips from the TAZ to the transit station.

Walk access connectors are generated using the PT module as a function of the highway network and the locations of bus stops. The average walking speed applied to the model is two and a half miles per hour, and the assigned travel time for the walk trip is calculated and saved as a variable of cost in the connector. Up to 99 connectors can be built per centroid to transit facilities within one-half of a mile. Walk access connectors are typically calculated as two-leg trips.

Percent walks are utilized in models with both local and express bus service in the FVTM, and unlike the PT module, assume ubiquitous access. Percent walks are calculated in GIS for zones by determining to what extent walk access is permitted throughout the entire zones, spatial distribution of productions and attractions, and environmental barriers that block walk access. The REWALK application is then used to calculate the percent walks for each zone using GIS utilities and walk access connectors.

Auto access connectors are used to represent both park-and-ride and kiss-and-ride access trips. Auto access connectors utilize the AUTOCON function in the transit network to assign weights to specific highway and transit network attributes, like auto travel times, auto-operating costs, and parking costs, to in-vehicle travel times.

All-walk connectors are applied when the cost for transit is more than the cost for the walk path; and therefore, walking is the optimal mode. All-walk connectors are given a mode number four and a speed of two-and-a-half miles per hour. All-walk connectors are produced between each zone to compute the shortest distance between zones, and travel times are saved as the travel costs of the connector.

Transfer connectors are used to account for transfers between transit service where moving to a different platform is required. There are three types of these connectors: Central Business District (CBD) sidewalks, escalator links, and station-to-nearby-stop. Transfer connectors are given a mode

number of eleven and are not specifically regarded as access modes to transit. Rather, they accommodate for exchange between transit services.

3.4.4.3 Paths and Skims

Paths and skims in the FVTM were designed to incorporate both local bus and premium service for future years that can be used in FTA Starts project forecasting. Models with both local bus and premium transit service utilize four types of transit paths: walk-to-bus, drive-to-bus, walk-to-premium transit, and drive-to-premium transit.

Walk-to-bus and drive-to-bus trips are composed of only local bus service. Walk-to-premium and drive-to-premium trips are comprised of premium transit modes and possibly local buses, as well. Transit paths are built based on the four trip categories between each zone in the model. Cities without any premium transit services only have walk-to-transit and drive-to-transit paths. Therefore, skims are only produced for the two types of transit paths.

Each component of a trip is assigned a weight in the path building process to account for personal driver preferences and perceptions. For example, out-of-vehicle travel time is often perceived as longer than in-vehicle travel time. Out of-vehicle travel time is thus assigned a weight, so it receives a higher travel cost relative to other components of travel time. The default weights for transit paths are established in "*Technical Report – FSUTMS Transit Model Development Guide".* These weights should be tested and adjusted as needed before inclusion in the model.

Transit skims are used in the mode choice portion of the FVTM. Values for each of the above listed transit components are stored in the transit skims prior to the weighting process. There are fifteen established skims tables in the FVTM that include:

1. Walk Access Connector Travel Time;
2. Auto Access Connector Travel Time;
3. Transfer and Sidewalk Travel Times;
4. Local Bus Travel Time;
5. Premium Bus Travel Time;
6. Circulator Travel Time;
7. Urban Rail Travel Time;
8. Commuter Rail Travel Time;
9. "Other" Mode Travel Time (intended for a new mode that will be built in the future but are not involved in project analysis);
10. Project Mode Travel Time;
11. Number of Transfers;
12. Initial Wait Time;
13. Transfer Wait Time;
14. Transit Fare; and
15. Total Time.

3.4.4.4 New Modes

Because many FTA Starts projects require the addition of a new mode that does not exist in the validation year scenario, a method of handling new modes was established by the FTA to ensure that bias constants assigned to new modes follow a prescribed set of guidelines in the Alternative-Specific Effects for Transit Mode policy.

Alternative specific mode handling was discussed in detail in *Section 1.0*. The alternative specific effects methodology incorporates additional attributes, including guideway like characteristics, quality service span, and passenger amenities, each not included in standard regional travel models. Depending on these transit characteristics, adjustments and weights can be made to travel time savings to adjust total user benefits. A lump sum credit measured in minutes of travel time savings is given to each passenger trip, as well as a reduction in minutes of in vehicle travel time. The maximum amount of travel time savings is 15 minutes for each rider and a 20 percent discount on in vehicle travel time weight.

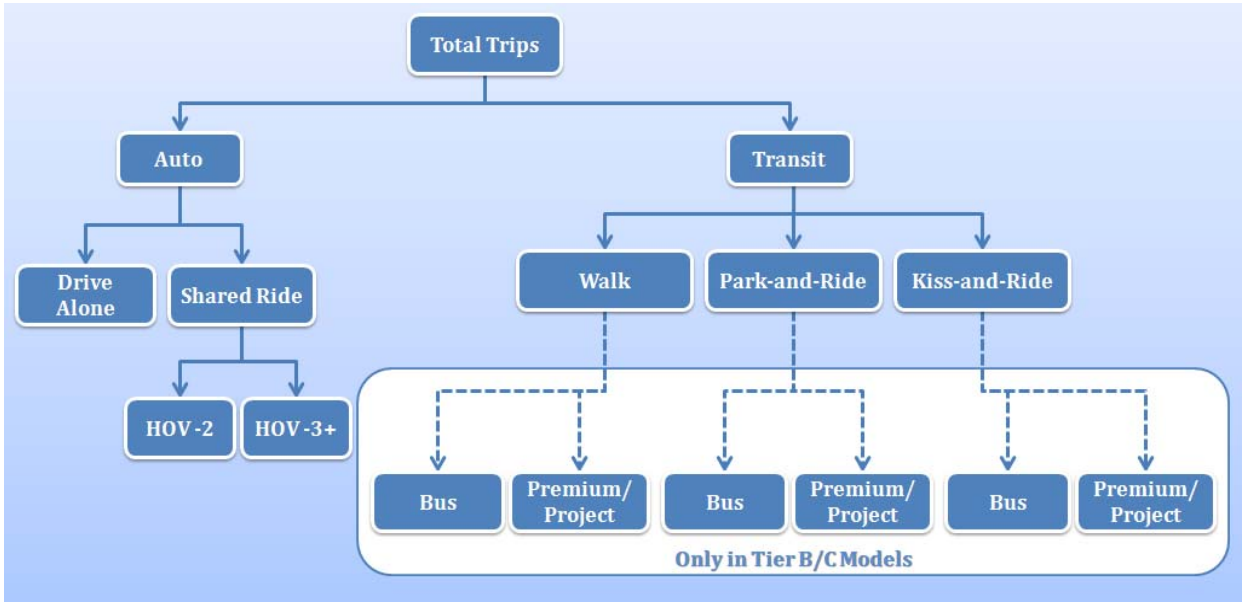
3.4.5 Mode Choice

In the FSUTMS structure two different tiers of models are identified depending on the presence of premium transit in the future year. Models that do not have an additional premium transit mode in the future year are termed "Tier A" models, and models with a premium transit mode in the future year are termed "Tier B/C" models. In the FVTM choice process, Tier B/C models have three sub-modes for auto travel, including drive alone, high-occupancy vehicle with two passengers, and high-occupancy vehicle with three or more passengers. These models also have six sub-modes for transit travel: walk-to-bus, walk-to-project/premium transit mode, park-and-ride-bus, park-and-ride-project/premium transit mode, kiss-and-ride-bus, and kiss-and-ride-project/premium transit mode. Tier A models with only local bus transit have the same auto travel sub-modes, but their transit sub-modes only include walk-transit, park-and-ride-transit, and kiss-and-ride transit.

A nested logit model determines mode share alternatives by using subsets of similar modes. The in-vehicle travel times, out-of-vehicle travel times, parking and transit fare costs, and other mode specific factors are computed for each mode-share alternative in the mode choice model to determine the utility component for each alternative.

FSUTMS models apply two different types of nested logit models depending on the transit modes present in the model. Nested logit models for Tier A models divide person trips by auto or transit trips. They are then divided by access mode. Auto trips are sub-divided into drive alone and shared ride, and transit trips are sub-divided into walk, park-and-ride, or kiss-and ride trips. Finally, shared ride trips are separated by shared ride- two riders or shared ride- three or more riders. The same process occurs for Tier B/C models, but transit trips are also sub-divided by access mode as either a bus or project trip in the lowest nests of the nested logit model. An illustration of the nested logit model is located in **Figure 3.4.1**.

Figure 3.4.1: Nested Logit Model Flow Chart



Source: FSUTMS Transit Model Development Guide

The markets in the FVTM mode choice model are divided as either zero-car, one-car, or two-or-more car households for home-based work and home-based other trip purposes. Number of cars is not defined by household for non-home based trips.

The FVTM establishes default coefficients for in vehicle travel time, out of vehicle travel time, auto access time, number of transfers, transit access, transit nest, auto nest, auto access, CBD walk paths, CBD park-and-ride paths, and CBD kiss-and-ride paths. These values are preset but must be estimated against existing data before being accepted as model-appropriate coefficients.

The FVTM sets the constants by market to a default value -1.00 that needs to be adjusted by the user. The model uses a constant -999.99 to negate non-existent transit choices. Markets are characterized by number of vehicles per household and they are separated by access modes: drive alone, two passengers, three or more passengers, walk-to-bus, walk-to-premium, park-and-ride to bus, park-and-ride to premium, kiss-and-ride to bus, kiss-and ride to premium, and room for additional access modes. The constants must be calibrated prior to application in the model.

Once the coefficients and constants are applied in the utility expression and the mode specific trip tables are produced, auto-access transit trips are converted to highway trips by dividing the selected occupancy rate from the production zone to the transit park-and-ride and kiss-and-ride area. Using this method, all transit trips will be accounted for in the highway network. It is also important that the weighting factors used in the mode choice model are consistent with those applied in the path building process.

3.4.6 Assignment

The FVTM choice model produces a trip table that is used to assign transit paths. Each transit trip is assigned to the best path in terms of minimum impedance. Transit trips are assigned in production and attraction (P&A) format. Transit assignment reports are produced in the form of boardings and alightings for each transit route and transit station. A summary report of all transit assignment is produced, along with a route summary report, a station activity report and a report of the total volume on the transit network.

For FTA Starts project evaluation, transit assignment must provide boardings by mode, route, route segment, station and any other data available. For FTA evaluation purposes, assignment should also provide travel times; volumes; on and off distribution; time-of-day travel; access and egress modes; and distribution of walk distance.

FSUTMS structures are currently designed to generate daily forecasts. One of FTA's primary forecasting concerns is the ability of highway assignment results by time-of-day to generate accurate peak speeds, congestion, and directional travel-time savings. Because the FSUTMS structure does not include specific time-of-day analysis, its forecasts remain at the daily level, which in terms of FTA Starts forecasting is not an accurate representation of travel demand in a region.

The FTA recommends that the highway equilibrium assignment process should include a large number of iterations to optimize traffic assignment. The highway travel times will stabilize as more iterations are applied to the highway assignment process. Highway assignment must be thoroughly checked using existing travel data. Close examination of travel times developed in the assignment process should be conducted, as these times are critical for FTA Starts project evaluations. Further quality assessment for these processes will be discussed in *Section 3.5*.

3.4.7 Reporting

FSUTMS has not finalized a standardized reporting mechanism yet, but several Florida models are designed with reporting capabilities. Reporting is helpful for model validation and testing as it simplifies creating data summaries.

A reporting template is recommended by FDOT Central Office and implemented into the Northeast Regional Planning Model (NERPM), the Southeast Regional Planning Model (SERPM) and the Statewide model. Another reporting procedure was developed for the Central Florida Regional Planning Model (CFRPM) and Tampa Bay Area Regional Planning Model (TBRPM) that generates HTML reports for specific model output and validation data.

3.5 Model Validation and Testing

The FTA emphasizes the importance of validation and testing of models for FTA Starts forecasting as these model checks are indicative of the model's performance. Processes including trip generation, trip distribution, transit, mode choice, and path-building are critical to model functions and greatly impact the output of the model. The products of each of these processes must be

systematically validated and tested to establish that model performance is reasonable for each study in which the model is applied. It is important that a model is separately validated and tested for each individual study due to variation in study areas, alternative needs, and other case-specific characteristics.

3.5.1 Validation

Model validation entails the matching of model-generated data with observed data from surveys or other primary data sources. With an emphasis on transit for FTA Starts project models, the transit network, transit access modes, transit paths, and mode choice elements will all be compared to existing data sources and checked for accuracy. Items like socioeconomic data, productions/attractions, trip distribution, highway and transit speeds, and highway volumes must be validated to create the base for a reasonable transit ridership estimates and forecasts.

Transit ridership tables can be created by mode, route, station, or other transit variable and compared to observed ridership tables. Differences should be examined and analyzed to determine the source of any significant variation. Comparison tables between pathbuilder and observed data can also be created that will evaluate complex factors like the sequence of modes used during a transit trip, the number of transfers during a transit trip, or the usage of park-and-ride lots. These tables identify differences between observed data. If any major differences are found in the data comparison, adjustments must be made to the model to correct the inconsistencies. The following estimates generated by the model are each evaluated against observed data and/or established standards based on observed data:

- Trips per household,
- Trip purpose percentages,
- Free-flow speeds,
- Terminal times,
- Trip lengths,
- Auto-occupancy rates,
- Volume over count ratios,
- Vehicle miles traveled,
- Vehicle hours traveled,
- Screenline volume over count ratios,
- Root mean standard errors,
- Transit ridership, and
- Trips by purpose and mode.

3.5.2 Testing

Model testing should be conducted once validation efforts are completed. Testing differs from validation in that it is an application of the entire model to test the function and impacts of model components. Model testing does not rely on data matching or the comparison of validation standards to model output. Testing should be conducted to establish an understanding of the full-

scale impacts of the project and gain insight from variation between model estimates and observed conditions.

The relative values and changes across model years for highway speeds, mode splits, and transit ridership must also be examined. If the marginal difference appears too high or too low in these comparisons, the parameters and data should be checked and adjusted to produce more reasonable results. The FTA stresses "telling the story" in the testing and application of models. Results must be analyzed in the context of the project, and model generated figures are needed to tell the story and present logical data that can be used for project evaluation. If the results look implausible, the model must be adjusted and rerun to ensure that the issues are resolved.

Testing is also effective when it involves the comparison of different alternatives. Trip tables, highway skims, and transit skims should be investigated across the tested alternatives. Variation in model results can identify sensitivities or atypical model performance. Modes, market segments, productions and attractions, and transfers can also be examined in the form of trip tables across alternatives. The model results should reasonably reflect the variation in alternatives and be indicative of the model's ability to represent changes in travel patterns related to provided services.

The FTA requires that models used for FTA Starts projects are thoroughly tested to ensure that the model is able to reasonably produce results across a variety of alternatives. Testing should be conducted logically to provide support for a project case, using consistent methodologies, alternatives, and evaluation techniques. As described in *Section 1.0*, a documentation of uncertainties must be provided with an FTA Starts project submission to identify any potential uncertainties in the model results. Because model testing will provide insight to the models strengths and areas for improvement, it will aid in the preparation of this document.

Past Florida New Starts projects ridership forecasts have significantly differed from the actual system ridership with transit improvements. The cause of this variance in ridership is not specifically identified in these cases as model data preservation requirements for FTA before-and-after studies were not yet established at the time of the forecasts. Issues relating to model structure, mode bias, socioeconomic data forecasts, and other input data are each potential sources of error in these forecasts. Therefore, significant testing efforts for models are critical to illustrate the reasonableness of model forecasts.

The FTA emphasizes the importance of full-scale model testing rather than simply validation, because data matching and comparison to validation standards cannot provide an all-encompassing understanding of model performance. The model results must be placed in the context of alternatives to observe the model's ability to respond to change and produce results for the specific case at hand.

3.6 Summary

The FSUTMS framework currently exhibits strong forecasting capabilities. **Table 3.6.1** provides an analysis of the FSUTMS's current forecasting capabilities. Several adjustments or enhancements

may be applied to the model to advance FSUTMS as a standard modeling tool for application in FTA Starts programs throughout the State of Florida.

Table 3.6.1: FSUTMS Current Capabilities by Model Factor

Model Factor	FSUTMS Capabilities
Travel Characteristics Data	MPO/Local Government information is primary source of socioeconomic input data. CTPP Data will be used as validation information at this time. Parking costs should be obtained from local agencies and averaged by TAZ. Household, Seasonal Resident, Cordon Line, Hotel/Motel, and other surveys can provide valuable travel pattern data available for model validation and testing.
Highway Counts	Use count data from FDOT and local agencies.
Highway Speeds	Validated against speed survey data and tested to ensure that mixed traffic transit speeds are accurate and that in-vehicle travel time will be calculated accurately.
Transit Ridership	Local transit agencies are a primary source for ridership information. Transit surveys are also critical for obtaining ridership data, and should follow the data collection recommendations provided by the FTA. All documentation of the survey should be sent to FTA with the project submission to ensure logical survey techniques were utilized.
Transit Speeds	Determined by calculations using either highway speeds (for mixed traffic transit vehicles) or transit technology and station location information (for fixed-guideway transit vehicles).
Transit Data	Transit fares can be obtained from transit agencies and calculated either as flat fares, free fares, or zone-based fares. Fares are different for each mode.
Traffic Analysis Zones	White paper available from FDOT should be referenced for the delineation of TAZs. Project-specific TAZ disaggregation may be appropriate. Change in zonal data variables recommended as in *Section 3.4.1*.
Special Markets	Use actual data to determine trips per event day and update standard rates. A special market annualization factor should be used to calculate events per year.
Highway Skims	Free flow and congested skims must be validated and tested to ensure that the speeds are accurate. Skims will be critical downstream when calculating transit speeds and in-vehicle time savings.

Model Factor	FSUTMS Capabilities
Trip Distribution	Zero-car household skims distributed with transit skims or highway skims for zonal interchanges where transit is available. Highway skims are used where transit is not available. Use of singly constrained gravity model for all trip types except Home-Based Work / Stratification of Home-Based Work trips by income issues is still in testing stages. Special market distribution should be thoroughly investigated.
Transit Coding	Standard FSUTMS includes all attributes needed for transit routes, mode, operator, headways, route name, segmentation, etc.
Wait Curves	A wait time of half the transit mode headway is typically applied as the wait time for FSUTMS models. In an effort to generate more accurate wait times with the FVTM, wait curves can be applied that develop a related wait time using headway data and wait time.
Station Micro-Coding	The FVTM incorporates station micro-coding to capture station-specific characteristics. Station characteristics are coded and walk connectors from park-and-ride and drop off locations are included for station access.
Transit Access Connectors	In the FVTM, transit access connectors were developed for walk-access, auto-access, and transfer riders to accommodate all transit access modes.
Percent Walks	The FVTM includes a percent walk file that determines the walk accessibility within a TAZ. It takes geological barriers, spatial distribution within neighborhood, and other land characteristics into account.
Transit Paths	There are four possible transit paths that are incorporated into the standard FVTM – Walk-to-Bus, Walk-to-Project, Drive-to-Bus, and Drive-to-Project. Project related paths are only included in models that include premium transit modes in future years.
Transit Skims	Skims in the FVTM were designed to include all transit components.
Incorporation of New Transit Modes	Alternative specific modes must be specified for future years. They have the ability to experience user benefit additions depending on the guideway, levels of service, and amenities by up to twenty percent of the in-vehicle transit time.
Mode Choice Coefficients and Constants	The mode choice coefficients and constants using the FVTM are given default values. During calibration and validation efforts, these parameters will need to be adjusted to account for local transit conditions.
Assignment	A large number of iterations must be completed to stabilize travel times. All assignment data must be checked against local travel patterns and examined thoroughly to tell the transit story.

As summarized in **Table 3.6.1**, FSUTMS currently addresses several of FTA's concerns to produce reasonable project forecasts. As mentioned throughout this section, there are several components or processes in the FSTUMS structure that will require further investigation and recommendations.

Most FSUTMS models currently perform daily assignment to generate average peak-period travel conditions. Some models in the State of Florida incorporate time-of-day modeling into their network processes. Time-of-day models allow for the development of skims by time period, rather than simply modeling peak and off-peak times. Current daily assignment practice is useful for addressing daily travel conditions for systems planning purposes. Time-of-day modeling can improve model performance by introducing a higher resolution to the model process, and thus a higher resolution to the validation of the model, as they can account for directional peak travel characteristics.

The method of time-of-day modeling applied in the model set-up depends on the model being updated. A more detailed discussion of the application of time-of-day models in FSUTMS for FTA Starts forecasting will be provided in *Section 5.0*.

Land-use modeling is another component that is not yet incorporated into the FSUTMS structure. Land-use modeling uses an iterative process to establish relationships between socioeconomic data and transportation planning to improve travel demand forecasting. Several land-use models exist within the State of Florida including Florida's Turnpike Land-Use Allocation Model (LUAM), the Simplified Land Allocation Model (SLAM), the Disaggregate Residential Allocation Model and/Employment Allocation Model (DRAM/EMPAL), Metroplan Orlando's land-use model development, and Tampa Bay's DELTASIM.

No standard framework is formulated to incorporate land-use modeling techniques into regional travel demand models, but studies are underway to establish a working structure. Land-use modeling can be helpful for FTA Starts forecasts because it presents an opportunity to account for transit oriented development and forecasting regional land-use patterns. A further discussion of land-use model incorporation into FSUTMS will also be included in *Section 5.0*.

Other various enhancements to the model structure, both large and small, can address remaining concerns from the FTA. Shortcomings in data requirements; TAZ structure and project-level disaggregation; zero-car and special market distribution; transit network coding; evaluation of new transit modes; highway assignment for peak speeds and travel times; and other factors that impact transit forecasts will be addressed in *Section 5.0*.

SECTION 4: Review of National Forecast Methodologies for New Starts and Small Starts Projects

4.1 Introduction

With hundreds of projects submitted to Federal Transit Administration (FTA) New Starts and Small Starts programs each year, the process continues to function as a competitive foreground for federal transit funding. Projects must exhibit sound forecast methodologies to effectively demonstrate the project's ability to yield needed transit improvements within the designated study area while supporting mobility improvement predictions.

To obtain a greater understanding of travel forecasting practices for New Starts and Small Starts submissions, a comprehensive list was compiled of New Starts projects on a national scale starting in 1997. Each project in the pipeline according to the *Annual Report on Funding Recommendations for New Starts, Small Starts* for each fiscal year was reviewed in order to document submissions and identify all allocated Full Funded Grant Agreements (FFGA). This list is located in **Appendix D** for a complete reference of projects on a national scale.

Due to the lack of readily available FTA New Starts and Small Starts submission information, projects used in the FTA workshop entitled *Travel Forecasting for New Starts*, held in Tampa Florida in March 2009, were reviewed and analyzed to provide examples of good forecasting practices for both New Starts and Small Starts projects. Additional project examples were also obtained using information published from New Starts Before and After Studies Reported to Congress in September 2008. Example projects utilized in *Section 1.0* are also briefly revisited in this section.

It is noted that upon the initiation of this project, the FTA became involved in the documentation of acceptable forecasting methodologies to aid in the development of Florida's forecasting methodology recommendations. The provision of example project forecasting processes and methodologies was discussed with the FTA, but the acquisition of these example projects remains in discussion at this time.

Forecasting methodologies and tools for each existing project were reviewed along with methods of data collection, model testing, analyzing forecasting uncertainties, and conducting before-and-after studies. Additionally, projects currently in the FTA Starts process, as well as newly developing projects from the State of Florida are discussed in *Section 4.5*.

4.2 New Starts Projects on a National Level

As discussed in the three previous technical memoranda, the FTA's primary concerns regarding New Starts and Small Starts forecasting involve the following issues:

- Providing project-specific insight to identify problems, special markets, and market-specific impacts in a study area;

- Data and model testing to accurately confirm identified travel markets and the ability of the model to address them;
- Analytical reporting and graphical presentation that follows a standard format and quantifies FTA evaluation measures;
- Making the case to tell a logical story and identify what the proposed transit improvement is designed to accomplish in terms of the travel market it serves;
- Analyzing uncertainties to ensure truth in forecasting by isolating possible sources of error and determining the potential implications they have on the model; and
- Coordinating with the FTA on a consistent and frequent basis to make certain that all forecasting methods will be accepted.

Because each travel market has different characteristics, existing transit infrastructure, and other local and regional issues, the importance of insight and market-specific forecasting is critical. In the 2009 Workshop in Tampa, several examples of good forecasting practices used in actual New Starts and Small Starts projects were identified. These projects illustrate the FTA's key principles of forecasting and may be utilized by agencies in the State of Florida to aid in the development of New Starts and Small Starts forecasts. Effective procedures, as well as lessons learned outside of Florida, can be compared and contrasted to Florida transit projects by utilizing their forecasting efforts as a valuable resource.

The New Starts projects examined in this section will cover data acquisition and application, the analysis of forecasting uncertainties, and the preparation of before-and-after studies. These issues are important components to FTA Starts applications and were selected for further analysis on an individual project-level basis as they can generally be applied to other New Starts projects. Projects in Dallas, Honolulu, and Portland are presented to demonstrate these guiding principles and the ability of local agencies to utilize forecasts to effectively illustrate their transit alternative.

4.2.1 Data Collection

The first New Starts forecasting practice reviewed was the data collection effort in Dallas, Texas, performed by Dallas Area Rapid Transit (DART). Current transit studies have involved the development of forecasts for a new Downtown transit facility and the proposed Cotton Belt Corridor Rail Line between Dallas and Fort Worth. In May 2007, DART conducted an on-board transit survey of its commuter rail, light rail, express bus, and local bus services. Transit on-board survey data was then used to validate the area's travel forecast model. In the 2009 Workshop, the 2007 DART survey was identified as having a noteworthy methodology for data quality control.

The 2007 survey was conducted on random vehicles by route direction for four time periods on 111 DART routes. The total number of adults (ages fifteen and above) were counted on each sampled vehicle and then expanded using a weekday expansion plan. A detailed account of the survey questions and the expansion plan is located in the 2009 Workshop PowerPoint that can be accessed on the FTA website:
http://www.fta.dot.gov/planning/newstarts/planning_environment_9547.html.

The North Central Texas Council of Governments (NCTCOG) conducted the analysis of survey data. The main methods of post-survey data quality evaluation employed by the NCTCOG included geocoding the results, identifying inconsistent answers, correcting conflicting answers, and assessing the quality of the resulting database. By geocoding the origins and destinations of the riders, cross-checks could be completed by measuring the distance between origins and boarding locations and the distance between destinations and alighting locations. Major outliers were identified through trip distance comparison. In this way, geocoding provided a simple and effective way to determine the reasonablness of origin and destination pairs from the survey.

Inconsistent answers may arise during survey efforts as a result of similar questions asked multiple times within the questionnaire. In some instances, a respondent answered one of these questions one way and another in a different way, rendering the answers inconsistent. Through the evaluation of the 2007 DART survey, it was found that approximately 40 percent of survey responses were inconsistent. Therefore, inconsistencies among survey questions were examined to determine what caused the inconsistency, establish how to address the inconsistent question so the survey could still be used, and note the problem to avoid similar issues from occurring in future surveys.

The most frequent inconsistencies found in the survey included: description of possible routes rather than the actual route taken; description of reverse trips rather than the actual trip taken; confusion of one-way and round trips; and confusion of "from" and "to" modes. By observing these discrepancies in detail, DART was able to correct many of the problems associated with inconsistent paths.

As part of the 2007 DART on-board transit travel survey effort, 3,168 surveys showing inconsistencies were reviewed in detail. Of these surveys, 3,004 were corrected and used, while the remaining 164 were flagged as unusable. Overall, the confidence in path sequence in the 2007 DART survey was determined to be 96%.

The 2007 DART survey is an exemplary survey effort as a result of the intricate data analysis and corrective survey actions. Several quality control tests were administered to ensure that the data presented logical paths that would capture local travel patterns. This quality control supports FTA's desire for insights rather than simply numbers. The resulting data was extremely useful in the testing of the forecast model as it yielded an accurate representation of the travel markets.

4.2.2 Model Testing

Model testing is a critical component in the process of preparing a model for New Starts or Small Starts forecasting. Traditional model calibration and validation are helpful tools for checking model output versus available data and assessing the plausibility of the model with regard to its constants, coefficients, and assumptions. Testing is the final step to ensure that the data and parameters are reasonable and the model, in its entirety, is producing reasonable forecasts and mode shares within the study area. Model testing should involve the review of highway speeds, transit running times, and transit trip tables applied to the transit network.

Forecasts should be feasible representations of actual travel patterns between neighborhoods, activity centers, employment centers, special venues, and other attractions in the model. Model testing should be a means through which this can be determined. Additionally, highway skims must be reviewed against current travel times and examined for future travel times.

Generally, a critical step in the model testing process used to assess the travel pattern representation is the verification of the ridership patterns. It is critical for data collected in recent survey efforts (at most five year-old data) to be used to assess and test the model. In order to complete this task, model estimates and survey results should be compared by time period, trip purpose, market segment, access mode, and egress mode. Peak versus off-peak trips, captive versus choice riders, and access versus egress modes should all be carefully compared using data percentages and actual ridership.

Once this verification of ridership patterns is completed, station-to-station matrices should be developed to determine if the travel patterns in the model provide similar indications of where travel occurs within the corridor as identified by the survey data. The observation of ons and offs by station in matrix format are able to highlight interchanges in which there is significant movement, thus allowing for the comparison of directional movement and volumes between model estimates and survey results.

Trip length percentages should also be compared between model estimates and survey data. Additionally, trip purpose percentages, specifically work-trips, should be reviewed by forming a matrix of work trips between centers of employment and other areas within the region using model estimates, survey data, and US Census data, if needed.

Unlike calibration or validation, the model testing process does not match numbers, but rather attempts to understand how the key travel markets in an area are captured by the model through the analysis of production and attraction flows, access and egress modes, and socioeconomic characteristics. Once the variances in estimates are distinguished, analysts must determine why these differences exist. It is only through model testing that variances in forecast and actual data can be identified. It is critical that model testing occur on a routine basis, and not only at the beginning of a study.

Using the above-mentioned DART survey example taken in Dallas in 2007, a specific emphasis was placed on testing the path-builder to determine the model's ability to capture trips on DART facilities. The model was calibrated using this observed data to create a reasonable and reliable transit path-builder in the model that would generate accurate zone-to-zone transit paths.

In this case, the survey data was used to develop an unweighted transit origin-destination matrix. To generate this matrix, segmented trip records were created using the data obtained from the survey. Paths from the unweighted records were used to calculate unweighted boardings for each DART route. These segments were assembled in matrix format and then used to establish ranges for pathbuilder parameters and create the pathbuilder. Using transportation modeling software, the paths were modeled and provided as output. The software also allowed for the paths to be tracked by mode. The observed and model assigned boardings were then compared by route.

Matching ridership counts does not ensure that all paths in the network are correct; however, if all paths in the network are correct, the resulting ridership will also be accurate. When paths estimated by the model were compared with paths observed in the survey effort by route, number of transfers, mode, and path characteristics, it was found that the paths were mostly consistent with actual data. Some inconsistencies arose between walk times and wait times.

When investigated on a closer level, it was found that some walk links were coded incorrectly, particularly in larger zones, and needed corrective network coding to represent actual walk movement. Initial wait times and transfer wait times varied with headway fluctuation and scheduling. It was recommended by the NCTCOG that further analysis of wait times was needed in order to obtain a more precise knowledge of wait time for incorporation into the model.

Throughout the data cleanup and development of the pathbuilder in the model, the NCTCOG maintained close coordination with the FTA. The FTA aided in the analysis of survey results and the proper implications of the data on the model. This coordination with the FTA was a critical component to the quality of the forecasting effort.

DART's data quality check and thorough review of results yielded an accurate database that was useful in creating and testing the pathbuilder used for project forecasting. Ascertaining a strong understanding of the observed data allowed for a better and more insightful analysis of modeled paths, which consequently led to a better model.

As model parameters and networks are adjusted, it is important to continually test the model to ensure that it is still capturing the appropriate directional flows and travel markets within the study area. In this routine testing process, it is also imperative that mode choice coefficients are not simply adjusted to generate more reasonable forecasts. Model processes as a whole must be involved to identify the exact causes of the difference in estimation using actual data while applying innovative and practical solutions to mitigate these effects.

Transit models should be tested thoroughly, and these tests should also consider the reasonableness of forecast year data, not just current year estimates. Peer reviews, especially in projects with the addition of new modes, should be conducted as another quality assessment for the reasonableness of forecasts as it provides examples of similar systems that may have similar lessons learned.

The aforementioned Dallas area projects have not been submitted for FTA review at this time, but DART and NCTCOG's strategic data collection assessment and application function as a good example of how meaningful survey analysis and thorough model testing using this data can create a model that is highly effective for project application.

4.2.3 Analysis of Uncertainties

One of the most critical elements covered in the FTA Starts application process is the making of the project case or, in other words, clearly articulating a need for the project. In order to make the case for the project, the following issues must be covered by the sponsoring agency: the context of the project, the current conditions within the study area, the future conditions within the study area,

the merits of the project, and the uncertainties associated with the development of the ridership forecasts.

The application for the Salt Lake Boulevard Alignment Project in Honolulu, Hawaii, provides a good example of the final element of making the project case: analyzing project uncertainties. FTA rates projects by their ability to maintain ratings through project development phases. Therefore, forecasting uncertainties must be addressed as a method of quality control. The analysis of uncertainties involves the review of potential sources of error, the analysis of these sources, and the production of three ranges (high, low, and best estimate) for project forecasts based on the uncertainties.

The first step in the Honolulu analysis of uncertainties was the identification of model inputs and responses relating to project demographics, highway investments, bus restructuring investments, and rail characteristics. Because the rail alternative created new elements in the model, analysis of these new factors and investigation of their impacts played a significant role in the uncertainties of the forecasts.

New features that were introduced into the model for the rail alternative included: park-and-ride facilities, bus-access to rail, multi-transfer trips, guideway effects, and special markets. In order to further investigate these elements of uncertainty and their effects on the model, several approaches were taken by Honolulu to ensure that each uncertainty was understood and balanced to maintain the integrity of the forecast.

To investigate the impacts of park-and-ride access to rail in the model, it was determined that a peer comparison was a useful and effective method for creating reasonable forecast ranges for park-and-ride access to rail. Bus access to rail was examined by comparing survey data versus forecasts to develop ranges for uncertainty using current bus data and model estiamtes. Multi-transfer trips were analyzed through the inspection of path choice within the model, as well as transfer penalties. The paths were determined to be acceptable. Guideway effects were analyzed by noting the unmeasured attribute improvements associated with rail and adding weights to account for these improvements in the forecast ranges. Finally, circulation trips were analyzed using peer comparison, while additional trips were added to each forecast range to account for these special markets.

Each of these uncertainties within the model was thoroughly investigated and viewed as either an upside uncertainty or a downside uncertainty depending on its positive or negative effects on ridership. The upside and downside uncertainties were compared against one another to ensure that the effects were balanced, thus minimizing the overall impact of uncertainties of the forecasts.

With coordination from the FTA, proficient quality assessment and quality control procedures, and peer review analysis, Honolulu was able to analyze each factor of uncertainty with an emphasis on real world conditions. As Honolulu made its project case insightfully, presenting project-focused data, they were able to clearly identify forecasting uncertainty and provide ranges reflecting the uncertainties. Thorough analysis of these uncertainties led to the initiation of additional analysis of employment data, highway investments, and driver transit-access to aid in the development of

future forecasts. Further detail as to the development of the Honolulu Salt Lake Corridor uncertainty analysis can also be located in the 2009 Workshop PowerPoint provided on the FTA website.

4.2.4 Before-and-After Case Studies

The FTA requires the analysis of conditions prior to building a New Starts project versus the conditions two years after the opening of the alternative transit facility in an effort to understand the impacts of the project. In the before-and-after case assessment, the accuracy of the project forecasts can be determined, and the causes of observed differences can be identified.

Before-and-after case study reviews for New Starts and Small Starts projects are presented by the FTA to Congress each year for review. In these before-and-after case studies, an emphasis is placed on the changes in service levels, operation and maintenance costs, and ridership levels as a result of the funded transit improvement. One of the most critical steps in conducting a before-and-after case study is the initial planning for and preparation of data for the study. Future data collection efforts must be planned. Analytical approaches to investigating the impacts must be derived, and initial forecast data and methodologies must be preserved for later use.

Two example before-and-after case studies are provided in this section to illustrate how a project that achieved very close results compared to initial opening year forecasts, as well as a project that generated ridership far below its opening year forecast. This variation in forecast accuracy is very helpful in the identification of specific causes of error by illustrating how forecasts could have been more accurate with the inclusion of additional testing, information, or development.

4.2.4.1 Portland Interstate MAX LRT

The Portland Study for Interstate MAX LRT conducted by TriMet provides a good example of a comprehensive before-and-after case study that illustrates an effective forecasting model. The Portland MAX LRT is a 5.8-mile extension where bus service was replaced by light rail vehicles running on exclusive lanes.

TriMet was able to preserve their initial travel mode estimates and obtain current data to conduct the before-and-after study. The 2005 opening year forecast (developed in 2000) predicted 13,900 riders. Actual ridership counts were taken by the agency showing similar numbers: Spring 2005 with 11,800 riders; Spring 2007 with 12,900 riders; Spring 2008 with 13,800 riders; and Summer 2008 with 14,700 riders.

In the before-and-after study, comparisons were made for weekday corridor ridership, as well as for distributions by trip purpose, land use characteristics, and service levels. By comparing the original model input and current study area characteristics at the station-level, the before-and-after study provided useful information regarding the accuracy and causes of differences in the forecasts and actual ridership. Each station was examined in detail to note any major difference in ridership. This method provided a simple means of pinpointing major ridership and service level differences.

Some examples of problems that were found at specific stations along the MAX LRT line are described as follows:

- Longer walk times than anticipated at transfer points yielded lower ridership than predicted;
- Indirect and uphill walk conditions yielded lower ridership than predicted;
- Higher household and employment levels than expected around a station generated higher ridership than predicted;
- Bus and car access from the freeway to a specific station was denied by the Department of Transportation and relocated to a different station causing higher levels of park-and-ride and bus-access at one station and lower levels at the originally planned station; and
- Direct access between stations that was not anticipated yielded higher ridership levels than predicted at both stations.

Each of these station-level characteristics were unforeseen in the original modeling effort, but played a significant role in either creating an additional market of riders or detracting a market of riders. In this case, the application of Geographic Information Systems (GIS) technology, other geographic software, or in-field observation is emphasized as a critical element for station-level modeling. With future application of these methodologies, better station-level forecasts may be derived for transit facilities.

The station-level analysis conducted by TriMet also drew attention to land-use characteristics. It was apparent in this study that economic cycles have a greater impact on the market in the short-term than in the long-term.

Through the application of this station-level analysis methodology, Portland conducted a thorough before-and-after study of the MAX LRT. Portland was able to access previously conducted forecast data. Then, using this information in comparison with current transit facility data, observations were made to identify inconsistencies to provide an understanding as to how forecasts in the future can be improved.

In before-and-after case studies the importance of the opening year forecast for New Starts projects is also emphasized. Future year forecasts are typically viewed as the most critical component in forecasting, but for project review and immediate understanding, the opening year forecast is a critical analysis tool.

4.2.4.2 Puerto Rico Highway and Transportation Authority Tren Urbano Heavy Rail Project

In March 1996, the Puerto Rico Highway and Transportation Authority (PRHTA) was awarded an FTA full-funded grant agreement (FFGA) for a double track heavy rail system spanning 10.7 miles. The project opened in December of 2004, over three years later than the proposed date of first operation, which was initially set for July 2001. The project required significant additional funding, with the incorporation of two additional stations, ten additional rail vehicles, and other contract-related expenditures, causing the project total to increase from the initial $1.654 billion estimate to $2.250 billion in 2004.

The project ridership forecast submitted in 1996 was 114,500 average weekday passengers for the year 2010. Once adjustments were made to the number of stations and rail vehicles in 1999, ridership predictions were estimated at 82,000 average weekday passengers for 2001 and 113,100

average weekday passengers by 2010. Once the service opened, its first year from 2005-2006 averaged only 24,700 passengers. The system's second year averaged a somewhat higher level of 26,900 weekday passengers, only 24% of the 2010 prediction forecasted in 1999.

Once these values were obtained and the percentages were calculated, a root-cause analysis was required to identify potential causes of the large deviation between the estimates and the actual ridership. Socioeconomic, station, access/egress, parking, fare-structure, and system-wide characteristics were examined in comparison from the forecast year (1999) to Year 2 (2006) to highlight the major components that negatively affected the ridership. The following contributing sources or error may be attributable to the high expectancy of ridership:

- Mode specifications in the model favored rail over bus;
- The fare used in forecasting was significantly lower than the opening year fare;
- Private and public buses were not coded in the transit network to appropriately reflect their competitiveness with the rail system;
- Rail system travel times were set substantially lower in the model than actually observed system travel times;
- Transfer access was over-anticipated in the model when compared to the actual number of transfers (30% higher);
- Park-and-ride and kiss-and-ride access riders were under-anticipated in the model, which caused a lack of parking spaces, creating a deterrent from taking the rail system; and
- Population data was predicted to experience a 19% increase between 1990 and 2000 but only experienced a 5% increase in this time period.

These potential causes for over-estimation effectively identify a variety of potential sources of error in forecast that may have yielded a significant impact on the level of ridership. This type of before-and-after analysis is extremely beneficial to the New Starts program as it can provide a concrete example of major factors that should be thoroughly investigated and discussed prior to application in the model to avoid these errors in future forecasts. In this circumstance, it is clear that many errors were the result of misrepresentation of the actual characteristics of the transit system.

It is important that studies of peer systems be reviewed by sponsor agencies prior to project forecasting. Important and unique characteristics of proposed systems, existing transit systems, and the surrounding demographics should be thoroughly understood. A variety of scenarios should be anticipated to prevent misrepresentation of the build system in forecasts.

4.3 Small Starts Projects on a National Level

As mentioned previously in this section, two Small Starts project forecasting examples are provided in *Section 1.0*. The East Bay Bus Rapid Transit (BRT) and Fitchburg Commuter Rail Improvements are discussed in detail in the document, and the templates submitted to the FTA are provided. Each of these examples was reviewed by the FTA, and the projects each received FFGAs using different methods of forecasting.

Small Starts projects require only opening year forecasts due to the smaller scale of the projects. Typically regional forecasting models can be utilized to obtain opening year forecasts, but in other instances, like Fitchburg, other off-model practices can be utilized to obtain reasonable forecast results.

The example reviewed in this section comes from New York City, New York. In this project New York City Transit (NYCT) developed an application for Small Starts funding for several improvements to the B44 Nostrand Avenue service line. The suggested improvements, entitled the +selectbusservice alternative, included: off-board fare collections; increased vehicle frequency; expansion of service spans; the shift to low-floor articulated buses; the branding of stations and buses; the development of interior bus lanes with bus bulb stations for just over 4.5 miles; and transit signal priority for almost four miles.

The forecasting methodology employed for the modeling of the +selectbusservice alternative was to assess transit demand and supply, and then analyze these factors to determine the user benefits that would be provided through the institution of the transit improvements. The +selectbusservice alternative estimation method utilized the Stochastic User Equilibrium (SUE) algorithm for trip assignment.

Transit demand for the system was analyzed using MetroCard data (assembled over the course of years using actual NYCT on-board data) to determine the location of ons and offs on the existing bus system. Origins and destinations for each trip were derived from the ons and offs locations, which were estimated using friction factors and the number of persons on-board according to MetroCard data. The total ons and offs were then balanced with actual MetroCard counts in a station-by-station matrix format.

To determine transit supply, the existing line and the +selectbusservice alternative, along with competing lines, were developed in a detailed transit network and given a walk network of a 0.15 mile radius. The network was extracted from a city-wide model and updated over the course of six weeks for application within the project. Centroids were added to the model to account for the distributed trips from the ons and offs of the system. The planned travel times for the alternatives were also hardcoded into the model.

For the assignment of the transit demand and supply conditions, the SUE program was applied. Wait time was established as one-half of the headway times, but random arrival times were also permitted. BPR volume/capacity time relationships were incorporated in the estimation program. Through the comparison of weighted travel times for the +selectbusservice alternative compared to the existing service, user benefits of the +selectbusservice alternative were determined.

The +selectbusservice alternative project approach placed an emphasis on using existing data, which aided in understanding the existing facilities and their ability to attract additional transit riders. The stop-to-stop matrices developed by the NYCT were very reasonable, yielding reliable estimates of travel time savings. The FTA viewed this forecast effort as a commendable approach, and utilized the project forecasts as an example for other Small Starts projects. The use of reliable data, the insightful analysis of the existing transit facility, and the development of a current and

well-developed study area model produced a reliable estimate of user benefits as a result of +selectbusservice alternative.

4.4 New Starts and Small Starts Projects in the State of Florida

A total of eight New Starts projects in the State of Florida have, at one time or another, been in the FTA pipeline since 1997, including projects in Miami, Fort Lauderdale, Jacksonville, Orlando, and Tampa. Two of these projects were awarded FFGAs: the Tri-County Commuter Rail Update (2002) and the Jacksonville Flagler to DuPont Place Extension of the Automated Guideway Express (1998). Currently the State has several projects in development for future submission requiring extensive planning and forecasting efforts. To date there are no Florida projects that have entered the FTA pipeline for Small Starts funding.

A complete list of Florida projects by year is provided in **Appendix E**. At this time, no forecasting or reporting examples for any of the Florida Starts projects are available for review. Project efforts on a national scale are discussed in the next section to provide examples of forecasting efforts and insightful working methodologies. A discussion of current and planned studies within the State of Florida for potential FTA Starts submission is provided in *Section 4.5*.

4.5 Current and Future Projects in Florida

New Starts projects typically go through three major funding phases prior to project completion. These include Alternatives Analysis, Preliminary Engineering, and Final Design. The SunRail project in Central Florida was submitted to the FTA and awarded an FFGA for fiscal year 2011 for the completion of a four-county north-south commuter rail system. Additionally, there are currently two major potential New Starts projects in the State of Florida that are in analysis stages and may potentially be submitting applications to the FTA New Starts program within the next few years. These projects include the Southeast Florida East Coast Corridor (SFECC) Study and the Tampa Rail Alternatives Analysis. Each of these projects have experienced extensive data collection, model development, and model testing efforts in recent years to ensure their models are reasonable and reliable for New Starts forecasting purposes.

4.5.1 Central Florida SunRail

The SunRail commuter rail project in Central Florida will proceed to construction stages in 2011 with an FTA FFGA. The study originally received a medium-low cost effectiveness rating when submitted to the FTA, but due to high rankings in other project rating categories, the project was able to elevate its status to receive funding.

The Florida Department of Transportation (FDOT) is working in coordination with FTA, Orange County, Osceola County, Seminole County, Volusia County, and the City of Orlando in the SunRail's project development. The first phase of the SunRail system includes a 31-mile corridor that will operate along twelve stations between the City of DeBary in Volusia County, and the City of Orlando in Orange County. Construction of Phase I will begin in early 2011, with service anticipated to

commence in 2013. Phase II of the SunRail Commuter Rail project will later incorporate service to five additional stations and provide service north of DeBary, connecting the line to DeLand. More information on the status and construction of this project status can be found at www.sunrail.com.

4.5.2 Southeast Florida East Coast Corridor Study

The SFECC study is sponsored by the FDOT District 4. The study involves an 82-mile-long, three-county (including Palm Beach, Broward, and Miami-Dade Counties) transit corridor. The project has conducted a thorough alternatives analysis and is currently undergoing SUMMIT analysis and testing at this time.

The South East Regional Planning Model Version 6.6a (SERPM6.6a) was developed and validated for use in the SFECC project. The SERPM6.6a is a time-of-day model and has been calibrated using on-board survey data collected on the region's commuter rail line (Tri-Rail). Travel demand updates include data from origin/destination surveys on major roadways and on major transit routes that run parallel to the SFECC to determine travel patterns, trip lengths, trip purposes, the intensity of travel to activity centers, as well as demographic characteristics.

The development of the SERPM6.6a and application of the model for the SFECC project forecasting was methodically coordinated with the FTA. Major issues with the model were addressed, and model application is continuing as a part of the determination of a Locally Preferred Alternative (LPA). One the LPA is finalized, an application to the FTA New Starts Program may be submitted. More information on the status of the SFECC study can be found at www.sfeccstudy.com.

4.5.3 Tampa Rail Alternative Analysis

The Tampa Rail Alternatives Analysis is sponsored by the Hillsborough Area Regional Transit Authority (HART). The study involves a 20.5-mile-long corridor that encompasses 18.5% of the Hillsborough County population and 57.6% of its employment. The corridor includes several residential and employment centers within the Tampa Bay Area including: the Westshore Business District, Downtown Tampa, Tampa International Airport, South Tampa, Ybor City, and the University of South Florida. The project is currently undergoing an extensive alternatives analysis, with the LPA scheduled for finalization in fall of 2010.

The Tampa Bay Regional Time-of-Day Model Version 1.0 (TBRTMv1.0) was developed for use in the Tampa Rail Project. In the time-of-day model, trips are split into peak and off-peak trips based on time-of-day factors developed from recent household survey data. A feedback loop is used in the AM-peak distribution module to provide more accurate congested travel time skims for use in the AM transit network. The model's AM-peak period was then validated to match AM traffic counts. Several survey efforts, including highway speed surveys and a transit on-board survey in Hillsborough County, were also integral components in the development of the TBRTMv1.0.

As the Tampa Rail Project progresses, HART's coordination with the FTA has remained constant. The model continues to experience further testing and development. Further analysis of the alternatives will continue toward an LPA for submission to the FTA New Starts program. Additional information on this project can be found at www.gohartaa.org.

4.5.4 Others

Aside from the SunRail FFGA and the two ongoing potential New Starts transit analysis efforts, there are several other urban areas that are in the conceptual stage of transit project development throughout the State of Florida. Areas like Jacksonville, Broward County, and Sarasota/Manatee Counties are individually taking steps towards transit project planning that may eventually lead to alternatives analysis and possibly FTA New Starts or Small Starts application submission.

4.5.4.1 Jacksonville Transportation Authority

Jacksonville has several transit improvement projects in initial analysis phases. A feasibility study for commuter rail was completed in 2008, as well as a recently completed streetcar study. Both of these studies found a clear need for the proposed transit improvement, but further scopes or schedules for analysis have not been outlined at this time.

Other current transit studies include the analysis of two BRT corridors: from Northwest Jacksonville to Downtown (Phase 1) and from Southwest Jacksonville to Downtown (Phase 2). The next phases of these studies are also undetermined. More information regarding the future of these transit projects can be obtained on the Jacksonville Transportation Authority (JTA) website: www.jtafla.com.

4.5.4.2 Central Broward East West Transit Study

Broward County Transit currently is in the Environmental Analysis phase of the Central Broward East West Transit Study. The project involves a study area from Weston to Fort Lauderdale. The study area runs as far north as the Bank Atlantic Center in Sawgrass Mills and as far south as the Fort Lauderdale-Hollywood International Airport. An Evaluation of Scoping Options was recently concluded in which six possible routes for the build alternative were selected to move into the Environmental Analysis phase of project development.

The Environmental Analysis will include the review and analysis of the six potential alternatives along with respective impacts on the study area. Additional components of this study include extensive public involvement and government coordination efforts. The various potential alternatives for transit improvement include bus rapid transit (BRT), modern streetcar, or other premium bus service and combinations of these modes thereof.

This project remains in the development phase, but, upon further analysis of the alternatives and environmental impacts, may be in contention for Small Starts project funding. Further project development and coordination efforts must be discussed before decisions are made. Information regarding the status of this project can be found on the Broward County Transit website: www.centralbrowardtransit.com.

4.5.4.3 Sarasota Manatee Transit Corridor Evaluation

In coordination with the Tampa Bay Area Regional Transportation Authority (TBARTA), FDOT District 1 is sponsoring a transit evaluation in Sarasota and Manatee Counties. The study area spans from Palmetto south to Bradenton, Sarasota, Venice, and east to Northport.

While, the intent of the corridor study is not to conduct a formal FTA New Starts or Small Starts Alternatives Analysis, the study intends to follow the standard procedures for such project endeavors in the event that the study could lead to an application for federal funding if the proposed transit improvements were found necessary. The goal of the study is to determine a locally preferred alternative that is consistent with the TBARTA Master Plan, a regional plan which covers both FDOT District 7 and a portion of FDOT District 1. More information regarding this study can be obtained through FDOT District 1 or the TBARTA website at www.tbarta.com.

4.6 Summary

Each of the examples listed in this section covers a different aspect of the FTA Starts program. As New Starts forecasts must reach further into the future to capture potential user benefits, they require extensive data collection and forecasting efforts to ensure that forecasts are reliable and convey user benefits as effectively as possible. Data must be checked systematically, models must be tested for a variety of factors, all possible impacts of uncertainties must be analyzed, and preparation for future testing of the accuracy of the model must be conducted. Each project presents a different array of challenges, markets, and special considerations. Therefore, FTA's emphasis on insightful and well-developed forecasts rather than technically generated ridership numbers is an imperative concept.

Small Starts data collection efforts must be similarly as extensive as those for New Starts projects. While the forecasting tools may not prove to be as complicated as those utilized for New Starts forecasting, the need to tell a coherent story, making the case, and presenting a reasonable estimation of user benefits is equally important.

SECTION 5: Analysis of TBEST and FSUTMS for Use in FTA New Starts and Small Starts Applications

5.1 Introduction

The Federal Transit Administration (FTA) has two major ridership forecasting requirements for New Starts and Small Starts forecasting, (1) models must be well tested, and (2) forecasts must logically represent ridership increases and mobility benefits as a result of the proposed transit alternative. Forecasts should provide a reasonable and insightful representation of future travel demand within the project study region that illustrates a logical case for the proposed transit improvement to decision makers.

The FTA provides guidance for the development of Starts forecasts and outlines several of the key success factors needed to produce reasonable ridership and marginal time savings estimations, as detailed in *Section 1.0* and *Section 3.0*. Submission requirements, recommended forecast methodologies, and example project forecast strategies were reviewed to create a comprehensive summary of the data, processes, and tools necessary for FTA Starts forecasting.

A review was conducted of input data, technical processes, and output data for both the Transit Boardings Estimation and Simulation Tool (TBEST) and the Florida Standard Urban Transportation Model Structure (FSUTMS). TBEST is a transit boardings estimation tool currently used in Florida for preparing Transit Development Plans, as well as for preparing other shorter term transit planning projects. The FSUTMS model, on the other hand, is a standardized statewide four-step travel demand model framework that is Florida's primary tool used to produce FTA Starts ridership forecasts.

New Starts projects require forecast horizons of 20 to 25 years in the future, while Small Starts projects require only Opening Year forecasts, which are typically within ten years of the project application submission. The TBEST model is not able to forecast to the 20 to 25 year horizons used for New Starts programs due to its ten-year maximum forecasting horizon. Therefore, TBEST was compared with the submission requirements for Small Starts programs to determine how it may be useful in the Small Starts planning process. Strategies for the potential use of TBEST in Small Starts project planning were developed through this comparison and analysis and are provided in this document.

Although the FSTUMS framework has been used in its current state for FTA Starts forecasting, the standard model framework was directly compared with the submission requirements for both FTA New Starts and Small Starts projects. Attention was given to areas where additional model enhancement or development is needed or useful for future FTA planning endeavors. Through this analysis, solutions and suggestions were developed to advance the structure of the standard modeling framework to provide additional support for FTA Starts applications and are provided in this section.

5.2 TBEST

TBEST is a direct-demand, micro-level ridership estimation model that was developed for short- to mid-term transit planning (no greater than ten years). The model directly calculates transit boardings, while incorporating sensitivity to walk access, zone size, and zonal characteristics. It also contains large amounts of data for each zone that is helpful in determining small-scale forecasts, allowing TBEST to address issues that cannot be measured using a regional forecasting model.

Table 5.2.1 below provides a summary of TBEST's modeling capabilities in comparison with the data and information required by FTA for Small Starts applications.

Table 5.2.1: TBEST and Small Starts Reporting Categories

Information Requirement	TBEST Capabilities
Travel Forecast Template	
Trip Purpose-Specific	TBEST is capable of generating peak, off-peak and daily transit trips, but cannot disaggregate trip purposes or measure highway travel times. The model is also not able to determine user benefits for transit improvement and therefore cannot complete this submission requirement.
Trip Purpose-Specific QC	Cannot be computed by template without user benefit hours.
Special Market	Without origin-destination trip tables, special market attractions and productions cannot be modeled in TBEST and therefore cannot complete this requirement.
Special Market QC	Cannot be computed by template without user benefit hours.
Transit Forecast Template - General Information	
Annualization Factor	Expansion factors for TBEST are typically calculated for a time period coincident with alignment and service schedules. Expansion can be conducted as appropriate and submitted to FTA for review.
Transit Dependents	The TBEST model includes variables that directly relate to transit dependency, including number of vehicles per household and average income. These variables can be used to establish transit dependency in TAZs and station areas.
Station Area	Buffer areas are used to capture socioeconomic data around station locations. The default buffer is 0.25 miles around each station, but this buffer can be changed depending on the project and area type.

As illustrated in **Table 5.2.1**, TBEST cannot calculate user benefits, one of the major criteria for scoring mobility improvements in FTA Starts projects. TBEST was not designed for FTA New Starts forecasting, but rather for the purpose of estimating ridership in the comparison of transit enhancements and alternatives for Transit Development Plans.

5.2.1 TBEST in Small Starts

The Florida Department of Transportation (FDOT) has invested substantial resources in the development of TBEST over the past decade as a direct estimation model for transit service area development planning. FDOT supported the development of TBEST networks for every transit agency within Florida. TBEST is available for use within Florida and provides a user-friendly interface that agency staff can operate soundly with little training.

While some agencies have not yet utilized these existing TBEST networks, many agencies have used TBEST in the development of TDPs and other transit service and operations planning efforts. The model has been proven to effectively analyze changes in local bus service in both urban and less-populated areas throughout Florida and the United States.

5.2.1.1 Sketch-Planning

TBEST does not include the trip generation, trip distribution, mode choice, and trip assignment modules of a traditional regional planning model or a highway network; therefore, TBEST is unable to measure user benefits for FTA Small Starts project development. Nevertheless, TBEST can estimate boardings up to ten years into the future and has the ability to evaluate the effects of transit improvements on ridership, which can be beneficial for Small and Very Small Starts initial alternatives screening.

Additionally, TBEST is currently being revised to utilize land use characteristics derived from parcel data. With the availability of land use codes at the address level, the TBEST modeling methodology will be updated to include stop-level Institution of transportation Engineers (ITE) trip-generation rates based on land use/market attractors. This new method of trip generation within TBEST will provide a detailed reflection of market characteristics at each stop and the level of trip attraction throughout the network. Land use codes within the parcel data include tourist attractions, entertainment facilities, parking lots, airports, and many other activities which explicitly define unique market activities. When implemented within TBEST, users have the ability to add or modify land use parameters.

Similar to the Aggregate Rail Ridership Forecasting (ARRF) model, TBEST uses Central Transportation Planning Package (CTPP) data, station area buffers in GIS, and a series of programs and calculations to determine aggregate estimates of transit ridership for an alternative. In this sense, TBEST estimates reflect an understanding of potential transit markets in a study area, in addition to the impacts that transit alternatives will have on ridership- like the ARRF model.

TBEST differs from the ARRF model in that it can currently provide estimates for local and express bus service, rather than the light rail transit and commuter rail transit facilities for which the ARRF model was developed. TBEST does, however, have an extensive array of data sets that is helpful in the analysis of socioeconomic characteristics within a region. TBEST's transit networks are also comprehensive, covering every route within a study area, as well as stop-level ridership. The model applies sophisticated accessibility calculations in conjunction with its wide-ranging databases to estimate ridership for transit service alternatives, as well as the corresponding impacts on all other

routes within the transit system. For this reason, it is an ideal model for initial ridership impact screening for areas in Florida that have updated and developed TBEST networks.

It is recommended that TBEST be utilized by sponsor agencies for sketch-planning in the initial planning stages of project development for FTA Small Starts projects with an opening year less than ten years in the future. TBEST is able to produce more precise forecasts of transit ridership for smaller geographical areas using its vast demographic database. TBEST provides detailed accessibility calculations that can be utilized as a cross-check to conventional travel demand model results.

There are often hundreds of alternatives to consider in the primary screening process prior to the filtering of alternatives to a feasible set for more detailed evaluation. TBEST run-time is significantly shorter than the run-time of a regional forecasting model; therefore, it is an ideal tool for sketch-planning of alternatives. Similar to the ARRF model, TBEST can provide ridership estimates for initial transit planning studies. TBEST's extensive socioeconomic database and geospatial station area information can provide an understanding of potential transit markets, provide grounds for evaluating the reasonableness of ridership forecasts and can function as a quality assessment tool for opening year ridership forecasts conducted using regional planning models.

5.2.1.2 Quality Assessment and Reasonableness Checks with TBEST

TBEST's boarding estimates can be compared to regional planning model results for Small Starts opening year forecasts to provide a quality check for model calibration for projects that represent new modes. For projects that are extending service, TBEST can estimate the impacts on the existing service, as well as related routes, to assess the quality of model results. Finally, TBEST boarding estimates can function as an overall reasonableness check for regional planning models. This applicability of TBEST is similar to the ARRF model. The ARRF model is often used in creating targets for regional planning model calibration in a starter line transit facility scenario, developing a basis for quality assessment for transit system expansion scenarios, and providing an overall reasonableness check for regional planning model forecasts.

5.2.1.3 Very Small Starts Applications

Very Small Starts projects do not require forecasts, but instead require current ridership numbers in the proposed corridor to be greater than 3,000, as confirmed through a data collection survey or transit agency ridership data. Additional detail regarding the data collection for Very Small Starts corridors is provided in *Section 1.0*. Current ridership for this purpose can be obtained by the local transit agency and through local survey efforts in the corridor. TBEST data may be a good tool for determining best route scenarios for Very Small Starts projects because they involve small scale study areas but have thorough sets of socioeconomic data that can be beneficial to these studies. Due to its low level of operating complexity and short term forecasting ability, TBEST is an ideal tool for the development of Very Small Starts project alternatives.

5.2.2 TBEST Modifications for Small Starts Application

TBEST is highly effective for transit service-level planning. To operate as a preliminary sketch-planning tool for Small Starts projects, additional functions and considerations should be addressed for TBEST. Development of new transit modes, uniform comparison of the impacts of transit alternatives, and creation of a unique way of telling the project story without trip tables are considered.

5.2.2.1 New Modes

To function as a sketch planning tool for Small Starts projects, TBEST requires only slight modifications. The development and addition of bus rapid transit (BRT), light rail transit (LRT), and commuter rail transit (CRT) coefficients is necessary, as Small Starts projects typically involve these modes.

The Los Angeles County Metropolitan Transportation Authority has developed an extensive TBEST network for transit service evaluation planning. For this multimodal system, the development and calibration of multiple transit mode coefficients was conducted and run successfully. To calculate ridership estimates for premium modes, TBEST coefficients derived from Los Angeles for BRT, LRT and CRT can be utilized for Florida TBEST systems. These coefficients for new modes should be incorporated and calibrated into Florida TBEST systems. This incorporation will involve the evaluation of various transit modes throughout the state; the testing of the existing coefficients against actual data to determine their ability to capture ridership trends effectively in an environment outside of Los Angeles; and the calibration of the coefficients.

5.2.2.2 Reporting System

As described in *Section 2.0*, TBEST includes a Report Builder that allows users to create stop-, segment-, and route-level reports for all or selected features in the network. TBEST currently does not have a standard reporting template for the comparison of alternative runs.

TBEST's current reporting system is sufficient for the analysis of individual runs. When used as an alternatives screening tool, it is recommended that TBEST be revised to include a template that will provide for the cross-evaluation of alternatives. The template should be able to compare alternatives at the route-level, as well as stop- and segment-level. Ridership counts, as well as access mode data – when incorporated, can be evaluated more effectively using this suggested standardized template methodology.

5.2.2.3 Telling the Story

TBEST does not allow for the analysis of travel markets, travel patterns, user benefits for transit alternatives and other demand considerations that are analyzed by module in the regional planning model chain. Therefore, TBEST is challenged with regard to "telling the story" of a transit alternative's impact on travel markets and travel time savings within a study area. TBEST estimates, however, are indicative of the magnitude of new ridership on a transit addition or enhancement, as it is able to illustrate differences between route boardings. As a simple and efficient tool for the refinement of estimates of alignment differences, this will aid in illustrating the purpose and need of a project to decision makers.

5.2.3 Other Potential Enhancements for TBEST

While new modes and reporting techniques must be developed for TBEST to be used as a sketch-planning tool for Small Starts and Very Small Starts projects, there are a number of other TBEST improvements that can be investigated for future incorporation into the TBEST model.

5.2.3.1 Park-and-Ride Transit Use

TBEST currently is limited in addressing park-and-ride usage, an access mode that oftentimes (especially in the case of BRT and LRT projects) yields the highest percentage of transit riders. Park-and-ride trips are generated using the number of parking spaces at the station park-and-ride lot in the TBEST model. No method of integrating a more detailed park-and-ride estimation technique into TBEST has been conceptualized to date, but there is potential for future research and development of this topic.

It is possible that a layered method for park-and-ride user estimation can be created by using the walk-access market estimated using TBEST's socioeconomic data; the drive-access market estimated through calculations determined by auto-access market information; and TBEST logic to determine access and egress opportunities. Additional research for the development of this feature for TBEST is necessary for further conceptualization.

5.2.3.2 Access Mode Specification

Trip purpose and access mode information cannot be included in the current TBEST structure as a standalone model due to the lack of trip generation and trip distribution modules. Potentially, an approach could be developed to incorporate access mode calculations into the TBEST structure to increase its transit ridership forecasting capabilities.

Additionally, TBEST applies special generators to capture park-and-ride trips in the morning peak period using the number of parking spaces at each park-and-ride lot. As mentioned above, this methodology uses the number of parking spaces at the park-and-ride lot as the only variable in its generation of park-and-ride trips at a stop. The enhancement of variables used in park-and-ride coding, such as parking cost, could also potentially aid in the development of access mode specification programming with further research on this topic.

5.2.3.3 First Step to Regional Planning Model

TBEST operates in a Geographic Information Systems (GIS) environment, while transit networks for regional planning models are also typically developed in a GIS environment. Because both transit networks for TBEST and regional four-step planning models are coded in GIS, it is possible that a method of integrating an existing TBEST transit network into a regional planning model structure be developed. This effort could be completed with a low level of complexity while providing an efficient means of detailed transit network coding for regional planning model development. This could be an extremely helpful tool in areas that do not have a regional planning model structure. The TBEST transit network could provide a starting point for the development of a regional planning model transit network.

5.2.3.4 Database Structure and Integration with FSUTMS

While TBEST has the potential to serve as a tool for preliminary alternatives screening for Small Starts projects in Florida, FSUTMS will in most instances be utilized as the primary forecasting tool in the alternatives analysis stage and subsequent forecasting efforts. Therefore, the development of a homogenous data structure will be critical to maintain consistency across forecasts in all stages of project development. Factors include zonal structure, parcel level data, and special generators that must be examined in relation to socioeconomic data and transit network structures for both TBEST and FSUTMS.

The socioeconomic data used in both TBEST and FSUTMS should be reviewed and compared to determine if and how the data structures could be modified and coordinated to offer consistent data. Additionally, the transit network structures used in TBEST and FSUTMS could be examined and compared to determine how the networks could be modified to create a more consistent structure across the models employed for FTA Starts ridership forecasting.

Furthermore, the comparison of data and network structures between TBEST and FSUTMS may facilitate further improvement of each system. The unique socioeconomic characteristics of TBEST may be useful for incorporation into FSUTMS, while detailed transit network and station coding practices in FSUTMS may be used with TBEST to enhance its network coding capabilities. Revisions to TBEST are in the research stage to apply parcel-level data in the development of land use characteristics. As this issue is researched further, it may also be considered for incorporation in FSUTMS models.

5.3 FSUTMS

Table 5.3.1 compares FTA New Starts and Small Starts template information with FSUTMS's forecasting capabilities. FSUTMS currently produces sufficient data for each of FTA's forecast requirements. Several FTA Starts forecasts have been generated by agencies within the State of Florida using this modeling methodology, but there are several components and processes in the FSUTMS structure that may be discussed to further enhance the accuracy of FSUTMS forecasts.

Table 5.3.1: FSUTMS and FTA Starts Reporting Categories

Information Requirement	FSUTMS Capabilities
Travel Forecast Template	
Trip Purpose-Specific	FSUTMS is able to generate transit trips and person trips by trip purpose for the baseline and build scenarios. FSUTMS's 10 standard trip purposes must be aggregated into 8 (up to 8 can be defined in the template) trip purposes, depending on study area conditions and characteristics. Calculations are used to compare the trips between scenarios. Summit is to compute user benefit hours using the FSUTMS model output.

Trip Purpose-Specific QC	New transit trip distribution and user benefit distribution (as generated by the transit improvement) are calculated in the template using the data input in the trip purpose specific section.
Special Market	For FTA Starts purposes, special markets are identified in the study area (up to 8 can be defined in the template). Data is collected pertaining to these markets, trip generation models are refined to account for these special markets, and the project trips generated by these special markets are isolated using the FSUTMS model to determine user benefits for the special markets. Annualization factors used in the FSUTMS model are also identified.
Special Market QC	Annual new transit trips and user benefits for the special markets within the study area are calculated in the template using the special market data input to the template.
Transit Forecast Template - General Information	
Annualization Factor	A service annualization factor is used to compute annual totals from daily estimates produced by FSUTMS (excluding special generator trips). Factors must be provided to the FTA prior to application in model data.
Transit Dependents	Typically population in zero-vehicle households in FSUTMS models are used to represent the transit dependent population. In coming years, income and accessibility may replace the vehicle ownership variable in the model, which means transit dependent populations will be calculated using income.
Station Area	Estimation of station area is calculated for FSUTMS models in GIS by (1) plotting the station locations on a map showing TAZs, (2) developing a 0.5 mile radius around each station, (3) estimating the socioeconomic data for each TAZ or proportion of the TAZ within the area if the entire TAZ is not within the buffer, and (4) avoiding double counting of overlapping station buffers by drawing a line dividing the buffers by station.
Other Necessary Reports	
Reporting of Changes over Time	Must be reported for Validation and Build Years. Demographics, person trips, travel times, number of transit trips, and transit shares must all be calculated using FSUTMS and the SUMMIT application. They may also be detailed by trip purpose using the FSUTMS standard trip purposes.
Reporting of Changes Between Alternatives	Must be reported for No-Build, Transportation Systems Management (TSM), and Build Alternatives. User benefit hours, user benefits for transit dependents, shares of user benefits, and negative user benefits must all be recorded using information produced by SUMMIT in conjunction with FSUTMS to compare alternatives.

Quality Control Reporting	Reports on user benefits as a direct impact of the project and user benefits caused by change in in-vehicle travel time are both calculated using FSUTMS in conjunction with the Summit application
Documentation of Uncertainties	Evaluation of socioeconomic data, transit fares, parking fares, auto-operating costs, auto-ownership, travel market data, and other model drivers should be examined for quality assessment. Ranges for low, medium, and high levels of ridership are developed using FSUTMS thorough incremental sensitivity testing of market identifying data from the current year to forecast year.
Documentation of Methodologies/ Assumptions	FSUTMS forecast methodologies must be documented during and after forecasts are developed to ensure that all processes are recorded to have as a back-up for submission materials. This documentation can also be used in the subsequent before-and-after study once the project is fully operational.
Supplementary/Optional	
Case for the Project	Data from FSUTMS is used to make the case for the project by quantifying the benefits that a project will have on its study area. Forecast data is used to compare forecast results to baseline conditions and outline all impacts of the transit alternative on the study area.
Alternative Specific Modes	The project sponsor documents facilities' attributes that are not taken into account in the regional planning model structure for the build alternative. The FTA reviews these attributes and may assign a credit of minutes of travel time savings for each project trip and a discount to in-vehicle travel time weight for the alternative based on these transit characteristics.

5.3.1 FSUTMS in New Starts and Small Starts

Models in the State of Florida operate using standard FSUTMS configuration, which helps to ensure that consistent and technically sound model structures are used throughout the State. While this standardized approach to modeling creates a solid framework for forecasting, it is imperative that all FSUTMS models maintain flexibility and control over the model's functions and parameters to capture local travel markets properly, a critical issue in New Starts and Small Starts program forecasting. Model parameters must be developed with local perspective on markets and should not be compromised by methods of standardization. This section will detail the processes needed for FTA forecasting model development aside from the general modeling framework. The intent is to emphasize the importance of individualized model development and response to localized planning issues and characteristics.

5.3.1.1 Model Preparedness

The specific model to be used for FTA forecasting must be established prior to the release of the project's Request for Proposal (RFP). Coordination with FTA should also occur at this stage to identify potential shortcomings of the model for project evaluation purposes and to outline the additional steps that must be taken to prepare the model for use in FTA Starts project analysis. As

the model and steps for improvement will already be identified prior to initiation of the project, no confusion regarding the necessary model enhancements or the data needed for the study will be encountered.

During initial model development, a clear definition of travel markets in the study area must be identified. Methodologies for capturing local travel markets should also be developed in this stage of the project and outlined for incorporation into the model's parameters. A model enhancement plan should be developed that outlines additional data collection or model modification that may be needed. This plan should be provided to the FTA for review and comment as well.

All FSUTMS models should undergo this initial assessment process with close FTA coordination to ensure that the model has the appropriate data and processes to capture the unique local markets. Early assessment of data availability and collection efforts necessary will prevent issues with the model at later stages in project development to prevent setbacks in the analysis stages.

5.3.1.2 Quality Assurance of Survey Data

Another model component that cannot be standardized is survey data. This information must be analyzed separately with respect to the survey area. Transit surveys are essential to obtaining quality travel demand information, but survey data must be carefully assessed prior to application of the model. Response rates must be examined to verify that the appropriate sample size was reached and the data accurately represents the transit ridership for each route. Also data should be examined for possible non-response biases.

In many cases, specific populations (for instance lower-income or non-English-speaking populations) will not complete a survey. In order to eliminate these non-response biases, measures to eliminate biases should be taken prior to implementing the survey. For example, developing surveys in multiple languages and providing surveyors to aid passengers in the completion of questionnaires will contribute to minimizing non-response biases. Biases may still be encountered in survey efforts despite mitigation efforts. Therefore, survey results should be expanded in multiple dimensions, including by route, time period, station, and/or direction. By expanding results on multiple dimensions, non-response biases will have less of an impact on overall survey results.

Transit surveys should be conducted according to the existing Transit On-Board Survey Guidelines available at www.fsutmsonline.com. Once data is collected in accordance with these guidelines, it must be thoroughly analyzed for incorporation into the model. Providing an appropriate sample size for each route and expanded by route or similar ridership constituency can help to eliminate non-response biases.

5.3.1.3 Model Testing

As discussed in *Section 4.0*, the FTA emphasizes the importance of model testing in the FTA Starts forecasting process. Project forecasting is an ad-hoc process for conceptualizing markets and determining how the model can successfully capture these markets. It is not related to the actual structure of the model itself, but rather is an analysis of model functions.

The output of each individual model process, as well as the overall model run, must be systematically and intellectually tested to establish that model performance is reasonable with respect to the study area and respective markets. It is important that a model is tested for each individual study for which it is applied. Substantial variation may occur between study areas, alternative needs, and other case-specific characteristics between projects which necessitates market testing on a case by case basis.

Through the review of previously submitted FTA Starts forecast examples in *Section 4.0*, it is evident that one of the most important steps in the FTA Starts forecasting process is model testing. The FSTUMS model structure is fully capable of producing reasonable forecasts, but with a variety of study areas, special markets, transit alternatives, parameters, and inputs, the model requires significant testing prior to application. This will ensure that each of the model elements works cohesively to produce reasonable and insightful forecasts.

Close coordination and participation must also be maintained among project sponsors, local governments, and the FTA in the model testing stages. Communication via meetings, model reviews, workshops, or other means are highly beneficial to ensuring that a model is accurately capturing local travel characteristics.

A specified process or checklist should be developed for FSTUMS model testing. The process or checklist may be developed using FTA suggested testing processes and example project forecasts from past studies. For example, the checklist should include detailed descriptions for the testing of trip tables, trip length frequency distributions, district-to-district flows, trips by trip purpose and population, and mode splits. This product will function as a quality check to guarantee that all possible model testing is conducted, irregularities in the model performance are identified and evaluated, and checkpoints with the FTA are met.

5.3.1.4 Peer Comparisons

Peer comparisons are effective tools in the forecasting of new modes, as they provide an example of a working system with similar characteristics to what the study's transit system will produce. Peer comparisons can provide additional insights for application in project development regarding overall transit system conditions.

By observing travel markets, system operations, and ridership trends of similar systems, travel behavior patterns can be compared with forecasts. Peer comparisons may provide additional perspective on the reasonableness of forecasts and can lead to the development of more realistic forecasts with lower levels of uncertainty in the study. Peer comparisons should be conducted for every FTA Starts study through the analysis of project forecasts in relation to existing data from a similar system, as coordinated with the FTA.

5.3.1.5 Documentation

The FTA provides a checklist of required documentation for New Starts submittals on its website. The list should be used to gather submission materials with the understanding that additional forecast methodology information may be required by FTA upon request.

One of these required documents, the documentation of technical methods, can also serve as a quality assessment procedure. Through the development of a model methodology memorandum, each step taken within the forecasting process must be revisited and described in detail. Forecasts should provide a straightforward explanation to effectively rationalize all forecasting methodologies to both decision makers and the modeling community. When summaries of the technical forecasting process do not appear clear or logical, it is possible that the technical forecasting approach applied must be reexamined.

Documentation can also be a valuable tool for quality assessment once a project has been built. Keeping the before-and-after study requirements in mind, all model development, practices, and testing should be documented and files should be stored for reference purposes. To avoid conflicts once forecasts are submitted or in a before-and-after study, all forecasts should be carefully documented and preserved. Guidance on the documentation and preservation of forecasts for New Starts and Small Starts studies is provided on the FTA website.

5.3.2 FSUTMS Modifications for New Starts and Small Starts Applications

Although FSUTMS models are used for New Starts and Small Starts forecasting in their current condition, there are four imperative structural enhancements that must be made to the standard model framework for future FTA Starts project forecasting endeavors. These enhancements include the following:

- Time-of-day modeling is critical for Starts forecasting because the FTA no longer accepts daily forecasts as they are not indicative of peak-hour or directional traffic.
- Distribution of zero-car household trips is critical for forecasting because this data indentifies the number of transit dependents within a study area and, thus, the impacts of a transit alternative on transit dependent populations.
- Special market analysis is critical to model development because it will ensure that the model captures a specific area's traffic flows in an effort to represent actual travel patterns.
- Transit network coding should be highly detailed and specifically coded to represent the individualized aspects of each project, as it will have a direct impact on ridership forecasts.

This section will discuss these issues relating to modification of a model's actual structure that must be made in order to produce reasonable forecasts for FTA Starts projects.

5.3.2.1 Time-of-Day Modeling

The FTA requires that models used for FTA Starts forecasting have a time-of-day component rather than daily assignment that generates only average peak-period travel conditions. Time-of-day models allow for the development of travel skims by time period, rather than modeling only for average congested and uncongested conditions. Current daily assignment practice is useful for addressing daily travel conditions for transit plan development, while time-of-day modeling has the added ability to improve model performance by accounting for directional peak travel characteristics.

In order for a time-of-day model to effectively forecast travel demand, time-of-day travel data is required to develop time-of-day factors. Time-of-day factors represent proportions of daily trips

broken into their respective time periods. They can be integrated into the modeling process at various stages in the model. Time-of-day factors are developed for the model from travel data collected from a reliable source (either a local survey effort or a data service whose methodology has been accepted by the FTA); assessed for any potential sources of error; and analyzed to establish the time-of-day factors for application in the model. Period-specific speed data is also needed to validate the model by time period. There are two methods by which time-of-day modeling can be incorporated into the model structure. Both methods vary by the step in which the time-of-day factors are applied.

The first method applies time-of-day factors to both the highway and transit networks after the mode choice modeling step. Trips are assigned to respective time period tables in both the highway network and the transit network. As the transit network levels-of-service change between peak and off-peak periods, the mode choice model must be able to account for origin-destination pairs that lack service in off-peak periods using variables developed using combinations of peak and off-peak characteristics. Similarly, both trip distribution and mode choice remain calculated on a daily basis in this methodology.

The second method for time-of-day factor application in the model applies the factors after the trip distribution modeling step. In this methodology, the time-of-day factors are applied after trip distribution to separate daily trips into discrete time periods. Mode choice is then run independently for each time period. After mode choice is run, the time-of-day factors are then reapplied to each of the auto trip tables and transit trip tables for each mode, trip purpose, and time period. As time-of-day factors are applied to each model process, except trip generation and trip distribution in this methodology, it is the preferred technique for time-of-day modeling.

As the State of Florida currently has no uniform practice for the incorporation of time-of-day factors into the FSUTMS model structure, it is recommended that a standard application of these factors be developed. The standard process should be documented, made accessible, and provided with a users' guide for time-of-day model development and application.

5.3.2.2 Zero-Car Distribution

The distribution of zero-car household trips is a critical factor in FTA Starts forecasting because it represents transit dependent population trips. In most models, highway skims for all travel market distribution. In some models, the methodology for zero-car households varies by area type and transit accessibility. For origin zones where transit is not available, highway network skims are used for zero-car household distribution. There are various methods that can be used for zero-car household distribution where transit does exist. In areas where the transit systems are well-developed, the use of transit skims may suffice for zero-car households. In other areas where transit is not a prominent a mode of transit, ratios of highway and transit users in the area can be developed using both transit and highway skims.

A standard methodology must be developed for the distribution for zero-car household trips by area type and proximity to transit facilities for FSTUMS models. There is currently no uniform methodology established for zero-car household trip distribution. As it is a major component in the

evaluation of FTA Starts forecasts, a standard approach that is consistent with FTA accepted forecast methodologies should be implemented.

5.3.2.3 Special Markets

As referenced above, one of the initial steps in project development should be a thorough evaluation of transit markets within the study area or corridor, which also includes the analysis of special markets. Characteristics of these special markets, including market-specific demographics, trip purposes, travel patterns, access and egress modes, and other notable features, should be examined in detail to develop a comprehensive special market evaluation.

To conduct this evaluation, production and attraction data must be collected and analyzed to illustrate these major markets that produce or attract an atypical number of daily trips that are not reflected in the model's simulation. For example, sports or entertainment venues that generate trips for events throughout the week; commercial or retail locations that attract a greater number of customers than can be calculated through an equation of employees per square foot; park-and-ride facilities; travel destinations like beaches or amusement parks; universities; ports of arrival and departure; and hotels or convention centers are each possible special markets that may be encountered in model development.

It is critical for travel demand models to identify the travel behavior within special markets, as they may significantly impact the transit improvement in the study area. To understand these special markets and establish an approach for appropriately generating trips to these locations, data must be collected regarding the daily or event patronage at each of these locations. The goal of the special market data collection effort is to understand the existing conditions of these special markets and generate accurate ridership responses for their productions and attractions.

Special market trips play a significant role in the evaluation of FTA Starts project mobility improvements. The number of special market trips; the user benefits per special market passenger per event day; the percent distribution of new special market trip user benefits; and overall percent of user benefits from special markets are considered in the determination of the effects of transit improvements on the study area. The most important aspect of special market distribution is the use of accurate and appropriate data for travel patterns, as well as providing behavioral explanations for any system-specific irregularities.

All special travel markets should be identified in the initial stages of model development. Data should be collected to determine the average productions and attractions for each market, tested, and compared with actual observed travel patterns. This comparison should be completed to ensure that all markets are properly represented in the model to produce accurate forecasts for these areas that may be impacted by potential transit improvements.

In various case studies, the most critical drivers of ridership patterns can be local policies and plans within these special markets. For example, parking policies, institutional transit subsidies, campus building placement, and similar factors may yield a more significant impact on ridership than the transit facilities themselves. In this sense, an acute understanding of the transit markets within the study area and the local policies that will be driving the markets must be obtained prior to model

testing to ensure that the model incorporates these variables and accounts for factors that are not intrinsically related to the transit system.

5.3.2.4 Transit Network Coding

Transit network coding involves a myriad of inputs, parameters, and processes that impact the overall transit system. Factors including walk access connectors, wait times, trip lengths, dwell times, and special generators at stations must each be individually assessed during model development.

In the development of a transit network, the factors listed below should be closely assessed in relation to the existing and planned transit infrastructure. The overall effects of these inputs on the model will be significant.

- Walk/Auto Access Connectors: Access connectors may prove to be either too long or too short depending on the market being served.
- Station-Level Coding: Walking within station areas must be realistically coded. In this sense, there must be individual nodes for each boarding platform, mode transfer location, park-and-ride facilities, and drop-off points within the station area itself.
- Wait Times: Wait times in FSUTMS models typically default to half of the headway, while at times there may be very long headways. Wait times typically should not be over 15 minutes in length. Therefore, wait times for long headways should be re-examined by evaluating the impacts on ridership of varying headways, specifically over 15 minutes.
- Dwell Times: Dwell times for buses should be carefully reviewed in the model, as scheduled dwell times are not always accurate.
- Fares: Fare structures will yield a significant impact on path choice, between auto and transit travel, as well as different modes of transit travel.
- Mode and Trip Length Relationships: There are instances where a trip is routed to a large-scale transit mode, for instance a Commuter Rail, when it is a short distance trip. In a real-life situation, it is assumed that these trips will not be routed to the larger mode due to cost or convenience issues. Short trip attenuation should occur to maintain a reasonable balance between larger-scale and smaller-scale modes of transit.
- Travel Times: Both fixed guideway and mixed traffic vehicle travel times should be reasonably represented.
- Park-and-Ride: Park-and-Ride lots may serve as particularly essential travel markets, as they have the possibility to attract both transit dependents and transit choice riders. The number of park-and-ride users depends on several elements at the park-and-ride lot including: parking costs; number of spaces available; transit access connectors; and station area demographics. Due to the unique nature of park-and-ride lots, observed park-and-ride data should be applied to the model in detail to ensure that the park-and-ride access to transit is appropriately generated. As FTA Starts projects often involve the incorporation of a premium transit alternative, the number of choice riders may increase, which may subsequently increase the number of park-and-ride users. Model characteristics at park-and-rides must be tested to ensure that the model is not over- or under-estimating the potential use of park-and-ride facilities.

5.3.3 Other Potential Enhancements for FSUTMS

In addition to the modifications to FSUTMS that are necessary for FTA forecasting, other factors for considerations that are not required but could be researched to enhance the forecasts are provided in this section.

5.3.3.1 Project-Specific TAZ Disaggregation

As discussed in *Section 3.0*, it is sometimes necessary to disaggregate TAZs based on the type of transit project, the study area, or the specific travel markets examined in a transit project evaluation. TAZs are often split in response to transportation facilities, so adjusting the geographical nature of the TAZs in relation to transit improvements and socioeconomic characteristics of the area may be necessary to appropriately capture ridership, specifically walk-to-transit access riders, at a new or improved transit stop or station.

TAZ disaggregation should be conducted following the suggested methods of TAZ splitting in FDOT's *A Recommended Approach to Delineating Traffic Analysis Zones in Florida*. Using this methodology, consideration should be given in the division of TAZs for socioeconomic data characteristics, employment characteristics, and other special markets or generators that exist in TAZs in consideration for disaggregation.

The document also includes directions for boundary shifts and revalidation that should also be reviewed prior to alteration of the TAZ structure. In TAZ alteration, specifically for FTA Starts forecasting, the main focus should lie on the travel markets served in the area and the ability of TAZs to accurately represent the walk-to-transit access markets through the review of walk connector placement and lengths. By developing a strong understanding of a study area's demographic and geographic characteristics, TAZ disaggregation may be completed to more effectively model walk-to-access transit within a project study area.

5.3.3.2 Reporting for FTA Purposes

The development of a standardized reporting procedure for FTA projects will provide a basis for quality assessment of forecasts. By reporting transit ridership values, transit dependent values, and new transit trips, forecasts can be analyzed and assessed for reasonableness in relation to other alternative forecasts. A standardized reporting structure will provide an efficient means of alternatives comparison and a systemized instrument for ensuring that all issues required by the FTA are covered in the project forecast.

5.3.3.3 New Transit Mode Standards

The establishment of new modes in a transit network is an area that requires extensive research and review. For models that do not include service for a particular transit mode in the validation year scenario, there is no data to calibrate the model for the given mode. Therefore, mode specific attributes and mode bias constants are not included (or unknown). Unlike the included attributes that represent quantified interzonal impedances such as in vehicle travel time, access time, and travel cost, mode bias constants must be estimated based on observed data.

One solution to the lack of observed data is the use of peer system data. This strategy must be utilized with discretion to ensure that the selected peer system is in fact comparable to the system

being analyzed. A detailed comparison of the peer and subject systems should be conducted for both supply and demand side variables. In the case of demand, the peer system should be comparable in terms of the total population and employment magnitude and composition. The peer system transportation supply should also be comparable, in terms of transportation infrastructure and levels of service.

Another method to estimate non-included attributes is to utilize the FTA's guidance on Alternative-Specific Effects for Different Transit Modes in the *Reporting Instructions for the Section 5309 New Starts Criteria*, which involves the use of a prescribed time savings value by three distinct attribute categories. Whereas the FTA requires the application of this technique to Summit User Benefits results rather than mode choice probability computations, it can be applied to estimate preliminary ridership forecasts for reasonableness testing. The FTA Office of Planning and Environment should be contacted for assistance, as the nature of the application of benefit for new modes must be handled on a case-by-case basis.

ARRF model estimates can also provide a helpful quality check for use in the development and assessment of new modes and their effects on the transit system. Also, the use of Alternative Specific Effects for Transit Mode studies may also be used to account for differences between new and preexisting modes. The critical factor in the incorporation of new modes is the development of reasonable mode parameters to most realistically represent the new mode in forecasts.

5.3.3.4 Land-Use Model Application

Land-use modeling utilizes socioeconomic data and transportation markets to forecast future highway and transit demands within a system. As mentioned in *Section 3.0*, there are several land-use models in the State of Florida that have been developed for a variety of studies. Recent FDOT efforts have investigated and researched the possibility of incorporating a land use model into the FSUTMS structure, and this research continues to date. As the understanding and development of land-use modeling increases, the recommendations for FSUTMS and the potential inclusion in FTA forecasting models will be examined more thoroughly.

5.4 Summary

The major objective in FTA Starts forecasting is to provide knowledge of local travel demand and the ability of transit solutions to respond to this demand. The TBEST model does not provide the appropriate forecast methodology for FTA Starts forecasting as it lacks access mode, transit congestion times, and user benefits analysis measures. TBEST does allow for an efficient and cost-effective method of transit sketch-planning for Small Starts projects due to its short run time and ability to analyze demographics and transit dependency within a study area.

Once TBEST incorporates a new mode and develops a uniform reporting system, it can perform as a helpful time and cost efficiency tool for preliminary sketch-planning. One of the most critical elements that will need to be investigated in the future is the consistency of TBEST and FSUTMS socioeconomic database and transit network inputs, as the tools will be used to complement one another in FTA Starts forecasting stages of project development.

FSUTMS is capable of preparing the forecasts necessary for New Starts and Small Starts planning. The primary structural components for the enhancement of FSUTMS are the incorporation of time-of-day modeling, the development of an approach for zero-car household distribution, the analysis of special markets in a study region, and strategies for highway network coding. Aside from these characteristic, model testing is the most critical element in the development of a model appropriate for FTA forecasting.

The advancement of both TBEST and the FSUTMS model framework will aid the State of Florida in the development of forecasting materials for FTA Starts projects. TBEST may be able to perform initial analyses for Small Starts projects with a maximum of ten year forecast horizons with the improvements described in this documentation. FSUTMS will continue to provide forecasts for FTA projects as it continually improves its forecasting capabilities.

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APPENDIX A: FTA Starts Templates

PROJECT DESCRIPTION TEMPLATE

PROJECT NAME:		
Participating Agencies		
Lead Agency	Name	
	Contact Person	
	Address	
	Telephone Number	
	Fax Number	
	Email	
Metropolitan Planning Organization	Name	
	Contact Person	
	Address	
	Telephone Number	
	Fax Number	
	Email	
Transit Agency	Name	
	Contact Person	
	Address	
	Telephone Number	
	Fax Number	
	Email	
State Department of Transportation	Name	
	Contact Person	
	Address	
	Telephone Number	
	Fax Number	
	Email	
Other Relevant Agencies	Name	
	Contact Person	
	Address	
	Telephone Number	
	Fax Number	
	Email	
Other Relevant Agencies	Name	
	Contact Person	
	Address	
	Telephone Number	
	Fax Number	
	Email	
Other Relevant Agencies	Name	
	Contact Person	
	Address	
	Telephone Number	
	Fax Number	
	Email	

PROJECT DESCRIPTION TEMPLATE (Page 2)		
Project Definition	Length (miles)	
	Mode/Technology	
	Number of Stations	
	List each station separately, including the number of park and ride spaces at each and whether structured or surface parking	
	List each station with major transfer facilities to other modes	

PROJECT DESCRIPTION TEMPLATE (Page 3)

Project Planning Dates	**Base Year**	**Opening Year**	**Forecast Year**
Capital Cost Estimate	**2009 constant dollars**	$ -	
	Year of Expenditure	$ -	
Levels of Service	**Headways**		
	Weekday Peak		
	Weekday Off-peak		
	Weekday Evening		
	Weekend		
	Hours of Service		
	Weekday		
	Weekend		
Opening Year Travel Forecast			
Fare Policy Assumptions Used in Travel Forecasts [footnote 1]			
Project Planning and Development Schedule	***Project Schedule***		
	Insert anticipated or actual dates/durations		
	Planning Studies Initiated		
	Planning Studies Completed		
	LPA selected		
	LPA included in the financially constrained long range plan		
	Included in Financially Constrained TIP		
	Initiation of DEIS		
	Completion of DEIS		
	Initiation of FEIS		
	Completion of FEIS		
	Public Referenda (where applicable)		
	Preliminary Engineering (duration – dates of beginning and ending)		
	Final Design (duration)		
	FFGA- submit request to award (duration)		
	Construction (duration)		
	Testing (duration)		
	Revenue Operations		
Project Management			
Project Manager	**Name**		
	Address		
	Phone		
	Fax		
	Email		
Agency CEO	**Name**		
	Address		
	Phone		
	Fax		
	Email		
Key Agency Staff: Overall New Starts Criteria	**Name**		
	Address		
	Phone		
	Fax		
	Email		
Key Agency Staff: Ridership Forecasts	**Name**		
	Address		
	Phone		
	Fax		
	Email		
Key Agency Staff: Cost Estimates	**Name**		
	Address		
	Phone		
	Fax		
	Email		

[1] Please summarize fare policy assumptions used for all regional transit services modeled in the forecast year. Attach this summary to the Project Description Template.

PROJECT DESCRIPTION TEMPLATE (Page 4)

Project Management (continued)

Key Agency Staff: Environmental Documentation	Name	
	Address	
	Phone	
	Fax	
	Email	
Key Agency Staff: Land Use Assessment	Name	
	Address	
	Phone	
	Fax	
	Email	
Key Agency Staff: Financial Assessment	Name	
	Address	
	Phone	
	Fax	
	Email	
Key Agency Staff: Project Maps	Name	
	Address	
	Phone	
	Fax	
	Email	
Contractors		
Current Prime Contractor	Name	
	Address	
	Phone	
	Fax	
	Email	
Prime Contractor: Project Manager	Name	
	Address	
	Phone	
	Fax	
	Email	
Contractor Responsible for Travel Forecasts	Name	
	Address	
	Phone	
	Fax	
	Email	
Contractor Responsible for Capital Cost Estimates	Name	
	Address	
	Phone	
	Fax	
	Email	

TRAVEL FORECASTS TEMPLATE

PROJECT NAME:

Line	Trip-Purpose-Specific Information	Source	Purpose 1	Purpose 2	Purpose 3	Purpose 4	Purpose 5	Purpose 6	Purpose 7	Purpose 8	DAILY TOTAL
1	Daily transit trips, Baseline Alternative	Summit: table 30									0
2	Daily transit trips, Build Alternative	Summit: table 40									0
3	Daily person trips, Build Alternative	Summit: table 20									0
4	Daily hours of user benefits (UB)	Summit: table 70 / 60									0
5	Positive UB hours from coverage changes	Summit: (tables 44+47+48) / 60									0
6	Change in hours of UBs due to capping	Summit: capping impact / 60									0
7	Daily hours of UBs for transit dependents	Summit: standard report									0
	Trip-Purpose-Specific Quality-Control Measures										
8	Daily new transit trips		0	0	0	0	0	0	0	0	0
9	Daily new transit trips -- distribution (%)		0%	0%	0%	0%	0%	0%	0%	0%	0%
10	Daily user benefits -- distribution (%)		0%	0%	0%	0%	0%	0%	0%	0%	0%
11	Daily transit trips, Baseline Alternative -- distribution (%)		0%	0%	0%	0%	0%	0%	0%	0%	0%
12	Percent change in user benefits due to capping		0%	0%	0%	0%	0%	0%	0%	0%	0%
13	Percent of capped user benefits accruing to transit dependents		0%	0%	0%	0%	0%	0%	0%	0%	0%

Line	Special-Markets Information	Source	Market 1	Market 2	Market 3	Market 4	Market 5	Market 6	Market 7	Market 8	ANNUAL TOTAL
14	Special-market project trips per event-day	Special-market forecasts									0
15	Special-market UB hours per event-day	Special-market forecasts									0
16	Special-market pass-miles per event-day	Special-market forecasts									0
17	Annualization factor (event-days / year)	Special-market forecasts									---
	Special-Markets Quality-Control Measures										
18	Annual new transit trips, special markets only -- distribution (%)		0%	0%	0%	0%	0%	0%	0%	0%	0%
19	Annual user benefits, special markets only -- distribution (%)		0%	0%	0%	0%	0%	0%	0%	0%	0%
20	Minutes of user benefits per project trip, special markets only		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Line	General Information	Source	Entry	General Information	Source	Entry
21	Annualization factor (days/year)	Current/similar guideway		Person trips by transit dependents	Travel forecasts	
22	Daily project trips, no special mkts	Travel forecasts		Person trips (stratified trip purposes only)	Travel forecasts	
23	Daily project trips, transit dependents	Travel forecasts		Station-area employees (within 1/2 mile)	Linked from Land Use Template	0
24	Daily project pass-miles, no special mkts	Travel forecasts		Station-area residents (within 1/2 mile)	Linked from Land Use Template	0
25	Daily project pass-miles, trn dependents	Travel forecasts		Project length (miles)	Linked from Project Descrip Template	0.0

	General Quality Control Measures (Excluding Special Markets)	Value	General Quality Control Measures (Excluding Special Markets)	Value
26	Minutes of user benefits per daily project trip (before capping)	0.0	Daily project trips per station area employee	0.00
27	Minutes of user benefits per daily project trip (after capping)	0.0	Daily project trips per station area resident	0.00
28	Percent of user benefits that are coverage related	0%	Daily minutes of user benefits per station area employee	0.00
29	Percent of user benefits that are off-model	0%	Daily minutes of user benefits per station area resident	0.00
30	Percent of project trips that are new transit trips	0%		
31	Project average trip distance / project length	0%		

MOBILITY AND COST-EFFECTIVENESS TEMPLATE

PROJECT NAME:

Mobility Improvements

	Column:	A	B	C	D	E	
		Alternative					
Line	Item	New Starts Baseline	New Starts Build	Difference	Annualization Factor	Annual Value	Source/Calculation
1	Transit trips for model-based trip purposes	0	0	0	0.0	0	Linked from the Travel Forecasts
2	Transit trips for special markets	---	---	---	---	0	Linked from the Travel Forecasts
3	Transit trips total	---	---	---	---	0	Sum of lines 1 and 2
4	User benefits for model-based purposes (hrs)	---	---	0	0.0	0	Linked from the Travel Forecasts
5	User benefits for special markets (hrs)	---	---	---	---	0	Linked from the Travel Forecasts
6	User benefits total (hrs)	---	---	---	---	0	Sum of lines 4 and 5
7	Project trips for model-based trip purposes	---	---	0	0.0	0	Linked from the Travel Forecasts
8	Project trips for special markets	---	---	---	---	0	Linked from the Travel Forecasts
9	Project trips total	---	---	---	---	0	Sum of lines 7 and 8
10	Project passenger-miles for model-based trip purposes	---	---	0	0.0	0	Linked from the Travel Forecasts
11	Project passenger-miles for special markets	---	---	---	---	0	Linked from the Travel Forecasts
12	Project passenger-miles total	---	---	---	---	0	Sum of lines 10 and 11
13	User benefits per project pass-mile for all riders (mins)	---	---	---	---	0.0	Line 6 divided by line 12 (times 60
14	User benefits for transit dependents	---	---	0	0.0	0	Linked from the Travel Forecasts
15	Project trips by transit dependents	---	---	0	0.0	0	Linked from the Travel Forecasts
16	Project passenger-miles by transit dependents	---	---	0	0.0	0	Linked from the Travel Forecasts
17	User benefits per pass-mile for transit dependents	---	---	---	---	0.0	Line 14 divided by line 16 (times 60
18	Share of UBs to transit dependents (percent)	---	---	---	---	0.0%	Line 14 divided by line 6
19	Share of person trips by transit dependents (percent)	---	---	---	---	0.0%	TF template cell L30 / TF template cell
20	Transit dependents: (share of UBs) / (share of pers-trips)	---	---	---	---	0.0%	Line 18 divided by line 19

Cost Effectiveness

		Alternative				
Line	Item	New Starts Baseline	New Starts Build	Difference	Value	Source/Calculation
21	Annualized capital cost (millions of constant 2009 dollars)			$ -	---	Source: SSC Worksheets
22	Total systemwide annual operating and maintenance cost (millions of constant 2009 dollars)			$ -	---	Source: O&M cost models (attach documentation).
23	Total annualized cost in forecast year (millions of constant 2009 dollars)	$ -	$ -	$ -	---	Sum of lines 21 and 22
24	Annual user benefits total (hours)	---	---	0	---	Line 6
25	Cost-Effectiveness: incremental annualized cost / annualized user benefits ($/hour)	---	---	---	$0.00	Line 23 divided by line 24
26	Total transit ridership	0	0	0		Linked from Travel Forecasts template
27	Cost Per New Transit Trip: incremental annualized cost / incremental annual transit trips ($/new trip)				$0.00	Line 23 divided by line 26

OPERATING EFFICIENCIES TEMPLATE

PROJECT NAME:

Line	Item	Alternative: New Starts Baseline	Alternative: New Starts Build	Difference	Source/Calculation
1	**Total systemwide annual operating and maintenance cost (millions of constant 2009 dollars)**	$ -	$ -	$ -	Linked from Mobility & Cost Eff. Template
2	**Total systemwide annual passenger-miles (millions)**			0.00	Source: Travel Forecasts
3	**Cost per passenger-mile ($/mi)**	$ -	$ -	$ -	Line 1 divided by line 2

LAND USE (QUANTITATIVE) TEMPLATE

PROJECT NAME:

Population and Employment – Metropolitan Area, CBD, and Corridor

Item	Base Year	Forecast Year	Growth (%)
Metropolitan Area			
Total Population			0.0%
Total Employment			0.0%
Central Business District [see footnote 1]			
Total Employment			0.0%
Employment – Percent of Metropolitan Area	0	0	---
CBD Lane Area (sq. mi.)		0.0	
Employment Density (e.g., jobs per sq. mi.)	0	0	---
Corridor			
Total Population			0.0%
Total Employment			0.0%
Population – Percent of Metropolitan Area	0%	0%	---
Employment – Percent of Metropolitan Area	0%	0%	---
Corridor Land Area (sq. mi.)		0.0	---
Population Density (persons per sq. mi.)	0.0	0.0	---
Employment Density (jobs per sq. mi.)	0.0	0.0	---
Total All Station Areas (1/2-mile radius) [See footnote 2]			
Housing Units	0	0	0.0%
Population	0	0	0.0%
Employment	0	0	0.0%
Land Area (square miles)	0.0	0.0	---
Housing Unit Density (units per sq. mi.)	0.0	0.0	---
Population Density (persons per sq. mi.)	0.0	0.0	---
Employment Density (persons per sq. mi.)	0.0	0.0	---
Station Area 1 [See footnote 3.] **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 2 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 3 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 4 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 5 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---

LAND USE (QUANTITATIVE) TEMPLATE (page 2)

	Base Year	Forecast Year	Growth (%)
Station Area 6 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 7 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 8 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 9 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 10 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 11 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 12 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 13 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---

LAND USE (QUANTITATIVE) TEMPLATE (page 3)

	Base Year	Forecast Year	Growth (%)
Station Area 14 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 15 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 16 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 17 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 18 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 19 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---
Station Area 20 **Station Name:**			
Housing Units			0.0%
Population			0.0%
Employment			0.0%
Land Area (square miles)		0.0	---
Housing Unit Density (units per sq. mi.)	0	0	---
Population Density (persons per sq. mi.)	0	0	---
Employment Density (persons per sq. mi.)	0	0	---

[1] Optionally, employment for the largest activity center(s) served by the New Start project may be reported.
[2] See Appendix A for a sample methodology for estimating station area population, households, and employment.
[3] Reporting of data by individual station area is required.

FINANCE TEMPLATE

PROJECT NAME:			
Total Capital Cost of Project in Millions of Constant 2009 Dollars (from the SCC Main Worksheet)		**Total Capital Cost of Project in Millions of YOE dollars (including finance charges, cost of PE and FD, and construction):** (from SCC Main Worksheet)	
Section 5309 New Starts Funding Anticipated (YOE $):		**Section 5309 New Starts Share of Project Cost:**	0.0%
Estimated Cost of Preliminary Engineering (YOE $):		**Estimated Cost of Final Design (YOE $):**	
Total Finance Charges Included in Capital Cost (include finance charges that are expected prior to either the revenue operations date or the fulfillment of the Section 5309 New Starts funding commitment, even if the financing charges are incurred by a funding partner that is not the project sponsor): (from SCC Main Worksheet)			

Other Federal Capital Funding Sources (Non-5309 New Starts Funds such as FTA Section 5307, Surface Transportation Program (STP), Congestion Mitigation and Air Quality (CMAQ), Section 5309 Rail Modernization,	**Type of Funds**	**Dollar Amount (millions of YOE dollars)**	**% of Total Capital Cost**
CMAQ			0.0%
2)			0.0%
3)			0.0%
4)			0.0%
State Capital Funding Sources (Funds provided by State agencies or legislatures such as bonds, dedicated sales tax, annual legislative appropriation, transportation trust funds, etc.)	**Type of Funds**	**Dollar Amount (millions of YOE dollars)**	**% of Total Capital Cost**
FFGA			0.0%
2)			0.0%
3)			0.0%
4)			0.0%
Local Capital Funding Sources (Municipal, City, County, Township, or Regional funding such as bonds, sales tax, legislative appropriation, transportation trust funds, etc.)	**Type of Funds**	**Dollar Amount (millions of YOE dollars)**	**% of Total Capital Cost**
1)			0.0%
2)			0.0%
3)			0.0%
4)			0.0%
Private Sector/In-kind match/Other (Donations of right-of-way, construction of stations or parking, or funding for the project from a non-governmental entity, business, or business assoc.)	**Type of Funds**	**Dollar Amount (millions of YOE dollars)**	**% of Total Capital Cost**
1)			0.0%
2)			0.0%
3)			0.0%
TOTAL NON-SECTION 5309 FUNDING (millions of YOE dollars)		$0	0.0%
QA/QC CHECK: TOTAL CAPITAL COSTS LESS SECTION 5309 FUNDING LESS NON-SEC. 5309 FUNDING (SHOULD EQUAL		$0	---

FINANCE TEMPLATE (page 2)			
New Starts Project Financial Commitment			
Other Federal Sources (Linked from page 1)	**Specify Whether New or Existing Funding Source**	**Specify Status of Funds -- Committed, Budgeted, or Planned (See notes below)**	**Identify Supporting Documentation Submitted to Verify Funding Source**
CMAQ			
2)			
3)			
4)			
State Sources (Linked from page 1)			
FFGA			
2)			
3)			
4)			
Local Sources (Linked from page 1)			
1)			
2)			
3)			
4)			
Private Sector/In-kind Match/Other (Linked from page 1)			
1)			
2)			
3)			

Reference Notes: The following categories and definitions are applied to funding sources:

Committed: Committed sources are programmed capital funds that **have all the necessary approvals** (legislative or referendum) to be used to fund the proposed project **without any additional action**. These capital funds have been formally programmed in the MPO's TIP and/or any related local, regional, or state CIP or appropriation. Examples include dedicated or approved tax revenues, state capital grants that have been approved by all required legislative bodies, cash reserves that have been dedicated to the proposed project, and additional debt capacity that requires no further approvals and has been dedicated by the transit agency to the proposed project.

Budgeted: This category is for funds that have been budgeted and/or programmed for use on the proposed project but remain uncommitted, i.e., the funds have not yet received statutory approval. Examples include debt financing in an agency-adopted CIP that has yet to receive final legislative approval, or state capital grants that have been included in the state budget, but are still awaiting legislative approval. These funds are almost certain to be committed in the near future. Funds will be classified as budgeted where available funding cannot be committed until the Full Funding Grant Agreement (FFGA) is executed, or due to local practices outside of the project sponsor's control (e.g., the project development schedule extends beyond the TIP period).

Planned: This category is for funds that are identified and have a reasonable chance of being committed, but are neither committed nor budgeted. Examples include proposed sources that require a scheduled referendum, reasonable requests for state/local capital grants, and proposed debt financing that has not yet been adopted in the agency's CIP.

FINANCE TEMPLATE (page 3)

Innovative Financing Methods
(Unconventional sources of funding which may include TIFIA, State Infrastructure Banks, Public/Private partnerships, Toll Credits, revenue finance methods, etc.)

Innovative Funding Source	Anticipated Funding Amount	Identify Supporting Documentation Submitted

Summary Information from the Operating Finance Plan

New Starts Project Annual Operating Cost in the Forecast Year (YOE$):		**Total Transit System (including New Starts Project) Annual Operating Cost in the Forecast Year (YOE$)**		
Proposed Sources of Operating Funds (Proposed sources of operating funds that are anticipated to support operating expenses of the transit system.)	**Dollar Amount**	**Type of Funding Source**	**Annual/Dedicated**	**Specify Whether New or Existing Funding Source**
Farebox Revenues		---	---	---
State Revenue Source A				
State Revenue Source B				
State Revenue Source C				
Local Revenue Source A				
Local Revenue Source B				
Local Revenue Source C				
Other				
Total	$0			

Transit System Operating Characteristics

Current Systemwide Characteristics (Can be the same data as reported to the FTA for the National Transit Database)	**Number/Value**	**Future Transit System with New Starts Project** (Systemwide characteristics at completion of the New Starts Project)	**Number/Value**
Farebox Recovery Percent		**Farebox Recovery Percent**	
Number of Buses		**Number of Buses**	
Number of Rail Vehicles		**Number of Rail Vehicles**	
Current Annual Passenger Boardings			
Daily Passenger Boardings			
Average Fare		**Average Fare**	
Average Age of Buses			
Average Age of Rail Vehicles			
Revenue Miles of Service Provided		**Revenue Miles of Service**	
Revenue Hours of Service Provided		**Revenue Hours of Service**	

APPENDIX B: Certification of Technical Methods

Certification of Technical Methods and Planning Assumptions

As Chief Executive Officer of _____, I understand that FTA's Reporting Instructions for Section 5309 New Starts Criteria, dated July 2009, establish common conventions for the development of information on proposed New Starts projects that are crucial to the fair and evenhanded evaluation of projects. These conventions include:

1. The horizon year used for the travel forecasts is 2030.
2. The ridership forecasts are based on a single set of projections and policies consistent with the regional transportation plan and are held constant for the preparation of travel forecasts for the New Starts Baseline and New Starts Build alternatives, including:
   - land use, demographics, socio-economic characteristics, and travel patterns;
   - the highway network, except as modified for changes inherent to the Build alternative (such as the conversion of traffic lanes to transit-only rights-of-way);
   - transit service policies regarding geographic coverage, span of service, and headways, modified where necessary to integrate transit guideways into the bus system;
   - pricing policies (fares, highway tolls, and parking costs); and
   - transit capacity provided given projected transit volumes, productivity standards, and loading standards.
3. The travel models used to prepare the forecasts have been developed and tested with the best available data on current conditions in the urban area, including:
   - Highway speed data collected in the year ____;
   - Transit travel-time data collected in ____;
   - Home-interview/travel-diary data collected in ____; and
   - Transit on-board survey data collected in ____.
4. Except for the impacts of physical changes introduced by the alternatives themselves, the performance of the highway and transit systems is held constant between the New Starts Baseline and New Starts Build alternatives, including:
   - highway congestion levels;
   - transit operating speeds in mixed traffic; and
   - maximum access and egress distances to/from transit services, as well as representations of walking, waiting, and transfer times.
5. Transit-mode-specific constants describing the unmeasurable attributes of individual modes are either the same across all transit line-haul modes or are derived from ridership experience on existing transit modes in the metropolitan area, and have magnitudes that are within acceptable ranges as reviewed and approved by FTA.
6. Service levels in both the New Starts Baseline and New Starts Build alternatives have been adjusted to meet projected ridership levels using consistent vehicle-loading standards.
7. The forecasts of ridership and transportation benefits have been subjected to quality-assurance reviews designed to identify and correct large errors that would threaten the usefulness of the information in project evaluation.
8. The forecast of ridership using park/ride access to an individual transit stop/station does not exceed the capacity of the associated park/ride lot as reported in the current planning and/or environmental documents for the alternatives.

11. Opening-year forecasts for the New Starts Build alternative are based on the same methodology as the out-year forecasts and are presented without adjustment.
12. The definitions of the New Starts Baseline and New Starts Build alternatives are up-to-date, include all items known to be part of the proposed scopes, and specifically identify any remaining sources of uncertainty in the scope of the project.
13. The capital cost estimates for the New Starts Baseline and New Starts Build alternatives are up-to-date, are based on unit costs that apply to expected conditions during construction, and specifically identify remaining uncertainties in those unit costs.
14. Estimates of operating and maintenance costs for the New Starts Baseline and New Starts Build alternatives are based on current local experience, are adjusted for differences in vehicle and service characteristics, and for any transit modes new to the system, are consistent with experience in similar settings elsewhere. All cost components are variable, not fixed. Costs vary with changes in service levels.
15. Annualization factors used to convert daily ridership and operating/maintenance costs into yearly totals are consistent with local experience and are the same for the New Starts Baseline and New Starts Build alternatives.
16. The capital cost estimates are presented in 2009 base year dollars as well as YOE$.
17. The financial plan has been updated with information from the most recent budget cycle.
18. Any financing costs incurred because of the project have been included in the total project cost as required by FTA, regardless of whether the project sponsor is seeking reimbursement of the costs from New Starts funds.
19. The full cost of preliminary engineering and final design has been included in the total project cost as required by FTA.

Therefore, I hereby certify that _____ (agency) has followed FTA's *Reporting Instructions for Section 5309 New Starts Criteria* (July 2009) in general, and the above-listed conventions in particular, in the preparation of this submission except for item(s) _____ that _____ (agency) has discussed with FTA and that FTA has approved.

_____ _____

Chief Executive Officer Date

APPENDIX C: Example Project Templates

Fitchburg Commuter Rail Line Improvements Project

PROJECT DESCRIPTION TEMPLATE		
PROJECT NAME:	**Fitchburg Commuter Rail Line Improvements Project**	
Participating Agencies		
Lead Agency	**Name**	Montachusett Regional Transit Authority
	Contact Person	Mohammed Khan
	Address	Montachusett Regional Transit Authority / R1427 Water
	Telephone Number	(978) 345-7711 , x2233
	Fax Number	(978) 345-9867
	Email	MKhan@mrta.us
Metropolitan Planning Organization	**Name**	Montachusett Regional Planning Commission
	Contact Person	Brad Harris
	Address	1427 Water St. / Fitchburg, MA 01420
	Telephone Number	(978) 645-7376 x2268
	Fax Number	(978) 348-2490
	Email	Bharris@mrpc.org
Transit Agency	**Name**	Montachusett Regional Transit Authority
	Contact Person	Mohammed Khan
	Address	Montachusett Regional Transit Authority / R1427 Water
	Telephone Number	(978) 345-7711 , x2233
	Fax Number	(978) 345-9867
	Email	MKhan@mrta.us
State Department of Transportation	**Name**	Massachusetts Executive Office of Transportation
	Contact Person	Steve Woelfel
	Address	Executive Office of Transportation, 10 Park Plaza, Suite
	Telephone Number	(617) 973-7474
	Fax Number	(617) 973-8035
	Email	Steve.Woelfel@eot.state.ma.us
Other Relevant Agencies	**Name**	Massachusetts Bay Transportation Authority
	Contact Person	Ronald Morgan
	Address	(617) 222-6181
	Telephone Number	(617)222-3130
	Fax Number	(617) 222-6181
	Email	rmorgan@mbta.com
Other Relevant Agencies	**Name**	Central Transportation Planning Staff (CTPS)
	Contact Person	Scott Peterson
	Address	Central Transportation Planning Staff / Ten Park Plaza /
	Telephone Number	(617) 973-7080
	Fax Number	(617) 973-8855
	Email	scottp@ctps.org
Other Relevant Agencies	**Name**	Metropolitan Area Planning Council
	Contact Person	Barbara Lucas
	Address	60 Temple Place / Boston, MA 02111
	Telephone Number	(617) 451-2770 x2043
	Fax Number	(617) 482-7185
	Email	blucas@mapc.org

PROJECT DESCRIPTION TEMPLATE (Page 2)		
Project Definition	**Length (miles)**	49.5
	Mode/Technology	Commuter Rail
	Number of Stations	18
	List each station separately, including the number of park and ride spaces at each and whether structured or surface parking	North Station
		Porter Square - 0 spaces
		Belmont - 0 spaces
		Waverley - 0 spaces
		Waltham - 45 surface spaces
		Brandeis/ Roberts - 58 surface spaces
		Kendal Green - 50 surface spaces
		Hastings - 8 surface spaces
		Silver Hill - 6 surface spaces
		Lincoln - 161 surface spaces
		Concord - 91 surface spaces
		West Concord - 191 surface spaces
		South Acton - 300 surface spaces
		Littleton / Rte 495 - 144 surface spaces
		Ayer - 72 surface spaces
		Shirley - 67 surface spaces
		North Leominster 141 spaces
		Fitchburg - 412 spaces (both structured and surface)
	List each station with major transfer facilities to other modes	North Station (MBTA Green & Orange Lines, 3 MBTA Commuter Rail Lines, 2 MBTA Bus Lines, Shuttle Service)
		Porter Square (MBTA Red Line, 4 MBTA Bus Lines)
		Belmont (3 MBTA Bus Lines)
		Waverley (7 MBTA Bus Lines)
		Waltham (7 MBTA Bus Lines)
		Brandeis/ Roberts (7 MBTA Bus Lines)
		North Leominster (MART Bus Lines)
		Fitchburg (MART Bus Lines, Fitchburg Intermodal Center)
	Number of vehicles/rolling stock	
Type of Alignment by Segment (Number of Miles)	**Above grade**	0
	Below grade	0
	At grade	49.5
	Exclusive	49.5
	Mixed Traffic	0
Status of Existing Right of Way	**Ownership – who owns the right of way?**	Massachusetts Bay Transportation Authority
	Current Use: active freight or passenger service?	Both

PROJECT DESCRIPTION TEMPLATE (Page 3)

Project Planning Dates	**Base Year**	**Base Year/Opening Year**
		2007/2012
Capital Cost Estimate	**2007 constant dollars**	$ 135,074,000
	Year of Expenditure	$ 149,983,000
Levels of Service	**Headways**	
	Weekday Peak	~30 minutes
	Weekday Off-peak	~1.5 hours
	Weekday Evening	~1.5 hours
	Weekend	~2 hours
	Hours of Service	
	Weekday	5:45 AM to 11:46 PM
	Weekend	6:50 AM to 1:01 AM
Opening Year Travel Forecast		10,600
Fare Policy Assumptions Used in Travel Forecasts [footnote 1]		Existing
Project Planning and Development Schedule	***Project Schedule***	
	Insert anticipated or actual dates/durations	
	Planning Studies Initiated	4/2003
	Planning Studies Completed	9/2007
	LPA selected	8/24/2007
	LPA included in the financially constrained long range plan	YES - FY 2000
	Included in Financially Constrained TIP	YES - FY 2008
	Initiation of NEPA Process *(A CE or EA will be prepared and reviewed by 12/31/07 to complete the project's NEPA requirements)*	8/24/2007
	Completion of NEPA Process	12/31/2007
	Initiation of FEIS	*n/a*
	Completion of FEIS	*n/a*
	Public Referenda (where applicable)	1/2009
	Preliminary Engineering (duration – dates of beginning and ending)	10/2007 to 6/2008
	Final Design (duration)	*n/a*
	PCGA- submit request to award (duration)	1/2008 to 1/2012
	Construction (duration)	9/2008 to 1/2012
	Testing (duration)	12/2001 to 1/20012
	Revenue Operations	1/2012 to 2/2012
Project Management		
Project Manager	**Name**	Mohammed Khan
	Address	Montachusett Regional Transit Authority / R1427 Water
	Phone	(978) 345-7711 , x2233
	Fax	(978) 345-9867
	Email	MKhan@mrta.us
Agency CEO	**Name**	Mohammed Khan
	Address	Montachusett Regional Transit Authority / R1427 Water
	Phone	(978) 345-7711 , x2233
	Fax	(978) 345-9867
	Email	MKhan@mrta.us
Key Agency Staff: Overall New Starts Criteria	**Name**	Elizabeth Falk
	Address	Montachusett Regional Transit Authority / R1427 Water
	Phone	(978) 345-7711 , x2237
	Fax	(978) 345-9867
	Email	efalk@mrta.us
Key Agency Staff: Ridership Forecasts	**Name**	Scott Peterson
	Address	Central Transportation Planning Staff / Ten Park Plaza /
	Phone	(617) 973-7080
	Fax	(617) 973-8855
	Email	scottp@ctps.org
Key Agency Staff: Cost Estimates	**Name**	David West
	Address	89 South Street 8th Floor / Boston , MA 02111
	Phone	(617) 222-3615
	Fax	(617) 222-8224
	Email	dave.west@mbcr.net

[1] Please summarize fare policy assumptions used for all regional transit services modeled in the forecast year. Attach this summary to the Project Description Template.

PROJECT DESCRIPTION TEMPLATE (Page 4)		
Project Management (continued)		
Key Agency Staff: Environmental Documentation	**Name**	Andrew Brennan (MBTA)
	Address	Massachusetts Bay Transportation Authority / 10 Park
	Phone	(617) 222-3126
	Fax	(617) 222-1557
	Email	abrennan@mbta.com
Key Agency Staff: Land Use Assessment	**Name**	Laila Michaud
	Address	1427 Water St. / Fitchburg, MA 01420
	Phone	(987) 345-7376 x2232
	Fax	(987) 348-2490
	Email	LMichaud@mrpc.org
Key Agency Staff: Financial Assessment	**Name**	Charles Passanisi, MBTA
	Address	Ten Park Plaza, 3rd Floor / Boston, MA 02116
	Phone	(617) 222-3365
	Fax	(617) 222-6180
	Email	cpassanisi@mbta.com
Key Agency Staff: Project Maps	**Name**	Bruce Kaplan, CTPS
	Address	Central Transportation Planning Staff / Ten Park Plaza /
	Phone	(617) 973-8112
	Fax	(617) 973-8855
	Email	bkaplan@ctps.org
Contractors		
Current Prime Contractor	**Name**	McMahon Associates
	Address	180 Canal Street / Suite 500 / Boston, MA 02114
	Phone	(617) 725 - 0099, x2002
	Fax	(617) 725 - 0049
	Email	
Prime Contractor: Project Manager	**Name**	William Steffens
	Address	180 Canal Street / Suite 500 / Boston, MA 02114
	Phone	(617) 725 - 0099, x2002
	Fax	(617) 725 - 0049
	Email	bill.steffens@mcmtrans.com
Contractor Responsible for Travel Forecasts	**Name**	Scott Peterson - CTPS
	Address	Central Transportation Planning Staff / Ten Park Plaza /
	Phone	(617) 973-7078
	Fax	(617) 973-8855
	Email	scottp@ctps.org
Contractor Responsible for Capital Cost Estimates	**Name**	William Steffens
	Address	McMahon Associates, Inc. / 180 Canal Street / Suite 500 /
	Phone	(617) 725-0099, x2002
	Fax	(617) 725-0049
	Email	bill.steffens@mcmtrans.com

TRAVEL FORECASTS TEMPLATE (OPENING YEAR)

PROJECT NAME: Fitchburg Commuter Rail Line Improvements Project

Line	Trip-Purpose-Specific Information	Source	Purpose 1	Purpose 2	Purpose 3	Purpose 4	Purpose 5	Purpose 6	Purpose 7	Purpose 8	DAILY TOTAL
1	Daily transit trips, Baseline Alternative	Summit: table 30	10,813								10,813
2	Daily transit trips, Build Alternative	Summit: table 40	11,492								11,492
3	Daily person trips, Build Alternative	Summit: table 20									0
4	Daily hours of user benefits (UB)	Summit: table 70 / 60	1,480								1,480
5	Positive UB hours from coverage changes	Summit: (tables 44+47+48) / 60									0
6	Daily hours of UBs changed by capping	Summit: capping impact / 60									0
7	Daily hours of UBs for transit dependents	Summit: standard report									0
	Trip-Purpose-Specific Quality-Control Measures										
8	Daily new transit trips		679	0	0	0	0	0	0	0	679
9	Daily new transit trips -- distribution (%)		100%	0%	0%	0%	0%	0%	0%	0%	100%
10	Daily user benefits -- distribution (%)		100%	0%	0%	0%	0%	0%	0%	0%	100%
11	Daily transit trips, Baseline Alternative -- distribution (%)		100%	0%	0%	0%	0%	0%	0%	0%	100%
12	Percent of user benefits lost to capping		0%	0%	0%	0%	0%	0%	0%	0%	0%
13	Percent of user benefits accruing to transit dependents		0%	0%	0%	0%	0%	0%	0%	0%	0%

Line	Special-Markets Information	Source	Market 1	Market 2	Market 3	Market 4	Market 5	Market 6	Market 7	Market 8	ANNUAL TOTAL
14	Special-market project trips per event-day	Special-market forecasts									0
15	Special-market UB hours per event-day	Special-market forecasts									0
16	Special-market pass-miles per event-day	Special-market forecasts									0
17	Annualization factor (event-days / year)	Special-market forecasts									---
	Special-Markets Quality-Control Measures										
18	Annual new transit trips, special markets only -- distribution (%)		0%	0%	0%	0%	0%	0%	0%	0%	0%
19	Annual user benefits, special markets only -- distribution (%)		0%	0%	0%	0%	0%	0%	0%	0%	0%
20	Minutes of user benefits per project trip, special markets only		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Line	General Information	Source	Entry	General Information	Source	Entry
21	Annualization factor (days/year)	Current/similar guideway	290			
22	Daily project trips, no special mkts	Travel forecasts	11,492			
23	Daily project trips, transit dependents	Travel forecasts		Station-area employees (within 1/2 mile)	Linked from Land Use Template	71,425
24	Daily project pass-miles, no special mkts	Travel forecasts		Station-area residents (within 1/2 mile)	Linked from Land Use Template	66,572
25	Daily project pass-miles, trn dependents	Travel forecasts		Project length (miles)	Linked from Project Descrip Template	49.5
	General Quality Control Measures (Excluding Special Markets)		**Value**	**General Quality Control Measures (Excluding Special Markets)**		**Value**
26	Minutes of user benefits per daily project trip (before capping)		7.7	Daily project trips per station area employee		0.16
27	Minutes of user benefits per daily project trip (after capping)		7.7	Daily project trips per station area resident		0.17
28	Percent of user benefits that are coverage related		0%	Daily minutes of user benefits per station area employee		1.24
29	Percent of user benefits that are off-model		0%	Daily minutes of user benefits per station area resident		1.33
30	Percent of project trips that are new transit trips		6%			
31	Project average trip distance / project length		0%			

COST-EFFECTIVENESS FOR SMALL STARTS TEMPLATE						
PROJECT NAME:		Fitchburg Commuter Rail Line Improvements Project				
Cost Effectiveness						
		Alternative		Difference	Value	Source/Calculation
Line	Item	New Starts Baseline	New Starts Build			
21	Annualized capital cost (millions of constant 2007 dollars)		$ 10	$ 10	---	Source: SSC Worksheets
22	Total systemwide annual operating and maintenance cost (millions of constant 2007 dollars)	$ 28	$ 28	$ (0)	---	Source: O&M cost models (attach documentation).
23	Total annualized cost in forecast year (millions of constant 2007 dollars)	$ 28	$ 38	$ 10	---	Sum of lines 21 and 22
24	Annual user benefits total (hours)	---	---	429,210	---	Line 6
25	Cost-Effectiveness: incremental annualized cost / annualized user benefits ($/hour)	---	---	---	$23.75	Line 23 divided by line 24
26	Total transit ridership	3,135,770	3,332,738	196,968		Linked from Travel Forecasts template
27	Cost Per New Transit Trip: incremental annualized cost / incremental annual transit trips ($/new trip)				$51.75	Line 23 divided by line 26

QUANTITATIVE LAND USE INFORMATION FOR SMALL STARTS	
PROJECT NAME:	**Fitchburg Commuter Rail Line Improvements Project**
Population and Employment – Metropolitan Area, CBD, and Station Areas	
Item	**BaseYear/Opening Year**
Metropolitan Area	
Total Population	4,465,551
Total Employment	2,408,584
Central Business District [see footnote 1]	
Total Employment	389,948
Employment – Percent of Metropolitan Area	0.161899274
CBD Lane Area (sq. mi.)	6.2
Employment Density (e.g., jobs per sq. mi.)	63,365
Total All Station Areas (1/2-mile radius) [See footnote 2]	
Housing Units	29,964
Population	66,572
Employment	71,425
Land Area (square miles)	13.4
Housing Unit Density (units per sq. mi.)	2237.0
Population Density (persons per sq. mi.)	4970.0
Employment Density (persons per sq. mi.)	5332.3

[1] Optionally, employment for the largest activity center(s) served by the New Start project may be reported.

QUANTITATIVE LAND USE INFORMATION FOR SMALL STARTS	
PROJECT NAME:	**Fitchburg Commuter Rail Line Improvements Project**

Population and Employment – Metropolitan Area, CBD, and Station Areas	
Item	**BaseYear/Opening Year**
Metropolitan Area	
Total Population	4,767,452
Total Employment	2,657,382
Central Business District [see footnote 1]	
Total Employment	426,689
Employment – Percent of Metropolitan Area	0.160567431
CBD Lane Area (sq. mi.)	6.2
Employment Density (e.g., jobs per sq. mi.)	69,335
Total All Station Areas (1/2-mile radius) [See footnote 2]	
Housing Units	32,174
Population	70,373
Employment	82,635
Land Area (square miles)	13.4
Housing Unit Density (units per sq. mi.)	2402.0
Population Density (persons per sq. mi.)	5253.8
Employment Density (persons per sq. mi.)	6169.2

[1] Optionally, employment for the largest activity center(s) served by the New Start project may be reported.

FINANCE TEMPLATE

PROJECT NAME:	Fitchburg Commuter Rail Line Improvements Project		
Total Capital Cost of Project in Millions of Constant 2007 Dollars (from the SCC Main Worksheet)	$135,074,000	**Total Capital Cost of Project in Millions of YOE dollars (including finance charges, cost of PE and FD, and construction):** (from SCC Main Worksheet)	$149,983,000
Section 5309 New Starts Funding Anticipated (YOE $):	$74,991,500	**Section 5309 New Starts Share of Project Cost:**	50.0%
Estimated Cost of Preliminary Engineering (YOE $):	$5,391,000	**Estimated Cost of Final Design (YOE $):**	$9,091,000
Total Finance Charges Included in Capital Cost (include finance charges that are expected prior to either the revenue operations date or the fulfillment of the Section 5309 New Starts funding commitment, even if the financing charges are incurred by a funding partner that is not the project sponsor): (from SCC Main Worksheet)			$177,000

Other Federal Capital Funding Sources (Non-5309 New Starts Funds such as FTA Section 5307, Surface Transportation Program (STP), Congestion Mitigation and Air Quality (CMAQ), Section 5309 Rail Modernization,	**Type of Funds**	**Dollar Amount (millions of YOE dollars)**	**% of Total Capital Cost**
CMAQ			0.0%
2)			0.0%
3)			0.0%
4)			0.0%
State Capital Funding Sources (Funds provided by State agencies or legislatures such as bonds, dedicated sales tax, annual legislative appropriation, transportation trust funds, etc.)	**Type of Funds**	**Dollar Amount (millions of YOE dollars)**	**% of Total Capital Cost**
FFGA			0.0%
2) Massachusetts Executive Office of Transportation and Public Works	Bond	$74,991,500	50.0%
3)			0.0%
4)			0.0%
Local Capital Funding Sources (Municipal, City, County, Township, or Regional funding such as bonds, sales tax, legislative appropriation, transportation trust funds, etc.)	**Type of Funds**	**Dollar Amount (millions of YOE dollars)**	**% of Total Capital Cost**
1)			0.0%
2)			0.0%
3)			0.0%
4)			0.0%
Private Sector/In-kind match/Other (Donations of right-of-way, construction of stations or parking, or funding for the project from a non-governmental entity, business, or business assoc.)	**Type of Funds**	**Dollar Amount (millions of YOE dollars)**	**% of Total Capital Cost**
1)			0.0%
2)			0.0%
3)			0.0%
TOTAL NON-SECTION 5309 FUNDING (millions of YOE dollars)		$74,991,500	50.0%
QA/QC CHECK: TOTAL CAPITAL COSTS LESS SECTION 5309 FUNDING LESS NON-SEC. 5309 FUNDING (SHOULD EQUAL		$0	---

FINANCE TEMPLATE (page 2)			
New Starts Project Financial Commitment			
Other Federal Sources (Linked from page 1)	**Specify Whether New or Existing Funding Source**	**Specify Status of Funds -- Committed, Budgeted, or Planned (See notes below)**	**Identify Supporting Documentation Submitted to Verify Funding Source**
CMAQ			
2)			
3)			
4)			
State Sources (Linked from page 1)			
FFGA			
2) Massachusetts Executive Office of Transportation and Public Works	Existing	Planned	EOT-PW is committed to seeking bond authorization for this project in the State Bond Bill anticipated to be filed in the Fall of 2007 with the Massachusetts State Legislature. The proceeds from the bond funds will be used as a state match (up to 50% or $75 million, whichever is lower) toward FTA's %5 million federal grant.
3)			
4)			
Local Sources (Linked from page 1)			
1)			
2)			
3)			
4)			
Private Sector/In-kind Match/Other (Linked from page 1)			
1)			
2)			
3)			

Reference Notes: The following categories and definitions are applied to funding sources:

Committed: Committed sources are programmed capital funds that **have all the necessary approvals** (legislative or referendum) to be used to fund the proposed project **without any additional action**. These capital funds have been formally programmed in the MPO's TIP and/or any related local, regional, or state CIP or appropriation. Examples include dedicated or approved tax revenues, state capital grants that have been approved by all required legislative bodies, cash reserves that have been dedicated to the proposed project, and additional debt capacity that requires no further approvals and has been dedicated by the transit agency to the proposed project.

Budgeted: This category is for funds that have been budgeted and/or programmed for use on the proposed project but remain uncommitted, i.e., the funds have not yet received statutory approval. Examples include debt financing in an agency-adopted CIP that has yet to receive final legislative approval, or state capital grants that have been included in the state budget, but are still awaiting legislative approval. These funds are almost certain to be committed in the near future. Funds will be classified as budgeted where available funding cannot be committed until the Full Funding Grant Agreement (FFGA) is executed, or due to local practices outside of the project sponsor's control (e.g., the project development schedule extends beyond the TIP period).

Planned: This category is for funds that are identified and have a reasonable chance of being committed, but are neither committed nor budgeted. Examples include proposed sources that require a scheduled referendum, reasonable requests for state/local capital grants, and proposed debt financing that has not yet been adopted in the agency's CIP.

FINANCE TEMPLATE (page 3)

Innovative Financing Methods
(Unconventional sources of funding which may include TIFIA, State Infrastructure Banks, Public/Private partnerships, Toll Credits, revenue finance methods, etc.)

Innovative Funding Source	Anticipated Funding Amount	Identify Supporting Documentation Submitted

Summary Information from the Operating Finance Plan

New Starts Project Annual Operating Cost in the Forecast Year (YOE$):		**Total Transit System (including New Starts Project) Annual Operating Cost in the Forecast Year (YOE$)**		
Proposed Sources of Operating Funds (Proposed sources of operating funds that are anticipated to support operating expenses of the transit system.)	**Dollar Amount**	**Type of Funding Source**	**Annual/Dedicated**	**Specify Whether New or Existing Funding Source**
Farebox Revenues		---	---	---
State Revenue Source A				
State Revenue Source B				
State Revenue Source C				
Local Revenue Source A				
Local Revenue Source B				
Local Revenue Source C				
Other				
Total	$0			

Transit System Operating Characteristics

Current Systemwide Characteristics (Can be the same data as reported to the FTA for the National Transit Database)	**Number/Value**	**Future Transit System with New Starts Project** (Systemwide characteristics at completion of the New Starts Project)	**Number/Value**
Farebox Recovery Percent		**Farebox Recovery Percent**	
Number of Buses		**Number of Buses**	
Number of Rail Vehicles		**Number of Rail Vehicles**	
Current Annual Passenger Boardings			
Daily Passenger Boardings			
Average Fare		**Average Fare**	
Average Age of Buses			
Average Age of Rail Vehicles			
Revenue Miles of Service Provided		**Revenue Miles of Service**	
Revenue Hours of Service Provided		**Revenue Hours of Service**	

East Bay Bus Rapid Transit

PROJECT DESCRIPTION TEMPLATE

PROJECT NAME:	East Bay Bus Rapid Transit	
Participating Agencies		
Lead Agency	**Name**	Alameda Contra-Costa Transit District (AC Transit)
	Contact Person	Jim Cunradi
	Address	1600 Franklin Street, Oakland, CA 94612
	Telephone Number	510-891-4841
	Fax Number	510-891-4874
	Email	jcunradi@actransit.org
Metropolitan Planning Organization	**Name**	Metropolitan Transportation Commission
	Contact Person	Valerie Knepper
	Address	Joseph P. Bort MetroCenter, 101 Eighth Street Oakland, CA 94607-4700
	Telephone Number	510-817-5824
	Fax Number	510-817-5848
	Email	vknepper@mtc.ca.gov
Transit Agency	**Name**	Alameda Contra-Costa Transit District (AC Transit)
	Contact Person	Jim Cunradi
	Address	1600 Franklin Street, Oakland, CA 94612
	Telephone Number	510-891-4841
	Fax Number	510-891-4874
	Email	jcunradi@actransit.org
State Department of Transportation	**Name**	California Department of Transportation (Caltrans)
	Contact Person	Jean Finney
	Address	111 Grand Ave, PO Box 23660, Oakland, CA 94623-0660
	Telephone Number	510-286-6196
	Fax Number	510-286-5559
	Email	jean_finney@dot.ca.gov
Other Relevant Agencies	**Name**	City of Berkeley
	Contact Person	Matt Nichols
	Address	1947 Center St, 3rd Flr, Berkeley, CA 94704
	Telephone Number	510-981-7068
	Fax Number	510-981-7060
	Email	mnichols@ci.berkeley.ca.us
Other Relevant Agencies	**Name**	City of Oakland
	Contact Person	Dan Lindheim
	Address	250 Frank Ogawa Plaza, Oakland, CA 94612-2033
	Telephone Number	510-238-6840
	Fax Number	510-238-4731
	Email	dlindheim@oaklandnet.com
Other Relevant Agencies	**Name**	City of San Leandro
	Contact Person	Keith Cooke
	Address	835 East 14th St, San Leandro, CA 94577
	Telephone Number	510-577-3439
	Fax Number	510-577-3294
	Email	kcooke@ci.san-leandro.ca.us
Other Relevant Agencies	**Name**	Alameda County
	Contact Person	Cindy Horvath
	Address	224 West Winton Avenue, Suite 111, Hayward, CA 94544
	Telephone Number	510-670-6511
	Fax Number	510-785-8793
	Email	cindy.horvath @ acgov.org
Other Relevant Agencies	**Name**	Alameda County Congestion Management Agency
	Contact Person	Dennis Fay
	Address	1333 Broadway, Suite 220, Oakland, CA, 94612
	Telephone Number	510-836-2560
	Fax Number	510-836-2185
	Email	dfay@accma.ca.gov
Other Relevant Agencies	**Name**	Alameda County Transportation Improvement Authority (ACTIA)
	Contact Person	Art Dao
	Address	1333 Broadway, Suite 300, Oakland, CA, 94612
	Telephone Number	510-893-3347
	Fax Number	510-893-6489
	Email	adao@actia2022.com

PROJECT DESCRIPTION TEMPLATE (Page 2)		
Project Definition	**Length (miles)**	16.9
	Mode/Technology	BRT
	Number of Stations	49
	List each station separately, including the number of park and ride spaces at each and whether structured or surface parking	See attachment for list of individual stations; no park and ride
	List each station with major transfer facilities to other modes	See attachment for list of individual stations and transfers; East Bay BRT provides connections to: BART, other AC Transit bus routes, UC Berkeley Bear Transit, and Emery Go Round (shuttle).
	Number of vehicles/rolling stock	31 peak vehicles, no increase over Baseline
Type of Alignment by Segment (Number of Miles)	**Above grade**	0
	Below grade	0
	At grade	16.9
	Exclusive	14.4
	Mixed Traffic	2.5
Status of Existing Right of Way	**Ownership – who owns the right of way?**	Cities of Berkeley, Oakland and San Leandro, Caltrans, and BART (public); and Bayfair Center (private)
	Current Use: active freight or passenger service?	No

PROJECT DESCRIPTION TEMPLATE (Page 3)

Project Planning Dates	**Base Year**	**Base Year/Opening Year**
		2015
Capital Cost Estimate	**2007 constant dollars**	$ 199
	Year of Expenditure	$ 235
Levels of Service	**Headways**	
	Weekday Peak	5 minutes
	Weekday Off-peak	5:00 AM-6:00 AM, 6 minutes 9:00 AM-3:00 PM, 5 minutes
	Weekday Evening	7 PM-Midnight: 10 minutes Midnight-5:00 AM: 60 minutes
	Weekend	Downtown Berkeley to Downtown Oakland: 5:00-6:00 AM, 15 minutes 6:00 AM-7:00 PM, 12 minutes 7:00 PM-Midnight, 15 minutes Midnight-5:00 AM, 60 minutes Dowtown Oakland to Bay Fair BART: 5:00-6:00 AM, 10 minutes 6:00 AM-7:00 PM, 8 minutes 7:00 PM-Midnight, 10 minutes Midnight-5:00 AM, 60 minutes
	Hours of Service	
	Weekday	5:00 AM to 4:59 AM
	Weekend	5:00 AM to 4:59 AM
Opening Year Travel Forecast		42,560
Fare Policy Assumptions Used in Travel Forecasts [footnote 1]		AC Transit - 1995 cash fare, $0.61 (1980 dollars) BART - 1995 cash fare (variable, station to station)

Project Planning and Development Schedule	***Project Schedule***	
	Insert anticipated or actual dates/durations	
	Planning Studies Initiated	1999
	Planning Studies Completed	2002
	LPA selected	Aug-01
	LPA included in the financially constrained long range plan	Feb-05
	Included in Financially Constrained TIP	n/a
	Initiation of DEIS	Jan-04
	Completion of DEIS	May-07
	Initiation of FEIS	Fall 2008
	Completion of FEIS	Spring 2010
	Public Referenda (where applicable)	n/a
	Preliminary Engineering (duration – dates of beginning and ending)	Fall 2008-Fall 2009
	Final Design (duration)	Spring 2010-Spring 2012
	FFGA- submit request to award (duration)	Spring 2012
	Construction (duration)	2012-2015 (2.5 yrs)
	Testing (duration)	1.5 months
	Revenue Operations	2015

Project Management		
Project Manager	**Name**	Jim Cunradi
	Address	1600 Franklin Street, Oakland, CA 94612
	Phone	510-891-4841
	Fax	510-891-4874
	Email	jcunradi@actransit.org
Agency CEO	**Name**	Rick Fernandez
	Address	1600 Franklin Street, Oakland, CA 94612
	Phone	510-891-4753
	Fax	
	Email	rfernand@actransit.org
Key Agency Staff: Overall New Starts Criteria	**Name**	Jim Cunradi
	Address	1600 Franklin Street, Oakland, CA 94612
	Phone	510-891-4841
	Fax	510-891-4874
	Email	jcunradi@actransit.org
Key Agency Staff: Ridership Forecasts	**Name**	Jim Cunradi
	Address	1600 Franklin Street, Oakland, CA 94612
	Phone	510-891-4841
	Fax	510-891-4874
	Email	jcunradi@actransit.org
Key Agency Staff: Cost Estimates	**Name**	Jim Cunradi
	Address	1600 Franklin Street, Oakland, CA 94612
	Phone	510-891-4841
	Fax	510-891-4874
	Email	jcunradi@actransit.org

[1] Please summarize fare policy assumptions used for all regional transit services modeled in the forecast year. Attach this summary to the Project Description Template.

PROJECT DESCRIPTION TEMPLATE (Page 4)		
Project Management (continued)		
Key Agency Staff: Environmental Documentation	**Name**	Jim Cunradi
	Address	1600 Franklin Street, Oakland, CA 94612
	Phone	510-891-4841
	Fax	510-891-4874
	Email	jcunradi@actransit.org
Key Agency Staff: Land Use Assessment	**Name**	Jim Cunradi
	Address	1600 Franklin Street, Oakland, CA 94612
	Phone	510-891-4841
	Fax	510-891-4874
	Email	jcunradi@actransit.org
Key Agency Staff: Financial Assessment	**Name**	Jim Cunradi
	Address	1600 Franklin Street, Oakland, CA 94612
	Phone	510-891-4841
	Fax	510-891-4874
	Email	jcunradi@actransit.org
Key Agency Staff: Project Maps	**Name**	Jim Cunradi
	Address	1600 Franklin Street, Oakland, CA 94612
	Phone	510-891-4841
	Fax	510-891-4874
	Email	jcunradi@actransit.org
Contractors		
Current Prime Contractor	**Name**	Cambridge Systematics, Inc.
	Address	555 12th Street, Suite 1600, Oakland, CA 94607
	Phone	510-873-8700
	Fax	510-873-8701
	Email	atang@camsys.com
Prime Contractor: Project Manager	**Name**	Andrew Tang
	Address	555 12th Street, Suite 1600, Oakland, CA 94607
	Phone	510-873-8700
	Fax	510-873-8701
	Email	atang@camsys.com
Contractor Responsible for Travel Forecasts	**Name**	Damian Stefanakis, Dowling Associates, Inc.
	Address	180 Grand Avenue, Suite 250, Oakland, CA 94612
	Phone	510-839-1742
	Fax	510-839-0871
	Email	damian@dowlinginc.com
Contractor Responsible for Capital Cost Estimates	**Name**	Conrad Franchi, Parsons Transportation Group
	Address	50 Fremont Street, Suite 1500, San Francisco, CA 94105
	Phone	415-490-2400
	Fax	415-546-1602
	Email	conrad.franchi@parsons.com

AC Transit East Bay BRT
List of Stations - 24 March 2008
Below for 24 March 2008 definition of BRT project

Station Location	BRT Station	Distance from Previous BRT Station (miles)	Transfer to
Shattuck at Center	1		BART, UC Berkeley Bear Transit, other AC routes
Shattuck at Bancroft	1	0.22	
Bancroft/Durant at Telegraph	1	0.47	UC Berkeley Bear Transit, other AC routes
Telegraph at Haste	1	0.16	
Telegraph at Derby	1	0.32	
Telegraph at Webster	1	0.43	Other AC routes
Telegraph at Alcatraz	1	0.40	
Telegraph at 57th	1	0.44	
Telegraph at 49th	1	0.49	Other AC routes
Telegraph at 39th	1	0.51	BART, Emery Go Round, other AC routes
Telegraph at 34th	1	0.42	
Telegraph at 30th	1	0.21	
Telegraph at 24th	1	0.39	
20th at Broadway	1	0.35	BART, other AC routes
Broadway at 14th	1	0.41	Other AC routes
11/12th at Broadway	1	0.15	BART, other AC routes
11/12th at Harrison	1	0.19	
11/12th at Madison	1	0.22	BART, other AC routes
International at 2nd	1	0.42	Other AC routes
International at 5th	1	0.20	Other AC routes
International at 10th	1	0.33	
International at 15th	1	0.37	Other AC routes
International at 20th	1	0.35	
International at Munson	1	0.22	Other AC routes
International at 28th	1	0.46	
International at 31st	1	0.22	Other AC routes
International at 35th	1	0.27	BART, other AC routes
International at High	1	0.48	Other AC routes
International at 54th	1	0.58	
International at Seminary	1	0.43	Other AC routes
International at Havenscourt	1	0.38	
International at 72nd	1	0.30	Other AC routes
International at 78th	1	0.28	
International at 82nd	1	0.30	Other AC routes
International at 90th	1	0.44	Other AC routes
International at 98th	1	0.44	Other AC routes
International at 104th	1	0.36	Other AC routes
E 14th at Durant	1	0.32	
E 14th at Georgia	1	0.29	
E 14th at Begier/Lorraine	1	0.25	
E 14th at Estudillo	1	0.34	Other AC routes
E 14th at Dolores/Parrott	1	0.23	
E 14th at Estabrook	1	0.36	
E 14th at 136th	1	0.42	
E 14th at 143rd	1	0.34	
E 14th at 148th	1	0.32	
E 14th at 150th	1	0.31	Other AC routes
Bayfair Center	1	0.47	Other AC routes
Bay Fair BART	1	0.27	BART, other AC routes
TOTAL	**49**		

Number of Stations by Area	**Number of Proposed BRT Stations**
Downtown Berkeley (Univ Ave to Oxford)	2
Berkeley Southside (Oxford to Dwight)	2
North Telegraph - Berkeley (Dwight to border)	2
North Telegraph - Oakland (border to SR24)	2
Temescal (SR24 to Shattuck)	1
Telegraph/MacArthur (Shattuck to I-580)	1
South Telegraph - Oakland (I-580 to 20th)	3
Downtown Oakland (20th to 11/12th)	2
Chinatown/Jack London (11/12th to 1st)	3
International - Eastlake (1st to 14th)	3
International - San Antonio (14th to 30th)	4
Fruitvale (30th to 42nd)	2
International - Central East Oakland (42nd to 73	5
International - Elmhurst (73rd to border)	5
San Leandro North (border to Davis)	3
Downtown San Leandro (Davis to Blossom)	3
San Leandro South (Blossom to Bay Fair Mall A	4
Bay Fair	2
Berkeley	6
Oakland	31
San Leandro	12

TRAVEL FORECASTS TEMPLATE (OPENING YEAR)

PROJECT NAME: East Bay Bus Rapid Transit

Line	Trip-Purpose-Specific Information	Source	HB Work	HB Social Rec	HB Shop Other	Non HB	HB School	HB College	Purpose 7	Purpose 8	DAILY TOTAL
1	Daily transit trips, Baseline Alternative	Summit: table 30	257,085	30,789	71,959	37,422	38,276	31,350			466,881
2	Daily transit trips, Build Alternative	Summit: table 40	259,531	31,099	73,907	38,621	39,155	31,384			473,697
3	Daily person trips, Build Alternative	Summit: table 20	1,586,545	823,219	1,448,167	1,580,617	591,502	74,396			6,104,446
4	Daily hours of user benefits (UB)	Summit: table 70 / 60	2,365	526	1,795	653	1,018	432			6,788
5	Positive UB hours from coverage changes	Summit: (tables 44+47+48) / 60	0	0	0	0					0
6	Daily hours of UBs changed by capping	Summit: capping impact / 60	-34	-5	-21	-5					-64
7	Daily hours of UBs for transit dependents	Summit: standard report									0
	Trip-Purpose-Specific Quality-Control Measures										
8	Daily new transit trips		2,446	310	1,948	1,199	879	34	0	0	6,816
9	Daily new transit trips -- distribution (%)		36%	5%	29%	18%	13%	0%	0%	0%	100%
10	Daily user benefits -- distribution (%)		35%	8%	26%	10%	15%	6%	0%	0%	100%
11	Daily transit trips, Baseline Alternative -- distribution (%)		55%	7%	15%	8%	8%	7%	0%	0%	100%
12	Percent of user benefits lost to capping		-1%	-1%	-1%	-1%	0%	0%	0%	0%	-1%
13	Percent of user benefits accruing to transit dependents		0%	0%	0%	0%	0%	0%	0%	0%	0%

Line	Special-Markets Information	Source	Market 1	Market 2	Market 3	Market 4	Market 5	Market 6	Market 7	Market 8	ANNUAL TOTAL
14	Special-market project trips per event-day	Special-market forecasts									0
15	Special-market UB hours per event-day	Special-market forecasts									0
16	Special-market pass-miles per event-day	Special-market forecasts									0
17	Annualization factor (event-days / year)	Special-market forecasts									---
	Special-Markets Quality-Control Measures										
18	Annual new transit trips, special markets only -- distribution (%)		0%	0%	0%	0%	0%	0%	0%	0%	0%
19	Annual user benefits, special markets only -- distribution (%)		0%	0%	0%	0%	0%	0%	0%	0%	0%
20	Minutes of user benefits per project trip, special markets only		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Line	General Information	Source	Entry	General Information	Source	Entry
21	Annualization factor (days/year)	Current/similar guideway	300			
22	Daily project trips, no special mkts	Travel forecasts	42,560			
23	Daily project trips, transit dependents	Travel forecasts		Station-area employees (within 1/2 mile)	Linked from Land Use Template	179,400
24	Daily project pass-miles, no special mkts	Travel forecasts	153,149	Station-area residents (within 1/2 mile)	Linked from Land Use Template	261,100
25	Daily project pass-miles, trn dependents	Travel forecasts		Project length (miles)	Linked from Project Descrip Template	16.9

	General Quality Control Measures (Excluding Special Markets)	Value	General Quality Control Measures (Excluding Special Markets)	Value
26	Minutes of user benefits per daily project trip (before capping)	9.7	Daily project trips per station area employee	0.24
27	Minutes of user benefits per daily project trip (after capping)	9.6	Daily project trips per station area resident	0.16
28	Percent of user benefits that are coverage related	0%	Daily minutes of user benefits per station area employee	2.27
29	Percent of user benefits that are off-model	0%	Daily minutes of user benefits per station area resident	1.56
30	Percent of project trips that are new transit trips	16%		
31	Project average trip distance / project length	21%		

APPENDIX D: 1997 to Current - List of National New Starts Projects

1997 to Current - List of National New Starts Projects

State	City	Project	Year Entered	FFGA Year
Alaska	Anchorage	Alaska Railroad South Anchorage Double Track	2003-2004	
	Craig	Hollis-Ketchikan Ferry	1998	
	Eagle River to Knik River	Eagle River to Knik River Commuter Rail	2004	
	Kink River - Wasillia	Alaska Railroad Knik River to Wasilla Commuter Rail	2003-2005	
	Prince William Sound	Alaska Marine Highway System	2003-2004	
Arizona	Phoenix	Central Phoenix/East Valley LRT Corridor	2000-2010	2007
Arkansas	Little Rock	Junction Bridge Project	1998-2000	
		River Rail Project	2001-2004	
California	Los Angeles	San Fernando Valley East-West Transit Corridor	2003	
		Mid-City Exposition Light Rail	2003-2005	
		LOSSAN CR to San Diego	1997-2004	
		MOS - 3 Segments of Metrorail	1997-2005	1997
		Eastside Corridor LRT	1997-2010	1997
		West Central	1997-1998	
		Transit Parkway	1997-1998	
	Orange County	Centerline Rail Corridor	1997-2005	
	Sacremento	South LRT Extension	1997-2002	2000
		South Corridor Phase 2	2010	
	San Diego	Mission Valley East LRT Extension	1997-2007	2002
		Oceanside Escondido Rail Project	1998-2007	2005
		Midcoast LRT Extension	1997-2006	
	San Francisco	Bayshore	1998-2000	
		BART Airport Extension	1997-2007	2000
		Third Street Light Rail Phase 1	2001-2003	
		New Central Subway	2004-2011	
	San Jose	Tasman LRT	1997-2001	1997
	Santa Clara County	Silicon Valley Rapid Transit	2004-2005	
	Vallejo	North Bay Ferry Service	1997-1998	
Colorado	Denver	Southwest Corridor	1997-2002	1997
		North Central Corridor	1997	
		Southeast Corridor LRT	2000-2010	2002
		West Corridor LRT	2003-2011	2010
		East Corridor	2011	
		Gold Line	2011	
	Fort Collins	Mason Street Transportation Center	2003-2005	
Conneticut	Bridgeport	Intermodal Center	2003-2005	
	Hartford	Griffin Line	1997-1998	
		Net Britain - Hartford Busway	2001-2011	
	Stamford	Urban Transitway and ITC Improvements	2003-2004	
Florida	Fort Lauderdale	Tri-Rail Commuter Rail Upgrade	2000-2005	2002
	Jacksonville	Flagler to duPont Place	1998	1998
	Miami	South Miami-Dade Busway Extenion	2001	
		East-West Corridor	1997-2001	
		North 27th Avenue Corridor	1997-2005	
	Orlando	I-4 Central Florida LRT Project	1998-2000	
		Central Florida Commuter Rail Transit	2010-2011	
	Tampa	Tampa Bay Regional Rail System	1997-2005	
Georgia	Atlanta	North Line Extension	1997-2005	1997
		Athens Corridor	1998	
		Greensboro Corridor	1997	
		Buckhead People Mover	1997-1998	
Hawaii	Honolulu	Primary Transportation Corridor Project	2003-2011	
Illinois	Chicago	Transit Improvements	1998	
		Central Area Circulator	1997	1997
		Douglas Branch Reconstruction	2001-2007	2002
		Metra South West Corridor Commuter Rail	2000-2006	2003
		Metra Commuter Rail (North Central)	2000-2006	2003
		Central Kane Corridor	2000	
		Metra Commuter Rail (UP West)	2001-2007	2003
		Ravenswood Line Extension	2001-2010	2005
Indiana	North Indiana	Northern Indiana Commuter Rail	1998	
Kentucky	Louisville	South Central Corridor LRT	2003-2005	
Louisiana	New Orleans	Canal Street	1997-2005	2005
		Desire Streetcar Study	1998-2005	
Maine	Boston-Portland	Boston-Portland CR	1997	

Data was obtained from FTA Annual Reports on New Starts
Complete aata for years 1999 and 2002 were unavailable.

1997 to Current - List of National New Starts Projects

State	City	Project	Year Entered	FFGA Year
Maryland	Baltimore	Glen-Burnie LRT Extension	1998	
		Central LRT Extension	1997-1998	1997
		Central Corridor LRT Double Track	2000-2007	2003
		MARC Penn-Camden Connection	2004	
	InterCity	MARC Extension to Frederick	1997-2000	1997
		MARC Commuter Rail Improvements	2001-2003	
		Waldorf Corridor Study	1997-1998	
		MARC Intermodal Transit Center	2004	
Massachusetts	Boston	South Boston Piers Phase 2	1997-2005	
		South Boston Piers Phase 1	1997-2003	1997
		New Bedford/Fall River	1997	
		North Station-S. Station Rail Link	1997-1998	
		Urban Ring Study	1997-1998	
		Silver Line Phase 3	2004	
	Lowell - Nashua	Lowell - Nashua, NH Commuter Rail	2003-2005	
Michigan	Detroit	Woodward Corridor	1997-1998	
Minnesota	Minneapolis	Hiawatha Corridor Transitway	2000-2005	2002
		Northstar Commuter Rail	2003-2010	2009
		St. Paul Central Connector	1997-2011	
Mississippi	Jackson	Intermodal Center	1998	
Missouri	Kansas City	Southtown Corridor BRT	1997-2005	
		I-35 Commuter Rail - Johnson Cty, KS		
	St. Louis	St. Clair Extension	1997-2005	1998
		Metrolink	1997-1998	1997
		Cross-County Corridor	1997-1998	
		St. Charles Corridor	1997-1998	
Nevada	Las Vegas	Resort Corridor Fixed Guideway MOS	2000-2005	
New Jersey		Secaucus	1997-1998	1997
		Hudson-Bergen LRT	1997-2005	1998
		Hudson-Bergen LRT MOS-2	2000-2011	2002
		Burlington-Gloucester	1997-1998	
		Hawthorne Warwick Corridor	1997-1998	
		Lakewood Freehold Matawan	1997-1998	
		West Trenton Commuter Rail	1998	
		Access to Region's Core	2010-2011	
	Newark	Rail Link (MOS-1)	1997-2005	2002
New York	New York City	Queens Connection	1997-1998	1997
		LIRR East Side Access	2000-2010	2008
		2nd Avenue Subway	2001-2011	2009
		New York/New Jersey West Shore Corridor	1997-1998	
		Midtown Ferry	1997-1998	
		Whitehall Ferry Terminal	1997-1998	
North Carolina	Charlotte	South Corridor LRT Project	1997-2007	2007
	Raleigh-Durham	Research Triangle Regional Rail	1998-2005	
Ohio	Cinncinnati	Northeast Corridor	1997-2004	
	Cleveland	Dual Hub Corridor (Canton-Akron)	1997-1998	
		Highland Hills Extension	1997-1998	
		Northeast Ohio Corridor	1997-1998	
		Euclid Corridor Improvement Project	1998-2007	2006
		Euclid Corridor BRT	2003	
	Columbus	North Corridor	2003-2005	
Oklahoma	Oklahoma City	MAPS Link	1997-2000	
Oregon	Portland	Westside Hillsboro LRT	1997-2001	1997
		South-North Corridor	1997-2000	
		Interstate MAX LRT Extension	2001-2007	2002
		Wilsonville to Beaverton Commuter Rail	2003-2007	
		South Corridor I-205/Portland Mall LRT	2007-2010	2009

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Complete aata for years 1999 and 2002 were unavailable.

1997 to Current - List of National New Starts Projects

State	City	Project	Year Entered	FFGA Year
Pennsylvannia	Altoona, PA	Pedestrian Crossover	1997-1998	
	Harrisburg	CorridorOne Rail	2004-2005	
	Philadelphia	Cross County Metro Corridor	1997-1998	
		Northeast Corridor	1997-1998	
		Schuklkill Valley Metrorail	2003-2005	
	Pittsburgh	Airport Busway Phase 1	2000	
		Phase 1 Airport Busway Wabash HOV	1998	1998
		Stage II LRT Reconstruction	1997-2005	2002
		Northshore LRT Connector	2003-2010	2008
Puerto Rico	San Juan	Tren Urbano	1997-2007	1997
		Minillas Extension	2004-2005	
Rhode Island	Pawtucket	Rhode Island commuter Rail Improvement Program	2003-2004	
Tennessee	Memphis	Medical Center Extension	2000-2005	2002
		Regional Rail Plan	1997-1998	
	Nashville	East Corridor Commuter Rail	2001-2004	
Texas	Austin	Northwest/North Central Corridor	1997-2004	
	Dallas	South Oak Cliff	1997	1997
		RAILTRAN CR	1997-2000	
		North Central LRT Extension	1998-2005	2001
		Northwest Southwest LRT MOS	2003-2011	2008
		Trinity Railway Express	2001	
	El Paso	Sun Metro Area Rapid Transit (SMART) Starter Line	2005	
	Gavleston	Trolley Extension	2003-2005	
	Houston	Regional Bus Plan	1997-2002	1997
		Downtown to Astrodome Light Rail	2001	
		North Corridor	2008-2011	
		Southeast Corridor	2008-2011	
Utah	Salt Lake City	North-South LRT	1997-2003	1997
		Downtown Connector	2000-2005	2002
		Medical Center Extension	2003-2005	2004
		Weber County to Salt Lake City Commuter Rail	2005-2011	2008
		Mid-Jordan LRT	2010-2011	2010
Vermont	Burlington	Burlington-Charlotte Corridor	1997-1998	
		Burlington-Essex Corridor	1997-2004	
Virginia	Norfolk	Virginia Beach Corridor	1997-2009	2009
	Multi-City	Virginia Railway Express	1998	
Washington	Seattle	Sound Move - Central Link LRT (MOS)	1997-2010	2005
		Seattle Tacoma Commuter Rail	1997-2003	
		Everett to Seattle Commuter Rail	2001-2004	
		Link Extension and North Link	2003-2004	
		Airport Link	2004	
		University Link Extension	2007-2011	2010
Washington, DC		Largo Extension	1997-2010	2003
		Dulles Corridor	1997-2011	2010
		MARC Mid-Day Storage	2004	
West Virginia	Morgantown	Train Control Study	1998	
Wisconsin	Milwuaukee	East-West Corridor	1997-1998	

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Complete aata for years 1999 and 2002 were unavailable.

APPENDIX E: 1997 to Current - List of Florida New Starts Projects

1997 to Current - List of Florida New Starts Projects

FTA New Starts Submission Record for the State of Florida, 1997 - 2010			
1997			
City	Project	Phase	Rating
Fort Lauderdale	Tri-County Commuter Rail	Final Design	Highly Recommended
Jacksonville	Flagler to duPont Place	Final Design	N/A
Miami	East/West Corridor	MIS/Systems Planning	N/A
Miami	North 27th Avenue Corridor	MIS/Systems Planning	N/A
Tampa	Tampa Lakeland Corridor	MIS/Systems Planning	N/A
1998			
City	Project	Phase	Rating
Jacksonville	Flagler to duPont Place	Full Funding Grant Agreement	FFGA
Fort Lauderdale	Tri-County Commuter Rail	Final Design	Highly Recommended
Miami	East/West Corridor	Preliminary Engineering	N/A
Miami	North 27th Avenue Corridor	Preliminary Engineering	N/A
Orlando	I-4 Central Florida Light Rail System	Preliminary Engineering	N/A
Tampa	Tampa Lakeland Corridor	MIS/Systems Planning	N/A
2000			
City	Project	Phase	Rating
Fort Lauderdale	Tri-County Commuter Rail Upgrade	Proposed Full Funding Grant Agreement	Highly Recommended
Orlando	I-4 Central Florida Light Rail System	Proposed Full Funding Grant Agreement	Highly Recommended
Miami	East/West Corridor	Preliminary Engineering	Not Recommended
Miami	North 27th Avenue Corridor	Preliminary Engineering	Not Recommended
Tampa	Tampa Regional Rail	Preliminary Engineering	Not Recommended
2001			
City	Project	Phase	Rating
Fort Lauderdale	Tri-County Commuter Rail Upgrade	Pending Full Funding Grant Agreement	Recommended
Miami	South Miami-Dade Busway Extension	Preliminary Engineering	Recommended
Miami	East/West Corridor	Preliminary Engineering	Not Recommended
Miami	North 27th Avenue Corridor	Preliminary Engineering	Not Recommended
Tampa	Tampa Regional Rail	Preliminary Engineering	Not Recommended
2002			
City	Project	Phase	Rating
Fort Lauderdale	Tri-County Commuter Rail Upgrade	Existing Full Funding Grant Agreement	FFGA
Miami	South Miami-Dade Busway Extension	Proposed Funding Commitments	Exempt due to Low Cost
Miami	North 27th Avenue Corridor	Preliminary Engineering	Not Recommended
2003			
City	Project	Phase	Rating
Fort Lauderdale	Tri-County Commuter Rail Upgrade	Existing Full Funding Grant Agreement	FFGA
Miami	North 27th Avenue Corridor	Preliminary Engineering	Not Recommended
Tampa	Tampa Regional Rail System	Preliminary Engineering	Not Recommended
2004			
City	Project	Phase	Rating
Fort Lauderdale	Tri-County Commuter Rail Upgrade	Existing Full Funding Grant Agreement	FFGA
Miami	North Corridor Metrorail Extension	Preliminary Engineering	Not Recommended
Tampa	Tampa Regional Rail System	Preliminary Engineering	Not Recommended
2005			
City	Project	Phase	Rating
Fort Lauderdale	South Florida Commuter Rail Upgrade	Existing Full Funding Grant Agreement	FFGA
Miami	North Corridor Metrorail Extension	Preliminary Engineering	Not Recommended
Tampa	Tampa Regional Rail System	Preliminary Engineering	Not Recommended
2006			
City	Project	Phase	Rating
Fort Lauderdale	South Florida Commuter Rail Upgrade	Existing Full Funding Grant Agreement	FFGA
Miami	North Corridor Metrorail Extension	Preliminary Engineering	Not Rated
Tampa	Tampa Regional Rail System	Preliminary Engineering	Not Recommended
2007			
City	Project	Phase	Rating
Miami	North Corridor Metrorail Extension	Preliminary Engineering	Medium
2008			
City	Project	Phase	Rating
Jacksonville	Downtown Transit Service Enhancement Project	Preliminary Engineering	Exempt due to Low Cost
Miami	North Corridor Metrorail Extension	Preliminary Engineering	Medium
2009			
City	Project	Phase	Rating
Miami	Orange Line Phase 2: North Corridor Metrorail Ext.	Preliminary Engineering	Medium
Orlando	Ctrl Florida Commuter Rail- Initial Operating Segment	Preliminary Engineering	Medium
2010			
City	Project	Phase	Rating
Orlando	Ctrl Florida Commuter Rail- Intial Operation Segment	Recommended Full Funding Grant Agreements	Medium
Miami	Orange Line Phase 2: North Corridor Metrorail Ext.	Preliminary Engineering	Medium-Low

Information for Year 1999 Not Available
N/A = Not Available
FFGA = Full Funding Grant Agreement

Information Obtained through FTA New Starts Program Annual Reports, Provided at: http://www.fta.dot.gov/planning/newstarts/planning_environment_2618.html