Contractor Performance Assessment Report

September 2007

Prepared by:
Federal Transit Administration
Office of Planning and Environment
U.S. Department of Transportation

http://www.fta.dot.gov

Alphabetical List of Acronyms

Acronym	Name
AA	Alternatives Analysis
ANPRM	Advanced Notice of Proposed Rulemaking
BRT	Bus Rapid Transit
CBD	Central Business District
CMAQ	Congestion Mitigation and Air Quality
DOT	Department of Transportation
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FONSI	Finding of No Significant Impact
FFGA	Full Funding Grant Agreement
FTA	Federal Transit Administration
FY	Fiscal Year
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
HRT	Heavy Rail Transit
LPA	Locally-Preferred Alternative
LRT	Light Rail Transit
MIS	Major Investment Study
MOS	Minimum Operable Segment
NEPA	National Environmental Policy Act
NPRM	Notice of Proposed Rulemaking
PE	Preliminary Engineering
ROW	Right-of-Way
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TEA-21	Transportation Equity Act for the 21st Century (1998)
STP	Surface Transportation Program
USC	United States Code
YOE	Year of Expenditure

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1 Introduction

Section 5309 of Title 49 of the United States Code, as amended by the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), emphasizes the need to improve the quality of the estimates of ridership and costs used to support funding decisions for major transit investments. To help fulfill this goal, FTA is required to submit an annual report to Congress that documents and analyzes the performance of contractors that develop cost and ridership estimates to support decision-making for New Starts and Small Starts projects. The SAFETEA-LU Conference Report indicates that the Contractor Performance Assessment Report (CPAR) "will provide public transportation agencies with an informational tool, allowing them to better identify contractors able to perform accurate estimates of cost and ridership figures. Additionally, consulting the CPAR as a condition of Federal assistance will help ensure the reliability of estimates used in awarding FFGAs."

The contractor performance report is required in 49 U.S.C. 5309(l)(2), as amended by SAFETEA-LU. The relevant text in the law is as follows:

> *(2) CONTRACTOR PERFORMANCE ASSESSMENT REPORT.*
> *(A) IN GENERAL. Not later than 180 days after the enactment of the Federal Public Transportation Act of 2005, and each year thereafter, the Secretary shall submit to the committees referred to in subsection (k)(1) a report analyzing the consistency and accuracy of cost and ridership estimates made by each contractor to public transportation agencies developing new fixed guideway capital projects.*
> *(B) CONTENTS. The report submitted under subparagraph (A) shall compare the cost and ridership estimates made at the time projects are approved for entrance into preliminary engineering with*
> > *(i) estimates made at the time projects are approved for entrance into final design;*
> > *(ii) costs and ridership when the project commences revenue operation; and*
> > *(iii) costs and ridership when the project has been in operation for 2 years.*
>
> *(C) CONSIDERATIONS. In making comparisons under subparagraph (B), the Secretary shall consider factors having an impact on costs and ridership not under the control of the contractor. The Secretary shall also consider the role taken by each contractor in the development of the project.*

The Contractor Performance Assessment Report requirement is representative of a major theme in SAFETEA-LU: that the reliability of planning information is critical for decision making. In addition to the Contractor Performance Assessment Report provision, this theme is reiterated in several places in SAFETEA-LU, including: 1) the incorporation of Before and After Study requirements into law (49 U.S.C. 5309(g)(2)(C)); 2) the addition of forecast accuracy and reliability as a specific New Starts rating criterion (49 U.S.C. 5309(d)(3)(B) and 5309(d)(4)(B)(i)); and 3) the introduction of incentive provisions for producing accurate ridership and cost estimates (e.g., 49 U.S.C. 5309 (l)(3)).

FTA has long been concerned about the reliability of the cost and ridership information used in the planning and project development process. The Department of Transportation's 1990 report on this subject[1], several studies by Bent Flyvbjerg[2], and analyses by FTA have documented the fact that the majority of rail transit projects have significantly underestimated their construction costs and overestimated the actual ridership at the time those projects were chosen locally as the preferred alternatives, compared to the actual cost and ridership figures after the projects were constructed. While FTA's 2003 analysis of the predicted and actual ridership and cost information for 19 New Starts projects (see Appendix) show improvements versus those documented in the Department's 1990 report, there is considerable room for improvement. This Contractor Performance Assessment Report and subsequent annual Reports will support improved forecasts by providing valuable information to project sponsors about the quality of the information provided by contractors that prepare cost and ridership estimates for prospective New Starts and Small Starts projects.

[1] Pickrell, D.H., 1990. *Urban Rail Transit Projects: Forecast versus Actual Ridership and Cost*. US Department of Transportation, Washington, DC.

[2] "How (In)accurate Are Demand Forecasts in Public Works Projects? The Case of Transportation." Principal author: Bent Flyvbjerg; co-authors: Mette Skamris Holm and Søren L. Buhl. *Journal of the American Planning Association*, vol. 71, no. 2, Spring 2005, pp. 131-146.

"How Common and How Large Are Cost Overruns in Transport Infrastructure Projects?" Principal author: Bent Flyvbjerg; co-authors: Mette K. Skamris Holm and Søren L. Buhl. *Transport Reviews*, vol. 23, no. 1, January-March 2003, pp. 71-88.

2 Approach to the Contractor Performance Assessments

Since the Contractor Performance Assessment is based on much of the information that is also included in the *Before and After Study* reports and coincides with the same key decision points, FTA will track the information for these two efforts together. The Contractor Performance Assessment Reports extend the *Before and After Study* information to include the identification of each party responsible for the cost and ridership information. During the New Starts/Small Starts project development process project sponsors report cost estimates and ridership forecasting information to support the data collection and analysis requirements of the *Before and After Studies.* FTA will use this information to attribute, if possible, the causes and responsibility for those changes when FTA prepares future Contractor Performance Assessment Reports.

FTA's approach to this new requirement is forward looking. Projects that were not yet in preliminary engineering, final design, or project development as of May 2006 – when FTA published policy guidance establishing this requirement – are subject to these contractor performance reporting requirements.

The requirement to publish an assessment of contractor performance is likely to change the manner in which contractors and project sponsors relate to each other during planning and project development. Responsibilities for the inputs needed to develop cost estimates and ridership forecasts will likely become more clearly delineated since contractors will strongly desire to make certain that they are not found responsible for errors that are the fault of outside parties.

FTA is cognizant of the fact that contractors only play one part in the development of cost and ridership forecasts. Contractors generally make extensive use of information and other forecasts and estimates provided by project sponsors, metropolitan planning organizations, and other local agencies. Therefore, FTA will not focus entirely on contractor performance but on the reliability of the forecasts from whatever source they are derived.

For both the *Contractor Performance Assessment Report*, and the *Before and After Studies*, FTA intends to evaluate cost and ridership estimates at the key decision-making points and compare these estimates to actual results after the project has been completed. The reporting times for cost and ridership forecasts and for identifying the parties responsible for the inputs and estimates will be:

- Entry into Preliminary Engineering for New Starts or Project Development for Small Starts;
- Entry into Final Design (for New Starts); and
- Signing of Full Funding Grant Agreement (FFGA) or Project Construction Grant Agreement (PCGA).

The three milestones correspond to key decision points for FTA and the project sponsors. FTA will then assess the contractors' performance by comparing the forecasts of ridership and costs prepared at these decision points to the actual ridership and capital costs two years after opening to revenue service.

3 Contractor Performance Assessment Information

3.1 New Starts Projects

Four New Starts projects have been admitted to Preliminary Engineering since the contractor performance assessment was established:

1. New Jersey Transit's Trans-Hudson Tunnel Project (Access to the Region's Core);
2. Central Corridor Light Rail Transit (LRT) in Minneapolis/St. Paul;
3. Central Florida Commuter Rail project in Orlando; and
4. Mid-Jordan LRT (MJLRT) extension in Salt Lake City.

None of these projects has yet advanced into final design. One additional project, the Silver Line Phase III BRT in Boston, was re-approved into preliminary engineering in December 2006. This project was originally approved in the summer of 2000 and is not subject to the contractor performance assessment requirement.

3.1.1 Access to the Region's Core, Northern New Jersey

The New Jersey Transit Corporation (NJT) is proposing to construct a new 9.3-mile commuter rail line along the existing Northeast (Rail) Corridor (NEC) between Secaucus, New Jersey and Manhattan. The Trans Hudson Express Tunnel project, also known as "Access to the Region's Core" (ARC), includes the construction of two new tunnels under the Hudson River, new rail tracks between Secaucus Junction and New York Penn Station (NYPS), a new six-track rail station underneath 34th Street in midtown Manhattan (with pedestrian linkages to NYPS), a storage yard in Kearny, New Jersey, and the purchase of 20 rail locomotives and 200 bi-level coaches.

NJT completed a major investment study on the ARC corridor in 2003. A new Hudson River rail tunnel and expanded Penn Station capacity alternative was selected as the locally preferred alternative (LPA) in early 2006. FTA approved the LPA into preliminary engineering in August 2006.

Reporting Item	Information at Entry to Preliminary Engineering
Project Length Number of Stations First Year of Construction	9.3 Miles 1 2008
Opening Year Ridership (2015) Forecast Year Ridership (2030)	230,290 Average weekday boardings 67,705,260 Annual boardings 268,423 Average weekday boardings 78,916,362 Annual boardings
Responsible Party for Ridership Forecasts	New Jersey Transit One Penn Plaza East Newark, NJ 07105
Ridership Forecasting Consulting Support	AECOM Consulting 3101 Wilson Blvd, 4th floor Arlington, VA 22031

Reporting Item	Information at Entry to Preliminary Engineering
Capital Cost Estimates	$6.1095 billion (2005 $) $7.176 billion (YOE)
Responsible Party for Capital Cost Estimates	Transit Link Consultants (Joint Venture of Parsons Brinckerhoff and SYSTRA Consulting, Inc.) 2 Gateway Center #18 Newark, NJ 07102

3.1.2 Central Corridor LRT, St. Paul-Minneapolis, MN

The Metropolitan Council/Metro Transit (Met Council), in cooperation with the Ramsey and Hennepin Counties Regional Rail Authorities (RCRRA and HCRRA), is proposing an 11-mile, double-tracked light rail transit (LRT) line that would connect the downtowns of St. Paul and Minneapolis, while serving a number of other significant activity centers such as the University of Minnesota, the State Capitol, and major event venues (Target Center, Metrodome). From Minneapolis, the proposed Central Corridor LRT service would operate along 1.2-miles of the existing Hiawatha LRT in downtown before turning east in its own right-of-way, crossing the Mississippi River on the existing Washington Avenue Bridge to St. Paul, and following University Avenue to the State Capitol area, finally terminating at Union Depot in downtown St. Paul. The project scope includes a 0.6-mile tunnel through the University of Minnesota campus. The alignment would operate in an exclusive guideway with no mixed traffic operations. Metro Transit plans to procure 31 light rail vehicles for service which would operate at 7.5-minute peak-period frequencies.

The RCRRA, in cooperation with the Met Council, completed an alternatives analysis/Draft Environmental Impact Statement (AA/Draft EIS) in the Central Corridor linking downtown Minneapolis and St. Paul in April 2006. LRT was selected as the locally preferred alternative. FTA approved the project into Preliminary Engineering in December 2006.

Reporting Item	Information at Entry to Preliminary Engineering
Project Length Number of Stations First Year of Construction	11 Miles 16 Stations 2010
Opening Year Ridership (2014) Forecast Year Ridership (2030)	34,300 Average weekday boardings 43,300 Average weekday boardings
Responsible Party for Ridership Forecasts	AECOM Consulting 3101 Wilson Blvd 4th floor Arlington, VA 22031
Capital Cost Estimates	$817 million (2006 $) $932.30 million (YOE $)
Responsible Party for Capital Cost Estimates	URS Corporation Thresher House 700 Third Street South Minneapolis, Minnesota, USA 55415-1199

3.1.3 Central Florida Commuter Rail, Orlando, FL

The Florida Department of Transportation (FDOT) is proposing the CFCRT to be a 60.8-mile new commuter rail system, which will serve 16 stations. The CFCRT Project is proposed to operate bi-directional service on the existing CSX Transportation, Inc. (CSXT) A-Line rail corridor from the existing DeLand Amtrak Station in Volusia County, south through downtown Orlando and Kissimmee until its terminus at the Poinciana Industrial Park at the intersection on US 17/92 and the CSXT tracks in Osceola County. The CFCRT includes the purchase of 34 Diesel Multiple Unit (DMU) vehicles, 33-miles of new track, a new railway operations signal system, and a vehicle storage and maintenance facility (VSMF).

The CFCRT Project will be implemented in three phases. Phase 1, also known as the Initial Operating Segment (IOS), is the 31-mile long north corridor consisting of 10 stations between DeBary/Saxon Boulevard Extension Station and Orlando Amtrak/ORMC Station. Phase 2 is the south corridor, which will be a 23-mile extension of the IOS from Orlando Amtrak/ORMC Station to Poinciana Industrial Park (five stations total). Phases 1 and 2 combined make up the 54-mile LPA which has been approved into PE. Phase 1 is proposed to be operational by 2009 and Phase 2 by 2013. Phase 3, a seven-mile extension of the LPA north to the DeLand Amtrak Station, defines the entire 60.8-mile long system.

The LPA is currently undergoing an Environmental Assessment in compliance with the National Environmental Policy Act (NEPA).

Reporting Item	Information at Entry to Preliminary Engineering
Project Length Number of Stations First Year of Construction	54 Miles 16 Stations 2007 (4th Quarter)
Opening Year Ridership (2009) Forecast Year Ridership (2030)	3,619 Average weekday boardings 1,049,510 Annual boardings 10,676 Average weekday boardings 3,096,040 Annual boardings
Responsible Party for Ridership Forecasts	AECOM Consulting 3101 Wilson Blvd 4th floor Arlington, VA 22031
Capital Cost Estimates	$542.36 million (2007 $) $602.14 million (YOE $)
Responsible Party for Capital Cost Estimates	Earthtech 30 Keller Road Suite 500 Orlando, FL 32810

The opening year ridership forecast for the Orlando Commuter Rail project appears to have been developed contrary to FTA guidance. The consultant appears to have factored the opening year forecast down by an additional 55 percent in addition to the effect of lower population and employment in the opening year. FTA is still discussing this matter with FDOT to ascertain the cause of the unusually low opening year ridership projection.

FTA is aware that an unfortunate consequence of FTA's New Starts rating process and the Contractor Performance Assessment Report may be that contractors and sponsors have an incentive to produce low opening year forecasts and high long-range forecasts. The project's mobility benefits and cost-effectiveness evaluation are based on the forecast year results while the contractor's performance is evaluated based on the opening year forecast. Project sponsors also may be inclined to project low opening year ridership because of the public relations impact if actual performance exceeds projections.

In order to make a reasonable assessment of the contractor's performance, FTA needs opening year forecasts to be developed in a manner that is entirely consistent with the long range forecast but reflect opening year demographic information. FTA is working with the project sponsor to develop acceptable opening year forecasts.

3.1.4 Mid Jordan (MJLRT), Salt Lake City, UT

The MJLRT will be a 10.6 mile double-track extension of the existing Utah Transit Authority (UTA) Light Rail Transit (TRAX) Sandy/Salt Lake Line that will serve nine new stations. The project will include 28 new light rail vehicles and additional storage tracks at the Midvale Maintenance Facility. The MJLRT will operate on the 10.6 mile extension and interline with existing Sandy/Salt Lake TRAX service to downtown Salt Lake City and terminate at the Intermodal Hub currently under construction.

After this project applied to enter Preliminary Engineering, FTA's Project Management Oversight Contractor (PMOC) found that the costs developed during alternatives analysis were very likely to be underestimated. Therefore, FTA will track cost estimates for this project from the initial Preliminary Engineering submission which are $329.12 million in 2006 dollars and $354.09 million in year of expenditure dollars. The UTA's revised PE submittal increased the cost estimates to $357.1 million in 2006 dollars and $384.4 million in year of expenditure dollars (YOE$). Subsequent to this, the costs increased again to $412.7 million in 2006 dollars and $473.4 million in YOE$ due to changes in project scope, primarily 10 additional rail vehicles and 10 additional buses.

UTA's current schedule is to begin revenue operations on the MJLRT project in January 2010. UTA recently decided to use design/build as their preferred delivery method for this project. The MJLRT project is currently undergoing the National Environmental Policy Act (NEPA) review. A Draft EIS was signed in July 2005 and FTA is working with UTA to prepare the Final EIS for public review at this time.

Reporting Item	Information at Entry to Preliminary Engineering
Project Length Number of Stations First Year of Construction	10.6 Miles 9 Stations 2008
Opening Year Ridership (2010) Forecast Year Ridership (2030)	5,303 Average weekday boardings 1,548,371 Annual boardings 9,469 Average weekday boardings 2,764,948 Annual boardings
Responsible Party for Ridership Forecasts	Utah Transit Authority (developed internally) 3600 South 700 West P.O. Box 30810 Salt Lake City, UT 84130-0810
Capital Cost Estimates	$329.12 million (2006 $) $354.09 million (YOE $)
Responsible Party for Capital Cost Estimates	Parsons Transportation Group 406 W. South Jordan Parkway, Suite 300, South Jordan, UT 84095

3.2 Small Starts Projects

Small Starts projects are a subcategory of New Starts projects with a total cost less than $250 million and a Small Starts funding share of less than $75 million. Small Starts have only a single project development phase and will only be required to report their ridership forecasts, cost estimates and the parties responsible for them at three points: entry to Project Development, when a Project Construction Grant Agreement (PCGA) is executed, and two years after the start of revenue service. Very Small Starts will not be covered in this report because these projects are justified based on existing ridership rather than forecasts and the costs of these projects include mostly “off-the-shelf” components whose costs are largely known.

Two Small Starts projects initiated project development since the contractor performance requirement was established:

1. Pioneer Parkway Emerald Express (EmX) Bus Rapid Transit in Eugene/Springfield, Oregon
2. Streetcar Loop in Portland, Oregon. The Pioneer Parkway project was recommended for funding in the FY 2008 budget.

3.2.1 Pioneer Parkway EmX BRT, Springfield, OR

The Lane Transit District (LTD) proposes to construct and operate a 7.8-mile extension of the Franklin corridor Bus Rapid “EmX” Transit (BRT) “Green Line” currently operating in Eugene, Oregon. The proposed Pioneer Parkway EmX BRT project extends service from the eastern terminus of the Franklin corridor route north along the Pioneer Parkway to existing and new residential and employment areas in Springfield. The project includes 14 new stations, traffic signal priority, and the purchase of four low-floor, branded, hybrid-electric vehicles. The proposed service would operate at-grade with 10-minute headways during weekday peak- and off-peak periods.

A study of the feasibility of urban rail in the Eugene/Springfield area conducted in 1995 concluded that projected ridership in the region over a 20-year period was too low to be competitive for New Starts funding. Instead, the study identified BRT as a less capital-intensive way to provide efficient transit service for the region. In 2001, BRT was identified as a strategy to combat congestion in the adopted “Eugene-Springfield Regional Transportation Plan.” In this plan, the initial Franklin Boulevard BRT route was identified as the first phase of a potential 60-mile regional BRT system. BRT service in the Franklin corridor has begun.

LTD completed an environmental assessment on the Pioneer Parkway EmX BRT project in November 2006. FTA notified Congress of its intent to approve the project into project development in November 2006.

Reporting Item	Information at Entry to Project Development
Project Length Number of Stations First Year of Construction	7.8 Miles 14 Stations 2007
Opening Year Ridership (2010)	3,698 Average weekday boardings 2,183,143 Annual boardings
Responsible Party for Ridership Forecasts	Ms. Jennifer John (as private consultant) 7694 SW Barnard Dr Beaverton, OR 97007
Capital Cost Estimates	$33.439 million (2005 $) $36.986 million (YOE $)
Responsible Party for Capital Cost Estimates	Parsons Brinkerhoff 400 SW Sixth Ave Suite 802 Portland OR 97204

3.2.2 Streetcar Loop Project, Portland, OR

The Tri-County Metropolitan Transportation District of Oregon (Tri-Met) proposes to construct the Portland Streetcar Loop Project in Portland, Oregon, a 3.3-mile extension of the existing Portland Streetcar line. The Portland Streetcar Loop Project will extend streetcar tracks, stations and service from the Pearl District in NW Portland, across the existing Broadway Bridge, serving the eastern half of the Portland Central City. With ten new streetcars, the project would serve 18 new and 16 existing streetcar stations and station pairs. Later, as a separate project, the Loop will be completed via a new bridge at the south end, allowing continuous connections around the entire loop.

FTA approved the Portland Streetcar Loop Project into Project Development on April 26, 2007. FTA’s approval letter to Tri-Met indicated the need to improve the project’s cost-effectiveness for the project to continue to advance. FTA and Tri-Met have been exploring technical data revisions and possible changes to the project scope to address this issue. Any changes proposed during Project Development may have an impact on the travel forecasts and cost estimates reported below.

Reporting Item	Information at Entry to Project Development
Project Length Number of Stations First Year of Construction	3.3 Miles 18 Stations 2008
Opening Year Ridership (2009)	10,593 Average Weekday Boardings 3,463,911 Annual Boardings
Responsible Party for Ridership Forecasts	TriMet 4012 SE 17th Ave. Portland, OR 97202
Capital Cost Estimates	$134.454 million (2006 $) $151.887 million (YOE $)
Responsible Party for Capital Cost Estimates	URS Corporation 111 SW Columbia, Suite 1400 Portland, OR 97201-5814

Appendix

U.S. DEPARTMENT OF TRANSPORTATION

FEDERAL TRANSIT ADMINISTRATION

PREDICTED AND ACTUAL IMPACTS OF NEW STARTS PROJECTS

Capital Cost, Operating Cost and Ridership Data

Office of Planning and Environment

with support from

SG Associates, Inc

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This report was primarily authored by Mr. Frank Spielberg of SG Associates and Mr. Steven Lewis-Workman of the Federal Transit Administration. Portions of this report were also written by Mr. Tom Buffkin and Ms. Sarah Clements of the Federal Transit Administration and Mr. Joe Swartz of SG Associates. Ms. Jennifer Terry and Mr. Jason Mumford of URS Corporation compiled cost data from project reports. The authors would like to thank all of the project sponsors and FTA regional office staff who took the time to review and ensure the accuracy of the information contained in this study.

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1 Overview

The Federal Transit Administration's Office of Planning and Environment has implemented a program of analysis of the predicted and actual impacts of major transit projects implemented in the past 2 decades through Full Funding Grant Agreements and using Section 5309 funds (formerly the Section 3 program). The analysis has three purposes:

- To examine the adequacy of procedures and technical methods used to develop information for decision making by project sponsors and the FTA.
- To provide an up-to-date assessment of the actual performance of projects compared to the forecasts made for these projects.
- To establish a frame of reference for the Before and After studies of future[3] New Starts projects that will be prepared by grantees in response to requirements of the New Starts regulation.

This first phase of the effort was an inventory – from existing sources – of the forecasts prepared at various stages of the project planning process and of the actual results. These inventory data have been used to identify differences between projections of capital cost and the actual costs of constructing the projects,[4] of the operating costs and the actual costs of operating the services, and of projected ridership and the actual ridership achieved.

All data necessary to examine the cause of differences between forecast and actual values were not available during this inventory phase. While the data assembled during this phase and reported here provide some insight into trends in the forecasts associated with major transit investment projects many details unique to each project cannot be reflected in such a summary analysis. This phase focused on data and documentation that would identify topics that would be fruitful areas for further research in more detailed phase two case studies. Those detailed studies will strive to identify, with the assistance of project sponsors, the specific factors that contributed either to successful projections or particularly large errors.

The work in this first phase has been particularly useful in meeting the third objective cited above – establishing a frame of reference for the for the Before and After Studies of New Starts projects. The lessons learned in reconstructing project histories from available published documents have been reflected in the Before and After Study guidance developed by FTA.

[3] New Starts project sponsors are now required to collect and analyze information on the impacts of the new start project and the accuracy of the forecasts prepared during development of the project. The effort includes collection of "before" data on the current transit system; documentation of the "predicted" scope, service levels, capital costs, operating costs, and ridership of the project; collection of "after" data on the transit system two years after opening of the new start project; and analysis of the consistency of "predicted" project impacts with the "after" data.

[4] However, since the projects were built in different time periods and the costs are expressed in dollars adjusted to different base years, capital costs cannot be compared between projects.

1.1 Methodology

Data on project scope, service levels, costs and ridership were identified and documented, to the extent possible, at four milestones during project planning and implementation. These key milestones are:

- Completion of Alternatives Analysis and Draft EIS;
- Completion of a Final EIS;
- Signing of the Full Funding Grant Agreement; and
- Project completion, for capital cost data, or 2 years after opening, for operating and maintenance costs and ridership results.

The primary data recorded for each milestone were:

- Project scope (Length, horizontal/vertical alignment, stations, parking, vehicles, ancillary facilities);
- Service levels (headways, service hours, fares, vehicle miles and hours, if available);
- Capital cost (construction, right-of-way, engineering, administration, vehicles, etc.);
- Operating and maintenance (O&M) cost (vehicle operation, vehicle maintenance, guideway maintenance, station operation and maintenance, etc.); and
- Ridership (daily and annual boardings on the project, system-wide boardings and/or linked trips).

The projections at each stage of planning and project development were taken from the various reports prepared by project sponsors and/or their consultants. These documents were collected from FTA or from one of the repository libraries. FTA staff obtained the reports, reviewed each document to identify relevant sections and provided copies of these sections to the project team. The FTA Office of Planning and Environment staff recorded the data for project scope, service levels, and ridership. FTA staff also contacted each grantee to document the actual ridership experience for each project. The consultant team reviewed the published materials and abstracted the forecast and actual capital and operating cost data from the reports.

In most cases, the information in the published documents was not as detailed as desired. This lack of detailed information affects the ability to use the data to examine sources of error in the cost estimates or ridership forecasts but does not affect the assessment of overall project deviations.

Estimated capital and operating costs and the related “dollar years” were taken from AA/DEIS, FEIS and FFGA reports. As-built capital costs were derived from Project Management Oversight (PMO) reports. As-operated O&M costs were developed from the National Transit Database.

For all cost estimates, the base year of the estimates was also documented. This base year is the year from which the dollar values for unit costs applied in cost estimation were derived.[5] For

[5] Construction cost estimates are typically developed by applying unit costs to estimates of the number of units required. (e.g. six miles of track @ $8 million per mile). The unit costs are developed from the cost experience on similar projects built in the

purposes of comparison of predicted and actual costs, all cost projections were expressed in midpoint-of-construction year dollars. While not a perfect comparison to actual costs, year-by-year expenditures were generally not available so the approximation of using the midpoint-of-construction year was adopted. This adjustment is different for each project.

The adjustment of Capital Costs used the Engineering News Record Construction Cost Index. The specific city value was used when applicable; when not applicable the twenty-city average index value was used. The adjustment of operating costs from projection year dollars to year of operation dollars used an index based on the cost per vehicle-hour for bus service in the specific city as reported in the National Transit Database (NTD). For selected projects that are extensions of pre-existing lines or a new line of an existing mode, the operating costs could not be derived directly from the NTD. In those cases, an estimate was made based on the approximate relation of vehicle miles of service on the segment of interest relative to total vehicle miles of service for that mode.

Ridership forecasts were derived from the AA/DEIS, FEIS and related supplemental reports while actual ridership for each project was obtained directly from the transit agencies. This study compares forecasts of average weekday boardings to actual average weekday boardings. FTA attempted to match the actual ridership data to the forecast year. In cases where the forecast year remains in the future, typically 2005, 2010 or 2015, the actual 2002 ridership was inflated by the average annual growth in transit system ridership between 1990 and 2002. This “adjusted” actual ridership was then compared to the forecasts to evaluate the performance of those forecasts.

FTA and the contractor team condensed the relevant information collected regarding each project into project profiles. The profiles contain a description of the project purpose, summarize the planning and development of each project, and document the predicted and actual scope, service levels, ridership, capital costs, and operating costs for each project. These profiles were then sent to FTA regional offices and to each grantee for review and validation. The information in the project profiles, including the forecasts and actual data used for this analysis, has been reviewed for accuracy and validated by each grantee.

No attempt was made to adjust costs to reflect changes in the scope of a project. However, when changes in scope that would have a significant impact on capital or operating costs were identified, those changes were noted in the text of the Project Profiles. In cases where the actual project constructed was closer to an identifiable alternative included in the planning studies, actual costs and ridership were compared to forecasts from the alternative that most closely resembled the constructed project.

years preceding the estimates. If the base year for a cost estimate is 1988, it means that the unit costs applied in estimating reflected the cost of construction in 1988.

1.2 Findings for Capital Costs

- Adjusted for inflation between the time of the estimate prepared for the AA/DEIS (generally concurrent with the selection of the Locally Preferred Alternative) the cost of the completed projects averages about 20 percent greater than the initial estimates.

- The accuracy of early stage planning estimated for major transit projects has been improving over time.

- Inflation is the largest component of the difference in absolute dollars between the estimated cost and the as-built expenditure.

- The FFGA process has had a positive impact in controlling project costs.

1.3 Findings for Operating Costs

- Projections of operating costs, adjusted for general inflationary increases in the local costs of transit operations, are being achieved.

- Experienced project sponsors have better O&M cost estimates. This probably reflects not only the ability to use local experience in developing unit costs but also greater realism in the assessment of efficiencies that can be achieved.

1.4 Findings for Ridership

- The quality of ridership forecasts has improved markedly since the 1980s.[6]

- While ridership forecasts have improved, several ridership forecasts reviewed in this study have proven to be optimistic.

1.5 Organization of this Report

The material presented in this report is based on the forecasts made and values achieved for twenty-one transit New Starts projects opened for full service between 1990 and 2002. These projects are listed in Table 1.

[6] Pickrell, Don H., *Urban Rail Transit Projects: Forecast Versus Actual Ridership and Costs, DOT-T-91-04, Office of Grants Management, Urban Mass Transportation Administration, Washington DC, October 1990* found that in comparing ridership projected for major transit projects to ridership actually achieved, none of the ten projects examined had achieved, at the time of the analysis, ridership greater than 72% of the forecast. Nine of the ten projects had achieved less than 50% of the forecast.

Table 1: New Starts Projects Included in This Study

City	Project	Mode	Year of			
			AA/DEIS	FEIS	FFGA	Open
Atlanta	North Line Extension	HR	1990	1991	1994	2000
Baltimore	BWI, Hunt Valley, Penn Station Ext.	LR	1991	1993	1994	1997
Baltimore	Extension to Johns Hopkins	HR	1984	1987	1988	1995
Chicago	SW Transitway	HR	1982	1985	1987	1993
Dallas	South Oak Cliff	LR	1990	1991	1993	1996
Denver	North I-25	Bus/HOV	1988	1989	1989	1994
Denver	Southwest	LRT	1995	1996	1999	2000
Houston	Southwest Transitway	Bus/HOV	1985	1985	1987	1993
Jacksonville	Skyway Express	AGT	1982	1983	1994	2000
Los Angeles	Red Line	HR	1983	1983	1997	2002
Miami	Omni and Brickell Extensions	AGT	1987	1988	1989	1994
Pittsburgh	Airport Busway/ Wabash	Bus/HOV	1992	1994	1999	2000
Portland	Westside - Hillsboro	LRT	1982	1994	1994	1998
Salt Lake City	I-15/State Street	LRT	1990	1994	1995	1999
San Diego	El Cajon Extension	LRT	1985	1986	1986	1989
San Francisco	Colma BART Station	HR	1988	1990	1993	1996
San Jose	Guadalupe Corridor	LRT	1981	1983	1984	1991
San Jose	Tasman West	LRT	1991	1992	1996	1999
Seattle	Downtown Project	Bus	1984	1985	1987	1990
St. Clair Co.	MetroLink Extension	LRT	1995	1996	1996	2001
St. Louis	MetroLink	LRT	1984	1987	1995	1993

Planning for projects included in this analysis began as early as 1977 and as late as 1993. The time between the Alternatives Analysis report and the opening of service ranged from 4 years for the San Diego El Cajon Extension to 19 years for the Los Angeles Red Line.

The body of this report addresses the findings that have been gleaned from the project data. The details of any specific project are referenced only to illustrate points of interest.

The remainder of this report addresses the variations identified between projects as planned and projects as constructed and operated. The sections discuss, in turn, capital costs, operating and maintenance costs, and ridership. Tables and charts reporting the project information and suggesting some possible interpretations are presented. Project Profiles in **Appendix 1**, one for each project, include more detailed information on the project history, the scope of the project as conceived and executed, and other information necessary to interpret the summary statistics.

2 Capital Costs

This chapter compares the AA/DEIS, FEIS, and FFGA capital cost estimates to the actual costs incurred to complete these projects. The capital costs are compared both in nominal terms and in real (inflation adjusted) terms in order to ascertain whether the cost estimates developed in the planning and implementation of New Starts projects have accurately predicted the actual costs of constructing them. The capital costs in this analysis include:

- design and engineering;
- right-of-way acquisition;
- construction of all facilities and systems; and
- vehicles.

The purpose of this Phase 1 study is simply to identify the extent that the costs of New Starts projects have deviated from their cost estimates. The costs are not evaluated in enough detail to identify the specific reasons for any deviations from the cost estimates, though any obvious changes in scope or specific known construction difficulties are noted where appropriate. The detailed analysis of particular cost estimation problems is left to the future Phase 2 study.

2.1 Analysis Approach

Information about the nature of the project and the associated capital cost estimates were derived from a variety of available sources. The primary source documents for the planning stage estimates were the Alternatives Analysis documents, usually in the form of an AA/DEIS, and the FEIS. For some projects, particularly those with a longer planning history, these were supplemented with other documents, such as a Preferred Alternative Report, a local Feasibility Study, and/or a Supplemental DEIS/FEIS. The primary factors used to describe the scope of the project were the length of the line; the length proposed at-grade, below grade or above grade; and the number of stations. When available other information affecting the capital cost (e.g., amount of parking, number of vehicles to be purchased) was also documented. A list of the documents from which data were derived is presented in **Appendix 2**.

Capital cost estimates at the stage of the Full Funding Grant Agreements (FFGAs) were taken directly from FFGA documents. The cost reported includes all project costs identified in the FFGA, both local and federal. When known, other capital costs items funded through different sources have also been identified.

In many cases, the project as constructed differs from the project that was identified in the earlier studies as the Locally Preferred Alternative (LPA). For some projects these differences are minor. For others they are more significant (e.g., additional stations, fewer vehicles, portions of the project not built). No attempt has been made to adjust either the earlier estimates or the as-built costs to reflect these differences. Rather, the major differences are noted in the project profiles in **Appendix 1**.

The as-built costs of the projects are taken from reports prepared by the FTA Project Management Oversight (PMO) contractors assigned to each project. A final PMO report is prepared prior to closing out the FFGA. The cost reported in the final PMO report serves as the as-built cost for this analysis.

Capital cost estimates prepared at the AA/DEIS, FEIS and FFGA have been adjusted for inflation to the midpoint of construction year of the project. This adjustment attempts to approximate the year in which the as-built costs are expressed. These adjustments have been made based on the Engineering New Record Construction Cost Indices. When available the specific city indices were used; when the city specific indices were not available the twenty-city average was used. As-built costs are as reported (dollars expended) and were not adjusted.

2.2 Forecast and Actual Capital Cost

The inflation adjusted predicted and actual capital costs for the twenty-one projects are summarized in Table 2. Since the costs are adjusted to reflect midpoint-of-construction-year dollars for each project, costs cannot be compared between projects. The cost information provides an indication of how estimated costs changed as design became more definite over the project planning period and how the predicted costs compare to the actual costs of constructing the projects.

Table 2: Project Capital Costs Adjusted for Inflation

City	Project	Mode	Capital Cost (in Millions)[1] Adjusted for Inflation			
			AA/DEIS	FEIS	FFGA	As-Built
Atlanta	North Line Extension	HR	439.5	389.7	352.0	472.7
Baltimore	BWI, Hunt Valley, Penn Station Ext.	LR	81.9	110.2	109.5	116.2
Baltimore	Extension to Johns Hopkins	HR	313.7	310.5	310.5	353.0
Chicago	SW Transitway	HR	604.0	532.3	438.4	522.0
Dallas	South Oak Cliff	LR	325.4	374.6	377.0	360.0
Denver	North I-25	Bus/HOV	189.5	189.5	205.2	228.0
Denver	Southwest	LRT	149.6	158.3	176.9	177.7
Houston	Southwest Transitway	Bus/HOV	95.6	100.0	111.2	98.3
Jacksonville	Skyway Express	AGT	85.8	85.8	142.0	137.3
Los Angeles	Red Line	HR	3,031.3	3,181.3	3,505.6	4,469.7
Miami	Omni and Brickell Extensions	AGT	221.2	221.2	161.3	228.0
Pittsburgh	Airport Busway/ Wabash	Bus/HOV	274.4	338.6	361.7	321.8
Portland	Westside - Hillsboro	LRT	559.3	804.0	886.5	964.0
Salt Lake City	I-15/State Street	LRT	305.6	245.9	299.5	298.5
San Diego	El Cajon Extension	LRT	114.4	114.4	100.4	102.7
San Francisco	Colma BART Station	HR	112.5	130.1	171.6	179.9
San Jose	Guadalupe Corridor	LRT	257.7	321.5	395.2	380.3
San Jose	Tasman West	LRT	451.2	462.5	346.1	325.2
Seattle	Downtown Project	Trolley Bus	299.6	348.7	400.0	468.7
St. Clair Co.	MetroLink Extension	LRT	367.7	367.5	322.2	339.2
St. Louis	MetroLink	LRT	379.7	346.5	455.8	464.0

1. Cost estimates are reported in "midpoint of construction" dollars

Table 3, below, summarizes the relationship between the as-built capital cost of each project and the inflation-adjusted estimates prepared at different phases of project planning. In the table, a percent value less that 100 percent indicates that the as-built cost was less than the estimate while a value greater than 100 percent indicates that the as-built cost was greater than the estimate. For example, a value of 96.6 percent in the column headed AA/DEIS means that the actual cost was 3.4 percent less than the AA/DEIS cost estimate while a value of 120.7 percent in the column headed FFGA means that the actual cost was 20.7 percent greater than the FFGA cost estimate.

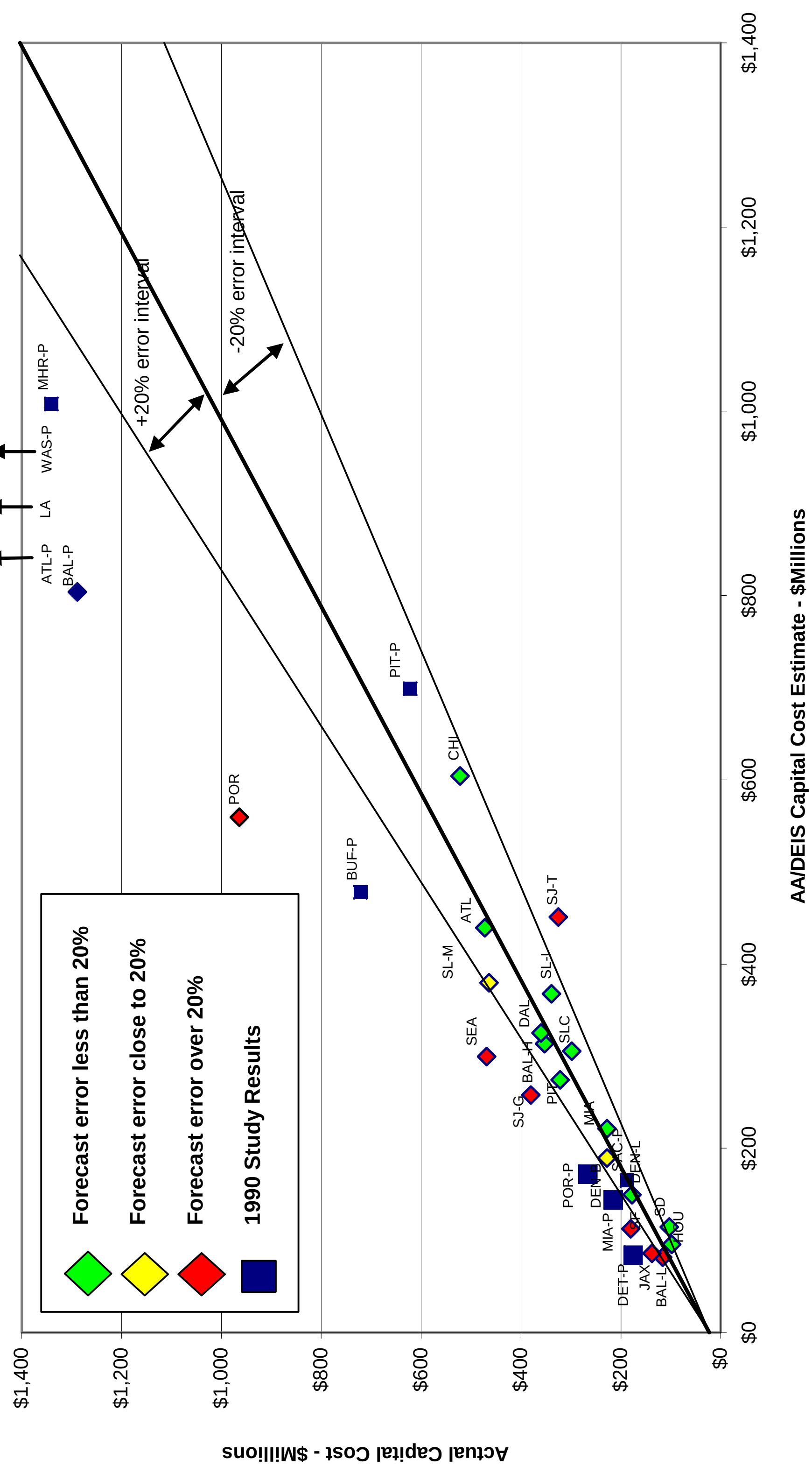
Table 3: As-built Project Costs as Percent of Estimate

City	Project	Mode	As-Built Capital Cost as Percent of Estimate, Adjusted for Inflation		
			AA/DEIS	FEIS	FFGA
Atlanta	North Line Extension	HR	107.5%	121.3%	134.3%
Baltimore	BWI, Hunt Valley, Penn Station Ext.	LR	141.9%	105.5%	106.2%
Baltimore	Extension to Johns Hopkins	HR	112.5%	113.7%	113.7%
Chicago	SW Transitway	HR	86.4%	98.1%	119.1%
Dallas	South Oak Cliff	LR	110.6%	96.1%	95.5%
Denver	North I-25	Bus/HOV	120.3%	120.3%	111.1%
Denver	Southwest	LRT	118.8%	112.2%	100.5%
Houston	Southwest Transitway	Bus/HOV	102.8%	98.3%	88.4%
Jacksonville	Skyway Express	AGT	160.0%	160.0%	96.7%
Los Angeles	Red Line	HR	147.5%	140.5%	127.5%
Miami	Omni and Brickell Extensions	AGT	103.1%	103.1%	141.3%
Pittsburgh	Airport Busway/ Wabash	Bus/HOV	117.3%	95.0%	89.0%
Portland	Westside – Hillsboro	LRT	172.4%	119.9%	108.7%
Salt Lake City	I-15/State Street	LRT	97.7%	121.4%	99.7%
San Diego	El Cajon Extension	LRT	89.7%	89.7%	102.3%
San Francisco	Colma BART Station	HR	159.9%	138.2%	104.9%
San Jose	Guadalupe Corridor	LRT	147.6%	118.3%	96.2%
San Jose	Tasman West	LRT	72.1%	70.3%	94.0%
Seattle	Downtown Project	Trolley Bus	156.5%	134.4%	117.2%
St. Clair Co.	MetroLink Extension	LRT	92.3%	92.3%	105.3%
St. Louis	MetroLink	LRT	122.2%	133.9%	101.8%
Average over twenty-one projects			**120.9%**	**113.5%**	**107.3%**

The actual capital cost of New Starts projects has been on average, 20.9 percent greater that the inflation adjusted AA/DEIS estimate, 13.5 percent greater than the FEIS estimate and 7.3 percent greater than the FFGA limit. The AA/DEIS is the point in project planning when the locally preferred alternative is selected, and therefore, is the most critical decision point for the implementation of any project. The data reported here suggest that in terms of the real economic cost the information presented at the time of selection of the LPA has been a generally reliable estimate of the cost of construction. Eleven of the twenty-one projects had construction costs that deviated less than 20 percent from the inflation adjusted AA/DEIS estimate. One project significantly overestimated capital costs (though this was due to scope reduction), while nine projects significantly underestimated capital costs in their AA/DEIS.

Figure 1 arrays the AA/DEIS capital cost results along a 45 degree line. Projects that fall within the ± 20 percent range were considered reliable. The results of the 1990 UMTA study, *Urban Rail Transit Projects: Forecast versus Actual Ridership and Costs* are included for comparison purposes.

Figure 1: AA/DEIS Cost Estimates vs. Actual



Key to Project Symbols

Atlanta HR* ('90)	NA	Dallas South Oak Cliff	DAL	Miami HR ('90)	MHR-P	San Diego El Cajon	SD
Atlanta North Line	ATL	Denver I-25 HOV	NA	Miami Omni/Brickell	MIA	San Jose Guadalupe	SJ-G
Baltimore HR ('90)	BAL-P	Denver SW LRT	DEN	Pittsburgh LR ('90)	PIT-P	San Jose Tasman West	SJ-T
Baltimore Johns Hopkins	BAL-H	Detroit DPM ('90)	DET-P	Pittsburgh West B'Way	PIT	Seattle Bus Tunnel	NA
Baltimore LRT Ext.	BAL-L	Houston SW Transitway	HOU	Portland LR ('90)	POR-P	St. Louis Initial System	STL-M
BART Colma	SF	Jacksonville ASE	JAX	Portland Westside-Hillsboro	POR	St. Louis St. Clair Ext.	STL-I
Buffalo LR ('90)	BUF-P	LA Red Line	LA	Sacramento LR ('90)	SAC-P	Washington HR ('90)	WAS-P
Chicago Orange Line	CHI	Miami DPM ('90)	MIA-P	Salt Lake South LRT	SLC		

2.3 Changes Between Planning and Construction

The projects studied, as constructed and operated often differ from the projects as contemplated in the AA/DEIS studies. In some cases, these changes are minor and would have little effect on the capital or operating costs. For other projects the changes have been significant and the effect is reflected in as-built or as-operated costs that differ markedly from early planning estimates. Changes in project scope primarily affect capital costs. Operating costs can also be affected by scope changes, but more often reflect changes in the service operating plan.

2.3.1 Project Scope

On average, the time between the publication of the Alternatives Analysis (AA) and/or DEIS reports, roughly the time at which the Locally Preferred Alternative (LPA) was selected and the revenue operations date, was 8 years. The most common duration was six years, though the range was quite broad. The shortest periods were four years for the San Diego East Line extension (El Cajon) and 5 years for the Denver Southwest Corridor project and the Hillsboro section of the Portland Westside-Hillsboro Extension. Each of these were extensions of light rail lines existing or under construction at the time the LPA was selected. The longest periods were nineteen years for the Los Angeles Red Line and 18 years for the Jacksonville Skyway.

Many changes in project concept and design can occur over extended project planning and development periods. Projects often change due to changes in development patterns, changes in community goals, changes in the technology of construction, changes in the cost of construction and changes in the funding available to complete the project. Some of these changes have relatively minor impact on the cost of a project while others are significant. To the extent possible from the documentation available, changes in project scope that would have had a significant effect on project cost are noted in Table 4 and described in greater detail in the Project Profiles (see **Appendix 1**).

In the analyses reported here, adjustments have been made for the effects of inflation in the cost of construction. When comparing project cost estimates at the several milestones with the actual as-built costs, the estimated costs have been adjusted to the midpoint-of-construction year.

Table 4: Changes in Project Scope and Capital Costs

City	Project	Changes	As-built Cost vs. Estimate			
			Inflation Adjusted		Nominal Dollars	
			AA/DEIS	FFGA	AA/DEIS	FFGA
Atlanta	North Line Extension	Built in two stages. FFGA included only Section 2- 1.9 miles, 2 stations from Dunwoody to North Springs. Parking in structure rather than surface lot.	+7.55%	+34.29%	+27.7%	+44.4%
Baltimore	BWI, Hunt Valley, Penn Station Extensions	Two stations added in FFGA but were not built. Double track planned for 4.6 miles but all built as single track.	+41.91%	+6.15%	+65.5%	+9.3%
Baltimore	Extension to Johns Hopkins	Significant delay due to leaking underground fuel storage tanks.	+12.52%	+13.68%	+37.5%	+9.7%
Chicago	SW Transitway	Elevated structure reduced from 4.3 to 2.7 miles. Stations: DEIS: 9 (1 underground, 3 elevated) As-built: 8 (0 underground, 2 elevated).	-13.58%	+19.08%	+15.2%	+27.0%
Dallas	South Oak Cliff	DEIS planned for 33 vehicles, FFGA and as-built included 19 vehicles. Yard and shop area in AA/DEIS estimate deleted from project.	+10.63%	-4.52%	+25.5%	-2.7%
Denver	North I-25	Length: DEIS 6.6 miles, As-built: 5.3 miles.	+20.31%	+11.09%	+27.6%	+13.3%
Denver	Southwest	0.2 miles planned as single track built as double track. 2 additional LRVs purchased.	+18.80%	+0.45%	+39.4%	+11.6%
Houston	Southwest Transitway	Surveillance, communications and control system planned and funded in FFGA not implemented. Project is 1.2 miles longer than AA/DEIS plan.	+2.78%	-11.57%	+17.3%	-5.0%
Jacksonvill e	Skyway Express	System retrofitted to new technology. Original vehicles sold and replaced with new systems. As-built has 8 stations rather than 9 as planned in AA/DEIS.	+59.98%	-3.31%	+126.2%	-3.3%
Los Angeles	Red Line	Realignment due to underground natural gas fields. Delays due to funding constraints. Length: DEIS 18 mi.; FFGA 23 mi.; As-built 17mi. Stations: DEIS 16; FFGA 22; As-built: 16	+47.45%	+27.50%	+90.0%	+42.9%

City	Project	Changes	As-built Cost vs. Estimate			
			Inflation Adjusted		Nominal Dollars	
			AA/DEIS	FFGA	AA/DEIS	FFGA
Miami	Omni and Brickell Extensions	Only minor changes.	+3.07%	+41.32%	+16.0%	+48.1%
Pittsburgh	Airport Busway/ Wabash	Length reduced from 8.1 mi. to 6.1 mi. Bridge across river not constructed. Wabash Tunnel rehabilitation not yet completed.	+17.26%	-11.03%	+42.4%	-1.6%
Portland	Westside - Hillsboro	DEIS assumed mostly surface construction. FEIS and as-built include 3 miles of tunnel and 1 underground station.	+72.37%	+8.75%	+104.7%	+17.3%
Salt Lake City	I-15/State Street	One planned station not built. One-half mile access single rather than double track.	-2.32%	-0.35%	+29.2%	+16.5%
San Diego	El Cajon Extension	DEIS: 11 miles single track. As-built: 0.3 mi. single track; 10.8 mi. double track.	-10.25%	+2.26%	-2.7%	+4.9%
San Francisco	Colma BART Station	Underground: DEIS 0.13 mi.; As-built 0.19 mi. Elevated; DEIS 0.0 mi; As-built 0.06 mi. Vehicles: DEIS 3; As-built 0	+59.90%	+4.86%	+89.6%	+5.7%
San Jose	Guadalupe Corridor	Project delayed for almost two years due to lawsuit. Single track: DEIS 0.0 mi.; As-built 1.6 mi. Double track: DEIS 20.0 mi.; As-built 18.4 mi.	+47.60%	-3.78%	+100.9%	+2.3%
San Jose	Tasman West	Length: DEIS 12.2 mi.; As-built 7.6 mi. Stations: DEIS 18; As-built 12 Parking spaces: DEIS 2380; As-built: 312 LRVs: DEIS 35; As-built 0	-27.92%	-6.04%	-9.0%	+0.1%
Seattle	Downtown Project	Minor changes only.	+56.47%	+17.19%	+62.6%	+18.5%
St. Clair Co.	MetroLink Extension	Length: DEIS 25 mi.; As-built 17.4 mi. Stations: DEIS 12-13; As-built 8 Parking spaces: DEIS 1800-2700; As-built 4500 Yard & Shop: DEIS – expand existing; FFGA – New	-7.74%	+5.28%	+0.6%	+10.2%
St. Louis	MetroLink	Some alignment changes and delay due to need to adjust for Airport plans.	+22.20%	+1.80%	+68.0%	+0.0%

Specific changes found in one or more of the projects considered include:

- Change in alignment

  These include changes in the horizontal alignment, vertical alignment, or both. Changes in vertical alignment tend to have greater impacts on capital costs since these can result in addition or elimination of structure or subsurface construction.

- Change in number of stations

  The projects reviewed included situations in which stations were added in response to new developments or community concerns and situations in which stations were omitted or delayed in order to reduce project costs.

- Change in technology

  In one project (Jacksonville ASE), the technology used for the guideway was changed from a rubber tire on concrete guideway to a monorail. This change required that the entire functioning system be shut down to accomplish substantial modifications to previously built segments.

- Delay in constructing one or more project elements

  Inflation is the single largest factor in considering the difference between the cost as estimated at the time of the LPA and the cost as-built (see Figure 2). The longer the period between the LPA and the time of construction, the greater the effect of inflation on the cost of a project in year-of-expenditure dollars. Lengthy delays tend to lead to greater differences between predicted and actual capital costs.

- Change in regulation

  Over the period of time between original planning and actual construction of projects considered in this report there were many changes in legislation and regulation that affected project requirements. Most notable were regulations implementing the National Environmental Policy Act (NEPA) and the Americans with Disabilities Act (ADA). While the data assembled for these studies have not been in sufficient detail to isolate the effects to these and similar regulatory factors, there can be no doubt that costs were incurred, especially when projects had originally been planned prior to the implementation of significant policy changes.

- Change in park-and-ride facilities

  Addition of park-ride areas, changes in the number of spaces, or changes from surface lots to structures were noted in several projects. For one project equipment related to collection of parking fees was added.

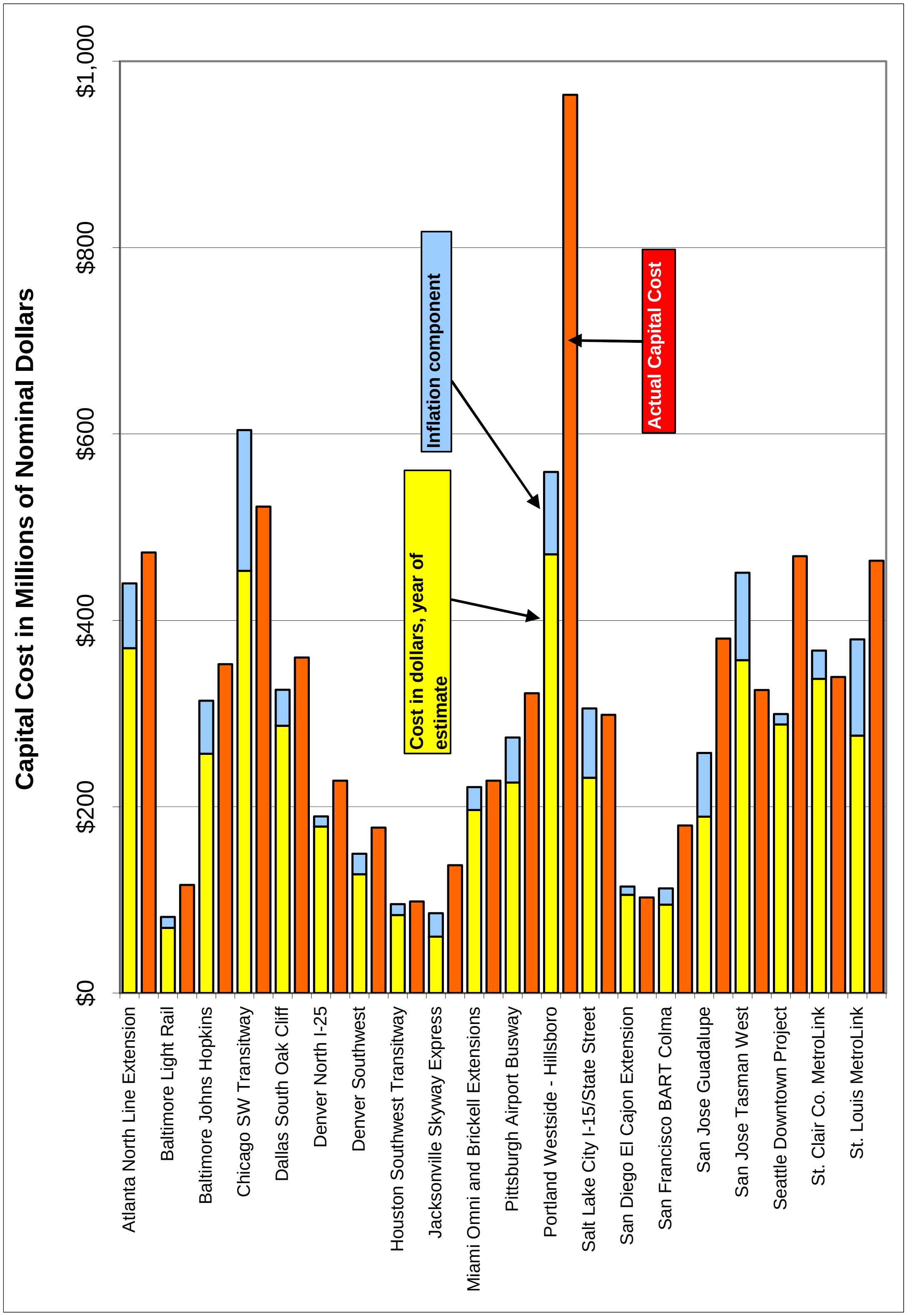
One goal of this Phase 1 study is to assess the degree to which there may be problems with the processes applied for estimating capital costs of New Starts projects. Differences between the estimates prepared early in project planning and the cost incurred when the project is built can arise from several sources including:

- Difficulties constructing the project as designed;
- Changes in project scope;
- Uncertainties regarding unit costs; and
- Unanticipated inflation.

The analyses presented in this report focus on the first three possible sources. These are the aspects of project development and cost estimation that are under the control of project sponsors and their consultants. The estimates produced relate to the “real” economic cost of the project and are the basis of local decisions related to selection of alternatives. Project estimators know that the costs of construction are constantly changing due to a variety of factors related to both local and national economic conditions. While estimators can, and often do, identify a cost component related to expected inflation, neither the estimators nor others associated with planning or implementing New Starts projects have control over the processes that influence inflation.

In the analyses reported in this study, adjustments have been made for the effects of inflation in the cost of construction. When comparing project cost estimates at the several milestones with the actual as-built costs, the estimated costs have been adjusted to the midpoint of construction year.

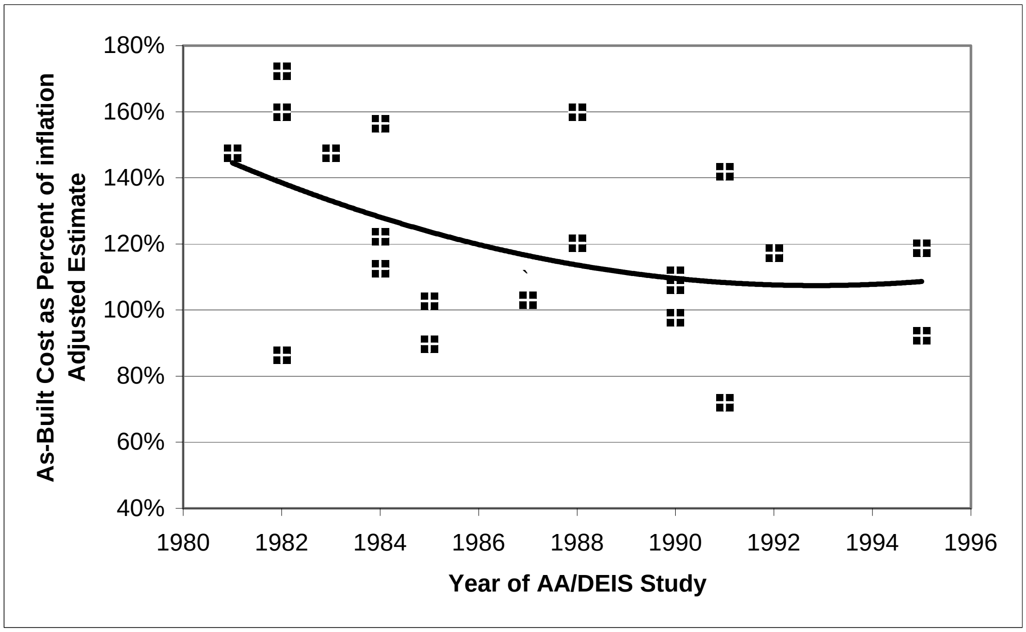
Figure 2: Capital Cost Estimates – AA/DEIS Base Estimate, Inflation, and Actual



2.4 Trends in New Starts Capital Cost Estimates

The analysis of predicted and actual capital costs (Figure 3) show that, adjusted for inflation, the discrepancy between the AA/DEIS estimate and the as-built cost has been decreasing over time.

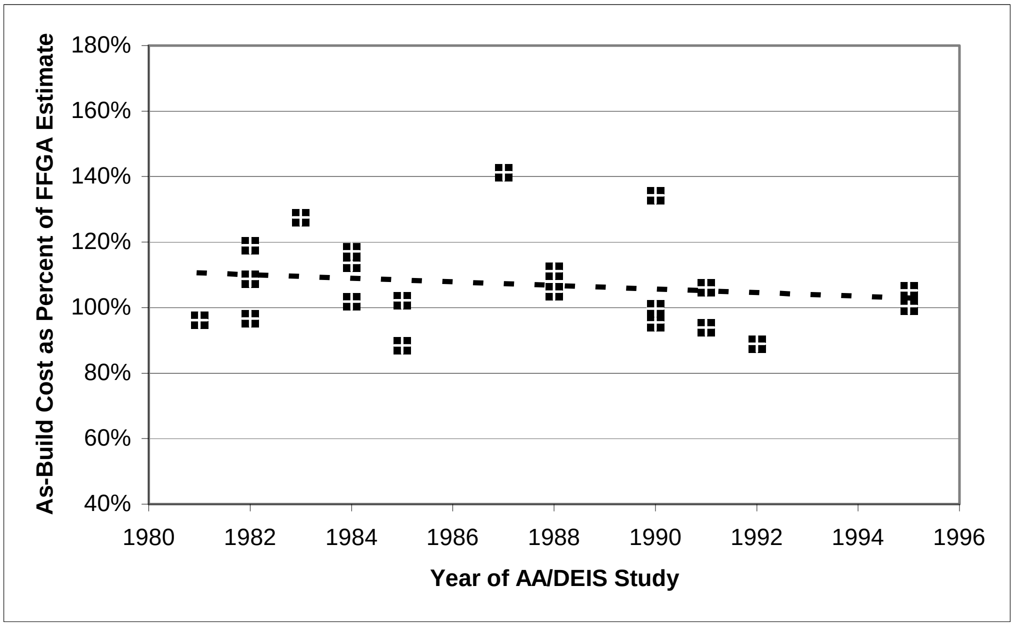
Figure 3: Trend in Accuracy of AA/DEIS Capital Cost Estimates



The Full Funding Grant Agreement process was developed in the early 1980s by FTA's predecessor agency, the Urban Mass Transportation Administration. The FFGA process was formalized in a model FFGA drafted by UMTA in 1990 and by the Congress in the Federal Transit Act Amendments of 1991.

The Full Funding Grant Agreement process appears to be an effective tool for controlling cost escalation. For New Starts projects included in these analyses with AA/DEIS reports since 1982 the as-built cost, after appropriate adjustments for inflation, has with three exceptions been within 20 percent of the grant amount. Figure 4 shows that the difference between the as-built cost is close, and getting closer, to the inflation adjusted FFGA estimate. On average, the actual project cost has exceeded the inflation adjusted FFGA estimate by about 7 percent. Even without adjusting for inflation the as-built costs have been within 13 percent of the FFGA, on average.

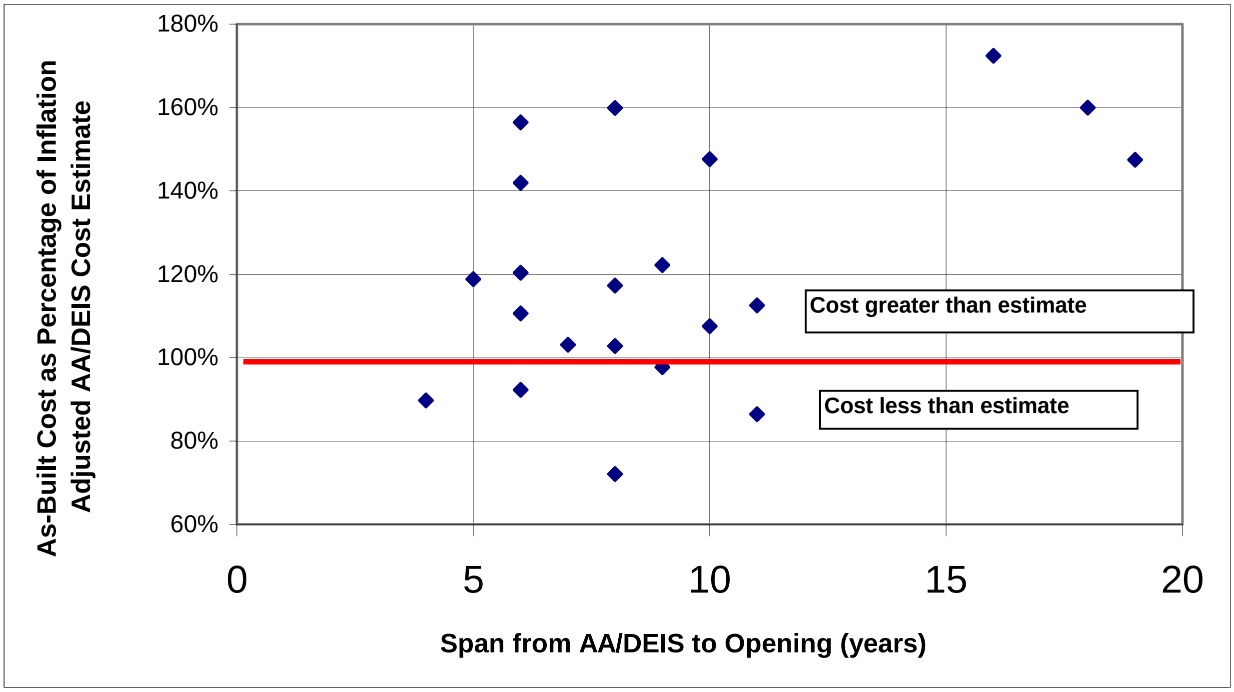
Figure 4: Trend in Accuracy of FFGA Capital Cost Estimates



Inflation, a factor outside the control of planners, is the biggest single factor in the difference between predicted and actual capital costs. Inflation makes up 41 percent of the difference in the nominal dollar AA/DEIS cost estimate and the actual project costs. For the FEIS cost estimate, inflation makes up 44 percent of the difference.

Even after adjusting for the effects of construction cost inflation, there is a tendency for capital costs to increase as the time from original plan to implementation increases. Figure 5 shows two groupings. For projects developed over the typical span of four to 11 years there is no clear pattern – half of the projects had costs greater than the inflation adjusted estimate and half had a cost lower. All of the three projects with a development span exceeding 15 years had costs greater than estimated by more than 35 percent. Each of these projects also had major design changes.

Figure 5: Increase in Project Capital Cost vs. Time Between Planning and Opening



The length of time to bring a project to fruition is getting shorter. Figure 6 shows that the time from AA/DEIS to opening for service was about 12 to 14 years for projects planned in the early 1980s. There has been a continuing trend to shorter durations with projects initially planned after 1988 having a development span of about 8 years. Reducing the development span reduces the effect of inflation on the cost of construction as well as minimizes the likelihood of significant design changes between planning and construction.

Figure 7 shows that the scope of the projects, as measured by the cost of construction expressed in 1996 dollars, has declined slightly over the period for the projects considered. Reductions in the scale of the projects may have contributed, in part, to the reduction in the average time required to implement major transit projects.

Figure 6: Project Development Duration Trend

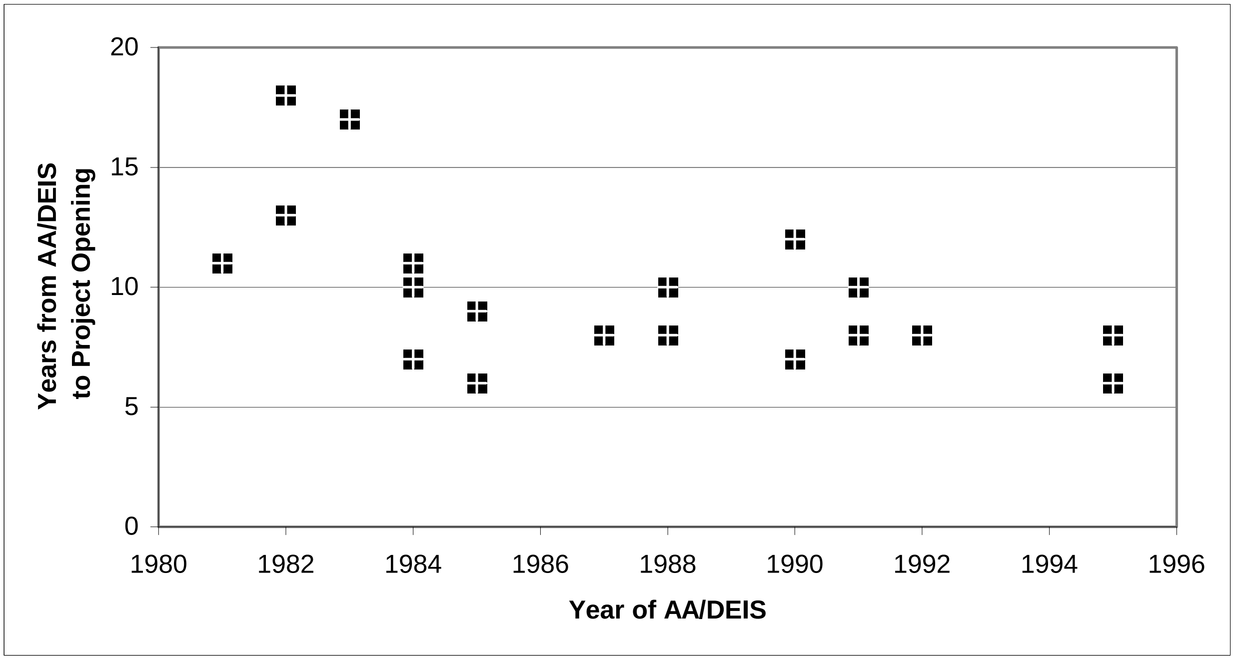
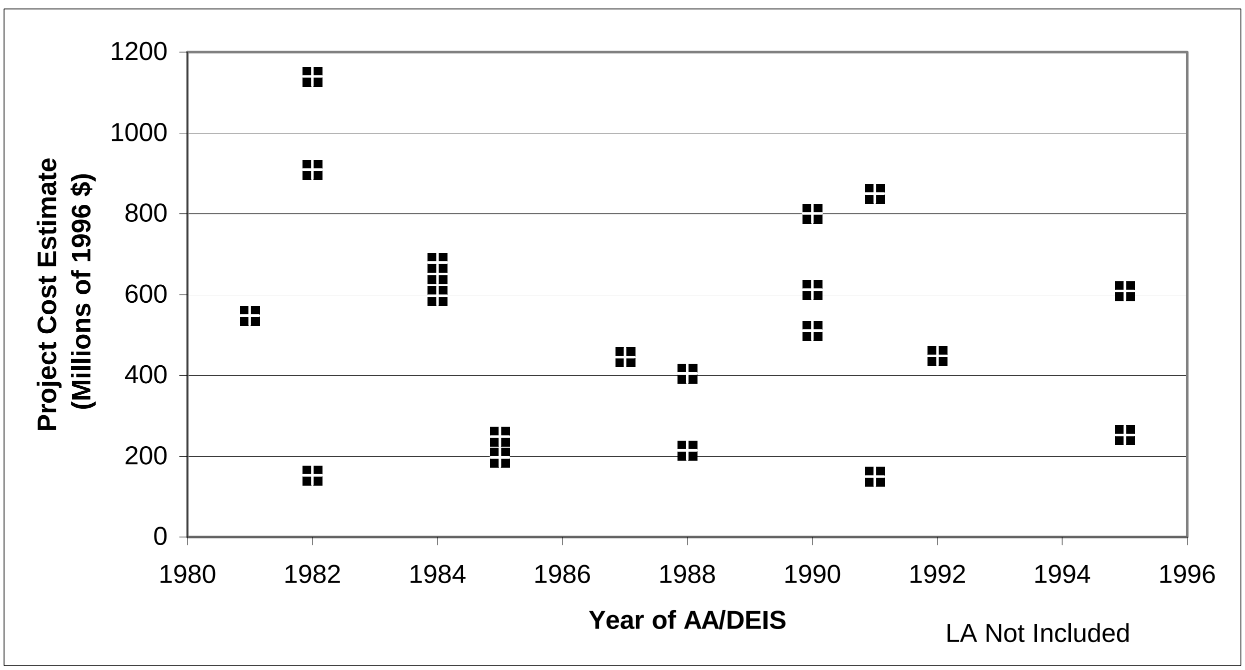


Figure 7: AA/DEIS Capital Cost Estimates (LA excluded due to scale)



2.5 Results and Interpretation

The forecasts of capital cost developed for New Starts Projects included in this study, after accounting for the effects of local inflation in construction costs, are showing steady improvement. For the eight projects with DEIS reports published in 1990 or later, the actual cost was within 20 percent of the AA/DEIS estimate for all but one project, while 8 out of 13 projects with AA/DEIS estimates published prior to 1990 had errors exceeding 20 percent. The causes for this improvement are not known with certainty and are outside the scope of this Phase 1 study. Clearly the experience gained in previous projects has some bearing. Some of the key findings from this study are summarized below.

1. Capital costs tend to increase between planning and construction, but less than commonly believed.

Between the time of the estimate prepared for the AA/DEIS (generally concurrent with the selection of the Locally Preferred Alternative (LPA)) the cost of the completed projects averaged about 20 percent greater than the initial estimates after adjusting for inflation.

2. Delays in planning, project development and implementation strongly influence capital costs.

Less time from the selection of the LPA to the completion of the project tends to reduce cost estimation errors, even adjusting for inflation. By placing greater emphasis on early planning activities, including the necessity of specifying a project in some detail in order to prepare satisfactory environmental documentation, many issues can be resolved before selection of the LPA. Reducing the number of changes during project development is one major factor in controlling capital costs.

3. The accuracy of early planning estimates has been improving over time.

Projects that were the subject of Alternatives Analysis studies in the early 1980s often resulted in as-built costs that were 40 to 60 percent greater than the estimates, even after adjusting for the inflation in construction costs. For projects with LPAs in the 1990s, the as-built costs are generally within 20 percent of the estimates.

4. Inflation is the largest component of the difference in absolute dollars between the estimated cost and the as-built expenditure.

During the period studied the costs of construction resulted in increases of about 6 percent per year in project cost. Inflation accounts for approximately 40 percent of the difference in nominal dollar cost estimates and the actual capital costs.

5. The FFGA process seems to have helped control project costs.

As-built expenditures differ from FFGA allocations by about 7 percent, on average. However, this is not purely a function of better cost estimation. Reductions in project scope or other changes to control costs have been necessary for some projects.

3 Operating and Maintenance Costs

3.1 Analysis Approach

Projected operating and maintenance costs for New Starts transit projects were derived primarily from the AA/DEIS and FEIS reports. There are no operating cost estimates presented in the FFGA documents. The operating and maintenance (O&M) cost estimates presented in the AA/DEIS and FEIS are for the full system in the design year – typically 20 to 25 years after the planning studies. The as-built O&M costs used for comparison are a best estimate of the O&M costs for the first full fiscal year after opening.

The O&M cost estimates in the AA/DEIS and FEIS documents were adjusted to reflect the change in transit operating costs in each specific metropolitan area between the year used as the basis for the cost estimate and the year following the opening of the project. The measure used for this adjustment was the change in cost per vehicle hour of bus service derived from the National Transit Database.

Actual operating costs were estimated from information in FTA's National Transit Database. For some projects, primarily rail lines that were the only application of light or heavy rail in a metropolitan area, the operating cost was taken as the cost for light rail or heavy rail operations reported in the National Transit Database. When a rail project was not the first application of that mode in an area, the operating and maintenance cost for the line of interest was estimated based on the observed change in rail operating and maintenance costs reported in the National Transit Database. For projects that were extensions of rail lines, publicly available data were used to estimate the proportion of rail-car miles in the region operated on the segment of interest. This proportion was then applied to the total operating and maintenance costs reported in the National Transit Database.

Estimating the actual operating and maintenance costs for bus projects presents a greater challenge. Each project required special treatment. For instance, the Denver I-25 North planning documents provided system-level O&M estimates, which were compared to operating costs in the National Transit Database. For the Pittsburgh West Busway Airport an estimate was prepared based on the proportion of the peak bus fleet using the Busway. For the Houston Southwest Transitway no operating and maintenance cost estimates were developed in the planning documents. For the Seattle Bus Tunnel the planning documents included an estimate of operating and maintenance cost savings, but there was no way of determining whether or not these savings had been realized.

3.2 Predicted and Actual Operating and Maintenance Cost

Table 5 summarizes the projected O&M costs from the planning studies and the estimated O&M costs for the first full fiscal year after opening.

Table 5: Predicted and Actual Operating Costs (Adjusted for Inflation)

City	Project	Mode	Operating Costs (in Millions) Adjusted for Inflation		
			AA/DEIS	FEIS	As-Built
Atlanta	North Line Extension	HR	6.1	7.7	5.4
Baltimore	BWI, Hunt Valley, Penn Station Ext.	LR	4.5	3.5	2.7
Baltimore	Extension to Johns Hopkins	HR	5.2	3.2	0.1
Chicago	SW Transitway	HR	24.0	24.8	16.7
Dallas	South Oak Cliff[1]	LR	18.8	18.8	23.1
Denver	North I-25[2]	Bus/HOV	169.4	169.4	129.9
Denver	Southwest	LRT	5.3	5.4	3.2
Jacksonville	Skyway Express	AGT	1.8	1.8	3.2
Los Angeles	Red Line	HR	78.6	84.7	48.5
Miami	Omni and Brickell Extensions	AGT	4.4	4.5	3.8
Pittsburgh	Airport Busway/ Wabash	Bus/HOV	14.1	14.1	17.1
Portland	Westside - Hillsboro	LRT	11.3	10.5	12.2
Salt Lake City	I-15/State Street	LRT	7.6	9.7	7.4
San Diego	El Cajon Extension	LRT	4.4	4.4	4.2
San Francisco	Colma BART Station[3]	HR	4.9	5.2	6.8
San Jose	Guadalupe Corridor	LRT	10.9	13.7	19.2
San Jose	Tasman West	LRT	12.2	8.2	10.2
St. Clair Co.	MetroLink Extension[4]	LRT	29.8	14.8	10.2
St. Louis	MetroLink	LRT	11.3	10.0	11.5

1. DEIS and FEIS estimates include North Central and South Oak Cliff ; As-built includes West Oak Cliff
2. Costs are for entire bus system
3. As-built cost based on estimated proportion of car-miles
4. As-built cost based on estimate of 45 percent of LRT revenue vehicle-hours

Table 6 presents the relationship between the achieved O&M cost and the estimates. The values shown are the as-built O&M cost as a percent of the estimates presented in the AA/DEIS or FEIS. The table confirms that, on average, predicted and actual operating costs are quite close, though close inspection of the data show that many projects either over or underestimated operating and maintenance expenses in their planning studies.

Table 6: Actual O&M Costs as Percent of Planning Estimates

City	Project	Mode	Actual O&M Costs as Percent of Estimates (Adjusted for Inflation)	
			AA/DEIS	FEIS
Atlanta	North Line Extension	HR	88.5%	70.1%
Baltimore	BWI, Hunt Valley, Penn Station Ext.	LR	60.0%	77.1%
Baltimore	Extension to Johns Hopkins[1]	HR	1.3%	2.2%
Chicago	SW Transitway	HR	69.6%	67.3%
Dallas	South Oak Cliff	LR	122.9%	122.9%
Denver	North I-25	Bus/HOV	76.7%	76.7%
Denver	Southwest	LRT	60.4%	59.3%
Jacksonville	Skyway Express	AGT	177.8%	177.8%
Los Angeles	Red Line	HR	61.7%	57.3%
Miami	Omni and Brickell Extensions	AGT	86.4%	84.4%
Pittsburgh	Airport Busway/ Wabash	Bus/HOV	121.3%	121.3%
Portland	Westside – Hillsboro	LRT	108.0%	116.2%
Salt Lake City	I-15/State Street	LRT	97.4%	76.3%
San Diego	El Cajon Extension	LRT	95.5%	95.5%
San Francisco	Colma BART Station	HR	138.8%	130.8%
San Jose	Guadalupe Corridor	LRT	176.1%	140.1%
San Jose	Tasman West	LRT	83.6%	124.4%
St. Clair Co.	MetroLink Extension	LRT	34.2%	68.9%
St. Louis	MetroLink	LRT	101.8%	115.0%
Average of 18 Projects (Baltimore Johns Hopkins excluded)			**97.8%**	**99.0%**

1. No valid comparison of actual and estimated operating costs is possible for the Baltimore Johns Hopkins Extension, and consequently, was excluded from the averages.

3.3 Changes between Planning and Operation

To develop an estimate of the Operating & Maintenance (O&M) costs for the planned systems, it is necessary to describe the anticipated services. This planned service level is generally consistent with the project ridership. For most projects, the design year remains in the future and the ridership is still less than anticipated. The operated service levels reflect this fact.

Another possible reason for deviations between projected O&M costs and those actually incurred is that the systems are still relatively new. The guideway, stations, electrical systems, etc., require only routine service and some portions may still be covered by warranties. As the systems age, the O&M costs may increase.

3.3.1 Service Levels

The service levels defined in the various studies conducted to assess the proposed transit investment typically are based on the anticipated development patterns and ridership demand in the design year – typically 20 to 25 years from the year in which the planning study was initiated. The actual service levels are reported for 2002. For half of the projects, this is less than six years after project opening. Actual service levels are typically less than those anticipated in the project planning documents. This may reflect a change in operating strategy or may indicate that the ridership projected had not yet developed so that the additional service is not required. Table 7 illustrates the service levels changes arrayed against the percent difference between the predicted (AA/DEIS) and actual O&M cost.

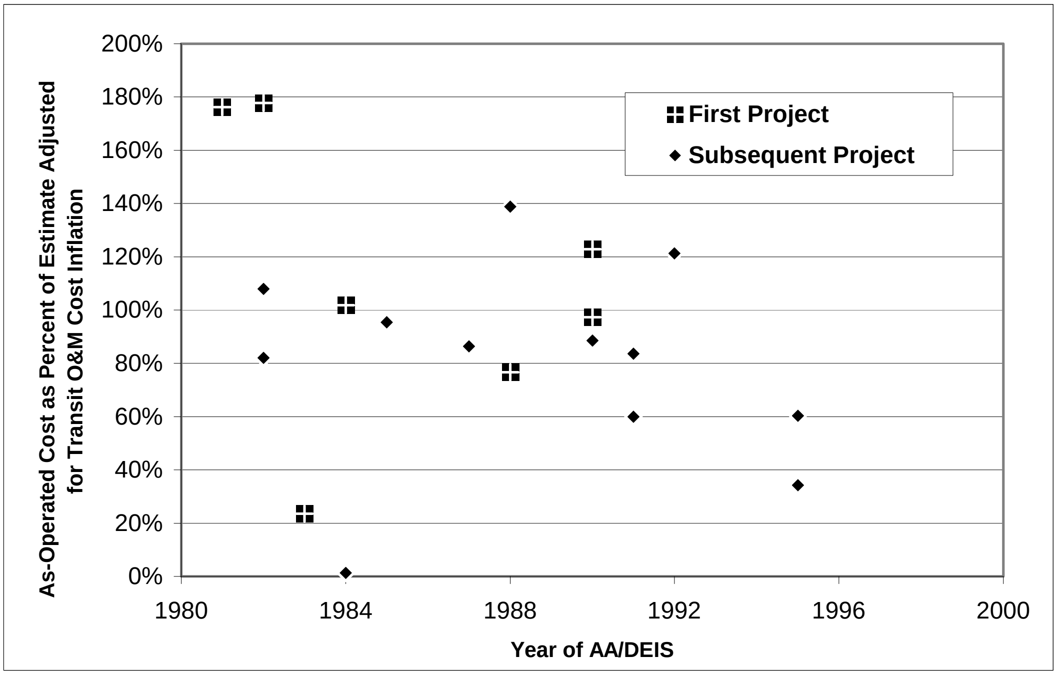
Table 7: Changes in Service Levels and O&M Costs

City	Project	Differences in Service Levels	Percent Error in AA/DEIS Estimates (Inflation Adjusted)
Atlanta	North Line Extension	Peak headway: DEIS 8 min vs. Actual 10 min.	-11.5%
Baltimore	BWI, Hunt Valley, Penn Station Ext.	No significant change.	-40.0%
Baltimore	Extension to Johns Hopkins	Peak Headway: FEIS 5 min; Actual 8 min.	-98.7%
Chicago	SW Transitway	Annual train-Hours: DEIS 43,000; Actual 39,000	-30.4%
Dallas	South Oak Cliff	DEIS Headway 4 min pk; 8 min mid-day, Actual 10 min pk; 15 min. mid-day	22.9%
Denver	North I-25	Peak Bus Trips: DEIS 114, Actual: 51	-23.3%
Denver	Southwest	No significant changes.	-39.6%
Houston	Southwest Transitway	Corridor Fleet Requirement DEIS 744; Actual 216	NA
Jacksonville	Skyway Express	Peak headway 2 min.; Actual 3 min.	77.8%
Los Angeles	Red Line	Peak Headway: DEIS 3-6 min. Actual: 5 min truck, 10 min branches	-38.3%
Miami	Omni and Brickell Extensions	No significant changes.	-13.6%
Pittsburgh	Airport Busway/ Wabash	Several routes proposed to use Busway are not operated or use other routes.	21.3%
Portland	Westside - Hillsboro	Peak Headway (Beaverton-Hillsboro) - DEIS 12 min.; Actual 6 min.	8.0%
Salt Lake City	I-15/State Street	Peak Headway - DEIS 10 min, Actual 15 min.	-2.6%
San Diego	El Cajon Ext.	No significant change.	-4.5%
San Francisco	Colma BART Station	Peak Headway: DEIS 4.5 min; Actual 7.5 min, Evening: DEIS 20 min; Actual 10 min.	38.8%
San Jose	Guadalupe Corridor	Not determined; apparently little change.	76.1%
San Jose	Tasman West	Peak Headway: DEIS 12 min; Actual 15 min.	-16.4%
Seattle	Downtown Project	Peak Hour Tunnel Bus Requirement - DEIS 360; Actual 236	-65.8%
St. Clair Co.	MetroLink Extension	No significant changes.	1.8%
St. Louis	MetroLink	No significant changes.	-11.5%

3.4 Trends in New Starts O&M Cost Estimates

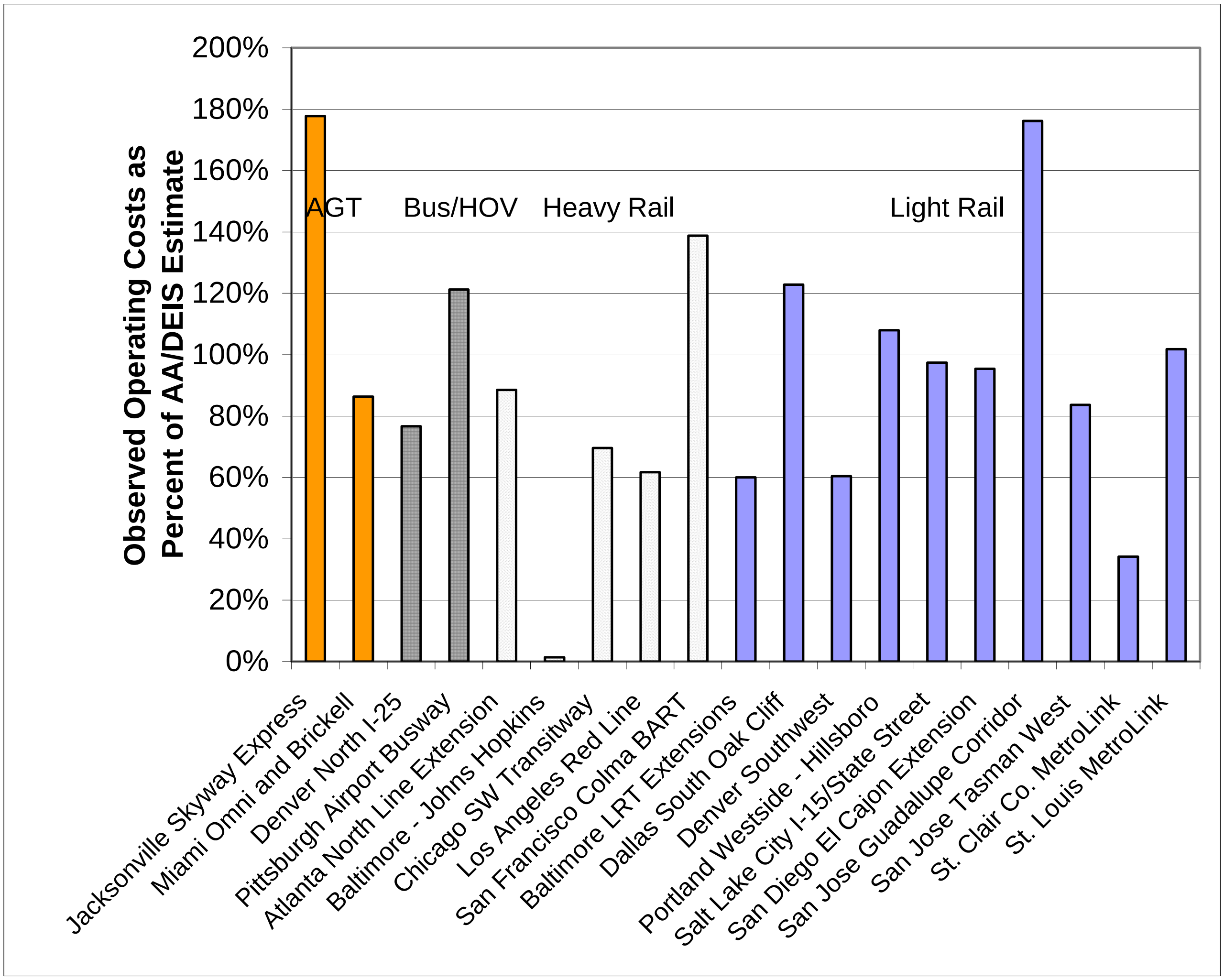
As with capital costs, forecasts of O&M costs are generally improving with time. Figure 8 shows that actual O&M costs tend to be less than the estimate prepared for the AA/DEIS – a finding consistent with the level of service offered. The estimates also tend to be more accurate when the project is the second or subsequent project in a metropolitan area.

Figure 8: Trends in O&M Cost Estimates



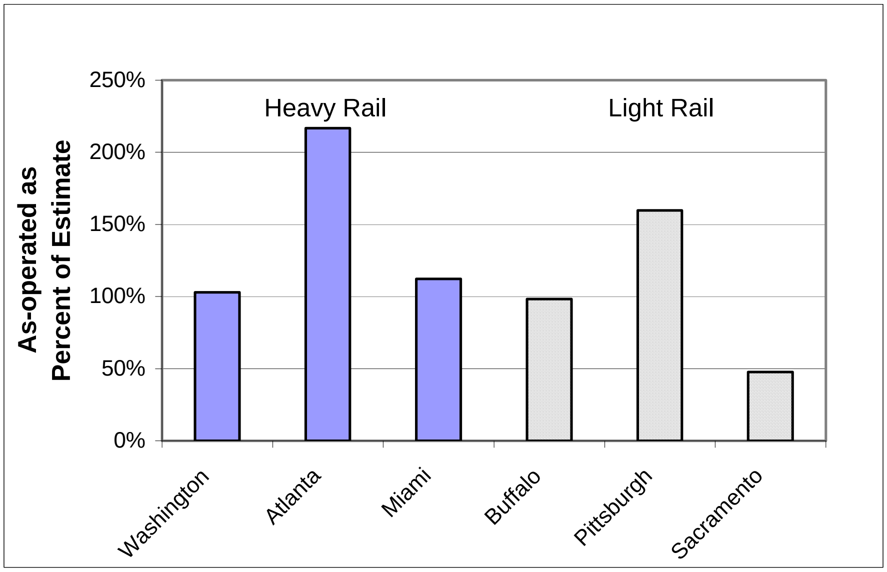
No clear trends emerge when variation in operating cost between estimate and actual is considered by mode. The actual O&M costs of some projects of each mode are both higher and lower than predicted in the AA/DEIS studies (see Figure 9).

Figure 9: Actual O&M Costs as Percent of Inflation Adjusted AA/DEIS Estimate



The variation in the project O&M cost, as-operated, from the cost as estimated for the 19 projects reported here is less than was reported for the six projects for which data were available in *Urban Rail Transit* (1990). For the projects in *Urban Rail Transit*, the actual O&M costs were, on average, 122 percent of the estimate (see Figure 10). For the projects reported here the as-operated O&M costs are on average 92 percent of the estimate. The data are not directly comparable since the 1990 report adjusted costs to a common year based on general cost inflation while in this study the adjustment is based on the local inflation in transit unit operating costs.

Figure 10: O& M Costs; As-operated Compared to Planning Estimates as Reported in *Urban Rail Transit (1990)*



3.5 Results and Interpretation

It is rare for New Starts project O&M costs to exceed the planning estimates. This is, in part, a result of the ability of transit agencies to determine the unit costs of service provision and, in part, a result of the lower levels of service in actual operation. The primary findings are summarized below.

1. Projections of operating costs, adjusted for general inflationary increases in the local costs of transit operations, are being achieved.

2. The quality of O&M forecasts is increased when the locality is already operating the mode under construction. This probably reflects not only the ability to use local experience in developing unit costs but also greater realism in the assessment of efficiencies that can be achieved.

3. In many cases, actual service levels appear to be less than assumed in the planning studies and likely influence the O&M cost estimation results.

4 Ridership

This chapter compares the AA/DEIS and FEIS ridership forecasts (the FFGA does not generally report new ridership forecasts) prepared for nineteen of the twenty-one (two projects had no usable ridership forecasts) New Starts projects in this study, to the actual ridership experienced by those projects after opening. The purpose of this exercise was simply to identify the extent to which the actual ridership on recent New Starts projects deviated from their original forecasts. The forecasts are not evaluated in enough detail to identify the specific reasons for any forecasting errors, though any obvious factors that influence ridership are noted where appropriate. The detailed analysis of particular ridership forecasting problems is left to the future Phase 2 study.

4.1 Analysis Approach

This study compares the predicted and actual ridership for each project at three main points:

- AA/DEIS
- FEIS
- Actual (2002, forecast year, or projected ridership in the forecast year)

The primary ridership measure chosen as the basis of comparison is average weekday boardings. This measure was chosen primarily because nearly every ridership forecasting effort produces a forecast of average weekday boardings. In addition, every agency measures actual average weekday boardings because this item is submitted to FTA for the National Transit Database (NTD). This measure was also chosen in FTA's previous study, *Urban Rail Transit Projects (*1990*)*, so the forecasting performance of the newer projects in this study can be compared to the results of the older study.

Projects that are extensions of existing systems present a minor problem when interpreting station boarding data. In many cases, the boardings on an extension to an existing system may be as little as half the total boardings caused by the project. This is because counting average weekday boardings at the new stations will miss many boardings associated with the return trip. For this reason, *average weekday boardings* is not the same as *average weekday ridership* for extensions. The comparison of average weekday boardings is still useful for evaluating the performance of the forecasts as long as the actual station boardings are compared to forecasts of station boardings. In order to better reflect the impact of the projects in this study on ridership, the forecast and actual average weekday boardings are doubled. The study team acknowledges that this methodology double counts a small proportion of boardings associated with trips that begin and end on the New Start. Since this potential double count impacts both forecast and actual ridership, the findings regarding forecast performance are still valid.

Other measures of ridership include system-wide average weekday boardings and average daily rail system boardings. These measures allow the evaluation of how well the forecasts predicted the regional performance of the transit system. In cases where forecasting errors are identified for project boardings, the magnitude of the corresponding errors relating to system-wide or rail system ridership can indicate potential sources of the errors.

4.2 Forecast and Actual Ridership – 19 New Starts Projects

This study compares the forecasts of average weekday boardings to the actual average weekday boardings experienced by each project. For two of the projects considered in this analysis – the Denver I-25 Bus/HOV project and the Seattle Bus Tunnel – forecasts of ridership could not be identified. Therefore, the analysis of forecast accuracy is based on only nineteen projects.

Forecasts are developed for a specific “forecast year”. In some cases, the forecast year has already passed, so direct comparison can be made between the forecasts and ridership that actually occurred in the forecast year. In many cases, the forecast year is 2005 or 2010, and in one case 2015. For these forecasts, the most recent actual weekday boardings estimate for 2001 or 2002 is compared to the forecast. In many cases, this comparison is quite accurate because most of the ridership is captured in the early years after opening with very slow growth in ridership thereafter. However, there are some rapidly growing urban areas that have shown rapid ridership growth. To account for the ridership that is likely to occur by the forecast year, FTA has adjusted the last available actual ridership number by the average annual growth in system-wide transit boardings between 1990 and 2002. This adjustment allows the comparison of the forecast to a reasonable approximation of future ridership based on observed data and recent trends.

4.2.1 Average Weekday Boardings

Table 8 reports forecast and actual average weekday boardings for each of the nineteen New Starts projects included in this study.[7] The results indicate that, as of 2002, three projects have exceeded their AA/DEIS ridership forecast, three other projects exceed 80 percent of their AA/DEIS ridership forecast, and four more projects exceed 70 percent of their ridership AA/DEIS forecasts. All told, about half of the New Starts projects included in this study either have achieved, or have a good chance of coming within a reasonable range (±20 percent) of their initial planning level ridership forecast. The overall performance of the ridership forecasts has improved markedly from the prior UMTA study, *Urban Rail Transit Projects: Forecast versus Actual Ridership and Cost (*1990*).*

As shown Table 8, only one ridership forecast is prepared for the majority of projects. Twelve out of nineteen projects (63 percent) used the ridership forecast developed for the AA/DEIS throughout project development. Only four projects had ridership forecasts that changed more than 5 percent between the AA/DEIS and the FEIS (St. Louis St. Clair Extension, St. Louis Initial System, Portland Westside/Hillsboro, and Salt Lake City). Three of these projects had major reductions in the forecast ridership, while only the St. Clair Extension had a significant increase in the forecasted ridership.[8]

[7] Forecast ridership could not be determined for the Denver I-25 North Bus/HOV lanes or for the Seattle Bus Tunnel.

[8] The higher FEIS forecast for the St. Clair Extension was likely the result of actual experience on the initial system. The AA/DEIS forecast was developed before the initial system had opened. When the initial system opened to ridership that was roughly equal to the forecasts, the forecasts for the St. Clair extension were likely revise to reflect the actual experience with the initial system. Upon opening, the St. Clair Extension easily exceeded the AA/DEIS forecasts and has a reasonable chance of coming close to the FEIS forecast, though the project is unlikely to exceed it by the forecast year.

Table 8: Predicted and Actual Ridership - Forecast vs. 2002 Actual

Project	Forecast Year	Forecast Average Weekday Boardings		Actual Average Wkdy Boardings - 2002	Ratio	
		AA/DEIS	FEIS		Actual vs. AA/DEIS	Actual vs. FEIS
Atlanta North Line	2005	57,120	57,120	20,878	37%	37%
Baltimore Johns Hopkins	2005	13,600	13,600	10,128 *	74%	74%
Baltimore LRT Ext.	2005	11,804	12,230	8,272 *	70%	68%
BART Colma	2000	15,200	15,200	13,060	86%	86%
Chicago Orange Line	2000	118,760	118,760	54,986 *	46%	46%
Dallas South Oak Cliff	2005	34,170	34,170	26,884	79%	79%
Denver SW LRT	2015	22,000	22,000	19,083	87%	87%
Houston SW Transitway	2005	27,280	27,280	8,875	33%	33%
Jacksonville ASE	1995	42,472	42,472	2,627	6%	6%
LA Red Line	2000	295,721	297,733	134,555	46%	45%
Miami Omni/Brickell	2000	20,404	20,404	4,158	20%	20%
Pittsburgh West B'Way	2005	23,369	23,369	9,000	39%	39%
Portland Westside-Hillsboro	2005	60,314	49,448	43,876	73%	89%
Salt Lake South LRT	2010	26,500	23,000	22,100	83%	96%
San Diego El Cajon	2000	21,600	21,600	24,950	116%	116%
San Jose Guadalupe	1990	41,200	41,200	21,035	51%	51%
San Jose Tasman West	2005	14,875	13,845	8,244	55%	60%
St. Louis Initial System	1995	41,800	37,100	42,381 *	101%	114%
St. Louis St. Clair Ext.	2010	11,960	20,274	15,976	134%	79%

* Figures are for 2001 (2002 not available at time of preparation)

4.2.2 Average Weekday Boardings Adjusted to Forecast Year

Ridership forecasts are developed to reflect trips in a particular year. For eleven of the twenty-one projects included in this study, the ridership forecast year remains in the future (as of this writing). Most of these forecasts were prepared for 2005, while two (Salt Lake City and St. Louis St. Clair Extension) are for 2010 and another (Denver Southwest LRT) is for 2015. Perhaps coincidentally, these three projects with forecast years in 2010 and 2015, are among the four projects with the highest ratio of forecast to actual ridership.

In order to compare the forecasts in the forecast year to actual ridership, the 2002 actual weekday boardings are adjusted to reflect a reasonable growth in ridership until the forecast year is reached (Table 9). FTA chose to inflate the last available actual ridership figure (2002 in most cases) by the average annual growth in transit boardings achieved by the project sponsor between 1990 and 2002. In most cases, the adjustment is quite small since the forecast year is typically 2005. For each project with forecast years in 2010 and 2015, the projects have already come quite close to the forecasts. Inflating the 2002 boardings to these distant years simply accentuates the actual ridership performance of these projects relative to their forecasts.

Figure 11 arrays the predicted and actual ridership adjusted to the forecast year along a 45 degree line. Projects that fall directly on the 45 degree line achieved 100 percent of their AA/DEIS forecast. The chart clearly shows a clustering of ridership forecasts around the 45 degree line, indicating a significant number of relatively accurate forecasts. Those within the ± 20 percent error range are represented in green and considered "accurate". Those just outside the ± 20 percent error range are colored yellow and appear to be "reasonable" forecasts with a good chance of falling within the reasonable range in the future. Those colored red are well outside the reasonable range and must be considered relatively inaccurate forecasts. The blue squares represent the projects studied in FTA's 1990 report and all but Washington Metro fall well outside the range of reasonable forecasts.

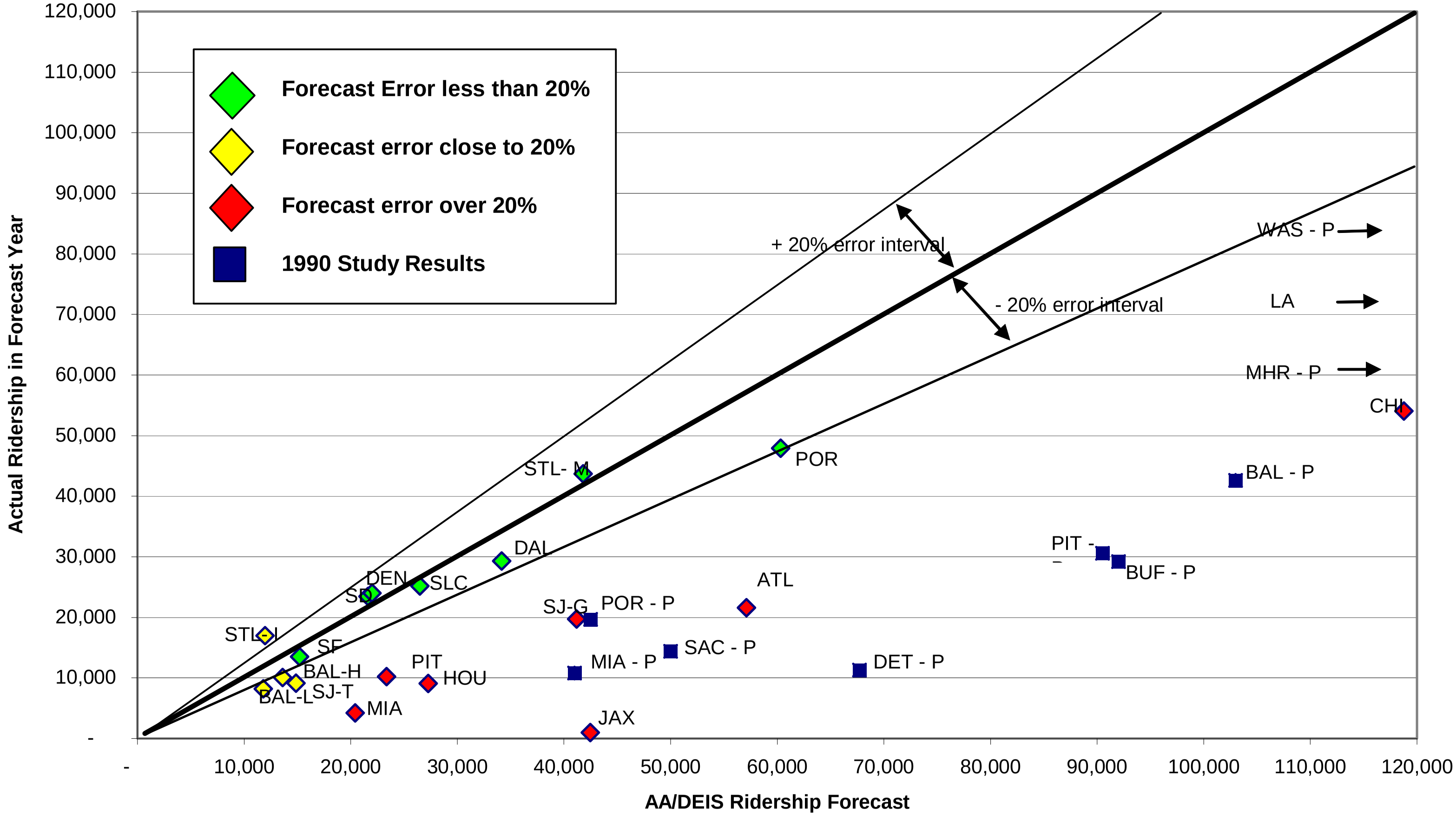
Table 9: Predicted and Actual Ridership - Forecast Year Comparison

Project	Forecast Year	Forecast Avg Wkdy Boardings		Actual (projected) Boardings in Forecast Year	Ratio - Forecast yr actual/Forecast	
		AA/DEIS	FEIS		Actual vs. AA/DEIS	Actual vs. FEIS
Jacksonville ASE	1995	42,472	42,472	2,627*	6%	6%
Miami Omni/Brickell	2000	20,404	20,404	4,209	21%	21%
Houston SW Transitway	2005	27,280	27,280	9,066	33%	33%
Atlanta North Line	2005	57,120	57,120	21,595	38%	38%
LA Red Line	2000	295,721	297,733	128,659*	44%	43%
Pittsburgh West B'Way	2005	23,369	23,369	10,200***	44%	44%
Chicago Orange Line	2000	118,760	118,760	54,042	46%	46%
San Jose Guadalupe	1990	41,200	41,200	19,738**	48%	48%
San Jose Tasman West	2005	14,875	13,845	9,110	61%	66%
Baltimore LRT Ext.	2005	11,804	12,230	8,207	70%	67%
Baltimore Johns Hopkins	2005	13,600	13,600	10,049	74%	74%
Portland Westside-Hillsboro	1995/2005	60,314	49,448	49,999	83%	101%
Dallas South Oak Cliff	2005	34,170	34,170	29,307	86%	86%
BART Colma	2000	15,200	15,200	13,482	89%	89%
Salt Lake South LRT	2010	26,500	23,000	25,201	95%	110%
St. Louis Initial System	1995	41,800	37,100	43,711****	105%	118%
San Diego El Cajon	2000	21,600	21,600	23,478	109%	109%
Denver SW LRT	2015	22,000	22,000	23,988[9]	109%	109%
St. Louis St. Clair Ext.	2010	11,960	20,274	16,965	142%	84%
Denver I-25 HOV	2000	not stated	not stated	8,853	NA	NA
Seattle Bus Tunnel	1990	not stated	not stated	44,400	NA	NA

* Actual boardings in forecast year given for 2001 since this is the first full year of operation.
** Actual boardings in forecast year given for 1992 since this is the first full year after opening
*** Actual boardings are assumed to increase 1,200 daily riders over 2002 as an additional park and ride lot is completed.
**** Actual boardings given for 1999 since Airport station did not open until 1998.

[9] Denver has experienced relatively fast ridership growth over the past decade. Since the forecast year remains far in the future, continued growth at recent trends appears overly ambitious. FTA assumed that the Denver project will achieve a growth rate 2/3rds of the growth rate observed between 1990 and 2002. Even at this lower assumed growth rate, this project is very likely to exceed its AA/DEIS forecasts by a significant margin.

Figure 11: Ridership Forecasts vs. Actual



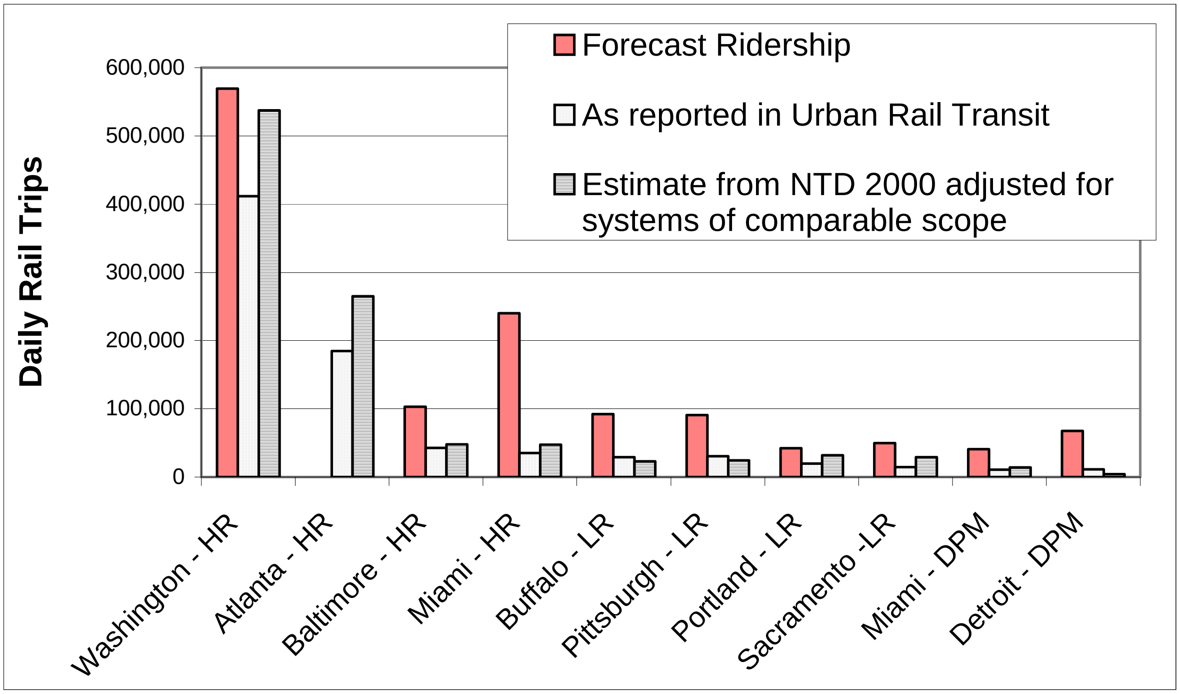
Key to Project Symbols

Atlanta HR* ('90)	NA	Dallas South Oak Cliff	DAL	Miami HR ('90)	MHR-P	San Diego El Cajon	SD
Atlanta North Line	ATL	Denver I-25 HOV	NA	Miami Omni/Brickell	MIA	San Jose Guadalupe	SJ-G
Baltimore HR ('90)	BAL-P	Denver SW LRT	DEN	Pittsburgh LR ('90)	PIT-P	San Jose Tasman West	SJ-T
Baltimore Johns Hopkins	BAL-H	Detroit DPM ('90)	DET-P	Pittsburgh West B'Way	PIT	Seattle Bus Tunnel	NA
Baltimore LRT Ext.	BAL-L	Houston SW Transitway	HOU	Portland LR ('90)	POR-P	St. Louis Initial System	STL-M
BART Colma	SF	Jacksonville ASE	JAX	Portland Westside-Hillsboro	POR	St. Louis St. Clair Ext.	STL-I
Buffalo LR ('90)	BUF-P	LA Red Line	LA	Sacramento LR ('90)	SAC-P	Washington HR ('90)	WAS-P
Chicago Orange Line	CHI	Miami DPM ('90)	MIA-P	Salt Lake South LRT	SLC		

4.3 Updated Ridership – Ten Projects from Urban Rail Transit (1990)

In *Urban Rail Transit Project: Forecast Versus Actual Ridership and Costs,*[10] published in 1990 data were presented for then rail system projects that had been funded with federal assistance at that time. Forecast and observed data were available for nine of these ten projects. Figure 12 below illustrates the data as reported in 1990 and the year 2000 ridership for each project as reported in the year 2000 National Transit Database.[11]

Figure 12: Ridership for Projects Studied in Urban Rail Transit (1990)



Two of the ten projects studied in 1990, Washington and Portland, now report ridership, for the portions of their systems comparable to those of 1990, quite close to the forecasts. Others – Atlanta and Sacramento - show continued growth. Detroit, Pittsburgh and Buffalo have actually lost ridership since 1990. The remaining projects show little change.

4.4 Results and Interpretation

This section includes an assessment of the accuracy of ridership forecasts for New Starts projects and attempts to draw some conclusions from the analysis of the 19 projects for which ridership forecasts were available. The primary findings of this analysis are presented as follows.

[10] *Ibid.*
[11] Ridership for the Washington Metro are from 2002 station boarding/alighting data from the Washington Metropolitan Area Transit Authority only for the 60 stations in operation when the 1990 report was published.

1. Ridership forecasts are improving.

While ridership forecasting clearly needs further improvement, the forecasts in this study have improved markedly compared to the results of FTA's last report on this topic, *Urban Rail Transit Projects: Forecast Versus Actual Ridership and Cost (1990)*. In the 1990 report, 9 of 10 projects had observed ridership less than half the forecast ridership (see Figure 13). That report found that only one project (Washington Metrorail) came anywhere close (28 percent below forecast) to achieving the ridership forecasts published in the project planning studies while all other projects attracted less than half their projected ridership. In the current Phase 1 study, four projects are expected to exceed their ridership forecasts, another four are expected to be between 80 and 100 percent of their forecasts and three more are expected to be between 60 and 80 percent of the forecast ridership (see Figure 14) by their forecast year.

Overall, almost 60 percent of the projects studied can be expected to achieve at least two-thirds of their forecast ridership by their forecast year. Comparing these results to the projects analyzed in the 1990 study reveals that more than half of ridership forecasts for the recent projects performed better than the best forecast in the older study. Of interest is that this improvement in forecast accuracy started well before the publication of the 1990 report. For projects with a DEIS between 1982 and 1990, six of 13 have achieved ridership within 20 percent of the DEIS forecast. For projects with an AA/DEIS after 1990, four of five have achieved, or are expected to achieve ridership 80 percent of more of the forecast.

There are several possible reasons for the improvement including:

- Experience;
- Scrutiny (federal, local, project opponents);
- Improving methods (nested logit, destination choice…); and
- Technology (computing power).

Projects have had the benefit of **experience**. FTA's 1990 report provided information on ten projects. For some of those projects initial work on system design and ridership forecasts dates from the 1960s before there were established and formalized procedures for projection of ridership for new transit projects. For all of those projects there were few examples of newly developed transit systems that could be used to assess the reasonableness of forecasts. The analysts charged with developing the forecasts for the projects reported here had the benefit of the actual ridership experience for several other projects as well as experience in the development and application of improved mode choice analysis procedures.

The more formalized procedures for planning and funding major transit investment projects also led to greater **scrutiny** of all forecasts. Among the major factors leading to increased scrutiny of all aspects of the process for planning and implementing federally funded transportation projects was the National Environmental Policy Act of 1969 (NEPA). During the 1970s, the Council on Environmental Quality (CEQ) developed standardized policies and procedures for the analysis and documentation of environmental factors as part of the project planning process. The Urban Mass Transportation Administration (UMTA) and the Federal Highway Administration (FHWA) first issued regulations implementing the CEQ requirements in 1980. In 1983 UMTA and

FHWA issued a Notice of Proposed Rulemaking to streamline the procedures. After comment and revision these were issued as formal regulations on August 28, 1987.

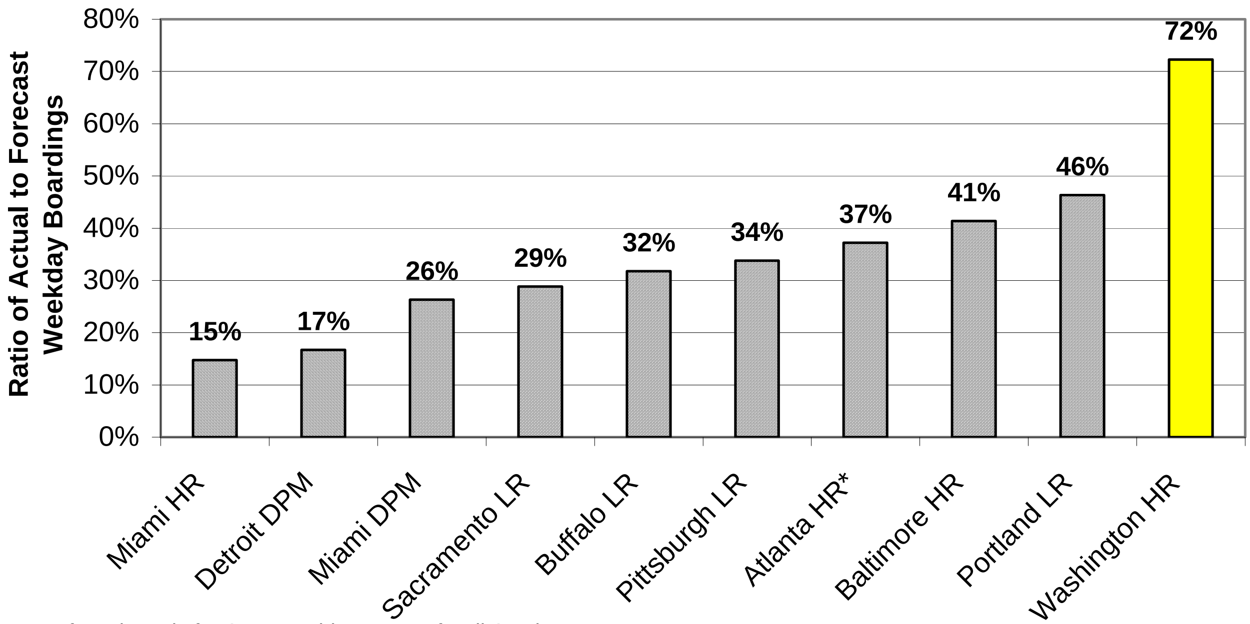
The process established by these regulations and followed by agencies developing projects during most of the 1980s required that planning assumptions be clearly stated, that there be consistency among alternatives and that the results of analyses be well documented. The process also required that the federal agency providing funding for the project, in this case UMTA, sign and issue the environmental documents. In combination these requirements led to greater scrutiny of the planning process by both the public and UMTA.

The 1980s also saw the completion and opening to revenue service of major portions of several of the projects that received the first federal transit project construction grants in the 1970s. Although formal studies had not been conducted, there was already an awareness of project expenditures that exceeded estimates and ridership falling short of projections. The analysts responsible for preparation of forecasts responded to these concerns and developed **improved methods** for travel forecasting and analysis. The Bay Area Rapid Transit system (BART), the first regional scale urban rail system planned and constructed in over fifty years, opened for service in 1972. The BART Impact Studies, reporting on the changes in travel behavior resulting from the implementation of BART, were published in 1979. Data collected as part of the BART Impact Studies led to the development of discrete choice theory by Daniel McFadden, for which he was awarded a Nobel Prize in 2000, and the application of the theory to studies of traveler mode choice. During the 1980s, software to permit estimation of the mode choice functions and application of the resulting models became more widely available and practitioners become more skilled in the use of these methods.

During the same period, the **technology** for developing travel forecasts changed rapidly. The growing availability and increased power of desktop computers permitted more detailed specification of system alternatives and, due to reduced processing costs, enhanced testing and analysis of alternatives.

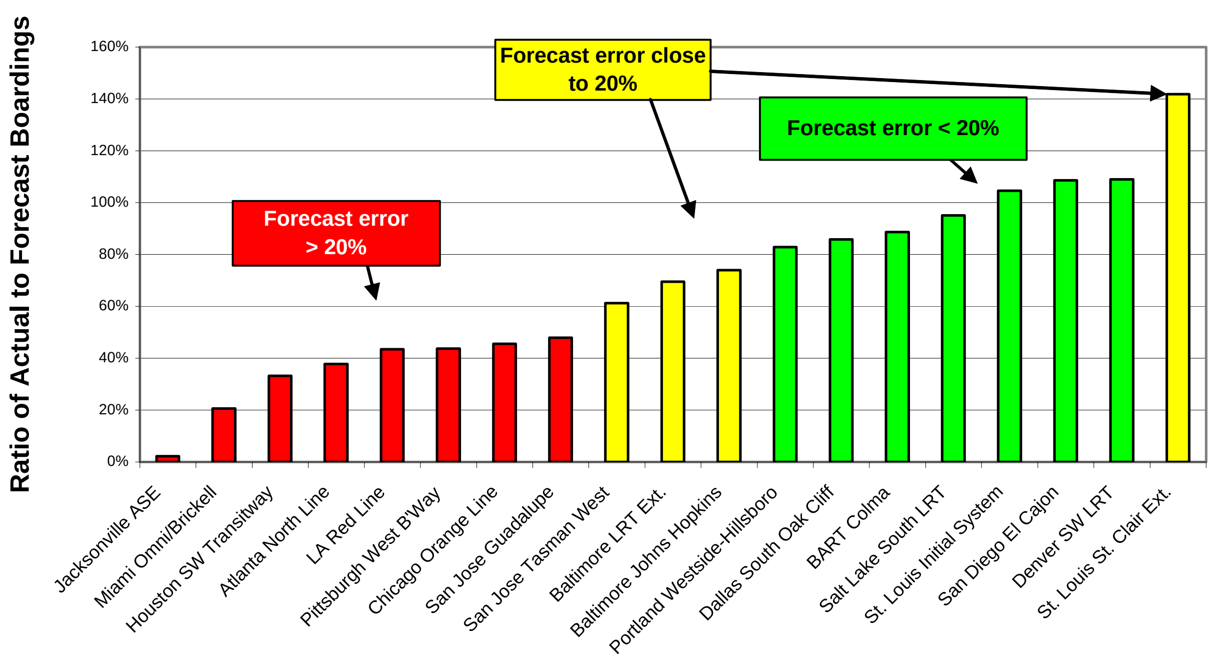
In combination, these factors provided the framework for greater understanding of travel forecasts produced by the improved models and contributed to projections of ridership more in keeping with expected system performance.

Figure 13: Ridership Forecast Accuracy for Projects Reported in *Urban Rail Transit (1990)*



* Data for Atlanta is for System-wide Impact of Rail Service

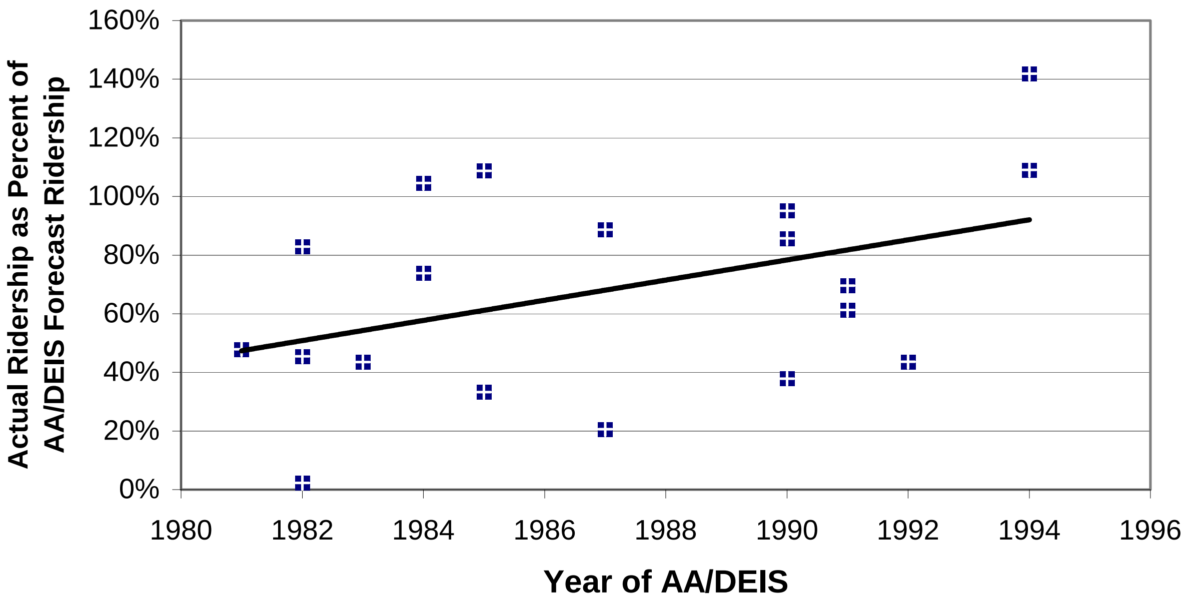
Figure 14: AA/DEIS Ridership Forecast Accuracy, Adjusted to the Forecast Year



2. Older forecasts tend to have higher errors.

Older forecasts appear to have higher errors than newer forecasts (see Figure 15). On average, projects with AA/DEIS forecasts that exceed 60 percent of actual ridership were published in 1989 compared to 1985 for other projects. There are several exceptions. The St. Louis Initial System, San Diego El Cajon, and Baltimore Johns Hopkins Extension projects produced reasonably accurate forecasts even though they are relatively old. Of these older forecasts, two of the three are extensions.

Figure 15: Trend in Accuracy of Ridership Forecasts



Most projects (14 of 21) only produced a single ridership forecast during planning and project development. These projects carried the AA/DEIS ridership forecasts all the way through project development. The seven projects for which new forecasts were prepared for the FEIS had generally successful forecasts prepared both in the DEIS and FEIS. But as a group, the forecasts prepared during the FEIS were not noticeably better than the AA/DEIS forecasts (see Table 10). San Jose, Portland, and the St. Louis St. Clair extension clearly improved their forecasts between the AA/DEIS and FEIS. The LA Red line, Baltimore LRT extensions, and St. Louis Initial system actually produced forecasts with larger errors for the FEIS than for the AA/DEIS. The Salt Lake City project forecasts could be better or worse depending on future ridership, but given recent trends, the FEIS forecast is likely to prove less accurate than the AA/DEIS forecast.

Table 10: Comparison of AA/DEIS and FEIS Ridership Forecasts

Project	Ratio - Forecast yr actual/Forecast yr projection	
	Actual vs. AA/DEIS	Actual vs. FEIS
LA Red Line	44%	43%
San Jose Tasman West	61%	66%
Baltimore LRT Ext.	70%	67%
Portland Westside-Hillsboro	83%	101%
Salt Lake South LRT	95%	110%
St. Louis Initial System	105%	118%
St. Louis St. Clair Ext.	142%	84%
Average Ratio of Actual/Forecast	86%	84%

3. Ridership forecasts for initial projects (starter systems) have higher errors than extensions or subsequent projects in the same metropolitan area.

Nine of the eleven projects with ridership expected to be more than 65 percent of the FEIS forecast are extensions of existing lines. On average, the forecast errors for initial systems have been 47 percent. Extensions or projects in areas with existing systems had forecast errors of 35 percent. The experience gained with existing lines and the ability to develop and calibrate travel demand models based on observed ridership appears to lead to more accurate ridership forecasts.

4. Downtown people-movers continue to have poor ridership forecasting performance.

In FTA's 1990 study of ridership forecasts, two of the three projects with the highest forecast errors were downtown people movers (DPMs). This pattern continues in this study. There are two DPM projects in the sample – the Jacksonville ASE and the Miami Omni/Brickell extension. Neither has achieved ridership greater than 21 percent of the estimate prepared at the time of the Alternatives Analysis - the highest errors observed out of all New Starts projects in this study.

People movers function mainly as distributor and circulator systems within downtown areas and, as such, service a completely different primary market than the rest of the projects. The travel demand forecasting procedures used to develop forecasts for most transit projects do not appear to provide accurate forecasts for downtown circulator transit projects. The reasons are not immediately clear, though some possibilities include:

- Difficulty modeling transfer behavior. One trip type served by these projects is the transfer from bus or rail originating outside of the project area. Transfers are difficult to model. Travelers appear to find transferring more onerous than just the time and money cost involved with the transfer. Travel demand forecasts may be overstating travelers' willingness to transfer to DPMs, which may contribute to unachievable ridership forecasts.

- Models need to account for walk trips. Since the trips served by DPMs are generally short, models need to accurately represent the competing walking trip in the travel demand model's mode choice procedure. It is unclear how well walk trips have been modeled in the ridership forecasting procedures applied to DPM projects. Station access and egress along with wait times may make DPM trips non-competitive with many walking trips and thus lead to overestimated ridership.

- Non-work circulation trips are generally ignored by traditional travel demand models so separate procedures and analyses are required to predict these types of trips. It is unclear whether the DPM forecasts have made the effort to collect the data required to correctly model non-work circulation travel.

More detailed analysis of the travel demand models, procedures and input assumptions would be required to specifically identify the causes of the overly optimistic ridership forecasts for DPMs.

5. Ridership forecasts for busway projects have performed relatively poorly.
There are only three busway projects and one (Seattle) had no project specific ridership forecast, but none of the available busway forecasts proved to be accurate. It appears from the limited sample that forecasts of ridership on busway projects – Houston SW and Pittsburgh Airport – will not exceed 41 percent of the forecasts. This may be due, in part, to lesser services being offered or, as in Pittsburgh, major portions of the project as initially planned not being completed by the forecast year. Also, the multiple routes using a busway and the combination of on and off-guideway operation by the same vehicle makes it difficult to allocate specific ridership to the busway project section.

In addition, while two may be too small a sample to identify industry-wide problems with busway forecasts, it may be an indication of some problems inherent in busway ridership forecasting that require additional attention relative to the following areas:

- Network coding;
- Mode choice constants for premium service; and/or
- Variations in actual vs. planned services.

Network coding issues arise because the pattern of services on a busway can be quite complex. Unlike a rail facility on which trains from one or two rail routes may operate, services on a busway may be provided by many separate routes. Each of these routes can have common service segments on the busway yet operate through very different geographic areas after leaving the busway. In addition, there are often separate routes that operate only on the busway. Some routes will stop at all stations; some routes will operate express with few or no stops. Depicting this service mix to the travel modeling software in ways that yield a valid representation of the travel times and costs facing travelers using the busway services requires creativity and imagination. The methods used may not have correctly reflected the choices, trip times, and costs perceived by individual travelers.

Issues related to **mode choice constants for premium service** arise from discussion in the travel forecasting community about the proper methods to account for differences between the way travelers perceive times and costs related to specific modes. FTA guidance has mandated that all transit modes be treated as being perceived in the same manner unless there is local experience with the different modes that supported the use of mode specific factors. In metropolitan areas with different services of different types or different modes, some agencies have developed mode choice models that attempt to reflect different public perceptions of “local” service and of “premium” service. Premium services have generally been defined to include rail and, in some instances, express bus. There is, however, no clear standard for defining a particular service as “local” or “express” and this definitional issue can be even cloudier for routes that operate a portion of the route on local streets and a portion of the route on a busway.

Variations between planned and actual service appear to be greater for the busway projects than for the rail projects in this study. This may be a result of the inherently greater flexibility offered by busways and the ability to add or delete service in smaller increments. Rail systems tend to be operated with policy headways at all times of day and all days of the week, so that the services provided may exceed the ridership demand at certain periods. The service offered on a busway represents that combination of service levels on many individual routes. The policy headways on each individual route will, in general, be longer than would be found on a rail line. Some routes may operate only in peak hours with no service in the midday, at night or on weekends. In addition, it is relatively easy to adjust bus service patterns to match ridership demand. When the ridership demand has not reached projected levels, the service offered may be less than was assumed during the preparation of ridership forecasts. This may have the unintended effect of moderating the growth in ridership.

6. Many projects operating at service levels well below planning assumptions.

There is a chicken-and-egg aspect to this observation. For many projects, the ridership is less than had been projected for the forecast year. The level-of-service offered (headway) is less than was assumed when the forecasts were made. It is difficult to discern whether the planned headways are not yet provided because ridership growth has not yet occurred or if the ridership growth has been delayed because the planned service frequency has not been offered.

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Appendix 1: Project Profiles

Atlanta North Line Extension

Description

The North Line Extension includes three stations north of the Medical Center terminus; Dunwoody, Sandy Springs, and North Springs. The transit improvement was meant to extend the rapid transit system to the North Atlanta corridor's rapidly growing population and employment center, which is the fastest growing part of the metropolitan area. The project is meant to provide park and ride access to the MARTA system in the congested GA 400 corridor and as well as serve the significant reverse commute market with the rail system.

Project Development

System Planning

MARTA's original plan for the North Atlanta Corridor at the time of the 1971 referendum was a busway in the median of the GA400 extension. The 4.7 mile busway would have connected to the rail system at Lenox station, and extended north to I-285. In 1986, MARTA and ARC amended the plans to call for rail construction past I-285 to North Springs.

FHWA and GDOT issued a joint highway-transit Final Environmental Impact Statement (FEIS) in August 1987 for the segment of the rail extension from the MARTA line in operation to the Medical Center station. This segment runs in the median of the GA 400 highway project, and was completely locally funded. This segment opened in 1996.

Alternatives Analysis

MARTA began studying the feasibility of extending the rail line to North Springs in 1988. MARTA completed the AA/DEIS in the spring of 1990 at which time the Board of Directors chose the Locally Preferred Alternative consisting of the extension of the MARTA North Line from Medical Center northward to a terminus at North Springs, with direct ramps from GA 400 into the station parking lot.

Preliminary Engineering

MARTA published the FEIS for a project from Medical Center to North Springs with stations at Dunwoody, Sandy Springs, and North Springs on April 11, 1991. Shortly after that, it was decided that MARTA would build the extension in 2 stages with the first stage terminating at the Dunwoody Station. MARTA conducted an Environmental Assessment for Dunwoody as a Temporary End-of-Line Station in May 1991.

Final Design and FFGA

The project began final design in spring of 1991. The extension to Dunwoody station received earmarks totaling $92 million for final design and construction in 1991 and 1992. The remaining 1.9 mile, two station segment moved forward as the North Springs extension. An FFGA was issued for the final segment in December 1994.

Opening for Service

Revenue operation to North Springs Station began December 16, 2000.

Project Scope

The two segments that make up MARTA's 3.1 - mile, 3-station North Springs extension to its heavy rail rapid transit system are:

1. The 1.2-mile, 1-station segment from Medical Center Station to Dunwoody Station. This segment received federal funding (approximately $92 million), but not under a FFGA.
2. The 1.9-mile, 2-station segment from Dunwoody to North Springs Station. FTA and MARTA entered into a FFGA on December 14, 1994 for the construction of this segment. The segment consists of approximately 0.8 mile of two-track, cut-and-cover subway with one subway station and approximately 1.1 miles of at grade and aerial line with a terminal station.

In the fall of 1999 (Sept/Oct), the scope of the 1.9-mile project expanded and a Revised and Restated Full Funding Grant Agreement was signed. The scope changes[12] included:

- 28 additional heavy rail passenger vehicles. The total quantity of rapid rail cars within the approved scope was 56 cars.
- The conversion of the customer parking facility at the North Springs (terminal) Station from a surface lot to a multi-level deck structure
- Customer security and convenience enhancements to the Sandy Springs and North Springs Stations
- Rights-of-way impacts stemming from widening of the adjacent GA 400 freeway.

[12] Refer to MARTA's "Application for and Amendment to the North Line Extension Full Funding Grant Agreement," dated July 19, 1999 for further details.

Table 11: Project Scope - Atlanta North Line Extension

	DEIS	FEIS	FFGA	As-built
Length	3.1	3.1	1.9	3.1
at grade	1.2	1.2	0.9	1.1
underground	0.8	0.8	0.8	0.9
elevated	1.1	1.1	0.2	1.1
Stations	3	3	2	3
underground	1	1	1	1
elevated	2	2	1	2
Trackage				
double	3.1	3.1	1.9	3.1
Parking Spaces	4250	4301	3700	4280
surface	550	2901	2300	1000
structure	3700	1400	1400	3280
Vehicles				
rail	10	24	28	56
Facilities				
control center	not stated	1	Not stated	not stated

Service Levels

Actual headways on the North Line Extension are slightly below the planned service levels. The operating hours approximately match the planning documents.

Table 12: Service Levels - Atlanta North Line Extension

	MIS/AA/ DEIS	FEIS	FFGA	Actual
Forecast Year	2005	2005	NA	NA
Span of Service				
Weekday	not stated	5:00 AM – 1:00 AM	NA	4:45 AM – 1:00 AM
Frequency of Service				
Pk Hr Headway	8 min	8 min	NA	10 min
Pk Period Hdwy				10 min
Mid-Day Hdwy				10 min
Evening Hdwy				15 min
Operating Statistics				
Annual Train Hours	6,930	6,930		5,150**
Annual Car Miles	1,875,300	1,875,300		1,620,900**
Peak Vehicle Reqs	10	10 / 24*	28	
Fare	not stated	not stated	not stated	$1.75

* FEIS states that 24 add'l vehicles are required for project; but also states that 10 incremental vehicles over the NB are required. Hours and Miles are incremental over the no-build.
**Annual train hours following the Revenue Operation Date were 8,819 prior to the March 2002 headway adjustment. With the reduction in headway from 8 minutes to 10 minutes, the annual train hours are approximately 5,150. Actual annual car miles are 1,620,900, after the March 2002 service cuts.

Ridership

The ridership forecasts developed during project planning overestimated ridership on the Atlanta North Line Extension. Projected average daily ridership for the year 2005 remain about 2.5 times higher than actual daily ridership in 2003 at the three stations included in the North Line Extension planning documents.

Table 13: Predicted vs. Actual Ridership - Atlanta North Line Extension

	Project - Average Weekday Ridership	System-wide		Forecast Year
		Rail System Boardings	Total Transit Boardings	
Predicted				
AA/DEIS	57,120	357,991**	461,963**	2005
FEIS	57,120	358,021**	461,963**	2005
Actual				
1995		227,482	469,802	
Dunwoody Opens 1996		234,104	474,284	
1997		246,084	497,593	
1998		251,445	516,439	
1999		262,583	537,854	
FFGA Proj. Opens 2000	12,768	273,990	546,900	
2001	23,780	264,114	530,450	
2002	20,878	270,110	521,804	
2003 (July-Dec est.)	22,328	245,800	478,800	

** System-wide forecasts are daily linked transit trips. Linked trips is always less than boardings.

Capital Costs

The capital cost estimate prepared for the 1991 DEIS was $370 million for 3.1 miles of guideway. Adjusted for the inflation in Atlanta area construction costs, this is equivalent to a capital cost of $439.5 million, about 8 percent less than the actual cost. Adjusted for inflation, the actual cost exceeded the FEIS estimate and the FFGA by 21 percent and 34 percent, respectively. This pattern may reflect reductions in planned project scope in the FEIS and initial FFGA. Subsequent changes to the FFGA added to the project scope and restored some features assumed at the time of the DEIS.

Table 14: Predicted and Actual Capital Costs - Atlanta North Line Extension

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$370.2 (1988 $)	$337.1 (1990 $)	$327.3 (1994 $)	$472.7	128%	140%	144%
Adjusted to Const. Midpoint (1997$)	$439.5	$389.7	$352.0	$472.7*	108%	121%	134%

*Note—there should also be a column to show the FFGA amended Budget of $463.2 Million. Also, the As-built cost shown of $472.7M includes the $9.45 million in locally funding system enhancements that MARTA elected to implement in the latter stages of the Project, which were not reflected in the FFGA Budget.

Operating Costs

Operating cost estimates for the AA/DEIS and the FEIS are based on the difference in total system operating cost between the No-Build and the locally preferred alternative expressed in year-of-expenditure dollars. The locally preferred alternative includes the full 3.1 miles from the Medical Center Station to the North Springs Station. The as-built estimate is derived from MARTA Heavy Rail operating cost as reported in the National Transit Database for 2000 ($128.4 million) and an estimate, derived from public schedules, that the North Springs Extension comprises 4.2 percent of the train hours and is therefore allocated 4.2 percent of the O&M cost.

With those caveats, the O&M costs achieved are consistent with the estimates and the differences between the services as assumed for planning purposes and as operated.

Table 15: Predicted and Actual Operating Costs - Atlanta North Line Extension

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$7.1 (2000 $)	$8.3 (2000 $)	NA	$5.4	76%	65%	NA
Adjusted to year of opening (2000 $)	$7.1	$8.3	NA	$5.4	76%	65%	NA

Assessment of Predicted vs. Actual Ridership and Costs

To date ridership for the North Springs Extension, opened for service in 2000, falls well short of projections. While the forecast year is 2005, ridership trends suggest that this project is unlikely to be significantly closer to the forecast ridership by 2005. The precise reason for the forecasting error is not immediately clear, though one contributing factor is the reduction in frequency. The magnitude of the forecast error is difficult to understand considering the small scope of the project that is an extension of a well established heavy rail system. A detailed review of the assumptions and travel forecasting procedures would be required to definitively determine the cause of the error.

The O & M costs appear to be less than projected but may reflect differences in operations or in the cost allocation methodology.

The project capital cost exceeded the nominal dollar cost estimates and the FFGA. The as-built project, while close to the project planned in alternatives analysis, is of greater scope than the project identified in the FFGA. The project scope changes included variations on the number of parking spaces and whether those spaces were built in a structure or on surface lots. In addition, the project as-built included significantly more vehicles than originally planned.

Baltimore MTA Light Rail Extensions: BWI, Hunt Valley, and Penn Station

Description

This project includes three distinct extensions to the Baltimore Central Light Rail line. The Hunt Valley segment extends the line to a fast growing employment center on the north side of the metropolitan area to better serve the reverse commute market. Most of the anticipated ridership increases on this segment were commuters living south of Hunt Valley with jobs near the new stations. The Penn Station extension provides a direct transfer from MARC commuter rail and Amtrak. The BWI extension provides an intermodal connection with the major International Airport in the Baltimore region.

Project Development

System Planning

In 1987, the MTA evaluated four corridors for potential rail transit: north, south, west and northeast. From that evaluation, Maryland's General Assembly approved the construction of the Central Light Rail Line (CLRL). The original concept of the CLRL included 28 miles of light rail serving the north and south corridors. State and local funds paid for the construction of a 22-mile segment of Phase I of the CLRL operating between Dorsey Road and Timonium. In 1988, MTA requested federal participation in the evaluation of transit options for three extensions to the CLRL, known as Phase II: Hunt Valley, BWI Airport and Penn Station.

Alternatives Analysis

Hunt Valley: MTA completed an Alternatives Analysis/Draft Environmental Impact Statement in September 1990 that examined five alternatives, including three LRT alternatives. The DEIS Gilroy Road alternative 3C, which eventually became the locally preferred alternative, called for four to five stations on an extension of about 4.5 miles from Timonium to the Hunt Valley Mall.

BWI Airport: MTA completed an AA/DEIS in May 1991 that examined five alternatives, including three LRT alignments. Of the three, the alignment closest to the eventual LPA was the DEIS Alternative 4 – LRT: Direct Connection – South. Alternative 4 called for an alignment of 2.3 miles (DEIS page S-6, or according to DEIS page 2-15, 2.7 miles) with two stations. The line would branch off from the CLRL north of Broadview Boulevard in the Linthicum Oaks area.

Penn Station: MTA completed an Alternatives Analysis/Environmental Assessment in November 1991. The AA/EA examined three alternatives, including an LRT alignment that would branch off from the CLRL mainline and travel north to an area just south of the Howard Street bridge over I-83, cross I-83 on a bridge, turn southeast and descend under Maryland Avenue, and end just west of Charles Street at Penn Station.

Preliminary Engineering

Hunt Valley: MTA completed a Final Environmental Impact Statement in October 1993. The FEIS included refinements and changes to the LPA including the addition of a station at Pepper Road north of Schilling Road, refinements to the alignment between Pepper and McCormick roads, and removing the construction of the Warren Road park- and-ride lot from the LRT project. Local officials decided to have the Maryland State Highway Administration build the lot independent of the LRT project.

BWI Airport: Local officials chose an LPA in November 1991. The LPA, which contained elements of the Direct Connection North and the Direct Connection South alternatives of the DEIS, called for 2.4-mile extension of the LRT with two new stations. As with the Direct Connection South, the LPA would branch off from the CLRL north of Broadview Boulevard in the Linthicum Oaks area. Officials completed the FEIS in October 1993.

Penn Station: The Penn Station spur was the subject of an EA rather than an EIS. This segment was combined with the Hunt Valley and BWI extensions into a single project during preliminary engineering.

Final Design and FFGA

An FFGA for all three extensions was signed in November 1994. The FFGA called for the Hunt Valley extension to be 4.6 miles with five stations, the Penn Station extension to be 0.3 miles and the BWI extension to be 2.4 miles with two stations. The FFGA calls for the Penn Station extension alignment to descend to grade level at Maryland Avenue, unlike the AA/EA which calls for the alignment to descend under Maryland Avenue.

Opening to Service

The Hunt Valley, BWI, and Penn Station extensions opened to service in 1997.

Project Scope

The primary scope changes during planning and project development included changes to the number of stations proposed in the FFGA and changes in the mix of single and double track (see Table 16). The DEIS and FEIS proposed mostly double track extensions with some single track segments. By the time the FFGA was executed, the project was entirely single track with sidings. The FFGA added two additional stations to those proposed in the planning documents; Timonium Park and Ride, and the Cross Transfer Station where the BWI extension branches off the CLRT. However, these two additional stations were not constructed.

The Project Management Oversight report, October 1993 states that the MTA planned to purchase 7 additional rail vehicles for $14.7 million under the Phase one project, rather than the 8 to 9 vehicles referenced in the DEIS and FEIS.

Table 16: Project Scope - Baltimore LRT Extensions

	DEIS	FEIS	FFGA	As-built
Length	7.6	7.3	7.3	7.3
at grade	7.3	7	7	7
elevated	0.3	0.3	0.3	0.3
Stations				
at grade	8	8	10	8
Trackage				
single+sidings	3	2.7	7.3	7.3
double	4.6	4.6		
Parking Spaces				
surface	400	550	not stated	455
Vehicles				
rail	8-9	8-9	8-9	7

Service Levels

Service levels on the Baltimore CLRT are slightly below the service levels in the planning studies for the extensions (see

Table 17). The service levels on the CLRT are limited by the preponderance of single track operations. The CLRT Double Track project was given an FFGA in 2001 and should allow double track operations in 2006, allowing for improved levels of service.

Table 17: Service Levels - Baltimore LRT Extensions

	AA/DEIS/EA	PE/FEIS	Actual
Forecast Year	***2005***	***2005***	
Span of Service			
Weekday	6:00 AM - 12:00 AM	6:00 AM – 12:00 AM	5:30 AM – 11:00 PM
Frequency of Service			
Pk Hr Headway	15 min	15 min	17 min
Pk Period Hdwy	15 min	15 min	17 min
Mid-Day Hdwy	15-30 min	15-30 min	17 min
Evening Hdwy	30 min	30 min	17 min
Operating Statistics			
Annual Platform Hours	10,950	10,950	
Annual Car Miles	102,500	102,500	
Fare			1.35

Ridership

Unfortunately, ridership data is unavailable for 1997-99. Like most other LRT systems, the Baltimore LRT uses proof of payment fare collection so station boarding estimates require surveys, which are often, but not always conducted every year. Average weekday boardings in 2001 on the stations constructed, as part of this project, were approximately 30 percent below the predicted boardings for 2005 (see Table 18).

Table 18: Predicted and Actual Ridership - Baltimore LRT Extensions

	Project - Average Weekday Boardings	System-wide		Forecast Year
		Light Rail System Boardings	Average Daily Transit Boardings	
Predicted				
AA/DEIS	11,804	not stated	342,000*	2005
FEIS	12,230	not stated	342,000*	2005
Actual				
1991			370,852	
1992		3,285	347,962	
1993		11,459	368,054	
1994		20,400	362,607	
1995		19,385	375,466	
1996		20,907	350,092	
Opens 1997	not avail	22,656	358,688	
1998	not avail	22,759	362,020	
1999	not avail	24,970	362,110	
2000	8,138	27,415	387,277	
2001	8,272	24,702	380,559	

* System-wide forecasts are weekday linked transit trips while actual ridership figures are average weekday boardings. These figures are not directly comparable as boardings will be significantly larger than linked trips.

Capital Costs

Project capital costs as estimated at the time of the AA/DEIS, even when escalated to the midpoint of construction dollars (1995$) are significantly less than the as-built cost. After completion of the AA/DEIS the Penn Station Extension was added to the project, explaining some of the additional cost. The preliminary engineering studies conducted prior to the FEIS led to more accurate determination of capital costs. In nominal dollars the difference between the FEIS estimate and the as-built is less than 10 percent; in escalated dollars the difference is about 5 percent.

Table 19: Predicted and Actual Capital Cost - Baltimore LRT Extensions

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$70.2 (1989 $)	$106.3 (1993 $)	$106.3 (1993 $)	$116.2	165.6%	109.2%	109.2%
Adjusted to Const. Midpoint (1995$)	$81.9	$110.2	$109.5	$116.2	141.9%	105.5%	106.2%

Operating Costs

Baltimore's heavy rail METRO has been in operation since 1983. The initial portions of the Central Light Rail in Baltimore opened for service in May 1992. Local area Light Rail operating costs were not available at the time of the AA/DEIS studies. Even by the time of the FEIS, the existing service had been in operation for only about 1 year – not sufficient time to develop a cost history. It appears that the planners adopted a conservative approach to estimating the unit cost for light rail. This, coupled with the limitation on the amount of service that can be operated under the existing single track configuration, resulted in projected operating costs higher in both nominal and inflated dollars than the costs actually incurred.

Table 20: Predicted and Actual Operating Costs - Baltimore LRT Extensions

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$2.8 (1989 $)	$3.1 (1992 $)	NA	$2.7	93.5%	85.7%	NA
Adjusted to year of opening (1997 $)	$4.5	$3.5	NA	$2.7	58.7%	75.9%	NA

Assessment of Predicted vs. Actual Ridership and Costs

The Light Rail extensions that make up this project are the latest in a series of rail projects planned and constructed in the Baltimore region. Planning for the initial heavy rail Metro commenced in 1966 and the first segment opened in 1983. The Central Light Rail was planned during the 1980's and opened in 1992. The heavy rail extension to Johns Hopkins Hospital was also planned in the 1980s and opened in 1995. Planning for the Central Light Rail extensions appears to have benefited from the experience gained in these other projects.

Boardings on the portions of the Light Rail that are the subject of this project are about 70 percent of the estimates for 2005. The ridership forecasts, with continued ridership growth, should come relatively close to the actual ridership on the project. However, there are several identifiable reasons that the forecasts were too high, including:

- The project was-built as a single track line with sidings, while the planned project was 2/3 double track;
- The as-built track layout limits headways to 17 minutes, about a 12 percent reduction in service levels compared to the planned project; and
- Preponderance of single track is likely to cause longer trip times and lower levels of operating reliability than assumed in the forecasting efforts.

The estimated capital costs, once detailed design studies were undertaken, were within 10 percent of the as-built costs with only minor changes in scope. In inflation adjusted dollars the cost estimates were closer to the as-built costs. The operating costs as estimated were greater than costs actually incurred for the opening year.

Baltimore Heavy Rail Section C Northeast Subway: Extension to Johns Hopkins Hospital

Description

The Northeast Extension of the Baltimore Metro was intended to accommodate projected downtown development and to provide an alternative to downtown congestion. Congestion on city streets was considered a serious limit to the performance of buses downtown with bus speeds expected to approach 3 miles per hour. The project allows passengers to travel across downtown Baltimore quickly and provides heavy rail transit service to Johns Hopkins Hospital, a major employer and traffic generator on the Northeast side of downtown.

The project is a heavy rail extension that extends 7,780 feet to the east and north terminating in a tail track just beyond the new Johns Hopkins Hospital station. The construction was by twin bored tunnels and cut and cover methods for the two stations.

Project Development

System Planning

Baltimore began planning its regional rail system in 1964. The MTA opened Section A of its heavy rail line from Reistertown Plaza to Metro Center in late 1983, and Section B to Owings Mills in July, 1987. In May 1983, the MTA issued the Bus/Rail Evaluation Study Report for West, Northeast and East/Southeast Corridors which ranked the Northeast Corridor highest in potential ridership among the three corridors considered.

Baltimore used Interstate Transfer Program funds to pay for this extension. As provided for in the Federal Aid Highway Act of 1976, this program allowed state and local officials to transfer funds from highway projects to public mass transit projects. Baltimore decided not to construct some segments of Interstate Routes 83 and 595. The State of Maryland received approval to make this transfer on September 29, 1983.

Alternatives Analysis

In February 1984, the MTA initiated the Northeast Corridor Alternatives Analysis Study. The AA/DEIS for Section C was completed in late 1984. Local officials selected the rail alternative to Johns Hopkins Hospital via Broadway as the LPA, which calls for an extension to the current system of 1.5 miles with two stations.

Preliminary Engineering

UMTA approved entry into preliminary engineering in December 1985. Local officials finished the Final Environmental Impact Statement (FEIS) for Section C in December 1988.

Final Design and FFGA

A Full Funding Grant Agreement was signed in December 1988 and called for a 1.5-mile extension with two stations.

Opening to Service

The FFGA specified completion of the project by December 31, 1994. Service began on May 30, 1995 although significant work on one station was incomplete when service was initiated. The project experienced schedule slippage and added costs due to unforeseen conditions related to gasoline vapors from leaking buried tanks, necessitating the use of fire proof tunneling equipment. Delays caused by this issue increased the costs of subsequent contracts. The books on the project were expected to be closed in late 1998 (projected in final PMO report).

Project Scope

The scope of the Baltimore Metro Section C project remained stable throughout planning and project development (see Table 21). The only significant change from the environmental documents to the FFGA was that the planned intermodal center was removed from the FFGA defined project.

Table 21: Project Scope - Baltimore Metro Section C (Northeast Extension)

	DEIS	FEIS	FFGA	As-built
Length				
underground	1.5	1.5	1.5	1.5
Stations				
underground	2	2	2	2
Trackage				
double	1.5	1.5	1.5	1.5
Parking Spaces	0	0	0	0
Vehicles				
rail	0	0	0	0
Facilities				
multimodal transfer	1	1	not stated	not stated

Service Levels

Actual peak service levels on the Baltimore Metro are below those shown in the planning documents (see Table 22). Peak period headways are three minutes longer than planned. In a significant expansion in service levels, the Baltimore Metro began Sunday service in September of 2001.

Table 22: Service Levels - Baltimore Metro Section C (Northeast Extension)

	MIS/AA/ DEIS	FEIS	Actual – 2002
Forecast Year	2005	2005	NA
Span of Service			
Weekday	not stated	5:00 AM - 1:00 AM	5:00 AM - 12:30 AM
Frequency of Service			
Pk Hr Headway	5 min	5 min	8 min
Pk Period Hdwy	5 min	5 min	8 min
Mid-Day Hdwy	10 min	10 min	10 min
Evening Hdwy	15 min	15 min	15-20 min
Weekend Hdwy			15-20 min
Fare	not stated	not stated	$1.35

Ridership

Average daily ridership on the Northeast Extension has grown to over 10,000 per day in 2001 compared to a projected 13,600 by 2005. Actual system-wide heavy rail boardings actually exceed the 2005 forecasts by about 6,000 boardings per day.

Table 23: Predicted vs. Actual Ridership - Baltimore Metro Section C (Northeast Extension)

	Project - Average Weekday Boardings	System-wide			Forecast Year
		Heavy Rail System Boardings	Commuter Rail Boardings	Total Transit Boardings	
Predicted					
AA/DEIS	13,600	32,900	not stated	not stated	2005
FEIS	13,600	42,000	not stated	not stated	2005
Actual					
1994		37,566	19,598	362,607	
1995	7,362	40,702	18,648	375,466	
1996	8,540	44,017	18,539	350,092	
1997	9,096	45,345	18,260	358,688	
1998	9,582	45,893	18,581	362,020	
1999	9,978	47,483	19,706	362,110	
2000	9,946	48,496	20,851	387,277	
2001	10,128	47,927	22,901	380,559	

Capital Costs

This project was the extension of an existing heavy rail line. Planning for the original segment of the rail line had begun in 1964. Segments of the rail line opened in 1983 and 1987. When the Alternatives Analysis and environmental studies were conducted in 1983 and 1984 the experience with heavy rail construction was current and light rail planning was also underway. As a result the cost estimates prepared for the planning studies, when adjusted to reflect inflation, appear to have been reliable – within roughly 13 percent of the actual cost expressed in 1991 dollars (see Table 24). This capital cost performance is particularly impressive given that significant construction difficulties were encountered with underground fuel leakage in the tunnel area.

Table 24: Predicted and Actual Capital Costs - Baltimore Metro "C"

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$256.8 (1990 $)	$321.7 (1992 $)	$321.7 (1992 $)	$353.0	137.5%	109.7%	109.7%
Adjusted to Const. Midpoint (1991$)	$313.7	$310.5	$310.5	$353.0	112.5%	113.7%	113.7%

Operating Costs

Operating costs for the as-built project were derived from the reported Heavy Rail operating expenses in the National Transit Database in the years before and after opening of the new segment. As such they do not properly account for other changes in the operation of the preexisting heavy rail segments that would affect costs. The data presented in Table 25 suggest that when the new segment was opened the operation of the overall rail line was modified to so that costs would not increase. No valid comparison of actual and estimated operating costs is possible from these data.

Table 25: Predicted and Actual Operating Costs - Baltimore Metro "C"

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/ DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$2.7 (1986 $)	$2.1 (1986 $)	NA	$0.07	2.8%	3.4%	NA
Adjusted to year of opening (1995 $)	$5.2	$3.2	NA	$0.07	1.4%	2.2%	NA

Assessment of Predicted vs. Actual Ridership and Costs

The daily ridership estimated for 2005 exceeds actual 2001 ridership by about 30 percent. This project represented a relatively short extension of an existing line into an area with a known and well developed transit market. Much of the ridership on the new segment represented extensions of trips already made on rail, transfers of existing riders from bus lines or travelers to and from the large Johns Hopkins Hospital Complex.

The forecast year is 2005, so it remains quite plausible that, with small annual gains in ridership, these forecasts will prove relatively accurate. For example, annual ridership gains of 2 percent annually until 2005 would bring the ridership forecast to within 20 percent of the forecasts. Some possible explanations for overestimating ridership for this project include:

- The service levels offered are much less that anticipated in the planning phases (headways are 60 percent longer than planned); and
- Employment in downtown Baltimore may not have achieved the assumed levels in the forecasts.

The capital costs incurred for project construction are relatively close to the estimated costs when adjusted for construction cost inflation.

The actual operating costs, as near as can be discerned from the NTD data, are far less than estimated. However, due to changes in service levels on Baltimore's entire heavy rail system and other cost saving efforts, the NTD data do not provide any clear basis for assessing the accuracy of the operating and maintenance cost estimates.

Overall these data suggest Baltimore succeeded in preparing relatively reliable forecasts, benefiting from recent experience in the development of similar facilities and from the fact that the project serves an existing transit market.

Chicago Southwest Transitway Project

Description

The Chicago Southwest Transitway project (CTA Orange Line) provides heavy rail transit service to the southwest side of Chicago, beginning in Downtown Chicago and terminating at Midway Airport. The project was undertaken to meet the travel needs of persons residing, working and shopping in southwest Chicago, as well as travelers and employees utilizing Midway Airport. Until the opening of the Orange Line, southwest Chicago not served by heavy rail transit service.

Project Development

System Planning

Planning for rapid transit in the Southwest Corridor began in 1966 with the Comprehensive Plan of Chicago. The plan identified the Southwest Corridor as the only major radial corridor without rapid transit service. The Chicago region's 1995 Transportation System Plan, completed in 1975, evaluated rapid transit in the corridor. In 1979, as part of the Interstate Transfer Program, the Chicago region cancelled plans for the Franklin Street subway and the Cross-town Expressway, which freed up more than $2.2 billion in federal funds for transportation improvements, including transit service in the Southwest Corridor.

Alternatives Analysis

The Phase I - Preliminary Alternatives Analysis began in 1977 and evaluated modal and alignment proposals for the corridor. The preliminary study recommended consideration of 11 transit improvement alternatives, including TSM, busway and rapid rail facilities. An Alternatives Analysis/Draft Environmental Impact Statement, completed in September 1982, evaluated those 11 alternatives and a twelfth hybrid alternative. Of those, the City of Chicago chose the 49^{th} Street-Midway alignment as the preferred alternative.

Preliminary Engineering

The city modified plans for the 49^{th} Street-Midway Alternative during Preliminary Engineering. The major change was the replacement of one mile of underground construction with aerial structure from Midway Airport to Kostner Avenue. The Final EIS was published in September 1985. The project was allowed to begin final design in late 1985.

Final Design and FFGA

The project sponsor carried out final design between late 1985 and the end of 1988. The FFGA was signed in July 1986.

Opening to Service

Construction began in 1987. Revenue service began in October 1993.

Project Scope

The scope of the Chicago Southwest Transitway project remained relatively stable throughout project development and construction, except for the deletion of a major vehicle procurement. Most changes during project development were changes in the vertical alignment of the project, which increased the portion of the alignment built at grade or on an embankment and reduced the length of the elevated sections and removed a planned underground section and station. These changes are summarized in Table .

The locally preferred alternative called for a rapid rail line of 9.3 miles, with one mile as subway, 4 miles on railroad embankment and 4.3 miles as aerial structure, and including nine stations. The Final EIS modified the 49th Street-Midway Alternative to include 3.4 miles of aerial structure and 5.9 miles of track in embankment or at-grade along railroad rights-of-way and eight stations.

The initial 1986 grant agreement was for a 9.3-mile line with eight stations. The 1987 amended grant agreement refers to a 9.0-mile line with eight stations. The original grant agreement also included a large number of rail vehicles, which appear to have been deleted from the amendment.

Table 26: Summary of Chicago Southwest Transitway Project Scope

	DEIS	FEIS	FFGA	As-built
Length	9.3	9.3	9	9
at grade/embankment	4	5.9	6.3	6.3
underground	1			
elevated	4.3	3.4	2.7	2.7
Stations	9	9	8	8
at grade/embankment	5	7	7	6
underground	1			
elevated	3	2	1	2
Trackage				
double	9.3	9.3	9	9
Parking Spaces				
surface	600	853	not stated	778
Vehicles				
rail	112	104	0	0
Facilities				
shops/yards	1	1	not stated	1

Service Levels

Service levels on the Orange line are below the levels specified in the planning documents (see Table 26). The line operates 19.5 hours per day at between 5 and 15-minute headways. The planning documents analyzed a 24-hour a day service with headways between 4 and 10 minutes.

Table 26: Service Level Summary - Chicago Southwest Transitway

	MIS/AA/ DEIS	FEIS	Actual
Forecast Year	2000	2000	NA
Span of Service			
Weekday	24 hrs	24 hrs	4:30 AM – 12:00 AM
Headways			
Pk Hr Headway	4 min	4 min	5 min
Pk Period Hdwy	4 min	4 min	7 min
Mid-Day Hdwy	7 min	7 min	12 min
Evening Hdwy	7-8 min	7-8 min	15 min
Weekend Hdwy	6-10 min	6-10 min	15 min
Operating Statistics			
Annual Train Hours	43,000	43,000	39,000[13]
Annual Car Miles	5,900,000	5,900,000	5,300,000[14]
Peak Vehicle Reqs	112	104	86[15]
Fare	Not stated	Not stated	$1.50

Ridership

The ridership forecasts developed in project planning for the CTA's Southwest Transitway have proven to be optimistic. Projected average weekday boardings for the year 2000 were over two times higher than the actual boardings experienced in 2000 (see Table 27).

[13] = trains per hour * annual hours
[14] = annual train hours * cycle distance * vehicles per train
[15] = (cycle time in minutes / headway) * vehicles per train * (1+ spare ratio)

Table 27: Predicted vs. Actual Ridership - Chicago Southwest Transitway

	Project - Average Weekday Boardings	System-wide Wkdy Heavy Rail System Boardings	System-wide Total Wkdy Transit Boardings	Forecast Year
Predicted				
AA/DEIS	118,760	531,440*	1,749,730*	2000
FEIS	118,760	531,440*	1,749,730*	2000
Actual				
1992		473,297	1,921,876	
1993	29,600	464,148	1,775,602	
1994	46,000	485,165	1,782,915	
1995	46,400	465,812	1,703,708	
1996	45,971	471,446	1,691,994	
1997	46,400	503,110	1,686,354	
1998	47,420	515,513	1,711,623	
1999	53,365	556,465	1,779,949	
2000	54,042	589,383	1,830,486	
2001	54,986	604,578	1,839,155	

Note: System-wide total transit boardings includes CTA bus, CTA heavy rail, and Metra commuter rail.
* System-wide forecasts are daily linked transit trips. Linked trips must be less than boardings.

Capital Costs

The AA/DEIS prepared in 1982 estimated the capital cost for the project to be $453 million including both construction and the purchase of 112 cars. This is equivalent to $604 million when adjusted to reflect inflation in Chicago area construction costs. The final project was over $80 million less than the AA/DEIS cost estimate. This cost reduction is largely the result of the deletion of vehicle purchases from the project scope as well as changes to the vertical alignment of the guideway.

Table 28: Predicted vs. Actual Capital Costs - Chicago Southwest

	Total Capital Cost (millions of $)				Comparison		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$453 (1981 $)	$460 (1984 $)	$411 (1987 $)	$522	115%	114%	127%
Adjusted to Const. Midpoint (1990$)	$604	$532.3	$438.4	$522	86.4%	98.1%	119.1%

Notes: Costs estimated fir the AA/DEIS and FEIS include vehicle purchase. The cost reported for the FFGA includes $60 M in 1987 $ as the allocated portion of a separate vehicle procurement. The As-Built includes $79.5 million in 1994 $ as the allocated portion of a separate vehicle procurement.

Operating Costs

The as-built operating cost reported below is an estimate derived from the National Transit Database. The service operated, span and frequency, is less than assumed in the original estimates, which likely accounts for the finding that the as-built operating costs are 60 percent to 70 percent of the inflation adjusted estimates of operating cost.

Table 29: Predicted and Actual Operating Costs - Chicago Southwest

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$15.3 (1981 $)	$19.3 (1984 $)	NA	$16.7	109.2%	86.5%	NA
Adjusted to year of opening (1993 $)	$24.0	$28.4	NA	$16.7	69.6%	58.8%	NA

Assessment of Predicted vs. Actual Ridership and Costs

The ridership projected in the Alternatives Analysis studies conducted between 1977 and 1982 far exceeds the ridership actually achieved. A number of factors contribute to the forecasting errors including:

- Reduced hours of operation (20 vs. 24 hour service);
- Off-peak service frequency only half the frequency assumed in the studies; and
- Peak frequencies 20 percent less than assumed in the planning studies.

Even with these explanations, detailed studies would be required to determine the relative contributions of discrepancies in forecasts of travel markets and mode shares to the resulting error. It is unlikely that service levels explain the majority of the observed forecasting error. These forecasts are relatively old, having been completed prior to 1982. Previous studies by FTA[16] have shown the majority of the ridership forecasts developed at that time have been unreliable.

There seems to have been a significant effort to hold the capital cost of the project close to the nominal dollar estimate developed in the AA/DEIS phase. In spite of a 64 percent increase in the Construction Cost Index for the Chicago area between the AA studies published in 1982 and the opening of the project in 1993, the as-built cost, in nominal dollars, was only 15 percent more than the cost estimated in 1982. Adjusting for inflation, the project was constructed at a total cost 15 percent less than the 1982 cost estimate.

[16] *Urban Rail Transit Projects: Forecast Versus Actual Ridership and Cost*, US Department of Transportation, Federal Transit Administration, October 1990.

As the project planning evolved the estimated car requirement and the cost for the cars was reduced. In the FEIS the car requirement was estimated to be 104. While project planning was underway the CTA undertook the procurement of new cars for the exiting operations. The car requirement for the Orange Line was incorporated in this purchase funded through other programs. The FFGA did not include any budget for car purchase. The as-built cost reported in the table includes $79.5 million for vehicle purchase as estimated elsewhere.[17] The number of vehicles attributed to the Orange Line is not reported.

The project as-built is shorter than originally planned by 0.3 miles. One mile of underground construction and 1.3 miles of elevated construction were either eliminated or changed to at-grade. Another change affecting capital cost is the reduction in the number of stations from 9 (planned) to 8 (built) with the elevation of an underground station and a reduction in the number of elevated stations from three to two.

The changes explain, in part, why the inflation adjusted original estimate is significantly greater than the as-built cost. The project as defined at the FFGA was much closer to the project as-built. The as-built cost was roughly 19 percent more than the FFGA estimate in inflation adjusted dollars.

Similarly, despite a 60 percent increase in the unit cost of transit service (measured in cost per vehicle hour) between the planning studies 1982 and the opening for service 1993 the cost of operations is less than 10 percent greater, in nominal dollars, than the AA estimate.

[17] Booz Allen & Hamilton, *Fixed Guideway Capital Costs; Heavy Rail and Busway/HOV Lane*, Federal Transit Administration, Office of Technical Assistance and Safety, September 1994

San Francisco Colma BART Station

Description

The project is a one station, one mile long extension of the existing BART line just south of the City of San Francisco. The purpose of the extension is to meet passenger demand (primarily park and ride) for transit service driven by growth in employment and population and access constraints at the terminal station at Daly City. The Daly City station operated at capacity during peak periods. Even with additional satellite parking, local decision-makers felt that the Daly City Station would not be able to serve potential demand. The Colma Station extension was designed to spread access routes to BART among more freeway ramps and provide sufficient parking opportunities to meet demand.

Project Development

System Planning

The California Legislature created the San Francisco Bay Area Rapid Transit District (BART) in 1957 to include the five counties of Alameda, Contra Costa, Marin, San Francisco, and San Mateo. In 1962, San Mateo and Marin Counties withdrew from the BART District while Alameda, Contra Costa, and San Francisco Counties approved a general obligation bond issue to finance construction of the BART system. As a result, BART's West Bay terminus was at the Daly City Station located at the San Francisco/San Mateo County border.

Daly City then became the busiest BART station outside of downtown San Francisco. As originally built, the station did not include a turnback track beyond the station or any BART car storage facilities, limiting the efficiency of the entire system. Train headways at Daly City Station were longer than originally planned, and empty trains had to return to the East Bay for overnight storage. In 1985, construction of the Daly City Station Turnback Improvement project began. That project included turnback tracks extending from the Daly City Station to a storage/maintenance yard 1.4 miles to the south.

Nonetheless, officials projected that the parking shortage and peak-hour traffic congestion would continue at the Daly City Station because of physical constraints at the station site. The San Mateo County Transit District (SamTrans), the City of Daly City and BART began a station improvement program to boost capacity. However, passenger demand was projected to exceed the capacity gained in the improvement program.

In November 1985, the electorate of San Mateo County approved, by a 73 percent favorable vote, a ballot measure authorizing SamTrans to fund the construction of a passenger station in unincorporated Colma and to contract with BART for service to this facility.

Alternatives Analysis

Officials began the Alternatives Analysis/Draft Environmental Impact Statement/Draft Environmental Impact Report (AA/DEIS/DEIR) in February 1987 and finished in October 1988, selecting the LPA in December 1988. The LPA was Alternative 4 in the AA/DEIS/DEIR and consisted of a new BART station in unincorporated Colma with a turnback that extends 1,630 feet from the station platform. The turnback was intended to enable trains to operate on an average headway of 4.5 minutes during the peak period. A new 1,400-space parking structure also was included in the project. Twenty-two kiss-and-ride parking spaces and 12 bus bays also are at the station.

Final Design and FFGA

The FEIS process finished in December 1990. The FEIS contained an updated description of the LPA, based on preliminary engineering design work, but the general elements of the project remained the same as in the AA/DEIS/DEIR – a 1,630-foot turnback and a new BART station in Colma. Construction bids were higher than expected, resulting in a $26 million increase in the capital cost. Officials signed the FFGA in September 1993.

Opening to Service

Revenue operation began on February 24, 1996.

Project Scope

The scope of the Colma extension remained relatively consistent between planning and construction (see Table 30). Minor changes on the order of a few hundred feet in the length and some small increases in the amount of underground and elevated sections are noted from the project documentation. The parking capacity built under the FFGA is less than planned parking capacity and the addition of three vehicles was removed from the project during preliminary engineering.

Table 30: Project Scope - San Francisco BART Colma Extension

	DEIS	FEIS	FFGA	As-built
Length	0.97	0.97	0.91	0.91
at grade/embankment	0.84	0.86	0.66	0.66
Underground	0.13	0.11	0.19	0.19
Elevated			0.06	0.06
Stations				
at grade	1	1	1	1
Trackage				
Double	0.65	0.65	0.59	0.59
triple +	0.32	0.32	0.32	0.32
Parking Spaces				
Surface	840	840		
Structure	1400	1400	1400	1400
Vehicles				
Rail	3*	0	0	0

Service Levels

Actual service levels on the extension are far lower than the service levels assumed in the planning documents (see Table 31). Two of the four lines that run on the BART system short-turn at Daly City. Before September 2002, one line ran to Colma all day while one additional line ran to Colma during rush hour. Currently, two lines run to Colma all day. The extension was designed to allow 4.5 minute peak period headways, but currently operates 7.5 minute headways.

Table 31: Service Levels - San Francisco BART Colma Extension

	MIS/AA/ DEIS	FEIS	Actual
Forecast year	2000	2000	NA
Span of Service			
Weekday	4:00 AM – 1:30 AM	4:00 AM – 1:30 AM	4:30 AM – 1:30 AM
Frequency of Service			
Pk Hr Headway	4.5 min	4.5 min	7.5 min
Pk Period Hdwy	4.5 min	4.5 min	7.5 min
Mid-Day Hdwy	5 min	5 min	7.5 min
Evening Hdwy	20 min	20 min	10 min
Fare	not stated	not stated	$1.95 - $4.95

Ridership

Actual average daily ridership on the Colma extension is about 10 percent less than the predicted ridership.

Table 32: Predicted and Actual Ridership - San Francisco BART Colma Extension

	Project - Average Weekday Boardings	System-wide Average Heavy Rail Boardings	System-wide Average Daily Transit Boardings	Forecast Year
Predicted				
AA/DEIS	15,200	no forecast	no forecast	2000
FEIS	15,200	no forecast	no forecast	2000
Actual				
1998	12,146	279,338	1,207,573	
1999	12,540	294,879	1,224,881	
2000	13,482	310,268	1,276,844	
2001	14,192	353,397		
2002	13,060	329,527		

Note: System wide total transit boardings reported for BART, MUNI, AC Transit and CalTrain.

Capital Costs

The capital cost for the project as estimated for the AA/DEIS was significantly lower than the cost ultimately incurred. By the time the FFGA estimate was prepared in 1993, the scope of the project had changed reducing the amount of at-grade construction and adding a small elevated section and about 0.1 additional mile of subway. Both of these changes would lead to greater construction cost. The FFGA estimate, in inflation adjusted dollars, was within five percent of the reported as-built cost.

Table 33: Predicted and Actual Capital Cost - BART Colma Extension

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/ DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$94.9 (1986 $)	$120.7 (1990 $)	$170.2 (1993 $)	$179.9	189.6%	149.1%	105.7%
Adjusted to year of opening (1996 $)	$112.5	$130.1	$171.6	$179.9	159.9%	138.2%	104.9%

Operating Costs

Operating costs for the as-built project were derived from the reported Heavy Rail operating expenses in the National Transit Database in the years before and after opening of the new segment. As such they do not properly account for other changes in the operation of the pre-existing heavy rail segments that would affect costs. The data presented below suggest that during the years when the new segment was opened the operation of the overall BART rail system were was modified in ways that increased service and led to increased costs. The actual operating cost presented below is an estimate based on Colma extension operations representing 2.64 percent (based on train-hours) of BART's total reported operating expenses of $257 million in the year following the start of revenue service on the Colma extension.

Table 34: Predicted and Actual Operating Costs - BART Colma Extension

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$3.5 (1987 $)	$4.0 (1990 $)	NA	$6.8	194%	170%	NA
Adjusted to year of opening (1996 $)	$4.9	$5.2	NA	$6.8	139%	131%	NA

Assessment of Predicted vs. Actual Ridership and Costs

The observed 10 percent error in the ridership forecasts is well within the range of error that can be expected of a travel demand forecast. This project was a one station extension of a long operating existing heavy rail system with ample data regarding the existing travel patterns. High quality data and long experience with the transit market near the extension surely helped to facilitate accurate forecasts. The slight overestimation of ridership may be explained by the operation of less service than planned. The level of service assumed for the AA/DEIS and the FEIS was 13 trains per hour and 12 trains per hour in the peak and midday periods, respectively. The service actually operated is eight trains per hour, 33 percent less than planned.

The capital costs estimated in the planning phases of the project were substantially lower than actually incurred. General inflation in construction costs coupled with the change in scope for the project contributed to this difference. The estimate prepared for the FFGA was within five percent of the actual.

Given that actual operating costs for the segment under study cannot be easily segregated from the O&M costs for the total system so that the reported as-built O&M values is an estimate based on the proportion train-hours on the segment, the O&M cost estimates seem to have been quite reasonable.

Dallas South Oak Cliff Light Rail Project

Description

The Dallas South Oak Cliff (SOC) project is a 9.6 - mile segment of a 20 - mile light rail starter system. The other two segments of the starter system were constructed by DART without federal funding. The population in the SOC corridor is generally low to moderate income and has a relatively high number of transit dependents. Traffic conditions in the corridor were not severely congested. This project was meant to provide dependable, fast, and convenient transit access to employment opportunities for the residents of the corridor, who tend to use DART more intensively than other area residents.

Project Development

System Planning

After Dallas Area Rapid Transit formed in 1982, Dallas area voters approved the Final Service Plan, which called for a 147-mile light rail network. In August 1986, economic conditions forced a re-examination of the DART service plan. The DART Board of Directors revised the service plan to call for 93 miles of light rail transit by 2010. In April 1988, the DART Board selected the South Oak Cliff corridor as the highest priority corridor for EIS evaluation. In June 1988, voters turned down a proposition to allow DART to issue long-term bonds. In response, DART revised its plans and issued a Transit System Plan in June 1989 that reconsidered technology and alignment alternatives. The plan did, however, reaffirm the 1988 SOC decisions. The main change that affected the SOC corridor was the decision to place the Dallas Central Business District alignment on a surface transitway instead of a subway.

Alternatives Analysis

The Alternatives Analysis/Draft Environmental Impact Statement (AA/DEIS), which DART completed in August 1990, examined 16 alternatives in the SOC corridor. The DART Board chose the locally preferred alternative (LPA) in November 1990. The LPA modified Alternative 15 (FEIS, 2-3) to use the Lancaster Median Alignment. The LPA is 9.6 miles long with 12 stations and would run from the Dallas CBD south to terminate at Ledbetter Drive.

Preliminary Engineering

UMTA granted a request to enter the PE/FEIS phase in November 1990. The Final Environmental Impact Statement (FEIS), completed in November 1991, evaluated four alternatives: no-build, TSM, the LPA and the Illinois MOS (AA/DEIS Alternative 16). The LPA encompasses the Illinois MOS (FEIS, 2-16).

Final Design and FFGA

Final design began in January 1992. Officials signed a Full Funding Grant Agreement (FFGA) in September 1993. The FFGA calls for a 9.6-mile light rail line with 13 stations. It was to run from a transitway mall in the Dallas CBD to South Oak Cliff, following the route described in the FEIS.

Opening to Service

Initial revenue service on the SOC line began in June 1996, followed by the non-federally assisted northern lines in January 1997. The final SOC segment opened for revenue service in May 1997, completing the starter system.

Project Scope

The project scope remained fairly stable throughout planning and project development (see Table 1). One station was added during preliminary engineering and the number of parking spaces declined between the FEIS and FFGA. The FFGA also reduces the number of vehicles attributable to the South Oak Cliff project, stating that 40 LRT vehicles are being procured, but only 19 vehicles are for the South Oak Cliff project.

The FFGA only refers to a single service and inspection (S&I) facility. The DEIS and FEIS envisioned the service and inspection facility in addition to a vehicle assembly/major maintenance facility. The documentation is unclear as to why this element is no longer needed. 47 percent of the costs of the S&I facility are allocated to the SOC project, the same percentage as the vehicle procurement.

Table 35: Project Scope - Dallas South Oak Cliff LRT

	DEIS	**FEIS**	**FFGA**	**As-built**
Length	9.6	9.6	9.6	9.6
at grade	9.1	9.1	9.1	9.1
Elevated	0.5*	0.5*	0.5*	0.5*
Stations				
at grade	12	13	13	13
Trackage				
Double	9.6	9.6	9.6	9.6
Parking Spaces				
Surface	1850	1820	not stated	1389
Vehicles				
Rail	33	33	19	19
Facilities				
shops/yards	2	2	1	1

* The planning documents state that a new bridge over the trinity river is required, but the precise length of the aerial structure is not specified. The 0.5 miles is based on visually inspecting maps of the area.

Service Levels

Actual Service levels on the Dallas South Oak Cliff line are far below the levels planned in the AA/DEIS and FEIS (see Table 37). Peak headways are more than double planned levels and midday headways are nearly double the planned services. The reduced levels of service may explain the reduced vehicle requirements noted in the project scope section above.

Table 36: Service Levels - Dallas South Oak Cliff LRT

	MIS/AA/ DEIS	**FEIS**	**Actual**
Forecast Year	2005	2005	NA
Span of Service			
Weekday	6:00 AM – 12:00 AM		4:30 AM – 12:30 AM
Frequency of Service			
Pk Hr Headway	4 min	4 min	10 min
Pk Period Hdwy	4 min	4 min	10 min
Mid-Day Hdwy	8 min	8 min	20 min
Evening Hdwy	15 min	15 min	20 min
Weekend Hdwy	15 min	15 min	20 min
Fare			$1.00

Note: The headways in the travel demand model are broken-down into peak and off-peak with no weekend headway. As for the actual the system started with 10-min/20min peak and off-peak respectively and later was changed to 10/15 mins and now has been reverted to 10/20 due to operating cost.

Ridership

Average weekday boardings in 2002 at the stations built as part of the Dallas South Oak Cliff LRT project are approximately 21 percent lower than the projected boardings for the 2005 forecast year.

Table 37: Predicted vs. Actual Ridership - Dallas South Oak Cliff LRT

	Project -Average Weekday Boardings	System-wide		Forecast Year
		Rail System Boardings	Total Transit Boardings	
Predicted				
AA/DEIS	34,800*	not stated	not stated	2005
FEIS	34,800*	not stated	not stated	2005
Opening day	16,097***			
Actual				
1996		16,709	177,638	
1997	20,441	25,719	169,255	
1998	25,129	36,727	173,963	
1999	24,801	37,563	195,653	
2000	25,049	37,682	195,744	
2001	24,702	39,600**	214,885**	
2002	26,884	51,200**	210,100**	

* Ridership forecast for station boardings only at stations that coincide with the South Oak Cliff project (excludes station boardings associated with North Central project).

** Ridership estimates from DART Web site (September 2001 and October 2002).

*** Opening Day forecast with updated demographic and headway assumptions.

Capital Costs

Project construction costs are difficult to define with precision since there were several concurrent light rail projects. Portions of the system are used by several lines – South Oak Cliff, West Oak Cliff and the northern segments. The West Oak Cliff line was locally funded. Portions of the track through downtown Dallas are used by all lines. The capital cost reported reflects project limits that were not necessarily the same as the limits used for estimation.

The capital costs as reported show a good match between estimates and as-built values. In nominal dollars the as-built cost exceeds the AA/DEIS, the earliest official estimate, by only 25 percent. When adjusted for the inflation in Dallas area construction costs the AA/DEIS estimate is about 10 percent less than the actual cost. The inflation adjusted FEIS and FFGA cost estimates exceed the actual cost.

Table 38: Predicted and Actual Capital Costs - Dallas South Oak Cliff LRT

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/ DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$286.8 (1989 $)	$343.4 (1989 $)	$369.9 (1993 $)	$360.0	126%	105%	97%
Adjusted to Const. Midpoint (1994$)	$325.4	$374.6	$377.0	$360.0	110.6%	96.1%	95.5%

Operating Costs

Operating costs for the South Oak Cliff line separate from the O&M costs for other light rail facilities are not available in either the DEIS and FEIS estimates or the data reported in the National Transit Database. The as-built O&M costs shown in the table are for *all* light rail services. The estimated costs are stated as reflecting the South Oak Cliff and North Central segments. It is unclear in the source documents whether the West Oak Cliff costs were included.

Table 39: Predicted and Actual Operating Costs - Dallas South Oak Cliff LRT

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$11.6 (1989 $)	$11.6 (1989 $)	NA	$23.1	199%	199%	NA
Adjusted to opening year (1996 $)	$18.8	$18.8	NA	$23.1	123%	123%	NA

Notes: AA/DEIS an FEIS O&M estimates of $11.6 million in 1989 $ includes North Central and South Oak Cliff Light Rail (DEIS p. S-13, FEIS p. S-11)

As-built operating cost of $23.1 million is for all Light Rail operations in year following initiation of South Oak Cliff service, not just South Oak Cliff operations.

Assessment of Actual vs. Predicted Ridership and Costs

Ridership reported in 2002 is roughly 80 percent of the ridership projected for 2005 in spite of service frequencies of 10 minutes (peak) and 15 minutes (base) rather than the planned frequencies of 4 and 8 minutes. The trend in ridership suggests that values quite close to those projected may be reached by 2005 even at current service levels.

Capital cost for the project, adjusted for construction cost inflation, appear to be quite close to costs incurred and do not exceed the FFGA amount.

Operating costs appear to have been underestimated but direct comparison is difficult. As noted above, the services operated on the South Oak Cliff and roughly half of those assumed for cost estimation purposes, yet the reported cost is significantly greater.

Denver – North I-25 Bus/HOV Lanes

Description

The Denver North I-25 Bus/HOV project is a 6.6 mile two lane reversible roadway in the center of I-25. The project funded by FTA is the initial 5.3 mile long segment terminating at 58th Street. The goal of the project was to increase the person-trip capacity in the corridor by shifting single occupant vehicles to car pools and transit riders. The preferred alternative was chosen to optimized transit and high occupancy vehicle use.

Project Development

System Planning

In January 1985, the Regional Transportation District designated the North I-25 Corridor as its first priority for early implementation of a new transit corridor.

Alternatives Analysis/Preliminary Engineering

In November 1985, UMTA granted RTD's request to enter alternatives analysis. The RTD completed the original environmental assessment (EA) in August 1988. The Bus/HOV lane from US 36 to the CBD with the underpass sub-alternative in the CBD, became the preferred alternative in the FONSI/revised EA, completed in June 1989. This alternative called for constructing two reversible bus/HOV lanes in the center of I-25 from 20th Street to U.S. 36. The total project length would be 6.6 miles. At the northern terminus, one of the two exclusive lanes would connect to U.S. 36 via an exclusive reversible lane. At the south end of the project, the bus/HOV driver would have a choice of taking a ramp from the center of I-25 to a new 20th Street viaduct that would have replaced the current, structurally deficient viaduct, or continuing south and merging into the general lanes on I-25.

In the original EA, officials considered two sub-alternatives to connect I-25 to the CBD: flyover and underpass. The EA noted that the underpass sub-alternative was possible only if the Denver Rio Grande Western railroad spur immediately east of the South Platte River were abandoned.

FFGA and Final Design

UMTA awarded an FFGA in December 1989. The project was to open by December 31, 1992. The FFGA contains few project details, but an FTA memo notes that the LPA assumes that AMTRAK lines near Denver Union Terminal would be relocated prior to completion of the project. If AMTRAK could not be relocated, the part of the project that provides access into downtown Denver would need to be redesigned to avoid an at-grade crossing with AMTRAK.

No agreement was reached by the deadline on the AMTRAK relocations, and local officials prepared a Supplement to the EA in March 1991. The supplement evaluated three other alternatives for connecting the project to downtown Denver. The FONSI identified a preferred alternative that would change the route of the project downtown and bring the bus/HOV lanes at grade across the Platte Valley.

Opening to Service

In September 1994, the Downtown Express/High Occupancy Vehicle (HOV) lanes were opened to buses and to car pools a year later.

Project Scope

The project actually constructed under the FFGA was completed in 1994 but terminated at 58th street, approximately 1.3 miles shorter than the planned project. In subsequent years, the direct connection to US-36 was constructed using local and FHWA funds. The segment to US-36 was opened for service very recently.

Project Management Oversight documents refer to a 12.3 mile project. The actual fixed guideway is only 6.6 miles long, but some park-and-ride expansions occur over 5 miles beyond the end of the fixed guideway facility, bringing the total corridor length to 12.3 miles.

Table 40: Project Scope - Denver North I-25 Busway

	EA	FONSI	FFGA	As-built
Length	6.6	6.6	6.6*	5.3
Stations	3	3	3	2
Lanes	2 lane reversible	2 lane reversible	2 lane reversible	2 lane reversible
Parking Spaces	1355	1501	not stated	1921
Vehicles				
bus	0	0	0	0

* The FFGA is not specific about length but the descriptions of the location of the improvements roughly coincide with the scope specified in the EA. The FTA project turned out to be shorter than 6.6 miles and ends at I-76 rather than US-36. The segment from I-76 to US-36 is part of the same project but funded locally and with FHWA funds.

Service Levels

The actual service levels on the I-25 Busway are less than planned. While the hours of operation are longer than planned, the peak intensity of bus service is approximately half the level originally planned.

Table 41: Service Levels - Denver North I-25 Busway

	EA	FONSI	FFGA	Actual
Forecast Year	2000	2000	NA	NA
HOV/Busway Hours				
So-bound	6:00 AM – 9:00 AM	6:00 AM – 9:00 AM		5:00 AM – 10:00 AM
No-bound	3:30 PM – 6:00 PM	3:30 PM – 6:00 PM		12:00 PM – 3:00 AM
Peak Hour Service Level				
Corridor Peak Hour Bus "Trips"	114	114		51*
Peak Hour Capacity	5,700	5,700		2,550
Fare	not stated	not stated		$2.50/$3.50

*Corridor peak hour bus trips based on morning peak buses arriving between 7 and 8 AM consistent with the definition in the EA. Bus routes using the Busway include 108X, 86X, 120X, 40X, 80X, 82X, 8X, T, B, and L.

Ridership

The EA for the I-25 North Busway project does not provide a forecast for average daily boardings for the facility. Instead, the EA produced system-wide ridership estimates. At this time, the actual boardings cannot be compared directly to a forecast values for the facility. However, actual system-wide transit boardings in 2000 were about 80 percent of the 2000 forecast.

Table 42: Predicted and Actual Ridership - Denver North I-25 Busway

	Project Average Weekday Boardings	System-wide Total Transit Boardings	Forecast Year
Predicted			
EA	not stated	325,582	2000
EA/FONSI	not stated	325,582	2000
Actual			
1993	Not Available	203,944	
1994 (Open)	Not Available	211,815	
1995	Not Available	226,799	
1996	Not Available	234,088	
1997	8,858	240,769	
1998	9,177	242,622	
1999	8,768	229,605	
2000	9,959	259,703	
2001	8,853	269,324	

Capital Costs

This project was a joint effort to create a facility that could be used by both transit vehicles (buses) and automobiles (HOVs), while at the same time making some improvements to I-25. Costs for "the undertaking" were allocated between CDOT/FHWA (34 percent), RTD/FTA (58 percent) and the City of Denver (eight percent). Grants under FTA programs represented about 40 percent of the budget for "the undertaking." A number of factors contributed to changes in cost after the FFGA including the need to study and design new alternatives to the connections to and from downtown Denver after Amtrak decided that it would continue to use the Denver Union Terminal, and some further changes to accommodate the location of a Coors Field for major league baseball.

Changes to other portions of the project, a shorter length, construction of the I-36 connection under a different program, were made to hold capital costs within an acceptable range of the forecasts and the FFGA. The best estimate of the as-built project cost ($228 million) is still over 20 percent greater than the inflation adjusted AA/DEIS estimate and 11 percent greater than the FFGA.

Table 43: Predicted and Actual Capital Costs - Denver I-25 North Busway

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	EA	EA/FONSI	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$178.7 (1986 $)	$178.7 (1986 $)	$201.2 (1989 $)	$228.0	128%	128%	113%
Adjusted to Const. Midpoint (1991 $)	$189.5	$189.5	$205.2	$228.0	120.3%	120.3%	111.1%

Operating Costs

Specific estimates for the operation and maintenance of the guideway or of the vehicle operations on the guideway were not developed for the planning documents and are not available for the opening year or any year thereafter. The O&M costs presented below are for the entire RTD bus system. However, in the Environmental Assessment (August 1988 and June 1989) the O&M cost of the selected alternative is $5 million (1985 $) greater than the Do-nothing alternative. This would be equivalent to $6.8 million in 1994 dollars. The change in RTD motorbus operating expenses reported in the NTD between the opening year and the previous year is $5.9 million.

As noted above, bus service on the I-25 HOV lanes is about half of planned service. The total system bus O&M costs, while quite close to the projected amount in nominal dollars is, in inflation adjusted dollars, only 77 percent of the projected amount. This suggests that the O&M costs are a function of system-wide budgetary factors rather than project related service demands.

Table 44: Predicted and Actual Operating Costs - Denver I-25 North Busway

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	EA	EA/FONSI	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$125.1 (1985 $)	$125.1 (1985 $)	NA	$129.9	104%	104%	NA
Adjusted to year of opening (1994 $)	$169.4	$169.4	NA	$129.9	77%	77%	NA

Note: Operating and Maintenance costs are for entire bus system, not just I-25 North Busway services

Assessment of Predicted vs. Actual Ridership and Costs

To the extent that can be determined from the available documentation the capital costs of “the undertaking” appear to exceed the forecasts by 20 percent although the scope of the project was reduced to avoid more extensive overruns.

Operating and maintenance costs are consistent with the services operated.

Denver Southwest LRT Project

Description

The Denver Southwest LRT is an 8.7 mile light rail line extending from I-25 and Broadway just south of downtown Denver to Mineral Avenue in Littleton. The project has five stations, is grade separated and generally follows the South Santa Fe freight rail corridor. The goals of the project were to reduce transit travel times, relieve congestion in the corridor, and contribute to attaining regional air quality objectives through reduced emissions.

Project Development

System Planning

In 1987, the Colorado Legislature directed the Regional Transportation District to develop a plan for implementing rapid transit in the Denver region. The first section of the light rail system in Denver, the Central Corridor LRT, opened in October 1994. The 1989 Southeast/Southwest Threshold Analysis determined that a transit investment in the Southwest Corridor would have the lowest cost per new rider, and recommended that an Alternatives Analysis/Draft Environmental Impact Statement be conducted so that a rapid transit project in the corridor would be eligible for Federal funding.

Alternatives Analysis

RTD initiated the AA/DEIS for the Southwest Corridor in 1992. The AA/DEIS study looked at alignment choices, technology options and end of line alternatives. While in progress, the AA changed to a Major Investment Study (MIS) with no DEIS, in response to new federal planning rules. The Southwest Corridor MIS initially identified six conceptual alternatives, five of which were advanced for further study. Those five were: no-build, transportation systems management, busway, light rail transit and commuter rail. RTD selected the LPA, light rail transit, in March 1994.

Meanwhile, in 1993, the RTD bought a 10-mile long, 40-foot wide strip within the existing railroad right of way from the Southern Pacific/Denver Rio Grande Railroad.

Preliminary Engineering

RTD evaluated the no-build alternative and the LPA in a Draft Environmental Impact Statement, completed in September 1995, and in a Final Environmental Impact Statement, completed in January 1996. The LPA consisted of an alignment of 8.7 miles beginning at the Central Corridor terminus at I-25/Broadway and extending to Mineral Avenue. The DEIS and FEIS proposed five stations to be built by 2015. A Record of Decision was issued on March 4, 1996.

Final Design and FFGA

The Full Funding Grant Agreement was signed on May 6, 1999, and called for an 8.7-mile LRT extension with five stations.

Opening to Service

Revenue operation began on July 14, 2000, as called for in the FFGA.

Project Scope

The scope of the Denver Southwest LRT was consistent throughout planning and project development. Additional parking, elimination of a small single track section, and two additional rail vehicles were the only significant increases in scope. The bulk of the project was constructed at grade though several bridges and two flyovers of the freight corridor were included.

The DEIS envisions 5 stations, but only 4 operational when the system opens. Parking on opening day was expected to be 1815 expanding to 3660 by 2015. The FEIS includes all 5 stations on opening day. Parking on opening day was expected to be 1915 spaces expanding to 3660 by 2015.

Table 45: Project Scope - Denver Southwest LRT

	DEIS	FEIS	FFGA	As-built
Length				
at grade	8.7	8.7	8.7	8.7
elevated	2 flyovers	2 flyovers	2 flyovers	2 flyovers
Stations				
at grade	5	5	5	5
Trackage	8.7	8.7		
single	0.2	0.2		
double	8.5	8.5	8.7	8.7
Parking Spaces				
surface	1815	1915	not stated	2597
Vehicles				
rail	12	12	14	14
Facilities				
shops/yards	expand existing	expand existing	Expand existing	expand existing

Service Levels

Service levels on the operating line meet or exceed the levels planned for the Southwest LRT service.

Table 46: Service Levels - Denver Southwest LRT

	MIS/AA/ DEIS	FEIS	Actual
Forecast Year	2015	2015	NA
Span of Service			
Weekday	not stated	not stated	4:00 AM – 2:30 AM
Frequency of Service			
Pk Hr Headway	10 min	10 min	3-8 min
Pk Period Hdwy	10 min	10 min	3-8 min
Mid-Day Hdwy	15 min	15 min	5-15 min
Evening Hdwy	30 min	30 min	7-15 min
Fare	not stated	not stated	1.10 / 2.50

Ridership

Actual average weekday boardings on the Denver Southwest LRT in 2002 are just over 13 percent below the 2015 forecast published in the DEIS and FEIS.

Table 47: Predicted and Actual Ridership - Denver Southwest LRT

	Project - Average Weekday Boardings	System-wide		Forecast Year
		Rail System Boardings	Total Transit Boardings	
Predicted				
AA/DEIS	22,000		264,600*	2015
FEIS	22,000		264,600*	2015
Actual				
1999		16,057	229,605	
2000 (Opens)		22,467	259,703	
2001	17,442	31,423	269,324	
2002	19,083	34,913	Not Available	

* Note: System-wide forecasts are for linked trips rather than boardings. Total transit boardings will exceed linked transit trips.

Examining the station by station boarding forecasts, the actual station boardings show that ridership at the Mineral terminal station were underestimated, while boardings at the Evans station are likely to be overestimated. On average, the project is serving longer trips than the forecasts indicated.

Table 48: Station Boardings - Denver Southwest LRT

Station Boardings	Predicted 2015 (DEIS/FEIS)	Actual 2001	Actual 2002
Mineral	4,400	5,735	6,794
Littleton	3,600	3,720	3,949
Oxford	1,800	946	1,003
Englewood (Hampden in DEIS/FEIS)	5,200	5,194	5,273
Evans	7,000	1,847	2,064
Total	**22,000**	**17,442**	**19,083**

Capital Costs

The Capital Cost estimates developed for the AA/DEIS included both an "opening day" estimate, then expected in about 2000, plus an increment that would be required in later years to provide the facilities required for 2015 operations. The increment included several items but the primary costs were related to right-of-way for park-ride facilities and the purchase of 25 additional light rail vehicles (LRVs).

Capital costs were reevaluated for the FEIS increasing the "opening day" estimate and reducing the expected increment. The major change was the elimination of the expected additional LRVs. As part of the cost reevaluation the estimated amounts for bridge construction, right-of-way purchase and park-ride/station facilities were increased. Further revisions to the estimated costs were developed during final design and were reflected in the FFGA budgets. The project, as-built, is closer in scope to the facilities assumed for the "opening day" estimates than the 2015 estimates.

Throughout the process of project planning and engineering the capital cost estimates were refined. The actual as-built cost is about 19 percent greater than the AA/DEIS estimate after adjustment for inflation. In nominal dollars the as-built was about 40 percent over the estimate. Actual costs are 12 percent greater (inflation adjusted) and 25 percent greater (nominal dollars) than estimated in the FEIS. The cost estimates prepared for the FFGA were on target. As-built cost in nominal dollars was within one percent of the budgeted amount.

Table 49: Predicted and Actual Capital Costs - Denver Southwest LRT

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated							
Opening Year	$127.5 (1992 $)	$142.5 (1995 $)		$177.7	139%	125%	
By 2015	$194.6 (1992 $)	$157.1 (1995 $)		$177.7	91%	113%	
			$159.2 (1996 $)				
			$176.3 (YOE $)	$177.7			101%
Adjusted to Const. Midpoint (1999 $)	$149.6	$158.3	$176.9	$177.7	118.8%	112.2%	100.5%
2015 estimate (1999 $)	$228.3	$174.5	$176.9	$177.7	77.8%	101.8%	100.5%

Note: YOE = Year of Expenditure

Operating Costs

The Southwest LRT is only one part of the LRT operations in Denver. Certain portions of the costs are common to the overall system and cannot be easily separated from the reported data. It does appear, however, that the actual costs of operation for 2000 were less than the amounts projected during project planning.

Table 50: Predicted and Actual Operating Costs - Denver Southwest LRT

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$4.4 (1992 $)	$4.4 (1995 $)	$4.4	$3.2	73%	73%	NA
Year 2000 $	$5.3	$5.4	$4.4	$3.2	60%	59%	NA

Note: As-built operating costs estimate from data reported to the national Transit Database

Assessment of Predicted and Actual Ridership and Costs

The Southwest LRT has proven quite attractive to riders. By 2002 ridership on the segment had reached about 80 percent of that forecast for 2015 with trends suggesting continued growth. Demographic trends in Denver and the long time frame before reaching the forecast year (2015) make it very likely that this project will meet or exceed its ridership forecast. Service levels on the project far exceed the levels contemplated in the planning studies. At times, service frequency is three times the levels assumed when the forecasts were developed.

Capital costs in the initial planning estimates were understated, by about 19 percent in inflation adjusted dollars, but the estimates were refined and became more accurate as more detailed engineering studies were prepared. The operating cost estimates were generally on target, likely reflecting the light rail operating experience of RTD.

Houston Southwest Transitway

Description

The Southwest Transitway project is a 9.7 mile single lane reversible HOV/Busway with five park and ride lots. The purpose of the project was to improve transit travel times and provide a transit alternative to the highly congested freeways and surrounding arterials.

Project Development

System Planning

The Southwest Freeway is U.S. 59 between Beltway 8 in far southwest Harris County to State Highway 288 near the Houston central business district. The freeway was-built in the 1960s, and as congestion increased, local officials implemented transportation system management improvements. By the late 1970s, officials concluded that few further TSM improvements were practical and that widening and major improvements were needed. In 1983, the Metropolitan Transit Authority of Harris County (METRO) began planning for possible transit improvements that could be integrated with ongoing Texas State Department of Highways and Public Transportation (SDHPT) roadway improvement projects. Officials began to study transit improvements to two SDHPT projects already scheduled for implementation: the Northwest Freeway and the Southwest Freeway. For the Northwest Freeway, local officials conducted an Environmental Assessment and an Alternatives Analysis, and received a construction grant from the Urban Mass Transit Administration.

Alternatives Analysis

For the Southwest Freeway, the SDHPT chose widening and improving the Southwest Freeway from Beltway 8 to SH 288 as the preferred alternative. METRO conducted an Alternatives Analysis to identify a preferred transit alternative in the corridor. The Draft Environmental Impact Statement (DEIS) was completed in June 1985. METRO selected the build alternative with its 8.5-mile transitway in the median as the Locally Preferred Alternative (LPA) for the transit component of the project.

Preliminary Engineering

METRO and the SDHPT, along with the Federal Highway Administration (FHWA) and UMTA then prepared a Final Environmental Impact Statement (FEIS) to evaluate combined highway and transit improvements to the Southwest Freeway. The agencies completed the FEIS in October 1985. The FEIS calls for widening and improving the Southwest Freeway for about 13.4 miles from Beltway 8 to SH 288 and construction of an 8.5-mile transitway in the median of the freeway from West Bellfort Avenue to IH 610 (West Loop). The transitway would be a 20.5-foot wide facility with one reversible lane, running primarily at-grade. The project also would include a new 1,200-car park-and-ride lot at West Bellfort Avenue and a new transit center near Hillcroft with about 1,100 spaces. The existing Westwood park-and-ride lot was to be modified to provide direct access to the transitway. Grade-separated ramps would provide access and egress to the transitway at four locations: at the new West Bellfort lot, at the existing Westwood lot, at Beechnut Street and at the new Hillcroft Transit Center, with an at-grade ramp providing access to Westpark Drive near South Rice Avenue. With the exception of the West Bellfort lot ramp, these ramps would be constructed to accommodate potential future two-way operation. Access/egress also would be provided by slip ramps to the freeway mainlines near the West Loop.

Final Design and FFGA

An FFGA was signed in September 1987. The FFGA called for a transitway extending for 9.1 miles from West Bellfort Avenue to a point west of Weslayan, with a new park-and-ride lot of 1,200 spaces at West Bellfort Avenue and a new transit center near Hillcroft with 1,100 spaces, as well as modifications to connect the existing Westwood park-and-ride lot to the transitway. Ramps at five locations were to provide access and egress for the transitway: the new West Bellfort park-and-ride lot, the existing Westwood park-and-ride lot, the new Hillcroft Transit Center, to Westpark Drive near South Rice Avenue and by slip ramps to the freeway main lanes near Weslayan. With the exception of the slip ramps, these ramps were to be built to accommodate potential future two-way operation.

Opening to Service

The Southwest Transitway opened to service in 1993.

Project Scope

The length for the Southwest Transitway grew during project development by about 1.2 miles. A surveillance communications and control system was originally in the scope of work defined in the FFGA. This system was to be a part of the highway departments Computerized Transportation Management System. Due to problems with the State Department of Highways and Public Transportation's design, the completion of this project element was delayed until well after the completion of the transitway. This system was removed from the scope of work.

Construction bids came in well under the baseline cost estimates resulting in the de-obligation of significant funds.

Table 51: Project Scope - Houston Southwest Transitway

	DEIS	FEIS	FFGA	As-built
Length				
at grade	8.5	8.5	9.1	9.7
Access Ramps				
at grade	1	1	1	1
elevated	4	4	4	4
Lanes				
single	8.5	8.5	9.1	9.7
Parking Spaces (new)				
surface	2300	2300	2300	2300
Vehicles				
bus	not stated	not stated	none	none
Facilities	not stated	not stated		none
control center			1	

Service Levels

While peak period service is in the range specified in the planning documents, the Southwest Transitway appears to operate primarily as a peak express service with little off-peak, evening or weekend service.

Table 52: Service Levels - Houston Southwest Transitway

	MIS/AA/ DEIS	FEIS	Actual
Forecast Year	2005	2005	NA
Frequency of Service			
Pk Hr Headway to CBD	1.7 - 7.5 min	5-30 min	6-7 min
Pk Period Hdwy		5-30 min	6-7 min
Mid-Day Hdwy		12-60 min	

Ridership

As of 2002, the Houston Southwest Transitway had only achieved about 33 percent of the 2005 ridership forecast. For system-wide transit boardings, the Houston area has, to date, achieved almost 66 percent of the 2005 forecast.

Table 53: Predicted and Actual Ridership - Houston Southwest Transitway

	Project Average Weekday Boardings	System-wide Total Transit Boardings	Forecast Year
Predicted			
AA/DEIS	27,280	511,500	2005
FEIS	27,280	511,500	2005
Actual			
1992		284,702	
Opens 1993	3,740	299,806	
1994	5,097	281,241	
1995	5,180	269,805	
1996	5,172	268,501	
1997	5,615	267,420	
1998	6,284	316,525	
1999	7,065	293,079	
2000	7,941	297,681	
2001	8,772	336,835	
2002	8,875	not available	

Note: Ridership on the facility is reported in terms of average daily boardings at corridor facilities.

Capital Costs

Project capital costs were estimated in the AA/DES in 1984 dollars with an assumed escalation in construction costs to the "day of expenditure" that yielded an estimated dollar outlay of $97.8 million. This proved to be almost exactly on target. The actual cost in year of expenditure dollars was reported to be $98.3 million, just one percent over the estimated outlay and slightly less than the AA/DEIS estimate escalated to the year of opening. The FEIS estimate adjusted to year of expenditure dollars, was about four percent greater than the actual cost. The FFGA of $97.6 million provided for an additional inflation allowance of about $5.9 million. Most of that amount was not required.

Table 54: Predicted and Actual Capital Costs - Houston Southwest Transitway

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$83.8 (1984 $)	$87.6 (1984 $)	$97.6 (1987 $)	$98.3	117%	112%	101%
YOE $	$97.8	$102.1	$103.5	$98.3	101%	96%	95%
Adjusted to Const. Midpoint (1990 $)	$95.6	$100.0	$111.2	$98.3	102.8%	98.3%	88.4%

Notes: YOE $ = Year of expenditure $; FFGA included an allowance for escalation of construction costs

Operating Costs

This project involved construction of a roadway for use by buses and HOVs. While the project plans called for adjusting the bus operations to take advantage of the facility, the available documentation provides no stated estimates of either the operating costs for services on the Transitway or for the cost savings to be achieved in overall bus system operations.

Assessment of Predicted and Actual Ridership and Costs

The ridership forecasts for the Southwest Transitway appear to overestimate ridership by a wide margin. The lack of off-peak service may help explain some of the discrepancy. If the forecasts classified service on the busway as a premium mode compared to regular bus service, this could explain why the forecasts were too high. Detailed analysis of the travel demand forecasting procedures would be required to determine the exact cause of the error.

Capital costs for the project, in inflation adjusted dollars, were remarkably close to the estimates even though the built project is over a mile longer than originally planned.

Jacksonville Automated Skyway Express

Description

The Jacksonville Automated Skyway Express (ASE) is a 2.5 mile elevated people mover that was intended to ease traffic congestion, pollution and parking constraints in Downtown Jacksonville. The project traverses downtown Jacksonville and crosses the St. John's River to link urban development on both sides. The project provides 3,200 downtown fringe parking spaces and has intermodal transfer facilities at the terminal stations.

Project Development

System Planning

In the early 1970s, Jacksonville leaders began planning for redevelopment and rehabilitation of the downtown area. The Plan for Downtown Jacksonville proposed development along the riverfront of new employment, residential and convention activity centers and the improvement of transportation to connect these activity centers. At this time, Jacksonville civic leaders began planning an automated transit system. The Jacksonville Transportation Authority (JTA) commissioned feasibility studies, passenger ridership studies and route evaluations.

Alternatives Analysis

JTA completed a DEIS in August 1982 for the downtown transit system. The DEIS evaluated four alternatives: no build, bus only, riverside automated transit and river crossing automated transit. The river crossing automated transit alternative would consist of an elevated double guideway, about 2.1 miles long with seven stations. In October 1982, JTA selected the river crossing automated transit alternative as the locally preferred alternative (LPA).

Preliminary Engineering

In February 1983, JTA finished the FEIS, which evaluated the LPA, the no-build alternative, the bus only alternative and the river crossing alternative. After the FEIS, JTA completed a Supplemental Draft Environmental Impact Statement (SDEIS) to evaluate extending the LPA alignment to serve a new convention center. JTA studied two alternatives for extending the alignment: the Western Line, an east-west line extending from the LPA alignment just east of Broad Street continuing west along the south side of Bay Street and crossing over Broad and Lee streets and ending at Terminal Station; and the West End Line which follows the same alignment until crossing Lee Street when it curves to the north and crosses West Bay Street to Johnson Street and then curves west into the Terminal Station at Stuart Street. The SDEIS, published in March 1984, also evaluated operating a three-station section of the alignment first before opening the rest of the system. This starter line alternative would comprise the West End Line (0.48 miles) and a 0.3-mile portion of the River Crossing ATA extending from its junction with the West End Line at Broad Street to Central Station. After the SDEIS, the JTA selected the Starter Line with the West End Alternative. According to the SFEIS, completed in August 1984, this alternative would reduce the visual effects on historic buildings, coordinate better with ongoing development and be more convenient to bus and park-and-ride users.

Final Design and FFGA

The FFGA for the starter line was signed in February 1985. Construction began in 1987 on the initial portion of the system, a 0.7-mile, three station (Convention Center Station, Jefferson Station and Central Station) starter line segment that provided “park-n-ride” capabilities for downtown commuters. This demonstration segment, using two MATRA-built vehicles, connected the Convention Center with the Omni Hotel and began service May 1989.

In order to take advantage of the bridge replacement project planned by the Florida Department of Transportation (FDOT), construction of the south leg of the system across the Acosta Bridge began in 1987, connecting the north and south banks of the St. Johns River.

A Full Funding Grant Agreement for Phase I North Extension was signed in September 1991. In 1992, the construction began on the north line from Central Station to the Florida Community College of Jacksonville (FCCJ). At this time, JTA was asked to include the reconstruction of Hogan Street with the North Line to coordinate street repair efforts by FDOT with major utility work by the City. Service to the San Marco and FCCJ Stations began on October 30, 1998.

Work began on the San Marco Station and the Operations and Maintenance (O&M) Center in 1995. The O & M Center was-built to accommodate the guideway at ground level as well as to provide storage tracks for vehicles not in service.

Opening to Service

The contract for the remaining 0.6 mile segment and two stations, Riverplace and Kings Avenue, of the South leg was awarded in August 1998. The final section of the ASE began revenue service in November 2000. In total, the 2.5-mile system has eight stations.

Project Scope

The table below does not adequately reflect the changes in project scope that occurred during planning and project development. This project was-built between 1985 and 2000 in four segments. The FFGA’s were amended multiple times such that by 2000, the ASE roughly coincided with the project proposed in the planning documents.

After signing the Phase I North Extension FFGA in 1991, negotiations with MATRA for the vehicles and systems expansion were unsuccessful during 1993. In 1994, following a competitive bid process, the Bombardier Corporation was selected to supply new vehicles and subsystems to expand and retrofit the existing system. In 1996, the existing MATRA vehicles, systems and spare parts were sold to the Chicago Airport Authority.

In late 1996, service on the guideway was shut down, and work began on the retrofit of the entire system into an automated monorail. The system was shut down in 1996, retrofitted and expanded as a monorail system with all new Bombardier vehicles and control systems. The Skyway was re-opened, after 12 months, in December 1997.

The FFGA was amended in February 1997 and again in August of 1998 to bring the total project scope up to 2.5 miles of dual guideway with 8 stations, completing the scope of the original planned project, minus one station. The significant amount of parking available to the project was funded separately as was an additional vehicle.

Table 55: Project Scope - Jacksonville ASE

	DEIS	FEIS	FFGA	As-built
Length				
elevated	2.58	2.58	2.5	2.5
Stations				
elevated	9	9	8	8
Trackage				
double	2.58	2.58	2.5	2.5
Parking Spaces	5700	5700	not specified	3224
Vehicles	12	10	9	9
Facilities				
shops/yards	1	1	1	1
control center	1	1	1	1

Service Levels

Service levels are fairly close to the levels planned for the ASE service. Headways are slightly less, but given that ridership is a small fraction of the forecast horizon year levels, reduced headways are probably advisable. The span of service is three hours longer on weekdays and Saturdays. The ASE system is closed on Sundays except for special events.

The effective fares charged for the service are not as high as assumed in the forecasts. Commuters who use the park-and-ride lots ride free while other passengers pay $0.35 (discounted to $0.10 for seniors). The planned $0.25 fares are in 1982 dollars. The planned fare, adjusted for inflation, would equal about $0.50 in 2002 dollars.

Table 56: Service Levels - Jacksonville ASE

	MIS/AA/ DEIS	FEIS	Actual
Forecast Year	1995	1995	NA
Span of Service			
Weekday	6:00 AM – 8:00 PM	6:00 AM – 8:00 PM	6:00 AM – 11:00 PM
Frequency of Service			
Pk Hr Headway	2 min	2 min	3 min
Pk Period Hdwy	2 min	2 min	3 min
Mid-Day Hdwy	5-10 min	5-10 min	6 min
Evening Hdwy	5-10 min	5-10 min	6 min
Weekend Hdwy	5-10 min	5-10 min	6 min
Operating Statistics			
Fleet Veh Reqs	10	8	8
Fare	0.25	0.25	Free/0.35

Ridership

Like all other downtown people mover systems in the U.S. (Detroit and Miami), the Jacksonville ASE has not achieved the ridership forecasts developed in planning. Current ridership on the system is less than 1/10th of the 1984 forecasts seven years past the forecast year.

Table 57: Predicted vs. Actual Ridership - Jacksonville ASE

	Project - Average Weekday Boardings	System-wide		Forecast Year
		Rail System Boardings	Total Transit Boardings	
Predicted				
AA/DEIS	42,472	42,472		1995
FEIS	42,472	42,472		1995
Actual				
1989	1,079	1,079	29,942	
1990	1,375	1,375	32,603	
1991	1,089	1,089	33,538	
1992	1,005	1,005	34,207	
1993	1,057	1,057	35,513	
1994	955	955	33,965	
1995	969	969	32,201	
1996	1,009	1,009	30,462	
1997	967	967	30,971	
1998	769	769	30,694	
1999	2,091	2,091	32,217	
2000	2,054	2,054	31,014	
2001	2,627	2,627	32,217	

Capital Costs

The Jacksonville ASE project was developed over an extended period with many changes in project scope and cost estimates. The AA/DEIS was completed in August 1982; the FEIS was finished shortly thereafter in February1983; a subsequent Supplemental DEIS was issued in March 1984. FFGA's reflecting various project scopes and amounts were signed in February 1985, January 1989, July 1991 and August 1994. As noted above, the final stage of the project included not only an extension of the guideway and new stations, but also replacement of many of the systems that were related to vendor specific vehicles and command and control systems, due to lack of funding in time to maintain attractive contractually required prices to complete the system. Portions of the system funded under prior FFGAs were removed and replaced. The project, as-built, has cost more that twice the original estimate in nominal dollars and 60 percent more in construction cost inflation adjusted dollars. Completion also took more than10 years longer to construct than the original cost estimate assumed. The JTA completed this project within the final FFGA amount.

Table 58: Predicted and Actual Capital Costs - Jacksonville ASE

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Cost (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$60.7 (1982 $)	$60.7 (1982 $)		$137.3	226%	226%	
February 1985			$15.5				886%
January 1989			$30.1 (mid-pt $)				456%
July 1991			$38.4 (mid-pt $)				358%
August 1994			$108.5 (mid-pt $)				127%
Adjusted to Const. Midpoint (1994 $)	$85.8	$85.8	$142.0	$137.3	160%	160%	96.7%

Note: 1989 FFGA costs escalated from 1984 dollar estimates to mid-point construction dollars (December 1985 to June 1987) depending on item. 1991 FFGA costs escalated from January 1991 dollar estimates to mid-point construction dollars (January 1993 to July 1993) depending on item. 1994 FFGA costs escalated from January 1994 dollar estimates to mid-point construction dollars (May 1995 to July 1996) depending on item.

Operating Costs

The AA/DEIS and FEIS studies were conducted in 1982 and 1983. No system similar to that contemplated was in operation in Jacksonville at the time so all costs had to be estimated based on assumed system requirements (e.g., staffing, energy, materials, etc.) and assumed unit costs. The operating costs were estimated in 1982 dollars for a seven station system – a configuration not achieved until early 2001Automated guideway operating costs as reported in the 2001 National Transit Database are $3,256,507. This cost is almost twice as much as the estimated O&M from the original studies even after adjustment for the increase in the unit costs of providing transit service in the Jacksonville area, but not including the increase in system length or the extended funding and construction duration.

Table 59: Predicted and Actual Operating Costs - Jacksonville ASE

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Cost (Percent)		
	AA/DEIS (1982 $)	FEIS (1982 $)	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$1.1	$1.1	NA	$0.5	43%	43%	NA
Year 1989 $ Year 1989 Operations	$1.5	$1.5	NA	$0.5	32%	33%	NA
Year 2001 $ Year 2001 Operations	$1.8	$1.8	NA	$3.2	181%	181%	NA

Assessment of Predicted vs. Actual Ridership and Costs

The Jacksonville system has taken far longer to build than original envisaged; has cost substantially more than originally estimated, even after adjustments for inflation, and has never lived up to stated ridership expectations. Even after completion of the planned system in 2001 ridership on the fixed guideway segment is only about 5 percent of the AA/DEIS forecast. Ridership on the total transit system, including JTA bus services, in 2001 is about 75 percent of the ridership forecast just for the ASE. The reasons for this variance are not clear. They may relate to unexpected changes in the demographics of the area, deviations for expected development patterns, failure to implement other portions of the planned transit services, or other factors.

The capital costs are about 125 percent greater than the nominal costs estimated in the DEIS and 60 percent greater than the construction cost inflation adjusted AA/DEIS estimate of costs are. Given the many changes and lengthy construction period, a major variance could have been expected.

The reasons for the great deviation in operating costs cannot be explained with the limited data available. Further studies of the operating plans and the actual unit costs would be necessary.

Los Angeles Red Line

Description

The 17-mile Los Angeles Red Line was constructed in three minimum operable segments between 1986 and 2000. The project is constructed as a subway with 16 underground stations serving Downtown Los Angeles running to the northwest, though the Santa Monica mountains into North Hollywood. The project was intended to improve access to the region's core to accommodate projected increases in travel demand in an area that was already severely congested. Bus service in many of the congested corridors serving the regional core was thought to be unable to absorb the forecast additional demand.

Project Development

The Los Angeles Red Line Project was conceived as an 18.6-mile, 18 station project when the Southern California Rapid Transit District (SCRTD) selected it as the original locally preferred alternative (LPA) in 1983. The original LPA traveled west along Wilshire Boulevard from the Los Angeles Central Business District, north on Fairfax Avenue, east along Sunset Boulevard serving Hollywood, and north to North Hollywood.

The original LPA was the central link of a 150-mile regional rapid transit system in accordance with Proposition A. Approved by Los Angeles County voters in November 1980, Proposition A authorized the collection of a one-half of one percent retail sales tax to fund the improvement of public transit in the county. Local officials conducted an Alternatives Analysis for the Red Line in 1980, entered preliminary engineering in 1981 and completed a Draft Environmental Impact Statement/Environmental Impact Report (DEIS/DEIR) in June 1983 and a Final Environmental Impact Statement/Environmental Impact Report in December 1983.

Due to budget constraints and a legislative prohibition on the commitment of federal funds beyond Fiscal Year 1986, UMTA could not enter a full funding contract for the entire cost of the proposed Red Line. SCRTD proposed a 4.4-mile, five-station Minimum Operable Segment (MOS-1), extending from a yard and shop facility south of Union Station to a Wilshire/Alvarado Station, as an initial segment for funding purposes and completed an Environmental Assessment in August 1984. On December 19, 1985, the President signed legislation directing the Secretary of Transportation to enter into a full funding contract with SCRTD for the construction of MOS-1. SCRTD initiated construction of MOS-1 in September 1986. MOS-1 opened for revenue service in January 1993.

In March 1985, a fire occurred at the Ross Dress-for-Less Store at Third and Ogden Streets. An investigation concluded that the source of the fire was naturally occurring methane gas and identified the geographic extent of this gas field. As a result, Congress passed a law in December 1985 that stipulated that the SCRTD could not tunnel in the gas field identified in the task force report. Congress directed SCRTD to identify and study candidate alignments that would avoid tunneling in these risk zones.

In compliance with the Congressional mandate, the SCRTD initiated in 1986 a Congressionally Ordered Re-Engineering (CORE) Study. SCRTD reviewed over 40 candidate alignments during this effort, and wrote detailed environmental reports for six alignments. The Draft Supplemental Environmental Impact Statement/Subsequent Environmental Impact Report (SDEIS/SDEIR), issued in November 1987, and the Draft Addendum to the Supplemental Environmental Impact Statement/Subsequent Environmental Impact Report, issued in May 1988, evaluated Candidate Alignments 1 through 6.

In July 1988, the SCRTD Board of Directors selected Candidate Alignment 1, with minor changes, as the Locally Preferred Alternative (1988 LPA). The 1988 LPA is a 17.3-mile subway with 16 stations and two branches:

- West on Wilshire Boulevard from the first segment station at Wilshire and Alvarado to a station at Wilshire and Western Boulevard; and
- North on Vermont Avenue from Wilshire Boulevard to Hollywood Boulevard, where it proceeds through Hollywood and then north to a station in North Hollywood.

The 1988 LPA differs from Candidate Alignment 1 chiefly in its substitution of the Hollywood Bowl station with one at Hollywood Boulevard and Highland Avenue.

A Final Supplemental Environmental Impact Statement/Subsequent Environmental Impact Report (SEIS/SEIR), issued in July 1989, examined the impacts of the 1988 LPA.

In 1988, the Los Angeles County Transportation Commission (LACTC) became the grantee for federal funds and applied for federal funding for MOS-2 which included two segments of the 1988 LPA: MOS-2a to Wilshire and Western (2.1 miles) and MOS-2b to Hollywood and Vine (4.6 miles). The FFGA for MOS-2 (both branches) was signed on April 10, 1990.

In May 1993, the FTA and the LACMTA signed a FFGA for MOS-3, which included three extensions to the Red Line:

- North Hollywood Extension north from the MOS-2b terminus at Hollywood and Vine;
- Mid-City Extension west from the MOS-2a terminus at Wilshire and Western; and
- A loosely defined Eastside Extension east from the MOS-1 terminus at Union Station.

The entire MOS-3 project was part of a larger commitment to meeting air quality goals through the Regional Mobility Plan.

The East Side Extension FEIS was completed in September 1994. In December 1994, the FFGA for MOS-3 was amended to specify the Eastside Extension. This segment consisted of a 3.7-mile, four station extension from the eastern terminus of MOS-1 at Union Station, across the Los Angeles River to First and Lorena in East Los Angeles.

LACMTA suspended tunnel construction along Hollywood Boulevard for several months in 1994 when significant surface damage occurred, but resumed the construction in December 1994 based on FTA's acceptance of LACMTA's Recovery Plan.

MOS-2a opened for revenue service in 1996.

The Mid-City Extension was originally planned to be primarily in tunneled subway. However, after the FFGA for MOS-3 was signed, core sampling found such high levels of naturally occurring, toxic hydrogen sulfide gas at the planned depth of the tunnel that LACMTA abandoned its original plan.

Due to a combination of these high levels of gas, funding shortages, budget overruns, schedule slippage, and a consent decree to shift its funding priority from completing the MOS-3 extensions to improving its bus service, FTA began to question LACMTA's ability to complete MOS-3 on-time and within budget. In January 1997, FTA requested that the MTA submit a financially constrained recovery plan to demonstrate its ability to complete MOS-2 and MOS-3. On June 9, 1997, the FTA and the LACMTA signed a Revised and Restated FFGA, which addressed the North Hollywood Extension only.

In January 1998, the LACMTA Board of Directors voted to suspend and demobilize construction on all rail projects other than MOS-2 and MOS-3 North Hollywood Extension. The MTA submitted a recovery plan to FTA on May 15, 1998, which was accepted by FTA on July 2, 1998. Additionally, a local initiative passed in November 1998 that restricted the use of local sales tax from being used for subway construction. In June 1999, revenue operation on MOS-2b to Hollywood began and in June 2000, revenue operation on MOS-3 to North Hollywood began.

Project Scope

The LA project was funded in three separate Minimum Operable Segments. The construction, environmental, and funding problems that plagued the project along with Board-directed modifications caused the scope and alignment of the project to change several times between the first FFGA for MOS-1 and the final amendment to MOS-3.

During construction of MOS-2, a gas explosion and fire resulted in Congressional prohibition on Metro Rail construction in the Wilshire/Fairfax area. A new alignment up Vermont Avenue was chosen which is slightly shorter than the original alignment with two fewer stations.

MOS-3 included the 6.3 mile North Hollywood extension that completes the 1988 LPA (17.3 miles). It also envisioned a 2.3-mile, 2-station extension from the Wilshire/Western station called the Mid-City extension. The 3.7-mile East Side Extension was also envisioned but had not completed AA as of the 1993 FFGA for MOS-3 and funds had not been included in that FFGA. In the December, 1994 FFGA amendment for MOS-3, $695 million was added for the 4-station East Side extension. The FFGA scope reflects the project as it stood in 1994.

By 1997, the Mid-City extension was $192 million over budget and 10 years behind schedule while the East Side extension was $69 million over budget and two years behind schedule. At FTA's direction, LACMTA began the development of a financially constrained recovery plan to try to salvage as much of the original budgets as possible. The revised and restated FFGA separated the North Hollywood extension from the others and committed to completing that link, while developing a plan to complete the other legs. The recovery plan suspended the Mid-City and East Side extensions.

Table 60: Project Scope - LA Red Line

	DEIS	FEIS	FFGA	As-built
Length				
underground	18	18.6	23.3	17
Stations				
underground	16 + 2 optional	18	22	16
Trackage				
double	18.6	18.6	23.3	17
Parking Spaces	unknown	3080	not specified	4551
surface		2905		
structure		175		
Vehicles				
rail	140	140	62	104
Facilities				
shops/yards	1	1	1	1
control center	1	1	1	1

Notes: As-built length was derived from PMO and FMOC reports. The number of rail vehicles is from 2000 NTD. As-built parking spaces from LACMTA station parking information (3000 of those spaces are at Union Station with is the Downtown terminus and are not necessarily used by Red Line riders).

Service Levels

Actual service levels on the LA Red Line are significantly lower than the levels in the planning documents. The span of service is approximately the same as planned.

Table 61: Service Levels - LA Red Line

	MIS/AA/ DEIS	FEIS	SFEIS	Actual Trunk*	Actual Branch**
Forecast Year	2000	2000	2000	NA	NA
Span of Service					
Weekday		5:30AM-1:30AM	5:30AM -1:30AM	4:45AM - 1:00AM	4:45AM – 1:00 AM
Frequency of Service					
Pk Hr Headway	3-6 min	3-6 min	6-8 min	5 min	10 min
Pk Period Hdwy	3-6 min	3-6 min	6-8 min	5 min	10 min
Mid-Day Hdwy	7.5 min	7.5 min	10 min	6 min	12 min
Evening Hdwy	7.5-15 min	7.5-15 min	10-20 min	10 min	20 min
Weekend Hdwy	10-15 min	10-15 min	15-20 min	6-10 min	12-20 min
Fare	not stated	not stated	not stated	$1.35	$1.35

* Trunk service between Union Station and Wilshire/Vermont Station
** Branch service between; 1. Wilshire/Vermont Station and North Hollywood Station, and 2. Wilshire/Vermont Station and North Hollywood Station.

Ridership

The project as constructed roughly matches the project evaluated in the FSEIS/SEIR so the meaningful comparison of predicted vs. actual ridership is between 298,000 predicted for 2000 and approximately 135,000 actual boardings for the full system in 2002. The LA Red Line has achieved approximately 45 percent of the predicted ridership for the general alignment and scope that was constructed.

Table 62: Predicted and Actual Ridership - LA Red Line

	Project - Average Weekday Heavy Rail Boardings	System-wide Average Weekday Transit Boardings	Forecast Year
Predicted			
AA/DEIS	376,375	2,347,000	2000
FEIS	364,137	2,429,000	2000
DSEIS/SEIR	295,721	1,929,000	2000
FSEIS/SEIR	297,733	1,946,000	2000
Actual			
Opens – 1993	14,414		
1994	17,358	1,231,983	
1995	20,751	1,138,665	
MOS 2A – 1996	27,330	1,131,339	
1997	36,794	1,182,069	
1998	35,100	1,244,531	
MOS 2B –1999	49,850	1,197,311	
MOS 3 – 2000	88,479	1,242,332	
2001	128,659	1,404,502	
2002	*134,555	*1,390,492	

* January – October 2002
Source: Estimated ridership numbers calculated by the Service Performance Analysis Department, LACMTA

Capital Costs

The Red Line project over the course of project development from the AA studies in the early 1980s through opening of all segments of the completed line to revenue service in 2000 went through many changes. These included project delays and changes in alignment. In addition elements were added to the project, with commensurate expenditures, and then subsequently deleted. The capital cost summary, below, attempts to portray the cost estimates at various stages for the project as it was actually built. The project was developed in three stages, MOS-1, 2, and 3. The total project as presented in the AA/DEIS and FEIS studies included, essentially, all three stages or close approximations thereto. Work on the project took place over a period of more than fifteen years. The actual cost of the entire project is slightly less than 50 percent more than the inflation adjusted planning estimates.

Table 63: Predicted and Actual Capital Costs - Los Angeles Red Line

	Total Capital Cost (millions of $)						Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA (Base $)	FFGA (YOE $)	FFGA Const. Midpoint $	As-built (YOE $)	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA Midpoint $
As estimated	$2352.2 (1983 $)	$2468.6 (1983 $)				$4490.6	191%	182%	
MOS – 1 Opened 1993			$844.6 (1985 $)	$1004.6 (1993 $)	$946.8	$1439.0			152%
MOS – 2 Opened 1999			$1150.5 (1986 $)	$1376.5 (1999 $)	$1289.6	$1717.9*			133%
MOS – 3 Amended North Hollywood segment only Opened 2000			$1132.2 (1992 $)	$1233.4 (2000 $)	$1269.2	$1312.8			103%
Totals	$3031.3 (1995 $)	$3181.3 (1995 $)		3371.5	$3505.60	$4469.7	147.5%	140.5%	127.5%

Notes: YOE = Year of Expenditure
MOS-3 amended replaced MOS-3. Project FFGA YOE $ sum is composed of MOS-1, MOS-2 and MOS-3 amended.
MOS-3 amended adjusted to discount funds expended on Mid-City and East Extensions.
* The MTA removed $30 million in legal costs that were deemed not part of the scope, and in consideration of court ruling in favor of MTA.
PMOC Comment: The numbers have been modified based on information available to the PMOC including FFGAs. The 'As-built' amount for Segment 2 includes approx. $65 million in locally funded costs that were outside of the FFGA scope.

Operating Costs

The service, as operated, is less frequent at all times of day than had been envisaged in the original O&M cost estimated. The actual costs incurred for operations are quite close to the estimated values in year of estimate dollars and well below the costs inflated to comparable 2000 dollars.

Table 64: Predicted and Actual Operating Costs - Los Angeles Red Line

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$45.0	$48.5	NA	$48.5	108%	100%	NA
Adjusted to year of opening (2000 $)	$78.6	$84.7	NA	$48.5	62%	57%	NA

Assessment of Predicted vs. Actual Ridership and Costs

Reported ridership increased significantly after the opening on MOS-3 but through 2002 is still only about 50 percent of the projections made during alternatives analysis of alternatives similar to the project actually constructed. The reasons for the error are not immediately clear, though the realignment of the project from Wilshire Boulevard to the less dense Vermont Avenue, may explain some of the error. Other factors could be a failure to achieve employment or population forecasts in the corridor and significantly lower service levels than predicted. Detailed study will be required to determine the precise reasons for the forecasting error.

Construction costs were about twice of the planning study estimates in dollar expended but only about 45 percent more in inflation adjusted dollars. Adjusted for inflation, the actual cost of the project exceeded the FFGA cost estimate by about 27 percent. In inflation adjusted dollars, operating costs are about 40 percent less than the planning estimates, but for a lesser service.

Miami Metromover Omni and Brickell Extensions

Description

The Miami Metromover system is an elevated downtown people designed to provide downtown distribution for the Metrorail system and for general circulation around downtown Miami. The Omni and Brickell extensions added 2.5 miles of additional guideway north and south of the initial 1.9 mile loop, added an additional Metrorail transfer at the Brickell station, and added a bus transfer facility at the Omni station.

Project Development

System Planning and Alternatives Analysis

In April 1976, the Urban Mass Transportation Administration (UMTA) announced a nationwide competition for funding downtown people movers (DPM) in urban areas. More than 65 cities expressed interest; eleven, including Miami-Dade County, were selected as finalists. UMTA gave Miami-Dade County conditional approval in December 1976 to pursue the DPM plan based on reprogramming $24 million from approved Metrorail funds to the people mover project. In March 1979, local officials adopted the full system DPM alignment after a joint public hearing by the Metro-Dade Board of County Commissioners and the City of Miami Commission. The full system alignment consisted of a 1.9-mile loop circling the CBD core, in addition to north and south legs connecting to Omni and Brickell. Local officials decided that because of federal funding constraints, studies would focus on the final design and implementation of the downtown loop component of the full Metromover System. The Omni and Brickell legs were to be completed later. In May 1979, UMTA committed $19.2 million in federal funds to the DPM project. Construction on the downtown loop began in August 1982. In April 1986, after a 23-month delay and a $121 million increase in cost, the Metromover started revenue operations, providing service to nine stations in downtown Miami, covering a 1.9-mile loop (from http://www.co.miami-dade.fl.us/transit/history/info.htm, Capital Cost Analysis for Urban Transit Projects and DEIS).

Preliminary Engineering

From 1980 to 1982, planning studies progressed on the Omni and Brickell legs. Local officials considered three alignment variations for the Omni leg and 12 for the Brickell leg approving a final alignment for each leg in 1981. Further environmental studies resulted in changes to the adopted alignments in order to avoid historic and park sites. Specifically, on the Omni leg, the alignment was moved from within a park to just outside of the park. On the Brickell leg, the alignment was moved a block to avoid a historic site. These were the two alignments studied in the DEIS (July 1987) and the FEIS (February 1988). According to both EIS documents, The Omni leg would be 1.4 miles with six stations. It would connect with the existing Metromover loop at N.E. 5th Avenue and extend north. The Brickell Leg would be 1.1 miles with six stations and would connect to the existing Metromover loop between Miami Avenue and S.E. 1st Street just north of the I-95 expressway and extend south.

Final Design and FFGA

The FFGA was signed in March 1989 and called for six stations on each leg. The FFGA also called for the purchase of up to 15 automated vehicles and the construction of a service and storage facility. The completion date for the project was the end of 1993.

Officials further studied the alignment described in the FEIS in an effort to save costs of property acquisition by moving more into public streets. As a result of this final alignment, the Metro Dade Transit Agency only needed to acquire 30 parcels, instead of 54, costing $14 million instead of $49.3 million (Capital Costs Analysis for Urban Transit Projects). FTA approved the final alignment in January 1990, and construction began in March 1991.

Opening to Service

In August 1992, Hurricane Andrew hit Florida, and the project completion date was extended to May 1994, which is when the extensions began revenue service.

Project Scope

The scope of the project remained stable throughout planning and project development with only minor changes to the alignments. The FFGA reduced the number of vehicles to be purchased, but two additional vehicles were procured based on a change order during construction.

Table 65: Project Scope - Miami Metromover Omni and Brickell Extensions

	DEIS	FEIS	FFGA	As-built
Length				
elevated	2.5	2.5	2.5	2.5
Stations				
elevated	12	12	12	12
Trackage				
double	2.5	2.5	2.5	2.5
Parking Spaces	not stated	not stated	not stated	not stated
Vehicles	18	18	15	17
Facilities				
shops/yards	1+	1+	1	1+

Service Levels

Service levels on the Metromover system exceed the levels proposed in the planning documents. The longest headway is currently only 3 minutes and the hours of operation are slightly longer than originally planned. Due to the passage of a major funding initiative in 2002, fares on the Miami Metromover system have been eliminated.

Table 66: Service Levels - Miami Metromover Omni and Brickell Extensions

	MIS/AA/ DEIS	FEIS	Actual
Forecast Year	2000	2000	NA
Span of Service			
Weekday	not stated	6:00 AM – 10:30 AM	5:15 AM – 12:30 AM
Frequency of Service			
Pk Period Headway Inner Loop	1.5 min	1.5 min	1.5 min
Pk Period Hdwy Omni/Bucknell Loop	3.5 min	3.5 min	1.5 min
Mid-Day Hdwy	3.5 min	3.5 min	3 min
Evening Hdwy (no inner loop svs)	7 min	7 min	3 min
Fare			
Metromover	0.25	0.25	0.25/Free
Metrorail	1.00	1.00	1.25

Ridership

Ridership forecasts for the Miami Metromover Omni and Brickell Extensions have proven to be optimistic. The highest average weekday boardings occurred in the opening year at about 1/3rd of the forecast for 2000. In the forecast year, average weekday boardings were running at about 21 percent of the forecast level. The passage of a major funding initiative in 2002 and the resulting elimination of fares on the Metromover system has caused significant recent gains in ridership with boardings on the Omni and Brickell legs back up to almost 30 percent of the 2000 forecast and system-wide boardings almost 50 percent of the 2000 forecast.

Table 67: Predicted and Actual Ridership - Miami Metromover Omni and Brickell Extensions

	Project - Average Weekday Boardings	System-wide		Forecast Year
		Average Weekday Metromover Boardings	Average Weekday Transit Boardings	
Predicted				
AA/DEIS	20,404	43,289		2000
FEIS	20,404	43,289		2000
Actual				
1993		7,950	281,500	
Opens 1994	6,920	11,381	263,928	
1995	4,413	13,225	260,237	
1996	3,909	12,712	257,576	
1997	4,229	13,558	263,096	
1998	3,972	13,735	261,823	
1999	3,924	13,689	265,320	
2000	4,209	14,295	273,090	
2001	4,241	16,323	274,436	
2002	4,158	16,303	not available	
2003 (two months)	5,797	21,243	not available	

Capital Costs

The FFGA issued in 1990 was for $228 million. At that time it was estimated that the cost of the project would be $240 million with a federal share of $180 million of which $151.4 million had been earmarked by the Congress. The FFGA was limited to a federal share of $115.5 million due to “local share constraints.” The estimate of $240 million is within 5 percent of the reported as-built cost. The FFGA amount was low only due to constraints on funding that were subsequently ameliorated.

Table 68: Predicted and Actual Capital Costs - Miami Metromover Omni and Brickell Extensions

	Total Capital Cost (millions of $)				Ratio of Actual Cost/Predicted Cost		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$196.5 (1986 $)	$196.5 (1986 $)		$228.0	116%	116%	
As stated in FFGA			$154.0 (1989 $)				148%
As reported in PMO report			$248.0 (1989 $)	$248.0			92%
Adjusted to Const. Midpoint (1991 $)	$221.2	$221.2	$161.3	$228.0	103.1%	103.1%	141.3%

Operating Costs

The as-built operating costs are estimated based on Automated Guideway operating costs reported in the National Transit Database for the fiscal years before and after the opening of the Metromover extensions. Even though the service offered is slightly greater than assumed in the DEIS and FEIS, the estimated as-built operating costs are less than the estimated costs in both nominal and inflation adjusted dollars. This may reflect savings that were achieved in other portions of the Metromover operation or changes in the service plans. In either case, the estimated costs are within 15 percent of as-built cost.

Table 69: Predicted and Actual Operating Costs - Miami Metromover Omni and Brickell Extensions

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual Cost/Predicted Cost		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$4.2 (1986 $)	$4.2 (1988 $)	NA	$3.8	91%	91%	NA
Adjusted to year of opening (1994 $)	$4.4	$4.5	NA	$3.8	86%	84%	NA

Assessment of Predicted vs. Actual Ridership and Costs

The ridership projections have proven to be optimistic. Service levels match or exceed the levels assumed in the planning studies and fares have been eliminated. Still, ridership remains only about 30 percent of the 2000 forecasts. The reasons for the forecasting error are difficult to understand considering that the project was an extension of an existing system whose ridership could be observed. A more detailed analysis of the assumptions and travel forecasting procedures would be required to understand the sources of the forecasting error.

The capital costs of the project, as estimated, were a good representation of the costs actually incurred in building the project and provided the necessary information to those making the investment decisions. The estimates of the operating costs for the extensions also were reliable estimates of the costs actually incurred.

Pittsburgh Airport Busway/Wabash HOV Facility Phase 1 (West Busway)

Description

The West Busway in Pittsburgh runs approximately six miles from Carnegie to Carson Street. The project also included renovations of the Berry Street and Wabash Tunnels. The purpose of the project was to provide improved transit access, reduce travel times, and increase development opportunities in the Airport Corridor, Western Allegheny County and Downtown Pittsburgh. The project also improves the visual aesthetics of the corridor by reusing and landscaping an abandoned freight railroad right-of-way.

Project Development

System Planning

Planning for the West Busway began in 1988 when the Southwestern Pennsylvania Regional Planning Commission (SPRPC) sponsored the Parkway West Multi-Modal Corridor Study to identify transportation improvements needed in the corridor between the airport and downtown Pittsburgh. In 1990, the Port Authority of Allegheny County initiated the Airport Busway Transitional Analysis to study the transit recommendations in the Parkway West Corridor Study. (Connextions Newsletter, 9/2000)

Alternatives Analysis

In September 1991, The Port Authority began the Phase I Airport Busway/Wabash HOV Alternatives Analysis/Draft Environmental Impact Statement. The Port Authority selected the busway as the locally preferred alternative in October 1992. In the DEIS, the busway consisted of an 8.1-mile long, two-lane road from Carnegie and the Parkway West to downtown Pittsburgh. The seven-mile section from Carnegie to the Wabash Tunnel/Station Square area would be a busway with eight stations and would use the former Berry Street railroad tunnel. Six park and ride lots also were included. A 0.7-mile HOV facility for buses and carpools would run through the Wabash Tunnel. The remaining 0.4 miles involved either a new HOV bridge over the Monongahela River or use of the existing Fort Pitt and/or Smithfield Street bridges.

Preliminary Engineering

FTA approved the project into preliminary engineering on October 29, 1992. The Port Authority completed the preliminary engineering in April, 1994 and the Final Environmental Impact Statement, also in April, 1994. In the FEIS, five remote and two station park and ride lots were included in the LPA (p. 4-22). The FEIS also called for a new bridge over the Monongahela River. The Federal Transit Administration issued a Record of Decision on June 22, 1994.

Final Design and FFGA

The FTA and the Port Authority signed a Full Funding Grant Agreement in October 1994, which formalized the Federal commitment of $121 million in Section 5309 New Starts funds based on a total project cost of $326.8 million. The 1994 FFGA called for six park and ride lots (three satellite and three adjacent to busway) and seven stations. The other details of the project scope remained the same. Construction began on October 27, 1994.

In January 1995, the Port Authority ran into difficulty in finishing the project, due in part to higher than anticipated bids for construction of the bridge over the Monongahela River. Other difficulties included the Port Authority's inability to acquire necessary right-of-way for the project, the objections of some elected officials to parts of the project, and disagreements with Conrail over the timing and scope of work on Conrail property. These problems eventually delayed the project by four more years and raised the cost estimate to $515 million (February 1999 FFGA).

By December 1996, the Project was substantially behind schedule and projected to be so over budget that the FTA asked the Port Authority to submit a "Recovery Plan" to identify the actions needed to complete and pay for the Project.

In June 1997, the Port Authority submitted a Recovery Plan proposing to eliminate two major elements of the Project: (1) construction of the exclusive busway segment along the Conrail shelf right-of-way, and (2) construction of the bridge over the Monongahela River to downtown Pittsburgh. The Conrail shelf segment would be replaced by a direct connection of the busway to Carson Street, and the bridge would be replaced by a ramp from the Wabash Tunnel to Carson Street. The FTA approved the Recovery Plan, which cut nearly $200 million from the project's cost.

After the Port Authority submitted the Recovery Plan and prepared an Environmental Assessment, elected officials in the Pittsburgh area told the Port Authority that the possibility remains that a new bridge will be built over the Monongahela River that would connect the Wabash/HOV Tunnel to downtown Pittsburgh in the next several years (February 1999 FFGA).

The Port Authority and the FTA signed a revised Full Funding Grant Agreement on February 25, 1999, which officially eliminated the Monongahela River Bridge and Conrail shelf portions of the project. The FFGA extended the revenue operation date of the project to December 31, 2001 for the Parkway West to Carson Street portion of the project and deferred completion of the connection from the Wabash HOV/Tunnel to Carson Street to December 31, 2002 to afford the Port Authority time to determine if there will be a connection of the tunnel to a new bridge. The revised FFGA calls for six stations on a 5-mile exclusive busway to an improved Carson Street to an existing bridge over the Monongahela River; a 1.1-mile HOV facility through the unused Wabash Tunnel and six park and ride lots (three satellite and three adjacent to busway).

Opening to Service

Revenue service on the exclusive busway began on September 8, 2000. Design and construction continued on the following elements of the project (according to September 2001 PMO report):

- The Woodville/Collier Park and Ride lot. Subsequently, the Port Authority completed design and construction activities for this facility, which opened for operations on December 30, 2002.
- Wabash HOV Tunnel: the uncertainty of whether a new bridge across the Monongahela River will be built has delayed this part of the project. The FTA has granted a schedule extension to December 31, 2004. The original completion date was December 31, 2002.

Project Scope

The scope of the Pittsburgh West Busway is substantially less than proposed in the planning studies and initial FFGA. The table below summarizes the changes to the project. While the length is only slightly less than the planned project, the elimination of the Monongahela River Bridge and Conrail shelf portions of the project significantly reduce the potential transit service levels provided by the project. The planned project would have provided a new bridge into Downtown Pittsburgh, providing significantly more capacity into a particularly congested area. The deletion of the new bridge means that all the bus traffic on the West Busway must enter Downtown Pittsburgh on congested facilities.

Table 70: Summary of Pittsburgh West Busway Project Scope

	DEIS	FEIS	FFGA	As-built
Length	8.1	8.1	8.1	6.1
at grade	7	7	7	4.9
underground	0.7	0.7	0.7	0.6 tunnel
elevated	0.4	0.4	0.4	0.6 bridges
Stations				
at grade	7	7	7	6
elevated	1	1	1	
Lanes				
double	8.1	8.1	8.1	6.1
Parking Spaces				
surface	2650	2650	not stated	1485*
Vehicles				
bus	40	40	0	0

*Remainder under development.

Service Levels

Due to the nature and flexibility of busways with multiple access points, the service frequencies are difficult to discern in the planning documents as are the actual service frequencies, since numerous bus routes use only parts of the facility. The planning documents reference 26 existing bus routes and 6 new routes to use the facility. In addition, many routes operate non-stop once they enter the busway. Many bus routes proposed to use some portion of the West Busway have not been rerouted onto the facility, which may be largely due to the reduced scope of the project.

Bus routes on the West Busway in 2002 include: 100 (route ABA in DEIS/FEIS), 33X, 33D, 33E, 33F, 28G, and 28X, 28E, 28F, 28J, 28K.

Existing bus routes that were proposed (DEIS/FEIS) to use the West Busway, but do not actually use it: Routes 26A, 26B, , 26D, 26E, , 21A, 21B, 21C, 21D, 31A, 31D, 36A, 36B, 36C, 36D, 37A, and 38C.

Proposed bus routes that were never implemented: BCTA-4, 33A, and 28C.

Table 71: Service Levels - Pittsburgh West Busway

	MIS/AA/ DEIS	FEIS	Actual
Forecast Year	2005	2005	NA
Span of Service			
Weekday	5:00 AM -1:00 AM	5:00 AM -1:00 AM	5:00 AM -1:00 AM
Weekend	5:00 AM -1:00 AM	5:00 AM -1:00 AM	5:00 AM -1:00 AM
Frequency of Service*			
Pk Hr Headway	see note	see note	5 min
Pk Period Hdwy	see note	see note	8 min
Mid-Day Hdwy	see note	see note	25 min
Evening Hdwy	see note	see note	25 min
Weekend Hdwy	see note	see note	20 – 60 min
Operating Statistics **			
Annual Rev Miles	5,328,500	5,328,500	542,366 on busway
Fare	not stated	not stated	$1.75 – $2.75

* Note: the frequencies in the planning documents cannot be determined precisely. However, the planned frequencies are would be far greater than the actual reported frequency since the actual service is a subset of the planned services.
** For DEIS and FEIS, these statistics are changes from no-build.

Ridership

While the forecast ridership for 2005 is more than double the actual ridership on the facility in 2002, the scope of the proposed Busway is smaller than the project analyzed in the planning studies. To partially account for the reduced scope, the ridership forecasts have been adjusted to reflect the "no bridge" option in the planning studies. The station boardings related to the stations, which were never constructed, were removed. The ridership forecasts still far outpace that actual ridership experience of the project.

Table 72: Predicted vs. Actual Ridership - Pittsburgh West Busway

	Project – Average Weekday Boardings	System-wide			Forecast Year
		Rail System Boardings	Bus System Boardings	Total Transit Boardings	
Predicted					
AA/DEIS*	23,369			287,404	2005
FEIS	23,369			287,404	2005
Actual					
1999		24,749	221,100	256,150	
2000	4,400	24,562	222,607	250,231	
2001	7,300	24,800	223,100	257,000	
2002	9,000	not avail	not avail	not avail	

* The AA/DEIS provides forecasts for busway boardings by stations. The projected daily ridership for the busway was adjusted to reflect only those stations that were actually constructed. Total project boardings on the original project were forecast to be 53,285.

Capital Costs

The estimated cost for the project in the DEIS was just over $226 million in 1992 dollars. This estimate is equivalent to $275 million adjusted to midpoint of construction dollars or just over 17 percent less than the actual cost. By completion of the FEIS in 1994 the estimated cost had increased by 31 percent to $295 million ($339 million in year 1999$). The FFGA estimate of $327 million ($362 million in year 1999$) represented a further increase of 11 percent.

The actual as-built cost reported *for the busway portion of the project* is less, in inflation adjusted dollars than either the FEIS or FFGA estimates. However, the project as-built has two fewer stations and two miles less guideway than originally planned. In addition a new bridge was eliminated from the project. The rehabilitation of the Wabash Tunnel has yet to be undertaken (see project description above). A complete analysis of estimated as-built cost would require further disaggregation of the estimated costs.

Table 73: Predicted and Actual Capital Costs - Pittsburgh West Busway

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$226 (1992 $)	$295 (1993 $)	$327 (1994 $)	$322	142.5%	109.2%	98.5%
Adjusted to Const. Midpoint (1999 $)	$274.4	$338.6	$361.7	$322	117.3%	95%	89.0%

Operating Costs

Operating costs for transit services operating on the busway were estimated to be just under $12 million. Actual operating cost data for the services as operated can be estimated as follows. West Busway peak buses of 58 represent 7 percent of the bus system peak requirement of 830. Taking 7 percent times FY 2001 bus mode operating costs of $198.5 million, yields $13.9 million operating and maintenance costs for the West Busway. The actual operating costs come very close to the cost predicted in the planning studies, but for a lesser service than planned.

Table 74: Predicted and Actual Operating Costs - Pittsburgh West Busway

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	11.7 (1992 $)	11.7 (1992 $)	NA	$13.9	118.8%	118.8%	NA
Year 2000 $	14.1	14.1	NA	$13.9	98.5%	98.5%	NA

Assessment of Predicted vs. Actual Ridership and Costs

The ridership forecasts are much higher than the actual boardings on the project. Construction difficulties resulted in major reductions in project scope. The planned new river crossing and the Conrail shelf portion of the right of way were never built. Changes in scope also reduced many of the travel time benefits that would have resulted from the project and fewer bus line can take advantage of the new right-of-way than assumed in the planning study. Since the forecasts are given by bus line, it is possible to isolate the ridership on the bus lines that actually operate on the new guideway. The projected ridership in the DEIS on bus lines that actually use the West Busway were as follows:

Route	Projected daily boardings (DEIS) for no-bridge option (Forecast Year 2005)
33D	1,210
33E	1,832
33F	784
28G	55
28X	6,143
ABA	5,992
Total	16,016

The actual ridership on the West Busway is closer to the forecast for the routes that actually use the facility. An additional 1,000 parking spaces were under construction at the time of this writing. Ridership will likely expand when those spaces become available. With the completion of additional parking along the busway, the facility may come close to 70 percent of the 2005 forecast for only routes using the West Busway. Even for those routes, however, the time benefits that would have accrued from operation along the Conrail Shelf or across the yet un-built bridge are not provided. Given the magnitude of these changes it is difficult to assess the degree of optimism in the ridership forecasts.

The project capital cost is less than predicted (adjusted for inflation) but not in proportion to the reduction in project scope. Cost of the built project, in nominal dollars, is less than but almost equal to the amount provided for in the Full Funding Grant Agreement. This suggests that the FFGA has served to limit expenditure. Further funding will be required if the remaining portions of the project are to be implemented.

The operating cost data are not detailed enough to judge the validity of the estimates or the estimation process.

Portland Westside-Hillsboro LRT Extension

Description

The Westside-Hillsboro line extended LRT service to the rapidly growing western portion of the Portland metropolitan area. The highway facilities between the Westside and Downtown Portland were at or near design capacity and purported to be incapable of handling projected growth. The topography of the area (the West Hills) also practically limit the ability to build new highways or expand existing ones cost-effectively. The Westside-Hillsboro project was-built to accommodate the forecast growth in travel between Downtown Portland and the Westside.

Project Development

System Planning

In 1979, the Metropolitan Service District (METRO) in cooperation with the Tri-County Metropolitan Transportation District (TRI-MET) and other local jurisdictions in the Portland, Oregon region completed a systems analysis of existing and future conditions in all of the major regional transportation corridors. This analysis culminated in the designation of the Westside Corridor as a priority corridor for major transit investment.

Alternatives Analysis

Local officials completed the Westside Corridor Project Draft Environmental Impact Statement in March 1982. In 1983, Westside Corridor jurisdictions chose the Sunset LRT to S.W. 185th Avenue as the LPA for the Westside. Plans called for a 12.2-mile two-track light rail alignment, but the project was not constructed at that time.

In 1990 the Westside Corridor was re-examined leading to publication of an SDEIS in January 1991. Those studies considered numerous variations including a different terminus, tunnel and station alternatives through the Canyon Segment, and alternative paths through Beaverton. The preferred alternative retained the 185th Street terminus and followed generally the same alignment through Beaverton. However, the Canyon Segment, rather than a surface alignment, included a tunnel approximately three miles long with a deep station serving the Portland Zoo.

An Alternatives Analysis began in June 1990 to study an extension of the Westside Corridor LRT to Hillsboro. The Hillsboro Corridor AA/DEIS, completed in April 1993, evaluated three alternatives. Following publication of the AA/DEIS, local officials selected the light rail alternative to the Hillsboro CBD including the Washington Street Option as the LPA. The new line would be 6.2 miles and run from S.W. 185th Avenue to the Hillsboro Park and Ride.

Preliminary Engineering

The LRT project was reintroduced in 1988 when UMTA approved the Westside extension to begin preliminary engineering. A Supplemental DEIS was completed in January 1991 for the Westside project to 185th Street. Those studies considered numerous variations including a different terminus, tunnel and station alternatives through the Canyon Segment, and alternative paths through Beaverton. The preferred alternative retained the 185th Street terminus and followed generally the same alignment through Beaverton. However, the Canyon Segment, rather than a surface alignment, included a tunnel approximately three miles long with a deep station serving the Portland Zoo.

After the selection of the LPA for the Hillsboro LRT extension, officials re-examined station locations and decided to eliminate the Sewell station, combine Main Street and Cornell station into the 12th Avenue station and modify the Oregon Graduate Institute, Orenco, and Hawthorn Farm Stations. The FEIS for the Hillsboro extension was completed in March 1994. The Hillsboro extension to be 6.2 miles long from S.W. 185th Avenue to the Hillsboro Park and Ride Station.

Final Design and FFGA

TRI-Met began final design on the Westside project in November of 1991 and signed an FFGA in September of 1992. An amendment to the Westside FFGA was signed in December 1994 to fund the extension to Hillsboro. The project went forward as the combined Westside-Hillsboro project.

Opening to Service

Revenue operation began in September 1998.

Project Scope

The project as constructed is the combination of two distinct projects, the Westside LRT and the Hillsboro extension. The scope of the two projects remained relatively stable throughout project development and construction. Tri-Met built slightly fewer stations than planned in the DEIS and built more parking spaces and purchased six more vehicles than originally proposed.

Table 75: Project Scope - Westside-Hillsboro LRT

	DEIS	FEIS	FFGA	As-built
Length	17.6-18.2	17.7	17.7	17.7
at grade		14.7	14.7	
underground		3	3	3
Stations		20	20	20
at grade	21-23	19	19	19
underground		1	1	1
Trackage				
double	17.6-18.2	17.7	17.7	18
Parking Spaces	3405-3705	4100	3700	3613
Vehicles				
rail	36	36	36	42
Facilities				
shops/yards	1	1	1	1
control center	not stated	expand existing	expand existing	expand existing

Service Levels

Actual service levels are better than planned. Peak hour frequencies on the Hillsboro extension segment are double planned frequencies. Evening frequencies on the entire line are also approximately double planned frequencies.

Table 76: Service Levels - Westside-Hillsboro LRT

	MIS/AA/ DEIS	FEIS	Actual
Forecast Year	2005	2005	NA
Span of Service			
Weekday	5:30 AM - 12:30 AM	5:30 AM - 12:30 AM	5AM -12PM
Frequency of Service			
Pk Hr Headway CBD-Beaverton	6 min	6 min	6 min
Pk Hr Headway Beaverton-Hillsboro	12 min	12 min	6 min
Pk Period Hdwy			6-10 min
Mid-Day Hdwy	7.5-15 min	7.5-15 min	10 min
Evening Hdwy	30 min	30 min	10-15 min
Operating Statistics			
Veh Capacity	166	166	166
Fleet Vehicle Reqs (entire LRT fleet)	84	84	78
Daily car miles (LRT system)	13,900	13,900	15,026
Daily Train Platform miles (system)	438	438	421
Fare	*see note	*see note	$1.25 - $1.55

* In 1993, Tri-Met's LRV fare was .95 for 1-2 zones and 1.25 for 3 zones. EIS assumes fare increase of 4.5 percent per year.

Ridership

Ridership comparisons for the Westside-Hillsboro project are complicated due to the fact that the Westside project was initially planned in 1982, long before the Hillsboro project was planned. A supplemental DEIS and FEIS for the Westside line were prepared in 1991. The DEIS for the Hillsboro extension was completed in 1993 with the FEIS completed during 1994. Altogether, there are two different Westside forecasts and one forecast for the Hillsboro extension, which includes updated forecasts for the Westside stations. The combined forecasts chosen to compare to actual ridership are presented in Table 77.

The initial ridership forecast prepared for the Westside AA/DEIS was optimistic. Actual ridership on the project was about 73 percent of the ridership projected in the initial planning studies. The new forecasts prepared for the Westside SDEIS corrected most of the errors. Actual average weekday project boardings in 2002 already exceed the 2005 projections prepared in the Westside SDEIS and Hillsboro AA/DEIS. Actual ridership has achieved almost 90 percent of the forecasts for the combined project reported in the Hillsboro DEIS and FEIS.

Table 77: Predicted vs. Actual Ridership - Portland Westside-Hillsboro LRT

	Project – Average Weekday Boardings	System-wide		Forecast Year
		Rail System Boardings	Total Transit Boardings	
Predicted – Westside				
1. AA/DEIS ('82)	51,400	NA	NA	1995
2. SDEIS ('91)	31,600	53,500	NA	2005
3. FEIS ('91)	31,600	53,500	NA	2005
4. Hillsboro DEIS/FEIS	40,534	68,600		
Predicted – Hillsboro				
5. AA/DEIS ('93)	8,914	68,600		2005
6. FEIS ('94)	8,914	68,600		2005
Total				
AA/DEIS (1 + 5)	60,314			
SDEIS/DEIS (2 + 5)	40,514	NA	NA	2005
FEIS (4 + 6)	49,448	NA	NA	2005
Actual				
1997		32,146	235,533	
1998	32,724	36,238	262,846	
1999	not available	68,388	266,876	
2000	not available	73,562	277,849	
2001	not available	69,800	276,200	
2002	43,876	not available	not available	

Capital Costs

The original planning for the Westside line was done in 1982; the planning for the Hillsboro extension was completed in 1990. The FEIS for the combined project was completed in 1994. The selected alternative in 1983 for the Portland Westside Corridor project was the Sunset LRT – a 12.2 miles light rail line for Downtown Portland terminating at N.W. 185th Ave. The selected alignment incorporated no tunnel sections. The estimated capital cost for this alternative was between $227.2 and $236.7 million (1980 $) [about $346 million in 1990 $].

In 1990 the Westside Corridor was re-examined leading to publication of an SDEIS in January 1991. Those studies considered numerous variations including a different terminus, tunnel and station alternatives through the Canyon Segment, and alternative paths through Beaverton. For the "Southside to 185th Via South/BN alternative", essentially the same surface option as the "Sunset LRT" the estimated cost was $445.8 million (1990 $). The preferred alternative retained the 185th Street terminus and followed generally the same alignment through Beaverton. However, the Canyon Segment, rather than a surface alignment, included a tunnel approximately three miles long with a deep station serving the Portland Zoo. The estimated cost for this alignment was $491.2 million (1990 $).

The FEIS completed in August 1991 estimated the cost for the Locally Preferred Alternative to be $522.4 million (1990 $) and $756 million (year of expenditure $). Subsequent studies, completed in 1993, considered the possibility of extensions to the planned LRT beyond 185th Street. The selected option was a 6.2 mile surface extension to Hillsboro. The estimated capital cost for this extension was $124.9 million (1990 $). The combined Westside-Hillsboro project cost estimate was $641.7 million (1990 $) or $878.0 million (year of expenditure $).

The long delay between initial planning and detailed engineering is evident in the increase in the estimated capital cost for the Part 1 segment between the AA/DEIS and the FEIS. The initial MAX services were generally viewed as successful leading to support for the Westside project. During the hiatus between initial and subsequent planning the community preference for a more ambitious project become evident. The latter studies also had benefit of both the construction cost experience gained from the building of the initial MAX line and the knowledge of actual inflation in construction costs between 1982 and 1993.

The capital costs estimated in 1982 were substantially lower than the costs ultimately incurred, even after adjustment for inflation, but this is not unexpected given the significant change in project scope including the addition of a three mile tunnel. The difference between the actual and the inflation adjusted estimates for the FEIS is less than 20 percent and less than 9 percent for the FFGA.

Table 78: Predicted and Actual Capital Costs - Portland Westside/Hillsboro LRT

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA (1993$)	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated							
Part 1	$236.7 (1980 $)	$522.4					
Hillsboro Ext	$124.9 (1990 $)	$154.6					
Total as estimated	Not applicable	$677.0	$821.8	$964.0	--	142%	117%
Adjusted to Const. Midpoint (1996 $)	$559.3	$804	$886.5	$964.0	172.4%	119.9%	108.7%

Operating Costs

The as-built operating cost is estimated based on the change in light rail operating costs from the between the opening year and the opening year plus one year as reported in the National Transit Database. As a result the value presented is only an estimate of the cost of operating the services on the Westside LRT as other service changes affecting LRT costs may have occurred during the same period. With the caveat the inflation adjusted operating costs as estimated are quite close to those actually incurred; within seven percent for the DEIS documents even given the 16 years between the Part 1 estimates and initiation of service, and within 16 percent of the inflation adjusted DEIS estimate.

Table 79: Predicted and Actual Operating Costs - Portland Westside/Hillsboro LRT

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated							
Part 1	$5.5 (1980 $)						
Hillsboro Ext	$6.2 (1990 $)						
Total as estimated	NA	$7.9		$12.2	--	163%	
Adjusted to year of opening (1998 $)	$11.3	$10.5	NA	$12.2	107%	116%	NA

Assessment of Predicted vs. Actual Ridership and Costs

The ridership forecasting performance for the Westside-Hillsboro extension is generally quite favorable. The initial forecast for the Westside extension, prepared in 1982, has proven to be optimistic. The initial Eastside light rail line in Portland opened in 1986, so subsequent forecasts had the benefit of actual ridership experience. The forecasts that were published after the opening of the initial segment predicted actual ridership quite well. Even using the high initial forecast for the Westside segment, the AA/DEIS forecasts exceed 2002 ridership by about 27 percent. Actual ridership already exceeds the SDEIS/DEIS forecasts for the combined project and are only about 10 percent shy of the FEIS combined forecast. Experience has clearly played a role in improving the forecasting performance for the Portland light rail system extensions.

The capital cost for the project was within nine percent of the FFGA and the operating costs are marginally more than projected. In summary, except for the initial DEIS from 1982, the cost estimates and ridership forecasts have been largely reliable indicators of actual project impacts.

San Jose, CA – Tasman West LRT

Description

The project was designed to provide increased transportation capacity between the residential areas of southern Alameda County and northeastern Santa Clara County and the rapidly growing employment centers of the Silicon Valley industrial parks in Santa Clara and Sunnyvale, as well as downtown San Jose. The Tasman West project is the first 7.6 mile phase of a 12 mile LRT line running across the north side of the metropolitan area and connecting to the existing Guadalupe LRT for connections to Downtown San Jose.

Project Development

Alternatives Analysis

The Metropolitan Transportation Commission and the Santa Clara County Transportation Agency began considering an extension to the Guadalupe Corridor LRT in 1984 as part of the Fremont-South Bay Corridor Study.

The Freemont-South Bay Phase I System Planning Analysis, completed in 1985, focused on defining the corridor and developing a set of alternatives to be screened further in an Alternatives Analysis. Santa Clara County Transportation Agency selected the most promising alternatives for detailed study in the Fremont-South Bay Alternatives Analysis and Environmental Review. Preliminary estimates indicated that the combined BART and LRT alternative was too expensive and did not meet the federal threshold for cost-effectiveness.

In 1988, the corridor study's policy committee decided to restructure the study by continuing to examine LRT in the Milpitas to Lockheed and Sunnyvale/Mountain View corridor under the federal AA/EIS process, and examining BART in a separate study in the Fremont to San Jose/Santa Clara corridor.

The MTC released the AA/DEIS/DEIR for public review and comment in May 1991. The MTC selected the Capitol/Hostetter to downtown Mountain View alternative, as the LPA. The DEIS called for extending the Guadalupe Corridor LRT west to downtown Mountain View and extends east to Capitol Avenue/Hostetter Road in East San Jose for 14.6 miles including the existing Guadalupe Corridor LRT tracks for 2.4 miles on Tasman Drive. The LPA also included 17 to 18 new stations. Additional stations and alignment options were added to the LPA, and FTA determined that a Supplemental DEIS/Recirculated DEIR (SDEIS/RDEIR) should be prepared. The SDEIS/RDEIR examined three alternatives: no-build, TSM and the LPA.

The LPA includes 12 miles of new track and 19 stations and the expansion of existing maintenance facility serving the Guadalupe Corridor. The Final Definition of Alternatives Report, prepared in 1990, contains detailed descriptions of the no-build and TSM alternatives. The SDEIS/RDEIR was completed in June 1992.

Preliminary Engineering

The FEIS/FEIR evaluated the no-build alternative, the TSM and the LPA. The FEIS/FEIR was completed in December 1992.

Final Design and FFGA

In September 1995, the California Supreme Court overturned the Measure A one-half cent local sales tax, thus eliminating a major source of local funds to construct and operate the Tasman project. Because of this, the project separated into two phases, Phase I (West Extension) and Phase 2 (East Extension). The SCCTD sought federal funding for the Tasman West Extension, but would pay for the Tasman East Extension entirely with local and state funding. In July 1996, the FTA and SCCTD signed a full funding grant agreement. The FFGA called for constructing a 7.6-mile transit line with 12 stations.

Opening to Service

Revenue operation for the West Extension began in December 1999. The East Extension to Milpitas opened in May 2001, and the projected full revenue operation date is spring 2004.

Project Scope

The AA/DEIS states that a portion of the line will be constructed along an existing freight spur. The project would only construct single track along the freight spur under the assumption that the LRT system would use the freight spur as the second track.

The eastern portion of the line are expected (DEIS/FEIS) to have some elevated sections of unspecified lengths. The Tasman East section of the project is currently under construction and scheduled to open in 2004.

Table 80: Project Scope - San Jose Tasman West LRT

	DEIS	FEIS	FFGA - West	As-built - West
Length	12.2	12.4	7.5	7.6
Stations	18	19	12	12
Trackage	mix		mix	
double		12		6.8
single				0.8
Parking Spaces	2380	2164	not stated	312
Vehicles				
rail	35	35	0	0
Facilities				
shops/yards	expand existing	expand existing	expand existing	expand existing

Service Levels

Actual headways on the Tasman West line are about 25 percent longer than the planning documents indicated while the span of service is slightly longer than planned.

Table 81: Service Levels - San Jose Tasman West LRT

	MIS/AA/ DEIS	SDEIS	FEIS	Actual
Forecast Year	2005	2005	2005	NA
Span of Service				
Weekday	5AM-12PM		5AM-12PM	445AM-2AM
Frequency of Service				
Pk Hr Headway	12 min	6-12 min	12 min	15 min
Pk Period Hdwy	12 min	12 min	12 min	15 min
Mid-Day Hdwy	20 min	20 min	12 min	15 min
Evening Hdwy	30 min	30 min	15 - 30 min	30 min
Weekend Hdwy			15 - 30 min	30 min
Operating Statistics				
Fleet Veh Reqs	35	35	35	
Pk Vehicle Reqs		30	30	
Off-Peak Veh Reqs		12-18	12-24	
Annual Rev Miles		1,400,000		
Annual Rev Hours		79,000		
Fare				1.40

Ridership

The Tasman West project is a shortened version of the project in the planning studies. The remainder of the Tasman light rail line is currently under development as the Tasman East extension. The ridership forecast used for comparison in this profile only used the station boardings associated with the Tasman West stations.

Average daily boardings on the Tasman West project are less than predicted. The project achieved around 70 percent of the forecasts in the first two years of operation, but recent economic trends and service level reductions have resulted in significant erosion of ridership.

Table 82: Predicted and Actual Ridership - San Jose Tasman West

	Project - Average Weekday Boardings	System-wide		Forecast Year
		Rail System Boardings	Total Transit Boardings	
Predicted				
AA/DEIS	14,875	not stated	197,780*	2005
SDEIS	14,115	not stated	192,501*	2005
FEIS	13,845	not stated		2005
Actual				
1999		22,487	176,595	
2000	10,142	25,673	177,056	
2001	10,296	30,383	183,091	
2002	8,244	25,573	170,396	

* Calculated as linked transit trips plus system level daily transfers.

Capital Costs

The project as-built is about 60 percent of the length planned in the AA/DEIS studies. The as-built cost is about 70 percent of the escalated cost reported in the same studies. The FFGA was signed seven years after the AA/DEIS studies and reflected both more detailed engineering and a reduced project scoped to match available funding. The reported final project cost matched the dollar amount of the FFGA.

Table 83: Predicted and Actual Capital Costs - Tasman West LRT

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$357.4 (1989 $)		$325.0 (1996 $)	$325.2	91%		100%
Escalated to year of expenditure	$465.7	$462.5			70%	70%	
Adjusted to Const. Midpoint (1997$)	$451.2		$346.1	$325.2	72%		94%
AA/DEIS adjusted for project length (60%) (1997 $)	$270.7			$325.2	120%		

Operating Costs

Operating and maintenance costs are estimated from the National Transit Database. O&M costs are comparable to the estimates prepared for the AA/DEIS but greater than the costs presented in the FEIS.

Table 84: Predicted and Actual Operating Costs - Tasman West LRT

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$9.8	$7.3	NA	$10.2	104%	140%	NA
Adjusted to year of opening (1999 $)	$12.2	$8.2	NA	$10.2	84%	124%	NA

Assessment of Predicted vs. Actual Ridership and Costs

Ridership on the Tasman West project has lagged behind predictions. A portion of the forecasting error is likely due to the severe economic contraction in the San Jose Metropolitan area after a long and rapid economic expansion in the 1990's. The loss of employment and population has caused system-wide loss of ridership that, in turn, required the transit operator to cut service on the project. If economic conditions rebound in the near future and service levels are restored, ridership could easily grow to within a reasonable range of the planning forecasts.

The actual project cost is about 20 percent greater that the cost estimated at the time of the Alternatives Analysis, adjusted for inflation and the reduced project length. Even though there was construction cost inflation between the time of the FFGA and the project completion, the capital costs were held to the amount programmed in the FFGA.

Actual operating and maintenance costs appear to be lower than estimated in the Alternatives Analysis, adjusted for inflation. The service span is longer than anticipated but the trips per hour in peak periods is 80 percent of the number assumed in the Alternatives Analysis. The resulting difference in inflation adjusted cost is consistent with this reduction.

San Jose Guadalupe Corridor

Description

The Guadalupe project in San Jose is a 20 mile light rail line that runs roughly North-South through downtown San Jose. The San Jose metropolitan are has grown extremely rapidly and experienced high levels of traffic congestion for a city its size. The largely suburban, low density development patterns exacerbated the impacts of rapid employment and population growth. This project was implemented as part of a strategy to redirect growth and change land use patterns in the area to provide an alternative to congested roads and make future growth more manageable.

Project Development

System Planning

Planning for mass transportation in Santa Clara County began in earnest in 1974 with the "Rapid Transit Development Project." The Santa Clara County Transit District investigated alternative transit system technologies in select corridors where it was believed that transit could attract 30 percent of the person trips. This investigation recommended the staged implementation of a high performance, medium-capacity transit guideway network in urban areas serviced by an extensive bus collection system as the most effective way of achieving the high transit ridership goal.

The County Transit District then initiated a second study in December 1975 to investigate the feasibility of light rail or bus transit alternatives in five of the highest demand corridors identified in the first study. The final report of that study recommended the State Route 87 right-of-way (Guadalupe Corridor), along with a portion of the Southern Pacific Railroad/Monterey Highway Corridor, as the most feasible route with the greatest potential ridership.

Alternatives Analysis

The Santa Clara Valley Corridor Evaluation study (SCVCE) was the next step. The SCVCE considered nine transportation alternatives and several land use scenarios for Santa Clara County in 1990. The SCVCE Draft Report (1978) recommended a priority list of land use, highway and transit projects. Among the principal recommendations was the detailed investigation of transportation alternatives in San Jose's Guadalupe Corridor.

In 1979, the SCVCE final recommendations were adopted. Officials identified State Routes 85 and 87 rights-of-way as priority corridors for transportation development. The SCVCE recommended acquisition of the remaining right-of-way and construction of a four-lane freeway between Interstate 280 and Curtner Avenue within the right-of-way.

Environmental impact reports for ROW acquisition of State Routes 85 and 87 were prepared in 1980 and 1982. Local officials completed an analysis of 14 highway/transit alternatives in 1981. Officials presented the results of the DEIS to the public, and selected the LPA in November 1981 (DEIS, S-3), which called for a two-track light rail line throughout the corridor, extending from Marriott's Great America theme park area in north Santa Clara to south San Jose, branching to service two areas, one between Santa Teresa Boulevard and U.S. Highway 101, and the other near the intersection of Coleman Road and Winfield Boulevard. The LPA also calls for a four-lane expressway within both State Route 85 and 87 segments of the Guadalupe Corridor.

Preliminary Engineering

Preliminary engineering for the LRT/expressway facility took place in 1982-83. The transit district completed the Guadalupe Corridor FEIS in 1983. According to the FEIS, the light rail line in the LPA would extend 19.7 miles with 35 stations (28 stations in the project, 3 in the downtown transit mall, and 4 future stations). The LPA also calls for a 9-mile expressway.

Final Design and FFGA

Officials signed an FFGA for the project in June 1984. The FFGA called for 18.4 miles of double track light rail line and 1.6 miles of single track and 28 stations. After the FFGA was signed, a group called People for Efficient Transportation filed a suit in U.S. District Court for the Northern District of California. The group said that there was not enough consideration of modal alternatives, specifically a busway. They requested an injunction against any construction or expenditures for the Guadalupe corridor facility. This lawsuit delayed the project for almost 24 months.

Opening to Service

The first 10 miles of the LRT system opened in May 1988. The Guadalupe Corridor was completed in April 1991.

Project Scope

The scope of the Guadalupe Corridor LRT remained relatively stable throughout planning and project development. Slight variations in the length of the proposed alignment are evident, particularly near the proposed single track spur on the Lick Branch right-of-way at the southern end of the line.

The downtown transit mall envisioned three stations in addition to the ones listed in the planning documents, but this project was planned and funded separately from the Guadeloupe line.

There is no documentation on the number of parking spaces actually built in the initial project. The planning documents note that initial parking capacity will be determined by demand and lots will be expanded to accommodate future needs up to a maximum of 6410 spaces at 10 stations.

Table 85: Project Scope - San Jose Guadalupe Corridor LRT

	DEIS	FEIS	FFGA	As-built
Length				
at grade	20	19.7	20	20
Stations				
at grade	28	28	28	28
Trackage				20
single		1.3	1.6	
double	20	18.4	18.4	
Parking Spaces	not stated	up to 6410	not stated	not known
Vehicles				
rail	50	50	50	50
Facilities	not stated			
shops/yards		1	1	1

Service Levels

Service levels are most likely in line with the headways envisioned in the planning documents. While the AA/DEIS and FEIS do not specifically state the planned headways, the assumed need for 50 vehicles implies a minimum headway of 10 minutes assuming 4 car trains in the peak and 120 minute cycle times. The span of service is somewhat longer than assumed in the planning studies.

Table 86: Service Level - San Jose Guadalupe Corridor LRT

	MIS/AA/ DEIS	FEIS	Actual
Forecast Year	1990	1990	NA
Span of Service			
Weekday	5:00 AM – 12:00 PM	5:00 AM – 12:00 PM	4:45 AM – 2:00 AM
Frequency of Service			
Pk Hr Headway	not stated	not stated	10 min
Pk Period Hdwy	not stated	not stated	10 min
Mid-Day Hdwy	not stated	not stated	10 min
Evening Hdwy	not stated	not stated	15-30 min
Weekend Hdwy	not stated	not stated	15-30 min
Operating Statistics			
Annual Veh Miles	2,600,000	2,600,000	2,086,000
Annual Veh Hours	130,000	130,000	133,600
Fleet Reqs	50	50	36
Fare	not stated	not stated	1.40

Note: Actual data from Data Tables, 1992 Section 15 Report Year

Ridership

Actual ridership on the Guadalupe Corridor LRT was been approximately ½ of the projected ridership after opening the full project. The forecast year for the ridership estimates in the planning studies is actually one year before the entire line opened for revenue service. In 1992, the first full year of operation, average weekday boardings were approximately 48 percent of the 1990 forecasts. Solid growth in ridership during the last half of the 1990's brought average daily ridership up to 62 percent of the 1990 forecast.

Table 87: Predicted and Actual Ridership - San Jose Guadalupe Corridor LRT

	Project- Average Weekday Boardings	System-wide		Forecast Year
		Rail System Boardings	Total Transit Boardings	
Predicted				
AA/DEIS	41,200	41,200	273,400	1990
FEIS	41,200	41,200	273,400	1990
Actual				
1990	7,974	7,974	163,478	
1991	12,797	12,797	155,289	
1992	19,738	19,738	169,338	
1993	20,155	20,155	179,925	
1994	19,735	19,735	148,127	
1995	18,095	18,095	148,485	
1996	19,959	19,959	159,718	
1997	21,963	21,963	172,187	
1998	22,689	22,689	173,226	
1999	22,487	22,487	176,595	
2000	20,602	25,576	177,056	
2001	24,791	30,383	183,091	
2002	21,035	25,573	170,396	

Capital Costs

The project over-ran the AA/DEIS cost estimate by almost 50 percent. The capital cost estimated for the FEIS was $296.7 million in 1983 dollars with an estimate of escalation over a construction period to 1989 resulting in an estimated capital cost of $382 million in year-of-expenditure dollars. This estimate proved to be on target, due in part to overestimation of the actual rate of inflation in construction costs. Adjusted for inflation, the actual project cost is within 20 percent of the FEIS estimate very close to the FFGA amount.

Table 88: Predicted and Actual Capital Costs - San Jose Guadalupe LRT

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/ DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$189.3 (1983 $)	$296.7 (1983 $)	$371.9 (1984 $)	$380.3	201%	128%	102%
		$382.0 (year-of-expenditure)				100%	
Adjusted to Const. Midpoint (1987 $)	$257.7	$321.5	$395.2	$380.3	147.6%	118.3%	96.2%

Operating Costs

Light Rail was not operated in Santa Clara County at the time the AA/DEIS or FEIS projections of operating costs were developed. The planners based the estimates on "…unit cost values derived from data relating to similar systems elsewhere and manpower estimates for the specified operations plan and services levels proposed." The service, as operated is similar to the service as planned. Annual car hours are slightly less than anticipated while car-miles are about 80 percent of planned.

The operating and maintenance costs actually incurred in operating the service exceed the estimates. In part this is due to the general increase in the unit costs of transit operations in Santa Clara County between the years in which the estimates were prepared and opening year. The remainder of the discrepancy likely relates to underestimation of the unit costs for specific elements of the operating costs.

Table 89: Predicted and Actual Operating Costs - San Jose Guadalupe LRT

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS (1980 $)	FEIS (1983 $)	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$8.8	$9.5	NA	$19.2	219%	203%	NA
Adjusted to year of opening (1991 $)	$10.9	$13.7	NA	$19.2	177%	141%	NA

As-built cost from 1992 Section 15 Annual Report, pp. 2-93. Cost reported for Fiscal Year ending between 1/1/92 and 12/31/92.

Assessment of Predicted vs. Actual Ridership and Costs

The Guadalupe Corridor was the first light rail service planned or implemented in Santa Clara County. Ridership has lagged behind the forecasts for 1990. As an initial system, the forecasts were developed without the benefit of experience. More detailed analysis would be required to identify the precise sources of the error.

The capital cost for constructing the line adhered quite closely to the nominal dollar estimates prepared after the completion of preliminary engineering and reported in the FEIS. The operating costs have proved to be significantly higher than estimated.

San Diego El Cajon Extension

Description

The San Diego El Cajon project extends the East Urban Corridor LRT from Euclid Avenue to El Cajon. The project was intended to add transportation capacity in a congested corridor that was expected to experience very rapid growth in population and employment. Existing transit services were at or near capacity and bus service was degraded by roadway congestion in the corridor. The project added new transportation system capacity using an existing (and operating) freight railroad corridor and replaced existing express bus service in the corridor with higher performance and higher capacity LRT service.

Project Development

System Planning

Public transportation planning in the San Diego area began in the early 1970s. In 1973, the Comprehensive Planning Organization (now San Diego Association of Governments) tested a variety of regional transit alternatives. In 1974, the organization initiated three other major planning efforts. One program recommended a 59-mile system of high level of service transit corridors for the metropolitan area. During this time, the County of San Diego investigated light rail alternatives, focusing on the cost differentials and operational trade-offs among light rail and other modes. The City of San Diego also analyzed Centre City transportation alternatives. The study's outcome recommended pursuit of a major activity center shuttle system for Centre City, and culminated in an application for state planning funds. In 1976, state legislation created the Metropolitan Transit Development Board (MTDB).

In January 1980, construction of the LRT system began. The 16-mile first increment, extending from Centre City San Diego to the International Border at San Ysidro, opened for revenue service in July 1981. After completing the South Line, attention turned to the East Urban Corridor. After review of travel needs and the ease of implementing improvements, the MTD Board selected the East Urban corridor as the next priority corridor in March 1981.

The MTDB developed sub-corridors within the East Urban Corridor and evaluated each sub-corridor's transit potential, service to major activity areas, costs, environmental impacts, and ease of implementation. MTDB selected the East Urban Corridor and the SR 94/SD&AE sub-corridor for more detailed study. MTDB chose this corridor because of the availability of right-of-way, and because it met the goals set forth by the MTDB and the needs of the population in the area.

In 1984, MTDB began implementing the first 4.5-mile extension from the South Line Imperial Station to Euclid Avenue (Euclid LRT Project) with state and local funds. The project did not rely on any federal funds. The next phase of the East Urban Corridor project focused on the extension of the Euclid project east to El Cajon.

Alternatives Analysis

The alternatives evaluated for the LRT to El Cajon provide service from Euclid eastward between 11 and 14.4 miles. MTDB completed the Alternatives Analysis/Draft Environmental Impact Statement (AA/DEIS) in February 1985. At the end of the AA/DEIS process, MTDB selected the LRT-El Cajon alternative as the locally preferred alternative. This alternative was primarily single track with sidings, approximately 11 miles long, and included eight stations.

Preliminary Engineering

The project began preliminary engineering in October 1982 and initiated the Environmental Impact Statement in August of 1983. During PE, the project expanded from a single track, 8 station line with sidings to a project with five miles of single track and 6.1 miles of double track and 8 stations. The FEIS for the project was approved by UMTA in September of 1986.

Final Design and FFGA

During final design, the percentage of single track continued to decline. The FFGA, signed in November 1986, calls for 6.8 miles of double track and 4.4 miles of single track construction for 11.2 miles with two bridges, and eight stations. Groundbreaking for the project took place in March, 1987. During construction, the MTDB decided to double track almost the entire length of the extension to gain maximum operational flexibility and performance. This expansion in scope was funded locally.

Opening to service

The project opened for revenue service in June, 1989, approximately one month ahead of schedule.

Project Scope

Throughout project development, the project continually increased the proportion of double track until only a very small portion of the actually constructed project was single track. The decision to double track almost all of the line was made during construction and funded locally.

Table 90: Project Scope - San Diego El Cajon Extension

	DEIS	FEIS	FFGA	As-built
Length				
at grade	11	11.1	11.2	11.1
Stations				
at grade	8	8	8	8
Trackage				
single	11	5	4.4	0.3
double		6.1	6.8	10.8
Parking Spaces				
surface	1500	1500	1500	1500
Vehicles				
rail	15	15	15	15
Facilities				
shops/yards	expand existing	not stated	expand existing	expand existing

Service Levels

The service levels specified in the planning studies were very similar to the actual operations today. The frequencies match the DEIS/FEIS planned frequencies, but the hours of operation are significantly longer than the span of service proposed in the planning studies. The project operates over an active freight rail corridor, so the limited hours of operation were probably the result of the need to accommodate freight traffic and temporal separation of track usage.

Table 91: Service Levels - San Diego El Cajon Extension

	MIS/AA/ DEIS	FEIS	Actual
Forecast Year	2000	2000	NA
Span of Service			
Weekday	6:00 AM-9:00 PM	6:00 AM-9:00 PM	4:45AM-1:30AM
Frequency of Service			
Pk Hr Headway	15 min	15 min	15 min
Pk Period Hdwy	15 min	15 min	15 min
Mid-Day Hdwy	15 min	15 min	15 min
Evening Hdwy	30 min	30 min	30 min
Fare	not stated	not stated	1.25-2.50

Ridership

The ridership forecasts developed during project planning for the San Diego El Cajon Extension have proven to be quite close to actual ridership. Average weekday boardings in 2000 exceeded the forecasts for 2000 by nine percent.

The system-wide forecasts also proved to be conservative. Actual LRT boardings exceeded the forecasts by 60 percent, while total system-wide transit boardings exceeded the forecasts by seven percent. However, the forecasts were prepared assuming a rail system that was about 13 miles shorter than what was actually constructed by 2000. Nevertheless, the growth in LRT boardings in San Diego during the 1990's and early 2000's was exceptionally rapid compared to other regions.

Table 92: Predicted vs. Actual Ridership - San Diego El Cajon Extension

	Project -Average Weekday Boardings	System-wide		Forecast Year
		Rail System Boardings	Total Transit Boardings	
Predicted				
AA/DEIS	21,600	53,180	317,110	2000
FEIS	21,600	53,180	317,110	2000
Actual				
1998	22,020	66,654	300,567	
1999	22,512	69,103	307,804	
2000	23,478	83,474	322,744	
2001	24,304	100,228	333,040	
2002	24,950	90,532	321,038	

Note: System-wide ridership reported for San Diego Regional Transportation Services, San Diego Transit Corp, North San Diego Transit Development Board, San Diego Trolley, and the San Diego Metropolitan Transit Development Board.

Capital Costs

This project, the extension of a recently built light rail line, moved relatively rapidly through the planning and project development process. The difference between the estimated capital costs expressed in year-of-planning dollars and the cost escalated to midpoint-of-construction are relatively small. Enhancements made following the FFGA signing, with no federal participation, included additional double tracking, a portion of the cost of a roadway bridge, a grade separation and a state required contingency. With these enhancements included, the project budget was $108.1 million compared to the as-built cost of $102.7 million. The actual cost of the project components specified in the FFGA was $93.3 million, or about $4.6 million less that the FFGA budget. The capital cost of the project, as-built, was also less than the estimates prepared in the early stages and within 5 percent of the nominal dollar FFGA amount.

Table 93: Predicted and Actual Capital Costs - San Diego El Cajon Extension

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$105.6 (1983 $)	$105.6 (1983 $)	$97.9 (1986 $)	$102.7	97%	97%	105%
Adjusted to Const. Midpoint (1987 $)	$114.4	$114.4	$100.4	$102.7	89.7%	89.7%	102.3%

Operating Costs

The operating plan that was the basis for the operating cost estimates in the DEIS and FEIS studies was constrained due to the expectation of single track operation and the need to maintain temporal separation from freight operations. The service as operated has a longer service span than used in the planning data. Nonetheless, the as-built operating cost, estimated from NTD data, is within 10 percent of the nominal dollar cost estimates. The estimated as-built O&M cost, adjusted for inflation in transit operating costs, is 6 percent less that projected even with the added service.

Table 94: Predicted and Actual Operating Costs - San Diego El Cajon Extension

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$3.9 (1983 $)	$3.9 (1983 $)	NA	$4.2	108%	108%	NA
Adjusted to year of opening (1989 $)	$4.4	$4.4	NA	$4.2	94%	94%	NA

Assessment of Predicted vs. Actual Ridership and Costs

The El Cajon project was the extension of a existing line that in itself represented the expansion of an existing LRT system. LRT construction in the San Diego area had been underway for several years prior to the start of planning for the El Cajon segment and the initial segment had been in operation for several years prior to preparation of the DEIS and FEIS. This experience, in not only capital and operating costs but also in ridership response, was applied to the planning for the El Cajon line. All the planning forecasts have proven to be very accurate.

Downtown Seattle Transit Project

Description

The Downtown Seattle Transit Project was implemented to address congestion problems in Downtown Seattle. The city was experiencing street circulation problems as downtown development grew more intense in the late 1970's. Since Downtown Seattle has only five North-South streets to channel traffic, the decision to build a tunnel to carry bus traffic was made. The tunnel is a 1.3 mile "L" shaped route through the center of Downtown Seattle and includes 5 stations making use of dual mode diesel/electric buses that allow passengers a one-seat ride into the tunnel.

Project Development

System Planning

In 1981, Metro, the Seattle region's transit agency, adopted the 1990 Plan, which called for creating a network of transit centers throughout King County. Although the plan did not define the precise improvements that should be made, it did discuss the possibility of a tunnel in downtown Seattle.

Alternatives Analysis

In 1983, the Seattle City Council and then the Metro Council each adopted preferred alternatives that included an electric vehicle tunnel. The DEIS, completed in March 1985, evaluated five alternatives including a 1.3-mile tunnel using electric and diesel buses. The tunnel would be under Third or Fourth Avenues and be of cut and cover and bored construction.

Preliminary Engineering

Local officials refined the preferred alternative, proposing in the FEIS a 1.3-mile L-shaped tunnel under Third Avenue constructed by the bored method. The Pine Street segment and station areas would be constructed by the cut and cover method. The transit/pedestrian mall concept evolved into wider sidewalks and other improvements on Third Avenue and Pine Street along with a better circulator system for moving people around downtown. General traffic would still use Third and Pine streets in the FEIS description.

Final Design and FFGA

The FFGA was executed in May 1986. The FFGA called for a 1.3-mile tunnel under Third and Pine streets. Dual-mode buses were to operate under diesel power outside the tunnel and would convert to electric power inside the tunnel. There were to be two portal stations and three underground stations in between. Earlier plans for a portion of the CBD circulator system, surface improvements on Third Avenue and Pine Street were eliminated from the project.

Opening to Service

The project opened to revenue service on September 15, 1990, approximately four months ahead of the schedule in the FFGA.

Project Scope

The DEIS notes that up to 500 new buses will be procured for any chosen alternative. The bus tunnel would require dual propulsion buses at additional cost so that the buses would not produce exhaust in the tunnel. However, the costs of dual propulsion buses were not included in the cost-estimates. The reasoning for excluding bus costs is not clear. The incremental cost of buying dual mode buses rather than diesel was about $70 million.

The FEIS states that 490 dual mode buses would be procured by 1995. Again, bus costs are not included in the capital cost estimates. The FFGA states that the initial 236 dual mode buses will be procured with formula funds outside the scope of the FFGA.

Seattle Metro installed LRT rails in the roadbed of the tunnel to prepare for future conversion to LRT operation. This was funded under a separate UMTA grant outside the scope of the FFGA project.

Table 95: Project Scope - Downtown Seattle Transit Project

	DEIS	FEIS	FFGA	As-built
Length	1.3	1.3	1.3	1.3
underground	1.3	1.3	1.3	1.3
Stations	5	5	5	5
at grade	2	2	2	2
underground	3	3	3	3
Lanes				
double	1.3	1.3	1.3	1.3
Parking Spaces	not stated		not stated	0
structure		see note		
Vehicles				
bus	500*	490	236**	236
Facilities				
control center	1	1	1	1

Note: The FEIS states that the decking over the two portal stations could be used for parking.

Service Levels

The peak period and midday headways approximate the levels proposed in the DEIS and FEIS. While the hours of service of the tunnel is much less than originally envisioned, bus service on surface streets continues at uncongested times.

Table 96: Service Levels - Downtown Seattle Transit Project

	MIS/AA/ DEIS	FEIS	Actual
Forecast Year	1990	1990	NA
Span of Service			
Weekday	not stated	4:00 AM – 2:00 AM	5:00 AM – 7:00 PM
Saturday (Closed Sunday)	not stated	not stated	10:00 AM – 6:00 PM
Frequency of Service			
Pk Hr Tunnel Headway	not stated	80-120 sec	90 sec
Pk Period Tunnel Headway	not stated	2 min	2 min
Midday Tunnel Headway	not stated		4 min
Weekend Hdwy	not stated	7.5-30 min	5-7 min
Operating Statistics			
Peak Hr Surface Bus Reqs	288*	393	unknown
Peak Hr Tunnel Bus Reqs	360	290	236
Annual Bus Hours (System wide)	3,127,000	3,147,000	unknown
CBD Capacity/hr (Surface + Tunnel)	43,000	43,000	unknown
Tunnel Capacity/hr	18,000	18,000	unknown

Ridership

Ridership data for the Downtown Seattle Transit Project cannot be reconciled with the planning estimates. The AA/DEIS and FEIS only report ridership forecasts for peak hour CBD trips (tunnel and surface) and annual system-wide boardings. It is not possible, from the planning documents, to determine a forecast value for average daily boardings for only the tunnel stations.

The only ridership forecast that can be compared to actual ridership is system-wide annual boardings. Actual system-wide ridership was 13.7 percent below the AA/DEIS forecast and about 10 percent below the FEIS forecast.

Table 97: Predicted and Actual Ridership - Downtown Seattle Transit Project

	Project - Average Weekday Boardings	System-wide		Forecast Year
		Average Weekday Boardings	Annual Boardings	
Predicted				
AA/DEIS	NA	NA	90,600,000	1990
FEIS	NA	NA	86,700,000	1990
Actual				
1989		250,879	74,387,616	
1990	6,600	263,134	78,109,409	
1991	27,800	263,216	77,803,690	
1992	31,500	267,933	80,954,213	
1993	33,800	271,166	80,466,108	
1994	33,600	265,494	79,253,072	
1995	34,100	269,578	80,325,997	
1996	36,400	288,913	87,304,870	
1997	39,900	307,765	93,006,895	
1998	47,100	300,196	90,376,175	
1999	49,000	320,325	95,876,742	
2000	47,400	330,929	99,295,852	
2001	44,400	340,105	101,000,283	

* Note: average daily boardings at the five tunnel stations.

Capital Costs

Initial estimates of capital costs prepared for the AA/DEIS, even adjusted for inflation in construction costs, underestimated actual costs by about 60 percent. The estimates, adjusted for inflation, improved as design progressed. The cost estimate in the 1987 FFGA underestimated the actual costs by just under 20 percent.

Table 98: Predicted and Actual Capital Costs - Seattle Bus Tunnel

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$288.3 (1983 $)	$334.6 (1984 $)	$395.4 (1987 $)	$468.7	163%	140%	119%
Adjusted to Const. Midpoint (1988 $)	$299.6	$348.7	$400.0	$468.7	156.5%	134.4%	117.2%

Operating Costs

The FEIS projected a saving in transit operating and maintenance costs of $4.4 million dollars per year (1984 $) compared to the no-action alternative. The total, system wide transit operating and maintenance costs projected for the year 2000, in 1984 $, were $150.9 million. This assumed 3,149,000 annual bus hours in 2000; an increase of roughly 700,000 hours per year in system wide bus operations. Reported annual hours for Motor Bus and Trolley Bus in 1990 were 1,839,000. The sum of Motor Bus and Trolley Bus operating costs, plus an allocated share of Joint Expenses, reported for 1990 in the NTD was $162.8 million. The comparable figure for 1989 was $148.3 million.

From the available data the accuracy of the project operating costs or operating cost savings cannot be determined.

Table 99: Predicted and Actual Operating Costs - Seattle Bus Tunnel

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS (198x $)	FEIS (1984 $)	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	NA	$ -4.4	NA.	NA	NA	NA	NA
Adjusted to year of opening (1990 $)	NA	$ -7.3	NA.	NA	NA	NA	NA

Assessment of Predicted vs. Actual Ridership and Costs

System-wide transit ridership at the time of the opening of the bus tunnel in 1990, was about seven percent below projections. By 1996, the system-wide ridership exceeded the estimate for 1990. Ridership directly related to the bus tunnel project cannot be determined.

Similarly, operating cost increase or savings resulting from operations in the tunnel cannot be separated from system-wide operations.

Capital cost estimates for the project improved as design progressed, but significantly underestimated actual costs.

Salt Lake City North/South Light Rail Transit Line

Description

The North/South LRT Line runs 15 miles south from the Salt Lake City CBD to the suburban community of Sandy. The Salt Lake Light Rail Project was intended to address traffic congestion along I-15, the predominant North-South freeway in Salt Lake City, and surrounding arterials.

Project Development

System Planning

During the early 1970's, local concern regarding energy use, the environment, congestion, and mobility for transit dependent individuals prompted a series of studies aimed at reversing the long run decline in transit patronage. The updated Transportation Plan for Salt Lake City reduced the number of new arterials and collectors and assumed a major expansion in transit usage, without specifying how that was to be accomplished.

In the mid 1980's, the Wasatch Front Regional Council identified the I-15/State Street Corridor as the highest priority for consideration of a major transportation investment in the Salt Lake Valley. Planning for the project began in 1984 with the I-15/State Street Corridor studies. The final recommendation of the Phase I study was to select a few multimodal alternatives for detailed definition and evaluation in an AA/DEIS initiated in 1986.

Alternatives Analysis

The I-15/State Street Corridor Alternatives Analysis and Draft Environmental Impact Statement (AA/DEIS), completed in February 1990, considered 12 alternatives. They included the integration of improved bus service, a light rail line, high occupancy vehicle lanes and combined improvements to I-15. The LPA included a light rail line along an existing right-of-way, an expanded bus system, an east-west bus feeder system, the addition of four lanes (two in each direction) on I-15 and improvements to I-15 interchanges. The participating local, state and federal agencies agreed the subsequent preliminary engineering and environmental documents would be done separately by the Utah Department of Transportation with FHWA for the I-15 improvements and by Utah Transit Authority with FTA for the transit improvements.

Preliminary Engineering

The original LPA did not include a preferred Salt Lake City CBD alignment for the transit element of the LPA. The agencies deferred that decision to the preliminary engineering phase of the project. In November 1992, voters turned down a sales tax referendum that would have provided the local share of the project as originally defined. UTA began contemplating changes to the project and financing plan. In April 1994, a Supplemental Environmental Impact Statement (SDEIS) was prepared to evaluate alternative CBD alignments, station sites, southern terminus locations and yard and shop facilities and included an updated financing plan for the project. In June 1994, the UTA selected preferred facilities from among the alternatives considered, resulting in a revised transit LPA. The UTA completed the FEIS in September 1994.

Final Design and FFGA

FTA signed a record of decision in November 1994. UTA and FTA entered into an FFGA in August 1995.

Opening to Service

Revenue operations began in December 1999, approximately one year ahead of the scheduled revenue operations date of December 31, 2000.

Project Scope

The scope of the project was reduced slightly in the FFGA and during construction. One station listed in the FFGA, 2700 South, was not constructed. The FFGA also called for a "mixture of single and double track" while the planning studies assumed double track over the full alignment. The project was completed under the budget provided in the FFGA, with only two bridges (combined length of approximately 475 feet) and a half- mile long access track, from the main line to the rail maintenance and storage facility, being single tracked.

Table 100: Project Scope – North/South LRT Line

	DEIS	FEIS	FFGA	As-built
Length				
at grade	15-17.1	15	15	15
Stations				
at grade	14-20	17	17	16
Trackage			15*	15
single				.01
double	15-17.1	15		14.99
Parking Spaces				
surface	3,450	980-1,715	not stated	2,158
Vehicles				
rail	16 to 18 +spares	18+spares	21	28
Facilities				
shops/yards	1	1	1	1
control center				

* The FFGA is not specific about the mix of single and double track.

Service Levels

Peak hour frequencies on the North/South LRT Line are lower than the frequencies cited in the planning studies (the SDEIS proposed a phased implementation and lower initial service). Initially the project opened with some 10 minute peak hour service, but UTA found the consistent headway better fit with the existing bus service. Table 101 summarizes the North/South LRT Line service levels as planned and actually operating. The horizon year for the planning studies was 2010, so increases in service levels to accommodate growing demand may bring future service levels closer to planned levels.

Table 101: Service Levels - Salt Lake North/South LRT

	MIS/AA/ DEIS	SDEIS	FEIS	Actual
Forecast Year	2010	2010	2010	NA
Span of Service				
Weekday	6:00 AM-12:00 PM	not stated	5:30 AM-12:00 PM	5:00 AM -12:00 PM
Frequency of Service				
Pk Hr Headway	10 min	10 min	10 min	15 min
Pk Period Hdwy	10 min	10 min	10 min	15 min
Mid-Day Hdwy	20 min	20 min	20 min	15 min
Evening Hdwy	20 min	20 min	30 min	20 min
Weekend Hdwy	20 min	20 min		15 min Sat 20 Min Sun
Fare	1.00	not stated	not stated	1.00

Ridership

Actual ridership on the Salt Lake Light Rail Project has come fairly close to predicted levels, even though the forecast year is 7 years (as of 2003) in the future. Predicted ridership was scaled back as the project's opening approached, with the highest forecast produced during Alternatives Analysis.

Table 102: Predicted and Actual Ridership – Salt Lake North/South LRT

	Project -Average Weekday Boardings	System-wide		Forecast Year
		Rail System Boardings	Total Transit Boardings	
Predicted				
AA/DEIS	26,500	26,500	98,100	2010
SDEIS	23,000	23,000	90,100	2010
FEIS	23,000	23,000	96,800	2010
FEIS opening year	14,000	14,000		1999
Actual				
1998			84,692	
1999	25,900*	25,900*	84,692	
2000	19,458	19,458	98,124	
2001	19,400	18,964**	101,003**	
2002	22,100	30,451	109,300	

* North/South Line opened December 1999
** University Line opened December 2001

Capital Costs

Capital cost estimates for the DEIS and FEIS included construction related activities and right-of-way. The FFGA estimate for construction was $191 million in 1992 dollars. Escalated to the mid-point of construction, about 1997, the comparable cost was $269 million. Added to this were financing costs of $25 million and railroad right-of-way cost of $18.5 million, both in escalated dollars. The $256 million FFGA cost reported below represents the nominal dollar amount $312.5 million de-escalated to 1992 dollars based on the Salt Lake City area Engineering News Record Construction Cost Index. Adjusted for actual inflation, as-built project costs were very close to the AA/DEIS estimate and the FFGA and about 20 percent more than the FEIS estimate.

Table 103: Predicted and Actual Capital Costs – Salt Lake North/South LRT

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$231.1 (1987 $)	$210.4 (1992 $)	$256.3 (1992 $)	$298.5	129%	142%	116%
Adjusted to Const. Midpoint (1997 $)	$305.6	$245.9	$299.5	$298.5	97.7%	121.4%	99.7%

Operating Costs

The service, as operated, provides a less frequent peak service but a more frequent midday service than was assumed in the planning studies. The operating cost for the first full year of operation, based on the National Transit Database, was quite close to the costs estimated for the AA/DEIS, adjusted for general inflation in transit operating costs, and somewhat less than the adjusted FEIS cost estimate. The actual cost was, in nominal dollars, within 10 percent of the FEIS estimate.

Table 104: Predicted and Actual Operating and Maintenance Costs – Salt Lake North/South LRT

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$4.8 (1987 $)	$6.9 (1992 $)	NA	$7.4	153%	107%	NA
Adjusted to year of opening (1999 $)	$7.6	$9.7	NA	$7.4	96%	76%	NA

Assessment of Predicted vs. Actual Ridership and Costs

Ridership on this project has grown to over 80 percent of the 2010 forecasts in the AA/DEIS. Even slow ridership growth of one percent would enable this project to meet its FEIS ridership forecasts, though annual ridership will need to grow at an annual rate of over two percent to achieve the AA/DEIS forecast. Service levels lag significantly behind the levels assumed in the ridership forecasts. The ridership forecasts have proven to be quite accurate, especially considering this project is the first rail line constructed in Salt Lake City and little actual experience was available when the forecasts were developed. If frequencies are improved in subsequent years, achieving even the AA/DEIS ridership forecasts would appear to be within reach.

The capital cost estimates proved close to the amounts actual expended due, in part, to an actual inflation of construction costs less than had been assumed. Actual operating costs are consistent with the original estimates.

St. Louis Metrolink Light Rail Project

Description

The St. Louis Metrolink LRT project was intended to improve public transit service by increasing the speed, comfort and reliability of transit and to increase accessibility to the major activity centers of Downtown St. Louis and East St. Louis, stadiums, and the Airport. The project is 18 miles long, predominantly grade separated, and makes extensive use of existing railroad right-of-way including a tunnel through Downtown St. Louis.

Project Development

System Planning

Local officials began a systems analysis in 1981 to help set priorities for transit improvements in four key regional corridors. As a result, officials selected the East St. Louis, St. Louis CBD, Clayton, and Lambert-St. Louis International Airport corridor as the priority corridor for further detailed study. (DEIS, 1-13)

Alternatives Analysis

The East-West Gateway Coordinating Council (EWGCC), the MPO for the St. Louis area, completed an Alternatives Analysis/Draft Environmental Impact Statement in May 1984. EWGCC selected the LRT alternative with bus service to Clayton as the LPA. The LPA, as described in the draft and final EIS documents, consists of 18 miles of LRT extending from East St. Louis, Illinois through downtown St. Louis to Lambert-St. Louis International Airport. The shuttle bus component of the LPA was to connect the St. Louis Galleria plus the County Government Center in Clayton and points in between to the LRT alignment. Twenty stations were planned.

Preliminary Engineering

EWGCC completed the FEIS in September 1987. EWGCC carried the project through preliminary engineering, then transferred responsibility to the Bi-State Development Agency, the area's transit agency, for final design.

Final Design and FFGA

The FFGA, awarded in 1988, called for 18 miles of light rail with 18 to 20 stations. However, according to the FFGA, two of those stations (East Riverfront and Airport) may be substantially delayed or altered as a result of efforts to create a new master plan for the airport. The FFGA called for the project to be complete by July 1993.

Construction began in May 1990. Also in 1990, the local airport authority and FAA informed Bi-State and FTA that the Metrolink alignments to the airport and to Berkeley conflicted with airport expansion plans. To avoid such conflicts and accomplish the project purpose of reaching the airport, Bi-State revised the Metrolink alignments in the airport area by extending the main line and terminus to the airport's main terminal and reducing the Berkeley line to a spur. The realignment also required the acquisition of a number of additional parcels. Originally configured to bypass the Washington Park cemetery, the LRT was constructed on an easement through the cemetery that required the reburial of about 2,500 remains.

Opening to Service

Revenue operation began July 31, 1993, with 16 stations. In 1994, the East Riverfront Station opened as well as the connection to the Lambert Airport Main Terminal. However, even after realignment, the Berkeley spur still conflicted with airport expansion plans and the spur was deleted from the FFGA in 1995. In 1998, the Airport East Station opened.

Project Scope

The St. Louis Metrolink Phase 1 project remained roughly the same scope throughout planning and project development. The main changes during project development were reductions in the number of stations and design and alignment variations for the segment that provides direct access to Lambert – St. Louis International Airport.

Table 105: Project Scope - St. Louis Metrolink Phase 1

	DEIS	FEIS	FFGA	As-built
Length	18	18	18	18
Stations	24-25	20	20	19
at grade				15
underground				2
elevated				2
Trackage	18	18	18	18
single	1	1.1		
double	17	16.9		
Parking Spaces	not stated		not stated	
surface		1924		2583
Vehicles				
rail	not stated	31	31	31
Facilities				
shops/yards	1	1	1	1
control center	not stated	not stated	not stated	not stated

Service Levels

Actual headways are within the range of headways reported in the planning documents, while the span of service is longer than suggested in the planning documents.

Table 106: Service Levels - St. Louis Metrolink Phase 1

	MIS/AA/ DEIS	FEIS	Actual
Forecast Year	1995	2000	NA
Span of Service			
Weekday	6:00 AM – 1:00 AM	5:30 AM – 1:00 AM	4:45 AM – 1:00 AM
Frequency of Service			
Pk Hr Headway	5-10 min	5-10 min	7-9 min
Pk Period Hdwy	5-10 min	5-10 min	7-9 min
Mid-Day Hdwy	12-30 min	15-30 min	10 min
Evening Hdwy	12-30 min	15-30 min	15-30 min
Weekend Hdwy	not stated	not stated	15-30 min
Operating Statistics			
Fleet Vehicle Reqs (System)	not stated	31	31
Peak Veh Reqs (System)	not stated	24	24
Fare	not stated	not stated	1.25

Ridership

Actual ridership for the St. Louis Metrolink Phase 1 project came quite close to the forecasts. The actual ridership came in about 11 percent less than predicted in the AA/DEIS, while actual ridership exceeded the FEIS forecast by almost 12 percent.

Table 107: Predicted and Actual Ridership - St. Louis Metrolink Phase 1

	Project - Average Weekday Boardings	System-wide		Forecast Year
		Rail System Boardings	Total Transit Boardings	
Predicted				
AA/DEIS	41,800	41,800	174,500	1995
FEIS	37,100	37,100	241,100	2000
Actual				
1993			137,589	
1994	26,796	26,796	163,713	
1995	37,045	37,045	166,188	
1996	37,249	37,249	162,919	
1997	42,572	42,572	170,500	
1998	41,867	41,867	172,958	
1999	43,711	43,711	170,575	
2000	41,454	41,454	166,059	
2001 – St. Clair opens	41,196*	42,381	163,452	
2002	38,743**	44,310	152,574	

*Represents system average weekday adjusted for the May and June average weekday ridership for the St. Clair extension. The extension was only open for two months which minimized its annual impact.
**Represents average annual weekday boardings including the St. Clair extension. Ridership in 2002 was impacted by a system-wide fare increase and a bus service reduction effective October 2001.

Capital Costs

The cost estimate reported in the AA/DEIS, when adjusted for inflation, was about 20 percent lower than the reported final construction cost. The FEIS estimate was lower in nominal dollars and even lower in real dollars, resulting in actual costs exceeding the estimates by over 30 percent. The FFGA signed in 1988 appears to have reflected available funds rather than the best estimate of project costs. Subsequent modifications brought the FFGA amount to within 20 percent of the final cost and, ultimately, matched the final cost.

Table 108: Predicted and Actual Capital Costs - St. Louis Metrolink LRT

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA (Year of signing $)	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$276.2 (1983 $)	$262.8 (1984 $)		$464.0	168%	177%	
10/5/1988			$199.3				233%
3/28/1990			$288.0				161%
9/23/1991			$362.2				128%
4/21/1992			$383.4				121%
11/18/1992			$435.8				106%
3/23/1994			$455.9				102%
1/15/1995			$464.0				100%
Adjusted to Const. Midpoint (1994 $)	$379.7	$346.5	$455.8	$464.0	122.2%	133.9%	101.8%

Operating Costs

Operating costs projected for the AA/DEIS is 1984, when adjusted for local inflation in the cost of providing transit service, were within 2 percent of the operating cost for the first year of full system operation.

Table 109: Predicted and Actual Operating Costs - St. Louis Metrolink LRT

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS (1983 $	FEIS (1994 $)	FFGA (1995)	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$10.2	$9.1	NA	$11.5	113%	126%	NA
Year 1993 $	$11.3	$10.0	NA	$11.5	102%	114%	NA

Assessment of Predicted vs. Actual Ridership and Costs

Ridership on the initial MetroLink line has met expectations. In the forecast year, ridership was approximately 11 percent short of the AA/DEIS forecast, which is within a reasonable range of error. Subsequent years have seen this forecast exceeded. The slightly lower FEIS forecast for 2000 has been exceeded in most years, though system-wide ridership for this forecast have proven to be optimistic. Ridership on MetroLink peaked in 1999 when ridership exceeded the AA/DEIS forecast by 5 percent. Recent economic trends appear to have caused an erosion of ridership system-wide.

Operating costs for the line are only slightly greater than projected; well within the range that would be expected.

Capital costs are more difficult to track. Adjusted for actual inflation in construction costs, the as-built cost is about 20 over the original AA/DEIS estimate. There is a greater variance from the FEIS estimate and the initial FFGA.

St. Clair County MetroLink Extension Project

Description

The primary transportation problem in the St. Clair corridor is congestion on the Mississippi River bridges between East St. Louis and Downtown St. Louis. The St. Clair extension seeks to increase use of public transit, reduce congestion, and spur economic development in a relatively low income area. The project is comprised of a 17-mile, eight station light rail extension from Downtown East St. Louis to Belleville.

Project Development

System Planning

Local officials began a systems analysis in 1981 to help set priorities for transit improvements in four key regional corridors. As a result, officials selected the East St. Louis, St. Louis CBD, Clayton, and Lambert-St. Louis International Airport corridor as the priority corridor for further detailed study. Following the DEIS and FEIS process, local officials selected light rail as the LPA. The initial line of the MetroLink Light Rail Project opened in July 1993. The Metro Link connection to Lambert Airport Main Terminal and the East Riverfront Station opened in June 1994.

Regional planners had identified the St. Clair County transportation corridor as the second major priority corridor (after the East St. Louis to Lambert Airport corridor) for a major transit investment.

Alternatives Analysis

The region's MPO, the East West Gateway Coordinating Council (EWGCC), chose the CSXT LRT alternative as the initial locally preferred alternative in February 1994. An MIS/DEIS, completed in March 1995, described that alternative as 26 miles with 14 stations. That alternative included an alignment that crossed I-64 at 9th Street in East St. Louis, and later followed a Norfolk Southern right-of-way from east of Swansea.

Preliminary Engineering

In the SDEIS, completed in May 1996, local officials had deleted the Sullivan Drive station from the LPA and changed the alignment in East St. Louis to cross I-64 at 13th Street instead of at 9th Street. By the time the FEIS was completed in August 1996, local officials had deleted another station from the alignment – the station at I-255. Local officials also had changed the alignment east of Swansea to pass through Belleville and Belleville Area College.

Final Design and FFGA

The FFGA was signed in October 1996 for a reduced scope project. The FFGA funded project is 17.4 miles long with eight stations and connects to the initial 17 miles of the existing Metrolink system.

Opening to Service

The Metrolink St. Clair Extension opened for revenue service on May 7, 2001.

Project Scope

The FFGA scope was reduced due to financial constraints of the Bi-State Development Agency and FTA concerns regarding the justification for the project beyond the Belleville Area College station. The Bi-State Development Agency has begun construction of a 3.5 mile extension to Scott AFB without federal funding.

Table 110: Project Scope - St. Clair County Metrolink Extension

	DEIS	FEIS	FFGA	As-built
Length				
at grade	25	25.9	17	17.4
Stations				
at grade	12-13	11	8	8
Trackage				
double	25	25.9	17	17.4
Parking Spaces				
surface	1800-2700	3460	not stated	4500
Vehicles				
rail	24	24	20	20
Facilities				
shops/yards	expand existing	expand existing	expand existing	new facility
control center			expand existing	

Service Levels

Actual service levels on the St. Clair extension are slightly lower than proposed in the SDEIS and FEIS and similar to the service levels proposed in the AA/DEIS.

Table 111: Service Levels - St. Clair County Metrolink Extension

	MIS/AA/ DEIS	SDEIS	FEIS	Actual
Forecast Year	2010	2010	2010	2002
Span of Service				
Weekday		5:00 AM – 1:45 AM	5:00 AM – 10:15 PM	4:45 AM – 1:00 AM
Frequency of Service				
Pk Hr Headway	7.5 min	5 min	5 min	7-9 min
Pk Period Hdwy	7.5 min	5 min	5 min	7-9 min
Mid-Day Hdwy	10 min	10 min	10 min	10 min
Evening Hdwy	15 min	15- 30 min	15- 30 min	15-30 min
Weekend Hdwy	10-15 min			15 min
Operating Statistics				
Weekday LRT Train Miles (System)	not stated	10,013	10,013	8,102
Weekday Car Miles	not stated	18,524	18,524	15,712
Weekday LRT Place Miles (System)	not stated	1,782,314	1,782,314	1,442,109
Weekday Platform Hours (System)	not stated	397	377	320
Weekday Transit (LRT + Bus) Veh Miles (St. Clair Co)	not stated	13,163	14,532	15,775
Weekday Corridor (LRT + Bus) Place Miles (St. Clair Co)	not stated	1,097,524	1,341,206	1,468,414
Fleet Vehicle Reqs (System)	not stated	65	65	65
Peak Veh Reqs (System)	not stated	56	56	44
Fare	not stated	not stated	not stated	1.25

Ridership

The forecasts for the St. Clair extension show a pattern of initial conservatism giving way to increasingly optimistic forecasts in the FEIS. Actual weekday boardings for the St. Clair County Metrolink Extension are currently (2002) about 33 percent above the AA/DEIS forecast for 2010, approximately equal to the SDEIS 2010 forecast, and about 22 percent below the FEIS forecast for 2010, excluding the stations that were not built under the FFGA.

Table 112: Predicted and Actual Ridership - St. Clair County Metrolink Extension

	Project - Average Weekday Boardings	System-wide		Forecast Year
		Average Weekday Boardings	Total Transit Boardings	
Predicted				
AA/DEIS	11,960	30,218	196,885	2010
SDEIS	15,762	55,460	not stated	2010
FEIS	20,274	63,398	not stated	2010
Actual				
2000		41,454	166,059	
Opens 2001	15,620*	42,381	163,452	
2002	15,976***	44,310	152,574	

*Represents May and June 2001 only with the extensions opening. The extension only ridership is 65 percent of total Illinois average weekday without special event ridership.
**Represents the 65 percent of the May and June 2001 Illinois MetroLink ridership.
***The average weekday ridership for FY02 represents the average for the extension between September 2001 and June 2002 plus the average weekday event ridership for the extension of 1,133.

Capital Costs

The St. Clair Extension is, as the name implies, the extension of an existing Light Rail line. The experience of constructing the first segments of the line was applied in developing forecasts for the St. Clair extension. The capital cost estimates reflect this experience. The cost estimates in nominal dollars are quite close to the as-built cost. This suggests that the project scope was reduced to match the original estimates as costs of construction increased over time. The actual capital cost is less than the planning estimates, and slightly higher than the FFGA amount, after adjustments for construction cost inflation.

Table 113: Predicted and Actual Capital Costs - St. Clair County Metrolink Extension

	Total Capital Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$337.3 (1995 $)	$351.0 (1996 $)	$307.7 (1996 $)	$339.2	101%	97%	110%
Adjusted to Const. Midpoint (1998 $)	$367.7	$367.5	$322.2	$339.2	92.3%	92.3%	105.3%

Operating and Maintenance Costs

Peak service is roughly half of the service assumed for the 2010 O&M cost estimates. The total St. Louis Light Rail operating and maintenance costs reported in the National Transit Database are $19.5 million for 2000 and $22.6 million for 2001, a change of $3.1 million. This is far less that the Operating and Maintenance cost projected for the St. Clair Extension. A review of the Metrolink schedules suggests that operations on the St. Clair Extension comprise about 45 percent of revenue vehicle-hours. If O & M costs are allocated in this proportion, the O&M cost for the St. Clair Extension in 2001 would be about $10.2 million. This is less than the inflation adjusted estimates by a significant margin.

Table 114: Predicted and Actual Operating Costs - St. Clair County Metrolink Extension

	Annual Operating and Maintenance Cost (millions of $)				Ratio of Actual to Predicted Costs (Percent)		
	AA/DEIS	FEIS	FFGA	As-built	As-built vs. AA/DEIS	As-built vs. FEIS	As-built vs. FFGA
As estimated	$22.8 (1995 $)	$11.7 (1996 $)	NA	$10.2	45%	87%	NA
Adjusted to year of opening (2001 $)	$29.8	$14.8	NA	$10.2	34%	69%	NA

Assessment of Predicted vs. Actual Ridership and Costs

The forecasts prepared for this project during planning and project development have varied widely. The initial forecasts prepared for the AA/DEIS were much lower than subsequent forecasts. The AA/DEIS was published fairly close to opening of the initial system so the subsequent forecasts have had the benefit of more operating experience. If Bi-State is able to achieve an average growth in annual ridership of 1 percent or better, this project would achieve ridership within a reasonable range of the FEIS forecast.

Capital costs for construction were also consistent with the estimated costs. O&M costs are less that estimated but the service levels assumed for the forecasts have not yet been achieved.

Appendix 2: References

Doc. No.	City	**Title**
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