Sample Final Report from a Before-and-After Study

This document provides an example of documentation that meets the expectations of the Federal Transit Administration (FTA) for the final report produced by a Before-and-After Study. The document was prepared by staff from FTA and from the Charlotte Area Transit System (CATS) as part of FTA's annual report to Congress on projects that have completed Before-and-After Studies in the previous 12 months. It is, in effect, a final version of the draft final report prepared by CATS in fulfillment of the requirement for a Before-and-After Study of the agency's initial light rail project – the South Corridor Blue Line.

FTA has received a growing number of requests for example from project sponsors who are undertaking Before-and-After Studies of New Starts and Small Starts projects currently under development. This document is an initial response – one that FTA provides with some important caveats:

1. Sample documents are often viewed – inappropriately – as models that all new documents must follow to the letter. For Before-and-After Studies, the treatment of this example as a detailed mandate would be particularly inappropriate. The Studies are intended to document the important impacts of each transit project and the accuracy with which the project sponsor predicted these impacts during project planning and development. Consequently, the emphasis areas in each final report should reflect the specifics of the impacts and the predictions for each project – and the variation in details within the reports will be as wide and as pronounced as the variation in project impacts and the accuracy of their predictions. This sample report does not obviate the need for each project sponsor to find and document the important characteristics of each project.
2. Much of the analysis of the predicted outcomes of the South Corridor project had to rely on materials unearthed from archives and retrospective analysis of differences in the predictions across the project-development milestones. Like all New Starts projects that have opened thus far, the South Corridor project was planned and developed before the May 2006 FTA policy guidance that required the assembly, analysis, and archiving of predicted outcomes for the project at each project-development milestone. CATS was able to retrieve most of the predictions from its archives. However, the larger difficulty was the absence of documentation on what predictions changed and why they changed from one milestone to the next. As a result, the analysis of the predictions for the South Corridor project is somewhat limited compared to the analysis that should be done by sponsors of later projects that have assembled and analyzed their predictions at each milestone.

Nevertheless, the summary report on the South Corridor Before-and-After Study provided here serves as a good example of the organization, focus, presentation, tone, and (with some caveats) length of a useful final report. Some comments are useful:

- Organization: The report orders the five project outcomes to deal first with the closely related discussions of physical scope and capital costs. It then moves to the three remaining topics – transit service, operating and maintenance costs, and ridership – that are also themselves closely related.
- Presentation: Within each outcome, the discussion first presents the actual outcome of the project and, only then, addresses the accuracy of the predicted outcome developed at the various milestones during planning and project development. One table for each

outcome documents both the actual project outcomes and compares those outcomes to the predictions.

- Focus: The report includes everything that is needed to document what happened and how well the predictions anticipated what happened. It foregoes other material that, while perhaps of general interest, adds nothing by way of insights and serves only to dilute focused presentation of the findings.
- Tone: The report is a straightforward presentation of actual outcomes and their predictions. It crisply presents findings that will add to the industry's understanding of major transit projects and to the successful prediction of their costs and performance during planning and project development. Consequently, the report neither skips past the rough spots nor dwells too long on the happy outcomes.
- Brevity: The sample document provided here is 11 pages long. It covers the substantive findings on both actual project outcomes and the accuracy of their predictions. This brevity is made possible by the careful selection of information for presentation in the tables, the focused discussions in the text, and the inclusion of a single map. Further, detailed supporting materials can be placed in as many appendices as might seem useful to interested readers who want the details. For the main body of the report, however, brevity and focus need to be the guiding principles.

- Appropriate length: It may be that longer, more complex, or more problematic projects will have more material to present on the actual impacts of the project. It may also be that Studies that have full access to archived records of the milestone predictions will have more to present on predicted-versus-actual analysis. Consequently, final reports might well exceed 11 pages in their appropriately focused presentation of important findings. However, FTA's current expectation is that 20 pages (plus appendices) will be sufficient to document the findings in all but the most unusual circumstances.

Project sponsors may find it useful to prepare an annotated outline of upcoming final reports, where the annotations identify the specific findings that will be the focus of each section. A review of this outline by FTA staff may help to promote efficient preparation of a full draft and early closure with FTA on the final report.

South Corridor Light Rail – Charlotte, NC
Final Report from the Before-and-After Study

The South Corridor project is a 9.6-mile light rail line extending south from Charlotte's central business district (CBD) roughly parallel to, and one to two miles east of, Interstate-77 to a terminus at Interstate-485, the beltway for the metropolitan area. The "Blue Line" is the first light rail project in metropolitan Charlotte.

The project was developed and built, and is now operated, by the Charlotte Area Transit System (CATS), a department of the City of Charlotte. Table 1 summarizes the key milestone dates in its development.

Table 1. Milestones in Project Development

Milestone	Date
Entry into Preliminary Engineering	September 2000
Entry into Final Design	August 2003
Full Funding Grant Agreement (FFGA)	May 2005
Amended FFGA	September 2007
Revenue service	November 2007

The "before" conditions for the Before-and-After Study are from the fall of 2007 while the "after" conditions are from the spring of 2009, 18 months after the project opened to revenue service.
Project Scope

1. Physical Scope of the Project

Figure 1 is a map of the South Corridor, the rail line and its stations, and current (2011) bus routes. The South Corridor light rail line comprises 9.6 miles of double-tracked rail with overhead electrification. In the northern 5.5-mile segment, from the northern terminus in downtown Charlotte to a point just south of the Tyvola station, the line is built on former railroad right-of-way purchased by the City of Charlotte in 1999 to preserve its availability. While a physically separate freight spur remains from north of Woodlawn to Tyvola to serve existing freight customers, no through freight operations remain in this segment. The remaining 4.1 miles to the south are built adjacent to an active Norfolk Southern freight line on right-of-way purchased from Norfolk Southern by the City as part of the South Corridor light rail project. Freight and light rail operations are physically separate throughout this southerly segment.

Most of the rail line is at grade (6.8 miles, 71 percent). The remainder is elevated on pre-existing retained fill in and near downtown Charlotte (1.8 miles, 19 percent) and on several pre-existing and new bridge structures (totaling 1.0 miles, 10 percent). The line is entirely separated from traffic for 5.3 miles over all its elevated and some of its at-grade alignments – the result of grade-separations at 18 crossings. It encounters cross-traffic at 21 intersections over the remaining 4.3 miles of at-grade alignment. The project also includes 20 light-rail vehicles, 15 passenger stations, park-ride facilities at seven stations providing a total of 3,200 spaces, a maintenance-and-storage facility for the rail vehicles, and an operations control center.

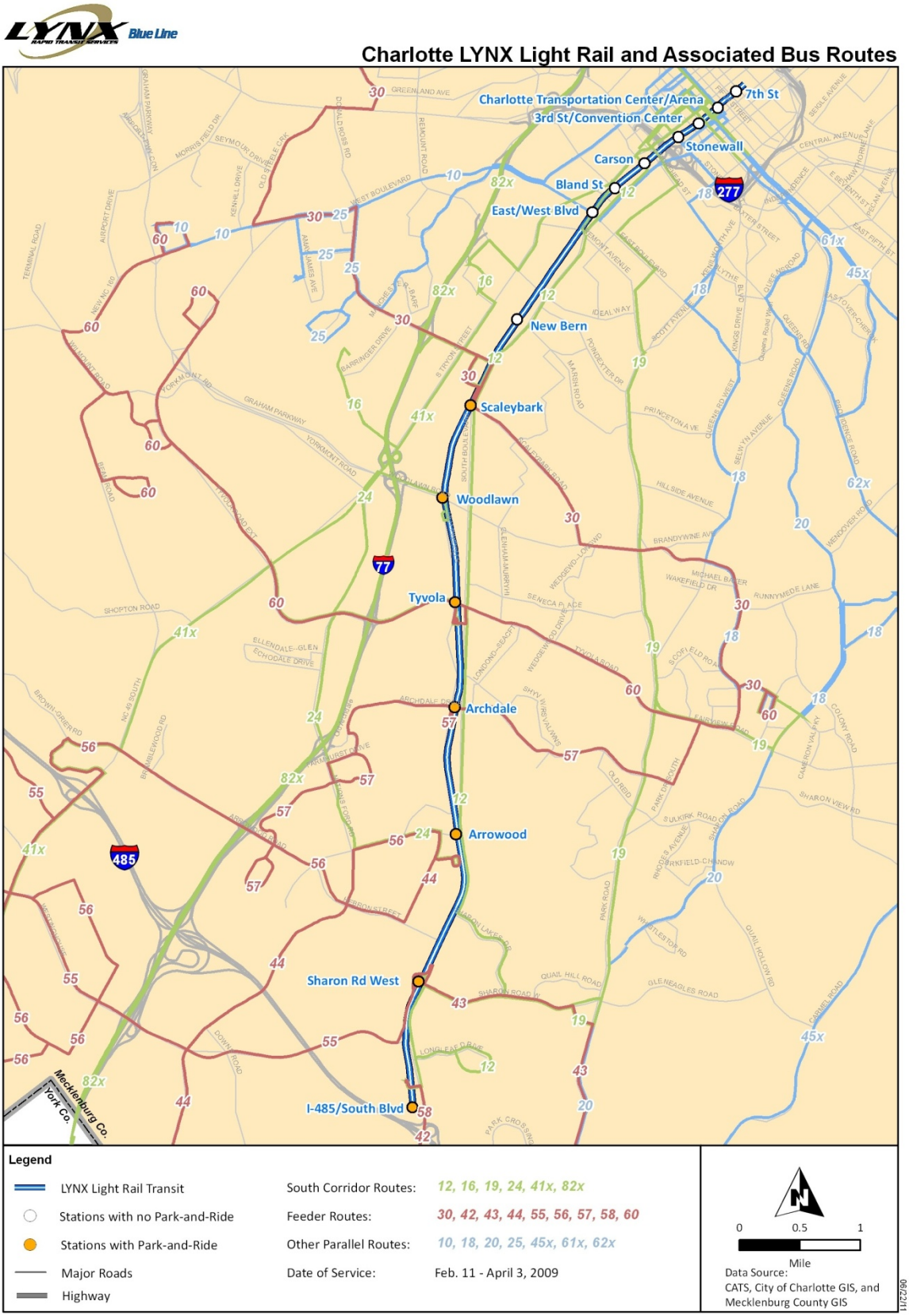

Figure 1. Map of the Charlotte South Corridor

In parallel with the rail project, the City of Charlotte established a South Corridor Infrastructure Program (SCIP) to fund capital projects associated with rail construction but not inherent to the scope of the rail project. The program was motivated by the City's desire to minimize construction impacts in the South Corridor by undertaking capital improvements that would otherwise be part of land development projects in the coming years – utility improvements, sidewalks, traffic intersections, and bike trails. Completion of these improvements in conjunction with rail construction made the rail corridor "development ready" and reduced the time period in which the corridor was disrupted by heavy construction.

The anticipated scope of the transit project during planning and project development was very consistent with the as-built project. Four changes occurred.

The alternatives analysis anticipated an 11.0-mile line that was subsequently shortened during preliminary engineering to the as-built 9.6 miles. The shorter line resulted from the elimination of the southernmost segment from Interstate-485 to the town of Pineville in response to the concerns raised by the town on potential impacts associated with a terminal station.

The project scope in the alternatives analysis included only 12 vehicles and the FFGA scope included only 16 light-rail vehicles based on final ridership projections for the line. CATS purchased four additional vehicles (for a total of 20) and built an additional track in the storage yard in response to ridership demands after opening.

The alternatives analysis anticipated an at-grade alignment at three locations that were subsequently changed to grade-separations.

The project scope in the alternatives analysis provided a total of 3,600 parking spaces in surface lots at three stations and structured parking at a fourth. In preliminary engineering, CATS added surface parking at three additional stations and marginally reduced the total number of spaces to 3,200.

In general, however, the scope of the project remained substantially the same – in its length, alignment, number and location of stations, and degree of grade separation – from its early conceptualization in alternatives analysis through project development to its as-built condition.

2. Capital Cost

Table 2 summarizes actual as-built cost of the project by major cost category. The actual capital cost of the South Corridor light rail line was $462.75 million in year-of-expenditure (YOE) dollars over the period of project construction from 2004 through 2007. Complementary transportation and utility improvements made through the City's SCIP cost $72 million separate from the project budget. The largest categories of the as-built costs were for the core physical elements (guideway, stations, and systems: 53 percent of the total cost), engineering services (12 percent), and rail vehicles (11 percent). Overall, the physical elements of the project comprised 71 percent of actual project costs, with the remaining 29 percent going to right-of-way purchases, engineering and design services, and other capital expenses (insurance, force account, testing and start-up, etc.).

Table 2 also presents the capital cost predicted at each milestone during project development and employs two additional dollar valuations besides YOE dollars (year-of-the-forecast dollars and constant 2007 dollars) to enable meaningful comparisons of the predictions across the milestones.

Table 2. Capital Costs at the Various Milestones

Milestone	As-Built	MIS/AA (1)	FEIS/ROD	FFGA	Amended FFGA
Year of actual/forecast costs	2007	1999	2002	2005	2007
Costs in Year-of-Expenditure Dollars (millions)					
Planned/actual opening date	Nov. 2007	Winter 2005	Spring 2006	Apr. 2007	Nov. 2007
Total ($ year of expenditure)	$ 462.75	$ 331.10	$ 370.85	$ 426.84	$ 462.75
Difference from actual	$ -	$ (131.65)	$ (91.90)	$ (35.91)	$ 0.0
Difference from actual (%)	-	-28%	-20%	-8%	0%
Costs in Constant Year-of-the-Forecast Dollars					
Total ($ year of forecast)(YOF)	$ -	253.73	356.30	412.36	462.75
$YOF / $2007	-	1.419	1.393	1.129	1.000
Costs in Constant 2007 Dollars (millions)					
Rolling Stock	$ 52.4	$ 47.3	$ 73.8	$ 57.7	$ 52.3
Guideway, stations, systems	$ 247.1	$ 158.5	$ 236.6	$ 238.0	$ 244.4
Maintenance & Storage Yard	$ 27.4	$ 35.5	$ 27.7	$ 28.8	$ 28.3
Right-of-Way	$ 36.8	$ 19.6	$ 36.7	$ 45.7	$ 36.0
Other Capital	$ 43.6	(2) $ -	$ 50.8	$ 47.3	$ 40.2
Engineering & Design	$ 55.5	$ 39.6	$ 50.0	$ 43.7	$ 52.6
Project Contingency	$ -	$ 59.5	$ 0.9	$ 4.2	$ 8.9
Total ($ 2007)	$ 462.7	$ 360.1	$ 496.4	$ 465.4	$ 462.7
Difference from actual	$ -	$ (102.8)	$ 33.8	$ 2.6	$ 0.0
Difference from actual (%)	-	-22%	7%	1%	0%

Notes: (1) Compared to the as-built project, the cost forecast from the MIS/AA reflects a project that was 1.4 miles longer and had one additional station, eight fewer rail vehicles, and one fewer park-ride garage.

(2) In the MIS/AA cost forecast, other capital costs were included as allowances within the forecasts for other cost categories.

In YOE dollars, the cost predictions at each milestone consistently underestimated the as-built costs but by a smaller amount as project-development proceeded. Cost forecasts in YOE dollars reflect (1) the anticipated project scope, (2) unit prices at the time the forecast was prepared, (3) anticipated inflation in those prices, and (4) the expected schedule for project development and construction. To understand the causes of the underestimate, it is necessary to separate out the contributions of these four components.

The second dollar valuation – "year of the forecast" dollars – in Table 2 is a partial step towards separating the underlying cost forecast – based on the scope and then-current unit prices – from the effects of unit-price inflation and schedule slippage. A cost forecast in these dollars effectively assumes that the entire project is built immediately – within the year of the forecast – and is therefore independent of inflation and schedule-slippage. (FTA uses capital costs in year-of-the-forecast dollars to compute the cost-effectiveness measure for ratings of proposed projects.)

However, cost forecasts in year-of-the-forecast dollars are not comparable across the milestones because they were prepared in different years' dollars. To permit a meaningful

comparison across the milestones, the last block of Table 2 adjusts all cost forecasts to 2007 dollars and presents both the total costs and subtotals for each cost category.

In constant 2007 dollars, the cost forecast from the MIS/AA underestimated actual costs by $103 million ($ 2007), or 22 percent. Given the modest scope changes that occurred after the MIS/AA forecast (length shortened by 1.6 miles but offset by additional grade separations, rail vehicles, and a parking structure), most of the underestimate apparently results from higher-than-anticipated unit costs for guideway/station construction and power/signals/communication systems, higher real-estate costs, and higher fees for engineering services (reflecting additional effort needed to respond to higher-than-anticipate bid prices from contractors). The cost forecast in the FEIS overestimated actual costs by a modest seven percent – reflecting the additional refinement of project scope and current unit costs accomplished during preliminary engineering. The cost forecast (again in constant 2007 dollars) at the FFGA was a percent over-estimate of actual costs and at the Amended FFGA (when most project construction was approaching completion) matched the actual outcome.

Cross-milestone cost comparisons in YOE and 2007 dollars provide substantially different pictures of the cost forecasts. In YOE dollars, forecasts of capital costs were substantially lower than the actual outcome – a problem that persisted throughout project development and into the construction period. In 2007 dollars, however, only the MIS/AA cost forecast was low – and by a modest percentage. The implication is that the YOE forecasts were low because they did not anticipate (1) the rapid general inflation in construction prices that occurred nationally and regionally during the engineering and construction of the project and (2) the added exposure to general cost inflation that resulted from the later-than-anticipated opening of the project to service in November 2007, nearly two years later than anticipated in the MIS/AA. Table 2 documents this increase: construction that cost a dollar in 1999 terms – the year of the MIS/AA estimate – cost 1.419 times as much by 2007, a 42 percent increase. Even over the short interval between the FFGA and project opening, general inflation of construction costs was 13 percent. Nationally, cost inflation was driven by increases in the global demand for, and prices of, steel and concrete. In the southeastern United States, rebuilding after hurricanes Katrina and Rita substantially increased the demand for contractors and workers, thereby adding further upward pressure on construction bid prices.

3. Transit Service Levels

Transit service in Metropolitan Charlotte has increased markedly over the past 15 years. In 1997, CATS operated 134 buses in peak fixed-route service. In 1998, Mecklenburg County voters approved a ½-cent sales tax to implement a 2025 transit plan that called for construction of a light rail system and significant expansion of bus services. By 2007, just before the light rail opened in the South Corridor, CATS was operating 263 buses in peak fixed-route service – effectively doubling service over the 10-year period.

The bus system in 2007 operated largely radial services with local bus routes – and a few expresses – connecting suburban areas to the Charlotte Transportation Center (CTC) in downtown where riders transferred between radial routes. Peak headways were 15 to 30 minutes while most off-peak headways were 30-60 minutes. Park-and-ride options were limited to a few informal lots served by express routes.

In the South Corridor, four local routes and three expresses provided service to the CTC. Other bus routes on the margins of the South Corridor paralleled these “core” buses and a few cross-town routes connected with other corridors. Table 3 summarizes the annual operating

characteristics of the South Corridor bus routes and the rest of the CATS fixed-route bus system before the Blue Line opening. At 2.29 million annual vehicle-miles and 161,000 annual vehicle-hours, the South Corridor had 24 percent of CATS system-wide service.

Table 3. Changes in Aggregate Measures of Actual Transit Service Levels

Characteristic	Weekday Vehicle-miles (annual thousands)				Weekday Vehicle-hours (annual thousands)			
Milestone	Before (FY07)	After (FY10)	Change	% Chg.	Before (FY07)	After (FY10)	Change	% Chg.
Transit Routes								
South Corridor Buses	**2,289**	**2,402**	**113**	**5%**	**161**	**179**	**18**	**11%**
Core	1,264	841	-423	-33%	87	66	-21	-24%
Parallel	732	665	-68	-9%	54	50	-4	-8%
Feeder	292	896	604	206%	20	63	43	211%
South Corridor Rail	**----**	**640**	**640**	**----**	**----**	**34**	**34**	**----**
South Corridor Totals	**2,289**	**3,042**	**753**	**33%**	**161**	**213**	**52**	**32%**
Other Corridors	**7,202**	**6,656**	**-475**	**-7%**	**509**	**475**	**-33**	**-7%**
System Totals	**9,420**	**9,698**	**278**	**3%**	**670**	**689**	**19**	**3%**

Table 3 also summarizes the changes in transit service levels over the 2-year interval in which the CATS opened the Blue Line and adjusted service levels in the bus system. Changes to the transit system reflected (1) the opening of the Blue Line, (2) the adjustments to South Corridor buses to integrate rail and bus services and (3) system-wide downsizing of service in response to a downturn in tax revenues caused by the national economic contraction. The table documents the net effects of these changes.

The Blue Line provides headways of 10 minutes in peak periods, 15 minutes mid-day, and 20 minutes in the evening on weekdays, with 15-minute headways on Saturday and 20-minute headways on Sunday. All trains have 2-car consists in the peak and car consists mid-day, evenings, and weekends. End-to-end runtime averages 25 minutes – an average operating speed of 23 mph. In aggregate terms, the Blue Line in 2009 operated 640,000 vehicle-miles and 34,000 vehicle-hours of service.

To integrate the Blue Line with South Corridor bus routes, CATS reduced service on the core radial routes by 33 percent, eliminating an express route and shortening local routes to connect with the Blue Line, and made minor service reductions on the parallel South Corridor bus routes. CATS structured a feeder-bus network around the Blue Line with six new feeder routes and adjustments to three existing cross-town routes. In aggregate terms, additional service on the feeder routes outpaced the reductions on parallel routes – resulting in a five percent increase in bus service in the South Corridor. In aggregate terms, transit service in the South Corridor increased by 33 percent between 2007 and 2009 (counting rail and bus vehicles as equal contributors to total vehicle-miles and vehicle-hours).

The effect of system-wide downsizing is evident in the seven percent reduction in vehicle-miles and vehicle-hours in other corridors. CATS uses productivity-based performance measures to prioritize adjustments to individual routes. Because the productivity of South Corridor bus routes was generally high compared to routes in other corridors, South Corridor routes were subject only to very modest service reductions. Overall, aggregate system-wide vehicle-hours of service after the reductions in 2009 remained at levels that were more than double the service provided by CATS in 2000.

Predictions of system-wide levels of bus service during project planning and development consistently overestimated the actual outcome. This over-estimate of costs directly reflects the anticipated higher levels of bus service by 2009 that were not achieved because of service reductions in response to the economic downturn. The FEIS anticipated a particularly ambitious expansion of service – an expectation that was scaled back shortly thereafter when further analysis showed that this rapid expansion would outpace increases in ridership. Anticipated characteristics of light rail service – headways and operating speeds – were consistent throughout project development and were accurate predictions of actual rail service.

4. Operating and Maintenance Costs

As CATS has implemented the transit expansion plan approved by the voters in 1998, operating and maintenance (O&M) costs for the system have increased from $22.0 million in 1997 (in 1997 dollars, equivalent to $30.0 million in 2009 dollars) to $83.2 million in 2007 (in 2007 dollars, equivalent to $86.1 million in 2009 dollars).

Table 4. Actual Changes in O&M Costs and Comparison to Predictions

	Operating and Maintenance Costs (Adjusted to 2009 Dollars)					
	Before	After	Predicted O&M Costs after Blue Line Opening (in 2009$)			
Milestone	FY 2007	FY 2009	Entry to PE	FEIS	Entry to FD	FFGA
			Sep-01	Apr-03	Aug-03	Aug-04
Fixed-route Bus	$77.6	$76.0	---	$89.7	$73.7	$70.0
DSS, STS, vanpools (1)	$8.5	$8.9	---	$9.8	$7.5	$10.0
South Corridor LRT	---	$16.8	---	$16.1	$16.6	$16.9
Historic Trolley	---	---	---	---	$0.8	$1.3
Administration	---	---	---	$12.4	$9.9	$9.8
Total Expense	$86.1	$101.6	$111.34	$127.96	$108.4	$107.9

Notes: (1) STS is the paratransit bus service that CATS provides for certified/eligible disabled customers under the ADA. DSS represents funding provided by CATS to Mecklenburg County to provide demand response service for access to health care. Vanpools comprise the fleet of vans that CATS owns, maintains, and leases out in support of its vanpool program.

Table 4 also documents the subsequent changes from 2007 to 2009 after opening of Blue Line service as well as the forecasts of O&M costs prepared at each milestone. All costs are translated into 2009 dollars to permit meaningful comparisons over time. Between CATS fiscal year 2007 and fiscal year 2009, system-wide O&M costs increased by 22.6 percent, reflecting a marginal (1.7 percent) increase in fixed-route bus costs and the advent light rail service.

Predictions of system-wide O&M costs during project planning and development consistently overestimated the actual outcome. This over-estimate of costs directly reflects the anticipated higher levels of bus service by 2009 that were not achieved because of service reductions in response to the economic downturn.

5. Ridership

Transit ridership has grown substantially over the past 10 to 15 years in response to the rapid expansion of transit service and demographic growth in the metropolitan area. In the mid-to-late 1990s, the CATS bus system served 11.7 million annual boardings by transit riders – with 41,000 boardings on the average weekday. By 2007, just before the light rail opened in the

South Corridor, ridership had grown to 20.4 million annual boardings – with 70,000 boardings on the average weekday.

The Blue Line opened on the Monday after Thanksgiving in November 2007. By happenstance, the opening followed by three weeks a ballot question in which county voters, after a long public debate, defeated by a 70-30 margin an initiative to repeal the sales tax increment approved in 1998 for transit expansion. Monthly average weekday boardings on the line averaged 12 thousand in its initial months to 17 thousand by the summer of 2008 and then settled to 14-15 thousand where it remains in mid-2011. During this interval, gasoline prices spiked in mid-2008, gasoline supplies to metropolitan Charlotte were disrupted by Hurricane Ike's Texas landfall in September 2008, the economy weakened, and CATS reduced bus service (largely in other corridors) in response to the consequent decline in sales-tax revenues. All of these events have had some degree of influence on transit ridership in Metropolitan Charlotte in addition to the impacts of the Blue Line opening.

Table 5 presents aggregate measures of CATS ridership before and after opening of the light rail line along with the vehicle-hour summaries from Table 4 for reference. The table measures ridership in terms of boardings, meaning that riders who transfer count each time they board a bus or train for a single door-to-door trip. Consequently, the 4,100 rail trips that used a bus to travel to and/or from the rail line are also counted among the bus riders. Over the interval, average weekday boardings on transit services in the South Corridor rose from 14,700 to 26,900, a gain of 83 percent in response to a 32 percent increase in vehicle-hours of service. The Blue Line attracted 14,400 trips while volumes on corridor bus routes declined by 15 percent – reflecting rider shifts from bus to rail as well as the adjustments to bus services with the introduction of light rail, primarily on core radial bus routes that were eliminated or shortened.

Table 5. Change in Average Weekday Boardings

Characteristic	Weekday Vehicle-hours (annual thousands)				Average Weekday Boardings (daily)			
Milestone	Before	After	Change	% Chg.	Before	After	Change	%
Transit Routes								
South Corridor Buses	**161**	**179**	**18**	**11%**	**14,716**	**12,505**	**-2,211**	**-15%**
Core	87	66	-21	-24%	9,744	4,773	-4,971	-51%
Parallel	54	50	-4	-8%	4,475	3,914	-561	-13%
Feeder	20	63	43	211%	497	3,818	3,321	668%
South Corridor Rail	**----**	**34**	**34**	**----**	**----**	**14,370**	**14,370**	**----**
South Corridor Totals	**161**	**213**	**52**	**32%**	**14,716**	**26,875**	**12,159**	**83%**
Other Corridors	**509**	**475**	**-33**	**-7%**	**46,042**	**51,386**	**5,343**	**12%**
System Totals	**670**	**689**	**19**	**3%**	**60,758**	**78,470**	**17,711**	**29%**

Outside of the South Corridor, where bus service was reduced by 7 percent because of budget constraints, bus boardings increased by 12 percent – reflecting some combination of higher gas prices, higher ridership transferring to and from light rail in the South Corridor, and, perhaps, an increased awareness of transit options caused by the public debate and vote immediately before the project opened.

Tables 6 (a, b, and c) focus on changes in transit ridership within the South Corridor based on detailed surveys of system-wide riders taken before and after the Blue Line opened. In contrast to the measure in Table 5, these tables count passengers traveling from their origins to their destinations as one trip, regardless of the number of times they might board buses or trains as they transfer between transit lines. Table 6(a) summarizes the 14,400 trips on the Blue Line in

April, 2009, by their beginning and ending locations. Overall, travelers from the South Corridor made 11,400 of the 14,400 daily trips on the project – over half to (and returning from) the Charlotte Central Business District (CBD), more than a quarter to/from other locations within the South Corridor, and the rest to/from other locations in the metropolitan area. The CBD was the largest single location attracting Blue Line travelers with half of all trips but activities at other locations in the South Corridor attracted a third of all rail trips. Some 2,100 of rail trips to South Corridor locations came from residents of other corridors in metropolitan Charlotte, who traveled by bus to the downtown transit center where they transferred to the Blue Line.

Table 6(a). Daily Trips on the South Corridor Light Rail Project (October, 2009)

	Daily Trips on the Project	Attracted to Workplaces and Other Activities in:			
		Central Business District	Other South Corridor Locations	Locations Outside the South Corridor	All Locations
Produced by Residents of:	Locations in the South Corridor including the CBD	6,400	3,300	1,700	11,400
	Locations Outside the South Corridor	700	2,100	300	3,000
	All Locations	7,100	5,300	2,000	14,400

Table 6(b). All Trips on Transit: 2007 Ridership + Increase from 2007 to 2009

	Daily Transit Trips 2007 + Delta to 2009	Attracted to Workplaces and Other Activities in:			
		Central Business District	Other South Corridor Locations	Locations Outside the South Corridor	All Locations
Produced by Residents of:	Locations in the South Corridor including the CBD	2,500 + 7,100	2,500 + 1,900	3,600 + 1,500	8,600 + 10,500
	Locations Outside the South Corridor	7,500 + 1,800	4,800 + 100	17,200 + 2,200	29,500 + 4,100
	All Locations	10,000 + 8,900	7,300 + 2,000	20,800 + 3,700	38,100 + 14,600

Table 6(b) summarizes the change in transit riders between 2007 and 2009 in these same travel markets. Overall, average weekday ridership increased by 14,600 per day – from 38,100 to 52,700. The strongest gains occurred in the South Corridor where ridership to (and returning from) downtown Charlotte increased by 7,100 trips – a nearly four-fold change from 2,500 to 9,600 weekday trips. Significant gains – particularly in relative terms – occurred in other travel markets to and from the South Corridor. The table gives some insight into the net effect of other influences besides the Blue Line opening on ridership in this interval. Transit trips from and to locations outside the South Corridor increase by 2,200 from 17,200 to 19,400 – a 13 percent gain. The Blue Line had almost no role in serving this market, carrying only 300 of the 19,400 trips in 2009 (Table 6(a)) and bus service contracted by seven percent (Table 5). A 13 percent gain in ridership in spite of a seven percent service reduction suggests that the net effect of other influences (soaring gas prices and supply interruptions, among others) were responsible for an underlying increase in the overall demand for transit of about 15 percent.

Table 6(c) compares the socio-economic status of Blue Line riders in 2009 versus bus riders in 2007 prior to the Blue Line opening. The table summarizes the fraction of transit riders in each travel market that are from the highest income grouping (those with annual household incomes over $56,000) in the rider survey data. Overall, 19 percent of bus riders in 2007 were from the highest income group while 36 percent of rail riders in 2009 were from that group. This marked

contrast in income levels has two very different causes: (1) the differences in the geographic markets served by rail and bus and (2) changes in the income distributions within each market. The first cause had by far the largest impact. Rail riders were drawn from transit markets in which higher income riders were already a high share of bus riders in 2007. For example, in the largest rail market – the 6,400 rail riders from South Corridor locations to the CBD – 59 percent of bus riders in 2007 were in the highest income group. This share increased only marginally – to 62 percent – for rail riders in 2009. However, the South-Corridor-to-CBD market became a much larger fraction of 2009 rail ridership (44 percent) than it was of 2007 bus ridership (7 percent) and the already-higher-income nature of this market became a much more important component of 2009 rail ridership and its income distribution. Overall, the different distribution of rail riders across the geographic markets would have produced a 32 percent share of rail riders from the highest income group. Changes in the number of higher-income riders within the individual markets account for the other four percentage points of the increase to 36 percent. These changes are evident in Table 6(c). The highest income group was a higher share of 2009 rail riders than 2007 bus riders in four of the six place-to-place transit markets. The extent to which this effect is associated with the Blue Line opening itself is unclear because (1) it is not consistent across all markets and (2) it occurs for travel between locations outside of the South Corridor (8 percent bus versus 14 percent rail) – a market in which the Blue Line attracts few riders (300 out of 19,400 in 2009).

Table 6(c). Share of Transit Trips Made by High-Income Riders: 2007 and 2009 Rail

	Percent High Income 2007 :: 2009 Rail	Attracted to Workplaces and Other Activities in:			
		Central Business District	Other South Corridor Locations	Locations Outside the South Corridor	All Locations
Produced by Residents of:	Locations in the South Corridor including the CBD	59% :: 62%	6% :: 14%	7% :: 14%	22% :: 42%
	Locations Outside the South Corridor	45% :: 40%	10% :: 5%	8% :: 14%	18% :: 14%
	All Locations	49% :: 60%	9% :: 11%	8% :: 14%	19% :: 36%

Note: For this tabulation, high income is defined as households with annual incomes greater than $56,000 in 2009 dollars.

Other tabulations of the 2007 and 2009 survey data provide insights on trip purposes and bus-rail transfers. Overall, 55 percent of rail trips were made by commuters but this share varied widely across markets: 68 percent of rail trips from the South Corridor to/from downtown Charlotte and 44 percent of rail trips in all other geographic markets. These trip-purpose characteristics of rail riders largely reflect the trip purposes of bus riders before the Blue Line opening. Overall, 28 percent of rail riders also boarded a bus to make their trips. Again, this share differed significantly across geographic markets: five percent for travel between the South-Corridor and downtown and 47 percent for all other markets – particularly for transfers between bus and rail at the CTC in downtown Charlotte.

Forecasts of project ridership varied significantly over the course of planning and development of the South Corridor light rail project. The 2025 plan completed in 1998 anticipated 14,000 trips per average weekday by 2025. Subsequent forecasts reported in the FTA annual report to Congress anticipated as many as 25,800 weekday rail trips by 2025 (in the February 2003 report). Later revisions to the forecasting tools produced revised forecasts of 18,000 per average weekday in 2025.

The revised tools produced forecasts of 11,600 average weekday riders in 2010 – a projection scaled back to 10,600 for a then-expected opening year of 2006 and further scaled back to 9,100 weekday trips to allow for a ramping-up period for park-ride ridership (an adjustment that FTA does not currently consider). Given the actual opening at the end of 2007, the 2010 projection is the best available forecast of Blue Line ridership two years after opening. Table 7 compares that forecast with rail rider patterns from the 2009 survey of CATS transit riders. Overall, the forecast underestimates actual ridership by 2,800 trips per average weekday, or -19 percent of actual ridership. A similar relative error occurs for all rail trips from both the South Corridor (-21 percent) and locations outside the South Corridor (-13 percent). The relative error is also similar for all rail trips to the CBD (-13 percent) and to other South Corridor locations (-19 percent). Only for rail trips to locations outside the South Corridor – the smallest rail market – is the relative error somewhat larger (-45 percent).

Table 7. Trips on the Project in 2009: Actual and Predicted

	Trips on the Project Actual::Predicted (Relative Error)	Attracted to Workplaces and Other Activities in:			
		Central Business District	Other South Corridor Locations	Locations Outside the South Corridor	All Locations
Produced by Residents of:	Locations in the South Corridor including the CBD	6,400::5,200 (-19%)	3,300::2,900 (-12%)	1,700::1,000 (-41%)	11,400::9,000 (-21%)
	Locations Outside the South Corridor	700::1,000 (+43%)	2,100::1,400 (-38%)	300::100 (-67%)	3,100::2,600 (-13%)
	All Locations	7,100::6,200 (-13%)	5,300::4,300 (-19%)	2,000::1,100 (-45%)	14,400::11,600 (-19%)

Other comparisons of the 2010 forecast and actual rail ridership in the fall 2009 rider survey suggest that approximately 1,100 of the 2,800 trips missing in the rail forecast are park-ride trips from the South Corridor to the CBD. The other 1,700 missing trips are scattered across the other travel markets. The forecasts were similar to actual outcome on the income distributions of rail riders and were slightly high on the share of rail riders who were traveling to/from work.

Careful analysis of the 2009 survey data – that includes both rail and bus riders and covers the entire CATS transit system in metropolitan Charlotte – and comparisons to the 2007 survey data have suggested that traveler response to the introduction of light rail into the formerly all-bus transit system cannot be fully explained by conventional forecasting methods. These methods assume that all travelers actively consider transit to be a travel options – subject only to its geographic proximity to the origins and destination of their trips – and become more or less likely to choose transit in direct response to changes in the relative attractiveness of transit and highway travel options. The Charlotte data suggest that some travelers did not consider transit an option when the only transit option was a local bus route. The introduction of light rail in the South Corridor and premium express-bus service in the I-77 corridor north of downtown appears to have prompted some of these travelers actively to consider transit options for the first time. CATS has updated the transit forecasting procedures for metropolitan Charlotte to incorporate this apparent behavior. Ongoing research funded by the Transit Cooperative Research Program (Project H-37) is pursuing this idea – using new data collected in Charlotte, Salt Lake City, and Chicago to test its validity in metropolitan areas with very different travel patterns and transit systems.