

East Valley Light Rail Project Before-and-After Study (2013)

Phoenix, Arizona



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Central Phoenix / East Valley Light Rail Project; Phoenix, Arizona

The Central Phoenix / East Valley (CP/EV) project is a 19.7-mile light rail line in metropolitan Phoenix. It is the first rail line in the Phoenix metropolitan area. The accompanying figure is a map of the project and its service area. The light rail line follows a predominantly north-south alignment between the Spectrum Mall and downtown Phoenix and then proceeds along an east-west alignment serving the airport and the cities of Tempe and Mesa.

The project was planned and developed, and is now operated, by Valley Metro Rail, Inc. (METRO). The project was 22 miles long when it emerged as the locally preferred alternative (LPA) from a Major Investment Study in May 1998. A 13-mile section of the LPA entered preliminary engineering (PE) in September 1998, shortening both the northwestern and eastern legs of the project. During PE, additions to both ends brought the total project length to 20.3 miles. Subsequent adjustments to the locations of both terminal stations during final design (FD) shortened the project to its final 19.7-mile length. The project entered final design in July 2003. The Federal Transit Administration (FTA) and METRO signed a Full Funding Grant Agreement (FFGA) for the project in January 2005, and the rail line opened for revenue service in December 2008.

To support meaningful comparisons across the project development milestones, the Before-and-After Study has taken the full-length scope to define the project at entry into preliminary engineering, ignoring the temporary condition under which only the 13-mile section had advanced into PE. Consequently, all predictions assigned to the PE-entry milestone are for the full-length project.

Physical scope of the project

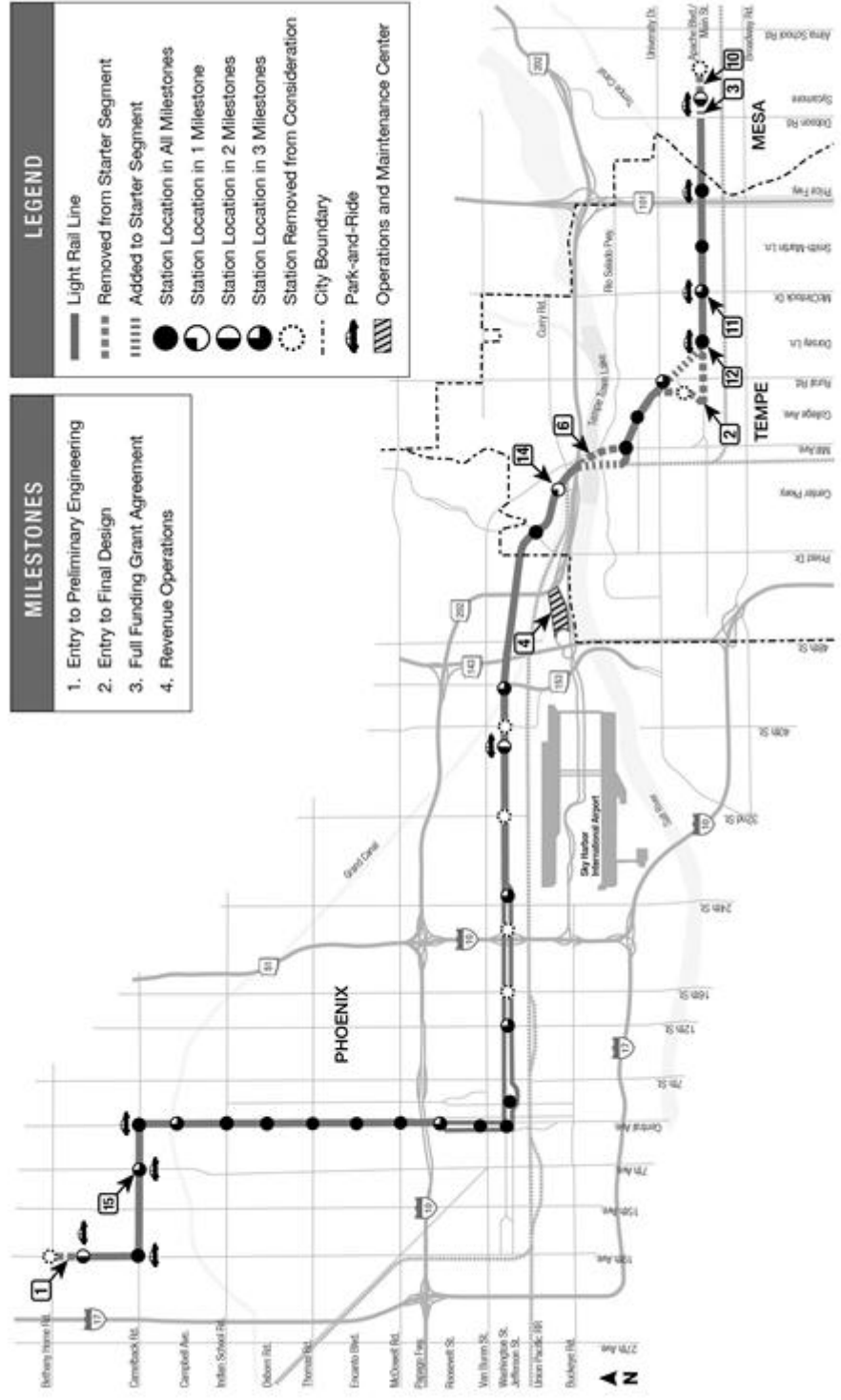
The CP/EV project comprises 19.7 miles of double-tracked rail with overhead electrification. For 17.8 miles, the alignment is at-grade within street rights-of-way with embedded tracks supported on a concrete slab. Tracks are located in either a reserved lane or a street median adjacent to vehicular traffic. The in-street alignment passes through 149 signalized intersections. For 1.3 miles, the alignment operates exclusively within a former railroad right-of-way. Finally, for 0.6 miles, the alignment is on a new bridge structure. The project includes 36 low-floor light-rail vehicles, 28 passenger stations, park-and-ride facilities at nine stations providing a total of 3,636 spaces, an Operations and Maintenance Center (OMC) for the rail vehicles, and an operations control center. Stations can accommodate 3-car trains at platforms that provide level boarding with the low-floor vehicles over their entire length.

In parallel with the light rail project, the cities of Phoenix, Tempe and Mesa initiated additional physical improvements that were not funded through the FFGA. These associated improvements were categorized as Concurrent Non-Project Activities (CNPA) and included various utility improvements, street improvements, transit interface facilities, airport connection improvements, adjacent land development projects and traffic signal improvements. Concurrent performance of the CNPA work and the METRO project eliminated additional costs that would have resulted from separate work efforts at different times within the same area.

The anticipated scope of the project at the project development milestones differed in several ways from the as-built project. At PE-entry:



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- The project was two miles longer largely because of the locations of both terminal stations that were adjusted in PE and again in FD to their as-built locations.

- The alignment in Tempe went through Arizona State University (ASU) campus and was relocated during FD, because of ASU concerns, onto an existing freight railroad alignment adjacent to the campus.
- In-street track-work was assumed to be ballasted except at intersections and was specified during FD to be embedded in pavement.
- The project introduced traffic-signal priority for light rail at 94 traffic signals and was expanded to 135 signals during FD and 149 signals prior to the FFGA.
- The utility-free zone along the tracks was 10 feet from centerline and was expanded to 16-feet at the request of the city of Phoenix during PE.
- The alignment used the existing Mill Avenue bridge across Tempe Town Lake but was changed to new bridge in FD.
- The line had one fewer station; the city of Tempe added a station at Centre Parkway as part of the CNPA after the FFGA.
- The maintenance facility was planned for the existing UPRR facility just east of downtown Phoenix and sized for 40 vehicles but was relocated during FD to a 30-acre site near the airport and sized for 58 vehicles.
- The line had fewer park-and-ride spaces than the as-built project; a 300-space structure was contributed late in FD and an additional lot was added with funds from the American Rehabilitation and Recovery Act (ARRA) after the project opened.

Capital cost

The actual cost of the CP/EV light rail project was \$1.405 billion in year-of-expenditure (YOE) dollars, including \$90 million in financing costs. Parallel improvements funded separately through the CNPA cost \$95.6 million. The average cost per mile was \$67 million excluding finance and CNPA costs. The physical elements of the project comprised 62 percent of total project costs, with the remaining 38 percent going to ROW purchases, engineering, administration and construction management, and testing and start-up costs.

Predicted costs at the project development milestones underestimated actual costs by decreasing amounts. Predicted total costs in YOE dollars were \$1.076 billion at PE-entry (a difference of -23 percent from actual), \$1.181 billion at FD-entry (a difference of -16 percent), and \$1.412 billion at the FFGA (a difference of +1 percent). Much of the increase between FD-entry and the FFGA was the inclusion of finance costs for the first time within the scope of the project. Without finance costs, the predicted cost at the FFGA was \$1.253 billion (a difference of -5 percent from actual costs). The project stayed within the FFGA budget by allocating the \$71 million contingency reserve as needed and reducing the \$159 million budgeted in the FFGA for finance costs to \$90 million.

A comparative analysis of the predicted costs in constant dollars – removing the effects of inflation – suggests that only 17 percent of the under-prediction at PE-entry, and none of the under-predictions at FD-entry and the FFGA, was caused by inflation effects. These effects include the lengthening of the construction schedule (from an opening year of 2006 anticipated at PE entry to the actual opening in December 2008) and unanticipated annual rates of inflation. Consequently, nearly all of the underestimates are attributable to the changes documented above in the physical scope of the project, unforeseen conditions, and understated unit prices for the

various project components. For example, contracts for project construction and station finishes together exceeded the FFGA budget for these items by \$99 million. Unforeseen conditions and utility conflicts added another \$34 million above the FFGA budget.

Transit service

The CP/EV light rail project has been implemented in the larger context of rapid expansion of transit service in metropolitan Phoenix, supported by a series of voter-approved taxes dedicated to transit. The result is a robust area-wide system of local, express, and Rapid bus service and, since 2008, the first line of a planned light rail system.

At opening, the light rail line operated on weekdays with 10-minute headways all day and 20-minute headways in the evening. In July 2010, as part of service reductions necessitated by the economic recession and its impacts on both transit tax revenues and state transit funding, weekday headways became 12 minutes all day while remaining at 20 minutes in the evening. Headways on Saturdays are 15 minutes all day and 20 minutes in the evening. Headways on Sundays and holidays are 20 minutes at all times. All CP/EV trains operate with 2-car consists. One-way run-time on the 19.7 mile alignment is approximately 65 minutes including dwell times at stations – an average operating speed of 18 mph.

Bus service in the Phoenix area is structured as a grid system, reflecting the fundamental character of the area's arterial street system. Some 65 percent of bus service was in the CP/EV corridor prior to the opening of light rail. The 20-mile rail line replaced the Red Line bus route that operated 2-way service from the Metrocenter Mall northwest of downtown Phoenix, through downtown, and east to Tempe and Mesa. Segments of the Red Line bus route that are not served by the 20-mile light rail line are now served by modifications to existing routes or the addition of new bus routes. Bus service was reduced along the north-south segment of the rail line on Central Avenue to avoid service redundancies. Bus service was also reduced along the east-west segment on Washington Street. Some bus routes on streets parallel to both segments of the rail alignment were re-routed to provide feeder connections.

Compared with METRO's fiscal year 2008 (that ended in July 2008), the net impact of changes within the CP/EV corridor by fiscal year 2010 was a 14 percent increase in vehicle-hours of bus service and, including the new light rail service, a 24 percent increase in total vehicle-hours. Area-wide, service increased over this 2-year interval by 33 percent. However, service reductions in METRO's FY 2011 eliminated much of this expansion: total vehicle-hours of service dropped to levels that were nine percent above 2008 within the CP/EV corridor and five percent above 2008 system-wide.

Throughout project development, light rail headways were planned for 10 minutes throughout the day on weekdays, an accurate prediction of actual service levels during the first 18 months of light rail operations. Headways were lengthened in July 2010 in response to the economic recession and its consequences. End-to-end run-times on light rail were projected to be 56 minutes; actual run-times average 65 minutes. Anticipated changes in corridor bus services were consistent with actual adjustments made to integrate the light rail line into the system. These changes were governed by a regional bus-rail interface plan developed early in final design by METRO, working with the cities of Phoenix, Tempe, and Mesa. Planned changes to the bus system did not anticipate the 2010 roll-back of much of the service expansion accomplished over the previous years.

Operating and maintenance costs

In METRO's fiscal year 2011, after the small roll-back in light rail service in July 2010, the 20-mile rail line cost \$31.0 million to operate and maintain. Bus O&M costs increased initially after light rail opening because of the net increase in bus service levels in the CP/EV corridor and in the region. After service roll-backs early in fiscal year 2011, however, O&M costs for system-wide fixed-route bus operations were nine percent below 2008 levels. With the addition of light rail and higher dial-a-ride costs, total O&M costs increased by nine percent over that interval.

During project development, METRO consistently anticipated annual O&M costs for light rail in the range of \$26-27 million in constant 2010 dollars (removing inflation effects to enable meaningful comparisons). The \$4-5 million under-estimate is attributable to under-estimates of both the vehicle-miles of service actually provided on the line (particularly on weekends and for special events) and the cost per mile for that service.

Ridership

Light rail ridership averaged 34,800 per weekday for the first year after project opening in December 2008, 39,400 per weekday by December 2010, and 40,700 in 2011. Ridership grew over this period even though the recession caused significant drops in local economic activity, employment, and transit service levels. Ridership varies significantly around these averages, with higher monthly averages during the academic year, during the winter when temporary residents relocate to Phoenix to avoid cold temperatures, and during months with several large attendance special events.

A rider survey in 2011 indicates that the most significant light rail ridership markets comprise travelers from throughout the metro area who travel to work, school, and other activities located at: (1) Tempe and Arizona State University (ASU); (2) downtown Phoenix and (3) Central Avenue north of downtown Phoenix. These markets account for 11,000, 8,000, and 7,000 weekday trips, respectively, and together represent 26,000 of the 41,000 total riders on light rail.

Trips by students to/from college campuses constitute the largest single market – 34 percent of all light-rail trips on the average weekday during the academic year – driven largely by the 55,000 students at ASU. The main ASU campus in Tempe attracts 8,300 college-student trips while the new campus in downtown Phoenix attracts 3,000 trips. Trips between home and work represent an additional 22 percent of light rail travel. Trips between home and non-work activities constitute a surprisingly large 34 percent, while trips between non-home activities add 10 percent of all weekday travel on light rail.

Average weekday transit ridership in metropolitan Phoenix grew from 141,000 door-to-door trips in 2007 to 175,000 in 2010, an increase of 33,000 trips. Ridership in the CP/EV corridor grew by 15,000 trips, accounting for 44 percent of all ridership gains. Light rail ridership appears to be on the order of two thirds former bus riders and one third travelers new to transit.

Predictions of project ridership initially focused only on the 2020 horizon year. The PE-entry forecast anticipated 25,800 light rail trips in 2020. Subsequent revisions to the travel models recognized emerging park-and-ride travel on the new Rapid bus-on-reserved-lane services, ridership to special events, travel by students, and emerging development patterns within the corridor. At the FFGA execution, the predicted light rail ridership was 49,900 weekday trips in 2020 and 26,000 weekday trips in the opening year.

The FFGA prediction of 26,000 trips opening-year trips on light rail is lower than actual 2011 ridership by 15,200 trips, or 37 percent. The FFGA prediction is also lower than actual 2011 ridership on the entire transit system by 56,300 trips, or 32 percent.

Careful analysis by METRO indicates that both under-predictions result largely from two problems in the underlying demographic forecasts used to make the FFGA predictions. First, the demographic forecasts did not anticipate the rapid growth in college-student enrollment, particularly at the ASU Tempe campus and the new ASU downtown campus. As a result, the FFGA opening-year forecast underestimated weekday college-student travel on light rail by 9,000 trips and on the entire transit system by 26,500 trips. Second, the demographic forecasts did not anticipate the rapid growth in the number of carless households and low-paid temporary workers associated with the boom in the construction labor market in metropolitan Phoenix from the 1990s through 2005. As a result, the FFGA opening-year forecast underestimated travel by members of carless households by 3,800 weekday trips on light rail, and 25,000 weekday trips on the entire transit system.

One component of the underestimates appears to be specific to rail. The FFGA prediction included only 1,300 weekday lightrail trips between non-home activities (like lunchtime trips from work to restaurants and retail stores) while actual ridership includes 4,000 weekday light rail trips. A second rail-specific difference in ridership patterns appears in the characteristics of riders traveling between home and various non-work activities. Light rail riders making these trips are much more likely than bus riders to come from car-owning households with higher incomes who often drive and park at a rail station to begin their trips. This difference suggests that travelers with choices are making discretionary trips on light rail – to restaurants, cultural centers, and sporting events – that do not appear in significant numbers in the bus system.