
Southwest Transitway Alternatives Analysis



*Technical Memorandum No. 8
Operating Cost Estimates*

*Prepared for
Hennepin County Regional Railroad Authority*

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1. Introduction

This technical memorandum documents the methodology, assumptions, and results of the Operating and Maintenance Cost Estimate task prepared for the Southwest Transitway Alternatives Analysis (Southwest Transitway AA).

2. Background and Assumptions

Annual operating and maintenance (O&M) costs consist of the ongoing costs of operating, maintaining, and managing the transit system.

These costs typically include:

- Labor costs (wages, fringe benefits, and other costs) for bus and rail operators, vehicle and facility maintainers, and other personnel directly engaged in providing transit service
- Fuel and electricity for motive power
- Parts, fluids and materials for maintaining the vehicles
- The non-labor operating costs of operating facilities (such as rail stations or bus park-and-ride lots) or maintenance facilities (such as bus and rail storage and maintenance facilities). These include utilities and materials for cleaning and maintaining the facilities.
- Administrative costs—labor and other costs associated with the management and direction of the transit agency.
- Insurance

Operating and maintenance costs were estimated in 2005 dollars and then escalated to 2006 dollars for reporting in this document. The costs also are reported in 2015 dollars, with all categories uniformly inflated at an annualized rate of 2.7%.

When estimating the annual operating and maintenance costs for the various Southwest Transitway alternatives it was assumed that all service identified in the Metropolitan Council's Transit 2030 Plan is operational. This includes the following transitway corridors: the Hiawatha light rail transit (LRT) line, the Northstar Commuter Rail line, the Central LRT line, the Cedar Avenue Busway, the I-35W Busway, the Bottineau Boulevard Busway, the Red Rock Commuter Rail, and the Rush Line Corridor. O&M costs include all bus and light rail system costs associated with the Southwest Transitway alternative improvements to the transit system but do not include costs for commuter rail services.

3. Methodology

The annual operating and maintenance cost estimates are developed on a system-wide basis, disaggregated into rail and bus services, to see that all changes to the transit system associated with a given alternative—whether the change is in the addition or modification of the rail system, or is in the underlying bus transit system—are reflected in the cost estimates. This methodology is consistent with the requirements of the Federal Transit Administration's New Starts process, which requires that projected annual

system-wide operating costs be a component of the calculation of user benefit statistics used for ranking potential projects.

Annual operating and maintenance costs for the alternatives were estimated using a multi-factor cost model. The cost model disaggregates actual O&M costs for recent years as reported by Metro Transit to the National Transit Database (NTDB), a database maintained by the Federal Transit Administration (FTA) to monitor and report the performance of US mass transit agencies. The costs are disaggregated into cost categories that can be reasonably assumed to vary with quantities of service provided. The differences in quantities of service provided under each alternative are expressed in differences in operating statistics that serve as cost drivers. These cost drivers include:

- Vehicle revenue hours of service
- Vehicle revenue miles of service
- Number of vehicles required in maximum service
- Number of fixed guideway miles

Some of the operating statistics relevant to operations and maintenance costing come from the Twin Cities Regional Model such as miles of bus and rail service and running times for the bus and rail routes; other operating statistics are factored from model numbers based on assumptions Metropolitan Council staff helped develop -- to obtain vehicle hours of service and fleet size, for example. As an example, under the LRT 1A alternative, the Twin Cities Regional Model estimated that compared to the Enhanced Bus alternative, the region would operate about 790,000 fewer annual revenue miles of service.

The basis for the FTA preferred process for operations and maintenance costing is based on existing local agency bus (and rail, if available) service characteristics factored for the cost categories that vary by the amount of each type of service characteristic. For example, some categories of operating costs tend to vary by miles of service (such as fuel costs), while others vary by hours of service (such as driver labor and fringe benefits), still others vary by the number of required peak vehicles (such as vehicle cleaning). For light rail operations, the model further segregates costs that vary by the number of fixed guideway miles.¹ These cost drivers were generated based on outputs from the ridership estimation tasks performed for each of the alternatives (the enhanced bus, BRT and LRT alternatives) using the Twin Cities Regional Model. Administrative costs are assumed to increase proportionally in response to changes in the volume of service based on their current proportion in the cost of operating the transit system. The model allows some cost items to remain “fixed” and invariable regardless of the volume of service operated. A full breakdown of the cost items and their assignment by cost categories is shown for bus operations in Table 1 and for rail operations in Table 2.

The data source for bus operating costs was Metro Transit’s 2003, 2004 and 2005 submissions to the NTDB. Costs for 2003 and 2004 were inflated to 2005 dollars at an annual inflation rate of 2.7%. Costs categories associated with each of the three cost drivers (revenue vehicle miles, hours and peak vehicles required under maximum

¹ NTDB does not require transit agencies to report statistics for BRT operations separate from those of other bus operations. For this reason the methodology applied to light rail—in which some cost categories are driven by the number of fixed guideway miles—was not used to estimate costs of BRT operations. BRT costs were included in overall bus operations.

service) were then averaged for the three years. The totals under each cost driver were then divided by the average value for each cost driver for the years 2003-2005.

For LRT, only 2005 costs categories and cost drivers were used, because 2005 was the first full year of LRT operations in the Twin Cities. For LRT, cost categories were assigned to a fourth cost driver, fixed guideway miles. The unit costs used in the estimates are reported at the bottom of Table 1 for bus and Table 2 for rail.

Table 1 Assignment of Operating Cost Items and Operating Cost Factors for Metro Bus Operations, Based on 2003-2005 Average Costs and Units

| 2003-2005 Actual Expenses | | | | | | | | |
|--|---------------------------|-----------------------|---------------------------------|----------------------|-------------------------------------|----------------------|------------------------------|------------|
| | Annual Cost & Attribution | | | | | | | |
| | Annual Cost | Revenue-Vehicle-Hours | Scheduled Revenue-Vehicle-Miles | Peak Vehicles | Exclusive Access Right-of-Way Miles | Fixed (not in model) | Gen Admin. Percentage Add-On | % of Total |
| Vehicle Operations Labor | | | | | | | | |
| Operator Salaries and Wages | \$ 54,900,139 | \$ 54,900,139 | | | | | | 27% |
| Other Salaries and Wages | \$ 12,748,443 | \$ 12,748,443 | | | | | | 6% |
| Fringe Benefits | \$ 46,082,752 | \$ 46,082,752 | | | | | | 23% |
| Services | \$ 341,688 | | | \$ 341,688 | | | | 0% |
| Sub-Total | \$ 114,073,022 | \$ 113,731,334 | \$ - | \$ 341,688 | \$ - | \$ - | | 57% |
| Vehicle Operations Materials and Supplies | | | | | | | | |
| Fuel and Lubricants | \$ 10,853,228 | | \$ 10,853,228 | | | | | 5% |
| Tires and Tubes | \$ 70,359 | | \$ 70,359 | | | | | 0% |
| Other Materials/Supplies | \$ 428,846 | | \$ 428,846 | | | | | 0% |
| Utilities | \$ - | | \$ - | | | | | 0% |
| Casualty and Liability | \$ - | | | \$ - | | | | 0% |
| Taxes | \$ - | | | \$ - | | | | 0% |
| Miscellaneous | \$ - | | | \$ - | | | | 0% |
| Expense Transfers | \$ - | | | | | \$ - | | 0% |
| Sub-Total | \$ 11,352,433 | \$ - | \$ 11,352,433 | \$ - | \$ - | \$ - | | 6% |
| Vehicle Maintenance Labor | | | | | | | | |
| Other Salaries and Wages | \$ 16,072,345 | | \$ 8,036,173 | \$ 8,036,173 | | | | 8% |
| Fringe Benefits | \$ 10,935,826 | | \$ 5,467,913 | \$ 5,467,913 | | | | 5% |
| Services | \$ 261,054 | | \$ 130,527 | \$ 130,527 | | | | 0% |
| Sub-Total | \$ 27,269,225 | \$ - | \$ 13,634,613 | \$ 13,634,613 | \$ - | \$ - | | 14% |

Source: Parsons Brinckerhoff, 2006

Table 1 cont. Assignment of Operating Cost Items and Operating Cost Factors for Metro Bus Operations, Based on 2003-2005 Average Costs and Units (continued)

| 2003-2005 Actual Expenses | | Annual Cost & Attribution | | | | | | |
|---|-----------------------|---------------------------|---------------------------------|----------------------|-------------------------------------|-----------------------|------------------------------|-------------|
| | Annual Cost | Revenue-Vehicle-Hours | Scheduled Revenue-Vehicle-Miles | Peak Vehicles | Exclusive Access Right-of-Way Miles | Fixed (not in model) | Gen Admin. Percentage Add-On | % of Total |
| Non-Vehicle Maintenance Materials and Supplies | | | | | | | | |
| Fuel and Lubricants | \$ - | | | \$ - | | | | 0% |
| Tires and Tubes | \$ - | | | \$ - | | | | 0% |
| Other Materials and Supplies | \$ 723,529 | | | \$ 723,529 | | | | 0% |
| Utilities | \$ - | | | \$ - | | | | 0% |
| Casualty & Liability | \$ 81,802 | | | \$ 81,802 | | | | 0% |
| Taxes | \$ - | | | \$ - | | | | 0% |
| Miscellaneous | \$ - | | | \$ - | | | | 0% |
| Expense Transfer | \$ 805,331 | | | | | \$ - | | 0% |
| Sub-Total | \$ 7,144,542 | \$ - | \$ - | \$ 805,331 | \$ - | \$ - | | 4% |
| General Administration | | | | | | | | |
| Other Salaries and Wages | \$ 13,383,947 | | | | | | \$ 13,383,947 | 7% |
| Fringe Benefits | \$ 8,402,777 | | | | | | \$ 8,402,777 | 4% |
| Services | \$ 4,993,994 | | | | | | \$ 4,993,994 | 2% |
| Fuel and Lubricants | \$ - | | | | | | \$ - | 0% |
| Tires and Tubes | \$ - | | | | | | \$ - | 0% |
| Other Materials and Supplies | \$ 1,655,942 | | | | | | \$ 1,655,942 | 1% |
| Utilities | \$ 4,751,012 | | | | | | \$ 4,751,012 | 2% |
| Casualty and Liability | \$ 2,482,302 | | | | | | \$ 2,482,302 | 1% |
| Taxes | \$ 25,130 | | | | | | \$ 25,130 | 0% |
| Miscellaneous Expense | \$ 2,028,723 | | | | | | \$ 2,028,723 | 1% |
| Expense Transfers | \$ (2,980,879) | | | | | \$ (2,980,879) | \$ (2,980,879) | -1% |
| Sub-Total | \$ 34,742,949 | \$ - | \$ - | \$ - | \$ - | \$ (2,980,879) | \$ 34,742,949 | 17% |
| TOTAL | \$ 199,881,320 | \$ 113,731,334 | \$ 30,351,760 | \$ 21,055,278 | \$ - | \$ (2,980,879) | \$ 34,742,949 | 100% |
| Percent | | | | | | | | |
| Units Per Year | | 1,878,701 | 23,657,087 | 724 | | 1 | \$ 165,138,371 | |
| UNIT COST (2005 Dollars) | | \$ 60.54 | \$ 1.28 | \$ 29,095 | | \$ (2,980,879) | 21.0% add-on | |

Source: Parsons Brinckerhoff, 2006

Table 2 Assignment of Operating Cost Items and Operating Cost Factors for Metro Light Rail Operations, Based on 2005 Costs and Units

| 2005 Actual Expenses | | | | | | | | |
|---|---------------------------|---------------------|-----------------------------|-------------------|-------------|----------------------|------------------------------|------------|
| | Annual Cost & Attribution | | | | | | | |
| | Annual Cost | Train-Revenue Hours | Scheduled Revenue-Car-Miles | Peak Vehicles | Track-Miles | Fixed (not in model) | Gen Admin. Percentage Add-On | % of Total |
| Vehicle Operations Labor | | | | | | | | |
| Operator Salaries and Wages | \$ 1,909,153 | \$ 1,909,153 | | | | | | 11% |
| Other Salaries and Wages | \$ 983,729 | \$ 983,729 | | | | | | 6% |
| Fringe Benefits | \$ 1,317,904 | \$ 1,317,904 | | | | | | 8% |
| Services | \$ 88,872 | | | \$ 88,872 | | | | 1% |
| Sub-Total | \$ 4,299,658 | \$ 4,210,786 | \$ - | \$ 88,872 | \$ - | \$ - | | 26% |
| Vehicle Operations Materials and Supplies | | | | | | | | |
| Fuel and Lubricants | \$ 6,201 | | \$ 6,201 | | | | | 0% |
| Tires and Tubes | \$ - | | \$ - | | | | | 0% |
| Other Materials/Supplies | \$ 79,520 | | \$ 79,520 | | | | | 0% |
| Utilities | \$ 1,107,638 | | \$ 1,107,638 | | | | | 7% |
| Casualty and Liability | \$ - | | | \$ - | | | | 0% |
| Taxes | \$ - | | | \$ - | | | | 0% |
| Miscellaneous | \$ - | | | \$ - | | | | 0% |
| Expense Transfers | \$ - | | | | | \$ - | | 0% |
| Sub-Total | \$ 1,193,359 | \$ - | \$ 1,193,359 | \$ - | \$ - | \$ - | | 7% |
| | \$ 5,493,017 | | | | | | | |
| Vehicle Maintenance Labor | | | | | | | | |
| Other Salaries and Wages | \$ 1,168,568 | | \$ 584,284 | \$ 584,284 | | | | 7% |
| Fringe Benefits | \$ 532,453 | | \$ 266,227 | \$ 266,227 | | | | 3% |
| Services | \$ 2,947 | | \$ 1,474 | \$ 1,474 | | | | 0% |
| Sub-Total | \$ 1,703,968 | \$ - | \$ 851,984 | \$ 851,984 | \$ - | \$ - | | 10% |
| Vehicle Maintenance Materials and Supplies | | | | | | | | |
| Fuel and Lubricants | \$ 33,479 | | \$ 33,479 | | | | | 0% |
| Tires and Tubes | \$ - | | \$ - | | | | | 0% |
| Other Materials and Supplies | \$ 174,084 | | \$ 174,084 | | | | | 1% |
| Utilities | \$ - | | | \$ - | | | | 0% |
| Casualty & Liability | \$ 196,373 | | | \$ 196,373 | | | | 1% |
| Taxes | \$ - | | | \$ - | | | | 0% |
| Miscellaneous | \$ - | | \$ - | | | | | 0% |
| Expense Transfer | \$ 403,936 | | | | | \$ - | | 0% |
| Sub-Total | \$ 2,107,904 | \$ - | \$ 207,563 | \$ 196,373 | \$ - | \$ - | | 2% |

Source: Parsons Brinckerhoff, 2006

Table 2 cont. Assignment of Operating Cost Items and Operating Cost Factors for Metro Light Rail Operations, Based on 2005

| 2005 Actual Expenses | | | | | | | | |
|---|---------------------------|---------------------|-----------------------------|---------------------|---------------------|----------------------|------------------------------|-------------|
| | Annual Cost & Attribution | | | | | | | |
| | Annual Cost | Train-Revenue Hours | Scheduled Revenue-Car-Miles | Peak Vehicles | Track-Miles | Fixed (not in model) | Gen Admin. Percentage Add-On | % of Total |
| Non-Vehicle Maintenance Labor | | | | | | | | |
| Other Salaries and Wages | \$ 1,602,646 | | | | \$ 1,602,646 | | | 10% |
| Fringe Benefits | \$ 730,150 | | | | \$ 730,150 | | | 4% |
| Services | \$ 94,723 | | | | \$ 94,723 | | | 1% |
| Sub-Total | \$ 2,427,519 | \$ - | \$ - | \$ - | \$ 2,427,519 | \$ - | | 15% |
| Non-Vehicle Maintenance Materials and Supplies | | | | | | | | |
| Fuel and Lubricants | \$ - | | | | \$ - | | | 0% |
| Tires and Tubes | \$ - | | | | \$ - | | | 0% |
| Other Materials and Supplies | \$ 326,707 | | | | \$ 326,707 | | | 2% |
| Utilities | \$ - | | | | \$ - | | | 0% |
| Casualty & Liability | \$ 19,176 | | | | \$ 19,176 | | | 0% |
| Taxes | \$ - | | | | \$ - | | | 0% |
| Miscellaneous | \$ - | | | | \$ - | | | 0% |
| Expense Transfer | \$ - | | | | | \$ - | | 0% |
| Sub-Total | \$ 345,883 | \$ - | \$ - | \$ - | \$ 345,883 | \$ - | | 2% |
| | \$ 2,773,402 | | | | | | | |
| General Administration | | | | | | | | |
| Other Salaries and Wages | \$ 817,588 | | | | | | \$ 817,588 | 5% |
| Fringe Benefits | \$ 402,385 | | | | | | \$ 402,385 | 2% |
| Services | \$ 495,065 | | | | | | \$ 495,065 | 3% |
| Fuel and Lubricants | \$ - | | | | | | \$ - | 0% |
| Tires and Tubes | \$ - | | | | | | \$ - | 0% |
| Other Materials and Supplies | \$ 126,583 | | | | | | \$ 126,583 | 1% |
| Utilities | \$ 469,828 | | | | | | \$ 469,828 | 3% |
| Casualty and Liability | \$ 255,844 | | | | | | \$ 255,844 | 2% |
| Taxes | \$ - | | | | | | \$ - | 0% |
| Miscellaneous Expense | \$ 176,971 | | | | | | \$ 176,971 | 1% |
| Expense Transfers | \$ 3,545,727 | | | | | \$ 3,545,727 | \$ 3,545,727 | 21% |
| Sub-Total | \$ 6,289,991 | \$ - | \$ - | \$ - | \$ - | \$ 3,545,727 | \$ 6,289,991 | 38% |
| TOTAL | \$ 16,664,314 | \$ 4,210,786 | \$ 2,252,906 | \$ 1,137,229 | \$ 2,773,402 | \$ 3,545,727 | \$ 6,289,991 | 100% |
| Percent | | | | | | | | |
| Units Per Year | | 67,081 | 1,051,373 | 22 | 24.40 | 1 | \$ 10,374,323 | |
| UNIT COST (Jan 2005 Dollars) | | \$ 62.77 | \$ 2.14 | \$ 51,692 | \$ 113,664 | \$ 3,545,727 | 60.6% add-on | |

Source: Parsons Brinckerhoff, 2006

The annual operating and maintenance cost estimates for the bus components of the Enhanced Bus, BRT and LRT alternatives were derived by multiplying the annual revenue vehicle hours of service, the annual revenue vehicle miles of service, and the number of vehicles required during the peak period by their respective cost factors. In addition, administrative costs were calculated by multiplying the total costs associated with these three cost drivers by the administrative cost factor (21%).

The operating statistics for the Enhanced bus and the BRT and LRT alternatives were developed through use of output for each of the alternatives generated by the Twin Cities Regional Ridership Model. The model generates an estimate of the directional revenue hours and miles of service, and the number of buses or trains required to operate the service, for each direction of each bus route or rail line in the network; this is done for one hour of peak and one hour of off-peak period of operation. By way of example, Table 3, below, shows the estimated one-way revenue travel time and distance in miles for the LRT lines included under Alternative 1C, which includes the existing Hiawatha Corridor LRT and planned Central Corridor LRT lines as well as one of the options for LRT service in the Southwest Transitway AA:

Table 3 One-Way Revenue Travel Time and Mileage for LRT Lines Tested Under Alternative 1C.

| Line | Revenue Travel Time (mins) | Revenue Distance (miles) |
|---------------------------------|----------------------------|--------------------------|
| Hiawatha Northbound | 37.7 | 11.63 |
| Hiawatha Southbound | 37.7 | 11.63 |
| Central Corridor Eastbound | 44.7 | 10.71 |
| Central Corridor Westbound | 44.7 | 10.71 |
| Southwest Transitway Northbound | 29.9 | 14.44 |
| Southwest Transitway Southbound | 29.9 | 14.44 |

Source: Parsons Brinckerhoff, 2006

The estimates of revenue travel time and distance are used to generate an estimate of the number of vehicles required to operate the service during the peak hour, and also are built up through factoring to create the annual estimates of revenue vehicle hours and miles of service for each alternative, with separate estimates developed for rail and bus services.

Revenue travel time is converted to revenue vehicle hours for bus and rail by adding a 15% layover factor to each single direction trip, to account for required operator rest and schedule recovery time. On LRT lines an additional 2 minutes is added to each directional trip for turn time, the time required for the LRT operator to walk from the head end to the tail end of the train between directional trips. Revenue vehicle miles, which do not include deadhead miles, are taken directly from the travel distance estimates provided by the model. The revenue vehicle hours and miles are multiplied by the number of trips operated during each peak and off peak hour to estimate the number of revenue vehicle hours and miles that each line will generate during each peak and off-peak hour.

The revenue vehicle hours and miles for the peak period are multiplied by 6, for the number of peak hours of operation in each weekday. The consultant team estimated the equivalent number of hours of typical mid-day service that would be required to

approximate a typical weekday, based on information provided by Metropolitan Council-Metro Transit that indicated the number of buses in operation under the existing (2004) Minneapolis-St. Paul regional transit system for each hour of the day. This equivalency factor accounted for the fluctuations in service over the course of a weekday; the buildup of service from 4:00 a.m. to 6:00 a.m.; the morning peak period (approximately 6:00 a.m. to 9:00 a.m.), the midday period (approximately 3:30 p.m. to 6:30 p.m.) and the gradual tapering off of service levels from approximately 7:00 p.m. to 2:00 a.m. Based on this analysis, the consultants estimated that make up the revenue vehicle hours of service operated by each line during each peak and off-peak hour was equivalent to about 12.45 hours of off-peak service and six hours of peak service as measured by the Twin Cities Transportation Model. Analysis of the existing Hiawatha LRT operation indicated that LRT services would operate approximately 10.5 equivalent hours of off peak service each day, in addition to six hours of peak period service.

The final step in developing annual revenue vehicle hours and miles of service is the application of the annualization factor. This factor converts the estimates of weekday vehicle revenue hours and miles of service to an annual estimate, taking into account the lower levels of service provided on Saturdays, Sundays and Holidays. For bus services, this factor was developed by comparing the average number of buses in operation by hour on weekdays to the number in operation on Saturdays and Sundays-Holidays. Using this methodology, the consultants estimated that the Saturday volume of service is about half (50%) of the weekday volume of service, and the volume on Sundays and Holidays is about one-third (35%) of the weekday volume. Based on this analysis, the consultants estimated the annualization factor for bus service to be 299 equivalent weekdays of service per year.

Based on examination of weekday and weekend schedules for the Hiawatha LRT service, the annualization factor for LRT was determined to be 349 equivalent weekdays per year.

The number of buses required under each alternative is estimated by dividing the travel and layover time for each direction of each bus route by the peak period headway of the route as provided under each alternative in the travel demand model. The number of buses required for each route are added together to make up a system-wide estimate. For the LRT services, a more precise methodology in which the travel and layover time for *both* directions of the service are added together and then divided by the peak headway was employed. This latter method is more precise than the method used for the bus alternatives, but was deemed impractical for estimating the number of vehicles required for the bus routes, primarily because many of the routes do not operate parallel alignments or schedules in the inbound and outbound directions during the peak period. These estimates are provided as inputs to the Capital Cost estimates, which are documented in Technical Memorandum No. 7.

Table 4 illustrates the operating and maintenance cost calculation for the bus portion of the Enhanced Bus alternative. This Enhanced Bus alternative includes improvements recommended as a part of the Southwest Transitway Alternatives Analysis to address transit needs in the southwest corridor, as well as numerous other improvements that would increase the volume of service provided by the Twin Cities Metropolitan Region's transit system. These include the recommendations of the Metropolitan Council's Transit 2030 Plan, which includes implementation of Central Corridor LRT and Cedar Avenue Busway, among other major projects. Under this alternative, the region's transit system would operate an estimated 3.4 million annual revenue vehicle hours of service

and about 49.4 million annual revenue vehicle miles of service. The system would require 1,275 buses (not including spares) to operate during the peak period of service. Multiplying each of these drivers by the relevant cost factors (and escalating the 2005\$ by 2.7% for 2006\$) indicates an operating cost of about \$314.9 million each year before administrative markup. Adding the 21% administrative markup increases the cost to \$381.2 million per year. The calculation is shown in Table 4.

Table 4 Calculation of Bus O&M Costs for 2030 Operation of Enhanced Bus Alternative (2006\$)

| Enhanced Bus | Ann Rev Veh Hrs | Ann Rev Veh Miles | Peak Fleet Requirement | O&M Costs |
|--|------------------------|--------------------------|-------------------------------|----------------------|
| Bus Units | 3,404,857 | 49,430,242 | 1,275 | |
| Bus Unit Costs | 60.54 | 1.28 | 29,095.27 | |
| Units X Unit Costs | 206,120,628 | 63,418,408 | 37,096,470 | 314,914,665 |
| General Administrative Costs related to bus (factored 21%) | | | | 66,253,918 |
| Total Bus Annual O&M Costs (2006\$) | | | | 381,168,582 |

Source: Parsons Brinckerhoff, 2006

The LRT component of the Enhanced Bus alternative includes both the operation of the existing Hiawatha Line as well as the planned Central Corridor line. The estimates anticipate that operation of these two lines, which together comprise 45.8 miles of fixed guideway, would generate 141,000 annual revenue vehicle hours and nearly 1.9 million annual revenue vehicle miles of service each year. The operation would require 56 vehicles (28 two-car trains) to operate at the period of peak demand. These operating statistics generate an annual O&M cost (escalated to 2006\$) for the LRT system of \$21.6 million. Adding the administrative markup (60.6%) increases the annual O&M cost to \$35.0 million. The calculations are shown in Table 5.

Table 5 Calculation of Rail O&M Costs for 2030 operation of Enhanced Bus Alternative (2006\$)

| Enhanced Bus-LRT | Ann Rev Veh Hrs | Ann Rev Veh Miles | Peak Fleet Requirement | Fixed Guideway Miles | O&M Costs |
|---|------------------------|--------------------------|-------------------------------|-----------------------------|----------------------|
| Rail Units | 141,424 | 1,887,846 | 56 | 45.8 | |
| Rail Unit Costs | 62.77 | 2.14 | 51,692.23 | 113,664.02 | |
| Units X Unit Costs | 8,877,440.96 | 4,045,318.74 | 2,894,764.73 | 5,205,811.95 | 21,590,925 |
| General Administrative Costs related to rail (factored) | | | | 60.6% | 13,090,659 |
| Total Bus Annual O&M Costs (2006\$) | | | | | 34,681,585 |

Source: Parsons Brinckerhoff, 2006

4. Results: Operating and Maintenance Cost Estimates for Build Alternatives

Annual O&M cost estimates were generated for the Enhanced Bus alternative, two BRT and eight LRT alternatives. The incremental annual O&M costs for the “Build” alternatives, defined as BRT and LRT, are generated by comparing the system wide transit costs with the “build” alternative implemented to the system wide transit costs with the Enhanced Bus alternative implemented. Again, for purposes of this analysis, the Enhanced Bus alternative assumes that by 2030 the following transitways are operational, the Hiawatha and Central LRT lines, the Northstar Commuter Rail line, the Cedar Avenue, I-35W, and Bottineau Boulevard busways, and the Red Rock and Rush Line Corridors.

The cost estimates take into account system wide costs for the Bus, BRT and LRT portions of the system, but do not include costs for commuter rail services. Table 6 includes the estimated costs for operating the entire regional transit system, including the proposed Southwest Transitway alternative, in year 2006 dollars. Table 7 includes the incremental cost over the Enhanced Bus alternative for operating the proposed Southwest Transitway alternative in year 2006 dollars.

As noted above, System wide revenue vehicle hours and miles and the peak requirement for vehicles were derived from the results of the regional travel demand model runs. The model generated these statistics for the following alternatives: Enhanced Bus, BRT 1, LRT 1A, LRT 1C, LRT 2C, LRT 3C, and LRT 4A. For the remaining alternatives interpolation was used to generate annual operating and maintenance cost estimates.

Table 6 Estimated Total System Cost for 2030 Operation of Enhanced Bus and LRT and BRT Build Alternatives (2006 \$)

| | Bus | Light Rail | Total |
|--------------|-------------|-------------------|--------------|
| Enhanced Bus | 381,168,582 | 34,681,585 | 415,850,167 |
| BRT 1 | 382,555,936 | 34,681,585 | 417,237,521 |
| BRT 2* | 383,141,199 | 34,681,585 | 417,822,783 |
| LRT 1A | 375,869,578 | 49,041,817 | 424,911,395 |
| LRT 1C | 375,630,349 | 50,722,625 | 426,352,974 |
| LRT 2A* | 376,714,840 | 50,770,988 | 427,485,829 |
| LRT 2C | 375,879,380 | 52,186,273 | 428,065,652 |
| LRT 3A* | 377,041,536 | 51,298,970 | 428,340,506 |
| LRT 3C | 376,205,436 | 53,075,423 | 429,280,859 |
| LRT 4A | 377,641,151 | 44,209,584 | 421,850,735 |
| LRT 4C* | 376,803,735 | 45,706,912 | 422,510,647 |

*Not modeled, estimate based on interpolation of data

Source: Parsons Brinckerhoff, 2006

Table 7 Estimated Incremental System Cost for Build Alternatives Compared to Enhanced Bus (2006 \$)

| | Bus | Light Rail | Total |
|---------|-------------|-------------------|--------------|
| BRT 1 | 1,387,354 | - | 1,387,354 |
| BRT 2* | 1,972,616 | - | 1,972,616 |
| LRT 1A | (5,299,004) | 14,360,232 | 9,061,228 |
| LRT 1C | (5,538,233) | 16,041,040 | 10,502,807 |
| LRT 2A* | (4,453,742) | 16,089,404 | 11,635,662 |
| LRT 2C | (5,289,203) | 17,504,688 | 12,215,485 |
| LRT 3A* | (4,127,047) | 16,617,386 | 12,490,339 |
| LRT 3C | (4,963,146) | 18,393,838 | 13,430,692 |
| LRT 4A | (3,527,431) | 9,527,999 | 6,000,568 |
| LRT 4C* | (4,364,847) | 11,025,328 | 6,660,480 |
| BRT 1 | 1,387,354 | - | 1,387,354 |

*Not modeled, estimate based on interpolation of data
 Source: Parsons Brinckerhoff, 2006

The operating costs also were escalated to 2015 dollars, using a single annual inflation factor of 2.7% (at 2.7% compounded annually 2005 to 2015). Table 8 shows the system-wide costs in 2015 dollars, while Table 9 shows the incremental cost in 2015 dollars.

Table 8 Estimated Total System Cost for Enhanced Bus and Build Alternatives (2015 \$)

| | Bus | Light Rail | Total |
|--------------|-------------|-------------------|--------------|
| Enhanced Bus | 484,452,375 | 44,079,121 | 528,531,496 |
| BRT 1 | 486,215,655 | 44,079,121 | 530,294,776 |
| BRT 2* | 486,959,504 | 44,079,121 | 531,038,625 |
| LRT 1A | 477,717,520 | 62,330,490 | 540,048,010 |
| LRT 1C | 477,413,468 | 64,466,740 | 541,880,208 |
| LRT 2A* | 478,791,820 | 64,528,209 | 543,320,028 |
| LRT 2C | 477,729,977 | 66,326,987 | 544,056,965 |
| LRT 3A* | 479,207,038 | 65,199,256 | 544,406,294 |
| LRT 3C | 478,144,384 | 67,457,067 | 545,601,451 |
| LRT 4A | 479,969,129 | 56,188,886 | 536,158,015 |
| LRT 4C* | 478,904,802 | 58,091,939 | 536,996,741 |

*Not modeled, estimate based on interpolation of data
 Source: Parsons Brinckerhoff, 2006

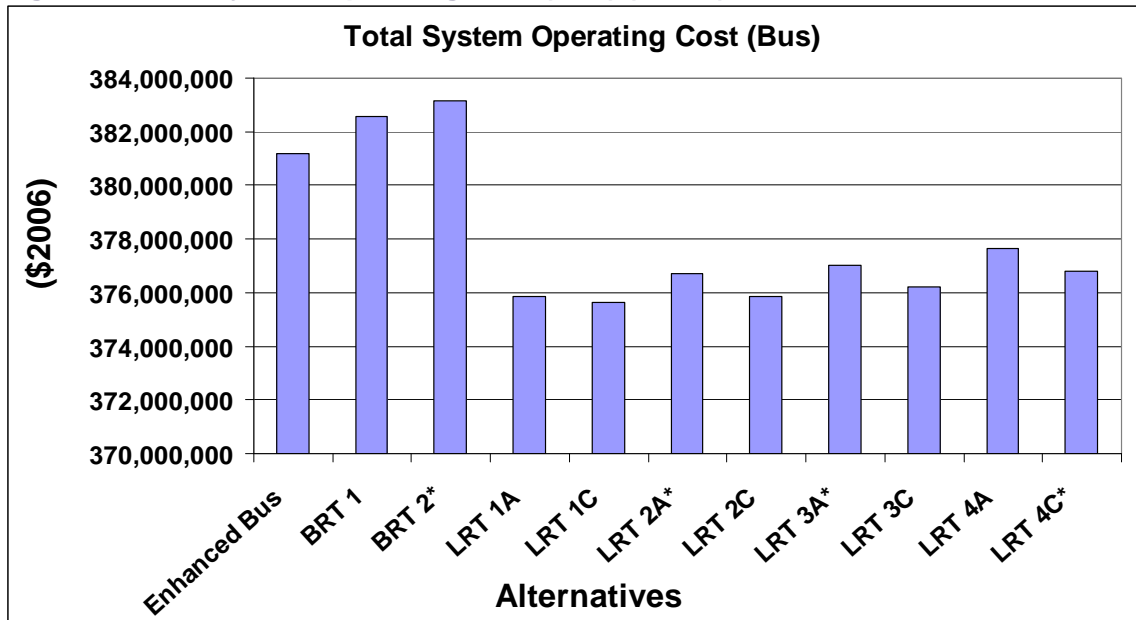
Table 9 Estimated Incremental System Cost for Build Alternatives Compared to Enhanced Bus (2015\$)

| | Bus | Light Rail | Total |
|---------|-------------|-------------------|--------------|
| BRT 1 | 1,763,280 | - | 1,763,280 |
| BRT 2* | 2,507,129 | - | 2,507,129 |
| LRT 1A | (6,734,855) | 18,251,370 | 11,516,514 |
| LRT 1C | (7,038,907) | 20,387,619 | 13,348,712 |
| LRT 2A* | (5,660,555) | 20,449,088 | 14,788,533 |
| LRT 2C | (6,722,398) | 22,247,867 | 15,525,469 |
| LRT 3A* | (5,245,337) | 21,120,135 | 15,874,798 |
| LRT 3C | (6,307,991) | 23,377,946 | 17,069,955 |
| LRT 4A | (4,483,246) | 12,109,765 | 7,626,519 |
| LRT 4C* | (5,547,573) | 14,012,818 | 8,465,245 |
| BRT 1 | 1,763,280 | - | 1,763,280 |

*Not modeled, estimate based on interpolation of data
 Source: Parsons Brinckerhoff, 2006

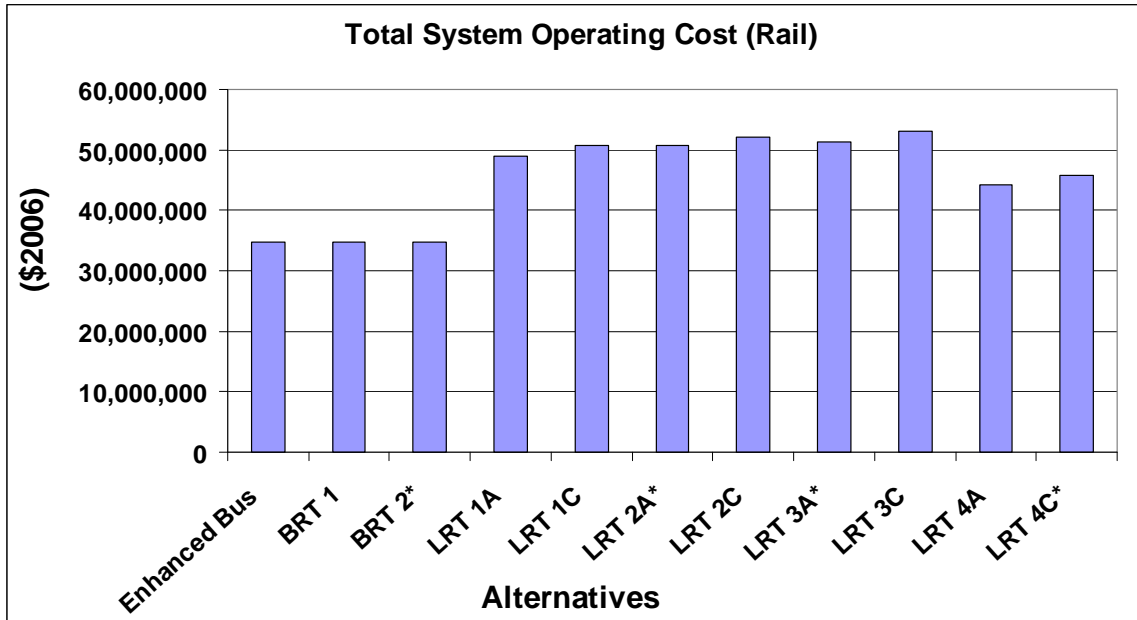
The following four figures illustrate the comparative relationships by modal types of operating costs among all alternatives for 2006. The relationships among the alternatives in 2015 would be exactly the same but at higher levels of operating costs.

Figure 1 Total System Operating Cost (Bus) (2006\$)



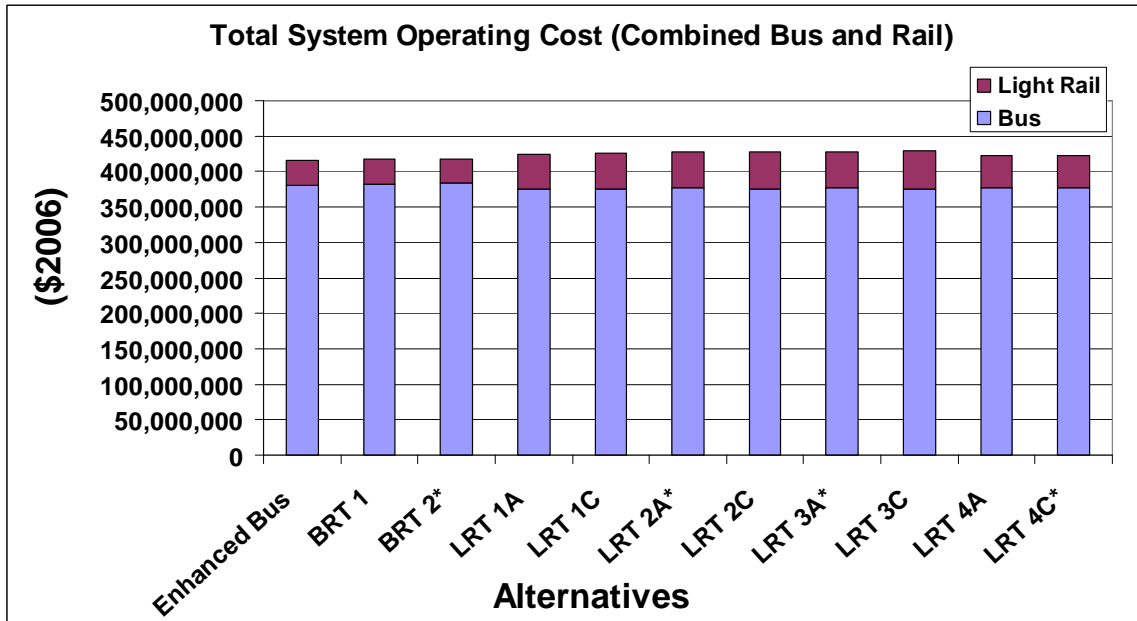
Source: Parsons Brinckerhoff, 2006

Figure 2 Total System Operating Cost (Rail) (2006\$)



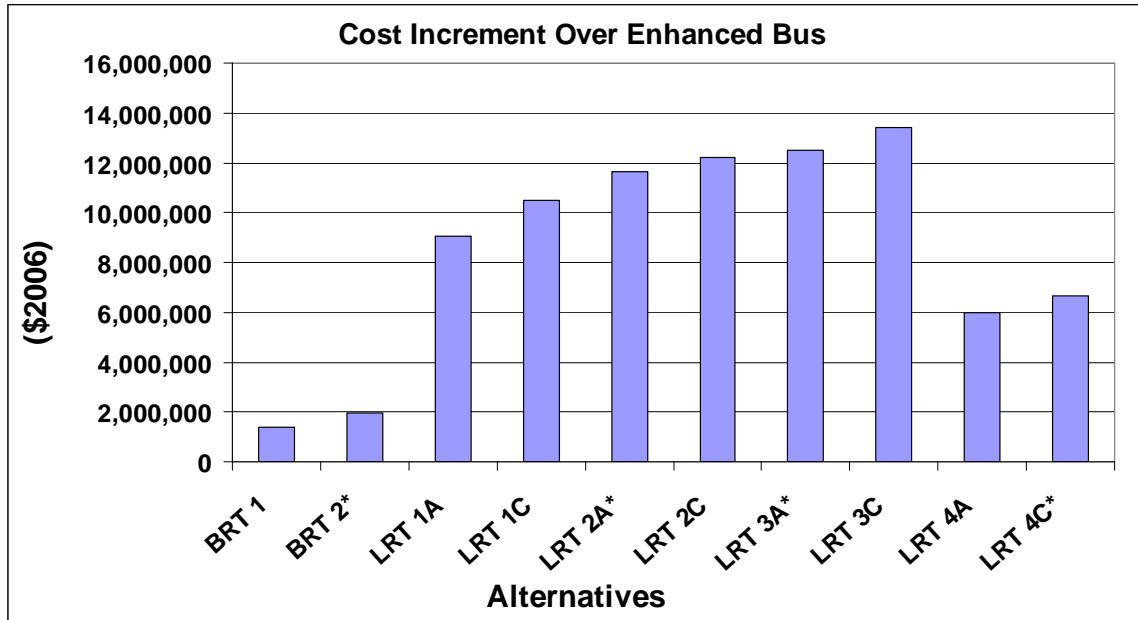
Source: Parsons Brinckerhoff, 2006

Figure 3 Total System Operating Cost (Combined Bus and Rail) (2006\$)



Source: Parsons Brinckerhoff, 2006

Figure 4 Cost Increment of Total System over Enhanced Bus (\$2006)



Source: Parsons Brinckerhoff, 2006