

# **SANTA CLARA-ALUM ROCK CORRIDOR**

**UPDATE TO CONCEPTUAL ENGINEERING**

## **Operating & Maintenance Statistics and Costs**

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prepared by

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## 1.0 Introduction and Description of Alternatives

This technical report documents the refinement of run times, operating statistics, and operating and maintenance (O&M) costs as developed in 2007 for refined alternatives in the Santa Clara-Alum Rock corridor. The following operations-related tasks were performed:

- Development of run times for alternatives along Santa Clara-Alum Rock corridor;
- Development of operating statistics (vehicle requirements, annual vehicle miles and annual vehicle hours); and
- Estimate of operating and maintenance (O&M) costs.

Two basic alternatives in the Santa Clara-Alum Rock corridor were analyzed: a bus rapid transit (BRT) alternative and a light rail transit (LRT) alternative.

### 1.1 *Bus Rapid Transit (BRT)*

Under this alternative, the project corridor would start at Diridon Station and proceed eastward along Santa Clara Street - Alum Rock Avenue, turning southward on Capitol Avenue – Capitol Expressway to a terminus at Eastridge Mall. Exclusive bus lanes would be provided along Santa Clara and Alum Rock from King to Capitol Avenue. Otherwise, buses would use mixed flow lanes. Transit priority is anticipated east of 15<sup>th</sup> Street/Santa Clara Street. Two bus routes would take advantage of the BRT facility: the existing Route 522 from Palo Alto to Eastridge Mall would be rerouted to use the BRT facility. A new Route 523 from Diridon to Eastridge Mall would be introduced. Proposed stops are listed in **Table 1-1**.

**Table 1-1. Summary of BRT Stops**

BRT Stops
Diridon
1st/Santa Clara
6th/Santa Clara
16th/Santa Clara
28th/Santa Clara
King/Alum Rock
Jackson
Alum Rock
Story
Ocala
Eastridge

It should be noted that an earlier option provided additional stops at Almaden/Santa Clara, 11<sup>th</sup> Street/Santa Clara, 21<sup>st</sup> Street/Santa Clara, Sunset/Alum Rock and Alexander/Alum Rock.

Headways for each line are assumed to be 12 minutes all day. This leads to a combined frequency of 6 minutes in the project corridor from Diridon to Eastridge. Service characteristics are assumed to be similar in span to existing Route 522, though it is assumed that Sunday

service will be added so that both routes operate seven days a week. A representative service schedule for each of the two routes is provided in **Table 1-2**.

**Table 1-2. Representative Service Levels for BRT Routes 522 and 523**

Time Period	Hours	Frequency of Service (minutes)
<b>Weekdays</b>		
AM Peak	6am to 9am	12 minutes
Midday	9am to 3pm	12 minutes
PM Peak	3pm to 6pm	12 minutes
Evening	6pm to 9pm	30 minutes
<b>Saturdays</b>		
Base	6am to 6pm	15 minutes
Evening	6pm to 8:30pm	30 minutes
<b>Sundays/Holidays</b>		
Base	6am to 6pm	15 minutes
Evening	6pm to 8:30pm	30 minutes

BRT vehicles are assumed to be articulated. It is anticipated that vehicles may be hybrid in the future.

### 1.2 Light Rail Transit (LRT)

The LRT route begins at Diridon Station and proceeds along San Fernando Street and Almaden Boulevard before making its way eastward along Santa Clara Street - Alum Rock Avenue, turning southward on Capitol Avenue – Capitol Expressway to a terminus at Eastridge Mall. Operations are assumed to be double-tracked. LRT would share its right-of-way with mixed traffic on the west end of Santa Clara Street until King. East of King, LRT would operate in exclusive lanes. Transit priority at signals is assumed east of 15<sup>th</sup> Street/Santa Clara Street. Once on Capital Expressway, the alignment is assumed to be on aerial structure south of Wilbur Avenue to the Ocala Station, transitioning to an underpass as it approaches the final station at Eastridge. This means there is no conflict or interaction with traffic south of Wilbur Avenue to its terminus. Proposed LRT stations are listed in **Table 1-3**.

**Table 1-3. Summary of LRT Stations**

LRT Stations
Diridon
San Fernando
Almaden
1st/Santa Clara
6th/Santa Clara
16th/Santa Clara
28th/Santa Clara
King/Alum Rock
Jackson
Alum Rock
Story
Ocala
Eastridge

Headways are assumed to be 15 minutes all day, matching headways with currently operated LRT services. Service characteristics are assumed to be similar in span to other LRT lines. This leads to a longer span of service assumed on weekends than what is assumed for the BRT alternative. A representative service schedule for the LRT line is provided in **Table 1-4**.

**Table 1-4. Representative Service Levels for LRT**

Time Period	Hours	Frequency of Service (minutes)
<b>Weekdays</b>		
AM Peak	6am to 9am	15 minutes
Midday	9am to 3pm	15 minutes
PM Peak	3pm to 7pm	15 minutes
Evening	7pm to 10:30pm	30 minutes
<b>Saturdays</b>		
Base	6am to 7pm	15 minutes
Evening	7pm to 10:30pm	30 minutes
<b>Sundays/Holidays</b>		
Base	6am to 7pm	15 minutes
Evening	7pm to 10:30pm	30 minutes

LRT trains are assumed to operate as single-car trains, since design constraints (block length) do not allow for longer consists.

## 2.0 Development of Operating Statistics

This section describes the development of operating statistics for the corridor alternatives: run times, annual service hours and annual service miles, and fleet requirements. These operating statistics are not only useful for operations planning purposes, but are used to calculate input variables for the model which estimates operating and maintenance (O&M) costs.

### 2.1 Run Time Estimates

Run times for the Santa Clara-Alum Rock corridor were estimated using a model which calculates run times based on distance between stations, maximum design speed, acceleration/deceleration characteristics of the vehicle, dwell time at stops, and estimated delay per mile based on industry guidelines. Run times were developed without regard to direction (that is, run times represent an average between westbound and eastbound directions).

**Distance between stations.** Measurements used engineering drawings. For stops where westbound and eastbound platforms were split, a midpoint location was used. For the segment along Santa Clara-Alum Rock, engineering drawings prepared by DMJM Harris/AECOM were used (Technical Appendix, Project Definition Report Santa Clara/Alum Rock Corridor, January 2007). Remaining segments on the west and east ends of the corridor used earlier engineering drawings from Korve Engineering since these remained unchanged from earlier efforts: Vasona drawings from 1999 for the segment from Diridon Station to Delmas, and Capitol Expressway drawings from 2002 for the segment from Alum Rock to Eastridge.

**Maximum design speed.** Maximum speeds were assumed to be the existing speed limit. For portions of the alignment where the geometry may limit speeds, the maximum speed reflects any limitations due to curves in the alignments.

**Acceleration/deceleration characteristics.** The rate at which the vehicle accelerates and decelerates is distinguished by mode, using prototypical vehicle specifications. All else being equal, an LRT vehicle is able to accelerate and decelerate more nimbly than a bus, leading to improved travel times over a bus.

**Dwell time at stops.** Dwell times for LRT stations are presumed to be 20 seconds. Dwell times for BRT stops are also presumed to be 20 seconds except for stations with anticipated high volumes or transfer points, which are presumed to be 30 seconds. (In the case of this corridor, high-volume stations are identified at 1<sup>st</sup>-2<sup>nd</sup>/Santa Clara, 6<sup>th</sup>/Santa Clara, Alum Rock and Eastridge.) The distinctions between LRT and BRT dwell times are based on the concept that LRT is able to maintain greater consistency in boarding times because of vehicle design features which allow greater room to board.

For LRT, two stations add 0.10 minutes (6 seconds) to the dwell time to represent the potential delay at the first station where the line merges with another LRT line. For the eastbound direction, this would occur at Diridon where the Vasona Line is assumed to have priority, and at Capitol/Alum Rock where the extended LRT line along Capitol is assumed to have priority. Westbound would be at Eastridge and San Fernando stations. The 0.10 minutes is an average which represents that about one in every ten trains will encounter a one-minute delay at the station.

**Estimated delay per mile.** Delay per mile is the factor used to account for congestion, stopping at traffic signals, and any other reasons that delay the pure ability of a vehicle to travel freely between prescribed stops.

Delay factors can be derived by any number of methods. For purposes of this study, CTG is guided by the Transit Cooperative Research Program (TCRP) Transit Capacity and Quality of Service Manual, First Edition, 1999 (Transportation Research Board). While a Second Edition has since been issued in 2003, its update uses categories and ranges that provide less guidance than its previous edition, and subsequently was not as useful for this analysis.

The TCRP transit capacity manual provides general delay factors based on whether bus transit vehicles operate in normal flow versus exclusive bus lanes, and whether it is a CBD, central city or suburban environment. These delay factors are also used for the LRT mode since the LRT operating environment also is in-street.

These factors do not account for transit signal priority. For purposes of this analysis, CTG has assumed that transit signal priority is able to reduce intersection delay by 40%.

The resulting delay per mile assumptions are summarized in **Table 2-1**.

**Table 2-1. Delay per Mile Assumptions**

Operating Environment (all street running)	Transit Signal Priority <sup>1</sup>	Delay/Mile (minutes) <sup>2</sup>
CBD, mixed traffic	No	3.00
City, mixed traffic	No	0.90
City, mixed traffic	Yes	0.54
City, exclusive lane	No	0.60
City, exclusive lane	Yes	0.36
Suburban, mixed traffic	No	0.70
Suburban, mixed traffic	Yes	0.42
Suburban, exclusive lane	No	0.50
Suburban, exclusive lane	Yes	0.30

<sup>1</sup>Transit signal priority assumed to reduce delay by 40%.

<sup>2</sup>Delay/Mile based on TCRP Transit Capacity and Quality of Service Manual 1st Ed.

Resulting estimated run times are presented in **Table 2-2**. Run times between the two alternatives are fairly similar. While LRT has the advantage of more nimble acceleration and deceleration as well as complete separation from traffic for a segment along Capitol Expressway, its more circuitous approach out of Diridon Station and extra station at San Fernando lead to a slightly longer end-to-end run time.

**Table 2-2. Summary of Estimated Run Times**

Alternative	Distance	Run Time	Run Time with added stations <sup>1</sup>
BRT	7.04	25.53	27.64
LRT	7.37	27.03	29.13

<sup>1</sup>BRT option adds stations at Almaden, 11th Street, 21st Street, Sunset and Alexander.

LRT option includes adds stations at 11th Street, 21st Street, Sunset and Alexander.

Detailed station-to-station run times for each alternative and station/stop option are presented in Appendix A.

## 2.2 Fleet Requirements and Annual Operating Statistics

Fleet requirements and annual operating statistics were calculated through use of “operstat worksheets.” These worksheets use travel time, distance, and headway (frequency) inputs for each corridor route in the operating plan to generate daily vehicle miles and vehicle hours for weekdays, Saturdays and Sundays. Daily statistics are then factored to provide annual operating statistics. Fleet requirements are based on weekday peak period service.

- Evening and weekend time periods were assumed to have similar operating characteristics (such as headways and span of service) as existing LRT lines.
- Vehicle spare ratio was assumed to be 20%.
- Layovers are assumed to be at least 10% of the total one-way runtime. In the case of LRT, layovers integrate an additional 3 minutes to account for the variability in sequencing trains since at either end of the route there is a separate LRT line that serves these stations.

A summary of peak vehicles, total vehicles, annual revenue hours and annual revenue miles is provided in **Table 2-3** for BRT, and **Table 2-4** for LRT.

**Table 2-3. Summary of BRT Operating Statistics**

Alternative	Peak Fleet	Total Fleet	Annual vehicle miles	Annual vehicle hours
BRT - upgrade Route 522	3	4	157,800	8,690
BRT - new Route 523	5	6	318,300	23,050
BRT - Total	8	10	476,100	31,740

**Table 2-4. Summary of LRT Operating Statistics**

Alternative	Peak Fleet	Total Fleet	Annual car miles	Annual train hours
LRT	5	6	328,900	28,450

The BRT and LRT operstat worksheets are provided in **Appendix B**.

### 3.0 Operating & Maintenance (O&M) Cost Estimates

This section describes the operating & maintenance (O&M) cost model and presents the O&M costs estimated for the corridor alternatives. A discussion regarding comparison of LRT versus BRT costs is also provided.

#### 3.1 VTA O&M Cost Model

O&M costs were calculated through use of an O&M cost model developed for VTA. The O&M cost model was developed to estimate O&M costs for VTA's bus, light rail, and demand response transit systems, as well as support department costs related to operations. This model was developed in a disaggregate, resource build-up format, consistent with the methodology specified by FTA<sup>1</sup> for Major Investment Studies. The FTA guidelines specify that: costs are computed by estimating labor and materials needed to provide a given level of service, and then unit costs are applied to the estimated future labor and material cost items; costs are calculated based on operating characteristics for each mode (e.g., LRT passengers), rather than for all modes combined (e.g., system-wide passengers); and each reported labor and non-labor expense are calculated separately, which ensures that equations are mutually exclusive and cover all operating costs. The FTA guidelines have strong implications that affect costs and staffing requirements estimated for transit alternatives, especially the stipulation that all costs should be treated as variable (i.e., in the long-term, even modest changes in operations would tend to result in additional overtime pay or higher base wage rates corresponding to increased responsibilities). It should be noted that some administrative costs were assumed to be fixed as reflected by VTA's historical costs as a long-established operator.

The basic structure of a resource build-up model is a series of line items representing specific labor or non-labor costs. Each line item is linked either directly or indirectly to an input variable that reflects level of service or some other system attribute. *Direct* links are expenses that are logically and strongly influenced by one of the input variables. For instance, it may be assumed that the cost of traction power depends upon the number of car-miles operated. *Indirect* links are expenses that depend upon prior direct links. For example, the amount of operator fringe benefits may be a function of operator wages, which may be directly linked to the number of hours trains are in revenue service. In these examples, car-miles are assumed to directly "drive" the cost of traction power, train-hours are assumed to directly "drive" operator wages, and the amount of operator fringe benefits are calculated as a percentage of the agency payroll.

The basis for each cost model is the "Calibration System" which can be defined as the values of actual operating expenses and operating statistics for the base year. Costs were calculated by comparing forecasts of operating statistics ("input values") for each future transportation alternative against the calibration system, and then applying base year costs. It is implicitly assumed that base year rates of consumption and productivity would continue into the future.

**Labor Cost Formulae.** Labor costs are a function of the number of employees in each job class and average wages and fringe benefits. The generalized equation for labor costs is of the form:

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<sup>1</sup> *Procedures and Technical Methods for Transit Project Planning*, Urban Mass Transportation Administration (now the Federal Transit Administration), September 1986 (Chapter II.4, Operating and Maintenance Costs, revised September 1990).

Annual Labor Cost	=	Value of Driving Variable	X	Labor Productivity Rate	X	Annual Cost per Employee
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where:

**Value of Driving Variable:** The quantity of the input variable that most strongly influences a cost item. For example, the number of mechanics depends on the number of bus or car-miles operated annually.

**Labor Productivity Rate:** The number of budgeted positions divided by the value of the driving variable for the calibration level of service. This factor implicitly accounts for local union rules, hiring and training of new employees, worker efficiency, and absenteeism.

**Annual Cost per Employee:** Average annual earnings which includes straight wages or salary, vacation, holiday and sick pay; plus fringe benefits, such as pension funds, social security, and medical insurance.

**Non-Labor Cost Formulae.** Non-labor costs include expense categories such as materials, utilities, and contract services. The generalized equation for non-labor costs is of the form:

Annual Non-labor Cost	=	Total Base Cost	X	Base Driving Variable	X	Future Driving Variable
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where:

**Total Base Cost:** Actual expense in the calibration year modeled.

**Value of Driving Variables:** The quantity of the input variable that most strongly influences a cost item. For example, the cost of light rail vehicle parts depends on the number of car-miles. The Annual Non-labor Cost is based on the ratio of the Future Driving Variable to the Base Driving Variable multiplied by the Total Base Cost.

The VTA O&M cost model estimates staffing requirements, labor costs, and non-labor expenses by transit mode (i.e., Motor Bus (directly operated), Light Rail, General and Administrative, and Operations Administration) and cost center within each mode. Purchased Transportation (Motor Bus), contributions to other transit operators or agencies (e.g. Caltrain, light rail shuttles, ACE), and Demand Response costs are included with the Operations Administration costs consistent with VTA's budget. The model is calibrated to VTA's FY 2004-05 budget.

The model includes direct model inputs that can be used to override some costs generated by the O&M cost model. Direct model inputs are useful when "off-model" analyses are performed that result in more accurate costs than can be estimated by the O&M model. Direct model inputs are available for costs associated with VTA's contribution to Caltrain, light rail shuttles, ACE, and Highway 17 and Dumbarton Express Bus; and for Demand Response service, fuel, traction power, and debt service.

In addition, the model includes factors that account for the increased cost of operating articulated buses. The O&M cost model applies a 13.2% premium to bus costs based on the proportion of articulated vehicle miles to those of the peak fleet. This premium is based on

actual 2005 maintenance costs provided by VTA. The articulated factor is applied to specific line items in the model. The articulated factor is included because it is assumed that articulated buses will make-up a much higher percentage of VTA's fleet in the future, and a mechanism for capturing those additional costs is needed to ensure that future O&M costs are calculated accurately.

The model uses operating statistics/characteristics (e.g., peak vehicles, number of stations, passengers) to determine future costs. As future operating plans change (e.g., new rail lines are constructed), costs change accordingly. These operating statistics/characteristics are presented in **Table 3-1**.

**Table 3-1.  
Operating Statistics/Characteristics Used in the VTA O&M Cost Model**

Operating Statistic/Characteristic	Bus	Light Rail
Unlinked Passengers (Boardings)	X <sub>p</sub>	X
Peak Vehicles	X <sub>p</sub>	X <sub>p</sub>
Active Fleet Vehicles	X <sub>p</sub>	X <sub>p</sub>
Operating Divisions	X <sub>p</sub>	X <sub>p</sub>
Annual Revenue Bus/Car Miles	X <sub>p</sub>	X <sub>p</sub>
Annual Revenue Bus/Train Hours	X	X <sub>p</sub>
Directional Track Miles		X <sub>p</sub>
Elevated Stations		X <sub>p</sub>
At-Grade Station		X <sub>p</sub>
Subway Stations		X <sub>p</sub>
Total Stations <sup>1</sup>		X <sub>p</sub>
NOTES: 1. Total Stations are calculated as Elevated Stations + At-Grade Stations + Subway Stations.		

- Daily boardings were obtained from ridership forecasts developed for the Silicon Valley Rapid Transit Corridor, since this data was readily available.
- Annual boardings use an annualization factor of 309.5 for bus and 316.8 for LRT as provided by VTA.
- Peak and total fleet, annual revenue car-miles, and annual revenue train-hours were derived from the operstat worksheet.
- Total operating divisions, total directional route miles, and number of stations by type (elevated, at-grade or subway) were derived using engineering drawings and other design information as developed for the study.

Details of these systemwide operating statistics are provided in **Appendix C**. These statistics are the inputs needed for the VTA O&M Cost Model to calculate annual O&M costs for the Santa Clara-Alum Rock alternatives.

### **3.2 O&M Cost Estimates for Santa Clara-Alum Rock Alternatives**

As described previously, the VTA O&M cost model estimates systemwide bus and rail costs as expressed in 2005 dollars. Costs are then escalated to 2007 dollars based on the region's Consumer Price Index. The O&M costs associated with operating the Santa Clara-Alum Rock alternatives are determined by subtracting the systemwide costs of each alternative with the systemwide cost of a baseline "No Build" scenario. O&M cost estimates are summarized in **Table 3-2**.

**Table 3-2. Summary of Operating & Maintenance Costs (2007 Dollars)**

Mode/Operator	No Project	BRT (Rte 522 upgrade and new Rte 523)	LRT
<b>O&amp;M Costs:</b>			
Motor Bus	\$175,096,300	\$179,573,600	\$175,096,300
Light Rail	\$75,967,300	\$75,967,300	\$82,787,500
General & Administrative	\$102,847,800	\$103,107,000	\$104,540,600
Operations Administration	\$106,880,600	\$107,703,900	\$110,101,200
<b>TOTAL</b>	<b>\$460,792,000</b>	<b>\$466,351,800</b>	<b>\$472,525,600</b>
<b>O&amp;M Cost vs. No Project</b>	<b>N/A</b>	<b>\$5,559,800</b>	<b>\$11,733,600</b>

NOTES:

- (1) O&M cost estimates based on SVTA O&M 2005 v7 cost model (calibrated to VTA FY2005 budget).  
O&M cost model estimates systemwide costs (not just costs of project). Project costs determined by comparing to No Project baseline.
- (2) Escalation from 2005 dollars based on CPI for San Francisco Bay Area (2.7% from FY2005-2006 and 3.1% from FY2006-2007).
- (3) All alternatives based on fewer stations (BRT also excludes Alameda).
- (4) BRT costs assume articulated (but not hybrid) buses.
- (5) Costs for BRT - Rte 522 & 523 reflect total incremental costs based on introducing new Route 523, time savings for existing Route 522, and headway improvement from 15 minutes to 12 minutes on Route 522.

To further understand the costs associated with implementing BRT, O&M costs were isolated for the various components: the cost of upgrading Route 522, further split out between the western end of the route outside the study area versus the segment within the study area, and the cost of introducing new Route 523. This cost breakout is presented in Table 3-3.

**Table 3-3. BRT Operating & Maintenance Cost Breakout (2007 Dollars)**

Mode/Operator	Rte 522 upgrade	New Rte 523	Total BRT (Rte 522 upgrade and new Rte 523)
<b>O&amp;M Costs:</b>			
Motor Bus	\$176,758,000	\$177,718,300	\$179,573,600
Light Rail	\$75,967,300	\$75,967,300	\$75,967,300
General & Administrative	\$102,920,800	\$103,029,500	\$103,107,000
Operations Administration	\$107,185,600	\$107,362,900	\$107,703,900
<b>TOTAL</b>	<b>\$462,831,700</b>	<b>\$464,078,000</b>	<b>\$466,351,800</b>
<i>Cost of Route 522 outside corridor</i>	\$956,800		
<i>Cost of Route 522 within corridor</i>	\$1,082,900		
<b>O&amp;M Cost vs. No Project</b>			
<b>Cost of \$460,792,000</b>	<b>\$2,039,700</b>	<b>\$3,286,000</b>	<b>\$5,559,800</b>

NOTES:

- (1) Costs for BRT - Route 522 upgrade reflect additional costs over Route 522 in No Project; that is, costs reflect headway improvement over entire route, and time savings for Santa Clara-Alum Rock portion of route.
- (2) Costs for BRT - new Route 523 isolate cost of introducing new route.
- (3) Costs for BRT - Rte 522 & 523 reflect total incremental costs based on introducing new Route 523, time savings for existing Route 522, and headway improvement from 15 minutes to 12 minutes on Route 522.

It should be noted that the calculated cost of the Route 522 upgrade plus the new Route 523 individually do not match the calculated cost of the total BRT incorporating both improvements, though the difference is minimal. This is due to the distribution of fixed costs under the different scenarios.

Summary detail from the O&M cost model is provided in **Appendix D**. Documentation includes detail for determining the breakout of O&M costs related to Route 522 within the study corridor, versus outside the study corridor.

### 3.3 BRT versus LRT O&M Costs

There are two major costs for any transit system after construction of a new system or expansion project is completed: operating and maintenance (O&M) and capital asset replacement. Cost differences between operating and maintaining and replacing capital assets for Bus Rapid Transit (BRT) systems and Light Rail Transit (LRT) systems can vary widely depending on operating plans, service characteristics, and the cost structure of the transit operator.

**Operating & Maintenance Costs.** In general, LRT tends to be more operationally efficient than BRT with regard to the number of vehicles required, vehicle hours, and vehicle miles during peak periods when passenger demand and vehicle loads are high. The LRT efficiencies diminish in situations where service characteristics are similar, such as during non-peak periods.

Operating costs for Bus Rapid Transit systems included such costs as operator salaries, fuel, vehicle maintenance, station maintenance, and maintenance of the busway or HOV lane. Light Rail operating costs include operator salaries, electricity, station maintenance, maintenance of the vehicles, and maintenance of track and power systems.

On average, operating and maintenance costs for LRT are generally higher than BRT for equivalent service. LRT costs tend to be higher because the costs to maintain systems unique to rail (e.g., track, catenary, more complex vehicles) are greater than the savings obtained from the peak period operational efficiencies.

O&M costs are driven by operating plan characteristics. The main driving variables are revenue bus/train hours and revenue bus/car miles. Driving variable and unit cost results for the Route 522 and 523 BRT (articulated vehicles) alternative and the LRT alternative are presented in **Table 3-3**:

**Table 3-3. Comparison of BRT and LRT Unit Costs**

Driving Variable	BRT	LRT
Revenue Bus/Train Hour	105,570	28,450
Revenue Bus/Car Mile	1,488,500	328,900
Cost per Revenue Bus/Train Hour	\$124.80	\$424.70
Cost per Revenue Bus/Car Mile	\$8.41	\$12.26

Thus, even though LRT peak vehicle requirements and annual revenue train hours/car miles are lower than BRT peak vehicle requirements and annual revenue bus hours/miles, the unit costs for these variables are much higher for LRT. For example, the LRT revenue miles (~329,000) are lower than the BRT revenue miles (1.49 million), but the unit cost per LRT revenue mile (\$12.26) is almost 1½ times greater than the cost of a BRT revenue mile (\$8.59).

**Capital Asset Replacement Costs.** Capital assets consist of vehicles, facilities, and equipment purchased or constructed at the time a specific transit system or expansion project is implemented. The type and cost of capital assets can be very different for BRT versus LRT. Capital assets common to both BRT and LRT include: fare revenue equipment, security and communication equipment, stations and stops, ticket vending machines, service vehicles, and maintenance facilities (although the tools and equipment at the facility would be different).

Assets are generally replaced based on useful life guidelines set forth by the Federal Transit Administration (FTA) and based on transit operator experience. For example, the FTA useful life of a standard bus is 12 years. Portions of some assets need to be replaced on an on-going basis (e.g. major bus components, overhead wire). Some assets need not be completely replaced, but major overhauls or rehabilitation would be required.

Transit operators are continuously replacing and overhauling assets because assets are constructed or obtained at different times and have different useful lives. For example, a maintenance building has a useful life of 50 years, but it would need a new roof, paint, etc. about every eight years. This process would apply to every maintenance facility owned by the transit operator, such as the three bus and one LRT facility owned by VTA. Similarly, transit vehicles generally receive a mid-life overhaul during their useful life and these overhauls are on-going as transit operators, such as VTA, purchase vehicles at different times.

Capital assets specific to BRT and other bus systems consist primarily of major bus components and the buses. Capital assets specific to LRT consist primarily of train control systems, power substations, overhead wire, track, and light rail vehicles. **Table 3-4** shows the useful life for various FTA Standard Cost Categories (SCC) and subcategories, estimated overhaul/rehabilitation requirements, and shows which categories are applied to BRT, LRT, or both.

**Table 3-4.  
Capital Asset Useful Lives and Application to BRT and LRT**

<b>Asset Category/Subcategory</b>	<b>Useful Life (years)<sup>1</sup></b>	<b>Overhaul/Rehab.<sup>2</sup></b>	<b>BRT</b>	<b>LRT</b>
Guideway: At-grade in Mixed Traffic	20	10	X	X
Track	20-35	6		X
Stations	30-70	10	X	X
Parking Lots & Structures	20-50	10	X	X
Maintenance Buildings/Facilities	50	8	X	X
Yard & Yard Track	80	20		X
Train Control Systems	30	15		X
Traction Power Systems	30-50	20		X
Communication Systems	20	5-12	X	X
Fare Collection System and Equipment	25	5-20	X	X
Light Rail Vehicles	25	12		X
Buses	12	6	X	
NOTES:				
1. Source: Federal Transit Administration, "070507_Rev_10_Web_only_Standard_Cost_Categories.xls".				
2. Overhaul/rehabilitation schedule for comparison purposes only. Actual overhaul/rehabilitation schedule for VTA may be different than presented in this table. Source: Peskin, Robert L, Methodology for Projecting Rail Transit Rehabilitation and Replacement Capital Financing Needs, Transportation Research Record Number 1165, Transportation Research Board, Washington D.C. and from the Long Range Plan model of the Los Angeles County Metropolitan Transportation				

Vehicles tend to contribute the most to major capital asset replacement costs. The useful life of a light rail vehicle (LRV) is 25 years while the life of a bus is 12 years. Thus, buses need to be replaced twice as often as LRVs, but LRVs can cost up to \$3 million each while articulated buses cost around \$500,000. In addition, LRVs would require mid-life overhauls around year 12 while buses would require mid-life overhauls around year six. The cost to overhaul and LRV can be significantly higher than for a bus.

In order to compare costs, future replacement costs can be annualized using discount factors. This discount process takes into account the time value of money that asserts that a dollar today is worth more than a dollar tomorrow. Using FTA's standard annual discount factor of 7%, the annualized replacement cost of a \$3 million LRV with a useful life of 25 years would be \$400,000, while the annualized replacement cost of a \$500,000 bus with a useful life of 12 years would be \$63,000.

In summary, the capital asset replacement and overhaul/rehabilitation costs for LRT tends to be higher than BRT. Although BRT vehicles would need to be replaced twice as often as LRT, the unit cost for each vehicle is lower. The number of vehicles needed to match an equivalent LRV would determine whether LRT or BRT would be more financially feasible. In addition, other non-vehicle costs associated with LRT (track, power systems, etc.) tend to be higher than non-vehicle BRT costs.

# Appendix A

## Run Times

# Santa Clara-Alum Rock Corridor O&M Statistics and Costs

## Santa Clara-Alum Bus Rapid Transit: Diridon to Eastridge BRT Running Times - no stops at 11th St, 21st St, Sunset or Alexander

	MAX. SPEED	DIST. (MILES)	CUMUL. DIST. (MILES)	RUN TIME NO DWELL OR DELAY (MIN.)	DELAY / MILE (MIN.)	DELAY (MIN.)	STA-STA TIME INCL DELAY	DWELL (MIN.)	STA-STA RUN TIME (MIN.)	ELAPSED RUN TIME (MIN.)
<b>DIRIDON</b>			<b>0.00</b>				0.00	0.00	0.00	<b>0.00</b>
<i>DIRIDON STOP-Start curve</i>	20	0.07	0.07	0.28	0.90	0.06	0.34			
<i>Start curve-End curve</i>	10	0.03	0.09	0.17	0.90	0.03	0.20			
<i>End curve-ALMADEN STOP</i>	25	0.39	0.48	1.05	0.90	0.35	1.40			
<b>ALMADEN</b>		0.48	<b>0.48</b>				1.93	0.33	2.26	<b>2.26</b>
	25	0.34	0.83	0.98	3.00	1.03	2.01			
<b>1ST-2ND/SANTA CLARA</b>		0.34	<b>0.83</b>				2.01	0.50	2.51	<b>4.77</b>
	25	0.28	1.11	0.84	3.00	0.84	1.68			
<b>6TH/SANTA CLARA</b>		0.28	<b>1.11</b>				1.68	0.50	2.18	<b>6.95</b>
	25	0.38	1.49	1.00	0.90	0.34	1.34			
<b>11TH/SANTA CLARA (no stop)</b>		0.38	<b>1.49</b>				1.34	0.00	1.34	<b>8.30</b>
<i>Start signal priority (15th St)</i>	25	0.28	1.77	0.74	0.90	0.25	0.99			
<b>16TH/SANTA CLARA</b>		0.28	<b>1.77</b>				0.99	0.33	1.32	<b>9.62</b>
	25	0.28	2.05	0.76	0.54	0.15	0.92			
<b>21ST/SANTA CLARA (no stop)</b>		0.28	<b>2.05</b>				0.92	0.00	0.92	<b>10.53</b>
	25	0.43	2.47	1.09	0.54	0.23	1.32			
<b>28TH/SANTA CLARA</b>		0.43	<b>2.47</b>				1.32	0.33	1.65	<b>12.18</b>
	35	0.55	3.02	1.19	0.54	0.30	1.49			
<b>KING/ALUM ROCK</b>		0.55	<b>3.02</b>				1.49	0.33	1.82	<b>14.01</b>
<i>Start exclusive ROW</i>	35	0.41	3.43	0.86	0.36	0.15	1.01			
<b>SUNSET (no stop)</b>		0.41	<b>3.43</b>				1.01	0.00	1.01	<b>15.01</b>
	35	0.36	3.79	0.72	0.36	0.13	0.85			
<b>JACKSON</b>		0.36	<b>3.79</b>				0.85	0.33	1.18	<b>16.19</b>
	35	0.35	4.14	0.76	0.36	0.13	0.88			
<b>ALEXANDER (no stop)</b>		0.35	<b>4.14</b>				0.88	0.00	0.88	<b>17.08</b>
<i>ALEXANDER STOP/End exclusive ROW-Start curve</i>	30	0.16	4.30	0.34	0.54	0.08	0.43			
<i>Start curve-End curve</i>	10	0.03	4.33	0.17	0.54	0.02	0.19			
<i>End curve-ALUM ROCK STOP</i>	35	0.31	4.64	0.74	0.54	0.17	0.90			
<b>ALUM ROCK</b>		0.49	<b>4.64</b>				1.52	0.50	2.02	<b>19.09</b>
	45	0.66	5.30	1.26	0.42	0.28	1.54			
<b>STORY</b>		0.66	<b>5.30</b>				1.54	0.33	1.87	<b>20.96</b>
	50	0.80	6.10	1.41	0.42	0.33	1.75			
<b>OCALA</b>		0.80	<b>6.10</b>				1.75	0.33	2.08	<b>23.04</b>
	50	0.95	7.04	1.59	0.42	0.40	1.99			
<b>EASTRIDGE</b>		0.95	<b>7.04</b>				1.99	0.50	2.49	<b>25.53</b>

	Total Stops	Dist (miles)	Time (min.)	Avg. Speed (mph)	Total Delay (min.)	Delay/mile (min.)	Avg. STOP Spacing (miles)
<b>DIRIDON-EASTRIDGE SUMMARY</b>	<b>12</b>	<b>7.04</b>	<b>25.53</b>	<b>16.55</b>	<b>5.26</b>	<b>0.75</b>	<b>0.64</b>

**NOTES:**

- Travel time calculated with CTG's running time model (bus performance characteristics).
- Distances based on Santa Clara-Alum Rock drawings 1/07 (Delmas-Capitol) and Capitol Expressway drawings 10/02 (Alum Rock to Eastridge). A single midpoint is used between eastbound and westbound bus stop locations.
- Dwell Time Assumptions:**  
 Average dwell time at typical BRT stop 0.33 minutes (20 seconds)  
 Dwell time at high-volume bus stops (CBD, key transfer points) 0.50 minutes (30 seconds)
- Delay per Mile Assumptions:**  
 Street running CBD area, mixed traffic 3.00 minutes based on TCRP Transit Capacity and Quality of Service Manual 1st Ed.  
 Street running (city), mixed traffic 0.90 minutes based on TCRP Transit Capacity and Quality of Service Manual 1st Ed.  
 Street running (city), mixed traffic with transit priority 0.54 minutes transit priority assumed to reduce delay by 40%  
 Street running (city), exclusive lane 0.60 minutes based on TCRP Transit Capacity and Quality of Service Manual 1st Ed.  
 Street running (city), exclusive lane with transit priority 0.36 minutes transit priority assumed to reduce delay by 40%  
 Street running (suburban), mixed traffic 0.70 minutes based on TCRP Transit Capacity and Quality of Service Manual 1st Ed.  
 Street running (suburban), mixed traffic with priority 0.42 minutes transit priority assumed to reduce delay by 40%  
 Street running (suburban), exclusive lane 0.50 minutes based on TCRP Transit Capacity and Quality of Service Manual 1st Ed.

# Santa Clara-Alum Rock Corridor O&M Statistics and Costs

## Santa Clara-Alum Bus Rapid Transit: Diridon to Eastridge BRT Running Times - additional stops at 11th St, 21st St, Sunset and Alexander

	MAX. SPEED	DIST. (MILES)	CUMUL. DIST. (MILES)	RUN TIME NO DWELL OR DELAY (MIN.)	DELAY / MILE (MIN.)	DELAY (MIN.)	STA-STA TIME INCL DELAY	DWELL (MIN.)	STA-STA RUN TIME (MIN.)	ELAPSED RUN TIME (MIN.)
<b>DIRIDON</b>			<b>0.00</b>				0.00	0.00	0.00	<b>0.00</b>
<i>DIRIDON STOP-Start curve</i>	20	0.07	0.07	0.28	0.90	0.06	0.34			
<i>Start curve-End curve</i>	10	0.03	0.09	0.17	0.90	0.03	0.20			
<i>End curve-ALMADEN STOP</i>	25	0.39	0.48	1.05	0.90	0.35	1.40			
<b>ALMADEN</b>		0.48	<b>0.48</b>				1.93	0.33	2.26	<b>2.26</b>
	25	0.34	0.83	0.98	3.00	1.03	2.01			
<b>1ST-2ND/SANTA CLARA</b>		0.34	<b>0.83</b>				2.01	0.50	2.51	<b>4.77</b>
	25	0.28	1.11	0.84	3.00	0.84	1.68			
<b>6TH/SANTA CLARA</b>		0.28	<b>1.11</b>				1.68	0.50	2.18	<b>6.95</b>
	25	0.38	1.49	1.07	0.90	0.34	1.41			
<b>11TH/SANTA CLARA</b>		0.38	<b>1.49</b>				1.41	0.33	1.74	<b>8.70</b>
<i>Start signal priority (15th St)</i>	25	0.28	1.77	0.83	0.90	0.25	1.08			
<b>16TH/SANTA CLARA</b>		0.28	<b>1.77</b>				1.08	0.33	1.41	<b>10.11</b>
	25	0.28	2.05	0.83	0.54	0.15	0.98			
<b>21ST/SANTA CLARA</b>		0.28	<b>2.05</b>				0.98	0.33	1.31	<b>11.42</b>
	25	0.43	2.47	1.18	0.54	0.23	1.41			
<b>28TH/SANTA CLARA</b>		0.43	<b>2.47</b>				1.41	0.33	1.74	<b>13.17</b>
	35	0.55	3.02	1.19	0.54	0.30	1.49			
<b>KING/ALUM ROCK</b>		0.55	<b>3.02</b>				1.49	0.33	1.82	<b>14.99</b>
<i>Start exclusive ROW</i>	35	0.41	3.43	0.95	0.36	0.15	1.10			
<b>SUNSET</b>		0.41	<b>3.43</b>				1.10	0.33	1.43	<b>16.42</b>
	35	0.36	3.79	0.88	0.36	0.13	1.01			
<b>JACKSON</b>		0.36	<b>3.79</b>				1.01	0.33	1.34	<b>17.76</b>
	35	0.35	4.14	0.85	0.36	0.13	0.98			
<b>ALEXANDER</b>		0.35	<b>4.14</b>				0.98	0.33	1.31	<b>19.07</b>
<i>ALEXANDER STOP/End exclusive ROW-Start curve</i>	30	0.16	4.30	0.47	0.54	0.08	0.55			
<i>Start curve-End curve</i>	10	0.03	4.33	0.17	0.54	0.02	0.19			
<i>End curve-ALUM ROCK STOP</i>	35	0.31	4.64	0.74	0.54	0.17	0.90			
<b>ALUM ROCK</b>		0.49	<b>4.64</b>				1.64	0.50	2.14	<b>21.21</b>
	45	0.66	5.30	1.26	0.42	0.28	1.54			
<b>STORY</b>		0.66	<b>5.30</b>				1.54	0.33	1.87	<b>23.08</b>
	50	0.80	6.10	1.41	0.42	0.33	1.75			
<b>OCALA</b>		0.80	<b>6.10</b>				1.75	0.33	2.08	<b>25.15</b>
	50	0.95	7.04	1.59	0.42	0.40	1.99			
<b>EASTRIDGE</b>		0.95	<b>7.04</b>				1.99	0.50	2.49	<b>27.64</b>

	Total Stops	Dist (miles)	Time (min.)	Avg. Speed (mph)	Total Delay (min.)	Delay/mile (min.)	Avg. STOP Spacing (miles)
<b>DIRIDON-EASTRIDGE SUMMARY</b>	16	7.04	27.64	15.29	5.26	0.75	0.47
<b>ALMADEN-EASTRIDGE SUMMARY</b>	15	6.56	25.38	15.51	5.26	0.80	0.47
<b>SANTA CLARA-ALUM ROCK BUSWAY ONLY</b>	11	3.82	17.36	13.19	5.20	1.36	0.38

**NOTES:**

1. Travel time calculated with CTG's running time model (bus performance characteristics).  
 2. Distances based on Santa Clara-Alum Rock drawings 1/07 (Delmas-Capitol) and Capitol Expressway drawings 10/02 (Alum Rock to Eastridge). A single midpoint is used between eastbound and westbound bus stop locations.

**3. Dwell Time Assumptions:**

Average dwell time at typical BRT stop 0.33 minutes (20 seconds)  
 Dwell time at high-volume bus stops (CBD, key transfer points) 0.50 minutes (30 seconds)

**4. Delay per Mile Assumptions:**

Street running CBD area, mixed traffic 3.00 minutes based on TCRP Transit Capacity and Quality of Service Manual 1st Ed.  
 Street running (city), mixed traffic 0.90 minutes based on TCRP Transit Capacity and Quality of Service Manual 1st Ed.  
 Street running (city), mixed traffic with transit priority 0.54 minutes transit priority assumed to reduce delay by 40%  
 Street running (city), exclusive lane 0.60 minutes based on TCRP Transit Capacity and Quality of Service Manual 1st Ed.  
 Street running (city), exclusive lane with transit priority 0.36 minutes transit priority assumed to reduce delay by 40%  
 Street running (suburban), mixed traffic 0.70 minutes based on TCRP Transit Capacity and Quality of Service Manual 1st Ed.

# Santa Clara-Alum Rock Corridor O&M Statistics and Costs

## Santa Clara-Alum Rock LRT: Diridon to Eastridge Train Running Times - no stops at 11th St, 21st St, Sunset or Alexander

	MAX. SPEED	DIST. (MILES)	CUMUL. DIST. (MILES)	RUN TIME NO DWELL OR DELAY (MIN.)	DELAY / MILE (MIN.)	DELAY (MIN.)	STA-STA TIME INCL DELAY	DWELL (MIN.)	STA-STA RUN TIME (MIN.)	ELAPSED RUN TIME (MIN.)
<b>DIRIDON</b>			<b>0.00</b>				0.00	0.10	0.10	<b>0.10</b>
DIRIDON STA./start tunnel-Start curve	25	0.09	0.09	0.31	0.00	0.00	0.31			
Start curve-End curve	10	0.04	0.04	0.25	0.00	0.00	0.25			
End curve-Start curve	30	0.09	0.18	0.25	0.00	0.00	0.25			
Start curve-End curve	10	0.03	0.07	0.17	0.00	0.00	0.17			
End curve/end tunnel-SAN FERNANDO STA.	25	0.13	0.20	0.42	0.60	0.08	0.50			
<b>SAN FERNANDO</b>		0.38	<b>0.38</b>				1.48	0.33	1.81	<b>1.91</b>
SAN FERNANDO STA.-Start curve	25	0.30	0.68	0.80	0.60	0.18	0.98			
Start curve-End curve	10	0.06	0.73	0.34	0.60	0.03	0.38			
End curve-ALMADEN STA.	25	0.06	0.80	0.24	0.60	0.04	0.28			
<b>ALMADEN</b>		0.41	<b>0.80</b>				1.63	0.33	1.96	<b>3.87</b>
ALMADEN STA./start curve-End curve	10	0.07	0.87	0.46	2.00	0.33	0.79			
End curve/start shared ROW-1ST STREET STA.	25	0.27	1.14	0.75	3.00	0.82	1.58			
<b>1ST-2ND/SANTA CLARA</b>		0.35	<b>1.14</b>				2.37	0.33	2.70	<b>6.57</b>
	25	0.29	1.43	0.84	3.00	0.87	1.71			
<b>6TH/SANTA CLARA</b>		0.29	<b>1.43</b>				1.71	0.33	2.04	<b>8.61</b>
	25	0.37	1.80	0.96	0.90	0.33	1.30			
<b>11TH/SANTA CLARA (no stop)</b>		0.37	<b>1.80</b>				1.30	0.00	1.30	<b>9.91</b>
Start signal priority (15th St)	25	0.30	2.11	0.79	0.90	0.27	1.06			
<b>16TH/SANTA CLARA</b>		0.30	<b>2.11</b>				1.06	0.33	1.39	<b>11.30</b>
	25	0.27	2.37	0.71	0.54	0.14	0.86			
<b>21ST/SANTA CLARA (no stop)</b>		0.27	<b>2.37</b>				0.86	0.00	0.86	<b>12.16</b>
	25	0.41	2.79	1.06	0.54	0.22	1.28			
<b>28TH/SANTA CLARA</b>		0.41	<b>2.79</b>				1.28	0.33	1.61	<b>13.77</b>
	35	0.59	3.38	1.21	0.54	0.32	1.53			
<b>KING/ALUM ROCK</b>		0.59	<b>3.38</b>				1.53	0.33	1.86	<b>15.63</b>
End shared ROW (King)	35	0.40	3.78	0.79	0.36	0.15	0.94			
<b>SUNSET (no stop)</b>		0.40	<b>3.78</b>				0.94	0.00	0.94	<b>16.57</b>
	35	0.37	4.15	0.73	0.36	0.13	0.86			
<b>JACKSON</b>		0.37	<b>4.15</b>				0.86	0.33	1.19	<b>17.76</b>
	35	0.30	4.45	0.62	0.36	0.11	0.73			
<b>ALEXANDER (no stop)</b>		0.30	<b>4.45</b>				0.73	0.00	0.73	<b>18.50</b>
ALEXANDER STA.-End signal priority/start curve	35	0.16	4.62	0.33	0.60	0.10	0.43			
Start curve-End curve	10	0.06	4.68	0.38	0.60	0.04	0.41			
End curve-ALUM ROCK STA.	35	0.28	4.96	0.63	0.60	0.17	0.80			
<b>ALUM ROCK</b>		0.51	<b>4.96</b>				2.77	0.43	3.20	<b>21.70</b>
Alum Rock Sta.-Wilbur Ave.	35	0.11	5.07	0.30	0.60	0.07	0.37			
Wilbur Ave. - Start Aerial Str.	35	0.04	5.11	0.06	0.60	0.02	0.09			
Start Aerial Str.-STORY STA.	55	0.51	5.62	0.77	0.00	0.00	0.77			
<b>STORY</b>		0.66	<b>5.62</b>				1.22	0.33	1.55	<b>23.25</b>
STORY-End Aerial Str.	45	0.23	5.85	0.45	0.00	0.00	0.45			
End Aerial Str.-OCALA STA.	55	0.57	6.42	0.79	0.00	0.00	0.79			
<b>OCALA</b>		0.80	<b>6.42</b>				1.24	0.33	1.57	<b>24.83</b>
OCALA STA.-Cunningham Ave.	35	0.25	6.66	0.53	0.00	0.33	0.86			
Cunningham Ave.-Start Underpass	50	0.30	6.97	0.40	0.00	0.00	0.40			
Begin -End Underpass	55	0.30	7.27	0.36	0.00	0.00	0.36			
End Underpass-EASTRIDGE STA.	35	0.09	7.37	0.26	0.00	0.00	0.26			
<b>EASTRIDGE</b>		0.95	<b>7.37</b>				1.87	0.33	2.20	<b>27.03</b>

	Total Stations	Dist (miles)	Time (min.)	Avg. Speed (mph)	Total Delay (min.)	Delay/mile (min.)	Avg. Sta. Spacing (miles)
<b>DIRIDON-EASTRIDGE SUMMARY</b>	13	7.37	27.03	16.35	4.77	0.65	0.61
<b>28TH-EASTRIDGE SEGMENT</b>	7	4.58	13.27	20.72	1.44	0.31	0.76

**NOTES:**

- Travel time calculated with CTG's train running time model.
- Distances based on Vasona drawings 5/99 (Diridon-Delmas); Santa Clara-Alum Rock drawings 1/07 (Delmas-Capitol); and Capitol Expressway drawings 10/02 (Alum Rock to Eastridge). For stations with split platforms, a single midpoint is used.
- Avg. station dwell time =** 0.33 minutes (20 seconds).  
Additional dwell time of .10 minutes is added at first station where merging with another LRT line. (Eastbound at Diridon where Vasona Line assumed to have priority, and at Alum Rock where Capitol Line assumed to have priority. Westbound at Eastridge and San Fernando stations.) Represents that about 10% of trains may encounter a one-minute delay at the station.
- Delay per Mile Assumptions:**

Street running CBD area, mixed traffic	3.00	minutes	based on TCRP Transit Capacity and Quality of Service Manual
Street running CBD area, exclusive lane	2.00	minutes	based on TCRP Transit Capacity and Quality of Service Manual
Street running (city), mixed traffic	0.90	minutes	based on TCRP Transit Capacity and Quality of Service Manual
Street running (city), mixed traffic with transit priority	0.54	minutes	transit priority assumed to reduce delay by 40%
Street running (city), exclusive lane	0.60	minutes	based on TCRP Transit Capacity and Quality of Service Manual
Street running (city), exclusive lane with transit priority	0.36	minutes	transit priority assumed to reduce delay by 40%

# Santa Clara-Alum Rock Corridor O&M Statistics and Costs

## Santa Clara-Alum Rock LRT: Diridon to Eastridge

Train Running Times - additional stops at 11th St, 21st St, Sunset and Alexander

	MAX. SPEED	DIST. (MILES)	CUMUL. DIST. (MILES)	RUN TIME NO DWELL OR DELAY (MIN.)	DELAY / MILE (MIN.)	DELAY (MIN.)	STA-STA TIME INCL DELAY	DWELL (MIN.)	STA-STA RUN TIME (MIN.)	ELAPSED RUN TIME (MIN.)
<b>DIRIDON</b>			<b>0.00</b>				0.00	0.10	0.10	<b>0.10</b>
DIRIDON STA./start tunnel-Start curve	25	0.09	0.09	0.31	0.00	0.00	0.31			
Start curve-End curve	10	0.04	0.04	0.25	0.00	0.00	0.25			
End curve-Start curve	30	0.09	0.18	0.25	0.00	0.00	0.25			
Start curve-End curve	10	0.03	0.07	0.17	0.00	0.00	0.17			
End curve/end tunnel-SAN FERNANDO STA.	25	0.13	0.20	0.42	0.60	0.08	0.50			
<b>SAN FERNANDO</b>		<b>0.38</b>	<b>0.38</b>				1.48	0.33	1.81	<b>1.91</b>
SAN FERNANDO STA.-Start curve	25	0.30	0.68	0.80	0.60	0.18	0.98			
Start curve-End curve	10	0.06	0.73	0.34	0.60	0.03	0.38			
End curve-ALMADEN STA.	25	0.06	0.80	0.24	0.60	0.04	0.28			
<b>ALMADEN</b>		<b>0.41</b>	<b>0.80</b>				1.63	0.33	1.96	<b>3.87</b>
ALMADEN STA./start curve-End curve	10	0.07	0.87	0.46	2.00	0.33	0.79			
End curve/start shared ROW-1ST STREET STA.	25	0.27	1.14	0.75	3.00	0.82	1.58			
<b>1ST-2ND/SANTA CLARA</b>		<b>0.35</b>	<b>1.14</b>				2.37	0.33	2.70	<b>6.57</b>
	25	0.29	1.43	0.84	3.00	0.87	1.71			
<b>6TH/SANTA CLARA</b>		<b>0.29</b>	<b>1.43</b>				1.71	0.33	2.04	<b>8.61</b>
	25	0.37	1.80	1.03	0.90	0.33	1.37			
<b>11TH/SANTA CLARA</b>		<b>0.37</b>	<b>1.80</b>				1.37	0.33	1.70	<b>10.31</b>
Start signal priority (15th St)	25	0.30	2.11	0.86	0.90	0.27	1.13			
<b>16TH/SANTA CLARA</b>		<b>0.30</b>	<b>2.11</b>				1.13	0.33	1.46	<b>11.77</b>
	25	0.27	2.37	0.78	0.54	0.14	0.93			
<b>21ST/SANTA CLARA</b>		<b>0.27</b>	<b>2.37</b>				0.93	0.33	1.26	<b>13.02</b>
	25	0.41	2.79	1.13	0.54	0.22	1.35			
<b>28TH/SANTA CLARA</b>		<b>0.41</b>	<b>2.79</b>				1.35	0.33	1.68	<b>14.70</b>
	35	0.59	3.38	1.21	0.54	0.32	1.53			
<b>KING/ALUM ROCK</b>		<b>0.59</b>	<b>3.38</b>				1.53	0.33	1.86	<b>16.57</b>
End shared ROW (King)	35	0.40	3.78	0.89	0.36	0.15	1.04			
<b>SUNSET</b>		<b>0.40</b>	<b>3.78</b>				1.04	0.33	1.37	<b>17.93</b>
	35	0.37	4.15	0.83	0.36	0.13	0.97			
<b>JACKSON</b>		<b>0.37</b>	<b>4.15</b>				0.97	0.33	1.30	<b>19.23</b>
	35	0.30	4.45	0.72	0.36	0.11	0.83			
<b>ALEXANDER</b>		<b>0.30</b>	<b>4.45</b>				0.83	0.33	1.16	<b>20.39</b>
ALEXANDER STA.-End signal priority/start curve	35	0.16	4.62	0.43	0.60	0.10	0.53			
Start curve-End curve	10	0.06	4.68	0.38	0.60	0.04	0.41			
End curve-ALUM ROCK STA.	35	0.28	4.96	0.63	0.60	0.17	0.80			
<b>ALUM ROCK</b>		<b>0.51</b>	<b>4.96</b>				2.98	0.43	3.41	<b>23.80</b>
Alum Rock Sta.-Wilbur Ave.	35	0.11	5.07	0.30	0.60	0.07	0.37			
Wilbur Ave. - Start Aerial Str.	35	0.04	5.11	0.06	0.60	0.02	0.09			
Start Aerial Str.-STORY STA.	55	0.51	5.62	0.77	0.00	0.00	0.77			
<b>STORY</b>		<b>0.66</b>	<b>5.62</b>				1.22	0.33	1.55	<b>25.36</b>
STORY-End Aerial Str.	45	0.23	5.85	0.45	0.00	0.00	0.45			
End Aerial Str.-OCALA STA.	55	0.57	6.42	0.79	0.00	0.00	0.79			
<b>OCALA</b>		<b>0.80</b>	<b>6.42</b>				1.24	0.33	1.57	<b>26.93</b>
OCALA STA.-Cunningham Ave.	35	0.25	6.66	0.53	0.00	0.33	0.86			
Cunningham Ave.-Start Underpass	50	0.30	6.97	0.40	0.00	0.00	0.40			
Begin -End Underpass	55	0.30	7.27	0.36	0.00	0.00	0.36			
End Underpass-EASTRIDGE STA.	35	0.09	7.37	0.26	0.00	0.00	0.26			
<b>EASTRIDGE</b>		<b>0.95</b>	<b>7.37</b>				1.87	0.33	2.20	<b>29.13</b>

	Total Stations	Dist (miles)	Time (min.)	Avg. Speed (mph)	Total Delay (min.)	Delay/mile (min.)	Avg. Sta. Spacing (miles)
<b>DIRIDON-EASTRIDGE SUMMARY</b>	17	7.37	29.13	15.17	4.77	0.65	0.46
<b>28TH-EASTRIDGE SEGMENT</b>	9	4.58	14.43	19.05	1.44	0.31	0.57

**NOTES:**

- Travel time calculated with CTG's train running time model.
- Distances based on Vasona drawings 5/99 (Diridon-Delmas); Santa Clara-Alum Rock drawings 1/07 (Delmas-Capitol); and Capitol Expressway drawings 10/02 (Alum Rock to Eastridge). For stations with split platforms, a single midpoint is used.
- Avg. station dwell time =** 0.33 minutes (20 seconds).  
Additional dwell time of .10 minutes is added at first station where merging with another LRT line. (Eastbound at Diridon where Vasona Line assumed to have priority, and at Alum Rock where Capitol Line assumed to have priority. Westbound at Eastridge and San Fernando stations.) Represents that about 10% of trains may encounter a one-minute delay at the station.
- Delay per Mile Assumptions:**

Street running CBD area, mixed traffic	3.00	minutes	based on TCRP Transit Capacity and Quality of Service Manual
Street running CBD area, exclusive lane	2.00	minutes	based on TCRP Transit Capacity and Quality of Service Manual
Street running (city), mixed traffic	0.90	minutes	based on TCRP Transit Capacity and Quality of Service Manual
Street running (city), mixed traffic with transit priority	0.54	minutes	transit priority assumed to reduce delay by 40%
Street running (city), exclusive lane	0.60	minutes	based on TCRP Transit Capacity and Quality of Service Manual
Street running (city), exclusive lane with transit priority	0.36	minutes	transit priority assumed to reduce delay by 40%

# **Appendix B**

## **BRT and LRT Operating Plans**

**OPERATING STATISTICS MODEL  
BRT OPERATING ASSUMPTIONS**

<b>PERIOD</b>	<b>DURATION (HRS)</b>	<b>DAILY TOTAL (HRS)</b>	<b>REPRESENTATIVE HOURS</b>
WEEKDAY PEAK HOUR	6.0		6am-9am; 3pm-6pm
WEEKDAY BASE HOUR	6.0		9am-3pm
WEEKDAY EVENING HOUR	4.0		5am-6am; 6pm-9pm
WEEKDAY EARLY/LATE HOUR	2.5	18.5	4:30am-5am; 9pm-1am
SATURDAY PEAK HOUR	2.5		6pm-8:30pm
SATURDAY BASE HOUR	12.0		6am-6pm
SATURDAY EARLY/LATE HOUR	2.0	16.5	8:30pm-10:30pm
SUNDAY PEAK HOUR	2.5		6pm-8:30pm
SUNDAY BASE HOUR	12.0		6am-6pm
SUNDAY EARLY/LATE HOUR	2.0	16.5	8:30pm-10:30pm

**ANNUALIZATION FACTORS**

ANNUAL WEEKDAYS	254
ANNUAL SATURDAYS	51
ANNUAL SUNDAYS, HOLIDAYS	60
ANNUAL PEAK	1801.5
ANNUAL BASE	2856
ANNUAL EARLY/LATE	1238

Periods based on Route 522 span of service (March 2007):

5am to 9pm (16 hours) weekday

6am to 8:30pm (14.5 hours) Saturday

currently no Sunday service but assume in future

**SANTA CLARA VALLEY TRANSPORTATION AUTHORITY**  
**Santa Clara-Alum Rock Corridor**

**BRT No Build (Route 522 only, no BRT lane)**

From	To	Run Time (minutes)	Distance (miles)	Headway					Vehicles		Daily		Annual	
				Day	Peak	Base	Eve	E/L	Peak	Total	Veh-Miles	Veh-Hrs	Veh-Miles	Veh-Hrs
<b>FULL ROUTE:</b>														
Palo Alto	Eastridge Mall	100.00	25.9	M-F	15.0	15.0	30.0	####	14	17	2,899.6	196.0	736,500	49,780
				Sat	30.0	15.0	0.0	####			2,486.3	168.0	126,800	8,570
				Sun	30.0	15.0	0.0	####			2,485.0	168.0	149,100	10,080
<b>ESTIMATED TOTALS:</b>								14	17	7,871	532	1,012,400	68,430	
<b>SEGMENT ANALYSIS:</b>														
Palo Alto	Almaden	72.59	19.3	M-F	15.0	15.0	30.0	####	11	13	2,165.0	156.0	549,900	39,620
				Sat	30.0	15.0	0.0	####			1,854.9	132.0	94,600	6,730
				Sun	30.0	15.0	0.0	####			1,855.0	132.0	111,300	7,920
<b>ESTIMATED TOTALS:</b>								11	13	5,875	420	755,800	54,270	

**NOTES:**

- (1) Operating hours and service frequencies consistent with current SCVTA BRT service.
- (2) Distances, run time estimates obtained from transportation demand model.
- (3) Calculated total fleet = peak vehicle requirement \* 1.2 (20% spare ratio).
- (4) Segment analysis from Palo Alto to Almaden for use in isolating costs associated with Santa Clara-Alum Rock segment of route under BRT alternative.

**BRT Alternative (new Route 523; Route 522 uses BRT lane)**

From	To	Run Time (minutes)	Distance (miles)	Headway					Vehicles		Daily		Annual	
				Day	Peak	Base	Eve	E/L	Peak	Total	Veh-Miles	Veh-Hrs	Veh-Miles	Veh-Hrs
Palo Alto	Eastridge Mall	97.97	25.9	M-F	12.0	12.0	30.0	####	18	22	3,520.9	248.0	894,300	62,990
				Sat	30.0	15.0	0.0	####			2,486.3	180.0	126,800	9,180
				Sun	30.0	15.0	0.0	####			2,485.0	180.0	149,100	10,800
Diridon	Eastridge Mall	25.04	7.0	M-F	12.0	12.0	30.0	####	5	6	957.5	68.0	243,200	17,270
				Sat	30.0	15.0	0.0	####			676.5	48.0	34,500	2,450
				Sun	30.0	15.0	0.0	####			676.7	48.0	40,600	2,880
<b>ESTIMATED TOTALS:</b>								23	28	10,803	772	1,488,500	105,570	
<b>Increment over No Build</b>								9	11	2,932	240	476,100	37,140	

**NOTES:**

- (1) Operating hours and service frequencies consistent with current SCVTA BRT service.
- (2) Run time estimate for Route 523 based on CTG travel time model.  
Run time estimate for Route 522 applies incremental travel time improvement of Route 523 to Route 522.
- (3) Calculated total fleet = peak vehicle requirement \* 1.2 (20% spare ratio).

**SANTA CLARA VALLEY TRANSPORTATION AUTHORITY**  
**Santa Clara-Alum Rock Corridor**  
**Additional Detail for Breakout of BRT O&M Components**

**Segment analysis: BRT Route 522 western segment (excludes Almaden-Eastridge)**

From	To	Run Time (minutes)	Distance (miles)	Headway					Vehicles		Daily		Annual	
				Day	Peak	Base	Eve	E/L	Peak	Total	Veh-Miles	Veh-Hrs	Veh-Miles	Veh-Hrs
Palo Alto	Almaden	72.59	19.3	M-F	12.0	12.0	30.0	####	13	16	2,628.7	176.0	667,700	44,700
				Sat	30.0	15.0	0.0	####			1,854.9	132.0	94,600	6,730
				Sun	30.0	15.0	0.0	####			1,855.0	132.0	111,300	7,920
<b>ESTIMATED TOTALS:</b>								13	16	6,339	440	873,600	59,350	
<b>Compared to full route</b>								5	16	2,153	168	296,600	23,620	

NOTES:

- (1) Operating hours and service frequencies consistent with current SCVTA BRT service.
- (2) Distances, run time estimates obtained from transportation demand model.
- (3) Calculated total fleet = peak vehicle requirement \* 1.2 (20% spare ratio).

**New Route 523 only**

From	To	Run Time (minutes)	Distance (miles)	Headway					Vehicles		Daily		Annual	
				Day	Peak	Base	Eve	E/L	Peak	Total	Veh-Miles	Veh-Hrs	Veh-Miles	Veh-Hrs
Diridon	Eastridge Mall	25.04	7.0	M-F	12.0	12.0	30.0	####	5	6	957.5	68.0	243,200	17,270
				Sat	30.0	15.0	0.0	####			676.5	48.0	34,500	2,450
				Sun	30.0	15.0	0.0	####			676.7	48.0	40,600	2,880
<b>ESTIMATED TOTALS:</b>								5	6	2,311	164	318,300	22,600	

NOTES:

- (1) Operating hours and service frequencies consistent with current SCVTA BRT service.
- (2) Run time estimate for Route 523 based on CTG travel time model.
- (3) Calculated total fleet = peak vehicle requirement \* 1.2 (20% spare ratio).

**OPERATING STATISTICS MODEL  
LRT OPERATING ASSUMPTIONS**

<b>PERIOD</b>	<b>DURATION (HRS)</b>	<b>DAILY TOTAL (HRS)</b>	<b>REPRESENTATIVE HOURS</b>
WEEKDAY PEAK HOUR	7.0		6am-9am; 3pm-7pm
WEEKDAY BASE HOUR	6.0		9am-3pm
WEEKDAY EVENING HOUR	3.5		7pm-10:30pm
WEEKDAY EARLY/LATE HOUR	4.0	20.5	4:30am-6am; 10:30pm-1am
SATURDAY PEAK HOUR	3.0		6am-7am; 10:30pm-12:30am
SATURDAY BASE HOUR	15.5		7am-10:30pm
SATURDAY EARLY/LATE HOUR	2.0	20.5	4:30am-6am; 12:30am-1am
SUNDAY PEAK HOUR	3.0		6am-7am; 10:30pm-12:30am
SUNDAY BASE HOUR	15.5		7am-10:30pm
SUNDAY EARLY/LATE HOUR	2.0	20.5	4:30am-6am; 12:30am-1am

**ANNUALIZATION FACTORS**

ANNUAL WEEKDAYS	254
ANNUAL SATURDAYS	51
ANNUAL SUNDAYS, HOLIDAYS	60
ANNUAL PEAK	2111
ANNUAL BASE	3244.5
ANNUAL EARLY/LATE	1111

Updated based on May 15, 2007 schedules

**SANTA CLARA VALLEY TRANSPORTATION AUTHORITY**  
**Santa Clara-Alum Rock Corridor**

**LRT No Build**

From	To	Run Time (minutes)	Distance (miles)	Headway					Consist				Vehicles		Daily		Annual	
				Day	Peak	Base	Eve	E/L	Peak	Base	Eve	E/L	Peak	Total	Car-Miles	Train-Hrs	Car-Miles	Train-Hrs
Santa Teresa	Eastridge Mall	78.6	27.7	M-F	15.0	15.0	15.0	30.0	3.0	3.0	2.0	1.0	36	44	10,640.6	222.0	2,702,700	56,390
				Sat	30.0	15.0	0.0	20.0	1.0	2.0	0.0	1.0			7,537.3	222.0	384,400	11,320
				Sun	30.0	15.0	0.0	20.0	1.0	2.0	0.0	1.0	7,536.7	222.0	452,200	13,320		
Almaden	Chynoweth	4.3	1.2	M-F	15.0	15.0	15.0	####	1.0	1.0	1.0	1.0	1	2	158.3	16.5	40,200	4,190
				Sat	0.0	15.0	0.0	####	0.0	1.0	0.0	0.0			149.0	15.5	7,600	790
				Sun	0.0	15.0	0.0	####	0.0	1.0	0.0	0.0	148.3	15.5	8,900	930		
Downtown Mountainview	Vasona Junction	79.05	23.2	M-F	15.0	15.0	15.0	30.0	3.0	3.0	2.0	1.0	36	44	8,901.2	222.0	2,260,900	56,390
				Sat	30.0	30.0	0.0	####	1.0	1.0	0.0	0.0			1,715.7	111.0	87,500	5,660
				Sun	30.0	30.0	0.0	####	1.0	1.0	0.0	0.0	1,715.0	111.0	102,900	6,660		
<b>ESTIMATED TOTALS:</b>												<b>73</b>	<b>90</b>	<b>38,502</b>	<b>1,157</b>	<b>6,047,300</b>	<b>155,650</b>	

- (1) Operating hours and service frequencies consistent with current SCVTA service.
- (2) Peak period train consists sized according to May 1, 2007 SVRTC No Build peak hour load reports (adjusted).
- (3) Distances, run time estimates obtained from CTG travel time worksheets.
- (4) Calculated total fleet = peak vehicle requirement \* 1.2 (20% spare ratio).
- (5) Peak hour loads for Santa Teresa-Eastridge Mall exceed acceptable load standards.  
 Consists set at maximum allowed under current design.

**SANTA CLARA VALLEY TRANSPORTATION AUTHORITY**  
**Santa Clara-Alum Rock Corridor**

**LRT Alternative**

From	To	Run Time (minutes)	Distance (miles)	Headway					Consist				Vehicles		Daily		Annual		
				Day	Peak	Base	Eve	E/L	Peak	Base	Eve	E/L	Peak	Total	Car-Miles	Train-Hrs	Car-Miles	Train-Hrs	
Santa Teresa	Eastridge Mall	78.6	27.7	M-F	15.0	15.0	15.0	30.0	3.0	3.0	2.0	1.0	36	44	10,640.6	222.0	2,702,700	56,390	
				Sat	30.0	15.0	0.0	20.0	1.0	2.0	0.0	1.0			7,537.3	222.0	384,400	11,320	
				Sun	30.0	15.0	0.0	20.0	1.0	2.0	0.0	1.0			7,536.7	222.0	452,200	13,320	
Almaden	Chynoweth	4.3	1.2	M-F	15.0	15.0	15.0	####	1.0	1.0	1.0	1.0	1	2	158.3	16.5	40,200	4,190	
				Sat	0.0	15.0	0.0	####	0.0	1.0	0.0	0.0			149.0	15.5	7,600	790	
				Sun	0.0	15.0	0.0	####	0.0	1.0	0.0	0.0			148.3	15.5	8,900	930	
Downtown Mountainview	Vasona Junction	79.05	23.2	M-F	15.0	15.0	15.0	30.0	3.0	3.0	2.0	1.0	36	44	8,901.2	222.0	2,260,900	56,390	
				Sat	30.0	30.0	0.0	####	1.0	1.0	0.0	0.0			1,715.7	111.0	87,500	5,660	
				Sun	30.0	30.0	0.0	####	1.0	1.0	0.0	0.0			1,715.0	111.0	102,900	6,660	
Diridon	Eastridge Mall	27.03	7.4	M-F	15.0	15.0	30.0	####	1.0	1.0	1.0	0.0	5	6	869.7	75.5	220,900	19,180	
				Sat	0.0	15.0	0.0	30.0	0.0	1.0	0.0	1.0			972.5	83.5	49,600	4,260	
				Sun	0.0	15.0	0.0	30.0	0.0	1.0	0.0	1.0			973.3	83.5	58,400	5,010	
<b>ESTIMATED TOTALS:</b>												<b>78</b>	<b>96</b>	<b>41,318</b>	<b>1,400</b>	<b>6,376,200</b>	<b>184,100</b>		
												<b>Increment over No Build</b>		<b>5</b>	<b>6</b>	<b>2,816</b>	<b>243</b>	<b>328,900</b>	<b>28,450</b>

- (1) Operating hours and service frequencies consistent with current SCVTA service.
- (2) Peak period train consists for base LRT system sized according to May 1, 2007 SVRTC 2030 No Build peak hour load reports (adjusted).
- (3) Peak period train consist for Santa Clara-Alum Rock LRT set to 1, per engineering design concept.
- (4) Distances, run time estimates obtained from CTG travel time worksheets.
- (5) Calculated total fleet = peak vehicle requirement \* 1.2 (20% spare ratio).
- (6) Peak hour loads for Santa Teresa-Eastridge Mall exceed acceptable load standards. Peak hour loads for Santa Clara-Alum Rock LRT require 1.4-car trains. Consists set at maximum allowed under current design.

# Appendix C

## Summary of O&M Statistics

# Santa Clara-Alum Rock Corridor O&M Statistics and Costs

O&M Modeling Statistics by Alternative		15 MIN NO BUILD - August 2007								
		2030 1a	2030 1b	2030 1c	2030 2	2030 3	2030 4	2030 4a	2030 5	
Target Year	ALTERNATIVE									
Description	Year 2000 Run Date	No Build Base (no 522 or 523) 8/27/2007	No Build with Rte 522 (15 min) 8/27/2007	No Build with Rte 522 west end 8/27/2007	LRT 8/27/2007	BRT (522, 523) 8/27/2007	BRT (522 only) 8/27/2007	BRT (522 west end) 8/27/2007	BRT (523 only) 8/27/2007	
<b>VTA</b>										
<b>OPERATING DIVISIONS (SYSTEMWIDE)</b>										
Bus	3	3	3	3	3	3	3	3	3	
LRT	1	1	1	1	1	1	1	1	1	
Joint bus and LRT (future yard at Sta Teresa stn)	0	1	1	1	1	1	1	1	1	
<b>BUS (SYSTEMWIDE)</b>										
Annual boardings	47,654,687	70,405,370	71,736,529	71,403,739	71,736,529	73,144,754	71,736,529	71,403,739	73,144,754	
Peak buses	456	417	431	428	431	440	435	430	436	
Active fleet buses	547	500	517	514	517	528	522	516	523	
Annual rev. veh. miles	19,621,805	18,684,478	19,696,878	19,440,278	19,696,878	20,172,978	19,854,678	19,558,078	20,015,178	
Annual rev. veh. hours	1,518,118	1,253,344	1,321,774	1,307,614	1,321,774	1,358,914	1,336,314	1,312,694	1,344,374	
ARTIC annual rev. veh. miles			1,012,400	755,800	1,012,400	1,488,500	1,170,200	873,600	1,330,700	
<b>LRT (SYSTEMWIDE)</b>										
Annual boardings	7,913,730	30,128,314	30,128,314	30,128,314	32,707,382	30,128,314	30,128,314	30,128,314	30,128,314	
Peak vehicles	43	73	73	73	78	73	73	73	73	
Active fleet vehicles	51	90	90	90	96	90	90	90	90	
Annual revenue car-miles	2,971,900	6,047,300	6,047,300	6,047,300	6,376,200	6,047,300	6,047,300	6,047,300	6,047,300	
Annual revenue train hours	124,560	155,650	155,650	155,650	184,100	155,650	155,650	155,650	155,650	
Route miles (owned directional)	56	86	86	86	96	86	86	86	86	
Total stations	48	71	71	71	79	71	71	71	71	
Elevated stations	8	12	12	12	12	12	12	12	12	
At-grade stations	40	59	59	59	67	59	59	59	59	
Subway stations	0	0	0	0	0	0	0	0	0	
<b>LRT: (GUADALUPE) SANTA TERESA - EASTRIDGE STA TSA-BVPT</b>										
Annual boardings										
Peak vehicles	32	36	36	36	36	36	36	36	36	
Active fleet vehicles	38	44	44	44	44	44	44	44	44	
Annual revenue car-miles	2,172,600	3,539,300	3,539,300	3,539,300	3,539,300	3,539,300	3,539,300	3,539,300	3,539,300	
Annual revenue train hours	63,540	81,030	81,030	81,030	81,030	81,030	81,030	81,030	81,030	
Route miles (owned directional)	33.6	55.4	55.4	55.4	55.4	55.4	55.4	55.4	55.4	
Total stations	29	43	43	43	43	43	43	43	43	
Elevated stations	8	12	12	12	12	12	12	12	12	
At-grade stations	21	31	31	31	31	31	31	31	31	
Subway stations	0	0	0	0	0	0	0	0	0	
<b>LRT: (ALMADEN) ALMADEN - CHYNOWETH</b>										
Annual boardings										
Peak vehicles	2	1	1	1	1	1	1	1	1	
Active fleet vehicles	2	2	2	2	2	2	2	2	2	
Annual revenue car-miles	79,900	56,700	56,700	56,700	56,700	56,700	56,700	56,700	56,700	
Annual revenue train hours	13,360	5,910	5,910	5,910	5,910	5,910	5,910	5,910	5,910	
Route miles (owned directional)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	
Total stations	2	2	2	2	2	2	2	2	2	
Elevated stations	0	0	0	0	0	0	0	0	0	
At-grade stations	2	2	2	2	2	2	2	2	2	
Subway stations	0	0	0	0	0	0	0	0	0	
<b>LRT: (TASMAN-VASONA) MOUNTAINVIEW - VAS</b>										
Annual boardings										
Peak vehicles	9	36	36	36	36	36	36	36	36	
Active fleet vehicles	11	44	44	44	44	44	44	44	44	
Annual revenue car-miles	719,400	2,451,300	2,451,300	2,451,300	2,451,300	2,451,300	2,451,300	2,451,300	2,451,300	
Annual revenue train hours	47,660	68,710	68,710	68,710	68,710	68,710	68,710	68,710	68,710	
Route miles (owned directional)	21.5	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	
Total stations	17	26	26	26	26	26	26	26	26	
Elevated stations	0	0	0	0	0	0	0	0	0	
At-grade stations	17	26	26	26	26	26	26	26	26	
Subway stations	0	0	0	0	0	0	0	0	0	
<b>LRT: (SANTA CLARA/ALUM ROCK) DIRIDON - EA</b>										
Annual boardings										
Peak vehicles		0	0	0	5	0	0	0	0	
Active fleet vehicles		0	0	0	6	0	0	0	0	
Annual revenue car-miles		0	0	0	328,900	0	0	0	0	
Annual revenue train hours		0	0	0	28,450	0	0	0	0	
Route miles (owned directional)		0.0	0.0	0.0	9.9	0.0	0.0	0.0	0.0	
Total stations		0	0	0	8	0	0	0	0	
Elevated stations		0	0	0	0	0	0	0	0	
At-grade stations		0	0	0	8	0	0	0	0	
Subway stations		0	0	0	0	0	0	0	0	

# Appendix D

## O&M Cost Model Detail



**SANTA CLARA-ALUM ROCK CORRIDOR  
O&M Cost Summary**

**VTA O&M Cost Model Results in 2005 Dollars**

Mode/Operator	Alternative							
	No Project Base	No Project	No Project, Rte 522 west segment only	LRT	BRT - Rte 522 upgrade	BRT - Rte 522 (west segment)	BRT - Rte 523	BRT - Rte 522 & 523
<b>O&amp;M Costs:</b>								
Motor Bus	\$157,336,300	\$165,366,600	\$163,419,100	\$165,366,600	\$166,752,800	\$163,972,300	\$167,659,800	\$169,228,800
BRT station maintenance					\$183,150		\$183,150	\$366,300
Total Motor Bus	\$157,336,300	\$165,366,600	\$163,419,100	\$165,366,600	\$166,935,950	\$163,972,300	\$167,842,950	\$169,595,100
Light Rail	\$71,746,000	\$71,746,000	\$71,746,000	\$78,187,200	\$71,746,000	\$71,746,000	\$71,746,000	\$71,746,000
General & Administrative	\$96,629,000	\$97,132,800	\$97,034,100	\$98,731,500	\$97,201,700	\$97,063,300	\$97,304,400	\$97,377,600
Operations Administration	\$99,117,300	\$100,941,500	\$100,365,200	\$103,983,100	\$101,229,600	\$100,686,500	\$101,397,000	\$101,719,100
<b>TOTAL</b>	<b>\$424,828,600</b>	<b>\$435,186,900</b>	<b>\$432,564,400</b>	<b>\$446,268,400</b>	<b>\$437,113,250</b>	<b>\$433,468,100</b>	<b>\$438,290,350</b>	<b>\$440,437,800</b>
<b>O&amp;M Cost vs. No Project</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>\$11,081,500</b>	<b>\$1,926,350</b>		<b>\$3,103,450</b>	<b>\$5,250,900</b>

Notes:

- BRT station maintenance assumed to be similar to marginal cost of LRT station maintenance
- Cost per station: \$33,300 (used to calculate BRT - Rte 522 & 523 combined)
- Prorated (50%) cost per station: \$16,650 (used to calculate BRT - Rte 522 upgrade and BRT - Rte 523)

**O&M Costs in 2007 Dollars**

(Escalates O&M cost model results in 2005 dollars and splits out cost of Route 522 outside study corridor versus within study corridor)

Mode/Operator	Alternative							
	No Project Base	No Project	No Project, Rte 522 west segment only	LRT	BRT - Rte 522 upgrade	BRT - Rte 522 (west segment)	BRT - Rte 523	BRT - Rte 522 & 523
<b>O&amp;M Costs:</b>								
Motor Bus	\$166,593,500	\$175,096,300	\$173,034,200	\$175,096,300	\$176,758,000	\$173,619,900	\$177,718,300	\$179,573,600
Light Rail	\$75,967,300	\$75,967,300	\$75,967,300	\$82,787,500	\$75,967,300	\$75,967,300	\$75,967,300	\$75,967,300
General & Administrative	\$102,314,400	\$102,847,800	\$102,743,300	\$104,540,600	\$102,920,800	\$102,774,200	\$103,029,500	\$103,107,000
Operations Administration	\$104,949,100	\$106,880,600	\$106,270,400	\$110,101,200	\$107,185,600	\$106,610,600	\$107,362,900	\$107,703,900
<b>TOTAL</b>	<b>\$449,824,300</b>	<b>\$460,792,000</b>	<b>\$458,015,200</b>	<b>\$472,525,600</b>	<b>\$462,831,700</b>	<b>\$458,972,000</b>	<b>\$464,078,000</b>	<b>\$466,351,800</b>
<b>Cost of Route 522 - full route</b>		<b>\$10,967,700</b>						
Cost of Route 522 west end		\$8,190,900			\$956,800			
Cost of Route 522 east end		\$2,776,800			\$1,082,900			
<b>O&amp;M Cost vs. No Project</b>	<b>N/A</b>	<b>N/A</b>		<b>\$11,733,600</b>	<b>\$2,039,700</b>		<b>\$3,286,000</b>	<b>\$5,559,800</b>

NOTES:

- Alternatives based on fewer stations (BRT also excludes Alameda).
- BRT incremental costs based on introducing new Route 523, time savings for existing Route 522, and headway improvement from 15 minutes to 12 minutes on Route 522.
- O&M cost estimates based on SVTA O&M 2005 v7 cost model (calibrated to VTA FY2005 budget).
- Escalation from 2005 dollars based on CPI for San Francisco Bay Area (2.7% from FY2005-2006 and 3.1% from FY2006-2007).
- O&M Cost Model estimates systemwide costs. Systemwide bus statistics based on 2030 No Build for SVRTC (May 1, 2007 transportation demand model run). Systemwide LRT statistics calculated by CTG, based on 2030 LRT network.
- BRT costs assume articulated (but not hybrid) buses. (Data for hybrid vehicles show disproportionately high costs since new to VTA fleet; would stabilize over time.) Future versions of SVTA O&M cost model will attempt to address hybrid mode.
- Columns in light gray are only provided to calculate segment data for Route 522, and are not alternatives in and of themselves.
- Route 522 west end is portion of route west of the Santa Clara-Alum Rock corridor. Route 522 east end is the portion along the Santa Clara-Alum Rock corridor.
- Costs for BRT - Route 522 upgrade reflect additional costs over Route 522 in No Project; that is, costs reflect headway improvement over entire route, and time savings for Santa Clara-Alum Rock portion of route.



## O & M COST MODEL

### System Characteristics & Cost Summary

**Santa Clara-Alum Rock - No Project Base**  
Year 2030

System Characteristic	Driving Variable	Input Value	Units
<b>MOTOR BUS:</b>			
Annual Boardings (Unlinked Trips)	BUSPASS	70.4	million
Peak Buses	PKBUS	417	
Active Fleet Buses	TOTBUS	526	
Operating Divisions	GARAGE	4	
Annual Revenue Vehicle-Miles	BUSMILE	18.68	million
Annual Revenue Vehicle-Hours	BUSHOUR	1.25	million

<b>LIGHT RAIL:</b>			
Annual Boardings (Unlinked Trips)	L RTPASS	30.1	million
Directional Track Miles	TRACKMILE	86	
Total Stations	STATION	71	
Elevated Stations	AERIAL	12	
At-Grade Stations	ATGRADE	59	
Subway Stations	SUBWAY	0	
Peak Vehicles	PEAKCAR	73	
Active Fleet Vehicles	TOTALCAR	90	
Operating Divisions	DIVISION	2	
Annual Revenue Car Miles	CARMILE	6.05	million
Annual Revenue Train Hours	TRAINHOUR	155.7	thousand

SUMMARY RESULTS				
Mode	Labor	Non-Labor	TOTAL	FTEs
<b>TOTAL:</b>	<b>\$293,901,309</b>	<b>\$148,838,767</b>	<b>\$424,828,549</b>	<b>2,746</b>
Motor Bus	\$137,175,307	\$20,160,974	\$157,336,281	1,260
Light Rail	\$55,037,995	\$16,707,996	\$71,745,991	506
General & Administrative	\$59,078,553	\$37,550,413	\$96,628,967	603
Operations Administration	\$42,609,454	\$74,419,383	\$99,117,310	377

<b>INCREMENTAL (compared to Calibration System):</b>		<b>\$97,413,201</b>	<b>604</b>
Motor Bus		\$14,647,272	93
Light Rail		\$37,058,600	219
General & Administrative		\$26,783,626	216
Operations Administration		\$18,923,703	76

Mode	Total Cost per Revenue:		
	Bus/ Train Hour	Bus/ Car Mile	Passenger
Motor Bus	\$125.53	\$8.42	\$2.23
Light Rail	\$460.94	\$11.86	\$2.38

NOTES:

All costs in FY2005 dollars.



## O & M COST MODEL

### System Characteristics & Cost Summary

**Santa Clara-Alum Rock - No Project + Route 522 (all)**  
 Year 2030

System Characteristic	Driving Variable	Input Value	Units
<b>MOTOR BUS:</b>			
Annual Boardings (Unlinked Trips)	BUSPASS	71.7	million
Peak Buses	PKBUS	431	
Active Fleet Buses	TOTBUS	526	
Operating Divisions	GARAGE	4	
Annual Revenue Vehicle-Miles	BUSMILE	19.70	million
Annual Revenue Vehicle-Hours	BUSHOUR	1.32	million

<b>LIGHT RAIL:</b>			
Annual Boardings (Unlinked Trips)	L RTPASS	30.1	million
Directional Track Miles	TRACKMILE	86	
Total Stations	STATION	71	
Elevated Stations	AERIAL	12	
At-Grade Stations	ATGRADE	59	
Subway Stations	SUBWAY	0	
Peak Vehicles	PEAKCAR	73	
Active Fleet Vehicles	TOTALCAR	90	
Operating Divisions	DIVISION	2	
Annual Revenue Car Miles	CARMILE	6.05	million
Annual Revenue Train Hours	TRAINHOUR	155.7	thousand

SUMMARY RESULTS				
Mode	Labor	Non-Labor	TOTAL	FTEs
<b>TOTAL:</b>	<b>\$301,477,763</b>	<b>\$151,414,930</b>	<b>\$435,186,868</b>	<b>2,813</b>
Motor Bus	\$144,345,743	\$21,020,816	<b>\$165,366,559</b>	1,323
Light Rail	\$55,037,995	\$16,707,996	<b>\$71,745,991</b>	506
General & Administrative	\$59,154,173	\$37,978,653	<b>\$97,132,826</b>	604
Operations Administration	\$42,939,852	\$75,707,465	<b>\$100,941,491</b>	380

<b>INCREMENTAL (compared to Calibration System):</b>		<b>\$107,771,520</b>	<b>671</b>
Motor Bus		\$22,677,549	157
Light Rail		\$37,058,600	219
General & Administrative		\$27,287,485	217
Operations Administration		\$20,747,885	79

Mode	Total Cost per Revenue:		
	Bus/ Train Hour	Bus/ Car Mile	Passenger
Motor Bus	\$125.11	\$8.40	\$2.31
Light Rail	\$460.94	\$11.86	\$2.38

NOTES:

All costs in FY2005 dollars.



## O & M COST MODEL

### System Characteristics & Cost Summary

**Santa Clara-Alum Rock - No Project + Route 522 (west segment)**  
 Year 2030

System Characteristic	Driving Variable	Input Value	Units
<b>MOTOR BUS:</b>			
Annual Boardings (Unlinked Trips)	BUSPASS	71.4	million
Peak Buses	PKBUS	428	
Active Fleet Buses	TOTBUS	526	
Operating Divisions	GARAGE	4	
Annual Revenue Vehicle-Miles	BUSMILE	19.44	million
Annual Revenue Vehicle-Hours	BUSHOUR	1.31	million

<b>LIGHT RAIL:</b>			
Annual Boardings (Unlinked Trips)	L RTPASS	30.1	million
Directional Track Miles	TRACKMILE	86	
Total Stations	STATION	71	
Elevated Stations	AERIAL	12	
At-Grade Stations	ATGRADE	59	
Subway Stations	SUBWAY	0	
Peak Vehicles	PEAKCAR	73	
Active Fleet Vehicles	TOTALCAR	90	
Operating Divisions	DIVISION	2	
Annual Revenue Car Miles	CARMILE	6.05	million
Annual Revenue Train Hours	TRAINHOUR	155.7	thousand

SUMMARY RESULTS				
Mode	Labor	Non-Labor	TOTAL	FTEs
<b>TOTAL:</b>	<b>\$299,567,197</b>	<b>\$150,701,870</b>	<b>\$432,564,461</b>	<b>2,797</b>
Motor Bus	\$142,656,109	\$20,762,986	<b>\$163,419,095</b>	1,309
Light Rail	\$55,037,995	\$16,707,996	<b>\$71,745,991</b>	506
General & Administrative	\$59,154,173	\$37,879,952	<b>\$97,034,126</b>	604
Operations Administration	\$42,718,920	\$75,350,935	<b>\$100,365,249</b>	378

<b>INCREMENTAL (compared to Calibration System):</b>		<b>\$105,149,113</b>	<b>655</b>
Motor Bus		\$20,730,086	142
Light Rail		\$37,058,600	219
General & Administrative		\$27,188,785	217
Operations Administration		\$20,171,642	77

Mode	Total Cost per Revenue:		
	Bus/ Train Hour	Bus/ Car Mile	Passenger
Motor Bus	\$124.98	\$8.41	\$2.29
Light Rail	\$460.94	\$11.86	\$2.38

NOTES:

All costs in FY2005 dollars.



## O & M COST MODEL

### System Characteristics & Cost Summary

**Santa Clara-Alum Rock - Rte 522 BRT only (articulated vehicles)**  
 Year 2030

System Characteristic	Driving Variable	Input Value	Units
<b>MOTOR BUS:</b>			
Annual Boardings (Unlinked Trips)	BUSPASS	71.7	million
Peak Buses	PKBUS	435	
Active Fleet Buses	TOTBUS	522	
Operating Divisions	GARAGE	4	
Annual Revenue Vehicle-Miles	BUSMILE	19.85	million
Annual Revenue Vehicle-Hours	BUSHOUR	1.34	million

<b>LIGHT RAIL:</b>			
Annual Boardings (Unlinked Trips)	L RTPASS	30.1	million
Directional Track Miles	TRACKMILE	86	
Total Stations	STATION	71	
Elevated Stations	AERIAL	12	
At-Grade Stations	ATGRADE	59	
Subway Stations	SUBWAY	0	
Peak Vehicles	PEAKCAR	73	
Active Fleet Vehicles	TOTALCAR	90	
Operating Divisions	DIVISION	2	
Annual Revenue Car Miles	CARMILE	6.05	million
Annual Revenue Train Hours	TRAINHOUR	155.7	thousand

SUMMARY RESULTS				
Mode	Labor	Non-Labor	TOTAL	FTEs
<b>TOTAL:</b>	<b>\$302,713,313</b>	<b>\$151,877,606</b>	<b>\$436,930,047</b>	<b>2,824</b>
Motor Bus	\$145,569,489	\$21,183,291	<b>\$166,752,780</b>	1,334
Light Rail	\$55,037,995	\$16,707,996	<b>\$71,745,991</b>	506
General & Administrative	\$59,154,173	\$38,047,516	<b>\$97,201,689</b>	604
Operations Administration	\$42,951,656	\$75,938,803	<b>\$101,229,586</b>	380

<b>INCREMENTAL (compared to Calibration System):</b>		<b>\$109,514,699</b>	<b>682</b>
Motor Bus		\$24,063,771	168
Light Rail		\$37,058,600	219
General & Administrative		\$27,356,349	217
Operations Administration		\$21,035,980	79

Mode	Total Cost per Revenue:		
	Bus/ Train Hour	Bus/ Car Mile	Passenger
Motor Bus	\$124.79	\$8.40	\$2.32
Light Rail	\$460.94	\$11.86	\$2.38

NOTES:

All costs in FY2005 dollars.



## O & M COST MODEL

### System Characteristics & Cost Summary

**Santa Clara-Alum Rock - Rte 522 BRT only (west segment, articulated vehicles)**

Year 2030

System Characteristic	Driving Variable	Input Value	Units
<b>MOTOR BUS:</b>			
Annual Boardings (Unlinked Trips)	BUSPASS	71.4	million
Peak Buses	PKBUS	430	
Active Fleet Buses	TOTBUS	516	
Operating Divisions	GARAGE	4	
Annual Revenue Vehicle-Miles	BUSMILE	19.56	million
Annual Revenue Vehicle-Hours	BUSHOUR	1.31	million

<b>LIGHT RAIL:</b>			
Annual Boardings (Unlinked Trips)	L RTPASS	30.1	million
Directional Track Miles	TRACKMILE	86	
Total Stations	STATION	71	
Elevated Stations	AERIAL	12	
At-Grade Stations	ATGRADE	59	
Subway Stations	SUBWAY	0	
Peak Vehicles	PEAKCAR	73	
Active Fleet Vehicles	TOTALCAR	90	
Operating Divisions	DIVISION	2	
Annual Revenue Car Miles	CARMILE	6.05	million
Annual Revenue Train Hours	TRAINHOUR	155.7	thousand

SUMMARY RESULTS				
Mode	Labor	Non-Labor	TOTAL	FTEs
<b>TOTAL:</b>	<b>\$300,257,757</b>	<b>\$150,903,759</b>	<b>\$433,468,111</b>	<b>2,803</b>
Motor Bus	\$143,137,607	\$20,834,729	\$163,972,336	1,313
Light Rail	\$55,037,995	\$16,707,996	\$71,745,991	506
General & Administrative	\$59,154,173	\$37,909,154	\$97,063,328	604
Operations Administration	\$42,927,981	\$75,451,879	\$100,686,455	380

<b>INCREMENTAL (compared to Calibration System):</b>		<b>\$106,052,763</b>	<b>661</b>
Motor Bus		\$21,283,327	146
Light Rail		\$37,058,600	219
General & Administrative		\$27,217,987	217
Operations Administration		\$20,492,849	79

Mode	Total Cost per Revenue:		
	Bus/ Train Hour	Bus/ Car Mile	Passenger
Motor Bus	\$124.91	\$8.38	\$2.30
Light Rail	\$460.94	\$11.86	\$2.38

NOTES:

All costs in FY2005 dollars.



## O & M COST MODEL

### System Characteristics & Cost Summary

**Santa Clara-Alum Rock - Rte 523 BRT only (articulated vehicles)**  
 Year 2030

System Characteristic	Driving Variable	Input Value	Units
<b>MOTOR BUS:</b>			
Annual Boardings (Unlinked Trips)	BUSPASS	73.1	million
Peak Buses	PKBUS	436	
Active Fleet Buses	TOTBUS	523	
Operating Divisions	GARAGE	4	
Annual Revenue Vehicle-Miles	BUSMILE	20.02	million
Annual Revenue Vehicle-Hours	BUSHOUR	1.34	million

<b>LIGHT RAIL:</b>			
Annual Boardings (Unlinked Trips)	L RTPASS	30.1	million
Directional Track Miles	TRACKMILE	86	
Total Stations	STATION	71	
Elevated Stations	AERIAL	12	
At-Grade Stations	ATGRADE	59	
Subway Stations	SUBWAY	0	
Peak Vehicles	PEAKCAR	73	
Active Fleet Vehicles	TOTALCAR	90	
Operating Divisions	DIVISION	2	
Annual Revenue Car Miles	CARMILE	6.05	million
Annual Revenue Train Hours	TRAINHOUR	155.7	thousand

SUMMARY RESULTS				
Mode	Labor	Non-Labor	TOTAL	FTEs
<b>TOTAL:</b>	<b>\$303,433,079</b>	<b>\$152,473,131</b>	<b>\$438,107,291</b>	<b>2,830</b>
Motor Bus	\$146,281,532	\$21,378,301	<b>\$167,659,833</b>	1,340
Light Rail	\$55,037,995	\$16,707,996	<b>\$71,745,991</b>	506
General & Administrative	\$59,154,173	\$38,150,268	<b>\$97,304,441</b>	604
Operations Administration	\$42,959,379	\$76,236,565	<b>\$101,397,025</b>	380

<b>INCREMENTAL (compared to Calibration System):</b>		<b>\$110,691,943</b>	<b>688</b>
Motor Bus		\$24,970,824	174
Light Rail		\$37,058,600	219
General & Administrative		\$27,459,101	217
Operations Administration		\$21,203,419	79

Mode	Total Cost per Revenue:		
	Bus/ Train Hour	Bus/ Car Mile	Passenger
Motor Bus	\$124.71	\$8.38	\$2.29
Light Rail	\$460.94	\$11.86	\$2.38

NOTES:

All costs in FY2005 dollars.



## O & M COST MODEL

### System Characteristics & Cost Summary

**Santa Clara-Alum Rock - Rte 522 and 523 BRT (articulated vehicles)**  
 Year 2030

System Characteristic	Driving Variable	Input Value	Units
<b>MOTOR BUS:</b>			
Annual Boardings (Unlinked Trips)	BUSPASS	73.1	million
Peak Buses	PKBUS	440	
Active Fleet Buses	TOTBUS	528	
Operating Divisions	GARAGE	4	
Annual Revenue Vehicle-Miles	BUSMILE	20.17	million
Annual Revenue Vehicle-Hours	BUSHOUR	1.36	million

<b>LIGHT RAIL:</b>			
Annual Boardings (Unlinked Trips)	L RTPASS	30.1	million
Directional Track Miles	TRACKMILE	86	
Total Stations	STATION	71	
Elevated Stations	AERIAL	12	
At-Grade Stations	ATGRADE	59	
Subway Stations	SUBWAY	0	
Peak Vehicles	PEAKCAR	73	
Active Fleet Vehicles	TOTALCAR	90	
Operating Divisions	DIVISION	2	
Annual Revenue Car Miles	CARMILE	6.05	million
Annual Revenue Train Hours	TRAINHOUR	155.7	thousand

<b>SUMMARY RESULTS</b>				
Mode	Labor	Non-Labor	TOTAL	FTEs
<b>TOTAL:</b>	<b>\$304,786,783</b>	<b>\$153,076,730</b>	<b>\$440,071,470</b>	<b>2,842</b>
Motor Bus	\$147,621,876	\$21,606,955	\$169,228,831	1,352
Light Rail	\$55,037,995	\$16,707,996	\$71,745,991	506
General & Administrative	\$59,154,173	\$38,223,413	\$97,377,587	604
Operations Administration	\$42,972,738	\$76,538,365	\$101,719,061	380

<b>INCREMENTAL (compared to Calibration System):</b>		<b>\$112,656,122</b>	<b>700</b>
Motor Bus		\$26,539,821	186
Light Rail		\$37,058,600	219
General & Administrative		\$27,532,246	217
Operations Administration		\$21,525,455	79

Mode	Total Cost per Revenue:		
	Bus/ Train Hour	Bus/ Car Mile	Passenger
Motor Bus	\$124.53	\$8.39	\$2.31
Light Rail	\$460.94	\$11.86	\$2.38

NOTES:

All costs in FY2005 dollars.



## O & M COST MODEL

### System Characteristics & Cost Summary

**Santa Clara-Alum Rock - LRT**  
Year 2030

System Characteristic	Driving Variable	Input Value	Units
<b>MOTOR BUS:</b>			
Annual Boardings (Unlinked Trips)	BUSPASS	71.7	million
Peak Buses	PKBUS	431	
Active Fleet Buses	TOTBUS	526	
Operating Divisions	GARAGE	4	
Annual Revenue Vehicle-Miles	BUSMILE	19.70	million
Annual Revenue Vehicle-Hours	BUSHOUR	1.32	million

<b>LIGHT RAIL:</b>			
Annual Boardings (Unlinked Trips)	LRTPASS	32.7	million
Directional Track Miles	TRACKMILE	96	
Total Stations	STATION	79	
Elevated Stations	AERIAL	12	
At-Grade Stations	ATGRADE	67	
Subway Stations	SUBWAY	0	
Peak Vehicles	PEAKCAR	78	
Active Fleet Vehicles	TOTALCAR	96	
Operating Divisions	DIVISION	2	
Annual Revenue Car Miles	CARMILE	6.38	million
Annual Revenue Train Hours	TRAINHOUR	184.1	thousand

SUMMARY RESULTS				
Mode	Labor	Non-Labor	TOTAL	FTEs
<b>TOTAL:</b>	<b>\$309,262,987</b>	<b>\$154,788,074</b>	<b>\$446,268,396</b>	<b>2,893</b>
Motor Bus	\$144,345,743	\$21,020,816	<b>\$165,366,559</b>	1,323
Light Rail	\$60,393,988	\$17,793,209	<b>\$78,187,196</b>	561
General & Administrative	\$60,151,521	\$38,580,012	<b>\$98,731,533</b>	616
Operations Administration	\$44,371,736	\$77,394,037	<b>\$103,983,108</b>	393

<b>INCREMENTAL (compared to Calibration System):</b>		<b>\$118,853,048</b>	<b>751</b>
Motor Bus		\$22,677,549	157
Light Rail		\$43,499,805	274
General & Administrative		\$28,886,192	229
Operations Administration		\$23,789,502	92

Mode	Total Cost per Revenue:		
	Bus/ Train Hour	Bus/ Car Mile	Passenger
Motor Bus	\$125.11	\$8.40	\$2.31
Light Rail	\$424.70	\$12.26	\$2.39

NOTES:

All costs in FY2005 dollars.